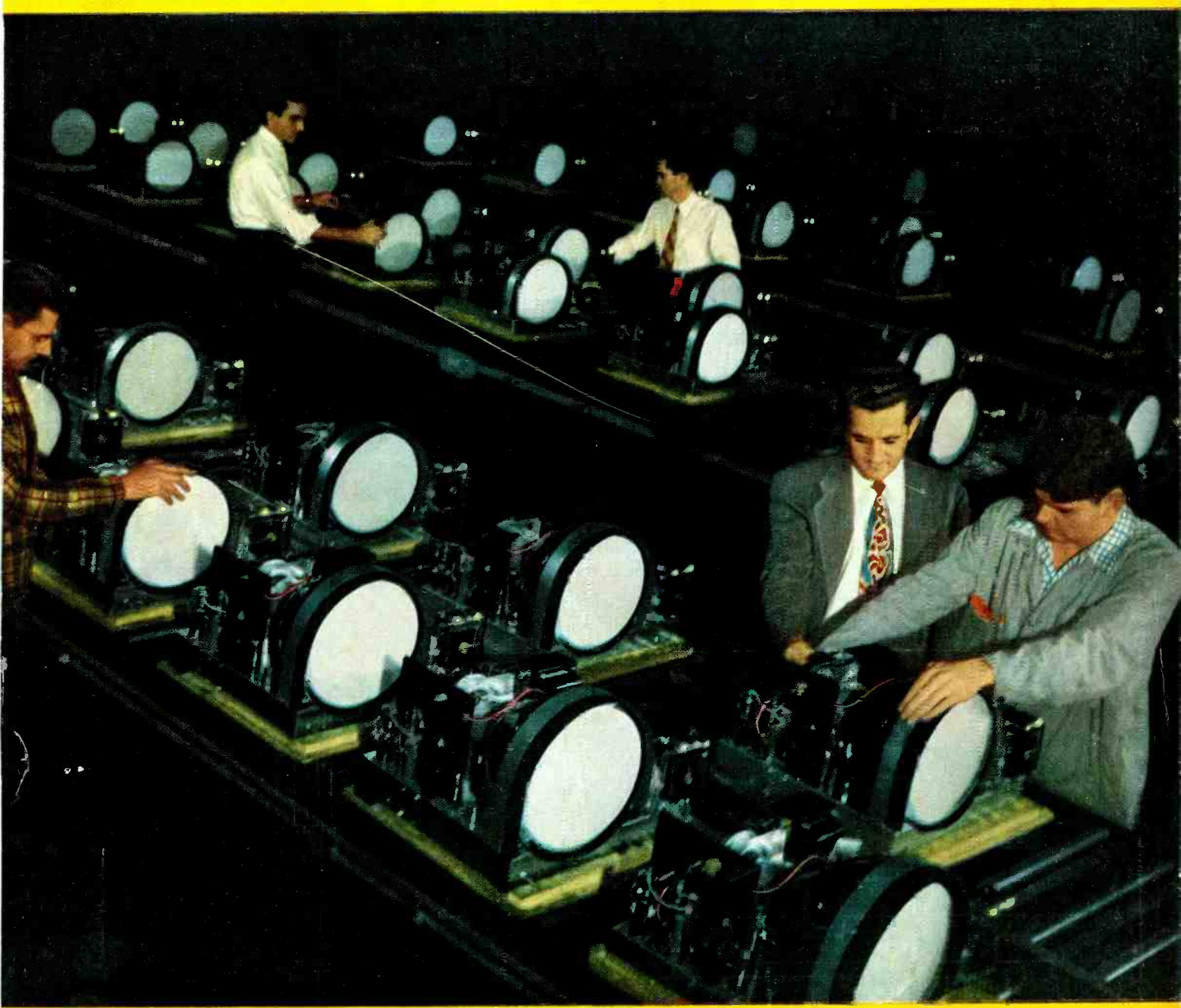
JANUARY 1950

electronics

A McGRAW-HILL PUBLICATION



AGING TV SETS

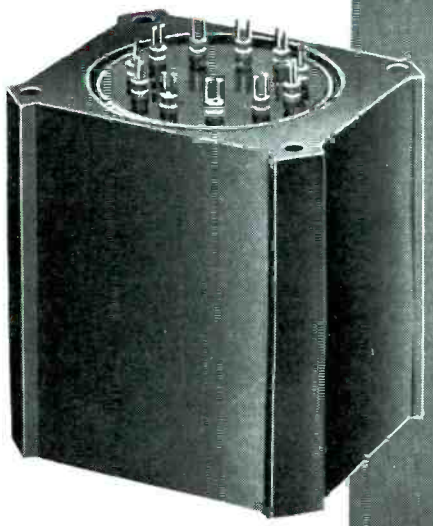
Linear Standard Units...

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.

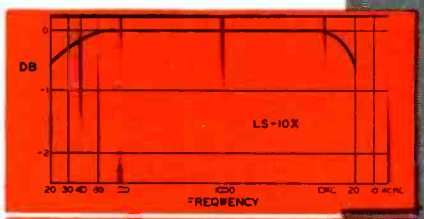
UTC Linear Standard Transformers feature . . .

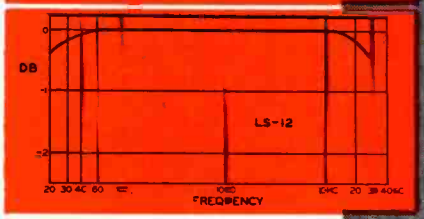
- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse coupling.
- **Reversible Mounting** . . . permits above chassis or sub-chassis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

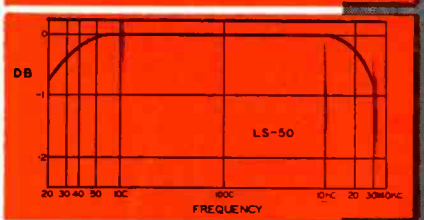


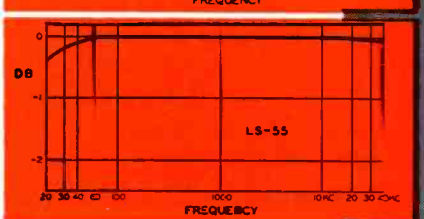
TYPICAL LS LOW LEVEL TRANSFORMERS

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 DE	—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

Write for our Catalog PS-409

United Transformer Co.

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electronics

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JANUARY • 1950

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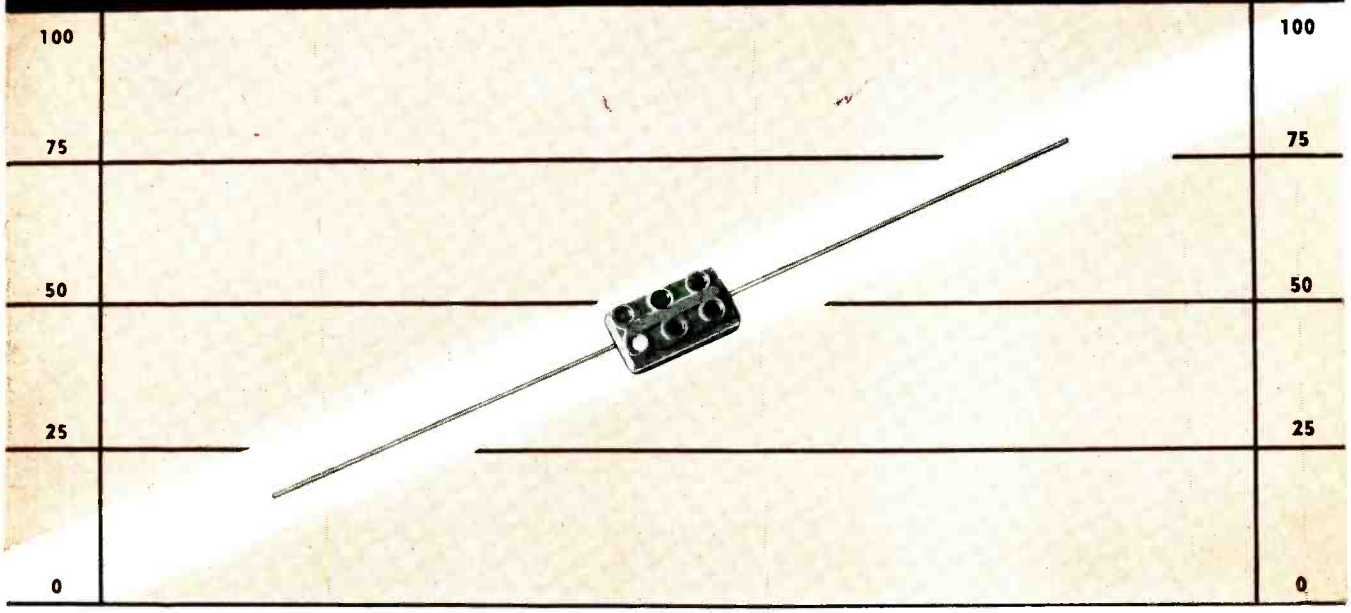

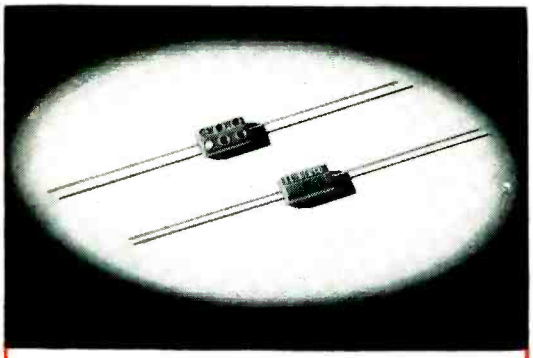

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Actual Size 9/32" x 1/2" x 3/16".
For Television, Radio and other Electronic Applications.
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Temp. Co-efficient ±50 parts per million per degree C for most capacity values.
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You can always depend on these tiny but tried and trusted El-Menco capacitors to give peak performance for long periods of time under the most exacting conditions. Rigid test during and after manufacture insures uniformity and assures quality.

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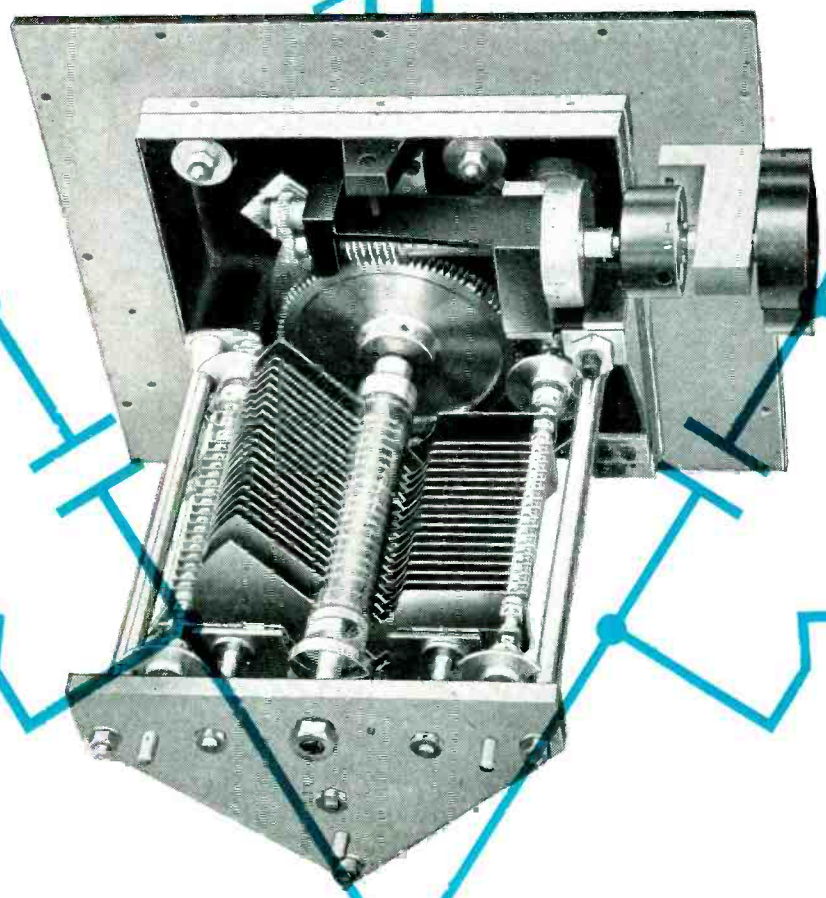
A STANDARD OF ZERO LOSS ANGLE

MUIRHEAD VARIABLE AIR CAPACITOR TYPE D-14



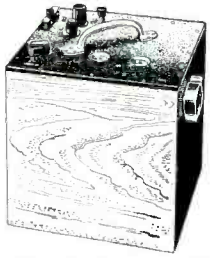
THIS three-terminal double-screened capacitor is provided with guard rings which ensure that the dielectric of the plate-to-plate capacitance is composed entirely of air. This, together with the special surface treatment of the plates, reduces the plate-to-plate power loss to a quantity which can be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

SPECIFICATION

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.

Write for further particulars

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M.U.5

Flexite

THE FLEXIBLE, EXTRUDED PLASTIC TUBING THAT RESISTS HIGH TEMPERATURES

APPROVED by the UNDERWRITERS LABORATORIES under their reexamination service

ABOVE 105° C

Flexite PHYSICAL & ELECTRICAL PROPERTIES

a—**tensile strength, minimum average** ..... 2500 PSI

b—**ultimate elongation, minimum average** 300%

c—**dielectric strength, minimum** ..... 800 v/mil

d—**flammability** ..... non-inflammable

e—**heat resistance** — after 100 hours at 300° F. the tubing is not brittle and when flexed does not crack.

f—**heat endurance** — recommended for continuous operating temperatures up to 105° C., and when baked at 125° C. for 2,000 hours does not become brittle.

g—**low temperature flexibility** ..... —30° C.

h—**heat shrinkage** ..... ASTM Standards

#20 — #17 incl. — less than 8%
#16 — # 6 incl. — less than 5%
5 and larger — less than 3%

i—**oil resistance** — highly resistant to effects of transformer and lubricating oils, does not stiffen when continuously exposed to them.

Colors — black, white, red, green, yellow and blue are standard colors.

Dimensions and Tolerances — standard sizes to fit B & S wires #20 to #0 inclusive, as speicfied by ASTM Spec. D922-47T.

Wall Thickness — in accordance with ASTM Spec. D922-47T, as follows:

#20 — #10 incl. — .016" ± .003"
9 — # 0 incl. — .020" ± .003"

Standard Lengths — Standard 36" lengths or continuous lengths in coils. Sizes #20 — #10 incl., will be supplied on paperboard spools when so ordered.

Quality — uniform in quality and condition, smooth on both inside and outside, free of defects such as pin-holes, blisters, foreign inclusions and other imperfections.

Test Methods — properties enumerated in above specifications shall be determined according to Tentative Methods of Testing Non-rigid Polyvinyl Tubing, American Society for Testing Materials, Designation D876-46T.

YES, FLEXITE is the electrical insulation tubing that sets new standards for resistance to extreme high temperatures. Compounded of a plasticized copolymer of vinyl chloride and vinyl acetate and manufactured with a true wall thickness, smooth inside and outside, FLEXITE PLASTIC TUBINGS offer the greatest resistance to high and low temperatures, are extremely flexible and have great tensile strength.

FLEXITE compares more than favorably with tubings of similar nature. Check the specifications of FLEXITE, compare them with the requirements for your products and against other insulations for identical use. . . .

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And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers . . . Flexite-Norm . . . write for specifications.

Whatever your electrical insulation problem Mitchell-Rand has the answer.

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Introducing THE NEW

POWERSTAT

TYPES 116 and 216

FOR LOADS UP TO 1 KVA

REDESIGNED FOR IMPROVED PERFORMANCE

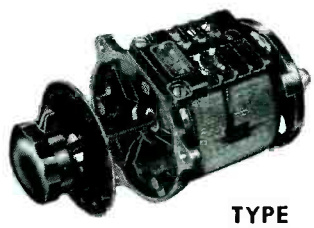
POWERSTAT variable transformers Types 116 and 216 have been redesigned. It wasn't a mere "face-lifting" operation, although a streamlined appearance has resulted. It has incorporated many of your worthwhile suggestions and the latest technical knowledge of variable transformer design and manufacture. All improvements have been made within the old standard mounting dimensions to conform to your existing panel layouts, assuring easy replacement if desired.

JUST A FEW OF THE IMPROVEMENTS

New fusing arrangement employed on cord-plug models. Twist-lock holder on side of terminal box gives easy access and simple replacement • New diecast aluminum terminal box on cord-plug models adds strength and longer service. On all models, the new, extra heavy and rugged terminal board of phenolic plastic prevents breakage. Solder-screw terminals arranged for better spacing for quicker, easier and more positive connections. Barriers between terminals reduce short-circuit hazards • Heavy-duty "ON-OFF" switch on cord-plug models is in a more convenient position to eliminate interference with input cord and output receptacle • Coil and core design provides excellent regulation, high efficiency and conservative rating for both 50 and 60 cycle duty • Polarity identification provided on cord-plug models for requirements involving ground loads.

Ratings of Types 116 and 216 remain the same. Type 116 operates from a 115V., 50/60 cycle, 1 phase source to deliver 0-135V., 7.5 amps. Type 216 has an output of 0-270V., 3.0 amps from 230V., 50/60 cycle, 1 phase. As in the past, the current rating is the current available over the entire range of output voltage. There's no need to refer to a graph to determine the allowable current at a specified value of output voltage.

Write today for complete details on these completely redesigned POWERSTAT Types 116 and 216.



TYPE 116U

For back-of-panel mounting, incorporation in existing equipment.

TYPE 116-2

A ganged assembly for open-delta, three phase or series, single phase connection.

TYPE MT116

A motor-driven unit for push-button remote-control operation.

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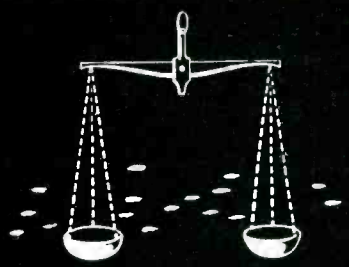
"There is hardly anything in this world that some man cannot make a little worse and sell a little cheaper and the people who consider only price are this man's lawful prey." —Ruskin



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ERSIN Multicore 3 Core Solder

THE ONLY SOLDER MADE WITH ERSIN FLUX . . . THE ORIGINAL NON-CORROSIVE, EXTRA-ACTIVE FLUX

TECHNICAL ADVANTAGES:

ERSIN FLUX

- Ersin Flux is exclusive to Multicore and will not be found in any other solder. It is a high grade, water white rosin, homogeneously activated.
- Ersin Flux has a vigorous fluxing action and possesses the non-corrosive and protective features of the original rosin.
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- Ersin Flux reduces the surface tension of molten solder, causing it to wet metals rapidly, increasing speed of operation with resultant production economies.
- Free from objectionable odor. Non-toxic in use.
- Leaves nothing but pure rosin on the work after soldering, and may be used wherever plain rosin is specified. Complies with all pertinent Federal Specifications.

MULTICORE SOLDER

- Three separate cores of flux eliminate possibility of no flux in a portion of the wire, which may occur in single cored solder. Guaranteed continuity of the flux stream prevents "dry" joints, i. e. those having high electrical resistance.
- Although there are three cores of flux in Multicore, the total percentage of flux to solder is less than many single cored solders.
- Very rapid melting results from the multiple core construction which provides thinner walls of solder than are found in same gauge single cored solder.
- Multicore's unique properties make perfect joints possible on difficult metals and alloys, even if oxidized.
- Ability to tin rapidly produces perfect joints with less solder. Greater coverage per pound.

Compare! STANDARDS OF QUALITY

Ersin Multicore Solder meets all requirements of Federal Specification QQ-S-571-b. Every pound you buy conforms to these specifications. No matter what soldering job you have, use Ersin Multicore, the finest solder ever made. Saves time and money! Guarantees finer performance!

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Ersin Multicore Solder is non-toxic in use. Cadmium is completely eliminated. The quantity of Antimony is even less than government standards allow. When you use Ersin Multicore there is no danger of harmful effects caused by these impurities.

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Every package of Ersin Multicore is labeled with the exact tin/lead content. This precise labeling results from Multicore's precise manufacturing methods. Where precision counts in your plant, use Ersin Multicore Solder.

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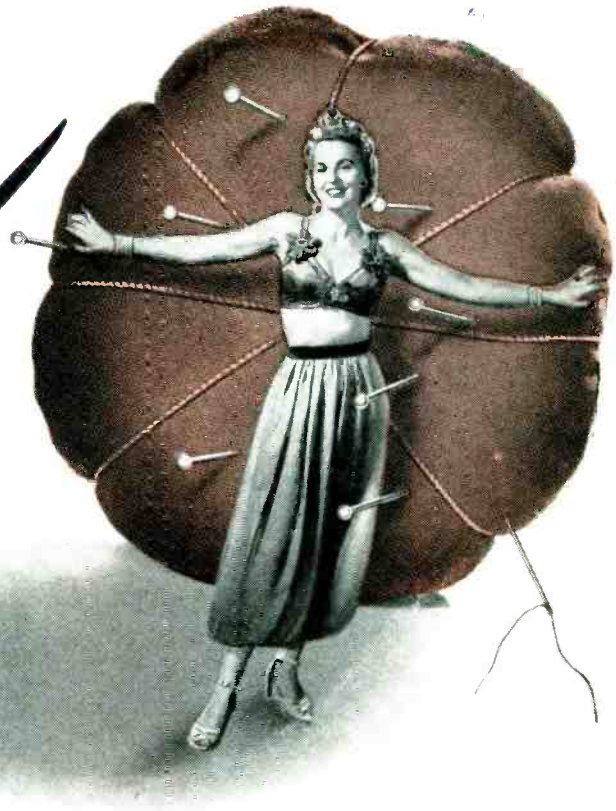
Pin point accuracy is

for resistors too!

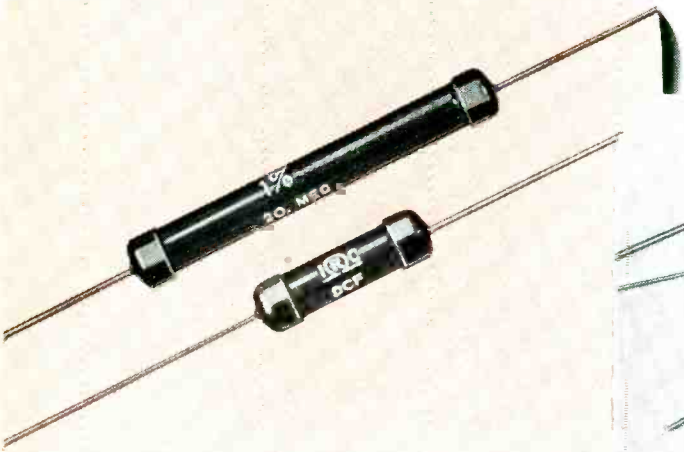


And IRC provides it. Witness leading manufacturers who specify IRC resistors for advanced electronic circuits. In instrumentation and industrial applications, IRC resistors excel in every important characteristic.

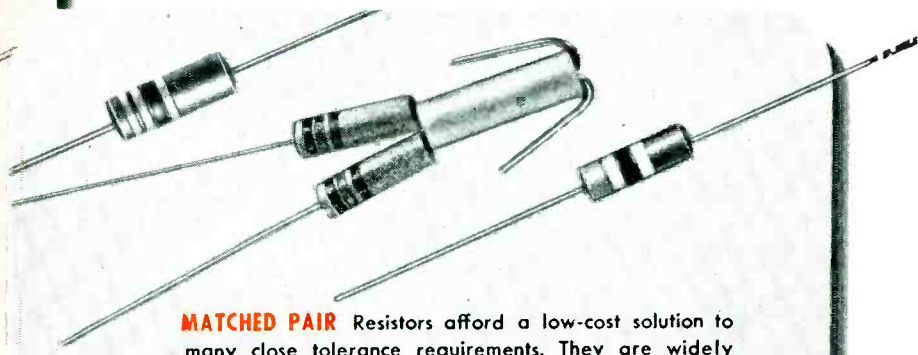
IN CRITICAL INSTRUMENTATION, IRC Precision Wire Wounds offer a fine balance of accuracy and dependability. Tolerances of 1% are standard, but ½%, ¼% and 1/10% are available. IRC Precisions also afford maximum temperature coefficient of .002% per ° C. at no extra cost. And in addition, their design and construction assure stability—even where recurring surges are encountered. Labels are acetate. May we send you complete technical data? Just check the coupon.

essential

SEALED PRECISION Voltmeter Multipliers find many critical applications such as are encountered in marine service because of absolute dependability under the most severe humidity conditions. Type MF's are compact, rugged, stable, fully moisture proof and easy to install. They consist of individual wire wound precision resistors, mounted, interconnected and encased in glazed ceramic tubes—and these may be either inductive or non-inductive, for use on AC as well as DC. Send coupon for technical data bulletin.



ACCURACY AND ECONOMY in close tolerance applications make IRC Deposited Carbon PRECISTORS ideal for television and similar circuits. They are outstanding in their ability to provide dependable performance in circuits where the characteristics of carbon composition resistors are unsuitable and wire-wound precisions too expensive. Manufactured in two sizes, 200 ohms to 20 megohms in 1%, 2% and 5% tolerance. Coupon brings full details.



MATCHED PAIR Resistors afford a low-cost solution to many close tolerance requirements. They are widely used as dependable meter multipliers. Two insulated IRC resistors are matched in series or parallel to as close as 1% initial accuracy. Both JAN-R-11 approved Advanced BT resistors and low-range BW insulated wire wounds are available in Matched Pairs. Use the coupon to send for Bulletin B-3.

For fast, local service on standard IRC resistors, simply phone your IRC Distributor. IRC's Industrial Service Plan keeps him well supplied with the most popular types and ranges—enables him to give you prompt, round-the-corner delivery. We'll be glad to send you his name and address.

IRC

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Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Controls • Rheostats • Voltage Dividers • Precisians • Deposited Carbon Precistors • H= and High Voltage Resistors • Insulated Chokes

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☐ Wire Wound Controls ☐ Voltmeter Multipliers
☐ Matched Pair Resistors ☐ Name of Local IRC Distributor

NAME .....

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J. F. ARNDT & CO., ADV. AGENCY

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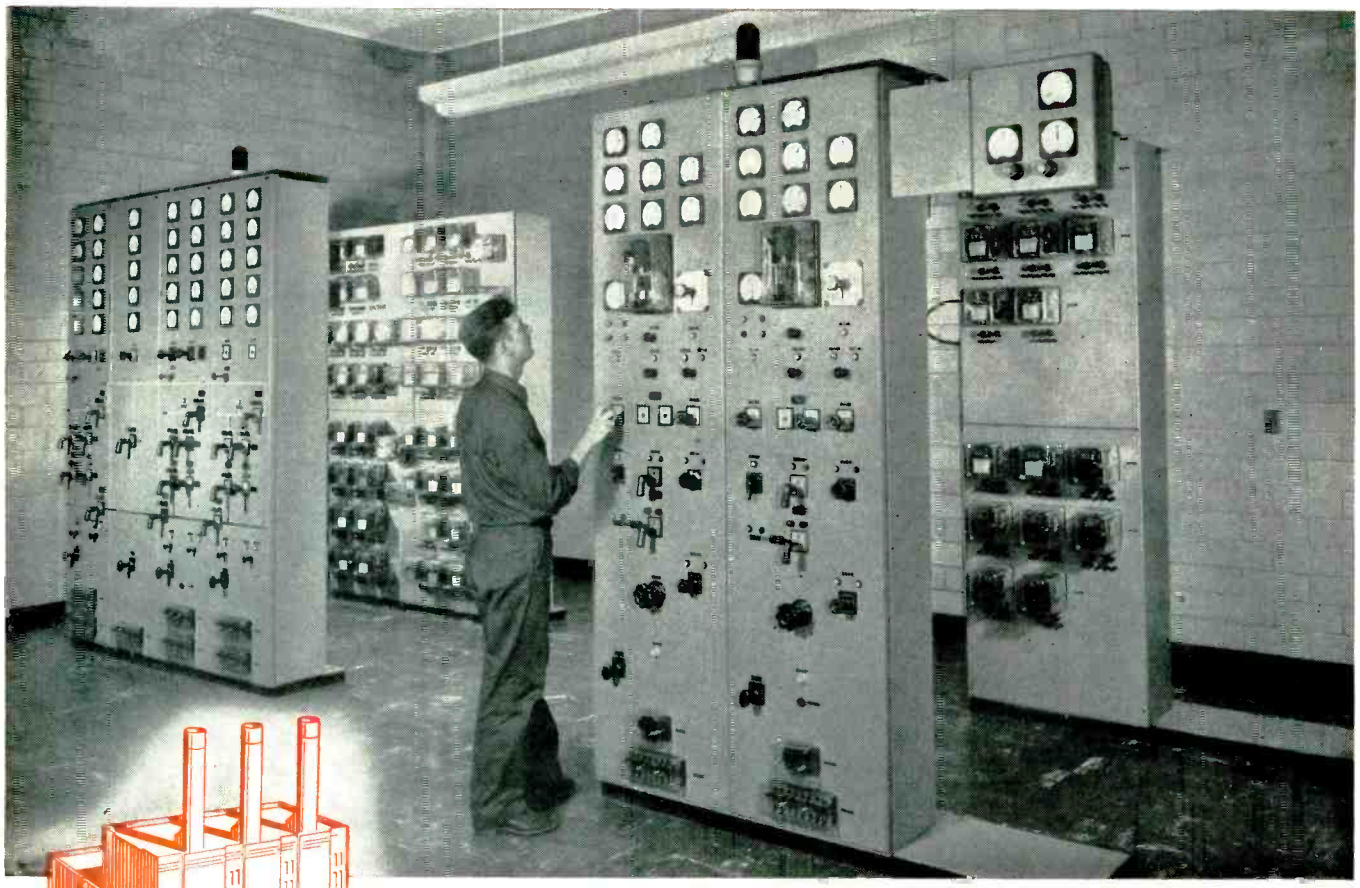
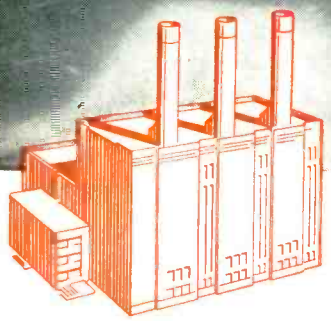
Westinghouse





Instruments "Check-Rein" 240,000 Horsepower!

When the power load builds up and up, it's Westinghouse Instruments that give the tip-off! Another generator is called into action—steady voltage flows over the network . . .

This is a familiar routine at the new B. C. Cobb Station, owned by Consumers Power Company. This modern steam electric generating plant, located on the shores of Lake Muskegon, Michigan, has a rated capacity of 180,000 kw, or 240,000 horsepower. Westinghouse Instruments have been standardized on here—keep a vigilant watch over power that is generated at 14,400 volts, then transformed to 22,000, 44,000 and 140,000 volts.

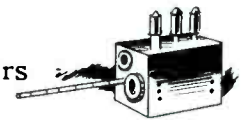
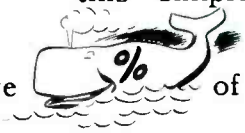
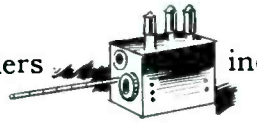
Serving as the "eyes" for this massive power system calls for instrument reliability to the nth degree. We believe Westinghouse Instruments meet this challenge. *You can be sure* of the complete line of Westinghouse Instruments—from calling the turn on a microamp. to keeping a "check-rein" on all the concentrated horsepower America's genius can devise.

Westinghouse Instrument Specialists are available in the field for consultation. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-40379

Westinghouse
INSTRUMENTS

ADVENTURES IN ELECTRONIC DESIGN

CENTRALAB HELPS SOLVE A TV TUNER DESIGN PROBLEM!

TV tuners  are the prima donnas  of the electronic art. Stability  , tracking  and a host of similar problems beset the hard-pressed design engineers  . A year ago  final adjustments of circuit balance  was a tedious problem. The need for a small  , simple, easily installed trimmer capacitor  was urgent. Centralab engineers  dug down into their bag of experience . . .  and came up with the answer  Another Centralab  first — our new Tubular Trimmer.  Result — the industry has welcomed  this simple answer to a serious problem  and a sizable percentage  of TV tuners  incorporate this new trimmer  in their design. Investigate for yourself the considerable variety  of available capacity ranges. It is the answer to your problem where a small, simple, inexpensive trimmer  is needed to balance out  the inherent stray  capacities in all high frequency circuits 

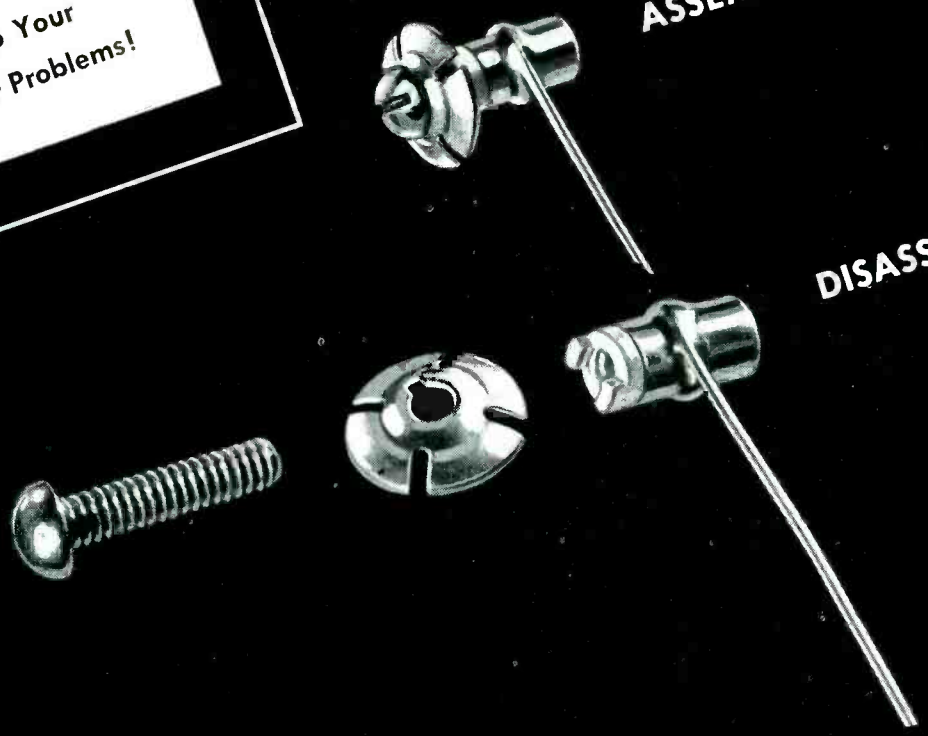
Centralab (CRL) — **DEVELOPMENTS THAT CAN HELP YOU** ➡

Division of GLOBE-UNION INC. • Milwaukee

Centralab reports to

JANUARY, 1950

Here's why CRL's Tubular Trimmer is the Answer to Your VHF Problems!



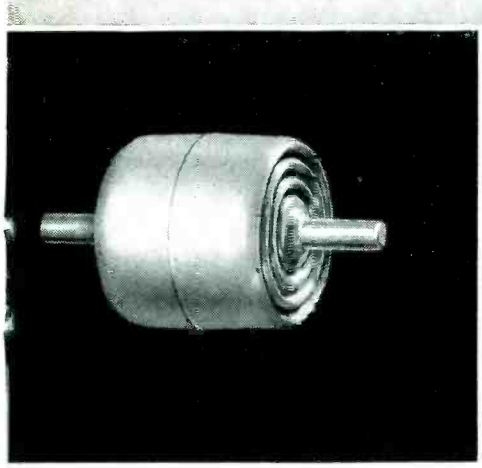
Because it is: (1) Small, simple, easily installed. (2) Saves valuable production time. (3) Body is sturdy L5 steatite. (4) Silver stator electrode—fired on. (5) Single wire #22 lead. (6) Simple adjustment—6/32 screw adjustment. (7) Positive ground to chassis through adjustment screw and Tinnerman locknut. (8) Low power factor — less than .2% at 1 MC. (9) Good retrace characteristics. (10) Variety of capacity ranges. (11) Low capacity to ground if desired. Ask for more detailed information from your nearest CRL representative — or write us direct.

Part No. XA1482
Our most popular size:
Length: ½"
Capacities: (two)
0.5 to 3.0 mmf.
1.0 to 4.0 mmf.

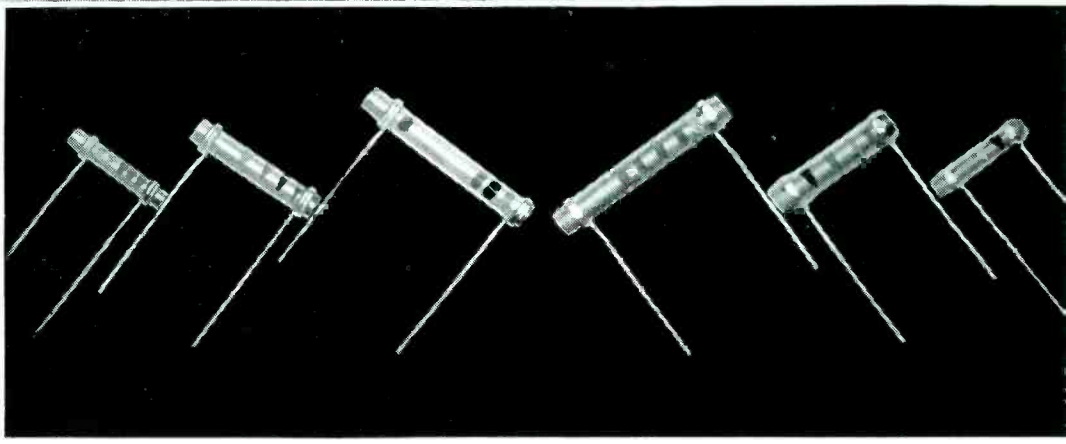
Part No. XA1515
Length: ⅝"
Capacity:
1.0 to 6.0 mmf.

Part No. XA1516
Length: 1 1/16"
Capacities: (two)
1.0 to 7.5 mmf.
1.5 to 10.0 mmf.

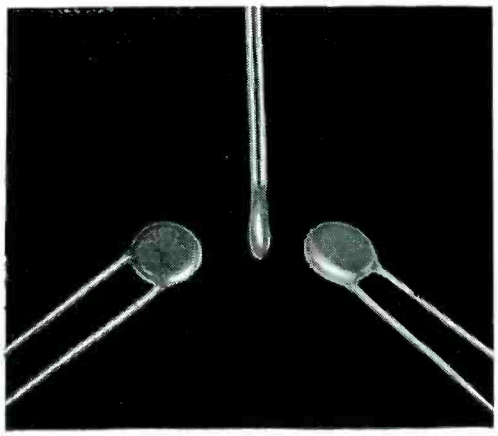
Electronic Industry



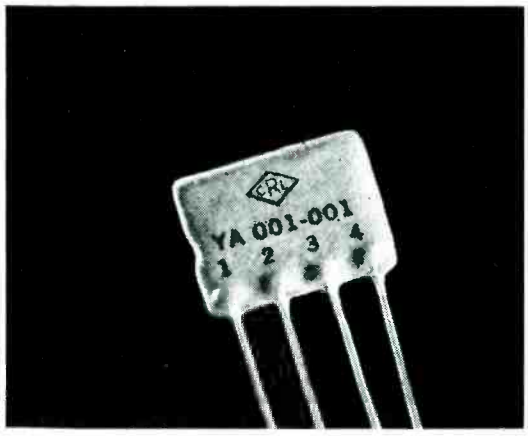
2 *Hi-Vo-Kaps* are filter and by-pass capacitors combining high voltage, (10 and 20 KV) small size and variety of terminal connections for TV needs.



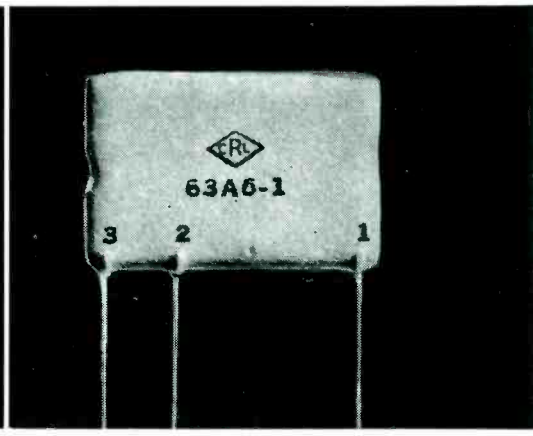
3 Centralab's TC (Temperature Compensating) Tubular *Hi-Kaps*, left, are the most stable capacitors available. With TC *Hi-Kaps*, there's practically no variation due to aging or changes in temperature or humidity. For applications where temperature compensation is unimportant, use Tubular BC *Hi-Kaps*, right.



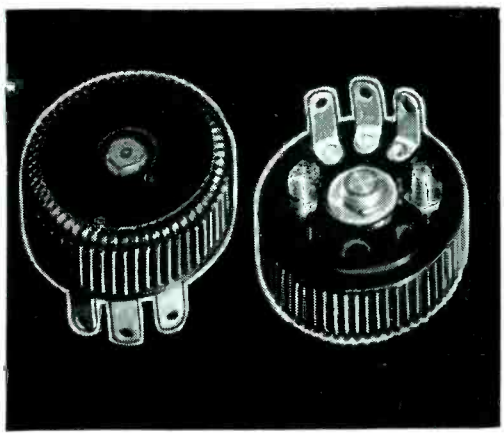
4 For by-pass or coupling applications, check Centralab's original line of ceramic disc *Hi-Kaps*. Disc *Hi-Kaps* are smaller than a dime!



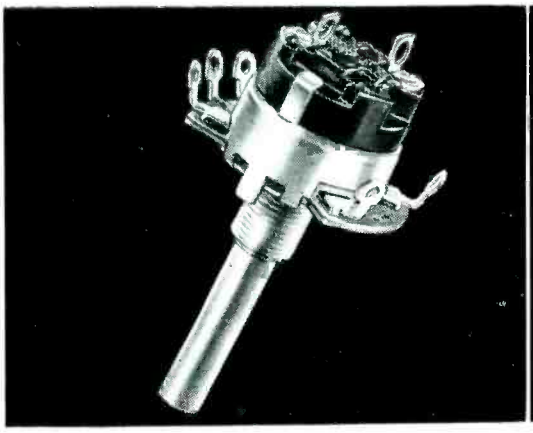
5 *Couplate* consists of plate and grid resistors, plate by-pass and coupling capacitors. Minimum soldered connections speed production.



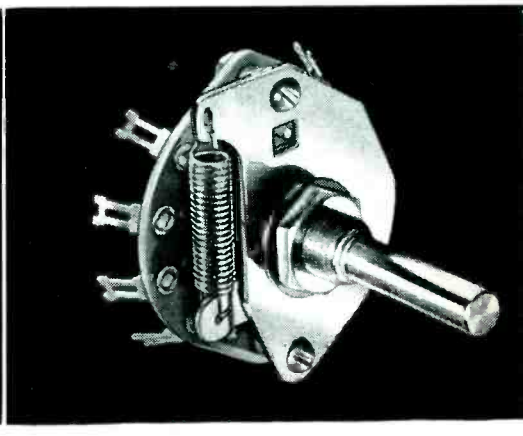
6 This is the new CRL *Vertical Integrator Network* used in TV sets. Variations of this Centralab *Network* are available on special order.



7 Model "1" *Radiohm* control, rated 1/10 watt — plain and switch types. No larger than a dime. Designed for miniature uses.



8 CRL's new high quality Model 2 *Radiohm* Controls specifically designed for TV, radio, other electronic equipment. Lower noise level, longer life.



9 Great step forward in switching is CRL's New Rotary, Coil, Spring and Cam Index Switch. It gives you smoother action, longer life.

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42-27 — MODEL 2 COUPLATE — for small or portable set applications.
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Centralab Capacitors

42-3 — BC TUBULAR HI-KAPS — capacitors for use where temperature compensation is unimportant.
42-4 — BC DISC HI-KAPS — miniature ceramic BC capacitors.
42-10 — HI-VO-KAPS — high voltage capacitors for TV 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.

Centralab Switches

953 — SLIDE SWITCH — applies to AM and FM switching circuits.
970 — LEVER SWITCH — shows indexing combinations.
995 — ROTARY SWITCH — schematic application diagrams.
722 — SWITCH CATALOG — facts on CRL's complete line of switches.

Centralab Controls

42-7 — MODEL "1" RADIOHM — world's smallest commercially produced control.

Centralab Ceramics

967 — CERAMIC CAPACITOR DIELECTRIC MATERIALS.
720 — CERAMIC CATALOG — CRL steatite, ceramic products.

General

26 — GENERAL CATALOG — Combines Centralab's line of products for jobber, ham, experimenter, serviceman or industrial user.

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.
900 East Keefe Avenue, Milwaukee, Wisconsin

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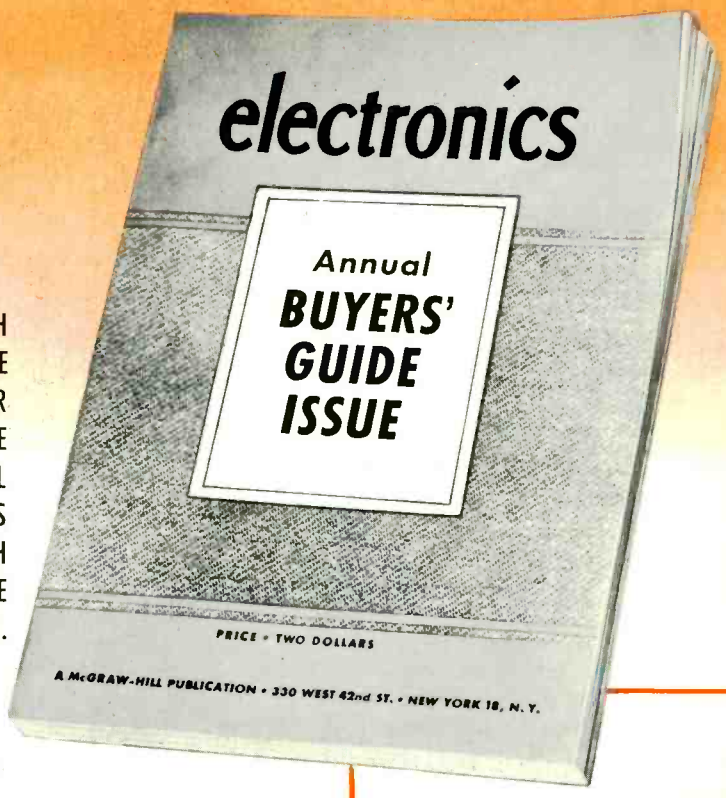
the book that became a habit

THE ANNUAL ELECTRONICS BUYERS' GUIDE, NOW IN ITS 10TH YEAR, HAS EARNED INDUSTRY-WIDE ACCEPTANCE AS THE ONLY COMPLETE AND ACCURATE SOURCE OF DATA FOR SPECIFYING AND BUYING. THE GUIDE IS IN CONSTANT USE THROUGHOUT THE YEAR BY DESIGN ENGINEERS; CONTROL ENGINEERS; MAINTENANCE, PRODUCTION AND METHODS MEN; AND P.A.'S. THESE MEN HAVE LEARNED, THROUGH EXPERIENCE, TO JUST NATURALLY REACH FOR THE GUIDE WHEN THEY NEED TECHNICAL OR BUYING INFORMATION.



Use of the "Guide" has become, through the years, an instinctive habit with those who have need of technical data or where-to-buy-it information on electronic components, equipment or allied products. And need of that information is by no means confined to electronic manufacturing. There are countless others whose interests may be in electronic applications in candy making, weaving or cosmetics, for example, as well as in the more technical fields of industrial processing. Electronics plays an important role in practically every industry, and the men in those industries whose function is to apply electronics to their manufacturing, processing or control problems rely on the GUIDE for the technical and buying information they need.

This industry-wide use of the GUIDE presents to every manufacturer whose products are used in electronic manufacturing or in industry generally, an unusual opportunity. There can be no more effective, nor more economical method of bringing the characteristics or operational qualities of those products to customers or prospects for them, than in the GUIDE — the publication which is constantly referred to by those very men. Manufacturers can have no greater assurance of an interested, buying readership of their advertisements than that which the ELECTRONICS Buyers' Guide actually gives them.

Manufacturers can add a large safety factor in their sales planning by putting this "habit-use" of the GUIDE to work for them. Advertising in the GUIDE cannot be considered in the class of a door opener for a manufacturer's salesman. It is, in fact, a most potent salesman in its own right due to the peculiar purchasing habits in the science-industry of electronics. Surveys have proven that products are bought by specifications in the designing stage, on the drafting board . . . where the GUIDE is at the design engineer's elbow . . . where a salesman can't be. And in the industrial use of electronic controls — well, a salesman would have quite a job finding the right plants and the right men in those plants. The GUIDE goes straight to those men — quickly and with the background of acceptance and recognition. Be sure your advertising plans for 1950 include the use of ELECTRONICS Buyers' Guide.

THE 13th ISSUE OF

electronics

The Annual

BUYERS' GUIDE

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THE ONLY COMPLETE REFERENCE BOOK IN THIS INDUSTRY

Used in every industry by designers, specifiers and buyers of electronic components, equipment and allied products.

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FOR COMPLETE DETAILS

on the use, acceptance and selling effectiveness of the ELECTRONICS BUYERS' GUIDE watch for the complete story which will be mailed to you shortly. You will find factual evidence in it on why you should include the GUIDE in your 1950 advertising plans.

The Manufacturers' "On-The-Spot" Salesman throughout the year

CONDENSED DATA ON THE 1950-1951 ELECTRONICS BUYERS' GUIDE

CIRCULATION: The ELECTRONICS Buyers' Guide will have the same large and selective circulation as the regular issues of ELECTRONICS. According to the June 1949 ABC Statement ELECTRONICS Total Net Paid Circulation was 30,050. In addition there's a pass-on readership of approximately 120,000. No other publication in the electronic field begins to approach this full coverage of the men who buy and influence the purchase of electronic components, equipment, and allied products.

PENETRATION INTO INDUSTRY: The large, selective circulation of the Buyers' Guide means industry penetration that can't be equalled in the field . . . penetration on a wide industry front giving complete horizontal coverage, as well as deep penetration to the men who influence and buy in every major company. Ask an ELECTRONICS representative to show you "Examples of ELECTRONICS' PENETRATION THROUGHOUT INDUSTRY" for complete proof that you'll reach the men you want to influence in the Buyers' Guide.

PRODUCTS ADVERTISED: Products advertised include a full line of communication equipment, industrial electronic equipment, components, measuring equipment, and allied products . . . the same products for which we list product sources in our comprehensive Index. Electronic engineers design-in many products which are not, strictly speaking, "electronic" but which are, nevertheless, essential parts of complete circuits. These engineers use the Buyers' Guide for sources and specifications of all products entering into the design of electronic circuits.

RATES: Advertisers will be entitled to the rate earned in 12 regular issues of ELECTRONICS or to the rate they earn in the Buyers' Guide, whichever is most advantageous. Space used in the Buyers' Guide will not help earn a rate in the regular issues of ELECTRONICS. But the rate earned in the regular issues will determine the rate for the Buyers' Guide issue.

MECHANICAL REQUIREMENTS

	Width	Depth	Width	Depth
1 page	7	10	....	....
2/3 page	4-9/16	10	....	....
1/3 page	4-9/16	4-7/8	2-3/16	10
1/6 page	4-9/16	2-5/16	2-3/16	4-7/8

Page is 3 columns, each column 2 3/16 inches wide.
Composition—no charge.
Halftone screens—all halftones should be 100-110 line screen. They should be etched to the depth of .003 of an inch in the highlights, .002 of an inch in the middle tones, and .0015 of an inch in the shadows. Typographical rights reserved.

COLOR AND BLEED: McGraw-Hill standard colors: yellow, orange, red, blue, and green, $100 per page for any one color. Special matched color $120 per page for any one color. Rates for metallic inks and more than one extra color quoted on request.

Bleed pages: per page, extra $75.00. Plate size 8 3/8 inches by 11 1/2 inches, which allows 1/8 inch additional at top, bottom, and outer edge for trim. Keep essential elements 3/8 inch within plate size. Trim size 8 1/4 inches by 11 1/4 inches.

INSERTS (Letter Press): Regular space rates apply on complete inserts which are ready for binding when received. Before making plates or ordering printing please check with your local ELECTRONICS representative as to number of pages, quantity required, trim size. Maximum acceptable weight 100 lb. coated 25 inches by 38 inches basis, or equivalent. See closing dates below.

INSERTS (Offset): Inserts prepared by our Copy Service Department can be produced by photo offset at a saving in production costs to the advertiser. If the advertiser desires reprints of his advertisement, the offset method will have the additional advantage of permitting us to supply him with preprints rather than reprints. See closing dates below.

REPRINTS: Regular run of book stock will be used unless special stock is supplied by the advertiser. For information on the cost of reprints consult your local ELECTRONICS representative.

COPY SERVICE: Copy and layout service by specialists in the catalog type of presentation best adapted to this type of issue is available at a moderate cost to all advertisers and advertising agencies. Complete details including all product data, availability of photographs, cuts, choice of color, if color is being used, etc. should be in our nearest district office not later than March 10th. It is to the distinct advantage of each advertiser to get all the information in the hands of our copy department as soon as possible in order that careful and individual attention can be given to the presentation of his advertisements.

CLOSING DATES

Copy to prepare: All details must be in our New York Office not later than March 15th. Layout and copy sent to the advertiser for his OK and also final proofs.

Copy to set . . . April 1st. If no proof required . . . April 10th
Complete plates . . . . . May 1st
Inserts . . . . . May 25th

ADVERTISERS' NAMES BOLDFACED IN DIRECTORY SECTION: Advertisers in the Buyers' Guide will have their names boldfaced in the product listing section and reference will also be made to the page number(s) on which their advertisements appear. This permits the engineer seeking product information the two vitally important elements of the Guide — namely, 1. Where he can buy it, and 2. Technical data, when he turns to the page to which he is referred. And that is all he needs in order to specify or buy. The non-advertiser doesn't get this opportunity to sell his products.

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ST. LOUIS George Sears, Continental Bldg., Lucas 4867

electronics

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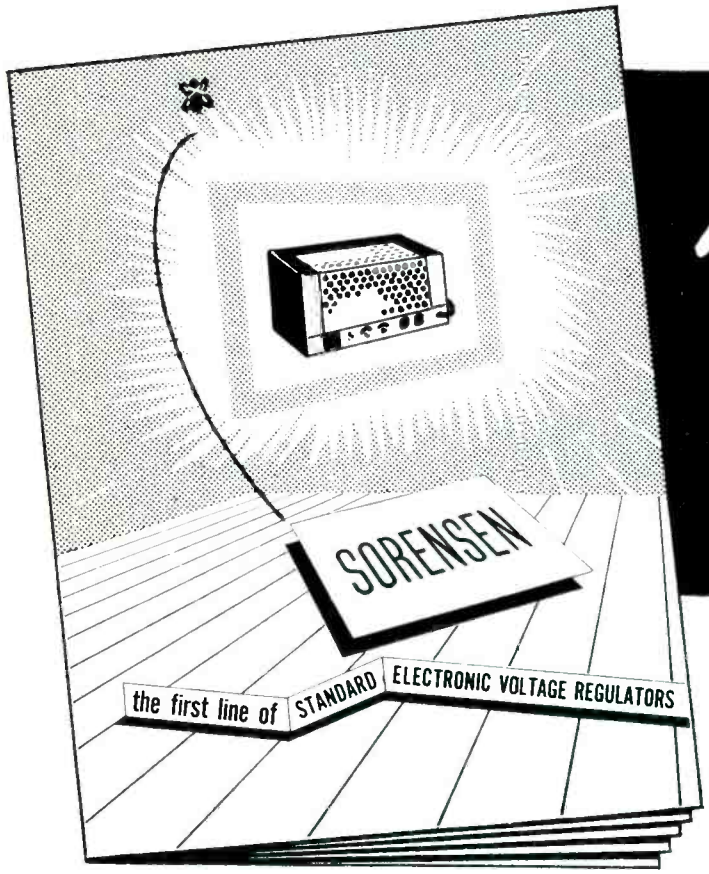
Sorensen's NEW LINE

OF ELECTRONIC VOLTAGE REGULATORS

Gives you

more for less!



MORE, because there's

- Greater Accuracy
- Less Distortion
- Range from no load to full load
- Temperature Compensation

LESS, because . . .

Sorensen Engineers and Sorensen Production has been laboring for many months to bring you greater value at less cost. And they've done it!

The Standard line of Sorensen Electronic Regulators, both AC and DC, has always been famous for outstanding features, low cost. Now, many additional features, previously available only in special models at extra cost, have been incorporated as regular features of the NEW SORENSEN STANDARD LINE — at *no extra cost!* Some *Improved Models* cost less than the former standard models. Write for the

NEW SORENSEN CATALOG

and compare these *new units* with any other similar units you've ever seen or heard about.

Sorensen stays out front!

Sorensen and Company, Inc.
375 Fairfield Ave., Stamford, Connecticut

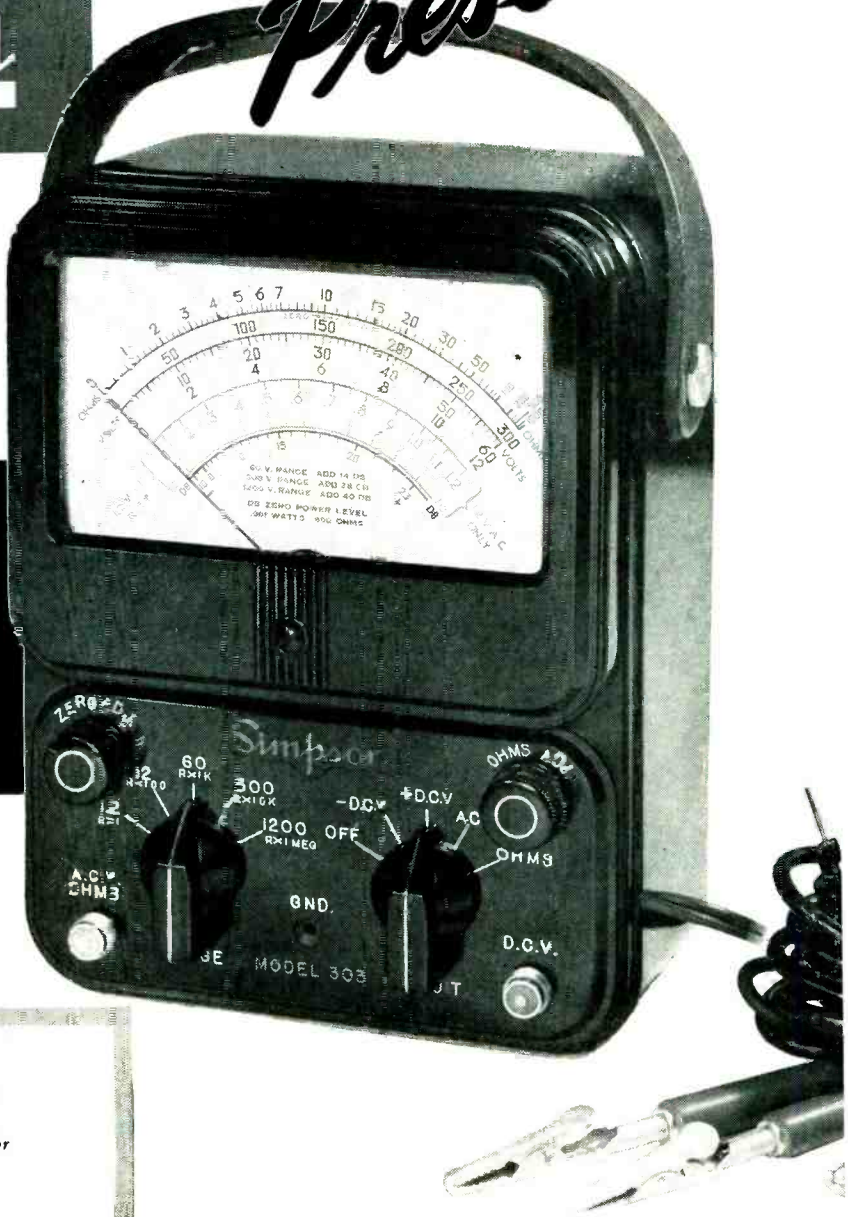
Simpson

INSTRUMENTS THAT STAY ACCURATE

Presents

the **New!** MODEL 303

VACUUM TUBE VOLT-OHMMETER



. . . A Worthy Companion of the 260

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 DC 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

Smaller and Handier for Greater Portability

A worthy companion of the world-famous Model 260 is this brand new addition to the Simpson line—the Model 303!

Skilled Simpson engineers spent months of painstaking research in the laboratory to produce the Model 303, which is one of the most versatile instruments ever made for TV servicing. This ruggedly constructed instrument offers the maximum in portability because it is approximately 60% smaller than other vacuum tube volt-ohmmeters. However, no sacrifice has been made in readability. The 303 has a large 4½" meter, despite its handy compactness.

One of the many features of the 303 is its low current consumption. The AC voltage range is wider than on any other similar instrument—from 1.2 volts minimum to 1,200 maximum. Like all other instruments bearing the Simpson name, the Model 303 is an instrument of highest quality at an amazingly low price.

SIMPSON ELECTRIC COMPANY
5200-5218 West Kinzie Street, Chicago 44, Illinois
In Canada: Bach-Simpson, Ltd., London, Ontario

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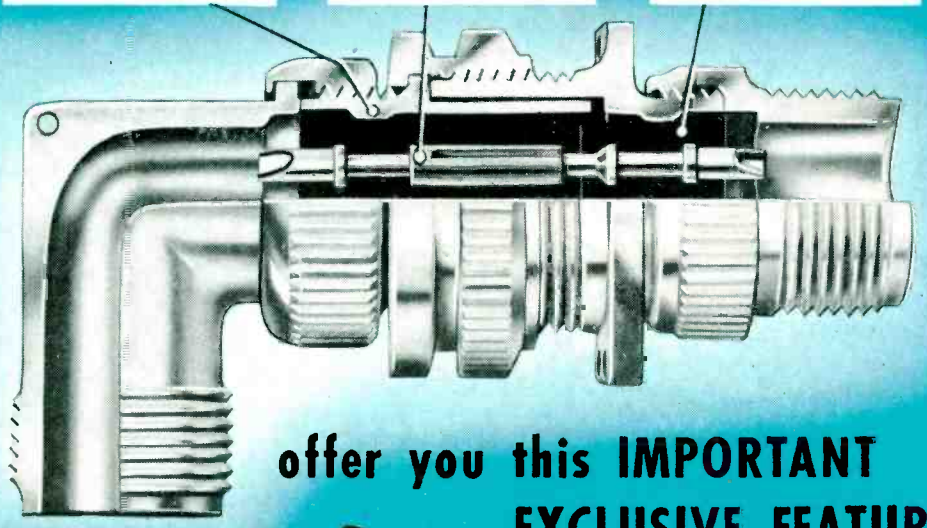
BENDIX-SCINTILLA

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

Bendix AVIATION CORPORATION

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

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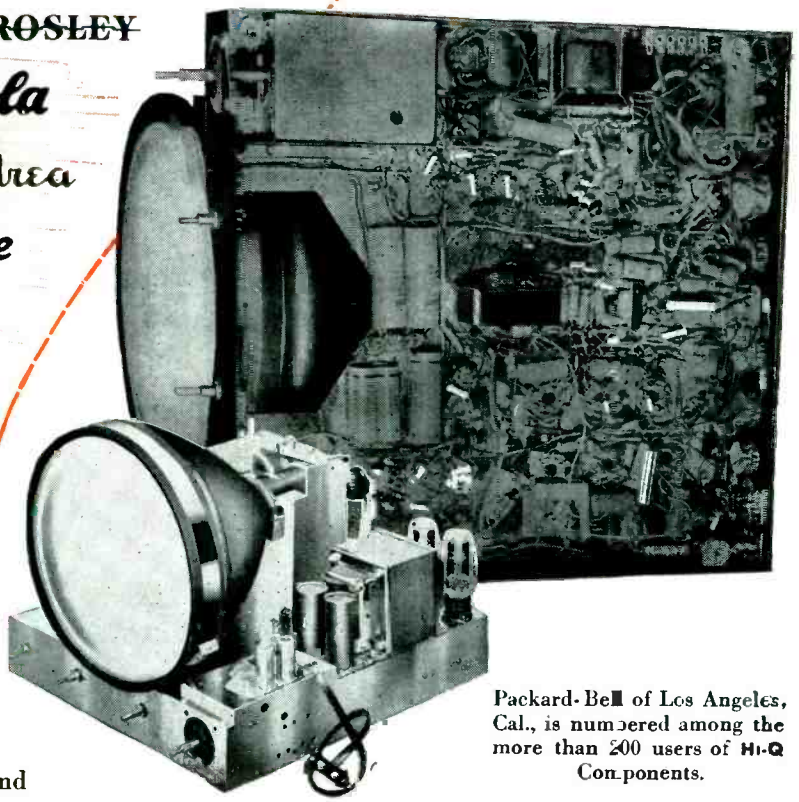
Magnavox Motorola
Admiral Emerson Andrea
Farnsworth Tele-tone
RAYTHEON BELMONT DUMONT
RCA VICTOR Sparton
GENERAL ELECTRIC Westinghouse
ZENITH RADIO STROMBERG-CARLSON

...and most other radio and TV producers specify and use **HI-Q** Components.



Packard-Bell of Los Angeles, Cal., is numbered among the more than 200 users of **HI-Q** Components.

Most leading radio and TV builders... and scores of other electronic manufacturers too ...are consistent users of **HI-Q** Components. The fact that they order again...and again ...and again is the best recommendation we know for **HI-Q** service, dependability and performance.

HI-Q engineers are ready to work with you in the development and production of ceramic capacitors, trimmers, wire-wound resistors and choke coils to meet your specific needs. Your phone call, wire or letter will receive a considered and prompt response.

HI-Q COMPONENTS BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

MINIATURIZATION The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

JOBBERS—Address Room 1332, 101 Park Ave., New York, N. Y.

HI-Q Electrical Reactance Corp.
FRANKLINVILLE, N. Y.

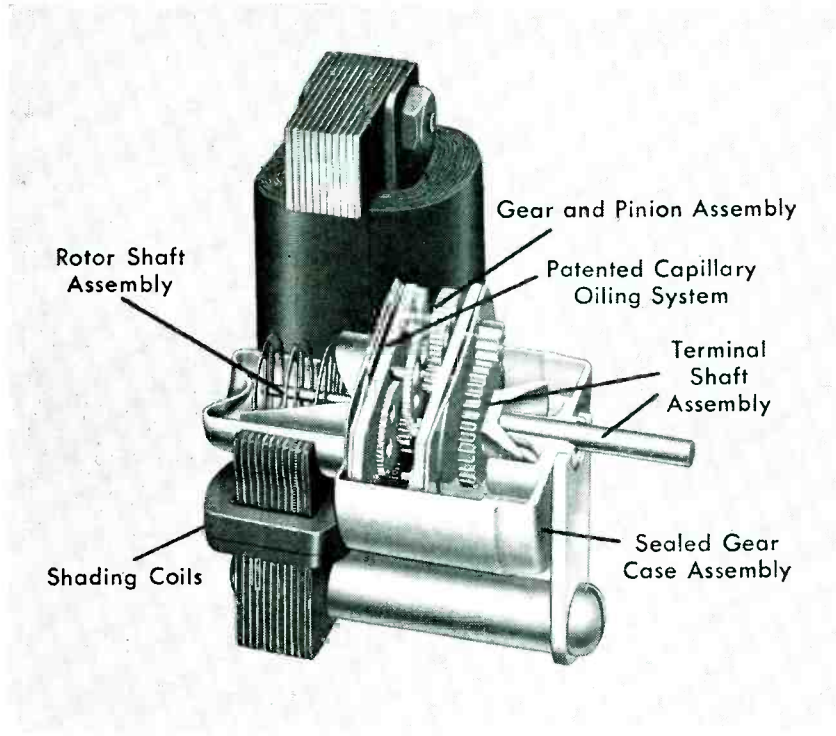
Plants: Franklinville, N. Y.— Jessup, Pa.— Myrtle Beach, S. C.
Sales Offices: New York. Philadelphia, Detroit, Chicago, Los Angeles

Floating Rotor Prevents Motor Lag or Slippage

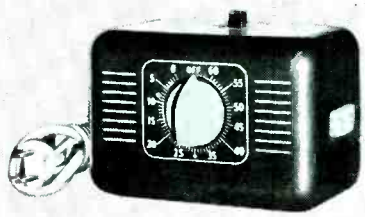
Specially designed light-weight rotor virtually floats in a rotating magnetic field. Rotor shaft rotates on a film of oil . . . no metal to metal contact with its bearing. These features, together with capillary oiling system, account for the fact that *All Telechron Timing Motors Are Instantly, Constantly Synchronous.*

That is why so many designers concerned with split-second timing or control of light-weight moving parts specify Telechron motors.

If you have such a problem, why not turn it over to a Telechron Application Engineer? Drawing on the experience that makes all electric timing possible (virtually all frequency-controlling master clocks in power stations are made by Telechron), he can probably show you how a standard Telechron motor can do your job, too. Consult him early in your planning for big savings in time and money. Use handy coupon below for complete data. TELECHRON INC. A General Electric Affiliate.



Telechron Type B Synchronous Motor. For medium duty purposes such as switches, recording-controlling mechanisms and other control equipment. Other models with lower or higher torque for light or heavy duty applications.



Typical of Telechron Type H3 light duty motor applications is this 60-minute timer, the purpose of which is to operate a switch or signal at the end of a pre-selected period.

Practically all time-stamps and recorders employ Telechron Type B motors to operate their timing mechanisms. Obviously a motor that is instantly, constantly synchronous is needed for such applications.

Telechron®

ALL TELECHRON TIMING MOTORS ARE INSTANTLY . . . CONSTANTLY SYNCHRONOUS

TELECHRON INC.
40 Union Street
Ashland, Massachusetts

Please send me information on sizes and types of Telechron Synchronous Motors. My possible application is:

- ☐ Instruments
- ☐ Timers
- ☐ Electric Appliances
- ☐ Cost Recorders
- ☐ Advertising, Display Items
- ☐ Juke Boxes
- ☐ Air Conditioning & Heating Controls
- ☐ Communications Equipment
- ☐ Other (please fill in)

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NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

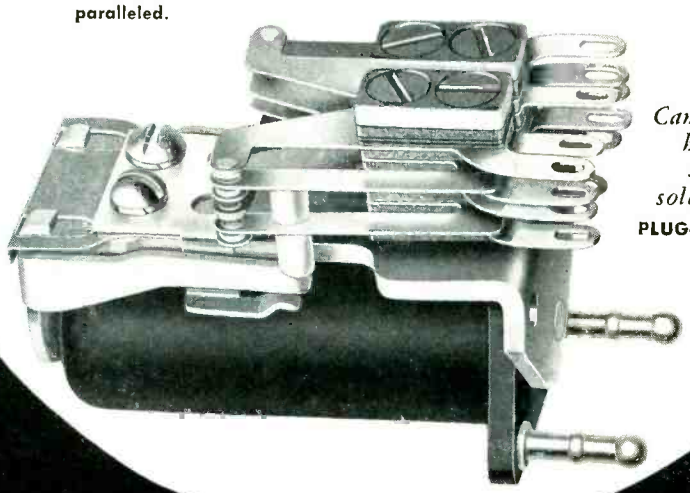
COIL POWER: From 40 milliwatts to 7 watts D.C.

CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS:
$1\frac{5}{8}$" HIGH, $2\frac{7}{32}$" LONG, $1\frac{3}{32}$" WIDE

These are the dimensions for the 6 pole relay.

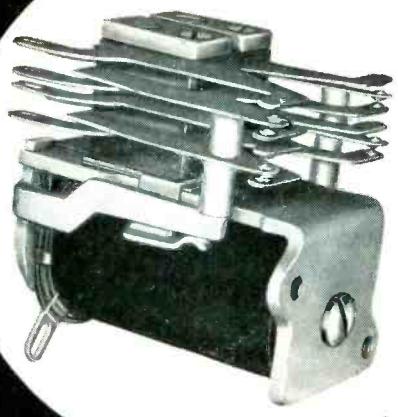
Will meet Army and Navy aircraft specifications as a component unit.



Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING-SPECIAL.

SK RELAY



MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

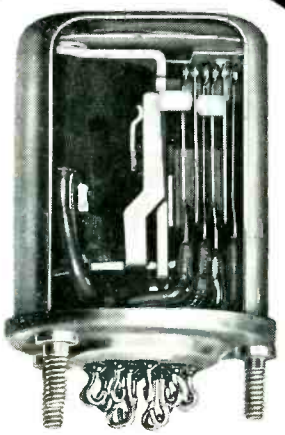
CONTACTS: Same as "LK".

DIMENSIONS: $1\frac{1}{2}$" HIGH, $1\frac{9}{16}$" LONG, $3\frac{1}{32}$" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS. PLUG-IN—SPECIAL.

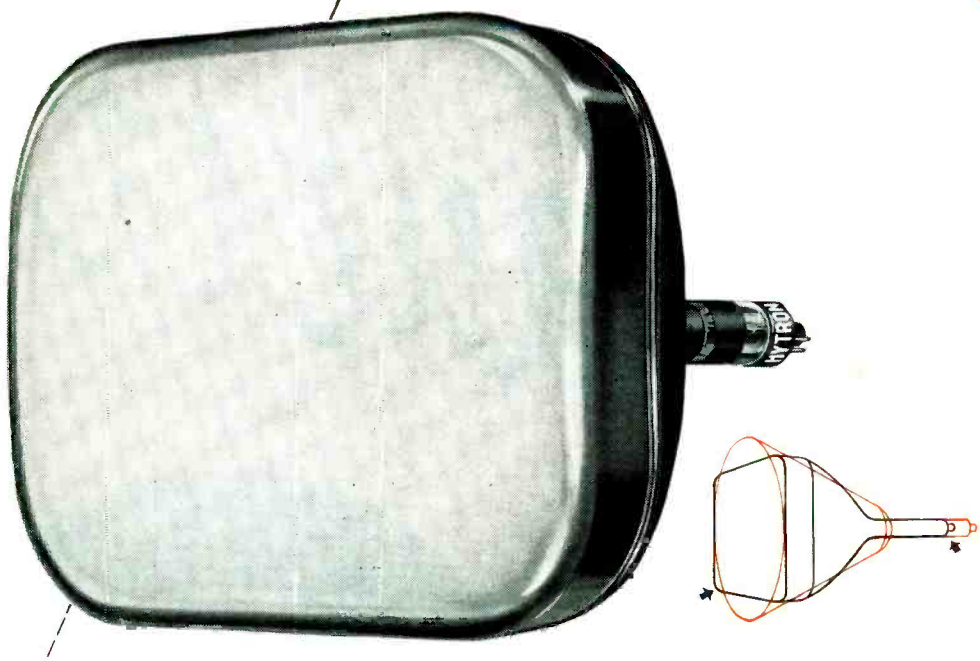


SK, HERMETICALLY SEALED

AL-132

ALLIED CONTROL CO. INC. 2 EAST END AVE., NEW YORK 21, N. Y.

ANOTHER HYTRON FIRST YOU'LL BE BUYING SOON



NEW HYTRON RECTANGULAR all-glass 16RP4

Meet Hytron's space and money saver. The new Hytron 16RP4. Revolutionary 16-inch rectangular picture tube. Takes approximately same cabinet space as 12LP4. Automatically sets the pace for more compact and economical TV set design. You'll be seeing it . . . buying it . . . soon.

The new 16RP4 is latest in a long series of Hytron firsts. Including: The GT tube. Over 50 GT types. The subminiature. Many new miniatures. Special low-cost TV deflection-circuit tubes: 1X2, 6BQ6GT, 6U4GT, 25BQ6GT. Check the 16RP4's many features. Watch for it. Buy the best by the leader. Buy Hytron!

With old-style round tube, you lose the corners.

With Hytron 16RP4, you see the picture just as transmitted.

Features of HYTRON 16RP4

1. Rectangular shape permits smaller, less costly cabinets.
2. Also just as short as 12LP4.
3. Weight is approximately two-thirds that of 16-inch, all-glass round tube.
4. Easy to mount. Can't roll or twist.
5. No high-voltage isolation of tube required.
6. Neutral gray face . . . increases contrast ratio.
7. Large viewing screen. You get the entire transmitted picture; no lost corners. Gives picture (with standard 3 by 4 aspect ratio) 10⅛ inches by 13½ inches.

Write for Bulletin E-147 giving complete data.

OLDEST MANUFACTURER OF RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

HYTRON RADIO TUBES

NEW MARION RUGGEDIZED METER

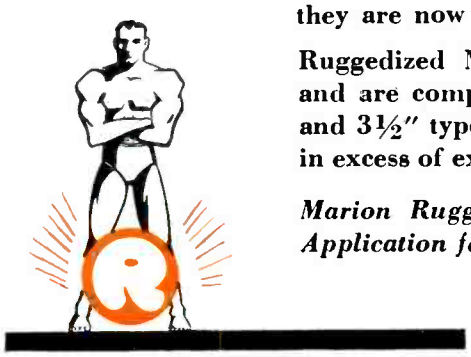
the new marion ruggedized meter gives you new freedom of application. now you can use this sensitive panel instrument where you never before dared use one.

THIS SYMBOL ON THE DIAL FACE OF YOUR METER MEANS *RUGGEDIZED*

obsoletes word "Delicate" in electrical instruments

RUGGEDIZED Meters . . . a whole new family of panel instruments created to perform perfectly under extreme conditions of physical shock or vibration, mechanical stress or strain . . . instruments impervious to extreme weather conditions in all climates . . . instruments that open whole new horizons of application.

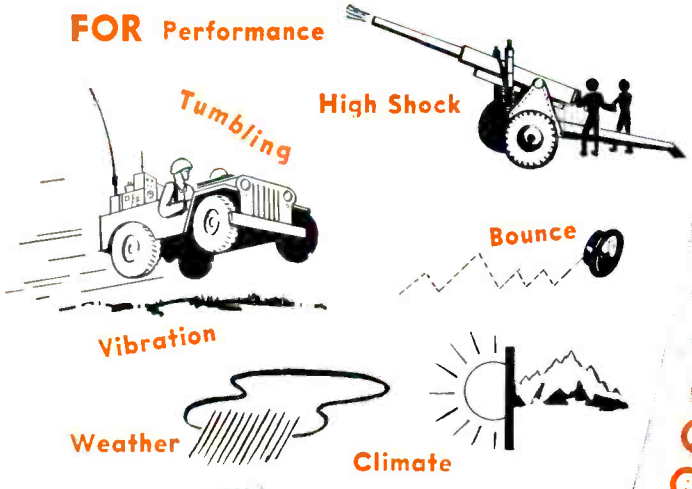
Marion Ruggedized Meters are *completely new and better instruments.* Developed by Marion for the U. S. Army Signal Corps, Fort Monmouth, N. J. (under contract No. W36-039 SC 33668) they are now released for commercial application.



Ruggedized Meters meet the dimensional requirements of JAN-I-6 and are completely interchangeable with existing standard JAN 2½" and 3½" types. They offer electrical and mechanical performance far in excess of existing JAN requirements.

Marion Ruggedized Meters set new standards in Performance and Application for Science and Industry.

MEET THIS METER THAT HAS MET STRENUOUS TESTS FOR Performance



Some of the developments that made this meter possible

- Newly developed Shock Mount successfully attenuates high amplitude, low frequency shock forces.
- Redesigned basic D'Arsonval Type DC movement sharply reduces mass and so reduces the magnitude of forces developed by shock.
- Revised frame structure secures the core against shock failure.
- New fastening techniques and materials prevent magnet fracture, increase shear resistance and minimize whipping and collision between dial and pointer assembly under shock and vibration.
- New hair springs reduce zero shift, raise fatigue point, eliminate deformation under shock.
- Extremely high torque-to-weight ratios permit larger radius pivots, reduce the unit loading of the bearings and permit them to withstand much greater shock and vibration without damage.
- Laminated aluminum alloy tubing pointer with a positive lock on the balance cross of the moving system withstands extreme shock and vibration and permits greater electrical overloads without pointer damage.
- New shock mounting ring distributes forces set up under high shock.
- Hermetic Sealing gives complete weather protection in any climate.
- Appreciably reduced overall weight.

RUGGEDIZED METERS PROVIDE LONGER LIFE AND IMPROVED ELECTRICAL PERFORMANCE IN ANY APPLICATION.

Send for your copy of our booklet on the new Ruggedized Marion Instruments today.

MARION MEANS THE MOST IN METERS

M·E·I

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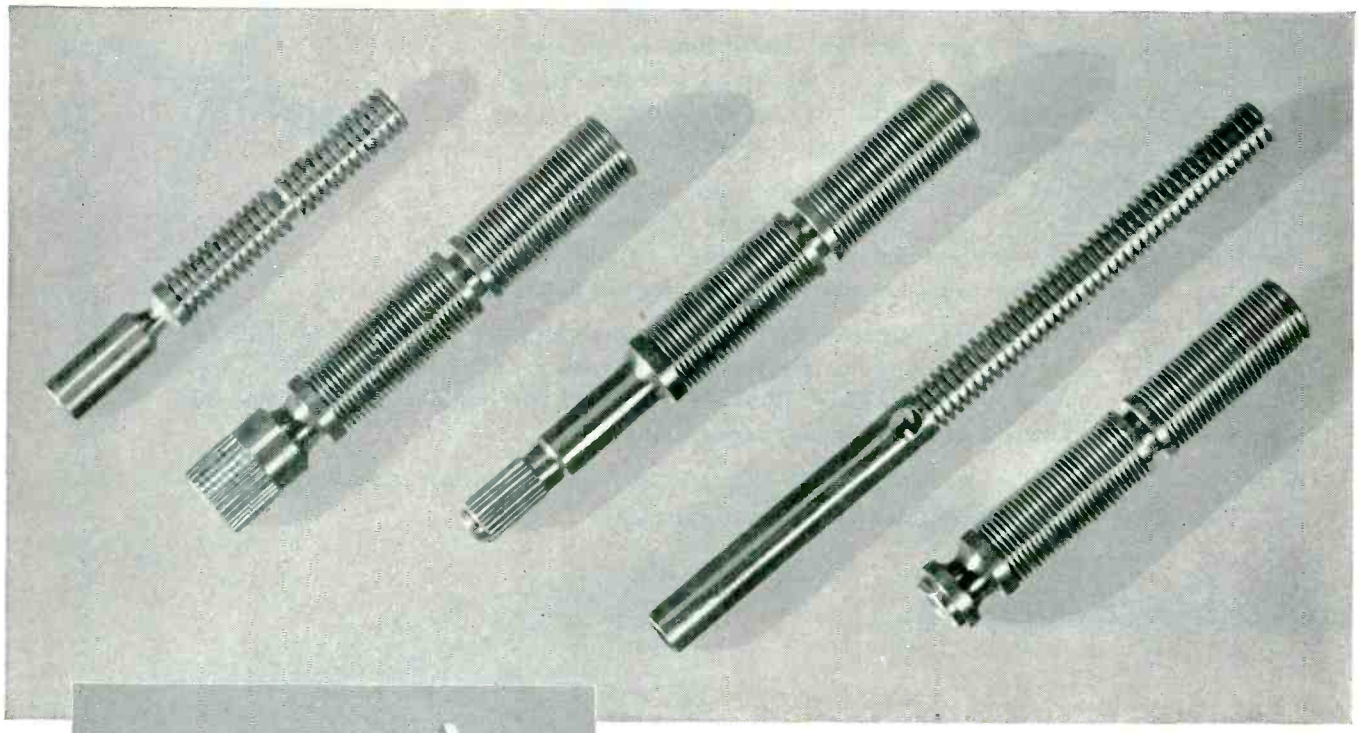
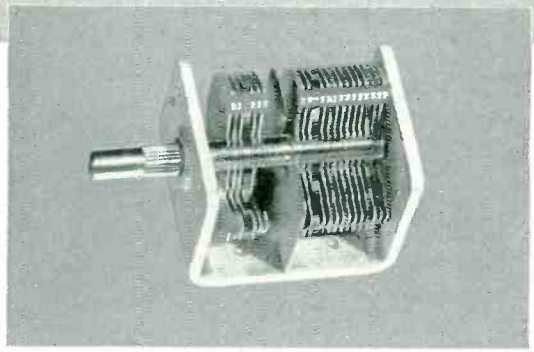
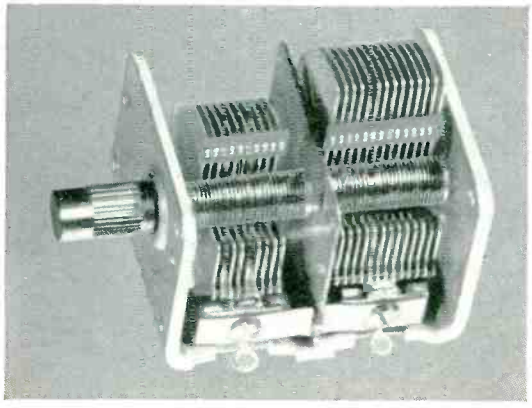
IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

MANUFACTURERS OF HERMETICALLY SEALED METERS SINCE 1944

For Tough Machining Jobs, Get REVERE FREE-CUTTING BRASS







Above, Model CS, smallest condenser, air space .009". Below, Model B, largest, air space .013". Rotor shafts, shown in top illustration, are Revere Free-Cutting Brass, plates aluminum. Made by The American Steel Package Co., Defiance, Ohio, an important supplier to the electronics industry.

HERE are several examples of the fact that Revere Free-Cutting Brass is really good. These rotor shafts for variable condensers are cut on automatic machines at 3600 r.p.m. Circular tools are used to cut the concentric slots which are .050" deep. Only one cut has to be taken. Approximately 425 pieces are produced per hour on a 6-second cycle. The American Steel Package Company, Defiance, Ohio, produces a number of different condenser models, with air spacing ranging from .009" up to .042". The slots in the shaft of Revere Free-Cutting Brass are all of the same width, regardless of air spacing, namely .014" plus or minus .0002". It takes good machines, good tools, good men, and good metal to work that closely. A report from a Revere Technical Advisor who had collaborated with the company states: "Customer is outstanding in his praise of Revere Rod." . . . If you have a problem in the machining of brass, why not give Revere an opportunity to work with you? The Revere Technical Advisory Service is at your command.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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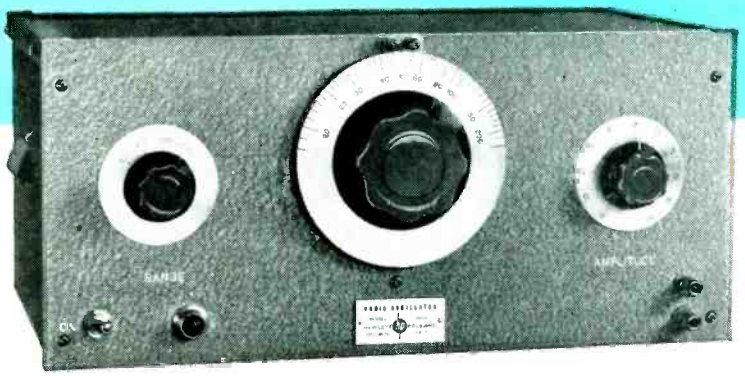
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

hp OSCILLATORS GIVE YOU PRECISE TEST VOLTAGES from ½ cps to 10 mc!



–hp– MODEL 200C

From ½ cps to 10 mc, there's an *–hp–* resistance tuned oscillator engineered to your exact need. Ten precision oscillators in all, including a portable unit that operates from batteries. Each has the familiar *–hp–* advantages of high stability, constant output, wide frequency range, low distortion and no zero set during operation. *–hp–* precision oscillators are used by radio stations, manufacturers, research laboratories and scientists throughout the world.

SPECIFICATIONS OF –hp– OSCILLATORS					
INSTRUMENT	FREQ. RANGE	OUTPUT	DISTORTION	FREQ. RESPONSE	PRICE
–hp– 200A	35 cps to 35 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc	$120.00
–hp– 200B	20 cps to 20 kc	1 watt/22.5v	Less than 1%	± 1 db to 15 kc	120.00
–hp– 200C	20 cps to 200 kc	100 mw/10v	Less than 1% to 20 kc	± 1 db to 150 kc	150.00
–hp– 200D	7 cps to 70 kc	100 mw/10v	Less than 1% 10 cps to 70 kc	± 1 db throughout range	175.00
–hp– 200H	60 cps to 600 kc	10 mw/1v	Less than 3%	± 1 db, 60 cps to 600 kc	350.00
–hp– 200I	6 cps to 6 kc	100 mw/10v	Less than 1% above 10 cps	± 1 db, 6 to 6000 cps	225.00
–hp– 201B	20 cps to 20 kc	3 w/42.5v	Less than ½% (1 watt output)	± 1 db throughout range	250.00
–hp– 202B	½ cps to 50 kc	100 mw/10v	Less than 1% 1 to 1000 cps	± 1 db, 10 to 50,000 cps	350.00
–hp– 202D	2 cps to 70 kc	100 mw/10v	Less than 2% 10 cps to 70 kc	± 1 db, 7 cps to 70 kc	275.00
–hp– 204A (Battery Op'd.)	2 cps to 20 kc	2.5 mw/5v	Less than 1%	± 1 db throughout range	175.00
–hp– 650A	10 cps to 10 mc	15 mw/3v	Less than 1% 100 cps to 100 kc	± 1 db throughout range	475.00

For complete details on any –hp– instrument, write direct to factory or contact the –hp– technical representative nearest you.

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1855A Page Mill Road, Palo Alto, California
Export Agents: Frazar & Hansen, Ltd.
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Person-to-Person Help With Your Measuring Problems

Almost anywhere in America, *–hp–* field representatives can give you personal help with your measuring problems. They have complete data on *–hp–* instruments, their performance, servicing and adaptability. Call the nearest *–hp–* field representative whenever, wherever you need help with a measuring problem.

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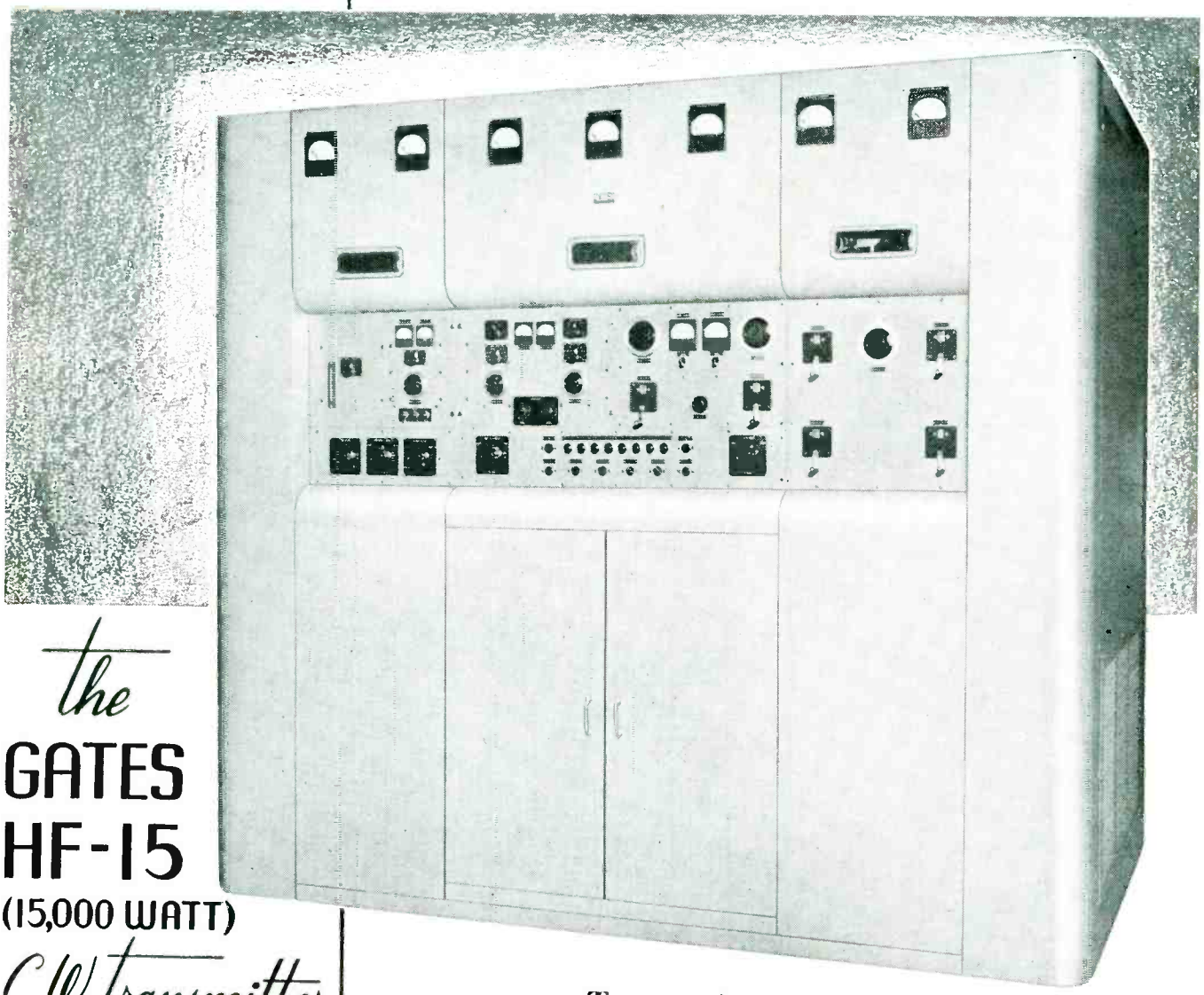
for International Communications



the GATES HF-15 (15,000 WATT) C.W. transmitter

. . . a new Transmitter

that will key at 400 W. P. M. a full 15000 watts,—designed for 4-22 megacycle operation and built for around the clock seven day a week operation.

The Gates HF 15 transmitter is only 8 feet wide, 7 feet high and 5 feet deep—is all self-contained and frequency change can be made in seconds. Operation is from 3 phase 220 volts or other primary voltages where required.

Soon off the press — a new catalogue on Gates communications transmitters and over a score of models in all power ranges to choose from. May we place your name on our mailing list?

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FOR GREATER LATITUDE IN PRODUCT DESIGN

Simple, dependable on-off switching is a must with many products . . . and generally, the shortest distance between the problem and the solution is a Honeywell Mercury Switch.

Honeywell Mercury Switches are tiny and compact . . . are adaptable to unusual mountings. They operate at low angles . . . have no moving parts . . . are sealed against dust, gas and corrosion. Fouled contact points cannot occur.

The complete line is at your command . . . offering greater latitude in product design, with improved performance and trouble-free operation. Write for a copy of new Catalog 1343 for down-to-earth information . . . or call in your local Honeywell engineer for a detailed discussion of a particular application.

BROWN INSTRUMENTS — WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL — BELFIELD VALVES

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FOR
- POSITIVE ACTION
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SPECIFY **HONEYWELL** *Mercury Switches*

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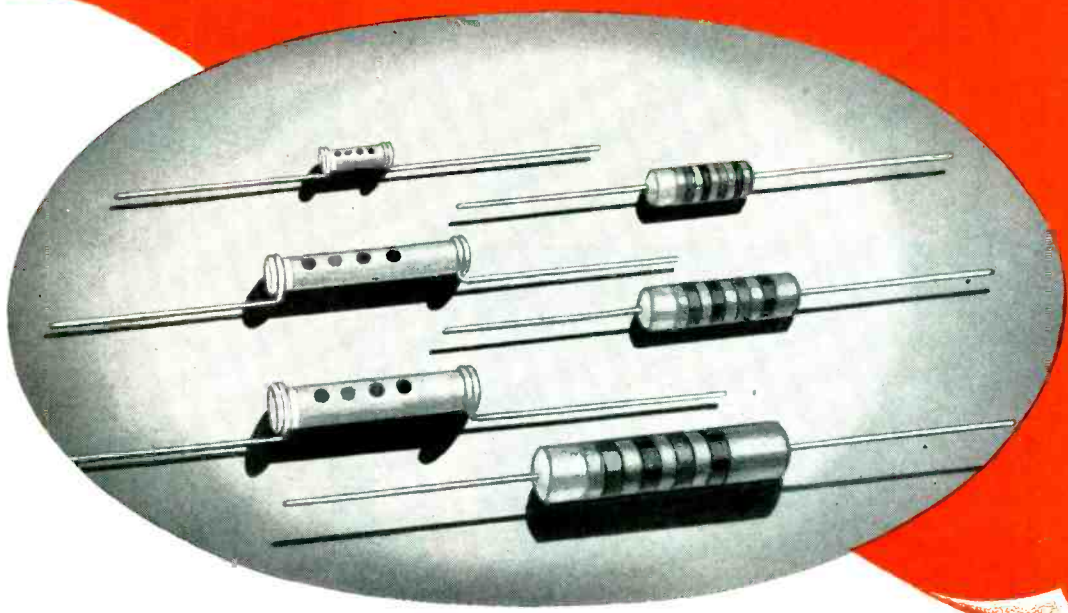
Erie "GP" Ceramicons*

meet every demand for ECONOMY and PERFORMANCE



QUANTITY production of "GP" Ceramic Condensers is achieved by limiting them to definite capacity values —with a consequent saving in cost without affecting quality. For by-passing and coupling applications which are not frequency determining, "GP" Ceramicons are unexcelled in performance.

General Purpose Ceramicons are sturdy, compact. They are easy to install in small spaces and their use increases production on the assembly line. This feature is proving especially valuable in assembling TV sets.

Erie "GP" Ceramicons are made in insulated and non-insulated styles in popular capacity values up to 10,000 MMF. Write for detailed information and samples.

*"GP" and Ceramicon are registered trade names of Erie Resistor Corporation.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND TORONTO, CANADA

WORTH LOOKING INTO!

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A·S·T·M TESTED
VARNISHED TUBINGS

SPECIFICATIONS		
GRADE	MAGNETO	RADIO
SIZES	43 SIZES FROM .022 TO 2" INSIDE DIA.	34 SIZES FROM .034" TO .625"
LENGTHS	BOTH GRADES AVAILABLE IN BUNDLES CONTAINING 42" STRANDS OR IN CONTINUOUS COILS ON SPOOLS.	
COLORS	STANDARD COLORS OF BOTH GRADES ARE BLACK AND YELLOW. OTHER COLORS SUPPLIED ON SPECIAL ORDER.	

IF IT'S TURBO IT SAFE-GUARDS

For *extra* dependability *AT NO EXTRA COST!*

TURBO Varnished Tubing is an excellent insulation for general applications. Supplied in two grades—Radio Grade for voltage to 4000 and Magneto Grade for voltages to 7000 — it features high tensile strength, good flexibility, non-peeling and non-cracking qualities, low moisture absorption, oil and acid resistance plus moderate cost. TURBO Varnished Tubing is a braided cotton sleeve thoroughly impregnated with a fine insulating varnish. Perfect concentricity facilitates wiring and a wide range of sizes meet all application needs. For further details, mechanical and electrical, write today on letterhead.

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EXCLUSIVELY PROCESSED FOR

- HIGHER TENSILE STRENGTH
- GREATER FLEXIBILITY
- ABSOLUTE CONCENTRICITY
- SLOW BURNING COMPOSITION
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An all-purpose insulation wherein the dielectric strength factor does not involve the requirements of the higher ranges: Flexible, high tensile strength, low moisture absorption, acid and oil resistant; slow-burning. In cotton, rayon and glass base; C-1, C-2, C-3 grades.

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- **SATURATED SLEEVING** An all-purpose sleeve insulation for low and medium high voltages. Flexible, strong, low absorption, acid and oil resistant, slow burning.
- **EXTRUDED SLEEVING** Excellent for low temperature service, resists embrittlement under sub-zero temperature. High dielectric strength, low moisture absorption.
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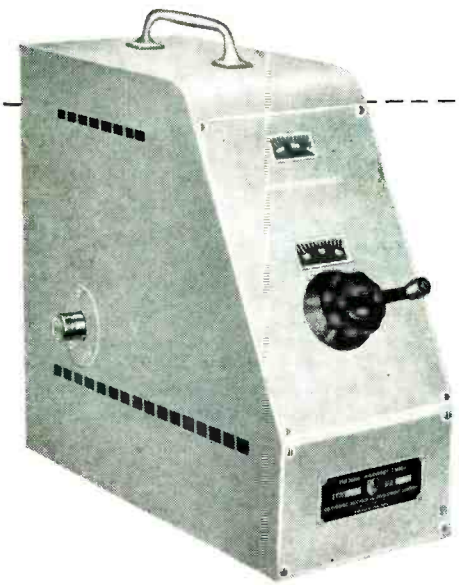
- **REL 16-A TUBING** A super-flexible dielectric capable of withstanding operating temperatures of 105° Centigrade continuously and higher intermittently.

a NEW domain for TELEVISION

and new UHF-TV Test Equipment by PRD

Type 584 UHF Frequency Meter
470-890 MC/SEC.

- DIRECT READING FREQUENCY DIAL, CONTINUOUSLY VARIABLE
- HIGH-Q CAVITY
- PRECISE CALIBRATION
- RESOLUTION BETTER THAN 0.1 MC/SEC.



Type 901 UHF Sweep Frequency Oscillator 470-890 MC/SEC.

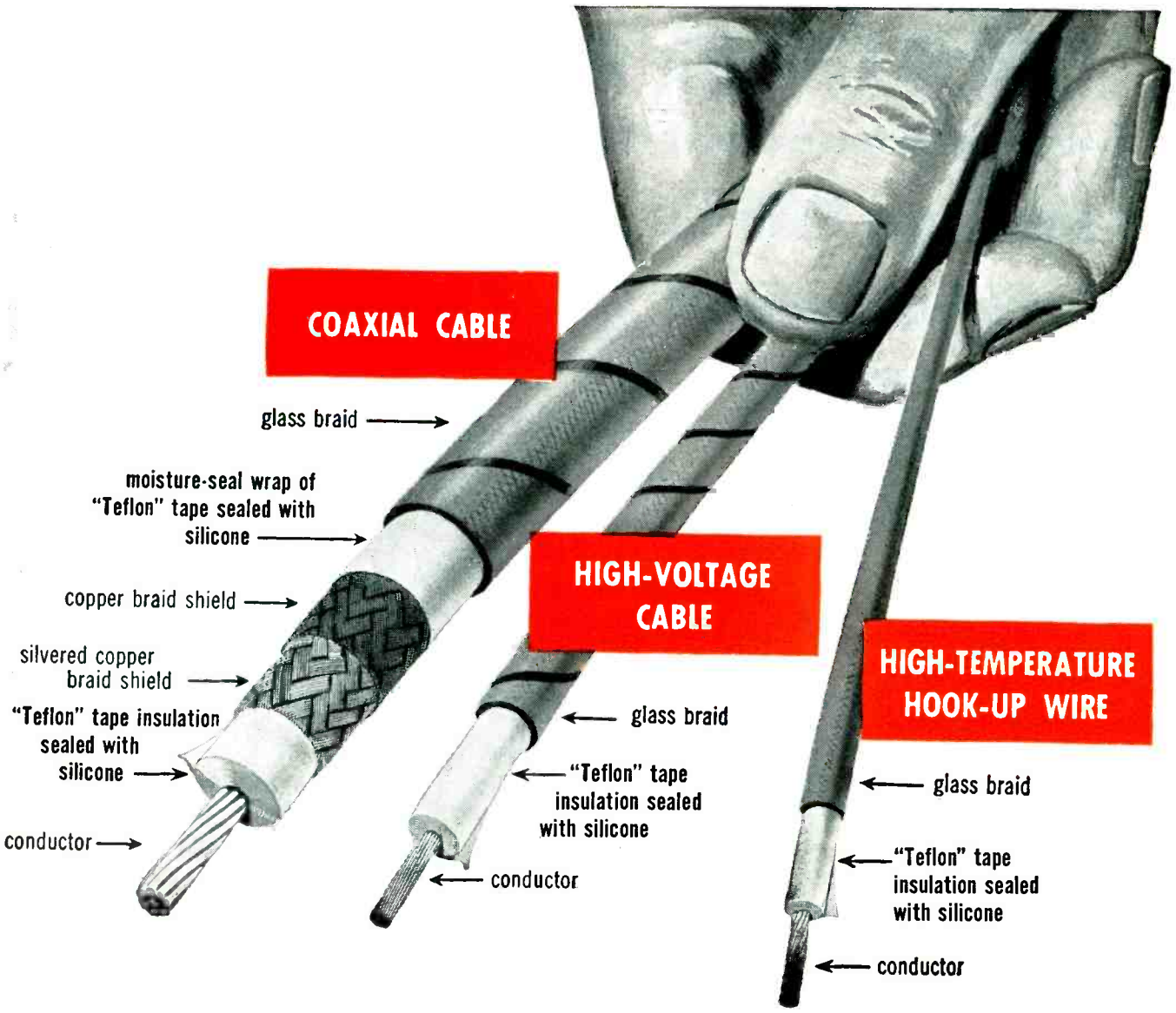
- DIRECT READING FREQUENCY DIAL, CONTINUOUSLY VARIABLE
- ADJUSTABLE SWEEP WIDTH, CALIBRATED 0 to 30 MC/SEC.
- ADJUSTABLE OUTPUT, 100 μ VOLTS TO 2 VOLTS
- FOUR-POSITION PHASE SELECTOR FOR OSCILLOSCOPE CENTERING

The expansion of television program transmission into the realm of distributed circuits has made it possible for PRD to apply its microwave "know-how" to the development of test equipment for the important new UHF-TV band.

First of a whole series soon to be offered, the instruments illustrated embody features essential to the rapid and accurate determination of receiver characteristics in the laboratory or on the production line.

See these instruments at our booth at the 1950 IRE Show. Our catalog of Microwave Test Equipment may also be had upon request; for full information write to Dept. E-6.

Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc.
202 TILLARY STREET, BROOKLYN 1, NEW YORK



"TEFLON"* TAPE INSULATION SERVES FROM -80° TO 500°F.

No other available material has the combination of low electrical losses and heat-resistance of Du Pont "Teflon" tetrafluroethylene resin.

"Teflon" tape is seeing wider and wider use in such applications as insulation for wire and cable, ground insulation for motors and generators, conductor and layer insulation in transformers and coils. Its power factor is less than 0.0005 and its dielectric constant only 2.0 over the entire spectrum measured to date, 60 cycles to 30,000 megacycles. Its dielectric strength is excellent and is unaffected by temperature changes up to at least 400°F. The tape gives service up to 500°F. "Teflon" tape has excellent mechanical strength and pliability . . . at temperatures as low as -80°F. In wrapped construction it fits even more tightly as the temperature is raised. It has zero water-absorption, and is unaffected by outdoor weathering.

"Teflon" is supplied by Du Pont in the standard shapes of rods, tubes, sheets, beading, and tape, and in molding powder, both shredded and granular. WRITE NOW for more data on the properties and electrical uses of "Teflon"!

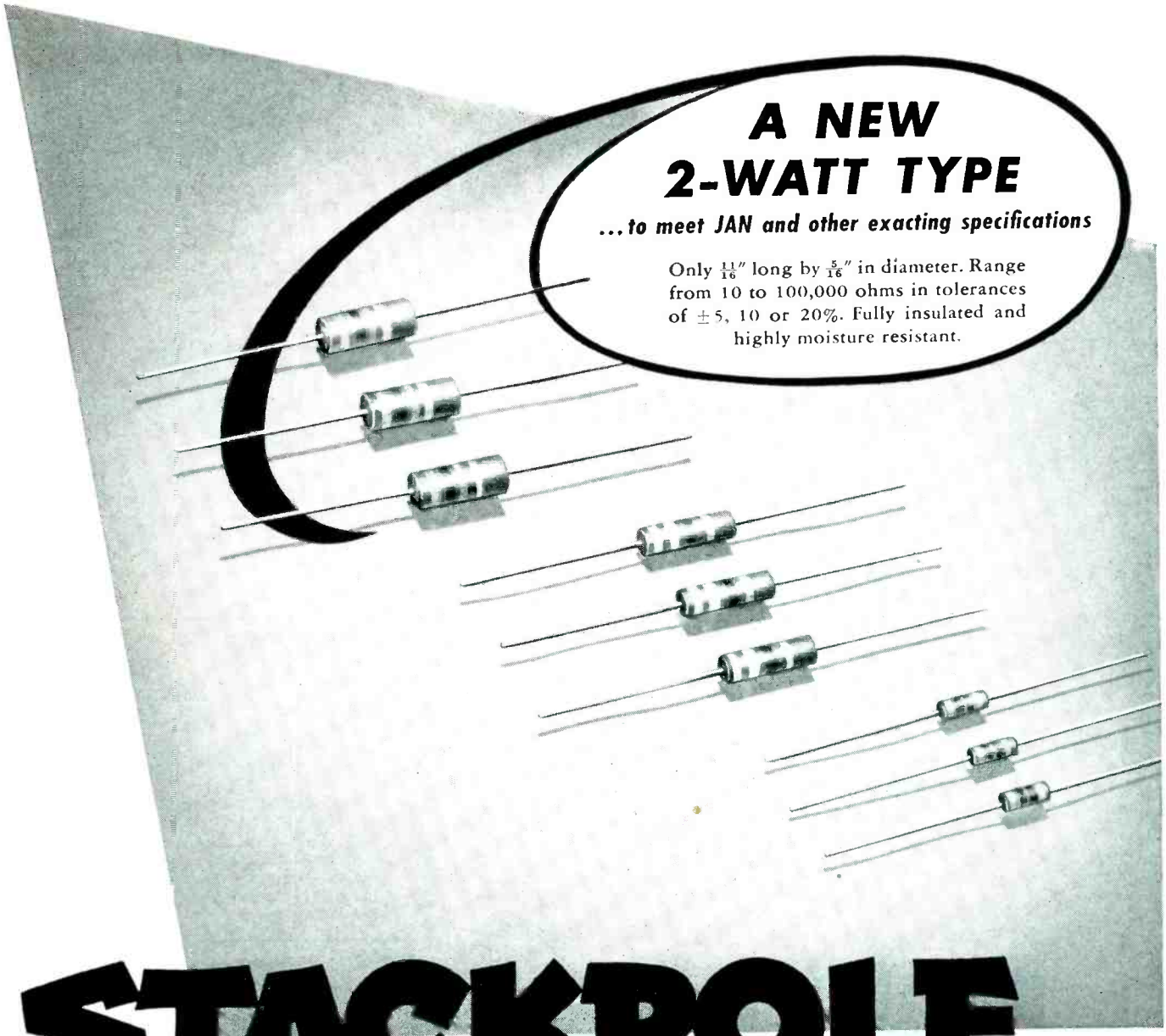
E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Main Sales Offices: 350 Fifth Avenue, New York 1, New York; 7 South Dearborn Street, Chicago 3, Illinois; 840 East 60th Street, Los Angeles 1, California.

*TRADEMARK REG. U. S. PAT. OFF.

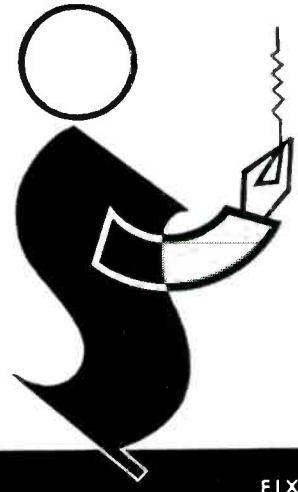
(Wire and cables shown above made with "Teflon" Tape by Boston Insulated Wire & Cable Co., Boston, Mass.)

Tune in to Du Pont "CAVALCADE OF AMERICA," *Tuesday nights—NBC coast to coast.*

DU PONT
REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY



STACKPOLE



FIXED RESISTORS

Stackpole fixed resistors of molded carbon composition are now available in a complete range of ½-, 1- and 2-watt sizes to match modern design and production requirements. Deliveries are good—quality and prices are right—and Stackpole engineers welcome the opportunity to cooperate in matching your specifications to the letter. Samples to quantity users on request.

ELECTRONIC COMPONENTS DIVISION

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

FIXED AND VARIABLE RESISTORS • IRON CORES • SINTERED ALNICO II PERMANENT MAGNETS • INEXPENSIVE LINE AND SLIDE SWITCHES • CONTACTS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT . . . *and dozens of carbon and graphite specialties*

(Model 901) PORTABLE TEST INSTRUMENTS available in DC, Model 901—and AC, Model 904, single and multiple ranges of wide coverage. Excellent scale readability and shielding. Accuracy within ½ of 1%.

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

(Model 622) ULTRA-SENSITIVE INSTRUMENTS portable DC and AC Thermo instruments for precision measurement of potentials and minute currents involving electronics, thermo-couples or laboratory research.

INSTRUMENTS

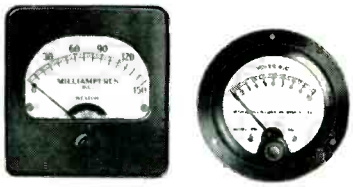
TO SPEED AND SIMPLIFY ELECTRONIC PRODUCTION AND MAINTENANCE

Illustrated are but a few of the many specialized instruments available from WESTON . . . all designed to simplify and speed-up electrical and electronic installations, production testing, and maintenance. For details, see your local representative, or write Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

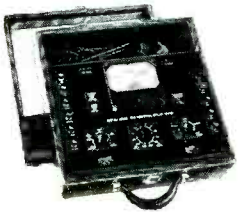
ALBANY • ATLANTA • BOSTON • BUFFALO • CHARLOTTE • CHICAGO
CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HOUSTON
JACKSONVILLE • KNOXVILLE • LITTLE ROCK • LOS ANGELES
MERIDEN • MINNEAPOLIS • NEWARK • NEW ORLEANS • NEW YORK
ORLANDO • PHILADELPHIA • PHOENIX • PITTSBURGH • ROCHESTER
SAN FRANCISCO • SEATTLE • ST. LOUIS • SYRACUSE • TULSA
IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.

(Model 798) MULTI-PURPOSE TUBE-CHECKER offering provision for testing Receiving Tubes — Voltage Regulator Tubes—Light Duty Thyratron Tubes such as 2A4—6D4—884—885—2051. Scale is calibrated "Good-Bad" as well as in mutual conductance range.



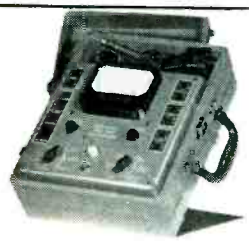
PANEL and SWITCHBOARD INSTRUMENTS a complete line of instruments in all types, sizes and ranges required for switchboard and panel needs . . . including DC, AC power frequencies and radio frequency, rectifier types and D.B. meters.

(Model 697) VOLT-OHM MILLIAMMETER one of a line of pocket-size meters, Model 697 combines a selection of AC and DC voltage, DC current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



(Model 785) INDUSTRIAL CIRCUIT TESTER a versatile, portable tester for laboratory or maintenance needs, where an ultra-sensitive instrument is required. Provides 27 AC and DC voltage, AC and DC current, and resistance ranges. (DC sensitivity 20,000 ohms per volt.)

(Model 779, Type 1) SUPER-SENSITIVE ANALYZER small, light, compact, 26 range Volt-Ohm-Milliammeter with 5 DC voltage ranges, sensitivity of 1000 or 20,000 ohms per volt. AC temperature compensated. Self-contained power supply. Ideal for many production and test requirements.



(Model 769) ELECTRONIC ANALYZER incorporating a conventional Volt-Ohm-Milliammeter with self-contained power source—a high-impedance electronic Volt-Ohmmeter using 115 volt, 60 cycle power—a stable, probe-type, Vacuum Tube Voltmeter, for use to 300 megacycles.

Ideal tube for electronic equipment that

SEALS AND STITCHES PLASTICS

"HERE'S THE ANSWER TO YOUR NEED FOR A COMPACT, ECONOMICAL V-H-F TUBE TO POWER YOUR NEW HEATER. PROVED WIDELY IN INDUSTRY!"

PLASTIC film and sheet are "taking over" where protection from moisture or chemicals is vital. Shop-windows feature plastic rainwear. Acid-proof work garments shield from noxious liquids. Packages are plastic-sealed against dampness. Moreover, plastic wallets, handbags, novelties of all types are pouring off production lines.

Millions of yards of plastic material are being sealed and stitched, with electronic heating doing the whole job. Certainly, here's a steady, growing market for h-f-heating equipment . . . and just as surely, you want your share of this important business.

Build your circuit around General Electric's great GL-592 power tube! Its special suitability for the work, its reliability and "toughness", are industry-demonstrated. The tube carries substantial plate ratings. For still more power, a pair or two pairs may be used without undue increase in cost of the equipment. Frequency range is high. The tube is exceptionally efficient, with conversion efficiencies above 70 percent the rule in well-designed circuits. Cooling offers no problem, merely calling for an 8-inch household-type fan or a small and inexpensive pressure blower.

Ample tube stocks are available, along with sockets, grid connectors, and finned anode connectors. Specify and install—there'll be no intervening delay! You owe it to yourself as designer or builder of h-f-heating equipment to study the economical GL-592's application in *your* circuit. G-E tube engineers will be glad to assist. Phone your nearby G-E electronics office, or wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-592 POWER TRIODE

Study these SUPERIOR G-E design features!

- A one-piece graphite anode, with no welds, accents the tube's mechanical strength. Zirconium coating provides excellent heat-radiating properties and helps maintain high vacuum.
- Large-diameter anode lead is sturdy, also makes for low inductance.
- The GL-592 has a combined seal-and-anode-terminal of unit construction. No cemented cap or screw connections are used. Good for the life of the tube!
- Filament leads are solidly braced for greater internal strength.
- Large-diameter G-E cup seals of matching metal and glass feature all terminals.
- External leads and seals are silver-plated for better conductivity.

RATINGS

Class C Power Amplifier and Oscillator

Filament voltage		10 v
Filament current		5 amp
Max ratings:	CCS	ICAS
d-c plate voltage	3,500 v	3,500 v
d-c grid voltage	—500 v	—500 v
d-c plate current	250 ma	350 ma
d-c grid current	50 ma	100 ma
plate input	670 w	1,000 w
plate dissipation	200 w	300 w
Type of cooling		forced-air
Frequency at max ratings		150 mc

GENERAL ELECTRIC

160-J25

They "Stack Up" For Heavy Industrial Use!

Seletron

Reg. Trade Mark

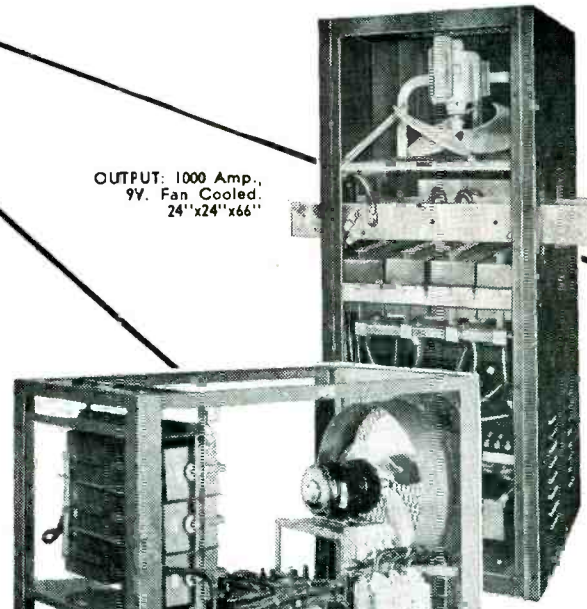
SELENIUM RECTIFIERS

POWER PACKS using Seletron Selenium Rectifiers range in output all the way up to 75 KW — They aren't made just in the "dainty" sizes also available for radio and television. The rugged, high powered Seletron Rectifiers are ideal for diversified industrial applications because of their flexibility and high efficiency over a wide range of load.

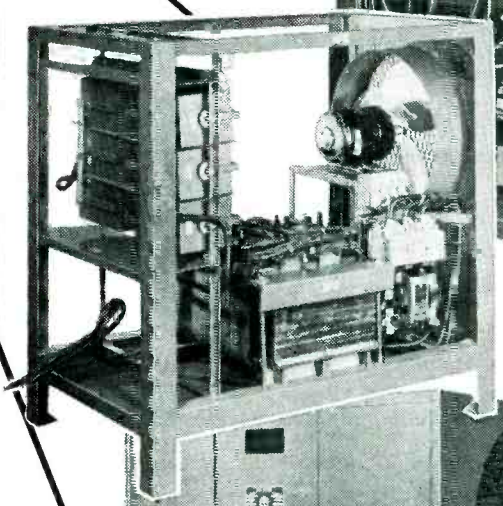
Pictured are a few applications for industry as developed by Seletron users. Clockwise from top right: Power Packs for electroplating and similar processes; for general industrial use; and elevator operation.

How about *your* rectification problems? Seletron engineers will be glad to discuss them with you. Write Dept. ES-25

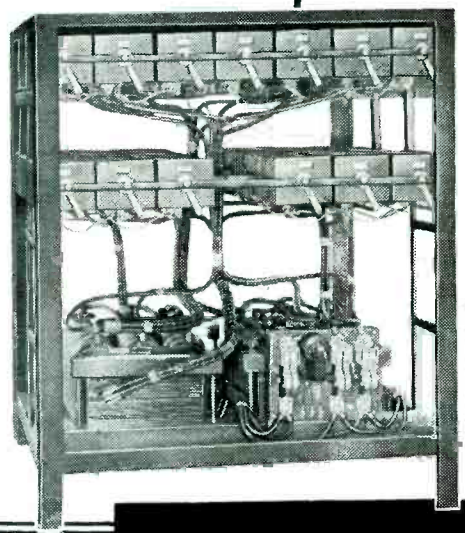
OUTPUT: 1000 Amp., 9V. Fan Cooled. 24"x24"x66"



OUTPUT: 25 KW, 230V. Fan Cooled. 24"x48"x48"

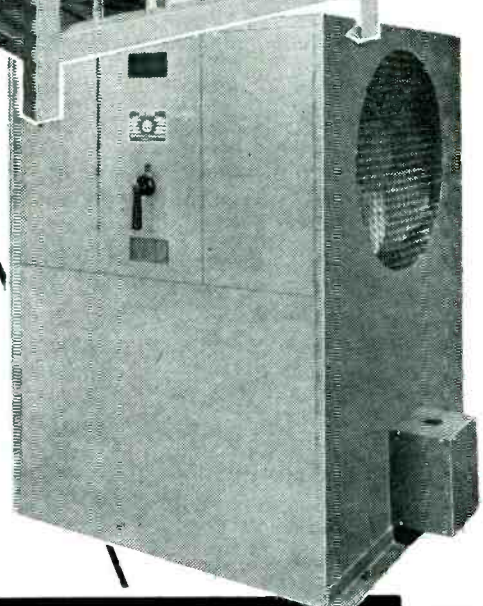


OUTPUT: 45 KW, 220V. Convection Cooled. 3½'x4½'x2½'



Let us send you our bulletin. It includes interesting technical data regarding the use of selenium rectifiers.

OUTPUT: 75 KW, 230V. Fan Cooled. 6'4"x5'10"x4'7"



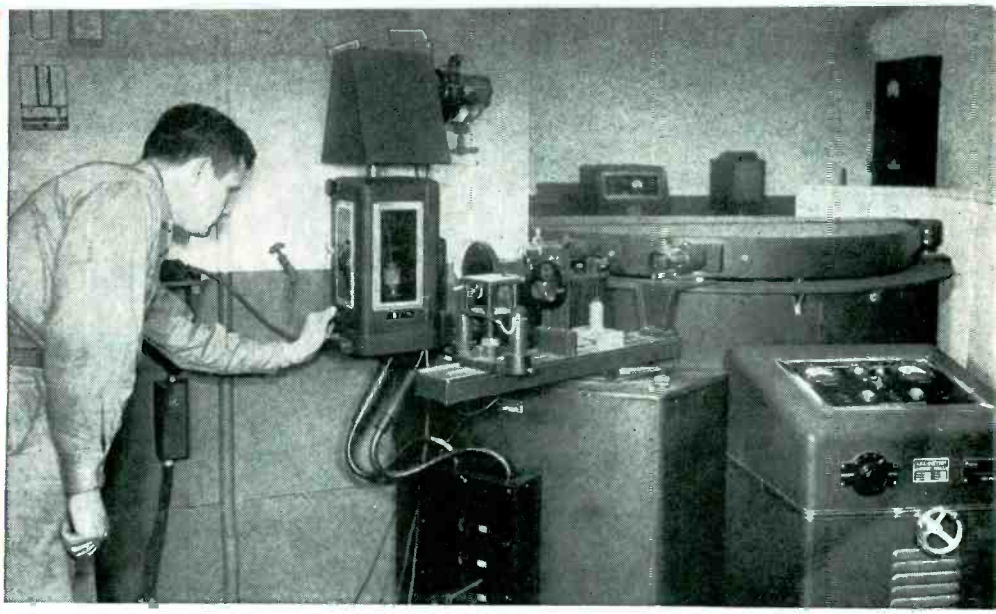
SELETRON DIVISION

RADIO RECEPTOR COMPANY, INC.

Since 1922 in Radio and Electronics

Main Office & Factory: 84 North 9th St., Brooklyn 11, N. Y. • Sales Department: 251 West 19th St., New York 11, N. Y.

Only the BEST pass these tests



The spectrograph provides one of the most efficient means for precise metallurgical control. Samples taken from a heat in the Driver-Harris melting furnaces are analyzed so rapidly by means of this apparatus, that a complete analysis can be obtained before the next heat is ready for pouring. Thus any necessary adjustments can be made immediately—an outstanding advantage in controlling the constituent elements of alloys being produced to extremely close specifications. The operator is here seen adjusting the size of the analytical gap in the arc-spark stand of the Driver-Harris grating spectrograph at the start of an exposure.

The quality of any manufactured item depends upon a number of factors, but on none so much as "inspection". And here, at Driver-Harris, we give top priority to inspection.

Through every stage of manufacture, precise metallurgical checks and controls are systematically applied to D-H Alloys to insure quality and uniformity that are unsurpassed—recognized the world over.

We have had 50 years' experience in continuous alloy research and manufacture. Every piece of D-H wire, ribbon or strip, and every casting embodies advantages such as only half a century of accumulated know-how can provide.

Whatever your requirements for electrical resistance and heat-resisting alloys, send us your specifications. We shall be glad to make recommendations, and supply you with the alloy best suited to your needs.

This operator is viewing the projection of a series of spectrograms, and is about to measure the intensity of specific spectral lines to determine the quantity of certain chemical elements in the samples being analyzed.

The research metallograph, the ultimate in metallurgical microscopes, is applied to both research and quality control at Driver-Harris.

A view in the Driver-Harris chemical laboratory —fully equipped for all standard types of volumetric, gravimetric and colorimetric analyses.

FIFTIETH ANNIVERSARY — SPECIAL PURPOSE ALLOYS SINCE 1890 — TRADE MARK REG. U.S. PAT. OFF.

*Makers of over 80 alloys for the electronic, electrical and heat-treating fields—including world-famous Nichrome**

Driver-Harris Company

HARRISON, NEW JERSEY

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

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

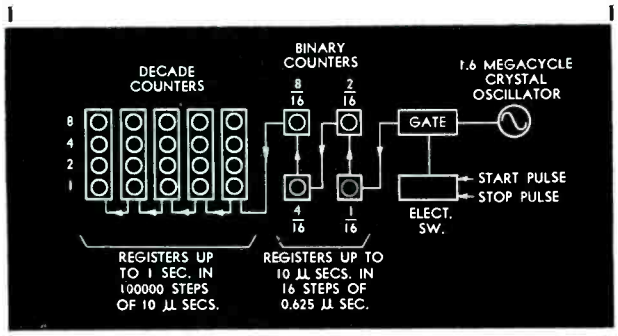
Divides a second into 1,600,000 parts—

1.6 MEGACYCLE COUNTER-CHRONOGRAPH

INSTRUMENT Potter COMPANY

APPLICATIONS:

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



FEATURES:

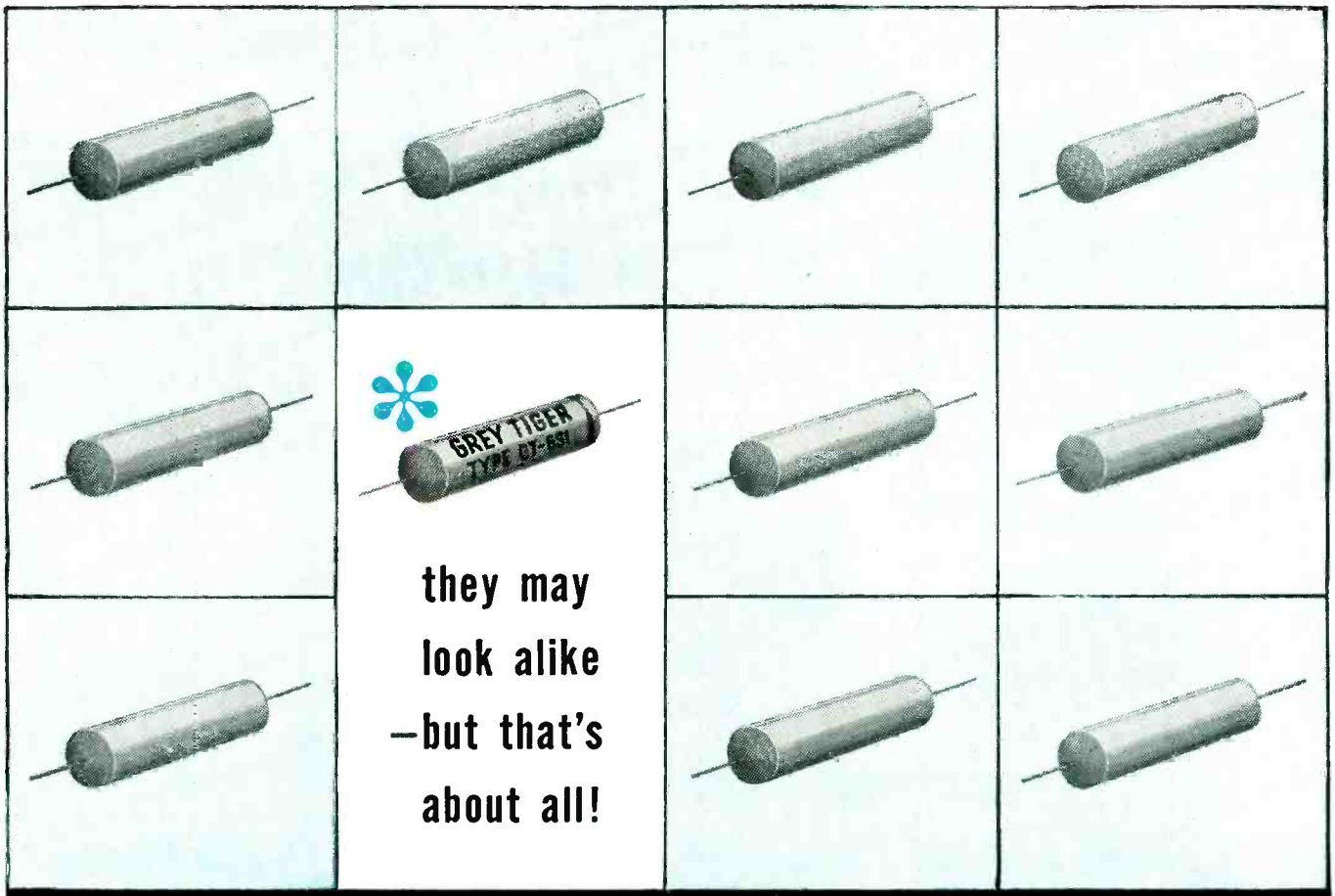
- **High Resolution and Accuracy—1/1,600,000 second.**
- **Direct Indication of intervals up to one second — recycling of counter can be observed or recorded for longer intervals.**
- **Retains Indication of measurement until reset.**
- **Easy to actuate — pulses from common or separate sources can be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

PRINCIPLE OF OPERATION:

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

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

POTTER INSTRUMENT COMPANY
INCORPORATED
136-56 ROOSEVELT AVENUE • FLUSHING • NEW YORK



they may look alike —but that's about all!

* CORNELL-DUBILIER CAPACITORS

may look like others, too...

but... there's quite a difference in performance, as most engineers know. That's why the overwhelming majority of engineers specify Cornell-Dubilier. There's one way you, too, can be sure of capacitors that won't let you down. That's to specify C-D s. Into the making of each unit goes engineering experience resulting from 40 years of concentration on capacitors. So why take chances? Our engineering-service department will gladly answer your inquiry. Catalogs on request.

Cornell Dubilier Electric Corporation, South Plainfield, New Jersey, Dept. L109. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I., Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

CORNELL-DUBILIER
CONSISTENTLY DEPENDABLE
★ CAPACITORS
★ VIBRATORS
★ ANTENNAS
★ CONVERTERS

TYPICAL OF THE C-D LINE OF CAPACITORS WITH BUILT-IN QUALITY CHARACTERISTICS IS THE

TYPE GT

"GREY TIGER" HIGH TEMPERATURE PAPER TUBULAR CAPACITOR

The "Grey Tiger" Vikane impregnated tubular capacitor has won wide acclaim in the industry as an economical, durable and stable tubular. A few of the many desirable features of this unit are:

• Vikane impregnation assures long life at high temperatures • exclusive C-D moisture seal and tube impregnation designed to stand temperatures up to + 100°C • nsulation resistance above 10,000 megs per unit at 25°C or 2000 meg mfds. • P.F. averages 0.35% at 1,000 cycles • excellent capacity stability over wide temperature range. An efficient, utilitarian tubular built to do a dependable job.

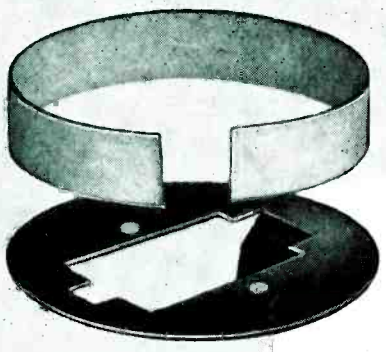
C-D Best by Field Test!

1918 CD CAPACITORS 1949

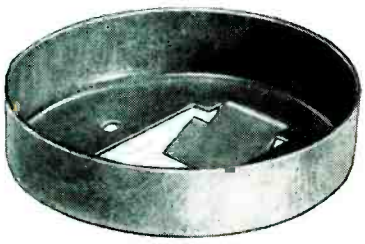
Reg. U. S. Pat. Off.

ROGERS HELPS CUSTOMER IMPROVE MICROPHONE INSULATION

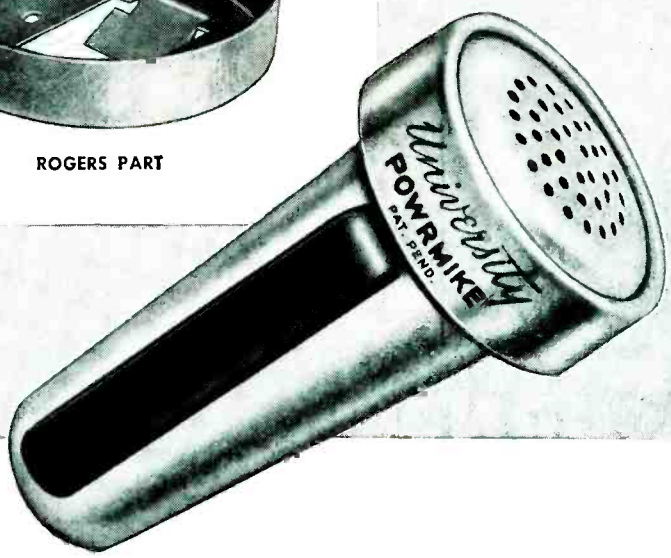
30% REDUCTION IN MATERIAL COSTS EFFECTED BY DESIGN CHANGE



ORIGINAL INSULATION



ROGERS PART



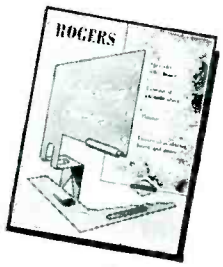
One part instead of two . . . reduced assembly time . . . a savings of approximately 30% in raw materials cost . . . improved insulation . . . are the benefits derived by University Loudspeakers, Inc., White Plains, N. Y. as a result of using a Rogers material and Rogers fabricating services.

The two-piece insulation previously devised for the carbon button assembly in the revolutionary University Powrmike microphone required an excessive amount of assembly time. In addition, because it was fairly tricky to handle, there was a possibility of poor insulation due to improper assembly, a condition that would lead to high rejections in production and a possibility of breakdown in the field.

Rogers fabricated the new one-piece component of DUROID. This new Rogers material offers many new advantages to users of fibrous materials either for insulating or structural purposes. It is similar to vulcanized fibre, but is non-brittle and is capable of being formed, drawn and shaped.

Never take your fibrous insulating components for granted — their costs, either. Rogers specialized fabricating services on fibrous and laminated parts are saving money for many manufacturers. It will pay you to see Rogers first on any such components.

Write for catalog on Rogers Fabricating Services. →



FABRICATING DIVISION, DEPT. E

ROGERS CORPORATION

GOODYEAR, CONNECTICUT

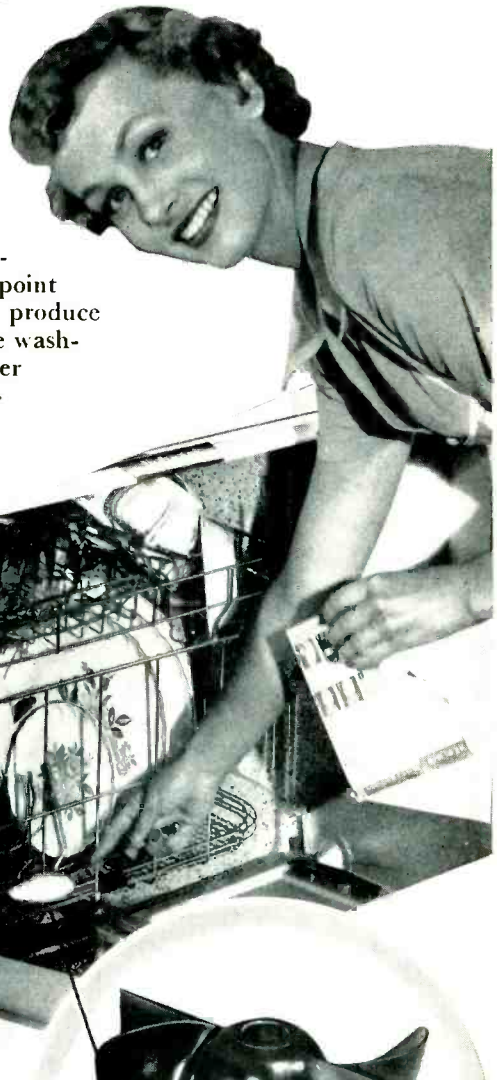
ROGERS

SPECIALTY FIBRE PRODUCTS
ELECTRICAL INSULATING BOARDS AND PAPERS
DUROIDS • SHOE PRODUCTS

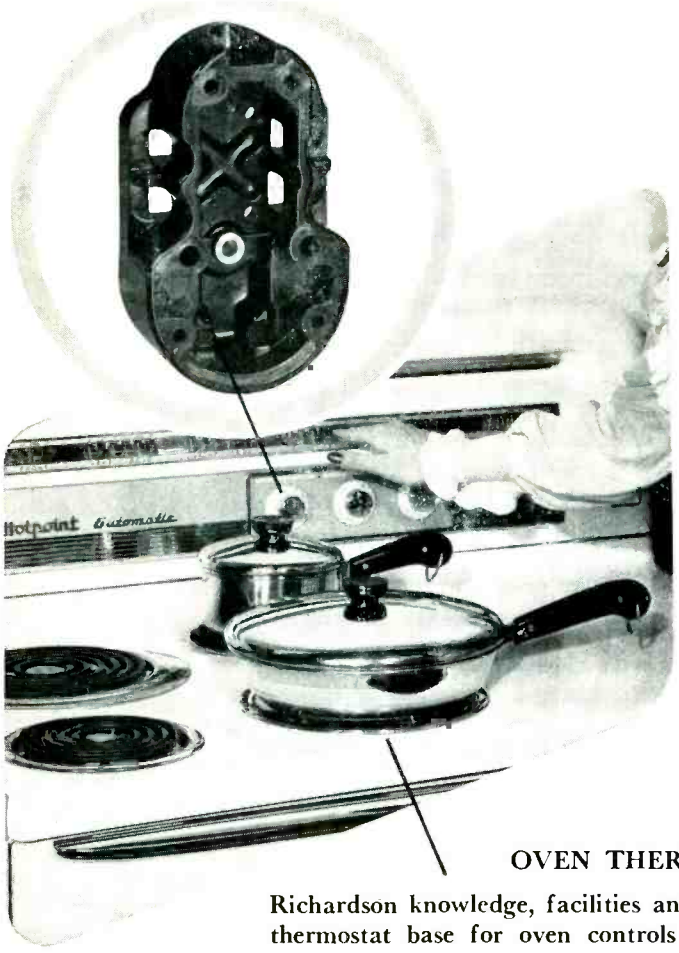
MOLDING AND LAMINATING PLASTICS
Boards • Blanks • Pre-shaped Preforms
High Strength Molding Compounds
Laminated Phenolics

COMPLETE FABRICATING SERVICES
ON FIBROUS MATERIALS AND
LAMINATED PHENOLICS

TWO VITAL Hotpoint PARTS OF INSUROK



IMPELLER FOR AUTOMATIC DISHWASHER — Richardson ability and experience were important factors in producing this intricate molded part for Hotpoint Automatic Dishwashers. Precision molding was important to produce a perfectly balanced impeller for high-speed rotation during the washing, rinsing and drying cycles. This Richardson-molded impeller has a smooth finish, requires a minimum of finishing and fabricating operations and is impervious to water and soaps or detergents.



OVEN THERMOSTAT BASE

Richardson knowledge, facilities and skill produced this intricate Bakelite thermostat base for oven controls on the Hotpoint Range. The metal insert is accurately positioned. The electrical and mechanical properties of this Richardson-molded part undergo precision tests following assembly.

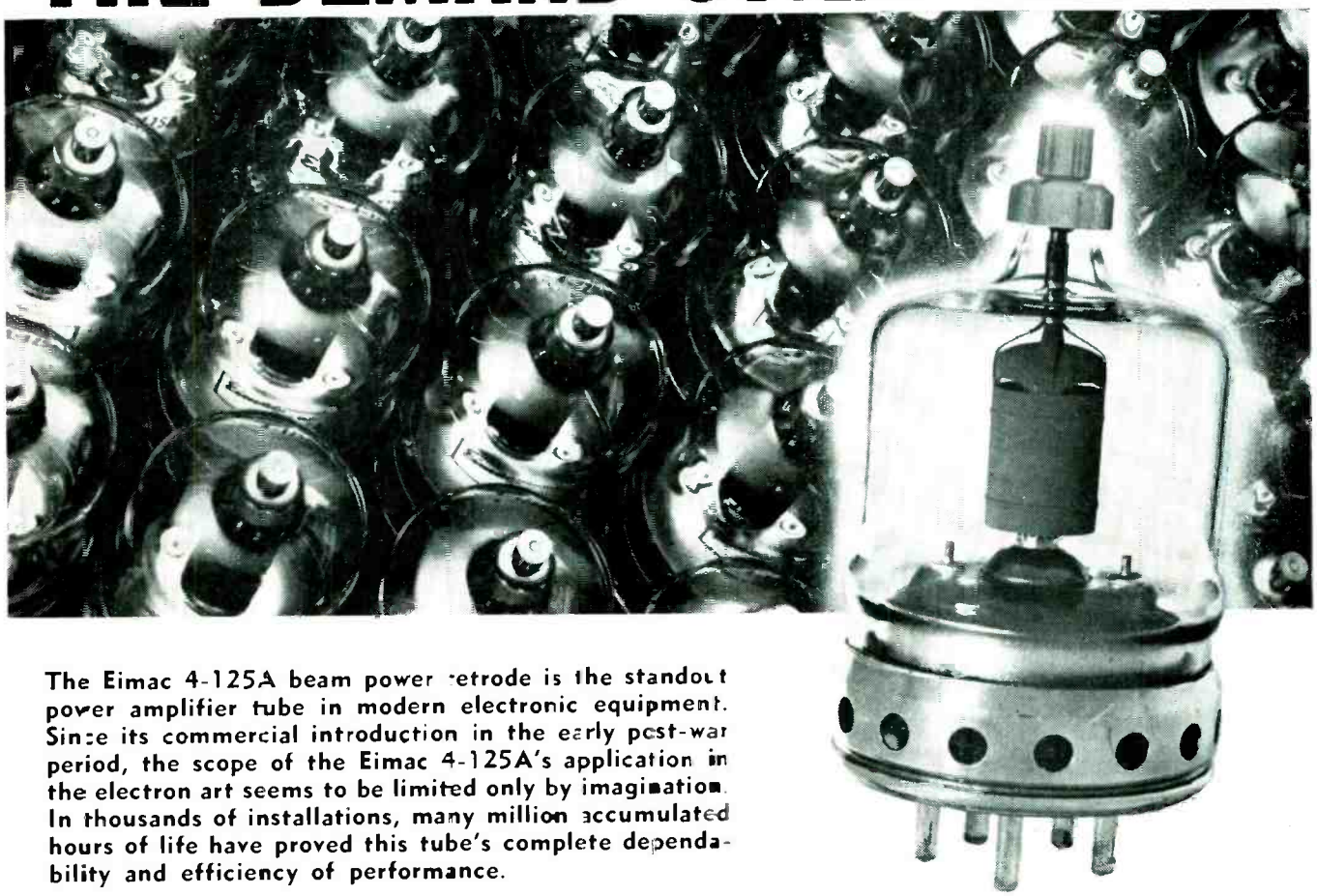
Send specifications or blueprints . . . learn, without obligation, how Richardson facilities and services might go to work for you.

INSUROK *by* RICHARDSON
Dependable names in plastics

The RICHARDSON COMPANY
GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858
Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND • DETROIT • INDIANAPOLIS • MILWAUKEE • NEW BRUNSWICK, (N. J.) • NEW YORK • PHILADELPHIA • ROCHESTER • ST LOUIS

THE DEMAND STILL GROWS



The Eimac 4-125A beam power tetrode is the standout power amplifier tube in modern electronic equipment. Since its commercial introduction in the early post-war period, the scope of the Eimac 4-125A's application in the electron art seems to be limited only by imagination. In thousands of installations, many million accumulated hours of life have proved this tube's complete dependability and efficiency of performance.

Incorporated in the design of the 4-125A are many features contributing to its outstanding capabilities. Most notable among these are:

Its pyrovac plate which enables the tube to withstand high momentary overloads.

Its processed non-emitting grids which impart the operational stability universally associated with this tube.

Its internal input-to-output-circuit shielding which allows considerable simplification of associated circuitry.

Its well engineered mechanical structures that make the tube physically rugged and maintain precise element alignment.

Detailed data and application notes on the Eimac 4-125A tetrode are, upon request, immediately available. Assistance in unusual application problems involving the use of the 4-125A is offered as a service of the Eimac Field Engineering Department.

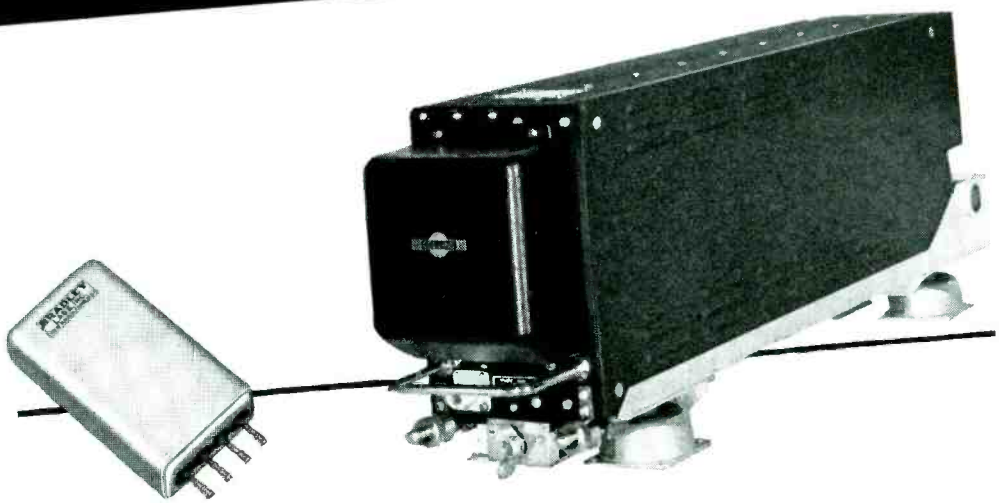
EIMAC 4-125A POWER TETRODE	
Electrical Characteristics	
Filament: Thoriated tungsten	
Voltage	5.0 volt
Current	6.5 amp
Grid-Screen Amplification Factor (Average)	6.2
Direct Interelectrode Capacitances (Average)	
Grid-Plate (Without shielding, base grounded)	0.05 μuf
Input	10.8 μuf
Output	3.1 μuf
Transconductance (i_b = 50 ma., E_b = 2500 v., E_{c_1} = 400 v.)	2450 μmhos
Maximum Ratings (Class-C FM or Telegraphy, key-down conditions, 1 tube)	
Plate voltage, d-c	3000 volts
Plate current, dc	225 ma.
Screen voltage, d-c	400 volts
Grid voltage, d-c	-500 volts
Plate dissipation	125 watts
Screen dissipation	20 watts
Grid dissipation	5 watts

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

243

A BRADLEY CASE HISTORY



BRADLEY RECTIFIER SOLVES DEMODULATING DIFFICULTY

Collins Radio Company, in its 51R-2 aircraft receiver, uses a Bradley hermetically sealed vacuum-processed selenium rectifier for demodulating an FM signal which provides navigation information in the newly developed omni-range system.

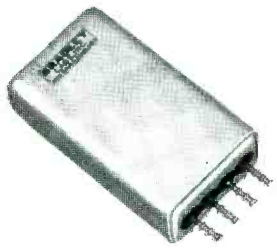
"We were," says Collins, "at one time having considerable trouble in this circuit. Your rectifiers remedied this situation completely. They have contributed a great deal in enabling us to obtain the required performance in our 51R-2 receiver.

"The characteristics of the rectifier are retained even under the extreme variation of temperatures stipulated by the Civil Aeronautics Administration in testing suitability for use in scheduled airlines service."

Through its exclusive vacuum process, Bradley has solved the problem of producing selenium and copper oxide rectifiers that are uniform and consistently true to rating. For improved power conversion in your product, consult Bradley engineers. They can help you obtain the right rectifier for your application.

THE BRADLEY LINE

SELENIUM RECTIFIERS
•
COPPER OXIDE RECTIFIERS
•
SELF-GENERATING PHOTOCELLS



SELENIUM SE8L

SPECIFICATION DATA

1. Reverse current at 150 volts DC 15 microamperes maximum at plus 72° C. to minus 50° C.
2. Forward current at 42 volts DC from 700 microamperes minimum to 2 milliamperes maximum at plus 72° C. to minus 50° C.
3. The unit shall be capable of operating continuously within limits at 95% relative humidity.

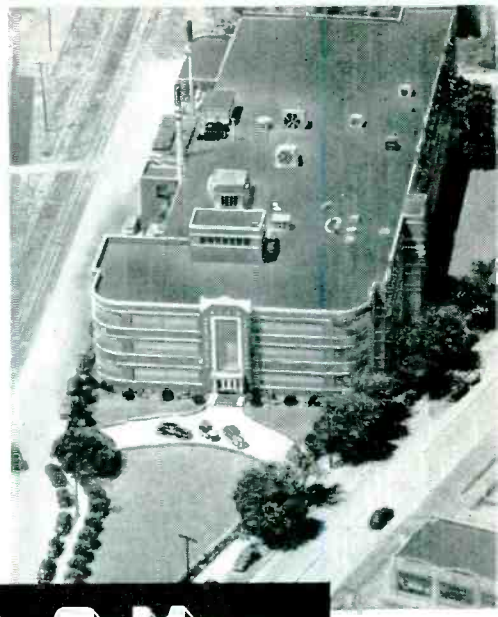
BRADLEY LABORATORIES, INC. 82 MEADOW STREET NEW HAVEN 10, CONN.

final inspection

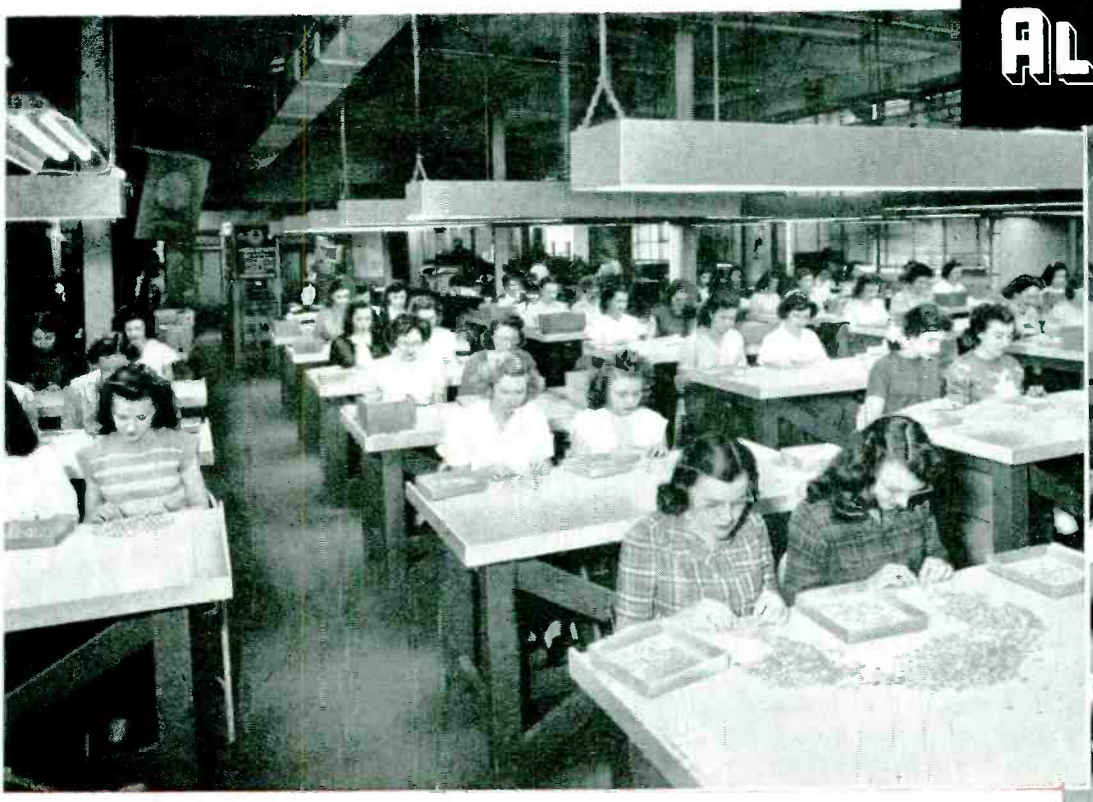
gives you assurance that

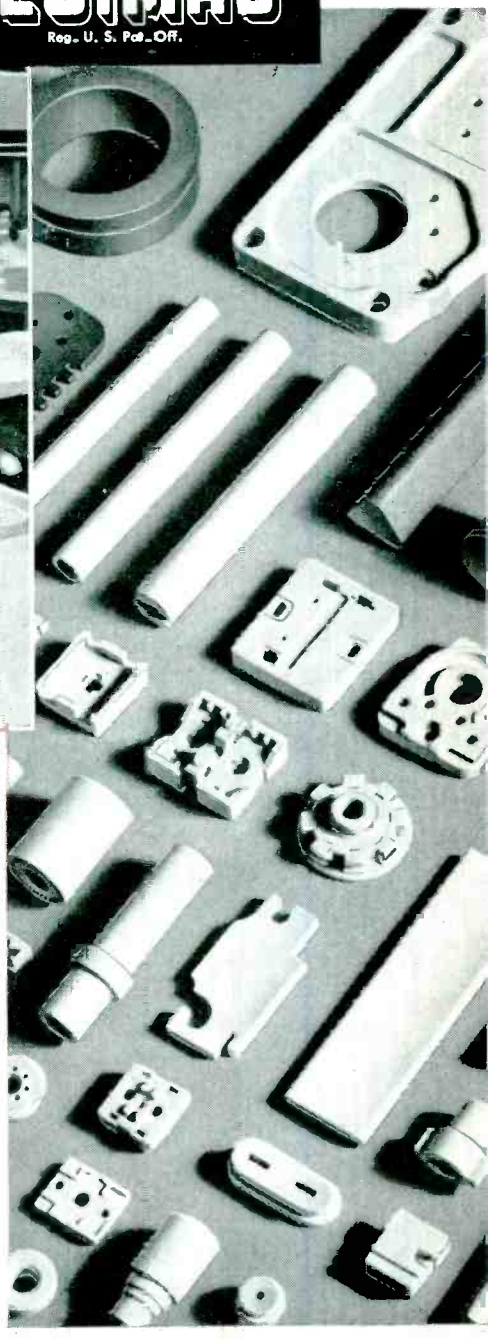
AlSiMag Custom Made Technical Ceramics

are within the specifications you set



AlSiMag
Reg. U. S. Pat. Off.





Quality control plus careful final inspection have earned AlSiMag a reputation for exceptional quality.

Quality control at every step of production permits an unusually high percentage of AlSiMag production to be OKehed promptly at final inspection.

Final inspection is guided by your specifications. It varies from simple visual inspection to elaborate individual physical or electrical tests. Practically every known inspecting device is available including flash-over electrical gang testers, dye checks for density and invisible checking; camera, pin, plug, dial and go or no go gauges; Arma electric sorting machines, optical projectors for dimensional accuracy of profile. Where unusual and especially rigorous final inspections are required, the facilities of the Research Division are available.

AMERICAN LAVA CORPORATION

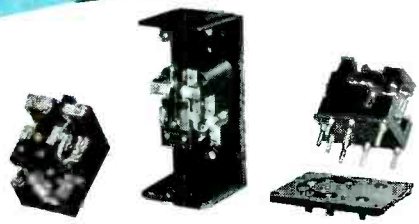
48TH YEAR OF CERAMIC LEADERSHIP

CHATTANOOGA 5, TENNESSEE

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

Digest

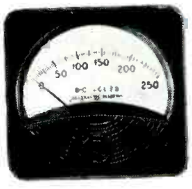
TIMELY HIGHLIGHTS ON G-E COMPONENTS



HEAVY-DUTY RELAYS THAT MOUNT 3 WAYS

This versatile, general-purpose, heavy-duty, a-c relay unit is available in three mounting arrangements: front connected, back connected, or plug-in connected. All three mounting types are available in open or enclosed models and are furnished in spst, dpst, or dpdt circuits. Heavy, long-lasting silver contacts carry 10 amps continuous. Normally-open forms make or break 45 amps; normally-closed forms make or break 20 amps. Relay coils come in 12-, 24-, 115-, or 230-volt, 60-cycle a-c sizes. D-c units are available in similar models. For full details see GEC-257.

ACCURATE BUT RUGGED



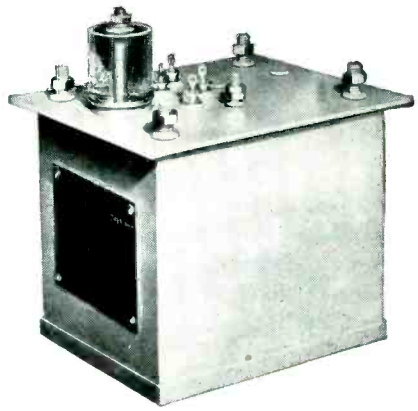
The new, modern-looking, easy-to-read 2½ inch G-E instrument line is improved inside as well as outside. A single, self-contained mechanism supported on an extremely strong Alnico magnet assures permanent alignment even under the most adverse operating conditions. This high-gauss Alnico magnet permits the use of a large air gap with a consequent smoother, non-sticking action. The greater torque-to-weight ratio means better damping and allows the use of heavier vibration-resisting pivots. Accuracy is 5% of full scale on rectifier types, 2% on all others. For complete details, send for Bulletin GEC-368.

SNAP-SWITCH INSTALLATION TIME CUT TO SECONDS

You'll have a firm electrical connection without the use of solder a few seconds after you begin to install this small but rugged Switchette. Only 1½ inches long and weighing only 9 grams, this 230-vac, 10-amp unit has solderless knife-contact terminals made of pure, tinned copper.

G-E Switchettes are available in a variety of forms and circuits, all of which have double-break contact structures. They're particularly well suited for electronic applications because of their low RF noise output (short contact-bounce).

For your convenience there are screw-terminal and soldering-lug types as well as this special quick-connect unit. Send for Bulletin GEA-4888.



A SMALL PACKAGE OF WELL-REGULATED HIGH VOLTAGE

You get both high voltage and good regulation with small lightweight G-E precision rectifiers. This may interest you if you need compact, well-regulated, high d-c voltage sources for cathode-ray tubes, television camera tubes, radar indicator scopes, electron microscopes, Geiger-Mueller counters, or similar jobs.

These supplies are hermetically sealed and oil-filled. Typical units have outputs of 7 kv at 0.1 ma.—have only 3.5% deviation for every 0.1 ma load and output ripple of less than 1%. Size—only 6" x 6" x 7". Weight—8 lbs. For further data, write: General Electric Company, Section 667-3, Schenectady 5, N. Y., giving complete information on the proposed application with specifications required.

General Electric Company, Section L667-3
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEA-3634 Voltage stabilizers
- ☐ GEA-4888 Switchettes
- ☐ GEA-4996 Capacitor networks
- ☐ GEC-257 Heavy-duty relays
- ☐ GEC-368 Instruments

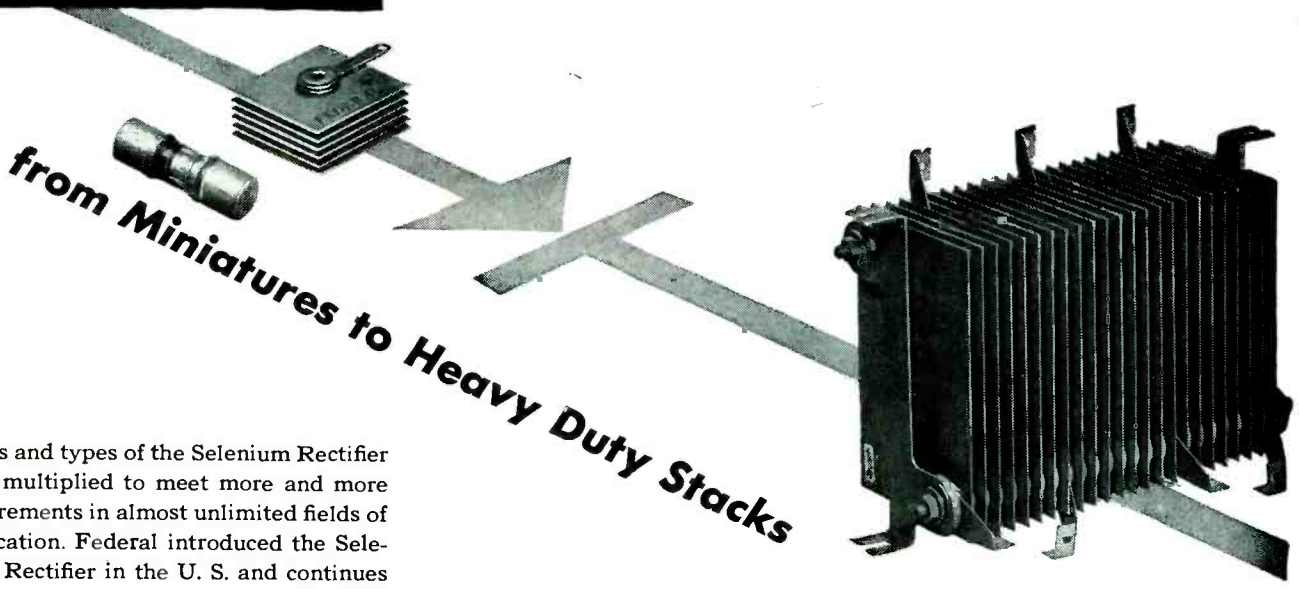
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

Federal SELENIUM RECTIFIERS



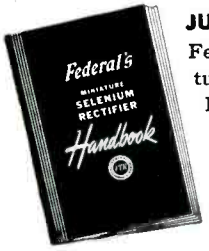
from Miniatures to Heavy Duty Stacks

Sizes and types of the Selenium Rectifier have multiplied to meet more and more requirements in almost unlimited fields of application. Federal introduced the Selenium Rectifier in the U. S. and continues to lead in developing and manufacturing this versatile circuit element.

Federal has cooperated with a host of engineers and designers in the development of a complete line of Selenium Rectifiers, ranging from tiny Miniatures to huge Stacks. There is a Federal Selenium Rectifier which will meet practically any power conversion need.

Wherever used, Federal Selenium Rectifiers bring important advantages of dependable power handling . . . instant starting . . . silent, efficient operation . . . long service life.

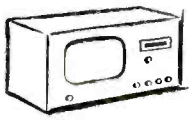
These typical applications may suggest a new use in your own product. A Federal Selenium Rectifier could be the solution to your own power conversion problem. Bring any question to Federal—America's oldest and largest manufacturer of Selenium Rectifiers. Direct your inquiries to Department E-313.



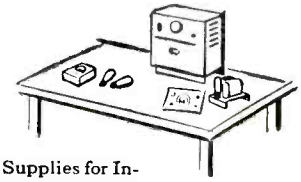
JUST OFF THE PRESS!
Federal's *new* Miniature Selenium Rectifier Handbook...48 pages of valuable design data. Available for 25 cents (coin only) from—

DO HUNDREDS OF POWER CONVERSION JOBS

more efficiently and economically than ever before!

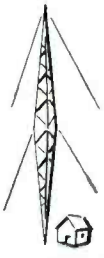


In television . . . radio . . . amplifiers and . . . intercommunication systems.

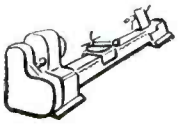


In Power Supplies for Industrial and Laboratory Use . . . Cathodic Protection . . . Electroplating.

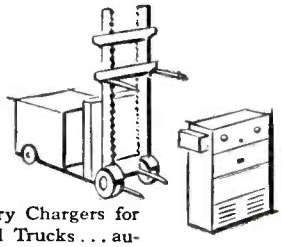
In fans . . . sewing machines . . . electric shavers . . . electronic organs . . . motion picture projectors . . . photoelectric cells.



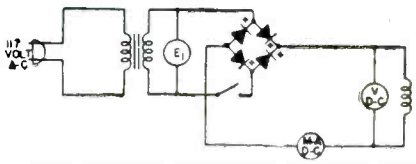
In High Power Communication . . . Broadcast Transmitters . . . Television Transmitters.



In machine tool controls . . . magnetic chucks . . . relay control systems . . . dial switching systems.



In Battery Chargers for Industrial Trucks . . . automobiles . . . telephone exchanges . . . and in Battery Eliminators.



And In Many Specialized Electrical and Electronic Applications.

Federal
Telephone and Radio Corporation

An IT&T Associate

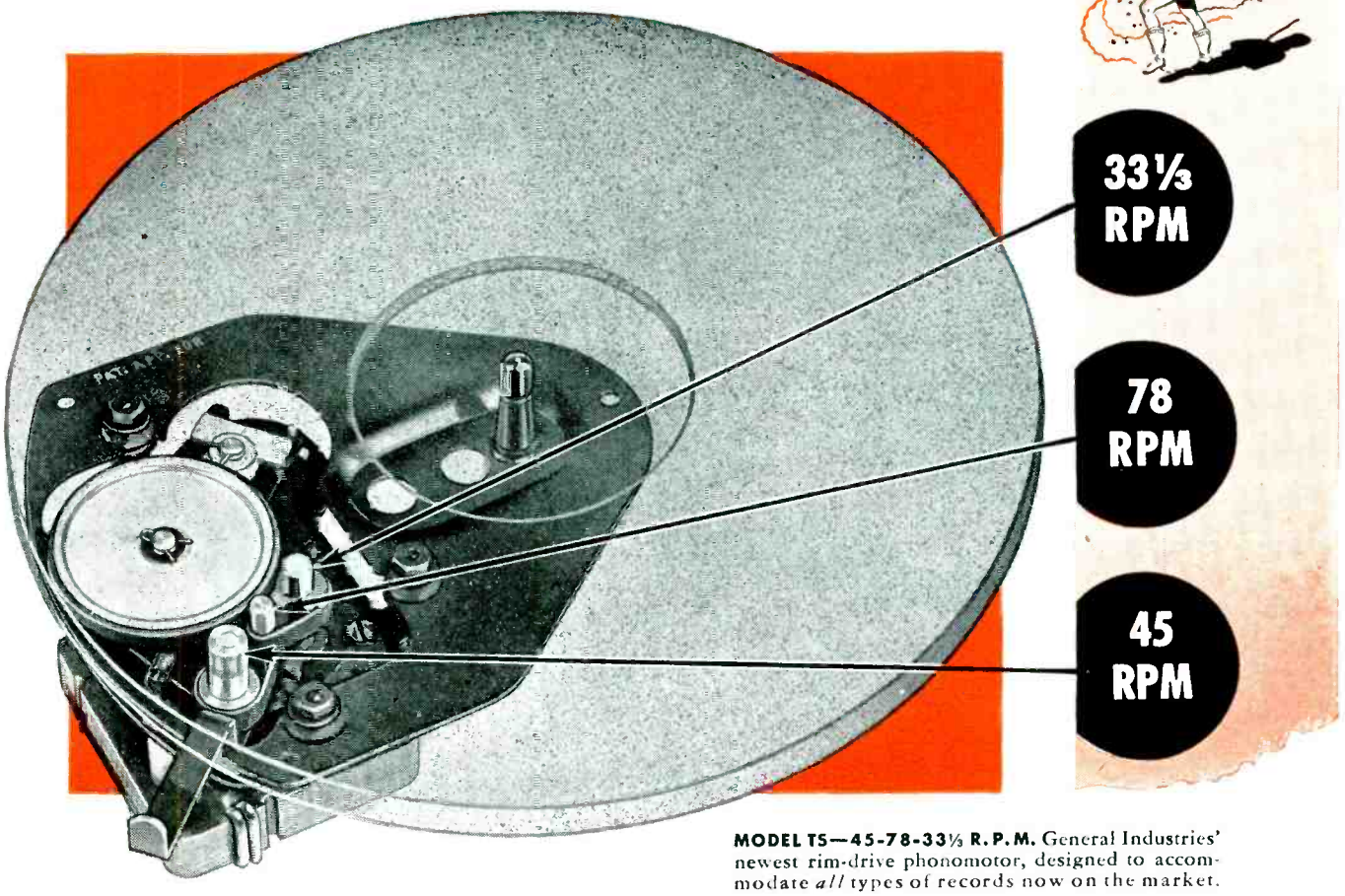
SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

FEDERAL TELECOMMUNICATION LABORATORIES, Nutley, N. J. . . . a unit of I T & T's world-wide research and engineering organization.

GENERAL INDUSTRIES

leads the Parade



MODEL TS—45-78-33⅓ R.P.M. General Industries' newest rim-drive phonomotor, designed to accommodate *all* types of records now on the market.

...with this low cost THREE-SPEED PHONOMOTOR!

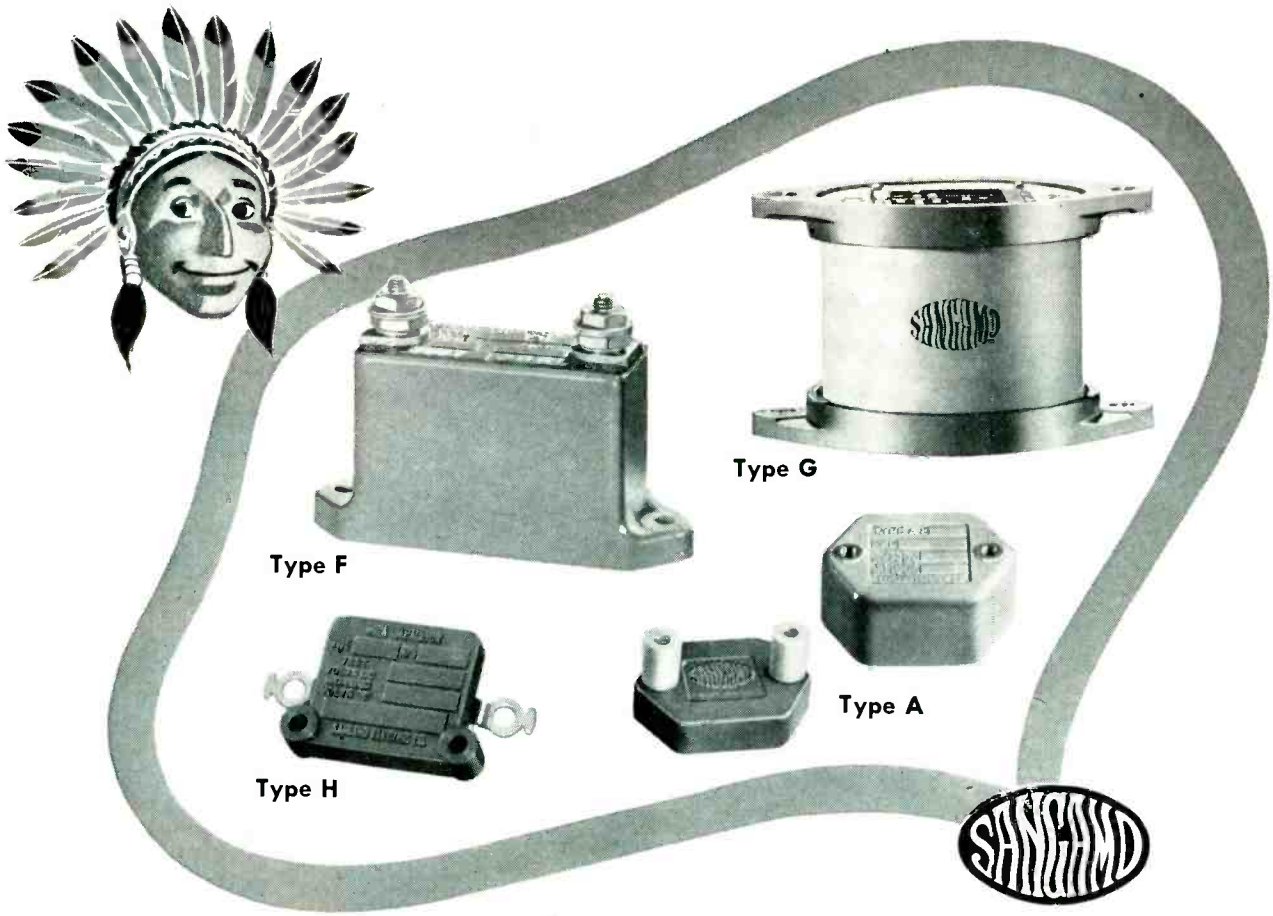
It's GI's Model TS...the *one* motor designed and engineered to meet *all* requirements for true record reproduction at 33⅓, 45 and 78 R.P.M. Already time-proved in actual service, this latest addition to the famous GI phonomotor line today is being used in a wide range of portables, table models and console radio-phonographs.

Outstanding features: standard narrow-flange turntable for easy, compact installation . . . simple, yet positive speed shift mechanism with external control lever . . . dependable, quiet *Smooth Power* motor for long, trouble-free service.

For full details—blueprints, performance specifications and quotations—write, wire or phone today.

The GENERAL INDUSTRIES Co.

DEPARTMENT B. • ELYRIA, OHIO



Transmitting *Micas* for every purpose

Correctly Designed • Precision Built • Carefully Tested . . .

Quality counts in capacitors used in transmitting applications. Sangamo Mica Capacitors are built to rigid specifications, of the best materials obtainable and with the most precise production methods. They are correctly engineered to assure high current-carrying ability, to hold losses to a minimum, and to provide maximum safety.

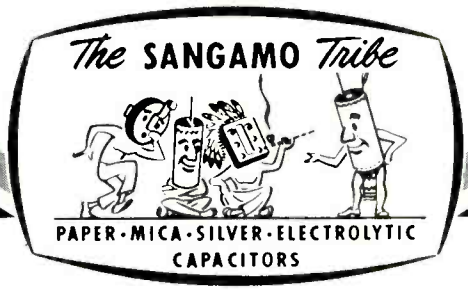
Type G Capacitors are designed for use in medium and high power, high voltage and high current circuits. They are ceramic encased and are frequently connected in gangs to handle heavy loads.

Type F Capacitors are used in similar applications to type G's and are potted in bakelite cases.

Type A and Type H Mica Capacitors are molded in a thermo-setting plastic and are designed for use in low voltage, low power and low current circuits.

These, and many other types of Sangamo Mica Capacitors, are fully described in Catalog No. 831. Write for your copy.

Your Assurance of



Dependable Performance

5C50-1

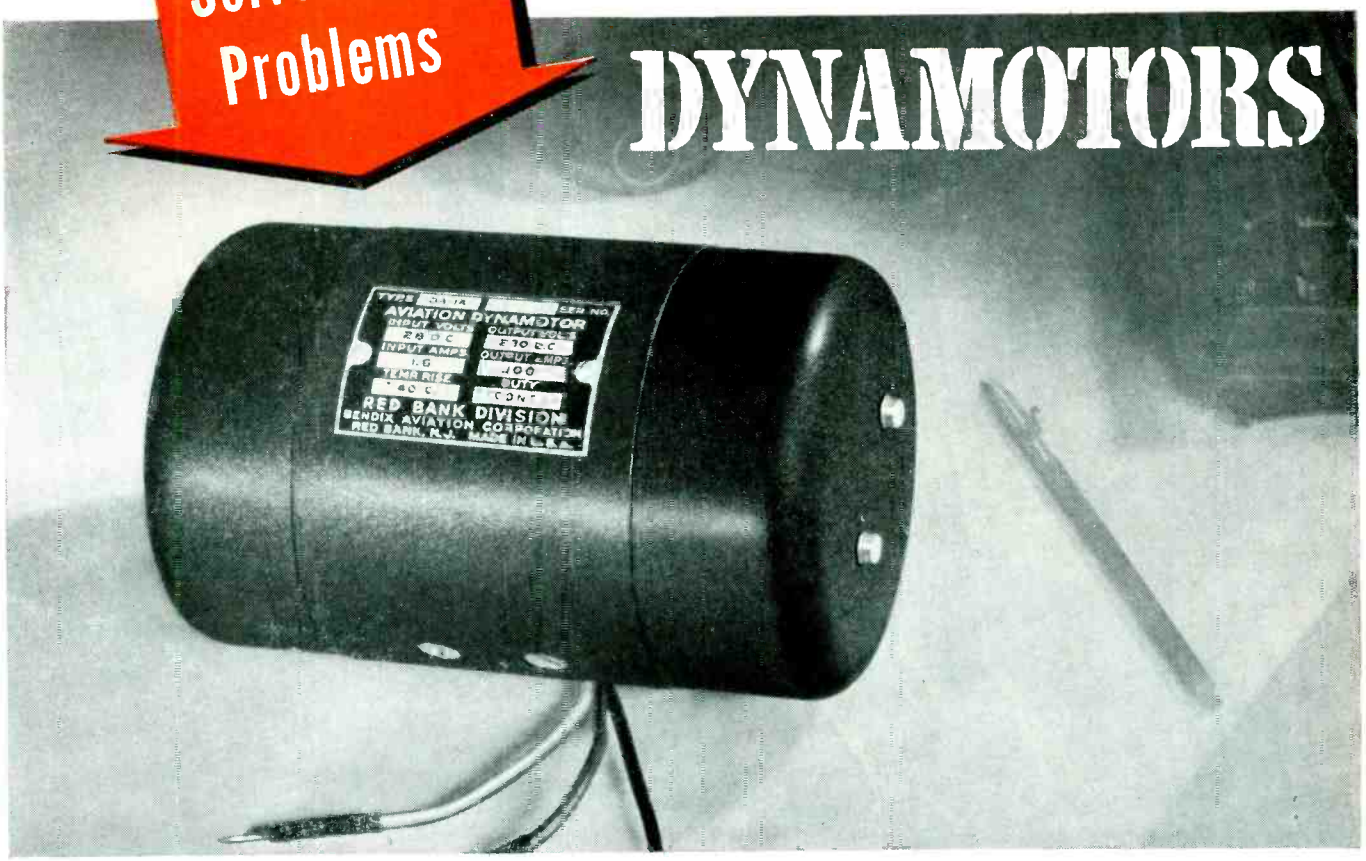
SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

Let *Bendix* Solve Your Problems

SPECIALIZED DYNAMOTORS



. . . Promptly and at Moderate Cost!

Bendix dynamotors are built to supply the *exact* power requirements of your equipment—to work from any input voltage and to deliver the necessary power at any output voltage. Dual or triple output voltages are available for high and low-level portions of the circuit, or for biasing. For critical circuits, regulated outputs will simplify your design problems, especially since a regulated filament supply can be obtained as a bonus when regulating the high voltage output. Bendix will build your dynamotors to the usual military specifications or to meet even more rigid requirements, such as operation at higher temperature, or altitudes in experimental equipment.

Samples or production units of special dynamotors are priced competitively. A definite proposal will be made upon receipt of the details of your problem. For immediate information call our Engineering Staff—Red Bank 6-3600, Red Bank, New Jersey.

THE RIGHT DYNAMOTOR FOR EVERY PURPOSE

- Sizes—2¾" to 5¼" diameter
- Power Range—10 to 500 watts
- Input Voltage—6 to 115 volts
- Output Voltage—6 to 1500 volts
- Single and multiple output and input
- Plain and regulated types

RED BANK DIVISION

Bendix AVIATION CORPORATION

RED BANK DIVISION OF BENDIX AVIATION CORPORATION
RED BANK, NEW JERSEY

Announcing

THE NEW ADLAKE *sensitive* RELAY

Only 7 Milliamperes in Coil—Controls 5-Ampere Contact

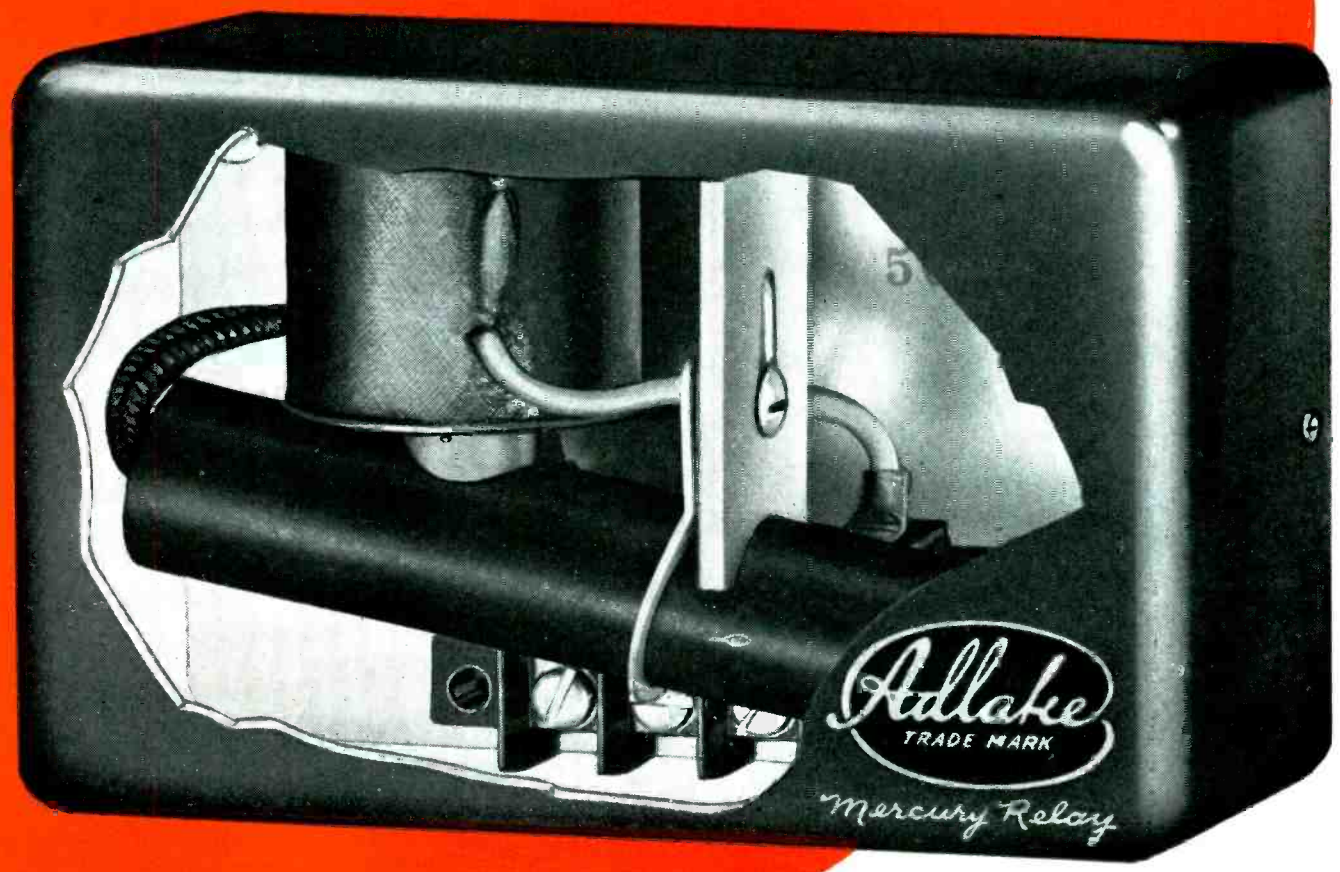
Here's the sensational ADLAKE 5000-type relay, now available after 3½ years of intensive research and development!

Because of its amazingly high load-input ratio, the No. 5000 relay operates at 115 volts 60 cycles on *only 0.007 ampere*—a fraction of the current consumed by any other type of mercury relay! With this low amperage operating the coil, the contacts will handle 5 amperes at the same voltage! And tests indicate the No. 5000 relay's life to be over *30 million operations!*

For full information on this truly remarkable relay, write us at 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

ADLAKE
No. 5000 Relay

Designed especially for sensitive thermo-regulation . . . Ideally suited for use in electronic tube circuits where the output of the tube is limited . . . Can be used as a pilot relay operating from a very sensitive thermo-regulator . . . Serves equally well for high and low temperature control, and can be used with either mercury-and-glass or bi-metal regulators



Every Adlake Mercury Relay brings you these advantages:

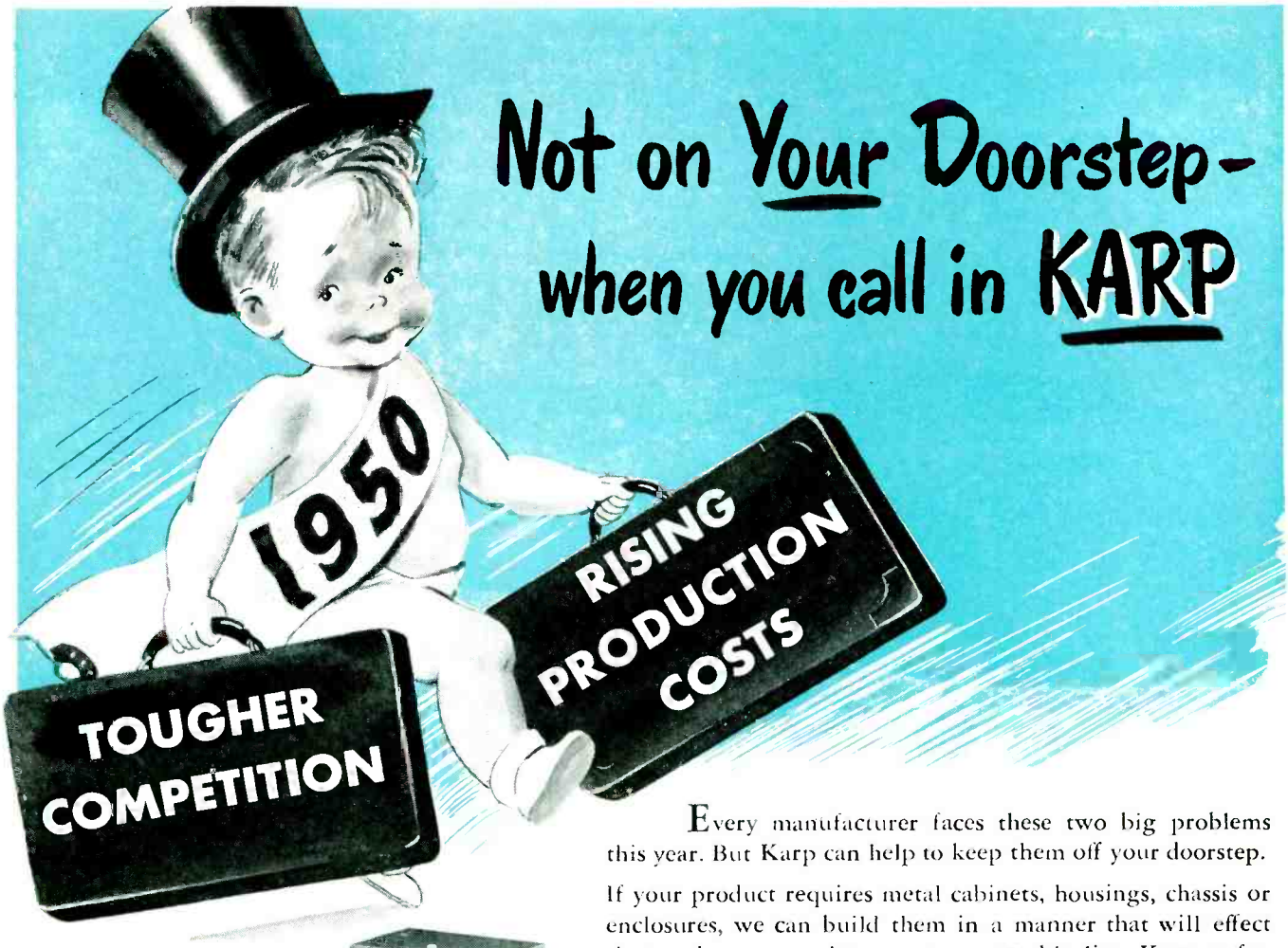
- Hermetically sealed—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.
- Silent and chatterless.
- Requires no maintenance.
- Absolutely safe.

Adlake TRADE MARK — THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

MANUFACTURERS OF HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD AND CONTROL CIRCUITS

Not on Your Doorstep— when you call in KARP



Every manufacturer faces these two big problems this year. But Karp can help to keep them off your doorstep.

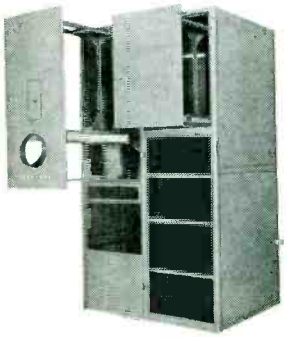
If your product requires metal cabinets, housings, chassis or enclosures, we can build them in a manner that will effect time and money savings on your assembly line. Karp craftsmanship is so accurate and thorough in detail that all units will be completely uniform. All your components will fit quickly and easily into place without forcing—without extra efforts on your part.

The resultant savings of your time and effort can help cut your costs and permit more competitive pricing, without cheapening your product in quality and value.

Let us prove that Karp's superior craftsmanship also means true economy. Pin the coupon below to your letterhead for more information.

Right: Desk panel cabinet rack

Below: Electronic control cabinet



WHAT KARP CUSTOM CRAFTSMANSHIP OFFERS

- Practical help with design problems, to improve product and cut cost.
- Our large accumulation of tools and dies often can save you special die costs and time.
- The specialized skill of several hundred of the finest metal craftsmen; expert forming, drawing, bending . . . welding with all latest techniques.
- Finest quality painting and finishing of all types in dustproof chambers equipped with water washed spray booth. Baking ovens with timing controls.
- Everything in sheet metal, from a simple chassis or panel to the most elaborate electronic apparatus housings. Any metal, any gauge, any size, any quantity—from a single lot to large run quantities.
- Efficient production and on-time deliveries.

KARP METAL PRODUCTS CO., INC.
215 63rd Street, Brooklyn 20, New York

Yes! Please send more information and PROOF of how your sheet metal workmanship can help us cut our production costs.

Name .....
Title .....
Company .....
Address .....
City ..... State .....

KARP METAL PRODUCTS CO. INC.
215 63rd Street, Brooklyn 20, N. Y.
Custom Craftsmen in Sheet Metal

These Case Style 40 Capacitors are "Sealed-for-Life"

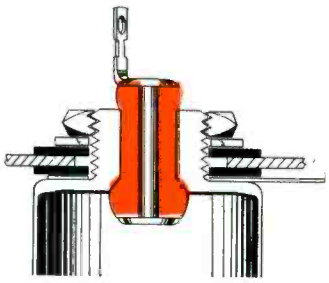
Here is a cylindrical d-c paper-dielectric capacitor that remains positively sealed, regardless of the position in which the unit is mounted. The G-E Case Style 40 utilizes a deep-drawn aluminum case with double-rolled base seams, avoiding solder-seams. The silicone bushing eliminates gaskets, maintains the hermetic seal by compression alone. And beneath the case, these units embody the excellent materials and construction, give the outstanding performance characteristic of General Electric capacitors.

The Case Style 40 capacitor for direct panel mounting with solder-lug terminals, is built in these ratings:

600 volts—1, 2 and 4 mu f
1000 volts—1 and 2 mu f
1500 volts—.25, .5 and 1 mu f

This is but one case style of a complete line of d-c capacitors made by General Electric to JAN-C-25 Specifications and suitable for both commercial and armed services applications. G-E paper-dielectric capacitors are available in characteristics E (Mineral Oil) or F (Pyranol®) and in case styles 40, 53, 54, 55, 61, 63, 65, 67, 69 and 70. *Apparatus Department, General Electric, Schenectady 5, N. Y.*

Please address inquiries to Transformer & Allied Product Div., General Electric Co., Pittsfield, Mass.



This is how the silicone bushing permanently compression-seals the new G-E Case Style 40 capacitor. Note that the conventional gasket is completely eliminated. This CP-40 can be freely handled with no worries about rupturing its seal.

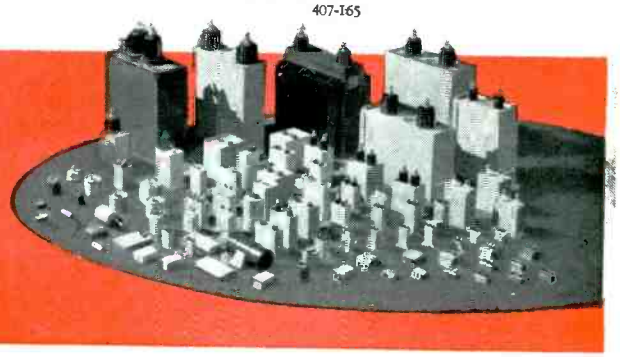
GENERAL ELECTRIC

407-165

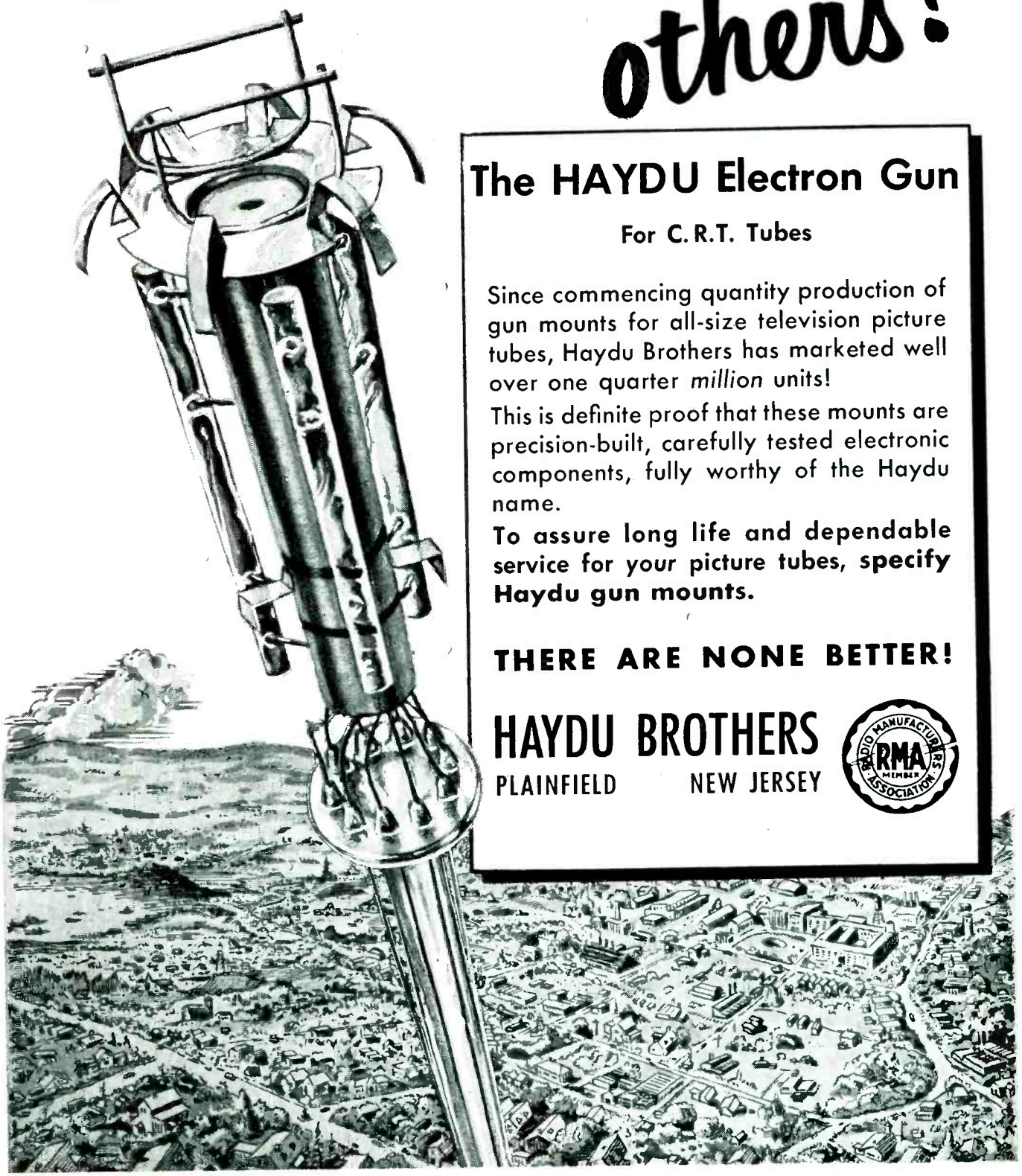
Specialty Capacitors FOR

Motors
Luminous-tube transformers
Fluorescent lamp ballasts
Industrial control
Radio filters
Radar
Electronic equipment
Communication systems
Capacitor discharge welding
Flash photography
Stroboscopic equipment
Television
Dust precipitators
Radio interference suppression
Impulse generators

AND MANY OTHER APPLICATIONS



TOWERS *above all others!*



The HAYDU Electron Gun

For C.R.T. Tubes

Since commencing quantity production of gun mounts for all-size television picture tubes, Haydu Brothers has marketed well over one quarter *million* units!

This is definite proof that these mounts are precision-built, carefully tested electronic components, fully worthy of the Haydu name.

To assure long life and dependable service for *your* picture tubes, specify Haydu gun mounts.

THERE ARE NONE BETTER!

HAYDU BROTHERS

PLAINFIELD NEW JERSEY

RADIO MANUFACTURERS ASSOCIATION RMA MEMBER

BUSINESS BRIEFS

By W. W. MacDONALD

Working Quietly through industry committees, the aircraft people determined some time ago that tube failures accounted for more than 50 percent of the electronic equipment failures in their field, and brought this disturbing fact to the attention of tube makers. Suggesting designs having special long-life characteristics rather than mere selection of high-test tubes from regular mass-production runs (see p 60, Dec.), they have already stirred up something of a furor in tube manufacturing circles.

Realizing that the production of tubes designed expressly for their highly demanding service is economically difficult, aircraft people realistically suggested that the job initially be confined to just 10 types. Two types have already been produced and shipped in quantity and statistics concerning their performance are currently being compiled.

American railroads are officially interested in the project and it seems likely that it will eventually influence the design of other mobile equipment, if not all industrial tube applications.

Milestone in the history of television was the sales slump experienced last summer and the sharp pickup in the fall. Manufacturers, distributors and dealers who had long since learned to accept this seasonal variation in radio business were caught napping.

It is unlikely that the experience will be repeated by industry leaders in 1950. In distribution at least, it is now apparent that television will follow the radio pattern.

First Audio Fair (p 128) staged by the Audio Engineering Society in New York was highly successful on all counts, and we wouldn't be surprised to see the idea spread to other cities. Audio is like photography in that it is an art, science, business and often a hobby. Show attendance is, therefore, not very difficult to attract.

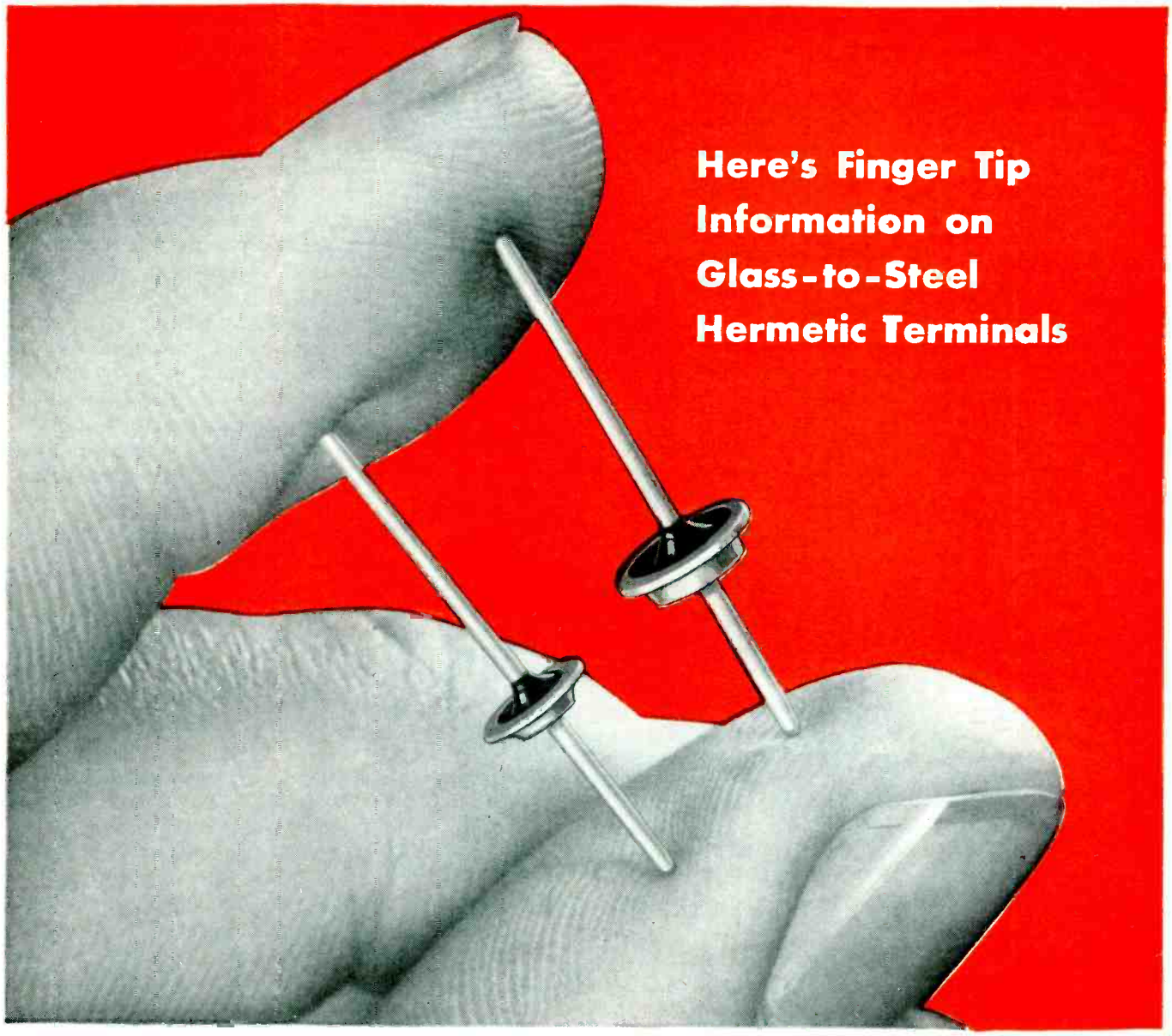
One of the major attractions was the fact that practically all equipment exhibited was working, and could be listened to without interference from other equipment. Selling was, literally, aimed at the customer's ear. We noted, nevertheless, and think this is the first printed mention of a trend, that where response curves were shown they usually went up to 20,000 cycles. Until recently, draftsmen seemed to run out of ink somewhere between 10 and 15,000.

This reminds us of a misprint in a field report that came across our desk the other day, in which "amplifier" was spelled "ampliliar." Our thought was then, as it is now, that many a truth is spoken in jest.

Another New York Meeting to which we wended our way was the Second Annual Conference on Electronic Instrumentation in Nucleonics and Medicine, and in each category we picked up an impression worth relaying.

Doctors with Ph.D.'s were careful when discussing electronic medical equipment not to express clinical opinions, preferring to paraphrase or repeat the findings of doctors who were M.D.'s. And the danger of working around projects of the Atomic Energy Commission was further debunked by statements such as one to the effect that radiation exposure is limited to about that experienced when wearing a so-called radium-dial wristwatch.

Out In East Pittsburgh, the Westinghouse engineering department conducted a two-day Mid-Century Review and Forecast Forum for the press. Due to the imminence of a deadline we can give you only a few highlights of this extremely informative session and some local color picked up around the research laboratories. If you have access to Chuck Scarlott's *Westinghouse Engineer* for January the full story will be



Here's Finger Tip Information on Glass-to-Steel Hermetic Terminals

INSULATE ELECTRICALLY
GLASS TO METAL
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TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

- The trend toward hermetic sealing in all phases of electrical manufacturing is gaining impetus. Fusite has pioneered in the field of glass-to-steel hermetic terminals for use in fusion sealing—the only truly hermetic process.
- We have prepared a brochure crammed full of illustrations, specifications, diagrams, and facts about the Fusite wide line of single and multiple electrode terminals.
- We assure you that regardless of your present level of knowledge concerning glass-to-steel terminals, you do not have a complete or accurate picture of the production possibilities of fusion sealing until you know the Fusite story.

Write today for your copy of this literature, to Dept.-E.

TERMINALS ILLUSTRATED: 104SW, Left, 105SW, Right.
Miniature—Straight Wire—Single—Glass-to-Steel Hermetic Terminals.

THE FUSITE CORPORATION

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

found there, in an issue that should resemble a telephone book.

The highlights:

If you think engineers in general and Circle-W engineers in particular have made progress in the first half of the 20th Century watch them really move in the next half.

Pure research, as distinguished from product research, must be supported by industry. (About 40 percent of the substantial Westinghouse expenditure for research in 1950 will be in that category.)

The keynote of future electrical and electronic equipment design will be more power in less bulk.

The local color:

"Materials research pays dividends because if nothing ever fails you are probably overdesigned."

Air-conditioning in certain rooms is essential to protect delicate laboratory instruments. It is also favored by ditto laboratory personnel.

Gwilym is Welsh for William.

Up In Syracuse at the fall meeting of the IRE and RMA Engineering Departments, the impression appeared general that hotel facilities were quite superior to those heretofore provided at Rochester. Some 500 engineers registered for the meeting, about 200 less than last year, but some of the attendance loss may be attributed to the fact that there were no exhibits. On the other hand, the absence of exhibits noticeably swelled attendance at the technical sessions.

Syracuse gets the meeting again in 1950. Toronto is being considered for 1951.

Labor And Materials Costs have both increased for manufacturers of component parts. From where we sit it seems that current pressure from distributors who want increased catalog subsidies, greater freight allowances and/or larger cash discounts must prove futile.

Strangely Familiar is a phrase passed along by Warren Shew of our Philadelphia office to the effect that high-quality loudspeakers are hard to sell because many listeners *"don't know their bass from their alto."*

Citizens Radio has captured the imagination of many people, but this interest has yet to be translated into business. Writes one of our readers: *"It appears to me that the Citizens' Band as now authorized, promulgated and restricted by FCC rules is not likely to be widely used by 'citizens' in general, or by citizens of moderate means in particular."*

We are inclined to agree. Some changes in the rules appear to be needed.

Speaking Of FCC, we knew that things were getting pretty hot in their Washington office (what with the color-television hearings and all) but had no idea there was danger of spontaneous combustion until the newspapers reported that a fire had broken out and destroyed some of the records.

Navy Contracts in excess of $50,000 recently awarded to firms in our field include:

Philco Corp. (field services)	$1,150,000
Western Electric (field services)	600,000
Collins Radio (spare parts)	187,860
Altec Service (field services)	100,000
RCA Service Co. (field service)	50,000

Navy is not spending as much money as some have hoped, but this still ain't hay.

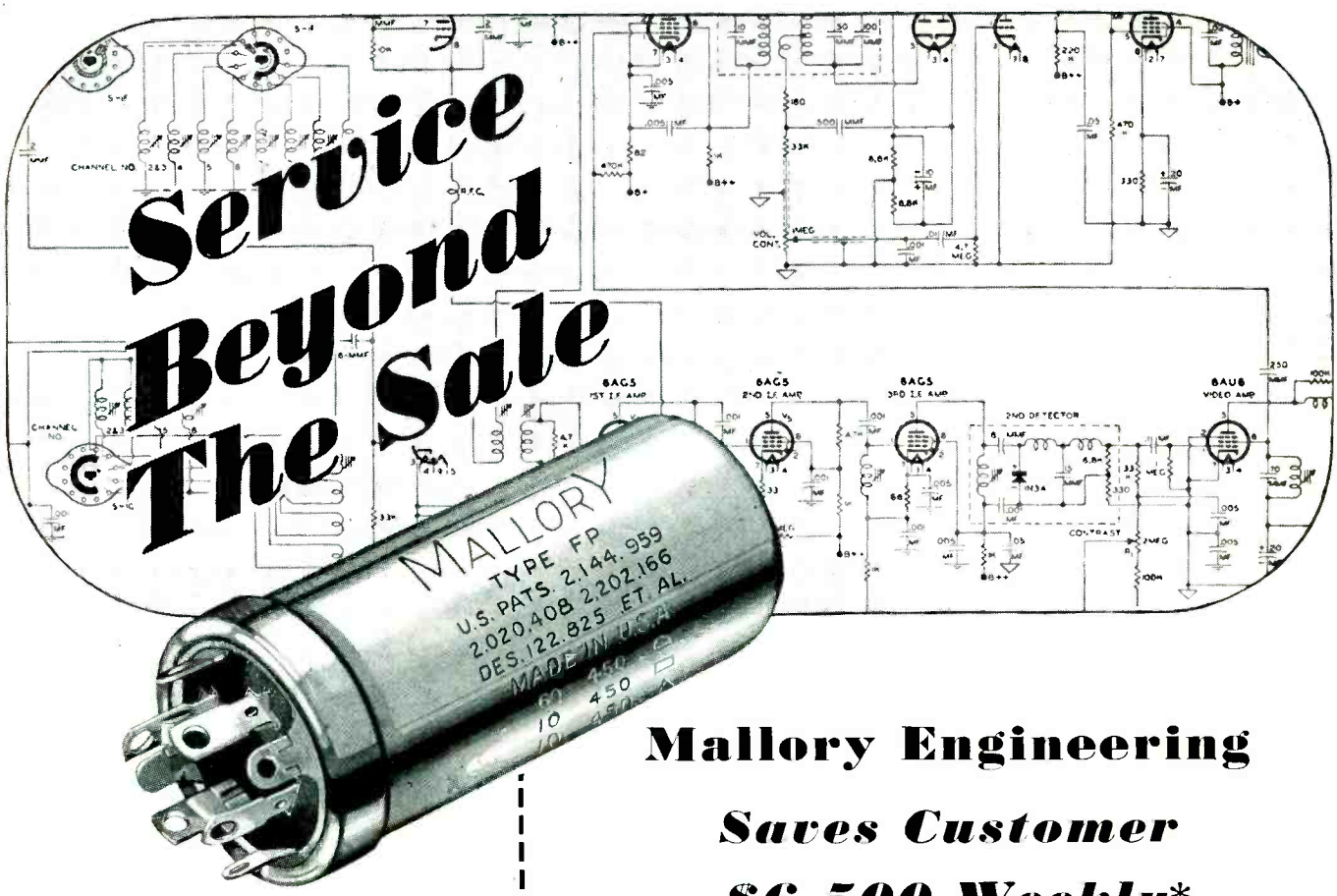
IBM's New Machine developed to speed up tabulation of data to be gathered in the U. S. 1950 census contains:

13,500 plug connectors
283 relays
144 tubes
75 circuit breakers
50 miles of wire

Electronic business machines individually use a large number of component parts and much material. The overall market is not yet large but it does appear to have a substantial long-range potential.

One Of Our Favorite Authors, who works in a laboratory where potentials up to 200,000 volts are not uncommon, recently stopped off at our offices enroute to deliver a technical paper. He showed us an interesting piece of equipment and, in the process, collected a severe jolt from a capacitor charged some six hours earlier to about 2,500 volts.

Please be careful, boys. We'd hate to have to write all these high-powered technical articles ourselves.



Mallory Engineering *Saves Customer $6,500 Weekly**

When you specify Mallory Capacitors for television receivers or other equipment where heat is a problem, you can be sure they will stand the test. Mallory FP Capacitors are designed to give long, trouble-free performance at 85° C.—naturally they give even longer service at normal temperatures. In addition, Mallory FP Capacitors are famous for their long shelf life. Write for your copy of the FP Capacitor Engineering Data Folder.

**Name on request*

Manufacturers buying Mallory Capacitors are receiving a value far beyond their specifications.

They benefit by an engineering service that is always available to them—a service that recently simplified a circuit for one television manufacturer, eliminating four capacitors, saving $6,500 weekly in materials and assembly time. That's service beyond the sale!

In addition, they benefit by the dependability and superior performance of a product that has been consistently ahead of the industry.

When you have capacitors to specify, remember Mallory. Remember the benefits of Mallory dependability, performance, and engineering service . . . they're all yours *at no premium in price!*

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured and famous throughout the industry for dependable performance.

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Capacitors	Contacts
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CROSS TALK

►**SALARIES** . . . Around this time of year (and any other time), everyone is interested in how his salary is trending. One of the interesting issues is how one's salary compares with the average. Browsing among the available data from the Bureau of Labor Statistics we found that, in 1946, the starting salary for new engineering graduates was about $240 monthly, and it was pretty much the same, plus or minus $10 or so, in five major categories of engineering. In the same year, engineers with ten years experience were earning about $370 on the average, the civil engineers being low at $340 and the mechanicals high at $400. After a decade of trying, the electricals (including electronics and communications) had hit about $360.

Age and experience count, particularly if you are a chemical engineer or in mining or metallurgy. Engineers who had been on the job for 35 years were earning in 1946 about $640 a month in the chemical field, about $600 in mining and metallurgy. The mechanicals and electricals, after pitching the ball for a third of a century plus, were rewarded at about $525, and the 35-year civil engineers, after as much travail and many more days working in the rain, were struggling along at $425. The same data ("Employment Outlook for Engineers", issued June, 1949) show that electrical engineers who keep working 37 years are due for a rude shock. At that level of experience, the average earnings reach a peak of $550 and three years later coast down to $500.

That was in 1946. The Department of Commerce indicates that the average earnings of all industrial employees in that year were $197 monthly, had risen to $232 in 1948. To add further to the confusion, in 1948 telephone and telegraph workers averaged $232, radio and television broadcasting employees $330, and electric-gas utilities ditto $266.

Those are the average figures; peg your own where they fit. And when talking to your supervisor about this, do *not* mention the name of this magazine.

►**T-W** . . . Editors, like readers, have difficulty in keeping up with the periodical literature on particular subjects. The case in point this month is traveling-wave tubes. When we asked Lester Field of Stanford University, some months ago, to prepare a review of progress in the t-w art, we knew we'd get a good paper. But when it arrived, we were shocked at the state of our ignorance. We should have known about these things, but didn't. So we recommend, highly, Dr. Field's story (p 100, this issue). Did you know that t-w tubes have produced 1,200 watts of c-w power, have operated at frequencies from 200 to 25,000 mc, have noise figures as low as 11.5 db? Turn the page, brother; things have happened while we were away.

►**LOUIE, DROP THAT AMPLIFIER** . . . A large and prominent sporting goods store in New York has recently advertised a "personal amplifier", a cylindrical gizmo with a mike at one end and ear piece at the other, "electronically operated on tiny batteries, easily replaceable". The ad goes on to say that this is the acoustic equivalent of binoculars, "amplifies the distant music of hounds, conversation out of ear-shot, theater dialogue from the back row." A right sensitive amplifier, we gather, through which one can clearly hear the gentle dropping of the eaves.

►**LUNAR** . . . We continue to be amazed at the exploits of the radio-astronomers. Winfield Salisbury reported last month to the URSI that he and two colleagues had measured the temperature of the surface of the moon, during a total lunar eclipse. The measuring device was not a thermopile but, of all things, a superheterodyne. It seems the thermal radiation was measured on a wavelength of 1.8 cm, the radiating layer being some 5 to 10 cm below the visible surface of the moon. Result: the temperature was found to be constant before, during and after the eclipse, at about −33 degrees centrigrade. Explanation: the layer of dust on the moon's surface has very high thermal insulation, particularly so because it is situated in a high vacuum. The first lunar explorers will do well to remember this, and be very careful about scuffing their feet.

CAME THE —TV REVOLUTION—

By DORMAN D. ISRAEL

Executive Vice-President
Emerson Radio and Phonograph Corporation
New York, N. Y.

ACCORDING to the dictionary, "revolution" can mean "any radical change." So defined, it is clear that the impact of television on the radio industry is indeed revolutionary. If there is any doubt about it, consider the production figures* for the past three years. Since 1947, a-m receiver average production has declined from about 315,000 sets per week to about 118,000 per week, while average tv production has increased from 3,400 per week to 40,000 per week. Striking as these figures are, they mask even greater changes in the use of component parts, and in dollar values. The revolution is not confined to the set manufacturers and their suppliers. A host of other industries are affected, from gin mills to glass blowers, from vaudeville to the stock market.

Production Trends

The accompanying chart, compiled from production figures of the RMA, shows the month-by-month trend in the manufacture of tv, a-m and f-m sets. These RMA figures are based on weekly production and are "complete, except for the usual omissions"; that is, they should be increased, by about 20 percent to account for production of non-RMA companies. But they are proportionately accurate and indicate unmistakable trends: Radio is settling to a lower, but substantial, level, while television continues to climb in spite of the deterrent effects of the tv "freeze."

Start with the year 1947. The average production for the year was 3,400 weekly for tv, 315,000 for a-m, and 22,600 for f-m. Allowing for the cost of an average tv set as 10 times that of an average a-m set and that of an f-m set as 3 times the a-m figure (these are typical figures), the dollar volume for a-m in 1947 was 76 percent of the total, f-m 16 percent and tv 8 percent.

In 1948 tv really got going; production rose from 6,000 to 30,000 tv sets weekly. The average dollar value in that year, figured on the same basis, put tv far ahead of f-m and almost on a par with a-m. The tv dollar volume climbed from 8 to 36 percent, while a-m dropped from 76 to 46 percent, and f-m rose slightly from 16 percent to 19 percent.

Through October, in 1949, the dollar volume of tv receivers has far outstripped its predecessors. Tv thus far this year has accounted for 71 percent of dollar volume, a-m has settled to 21 percent and f-m to 8 percent. Came the revolution, indeed!

Shift in Demand for Components

The foregoing figures on production and dollar volume of finished goods represent transactions between the equipment manufacturers and the public. Of equal interest to engineers are the more obscure but nonetheless drastic shifts in the use of component parts. The writer has conducted a "blood count" of representative a-m and tv receivers to evaluate the parts usage in each. The results are shown in Table I. These are startling figures. Small resistors are nearly 8 times as numerous in tv sets as in a-m sets; large resistors 12 times; small fixed capacitors 6.5 times; large ones, 7 times.

Electrolytic capacitors, taken as individual sections, are present in the ratio of 5 to 1. But this is only a part of the story. Typical radio sections are 16–30 μf, 150–350 volts. A 100-μf 450-volt electrolytic, common in tv sets, uses much more aluminum foil. Based on foil consumption, the tv demand is about 20 times that for a-m. The corollary of this foil growth is the substantial number of kilowatts required to electroform the foil.

And so it goes. A whole new art has grown up around the design and manufacture of horizontal scanning output transformers and deflection yokes in tv sets. Variable resistor controls usage is up about 6 times for tv. And the tube suppliers are in a class by themselves. The average a-m set today has slightly over 5 tubes. Tv sets use somewhat above 20 tubes, one of which is a 20-watt transmitting type tube.

The aggregate needs based on these ratios are equally startling. In 1947, a-m production required 4.5 million small resistors every week, while tv needed only 0.36 million. In 1948, the figures were 3.6 million for a-m, 1.7 million for tv. In 1949 the a-m demand has slid to 1.5 mil-

Table I—Count of Components in A-M and TV Receivers

Component	Number per A-M set	Number per TV set
Resistors under 3 watts	14	105
Resistors over 3 watts	0.25	3
Capacitors under 0.001	3.25	21
Capacitors over 0.001 (not electrolytic)	8.25	59
Electrolytic capacitors	2.75	14
Power Transformer	Negligible	0.875
Choke and output trans.	1+	7
High voltage transformer	0	1
Inductors used under 500 kc	2+	12
Inductors used over 500 kc	2.5	9

* All statistics are based on RMA published figures and thus are short of the industry total by about 20 percent.

Few recognize the full force of television's impact on the radio industry and allied arts. This survey, based on a paper presented before the Syracuse Fall Meeting of the IRE and RMA, was compiled by one of the keenest observers in the field

lion weekly, while tv takes no fewer than 4 million small fixed resistors each week.

Harassed friends in the resistor business will claim these figures are conservative, as indeed they are by at least the 20 or more percent non-RMA consumption we have "included out." The important fact is that, in three years, tv has taken over the resistor business.

Not all the traditional suppliers of radio-set components have fared so well. Those on the wrong side of the ratio sign include the makers of fancy dials, who have "converted" to picture-tube masks; the variable capacitor people, who are wrestling with head-end tuners, many of which do not even use variable capacitors. And lo! the poor loudspeaker manufacturer. Loudspeaker plants find it necessary to convert to ion traps, focus assemblies and other "debased" items employing permanent magnets.

Many newcomers, formerly on the fringe of the radio business, have cashed in on the tv trail. Take the glass business. A million 10BP4 and 10FP4 picture tubes, each containing several pounds of face plate and other glass, plus 7, 12 and 15-inch sizes, add up to a lot of fabricated glass.

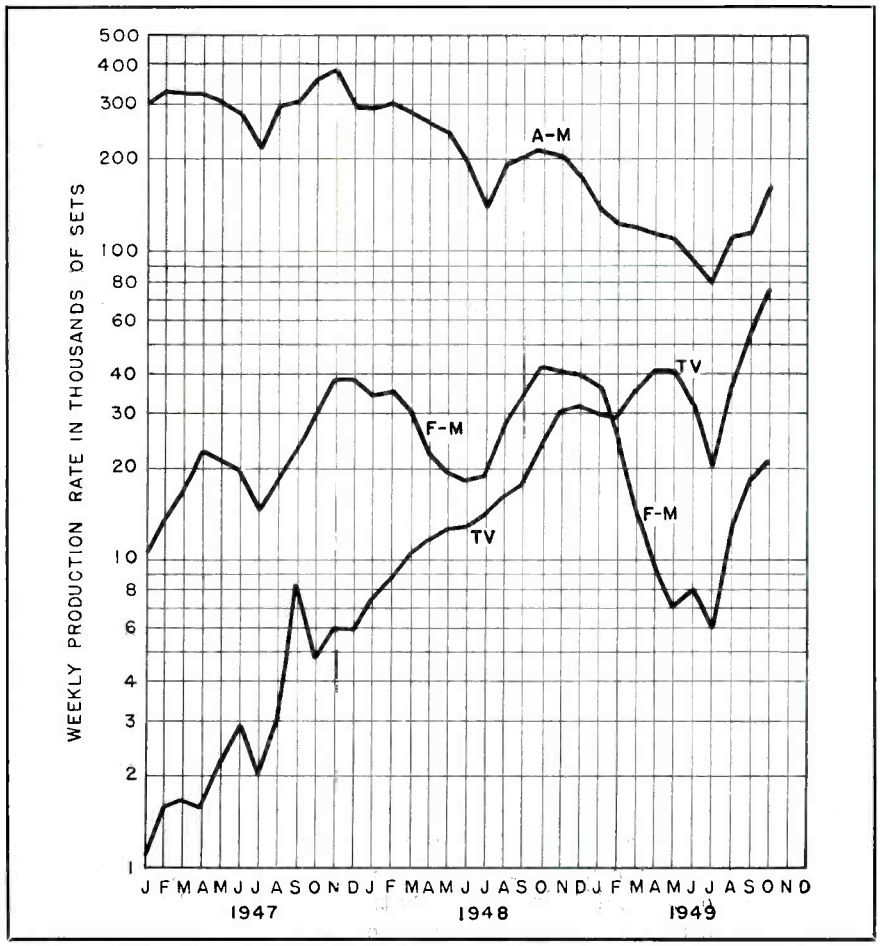
Or take the makers of tv antenna kits. No one has found a way to count or locate all the members of this group. This is probably all to the good, for the tv antenna designer has frequently been identified as the "chimney architect" most likely to meet with mayhem from a thousand residential neighborhoods.

There is no doubt that tv has had a far reaching effect on many different classes of personnel, not the least of which are the technicians. The earliest convert among the technicians was, of course, the bartender. Not far behind him is many a senior engineer who started designing superhets a quarter century ago. Such men say with feeling that tv is a young man's game. True enough the young tv engineer is familiar with rise-times and noise-figures, foot-lamberts and cathode-coupled multivibrators. But he may be short on knowledge of, and respect for, the teachings of radio history. In consequence he may waste time reinventing devices long since tried and abandoned.

The way of all concerned in television engineering will be smoothed if the trends affecting tv design and production today are analyzed as repetitions of similar incidents in the radio business 15 to 25 years ago. The cost-cutting project presently rampant on the tv designer's bench is closely patterned on a similar effort that struck radio in the early thirties. The lessons learned then should be applied with profit and benefit to tv today.

Table II—Weekly Production of Receivers (RMA figures, in thousands)

	1947				1948				1949			
	Start	Finish	Peak	Aver.	Start	Finish	Peak	Aver.	Start	Oct.	Peak	Aver.
TV	1.1	5.9	8.2	3.4	7.5	32.2	32.2	16.7	30.3	76.1	76.1	40
A-M	302	297	385	315	293	175	301	225	140	147	147	116
F-M	10.3	38.4	38.4	22.6	34	40.1	42.5	30.6	36.9	20.8	36.9	15.6



Receiver production figures reported by RMA

New look of tv transcription industry, as well as motion pictures, is the lip-synchronous tape recorder for making the master sound track. A Rangertone unit is here being used during production of an educational film by Eddie Albert Productions in New York City. Resulting master sound tape can easily be edited and spliced

NEW AUDIO TRENDS

Electronic speed control systems for magnetic tape recorders provide lip-synchronous playback accuracy for movie films and tv transcriptions. Other Audio Fair highlights include fluid for making magnetized tracks visible, portable shadowgraph for detecting wear in phono needles, and 78-rpm V-groove recordings going up to 20,000 cps

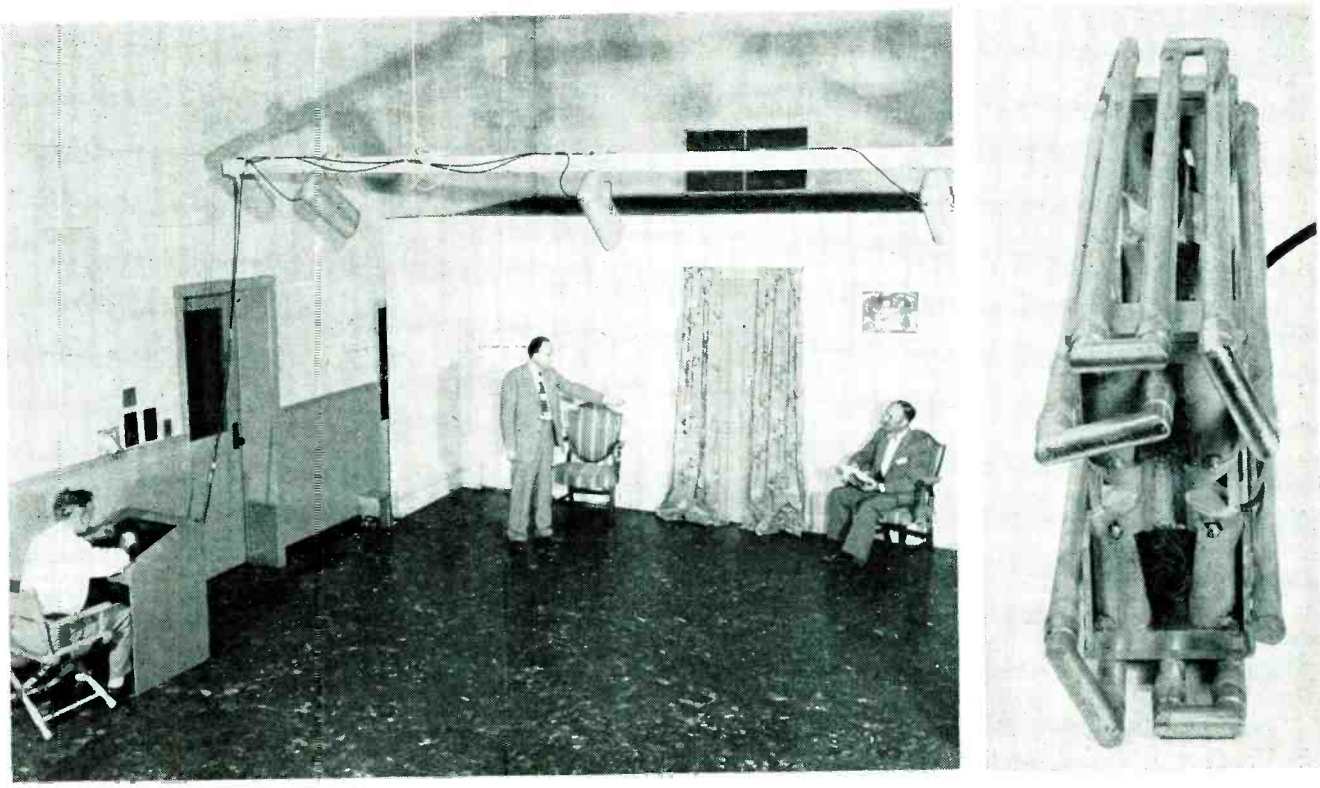
RECENT refinements in magnetic tape recording and playback equipment now make available a source of recorded sound that by actual listening test is indistinguishable from the original. As a result, tape recordings made off the air from topnotch f-m programs are replacing records and transcriptions in demonstrations of high-fidelity audio equipment.

Even the motion picture industry is turning to tape for the master recording of the sound accompaniment to a film. The significant trend in audio engineering today is thus to greater utilization of magnetic tape. This was clearly evident at sessions and exhibits at the Audio Engineering Society's first convention and Audio Fair, held recently in New York City. Further details of the Fair itself are given in the News of the Industry department in this issue.

Though the battle of disc speeds appeared to be either overlooked or forgotten, an occasional turntable could be seen in the exhibit rooms, and several outstanding new pick-ups were shown. For those who were unable to attend, this report will provide a few of the highlights and answer the question, "What's new in audio?"

Lip-Synchronous Recording

Three different methods of insuring playback of magnetic tape in precise synchronism with movie film were exhibited. Each requires the placing of something on the tape, in addition to the sound tracks, that will control the speed of playback to compensate for deviations in power



New look in tv studios is absence of mike boom and its shadow-producing headaches, through use of new RCA fixed-position directional microphones. Pipes providing directional characteristics are over 8 feet long, but folded back and forth between the two ribbon microphones too keep over-all length down. Operator switches smoothly between mikes to follow action

line frequency and changes in tape length with temperature and humidity.

Sprocket holes provide synchronization mechanically in the Magnagram 16-mm magnetic film recorder. Here the magnetic oxide coating is placed on standard 16-mm film stock.

In the Fairchild Pix-Sync tape recorder, a 14.5-kc carrier modulated with the 60-cycle line frequency is recorded simultaneously with the audio program, at a level sufficiently low to insure negligible effect on the normal dynamic range of the recorder.

In playback the 14.5-kc sync signal is amplified along with the program material in the first two stages of the standard playback amplifier. Just ahead of the playback-amplifier volume control is a 14.5-kc bridged-T rejection filter which removes the control carrier from the program channel. The control signal is taken off just ahead of this network. It goes to the demodulator chassis where it is amplified in a band-pass amplifier and demodulated. The band-pass is centered on 14.5 kc and is little over 1 kc wide at the 3-db point. It is down about 45 db at 10 kc.

After demodulation, the recovered 60-cycle signal is amplified through a push-pull power amplifier which feeds a small induction follow-up motor. The motor is coupled to the tape capstan flywheel through a special puck drive and its torque, either aiding or opposing that of the synchronous main capstan drive motor, changes the speed of the Synchroll drive to the capstan. The capstan rotational speed thus increases or decreases from the line synchronous speed to automatically compensate for any tape stretch or shrinkage which would cause a difference between the recorded 60-cycle signal and the line frequency at the moment of playback.

In the Rangertone lip-synchronous tape recording system the 60-cycle power frequency is recorded directly on the tape perpendicular to the normal sound track, using a separate recording head. Being at right angles to the standard recording, the sync signal does not cause interference during playback of the sound yet is readily removed with a separate 90-degree playback head.

The sync playback signal is fed to an amplifier and then to an electromechanical frequency discriminator which also receives the 60-cycle line frequency as a reference signal for playback. Any frequency difference between the two results in an error-correcting signal that is used to change the frequency of an oscillator that normally operates at 60 cps. This oscillator acts through a thyratron power amplifier to furnish power to the synchronous motor that drives the tape during playback.

Seeing Magnetic Tracks

A solution of very small particles of iron, marketed as Visi-Mag, shows clearly the tracks recorded on tape by single or dual-track recorders. The recorded paper or plastic tape is merely dipped into the solution for a few seconds, and allowed to dry in air for about a minute. Chief uses are for determining misalignment of record-playback and erase heads, for determining if a

machine is making proper head-to-tape contact and for arousing interest and curiosity by showing the patterns caused by various speech and music sounds. A special solution of extra-fine power is available for microscopic inspection of short wavelengths.

Folded Line Microphone

In television, the necessity of keeping the microphone out of the picture means that it has to be located farther from the subject than in regular broadcasting. The need to keep microphone shadows out of the picture aggravates the difficulty of obtaining a satisfactory sound pickup. One promising solution of this problem is a new RCA microphone with a more highly directive pattern and greater sensitivity than exist at the present time.

The new pickup, described by H. F. Olson at one of the technical sessions, makes it possible to use pickup distances up to 12 feet with speech in conventional studios. Frequency range is 50 to 15,000 cps. Directional efficiency (energy response to random sounds) is one-tenth.

The new directional microphone employs two similar ribbon-type units spaced 12 inches apart, in conjunction with a damped pipe 100 inches long that forms a part of the compound acoustical termination at the back of the ribbon and also serves as the frame. The pipe is folded back and forth to keep the over-all length of the mike down to approximately a foot, as compared to the 10-foot length of a predecessor line microphone. Response of the new unit is attenuated 20 to 40 db at 90 degrees and in the rear hemisphere. Sensitivity in the direction of maximum response is about 6 db higher than for conventional high-quality microphones. Total angle of reception for one-half energy response is about 60 degrees.

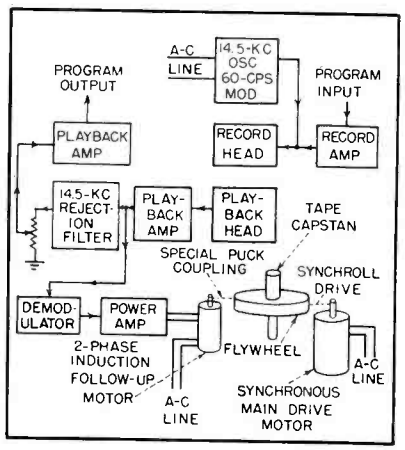
To eliminate the microphone boom problem in television studios, several of the new microphones are mounted overhead in fixed positions, each aimed to cover one portion of the field of action. As the action changes on the set, an operator at a monitoring console switches to the appropriate microphone. Slider-type volume controls are used instead of rotating knobs, to increase the speed of operation in making smooth transition from one microphone to the next.

TV Film Trends

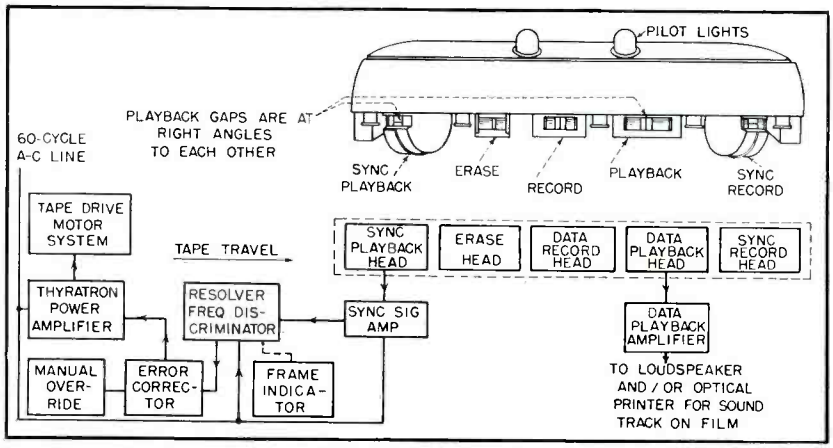
Film features, shorts and commercial spots make up a good portion of today's scheduled television programs. Much of this is old stock, of widely varying quality because of old recording techniques, non-standardization of equalization and because much of the film is 35 mm to 16 mm reduction. The tendency is toward 16-mm film because of its greater economy and ease of storage and handling. To get the most out of this film, according to S. R. Patremio of DuMont, a continuously variable equalizer is definitely needed for improving quality and reducing noise.

New and improved methods of 16-mm recording are giving greatly improved sound tracks. These include improved noise reduction and compression methods and the better frequency response obtained with new low-impedance phototubes that are not responsive to infrared. Low-frequency noise is reduced by using an r-f oscillator to supply voltage to the exciter lamp and by improving the mechanical vibration-suppressing mounting for the lamp.

New multiple variable-area sound track for 16-mm film, announced by J. A. Maurer, Inc., minimizes distortion due to improper adjustment of scanning light beam in projector. Sum of distortions for six narrow tracks is less than for one standard-width bilateral track

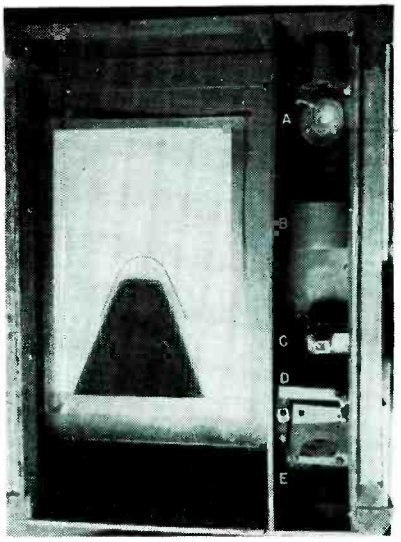


Fairchild tape recorder, showing how 14.5-kc carrier modulated with power line frequency is recorded simultaneously with sound for controlling playback speed



Rangertone lip-synchronous tape recorder, showing 90-degree orientation of special sync record and sync playback heads used to place 60-cycle power line frequency directly on tape at right angles to program magnetization. On playback, this sync signal controls a variable-frequency thyratron oscillator-amplifier system that feeds the tape drive motor

New magnetic fluid makes residual magnetic field visible when recorded tape is dunked as shown. Resulting pattern appears after about one minute of drying in air, as on two-track recorded tape sample on table. Powder can be wiped off without damaging tape



New Trac shadowgraph uses 4-foot optical path to magnify stylus point 500 times, using light source (A), condenser lens (B), holder for cartridge with stylus (C), enlarging lens (D), mirror (E) and additional lenses and mirrors underneath the ground glass screen

Teletranscriptions as made off the screen by DuMont for reuse later employ 16-mm film with a variable-area sound track. Incoming sound is separately recorded optically on film, using fixed equalization to achieve the proper recording characteristics and compensate for loss of high frequencies in developing and processing of the film. The developed sound negative is used to make the sound positive that is combined with the picture for the final sound-film print. To synchronize picture and sound, three light pulses are exposed to the picture simultaneously with feed of three sound buzzes to the sound recorder. The resulting cue marks permit proper synchronization when making the final print.

Separate recording of sound is necessary because of differing and continually changing requirements for optimum developing of exposed film and exposed optical sound tracks. Because of the time element, however, newsreels for television are generally made with both sound and picture exposed on the same film. As a result, it is not uncommon to have picture and sound alternately go bad on television newsreels because of the compromises required in developing the negative.

Some makers of tv transcriptions are using lip-synchronous magnetic tape recording to obtain a master sound track for protection in case the variable-area optical track on film goes bad. The equipment pays for itself in a few months through savings in the cost of film formerly used for a protective master. Tape masters are erased for re-use as soon as a satisfactory final sound-on-film print is obtained.

Stylus Shadowgraph

A light-weight console shadowgraph designed specifically for viewing a stylus point magnified 500 times was exhibited by Trac as a quick means of showing station engineers, studio engineers and record enthusiasts what is happening to a stylus point. With the Trac Shadowgraph it is possible to determine precisely when a stylus needs replacement or resurfacing to prevent damage to a record library. Likewise, when trouble hits the system it is possible immediately to confirm or rule out the stylus as a source of difficulty. The shaded viewing screen has on it a perfect reproducing stylus curve as a standard of comparison.

The shadowgraph is supplied with a holder for one type of cartridge, but other holders can be obtained if needed. The entire cartridge with its needle is placed in the holder for inspection. Three knob adjustments move the stylus in three planes for focusing and for positioning of the shadow under the perfect curve. Two cross-sectional profiles are then quickly obtained, the holder being rotatable through 90 degrees. The whole trick is done with front-surface mirrors and enlarging lenses, plus a condenser lens between the projection lamp and the stylus.

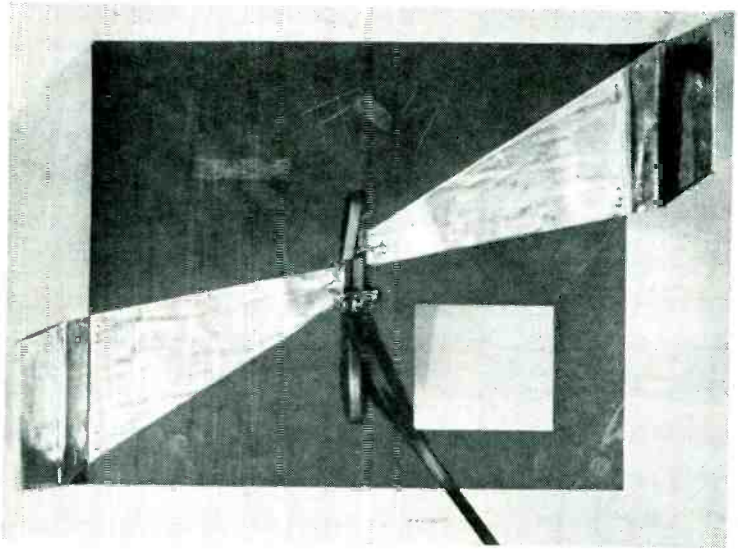
New V-Groove Records

A demonstration of 78-rpm records playing back frequencies up to 20,000 cycles, with the tinkle of triangles ringing loud and clear, attracted continual crowds to the exhibit room occupied jointly by Frank L. Capps & Co. and Cook Laboratories. The new records can be played back with either a 1.0-mil or 2.5-mil radius stylus.

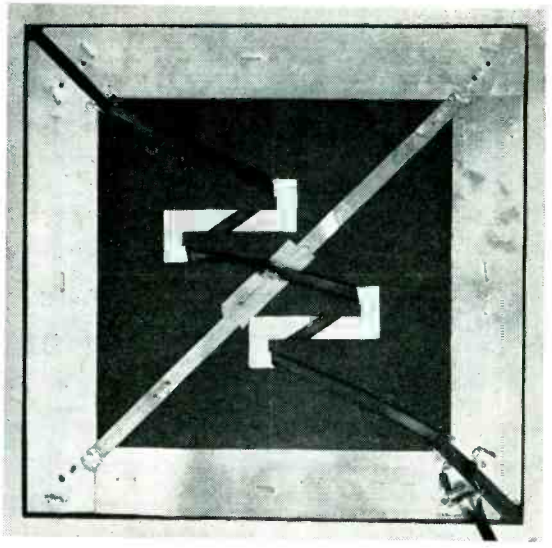
The V-groove recording stylus has two or more polished facets along the cutting edge, each microscopically small (0.1 mil). Because these facets are so small and do not interfere with each other, they allow the cutting stylus to trace high-frequency patterns while still polishing the groove walls. Resulting grooves are polished well enough to permit going up to 20,000 cps without excessive noise modulation and without objectionable distortion of the high-pitched tones.

All steps in the production and playing of 20,000-cycle records require special equipment. The first requirement is the new miniature condenser microphone, which responds well up to 20,000 cps and requires only a small amount of correction. Feedback recording is an indispensable link in achieving full dynamic range without excessive distortion. A special cutter and stylus together minimize the size and weight of the cutting portion so there is almost no resistance to distortion-free movement of the stylus as it engraves the musical pattern in the record groove.

For playback, high-quality amplifiers going up to 20,000 cps have long been available, but comparable loudspeakers are harder to find. A new loudspeaker capable of handling 30 to 20,000 cps faithfully is needed in order to reproduce these experimental records satisfactorily over their full wide range.—J.M.

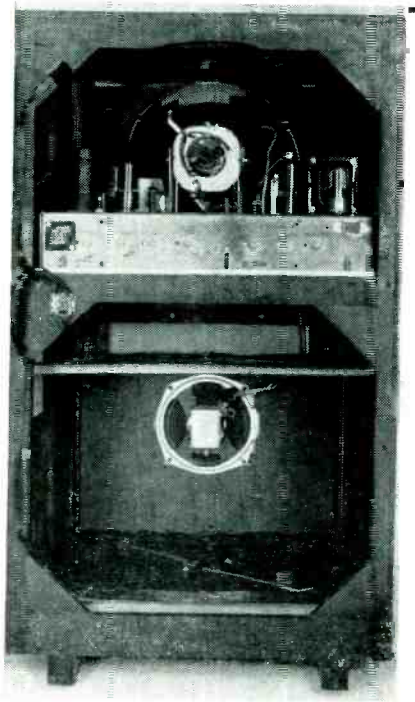


Built-in 20-inch dipole with fixed tuning stub and equalizer. Folding flaps at ends increase antenna capacitance and improve low-band pickup about 20 percent. Stapling of metal-foil vanes to fiber-board gives low production cost along with required rigidity



Built-in horizontal loop antenna for all twelve television channels, with equalizer network (lower right). Pickup is essentially omnidirectional, making orientation of cabinet unnecessary

BUILT-IN ANTENNAS for



Triple square-loop installation in television console. One loop is a few inches above floor, another is under chassis just above loudspeaker, and the third is fastened under top of cabinet. All three loops are connected in parallel

By KURT SCHLESINGER

Motorola Inc.
Chicago, Ill.

THE GREAT NUMBER of video antennas on our roof tops brings back to mind the state of the radio about twenty years ago. Since then, outdoor antennas for radio broadcast have largely disappeared. The development of radio reception went through the stage of indoor antennas mounted on top of the receivers, to its final form of the built-in radio loop.

Will television repeat this development? Conditions are not as favorable, since television is a form of broad-band communication, requiring about 20 times more signal voltage to overcome the increased receiver noise.

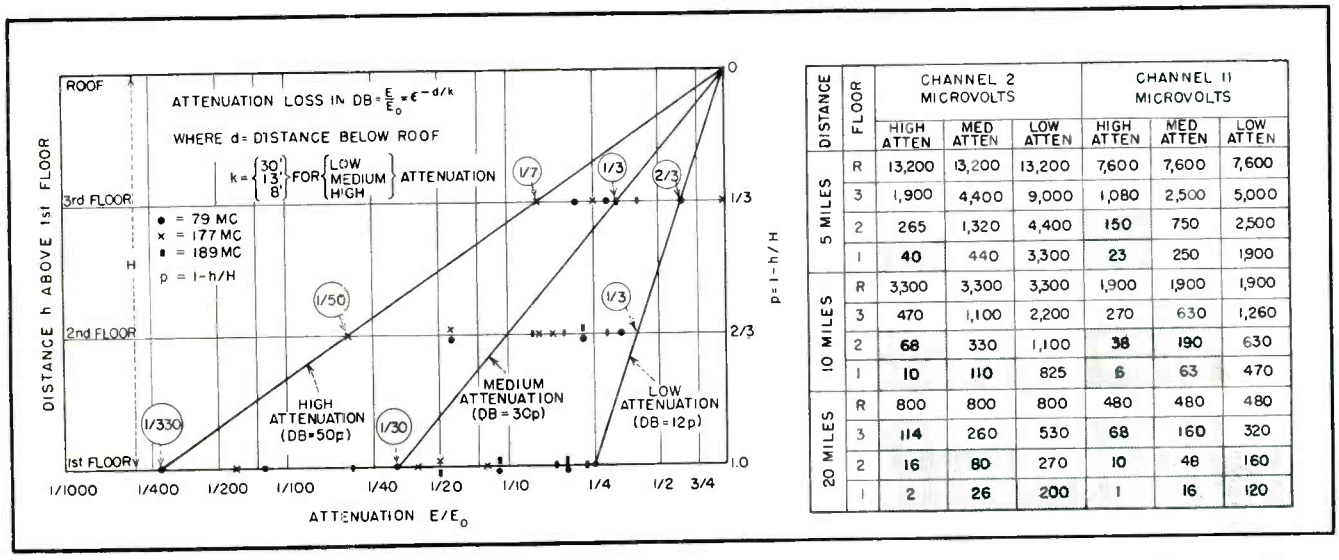
The overall transmission efficiency of a television system is thus about 30 db down as compared to a similar audio broadcasting system. To compensate for this loss, television transmitters should have about 400 times more power than their audio counterparts. Instead, they have less power! As a result, incidental signal attenuation has more serious effects in television than in audio broadcasting. Moreover, multipath and ghosts, which sometimes accompany indoor reception, do harm to a picture presentation, but have not been an obstacle in audio reception.

In spite of these difficulties, the development of indoor and built-in antennas is well under way, since it is possible to cover about ⅓ of the total radius of a station with such antennas.

Separate Indoor Antennas

Indoor antennas have been available for some time in the form of a simple dipole with adjustable

This article is based on a paper presented at the 1949 National Electronics Conference. The Conference paper will appear in the N.E.C. Proceedings.



DISTANCE	FLOOR	CHANNEL 2 MICROVOLTS			CHANNEL 11 MICROVOLTS		
		HIGH ATTEN	MED ATTEN	LOW ATTEN	HIGH ATTEN	MED ATTEN	LOW ATTEN
5 MILES	R	13,200	13,200	13,200	7,600	7,600	7,600
	3	1,900	4,400	9,000	1,080	2,500	5,000
	2	265	1,320	4,400	150	750	2,500
	1	40	440	3,300	23	250	1,900
10 MILES	R	3,300	3,300	3,300	1,900	1,900	1,900
	3	470	1,100	2,200	270	630	1,260
	2	68	330	1,100	38	190	630
	1	10	110	825	6	63	470
20 MILES	R	800	800	800	480	480	480
	3	114	260	530	68	160	320
	2	16	80	270	10	48	160
	1	2	26	200	1	16	120

FIG. 1—Measured values of signal attenuation at various locations in three-story brick-steel building are plotted here for three different frequencies. Curves drawn through extreme limits and through average of values on each floor show attenuation to be exponential function of height. Tabulated values of signal strength in microvolts, at right, are computed from curves; shaded values represent signal strengths considered too low for effective reception with indoor half-wave dipole

Television Receivers

Analysis of indoor antenna problem and details of dipoles and loops now being used. Square single-turn loop with simple broad-band equalizer mounts easily inside cabinets and requires neither tuning nor orientation. Design equations are given

length, which may be placed on top of the receiver and oriented for maximum reception. While these antennas may give satisfactory performance, their need for adjustment and orientation, their physical size and their null positions are objectionable.

Built-in Loops

It was soon found desirable to have a built-in antenna, installed inside the cabinet and invisible to the user. A horizontal loop antenna small enough to be built into table model as well as console sets has been developed and will be described in this paper. This antenna requires no tuning and no orientation in space. Instead, it is bi-resonant, and is designed to respond with a bandwidth of about 30 mc to television signals within the low and high-frequency bands. Furthermore, this antenna is omnidirectional in the horizontal plane, and is inoperative for signals arriving from vertical directions. The latter property helps to reduce pickup by the antenna of noise generated in the receiver, thus facilitating its operation in weak fields.

In table models, one unit of this loop is installed in the ceiling of the cabinet. In consoles a double-deck arrangement is used, with one loop under the top of the cabinet and one at the base at least 6 inches above the floor. Another arrangement employing three decks has also been used successfully, with the third loop in a plane at least 6 inches below the receiver chassis.

Before going into details of the design and operation of built-in antennas, it is well to point out the serious limitations under which these antennas must operate. It will be shown that attenuation of radio waves inside a building is the dominant factor. It may cause more loss than can be reclaimed by improvements in antenna design.[1]

Attenuation in Buildings

To get numerical data, signal strength was measured on various floors of a three-story factory building of brick-steel construction. The results, plotted in Fig. 1, show that attenuation is an exponential function of height, and that it increases rapidly from the window side inward into the building. The loss in db seems to be directly proportional to the distance from the roof. No marked difference in attenuation was found between high or low channels. Attenuation up to 50 db

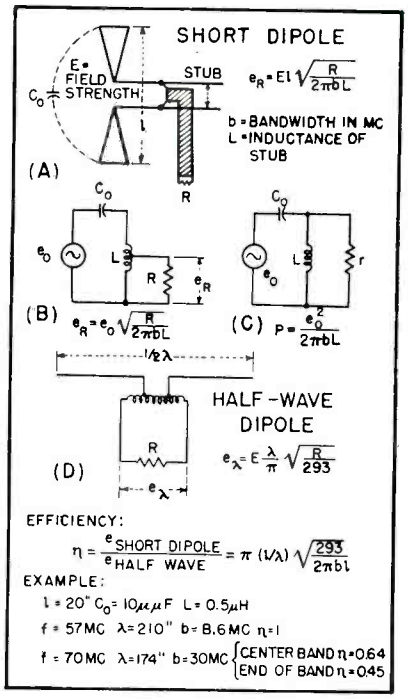


FIG. 2—Comparison of short tuned dipole and half-wave dipole

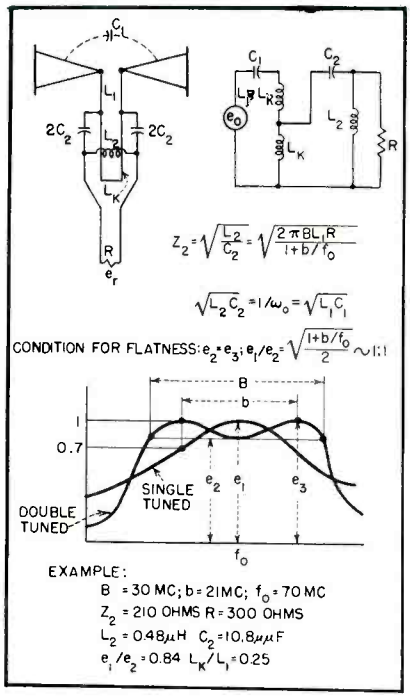


FIG. 3—Equalizer circuit used with short tuned dipole to broaden band

may occur at the ground floor inside a building of this type.

On the basis of the measured attenuation data, computed signal voltages are tabulated in Fig. 1 for distances of 5, 10 and 20 miles on various levels within a building of this type. Shaded values represent unusable signals. This is under the assumption that the receiver uses a half-wave dipole as indoor antenna and has a noise figure of 10 db. With such a receiver, signals of 200 microvolts will give a good picture with 10-percent noise; 80 microvolts constitutes just about the minimum usable signal.

Successful indoor reception requires increasing elevation with increasing range. Even at small distances, however, reception may be rendered impossible by heavy attenuation within the building. Furthermore, in many cases reception becomes useless because of multipath and ghost. Thus, no guarantee can be attached to indoor reception. Vagaries of propagation rather than small differences in antenna efficiency are the decisive factor.

Short Dipoles

A characteristic feature of all built-in antennas is their small size. Confined within cabinets of about two-foot size, the built-in antenna has the proper size of a halfwave dipole for reception on the high television band, but is about three-to-one undersized on the low television band. The resulting loss of efficiency can be largely reclaimed by the use of a tuning network with high selectivity. A dipole at the low frequency, connected to a tuning stub of variable length, with the 300-ohm load resistance tapped to some point along the stub, is shown in Fig. 2A. The equivalent lumped circuit appears in Fig. 2B, and Fig. 2C has the load resistance connected across the dipole after step-up transformation. The power output equation can be used once a given bandwidth b is selected by means of the tap.

The output voltage equations indicate that the effective length of a dipole is increased, by tuning, beyond its physical length. The stretching factor $\sqrt{R/2\pi bL}$ amounts to 2.4:1 for a broadband dipole (b = 30 mc) and increases to almost 4:1 if the bandwidth is reduced to one channel width (b = 6 mc). In the latter case, a 2-foot dipole acts like one with an 8-foot span.

The short dipole can now be compared to a half-wave dipole as in Fig. 2D to arrive at an efficiency ratio. The example shows that in order to match the half-wave dipole, the tuning network has to have a selectivity of about 6 mc at channel 2. Somewhat higher bandwidth can be tolerated at the higher channels of the low band.

In general, a short dipole is strictly a one-channel proposition and has to be adjusted from one station to the next. If it is intended to use a broad-band circuit, the efficiency of the short dipole drops to about 2/3 of the half-wave. However, this holds only for the center frequency of the band. At the extremes, the output drops below 50 percent of the standard of comparison. Channel 2 will be down more than channel 6, since the amplitude response of this circuit is not symmetrical around center frequency.

Equalizer

The broad-band network of Fig. 3, henceforth called the equalizer, helps to transform triangular response into rectangular response. A short dipole is connected to a stub

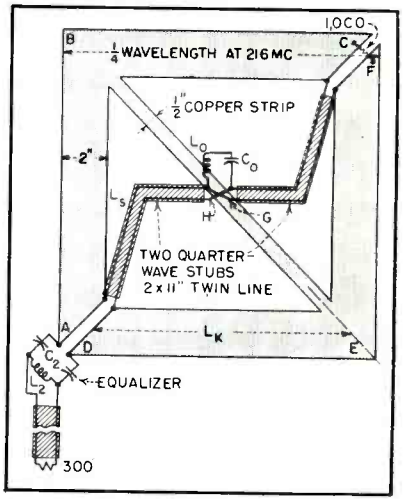


FIG. 4—Broad-band bi-resonant loop used as built-in television antenna

of constant length which is cut to resonate the antenna capacitance at mid-band or 70 mc. The load is not connected to this tuning stub directly, but rather through the equalizer circuit denoted as C_2 L_2. The lumped circuit equivalent of the equalizer is the familiar double-tuned circuit with one-sided damping by the load. The mutual inductance L_k can be adjusted by the

tap along the matching stub L_1.

The equations given in Fig. 3 are for the case of optimum flatness. They yield the shunt impedance of the equalizer which is the ratio of L_2/C_2. Since the product $L_2\ C_2$ is fixed by the tuning condition, the constants of the equalizer are uniquely determined.

The numerical example in Fig. 3 compares the response to that of a single-tuned antenna. The result indicates that the equalizer causes only a small loss of signal output, as demonstrated in the appendix. Pick-up outside the band is very much reduced, while the response within the pass band is much more uniform than for a single-tuned antenna. An equalizer of this type has been used successfully in built-in dipoles and loops and makes the tuning automatic.

Loop Antennas

In practical field tests with broad-band dipoles, the need for orientation was found objectionable. While perfectly feasible with separate antenna units mounted on top of a receiver, it was felt that a built-in antenna should not have directional characteristics.

Among omnidirectional antennas for horizontal polarization, the horizontal loop is a form of antenna that yields a circular pattern in the horizontal plane if the perimeter of the loop is smaller than the wavelength. When approaching this limit, the loop comes into resonance by standing waves along its sides. By use of a particular feed system, it has been possible to add another resonant mode in the low-frequency band.

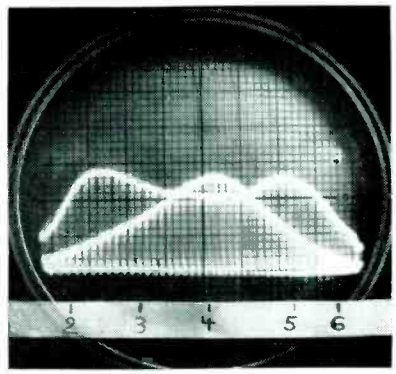
Square Loop

A complete broad-band omnidirectional loop system is shown in Fig. 4. It is a square whose perimeter equals the wavelength on channel 13. Opposite corners B and E of the square are connected by a copper strip to exclude undesired modes of operation, and the two remaining corners are fed through a transmission line transposed at the center. The electrical length of each center connector is very closely 90 degrees at channel 13. At the center of the loop is a 6-$\mu\mu$f tuning capacitor in series with an inductance which makes the capacitance look about six times larger than it actually is, as we approach the uppermost channels. The signal output is taken from a corner of the loop through an equalizer network like that previously described.

This loop is capable of two different types of operation. At the high band, legs ABC and DEF oscillate as two end-fed half-wave dipoles connected by quarter-wave lines and series aiding across the load, with zero voltage at the center capacitor in the loop. At the low band, the center capacitor carries maximum voltage, the voltage at corners A and D is stepped down from this maximum, and corners B and C are again at zero voltage. The current distribution is uniform all the way from point G through the outside rim back to H. Thus, we have actually two halfloops in parallel across the output terminals and the load is tapped down across the total inductance of these subsections. This loop antenna is bi-resonant, and the peaks of response can be made to occur within each of the two television bands.

Low-Band Operation

The pickup efficiency of a television loop as compared to a dipole is analyzed in Fig. 5 for low-band operation. The schematic shows the essential circuit elements at the low frequencies. Here V is the total voltage induced in a continuous square of the same size. By evolution we arrive at a simple equivalent circuit with transformed load r across the circuit capacitance, from which the equations for signal power and voltage output can be immediately written.



Spectral response of short dipole over television channels 2 through 6 without equalizer (single peak) and with equalizer (double peak). Curves are superimposed by electronic switch, and represent voltages across centers of dipoles

The phase angle of delay by the passing wave is, fortunately, much larger at television frequencies than in loops for audio broadcasting. It is on the average 30 degrees for the low band and over 90 degrees for the high band. As a result, the one-turn video-loop is not nearly as inefficient as its counterpart in a radio receiver would be.

The final equation for the output from the loop shows that relative pickup efficiency is 40 percent compared to a half-wave dipole, and 66 percent as compared to a short dipole of length a. Measurements have largely confirmed these estimates.

High-Band Operation

On the high band, the video loop antenna becomes remarkably effective.[2] Here a loop with quarter-wave legs approaches the performance of a half-wave dipole and has a radiation resistance of the order of 30 ohms or more.

Figure 6 shows the high-band response of a loop antenna and illus-

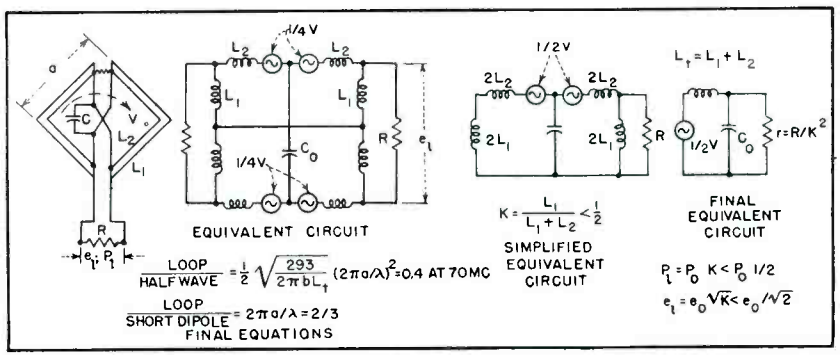


FIG. 5—Low-band operation of built-in television loop antenna

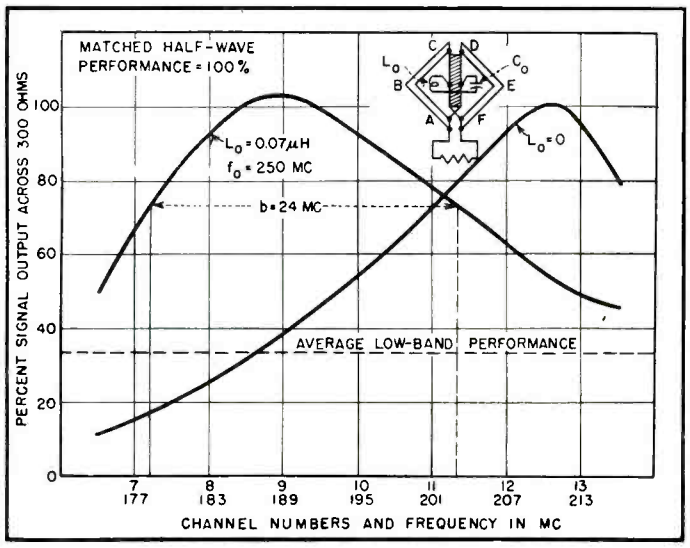


FIG. 6—High-band performance of television loop as compared to dipole

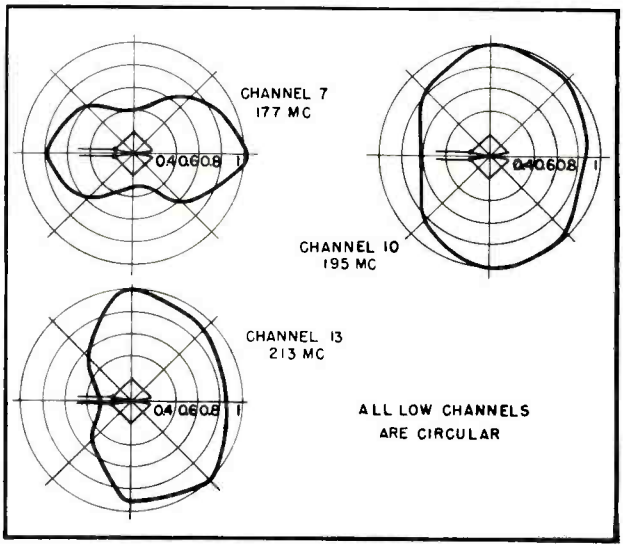


FIG. 7—High-band directivity patterns of horizontal loop for three different channels

trates the effect of the small series inductance L_0. This inductance serves to reduce the impedance across the center point and may be used to shift the peak of the response to any desired frequency within the high band. We have placed the peak efficiency between channels 9 and 10. The bandwidth of the system is four channels wide and can readily be increased with equalizers. However, this was not found necessary in practice in view of the high efficiency of the loop at those frequencies. For comparison, the average low-band performance is also indicated and is about $\frac{1}{3}$ of the peak of the high-band performance.

The directional pattern of the loop is shown in Fig. 7 for channels 7, 10 and 13. It deviates somewhat from circularity, but not so much as to lose the signal at any time. The direction of maximum pickup changes from one diagonal to the other diagonal as we pass through the band. On the low channels, the pattern is more nearly circular because the dimensions of the antenna are much smaller than the wavelength. These data, taken in free space, do not exclude the possibility that zero signal may occur inside buildings due to standing waves or other effects of wave propagation. Nulls may also be caused by antenna effect of the lead-in wires if these are too long or unbalanced electrically. However, in actual field experience the loop antenna was found to be remarkably free from dead angles and null positions.

Loop Antenna Arrays

In order to boost the efficiency of these small antennas, it has been found practical to connect two or more of them together to feed a common load. The simplest way to combine loop elements is as shown in Fig. 8.

Two loop elements are arranged in the ceiling and bottom of a receiver cabinet at a distance d apart which is smaller than a half-wavelength on all channels. The connection is made at the shortest possible length by 300-ohm twin-lead which is tapped at the center. At this point, output is taken through an equalizer network having one additional inductance L_3 directly across the loop connector. This inductance reduces the effective coupling coefficient of the double loop to the value found for a single loop, so that the desired bandwidth is not exceeded and a resultant loss of sensitivity is avoided.

A well-designed double-deck loop of this kind should give a power gain of 2:1 or a signal boost of 41 percent. Voltage gain averages 1.4 for the low and high channels, with occasional peaks up to 1.6 and more. These excess gains are due to standing waves along the connection to the receiver. With built-in antennas, such gains may often be used to advantage, since the short length of the line excludes troubles from reflections of long delay.

Figure 8 also snows how the gain from a double-deck loop depends on the separation of the elements. Full power gain is realized for a spacing of one-half diameter or at least 10 inches apart. This makes it possible to apply such double-deck loops in small, low table models. It was also found that the loops can be installed quite close to a metal chassis and do not lose much of their efficiency if the spacing is at least 7 inches from the nearest continuous metal plate. This feature, as well as the relative freedom from detuning and body effects, makes the application of a double-deck loop quite practical.

The performance of the built-in antennas described in this paper has been tested and compared to a standard half-wave dipole in Fig. 9. On the low band the short dipole leads the loop by a factor of 3/2, as was anticipated. The efficiency of both built-in antennas falls somewhat short of the value of 60 and 40 percent expected by theory. The dipole loses more by installation close to a metal chassis than the loop.

On the high band, all of these antennas perform quite well. The single loop matches the short dipole, and the double-deck loop meets the half-wave dipole and even seems to outperform it at some of the higher channels.

Short dipoles and loop antennas as used commercially in recent television receivers seem to be success-

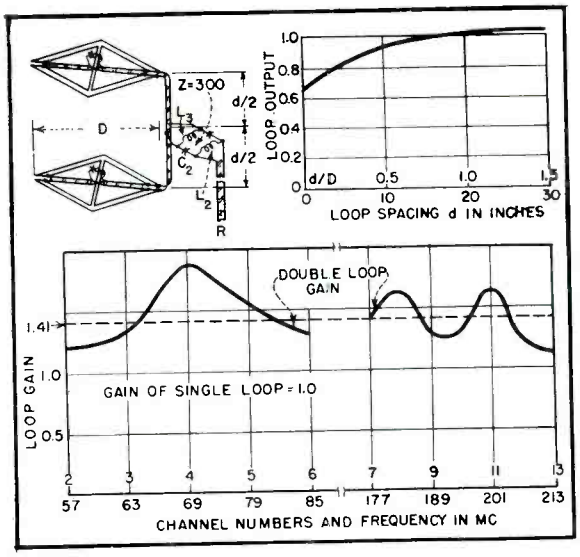


FIG. 8—Performance of double-deck loop array designed for installation above and below chassis

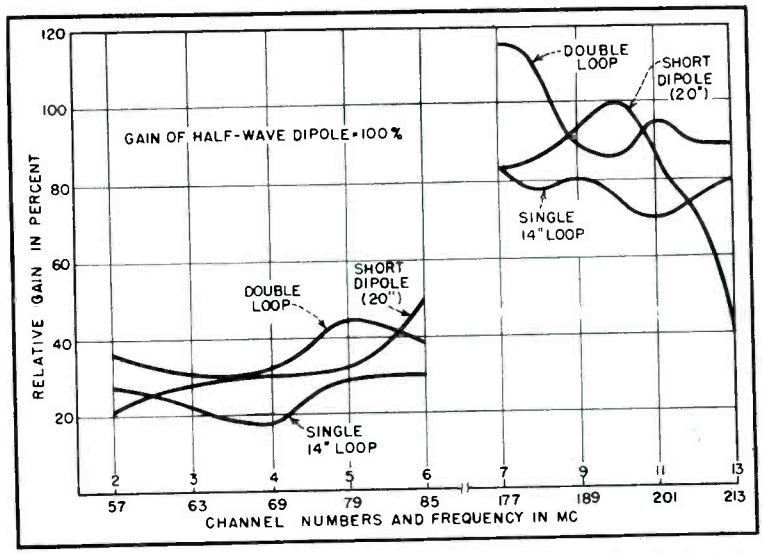


FIG. 9—Comparative performance of all antennas discussed, showing built-in antennas nearly equal to half-wave dipole in high band

ful in providing satisfactory reception within the limits defined by wave propagation and outlined in this paper. The safe average range is about 10 to 12 miles in connection with radiated transmitter powers of about 10 kw. Much higher distances have been covered occasionally. It is hoped that this work on built-in antennas may contribute to the further growth of the television audience by relieving the difficulties facing an ever increasing number of outdoor installations. Since these built-in antennas are inexpensive and automatic in operation, they may be included, for optional use, in receivers of almost any price class. This enables the set owner to do without outdoor antennas in a large percentage of instances.

Acknowledgment:

This work was done under the direction of D. E. Noble, vice-president and director of research at Motorola Inc. It was greatly furthered by the continued interest of P. V. Galvin, president of this corporation, and of E. Wavering, vice-president. Extremely helpful during this work was the assistance of V. Graziano and other members of the television research laboratory.

References

(1) W. L. Carlson, Television Reception with Built-In Antennas for Horizontally and Vertically Polarized Waves, *RCA Review*, April 1942.

(2) Andrew Alford and A. G. Kandoian, Ultra-High-Frequency Loop Antennas, *Transactions of the AIEE*, 59, p 843, 1940.

Appendix

Analysis of Equalizer

Optimum design of the tuned coupling network between antenna and load requires data about voltage transmission through a double-tuned system, not readily found in literature. Referring to Fig. 3, assume both primary (antenna) and secondary (equalizer) circuit tuned to the same frequency:

$$C_1L_1 = C_2L_2 = 1/\omega_0^2 \qquad (1)$$

The admittance across L_k looking into the secondary circuit is

$$1/Z_k = (R/Z_2^2)(1+j) \qquad (2)$$

This looks like a resistance Z_2^2/R shunted by a capacitor of equal reactance. The voltage across L_k then is at resonance

$$e_k = e_0 \frac{Z_2^2}{R} \frac{1}{\omega_0} \frac{1}{(1-j)} \qquad (3)$$

and the output voltage E_0 across R at mid-band frequency is

$$E_0 = e_0 \frac{Z_2}{\sqrt{2}\,\omega_0 L_k} \qquad (4$$

We now compute the output voltage E_2 at the higher side-band frequency ω_2. The peak at ω_2 occurs because of series resonance in the arm C_1 $(L_1 - L_k)$:

$$\omega_2^2 C_1 (L_1 - L_k) = 1 \qquad (5)$$

The generator voltage e_0 now appears directly across L_k. The equalizer transforms this voltage into the peak value E_2

$$E_2 = e_0 \frac{R}{Z_2} \frac{1}{\sqrt{2}} \qquad (6)$$

We now express the coupling inductance by bandwidth between peaks, using

$$b = \frac{1}{\pi}\left(\omega_2 - \omega_0\right) \qquad (7)$$

and combining Eq. 7, 5 and 1

$$L_k = L_1 \frac{b}{f_0 + b} \qquad (8)$$

This yields for the mid-band transmission

$$\frac{E_0}{e_0} = \frac{Z_2\,(1 + b/f_0)}{2\pi b L_1} \qquad (4a)$$

Equating 4a and 6 for flatness then furnishes the desired design information for the equalizer impedance

$$Z_2 = \sqrt{\frac{2\pi b\, L_1 R}{1 + b/f_0}} \qquad (9)$$

This equation, which is shown in Fig. 3, agrees with experience within 10 percent.

A single tuned antenna, without equalizer, but with the same bandwidth, would give the output

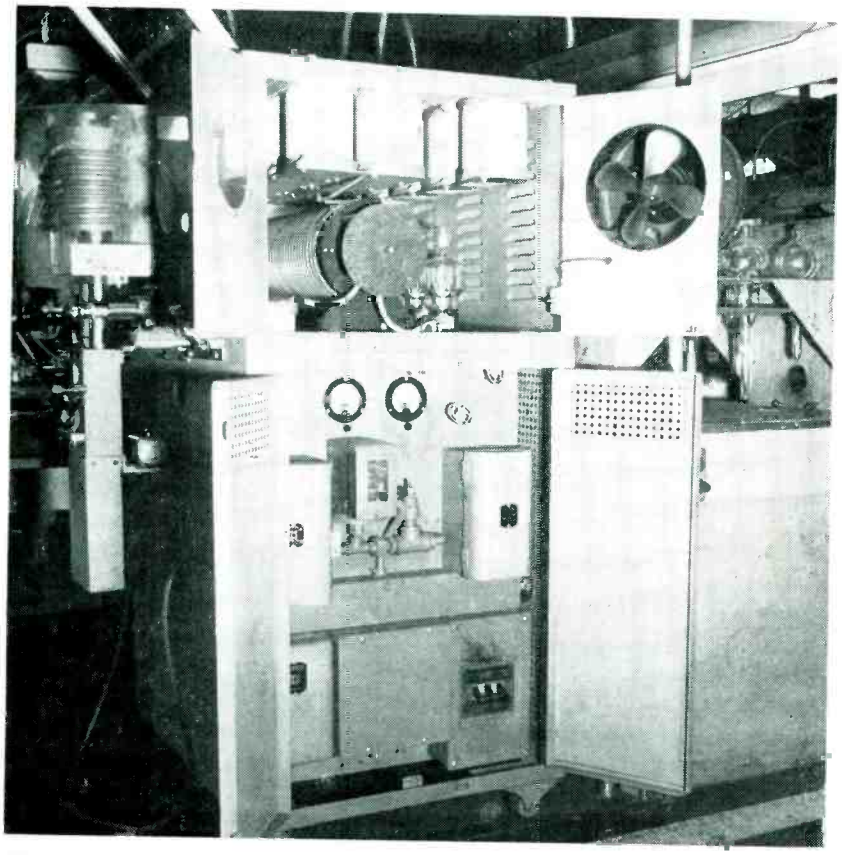
$$E_s = e_0 \sqrt{\frac{R}{2\pi b L_1}} \qquad (10)$$

This may be compared to the voltage from the equalizer, as shown in Eq. 4a, by dividing Eq. 4a by Eq. 10 and using Eq. 9:

$$\frac{\text{double-tuned output}}{\text{single-tuned output}} = \frac{E_0}{E_s} = \sqrt{\frac{1 + b/f_0}{2}} \qquad (11)$$

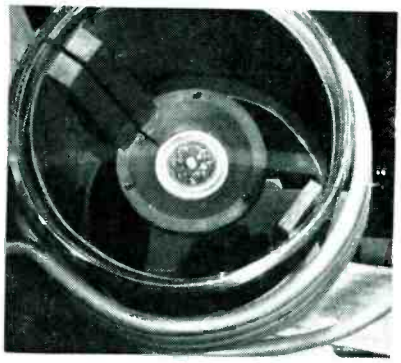
With a bandwidth of 30 mc around a center frequency of 70 mc, this factor is 0.84, hence there is only a 16-percent loss of signal through use of an equalizer.

INDUSTRIAL BRAZING



Complete pulse-brazing equipment. Work coil primary is visible in upper-left-hand corner of the photograph

Copper-gold brazing alloy being placed around base of tube prior to brazing operation



Looking down into special flux-concentration coil during brazing cycle

By J. L. REINARTZ
Eitel-McCullough, Inc.
San Bruno, California

IN THE MANUFACTURE of ultra-high-frequency vacuum tubes, there arise numerous problems, some of which present intriguing challenges to the design and production engineer. The specific job of brazing joints vacuum-tight, when the parts to be joined assume the size and delicacy of a watch and the brazing must be done after the watch is assembled, presents such a problem.

This sort of job was confronted in the assembly of the Eimac 4X150A uhf tube. Ordinary methods of heating the joint between the anode assembly and the grid-cathode assembly to brazing temperature caused damage to other metal-to-glass seals within the tube or the grid and cathode structures by heat conduction, and, if the braze were performed in air, resulted in extensive damage from oxidation.

It was found that pulsing techniques used in radar transmitters during the war could be applied successfully to the brazing process to provide a system of short-time induction heating by which the parts could be joined. Enormous peak power values are obtainable when the pulses are short. Another advantage is a considerable condensation of the size of the equipment, which allows a 15-kilowatt radar-pulse type electronic brazer to be housed in a cabinet 24 by 30 and 50 inches high.

The problem described may be met elsewhere in industry, and perhaps may be solved in a similar manner through the application of pulse brazing by induction heating. Electronic pulse brazing differs from normal high-frequency induction heating only in the application of a greater peak power to the work for a short time duration, thereby reducing thermal conduction of heat to other parts of the work.

General Considerations

Induction heating is caused by induced currents of great magnitude that flow around closed paths in the work. When a material is placed in a varying electro-magnetic field within a coil through which alternating current is flowing, eddy currents are generated and the heating of the work is the result of the I^2R losses in the work. The induced current travels a path of lowest impedance; therefore the current density is greater near the surface than at any other point and decreases exponentially toward the center of the work.

If other factors are held constant, the heat generated by induction will depend upon the resistivity of the work. Materials of low resistivity are more difficult to heat than those of high resistivity. Many applications of induction heating are possi-

by PULSE TECHNIQUES

Extremely high values of peak r-f power are applied in short-duration pulses to reduce heating by thermal conduction of parts adjacent to or near joint being brazed. System developed for tube manufacture has interesting possibilities for other applications

ble and practicable, such as soldering, melting ferrous and non-ferrous metals, annealing or hardening a controllable area, heating for forging, and many other applications where it is not practicable to apply heat by a flame as in such cases when the length of time of such a flame application results in the conduction of heat to parts from which heat must be excluded or where oxidation must be prevented or the work must be treated in a special atmosphere.

The equipment developed for the tube-brazing job supplies approximately 15 kilowatts of power at 400 kilocycles for 0.3 second. In this fraction of a second sufficient heat is developed by induced current flowing through the metal parts in the desired region to heat them to temperatures high enough to melt the brazing alloy by conducted and radiated heat. The alloy melts and flows smoothly over the metal surfaces being joined; also, it is drawn by capillary attraction into the space between the close-fitting sleeves which are brazed together.

This pulse brazing is performed in a hydrogen atmosphere, which not only helps to cool the work after brazing, but keeps the metal surfaces clean, reduces any oxide as the work heats and therefore permits the alloy to wet the metal surfaces and flow cleanly so that no vestige of unbrazed surface is left, thus rendering the brazed joint vacuum-tight. The temperatures attained easily melt the gold-copper alloy which requires more than 990 C (1,800 F) for optimum brazing results. All this takes place in the region of the braze, and the important feature is that the nearby glass seal is not injured, though the glass is approximately ⅝ inch from the

high-temperature area. The short periods of time required lend themselves readily to factory assembly-line conditions.

The Flux Concentrator

The electrical priciples involved in the flux-concentrator coil are derived from the fact that at the frequencies used in induction heating, practically only surface currents exist. We could place a solid copper bar within a multi-turn primary coil and find that the current concentration is in the outer section, while the magnetic flux concentration is in the space between the multi-turn primary coil and the copper bar. If we now drill a hole lengthwise through the copper bar we would find no appreciable change from the first condition of current and magnetic flux concentration and little if any magnetic flux would be found in the space of the hole in the copper bar. The copper bar now is, in effect, a thick copper cylinder effectively acting to prevent any flux transfer.

If, however, we cut a slit lengthwise through this thick copper cylinder, the situation is radically changed; and we will find a great concentration of magnetic flux within the inner space. There will also be a concentrated current flow in the inner cylinder wall as the result of the slit which changes the copper cylinder from a closed single-turn to an open single-turn, also allowing the currents which previously circulated only near the outer circumference of the copper cylinder to circulate in the inner circle by virtue of the lengthwise slit. It is this current and magnetic flux concentration that we make use of in the pulse brazing of the sleeves in the 4X150A. Any excess metal may be milled away, leaving the inner doughnut and the outer cylinder wall.

This whole assembly, called the flux-concentrator, is inserted within the multi-turn primary coil allowing a bell jar (which also serves as an insulator) to be placed closed end up between the multi-turn primary coil and the single-turn flux-concentrator coil, and a hydrogen atmosphere to be maintained in the bell jar.

The energy available from the multi-turn primary coil is transferred to the flux-concentrator coil and from there to the work placed within the flux-concentrator coil, by induction. The whole may be considered as a step-down transformer; and if the primary coil con-

Table I — Specific Heat of Materials for Calculating Pulse Power Required

Aluminum	0.214
Brass	0.092
Copper	0.0921
Gold	0.0312
Iron	0.107
Lead	0.0306
Nickel	0.105
Silver	0.056
Tin	0.0541
Zinc	0.093

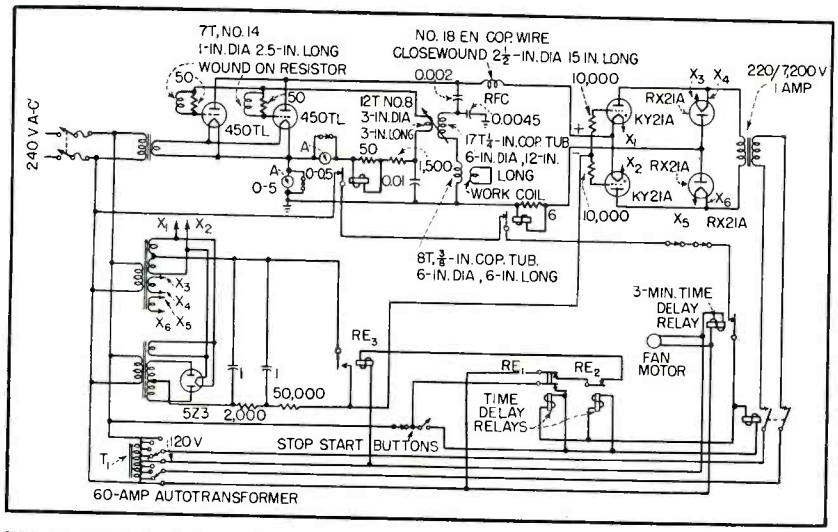


FIG. 1—Setting of time-delay relays RE_1 and RE_2 determines length of pulse. When RE_3 closes, bias is removed from KY21A thyratrons, and power is applied to the 450TL's

sists of ten turns and has 100 amperes of current flowing through it, then 1,000 amperes will flow through the one-turn flux-concentrator coil and the work within it, providing the magnetic coupling in this radio-frequency transformer is perfect.

The necessity for maintaining space between the coils and the work to prevent short-circuiting reduces the magnetic coupling and consequently the power transfer efficiency, so that it would be well to use a 50-percent power transfer figure for each of the several current transformation points. The flux-concentrator coil allows all the required induced energy to be concentrated in small or large functional areas, as determined by the positioning of the work and the extent to which it is inserted into the inner circle of the doughnut.

Calculation of Power

The amount of power necessary to raise a given material to some higher temperature in a definite time is:

$$H = SW(\Delta T)$$

where H = total heat delivered in Btu, S = specific heat of the material (see Table I), W = weight of the material in pounds, and ΔT = temperature change in degrees Fahrenheit.

The rate of heating in Btu per minute is given by $H/t = SW\Delta T/t$ where t is the heating time in minutes. The power required for a given amount of material to be heated in a specific time is

$$P = \frac{17.6\ SW\Delta T}{t} \text{ watts}$$

Therefore, if we take a ring section of the braze on the 4X150A of $\frac{1}{16}$-inch depth and compute weight in pounds, and apply the formula given above to ascertain the power requirement if the material involved must be raised 2,500 F, then $P = (17.6 \times 0.12 \times 0.0026 \times 2{,}500)/(0.005)$ which is 2.52 kw required at the Kovar ring. Assuming 50-percent efficiency transfer through air, 5.04 kw is required at the flux-concentrator, 10.08 kw at the primary of the r-f circuit, and, assuming 70-percent tube efficiency, the input to the tubes must be 14.4 kw.

The duration of the pulse is controlled by the setting of the time-delay relays RE_1 and RE_2 shown in the circuit diagram; these can be adjusted from 3 minutes down to 2/10 second or less, and can energize RE_3 for that period of time. In turn, RE_3 fires the KY21A thyratrons which allow plate power to flow to the two 450TL's only for the pre-set time mentioned above.

Calculation of Components

The electrical values of the capacitance and the inductance required in such a radio-frequency circuit can be computed quite readily. We know that the frequency should be about 0.4 mc. In a self-oscillating circuit the volt-ampere to watt ratio (or Q) in the oscillatory circuit should be 10 to 1, therefore the capacitance would be

$$C = \frac{300 \times Q \times I_b}{f \times E_b}$$

where C is in $\mu\mu$f, I_b is the plate current in ma, f the frequency in mc, E_b the plate voltage applied to tubes, and Q the volt-ampere to watt ratio.

Then L in μhenrys may be found by

$$L = \frac{25{,}330}{f^2 C}$$

For a 15-kw input flash brazer using a plate voltage of 5,000 volts we require a 3,000-milliampere plate current. Therefore, in this case, C is 4,500 $\mu\mu$f (10,000-volt rating) and L is 35 μhenrys. This value of inductance can be obtained with 25 turns in a coil 7 inches in diameter and 14 inches long spaced about 2 turns per inch using $\frac{3}{8}$-inch o.d. copper tubing.

The schematic circuit is shown in Fig. 1.

Choice of Tubes

The choice of tubes is dictated by the pulse rating of the tube when the on-to-off ratio is small. In the pulse brazing of small parts as in this case where 15 kilowatts input is sufficient, and where the time on is 0.3 second and time off is 30 seconds or more, two 450TL tubes are a good choice. These two tubes are good for the 5,000 volts plate voltage and the 3-ampere plate current required in the 1/100 duty cycle service mentioned above, nor does this place any strain on these tubes beyond that which they are normally capable of handling. The amount of power supplied to the work for any given period of time is controllable by the tapped transformer T_1 and can be varied over a wide range, not exceeding, however, a maximum plate input to the tubes of 11 kw for a pulse of 2-second duration or 45 kw for a pulse of ½-second duration, repeated once every 5 seconds. Where more power input than the maximum given above is needed, four such tubes may be connected in parallel or larger tubes may be used as required, due consideration being given to the associated transformers and other equipment.

Airways VHF Communications Receiver

By ARTHUR H. WULFSBERG
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Double superheterodyne has 100-db image rejection and 80-db attenuation of spurious responses. It employs series and shunt noise limiters, a noise-balancing circuit that improves series limiter about 8 db under conditions of CAA specified noise test and carrier-operated squelch relay that can be set slightly above ambient noise

USE OF FREQUENCIES from 108 to 136 megacycles for air-to-ground communications and aeronautical navigation has expanded rapidly since the end of the war.

The advantages which have won vhf wide acceptance in the aviation field include the increased number of channels available, freedom from atmospheric noise which in turn permits the use of simple yet effective receiver carrier-operated squelch circuits, relatively low transmitter power output requirements, and the use of small airborne antennas of low aerodynamic drag and relatively constant impedance over the frequency range.

To implement the changeover from medium high frequencies to vhf for such functions as Federal Airways enroute communications and airport traffic control in accordance with the recommendations of the Radio Technical Commission for Aeronautics (RTCA), the Civil Aeronautics Administration has recently procured a large number of single-channel vhf fixed-tuned ground station receivers (CAA Type RUQ) specially designed and manufactured to its specifications.

The equipment specifications reflect the wide experience of CAA engineers in this field; in addition to the usual requirements regarding sensitivity, selectivity, frequency stability and rejection of spurious responses, high standards of performance with respect to cross-modulation, desensitization due to strong off-frequency signals and rejection of the effects of pulse-

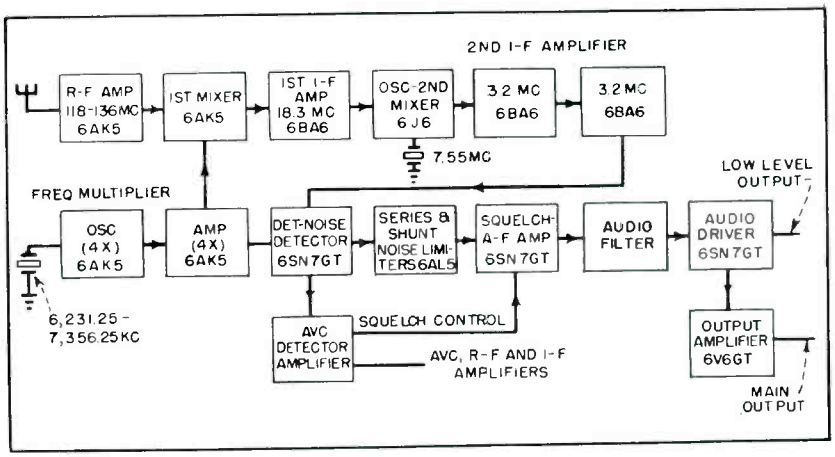
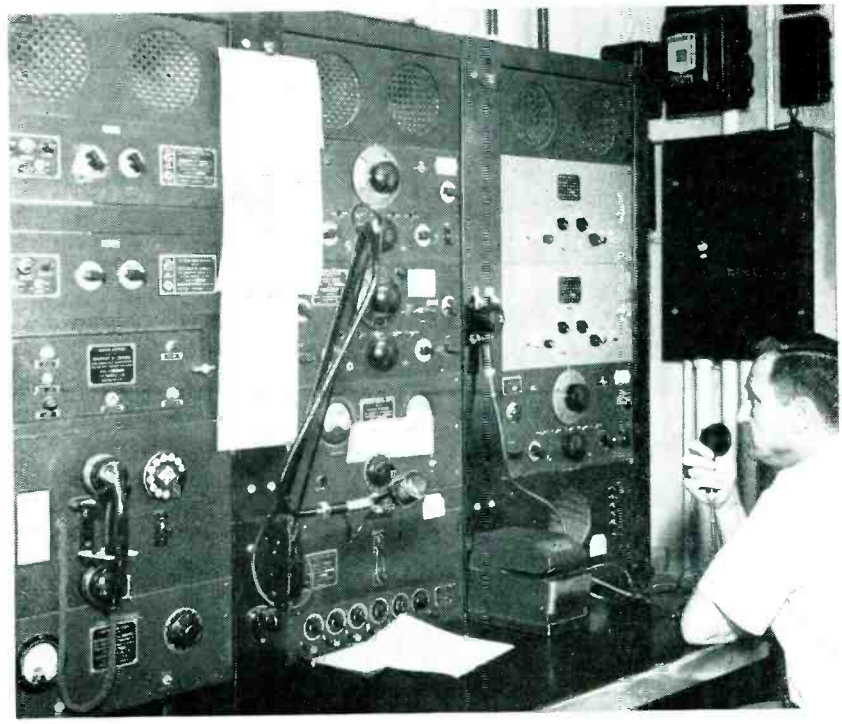


FIG. 1—Arrangement of stages and frequencies in the vhf fixed-tuned receiver



Two vhf fixed-frequency receivers (gray-panel units) in operation at Iowa City, Iowa, CAA station

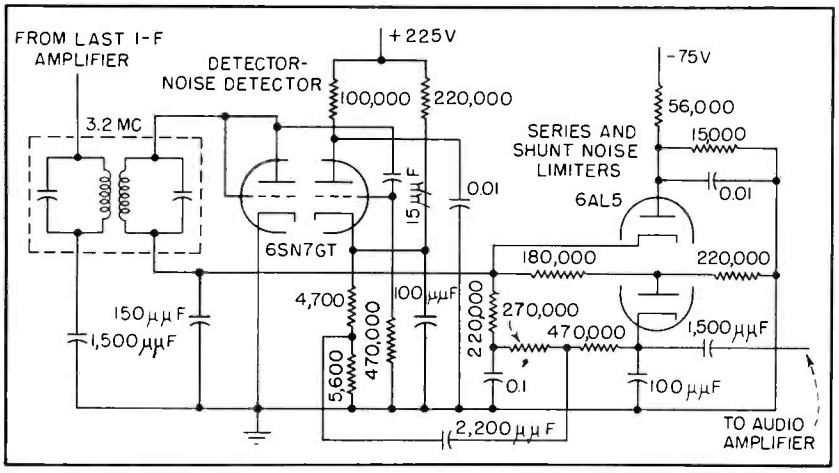


FIG. 2—Detector and noise limiter circuits

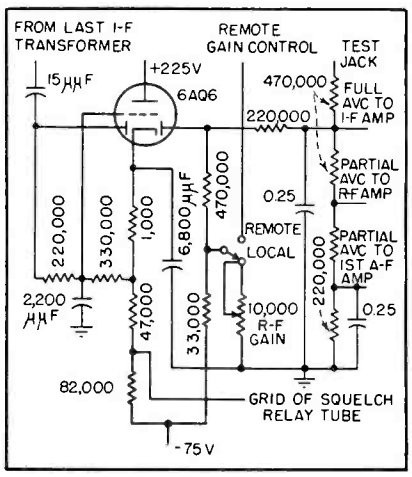


FIG. 3—AVC detector and amplifier

type interference were specified. Besides the actual performance specifications, a number of requirements covering the physical configuration of the equipment, simplicity of tuning and alignment procedures and quality of components and construction were specified.

Circuits

A block diagram of the receiver is shown in Fig. 1. The double-conversion superheterodyne circuit was selected in preference to the single-conversion type. The high first intermediate frequency permits a high degree of image rejection (approximately 100 db) to be obtained with a single-stage r-f amplifier.

Use of a relatively low second intermediate frequency permits obtaining the required selectivity through use of a two-stage amplifier employing only three double-tuned transformers and also contributes appreciably to the overall frequency stability of the receiver. It has been found that even with very careful compensation of the last i-f circuits, the temperature drift of this section can contribute as much to the overall frequency drift of a high-stability vhf receiver as do variations in crystal oscillator frequency. The use of a low final intermediate frequency is therefore advantageous.

Although double-conversion systems are usually regarded as being more susceptible to spurious response troubles than single-conversion circuits, careful selection of crystal and intermediate frequencies and provision of adequate selectivity in the r-f, i-f and frequency-multiplier circuits has resulted in obtaining better than 80 decibels attenuation of all spurious responses including image and i-f responses.

The r-f amplifier stage consists of a single pentode operating in conjunction with three capacitor-tuned circuits employing miniature air-dielectric variable capacitors. Removable grooved pins are inserted in holes in each capacitor shaft to provide dial pointers and rotation stops.

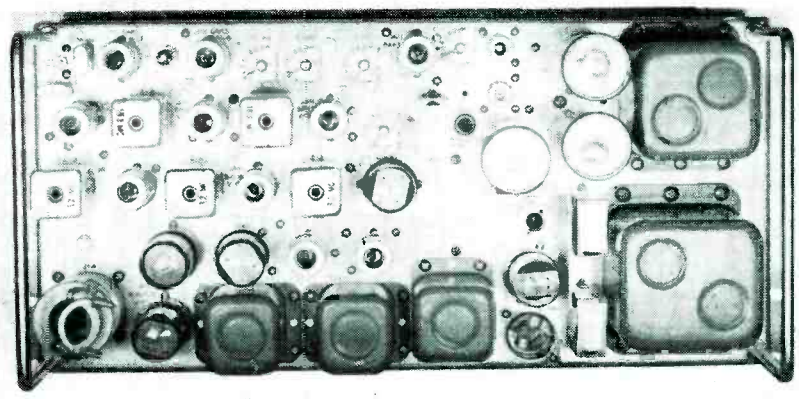
To achieve a high degree of selectivity in the input circuit for reduction of cross-modulation and desensitization effects, this circuit is operated with relatively loose coupling both to the single-turn antenna coupling link and to the grid of the r-f amplifier tube. The high operating Q of the input tuned circuit makes it possible to operate several receivers from a common antenna, the input coupling links of the receivers being operated in series using connecting cables approximately one-half wavelength long. Tests made with several multiple-receiver systems typical of control tower installations indicated very little loss of sensitivity with up to five receivers being operated with frequency separation as low as 200 kilocycles.

The first frequency conversion takes place in a pentode mixer operating with grid injection. To obtain optimum conversion gain and noise figure, this tube is operated at relatively low plate and screen voltages, approximately 50 and 30 volts respectively. The injection signal is obtained from a crystal oscillator-frequency multiplier system consisting of an oscillator-quadrupler and a second quadrupler.

The crystal unit is a hermetically sealed fundamental mode unit of the CR-18/U style operating without temperature control. Crystal oscillator frequency is held to 0.005 percent over the range −10 C to +60 C. Two capacitor-tuned circuits are employed at output frequency to provide a high degree of rejection to signals of undesired crystal harmonic frequencies.

The output of the first mixer circuit is coupled to a single-stage first i-f amplifier employing a pentode and two double-tuned transformers operating at 18.3 megacycles. The second frequency conversion takes place in an oscillator-second mixer circuit which uses a double triode. The crystal oscillator circuit operates at 7.55 megacycles; the second harmonic of this frequency is mixed with the 18.3-megacycle signal to produce the 3.2-mc second intermediate signal which is amplified in a two-stage amplifier. Three double-tuned transformers operating at slightly less than critical coupling provide the desired selectivity characteristics. A conventional diode detector circuit is used.

To achieve a high degree of rejection of impulse-type noise with regard to its effects on receiver desensitization and squelch operation



Layout of stages of the double-superheterodyne receiver

as well as audio output, the special noise limiter circuit shown in Fig. 2 was developed.

Noise Limiter

In addition to the conventional series diode automatic noise limiter, a shunt diode limiter is employed to reduce the effects of noise impulses on the avc and squelch circuits. This diode is biased to about —15 volts and presents a low-impedance path to ground to any noise impulses exceeding 100 percent upward modulation. This prevents the application to the avc detector of strong impulses which normally desensitize the receiver by generating undesired avc voltage. Since the avc circuit also controls the squelch circuit, undesired opening of the squelch in the presence of noise is also materially reduced.

The audio noise remaining in the output of the series diode limiter is reduced further by coupling a noise signal of opposite polarity in series with the output circuit of the limiter. This noise signal is developed in an infinite-impedance type detector which is biased so that signals of normal modulation are not detected.

The noise output of the receiver is approximately 20 decibels below normal output at 30-percent modulation when tested according to the CAA specified method. The method calls for the application of 10-microsecond r-f pulses at 1,000 pulses per second with amplitude up to 1.0 volt superimposed on a 100-microvolt unmodulated carrier. The use of the noise-balancing circuit results in an improvement of about 8 decibels over the performance of the series diode limiter alone under conditions of this test.

Automatic Gain Control

The avc detector-amplifier circuit shown in Fig. 3 develops a delayed and amplified gain control voltage. In this circuit one diode section operates as a detector circuit, the d-c output of which is applied to the grid of the triode section which operates as a cathode-loaded voltage amplifier. The output voltage is coupled to the avc time constant circuit through the second diode section.

With no carrier applied to the receiver, about 50 volts positive appears on the cathode; this voltage is not applied to the avc line because of the unidirectional characteristic of the output diode. When a signal developing approximately 8 volts audio detector bias is applied, the conduction of the triode circuit is cut off sufficiently to produce a negative cathode voltage which appears on the avc line and increases with increasing signal level. The 1,000-ohm cathode resistor provides d-c degeneration which improves the stability of the circuit and renders it less sensitive to variations in tube characteristics.

An amplified d-c control voltage for operation of the carrier-operated squelch relay tube is also supplied by this circuit. Since this voltage is not affected by the avc time constant circuit, virtually instantaneous operation of the squelch relay is obtained.

Because of the amplification of the control signal, the squelch circuit completely opens or closes with less than 20-percent change in input signal. This permits the squelch-opening threshold of the receiver, as determined by the setting of the r-f gain control, to be set only slightly higher than the ambient electrical noise level of the receiver location. In addition to the contacts required for audio silencing, the relay is provided with contacts for operation of a panel lamp and external apparatus.

A-F Stages

The audio amplifier circuits are conventional resistance-capacitance and transformer-coupled circuits. A low pass pi-section filter attenuates all frequencies above the normal communications range.

Two audio output amplifiers are provided; one has low-level output for operation with 600-ohm telephone lines, and the other provides up to one watt for operation of loudspeaker circuits.

The main output amplifier is provided with 12-decibel inverse voltage feedback to improve output regulation. Operation of up to five speakers is possible with negligible change in level when one or more speakers are switched in or out of service. All power input, audio output and control leads are filtered to eliminate possible interference due to any externally applied r-f signals.

Approximately 2,000 type RUQ receivers are now being placed in service in control towers and airways communications stations operated by the Civil Aeronautics Administration. A typical control tower installation includes receivers operating at 121.5 mc for emergency, 121.9 mc for airport utility, 122.5 mc for private aircraft control, and at one frequency in the range 118.1 to 121.3 mc for air carrier traffic control. Airways communications stations will normally be equipped for reception on 121.5 mc, 122.1 mc and 126.7, for emergency, private aircraft enroute and air carrier enroute communications, respectively.

Neon Diode

By JOHN C. MANLEY and ELERY F. BUCKLEY
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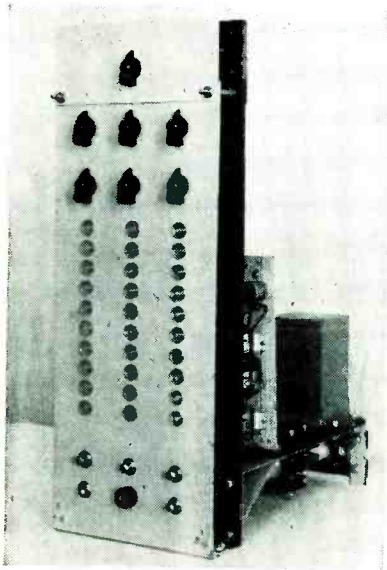
Instructor, Massachusetts Institute of Technology, Cambridge, Massachusetts



Complete three-decade counter comprising circuit of Fig. 4

DEVELOPMENT of the circuit to be described was prompted by the need for a simple and inexpensive counting device to replace the usual type of revolution counter which is subject to severe wear, particularly when it is frequently and rapidly reset to zero.

The high counting speed available in the relatively expensive flip-flop or ring counter using high-vacuum tubes is not required, and this feature makes possible the use of 0.04-watt or 0.25-watt neon glow-discharge tubes as the basic elements of the counter since de-ionization times of the order of several hundred microseconds can be tolerated. The counter uses glow-discharge diodes in conjunction with germanium crystal diodes, and employs capacitance coupling between stages. It thus offers a considerable advantage over an earlier circuit using glow-discharge tubes and employing transformer coupling between stages[1].

The circuit is capable of counting up to 30,000 impulses per minute. This rate is considerably in excess of that of any existing mechanical revolution counter or electromagnetic impulse register. Among the advantages of this circuit are essential simplicity, low cost, and small power consumption. The glow-discharge tubes serve not only as the basic elements of the counter, but inherently provide a visible indication of the count.

The circuit is basically a ring circuit, and while decades or rings-of-10 are discussed here, any even number of stages may be included in a ring. Any number of decades may be connected in tandem to make a counter which is capable of recording a total of 9, 99, 999, and so on, counts. Any such composite counter can be instantaneously reset to zero, presetting circuits can be added to set the counter to any required number before actual counting begins, and simple predetermining circuits can be added to detect the accumulation of any given number of counts within the range of the counter.

Principles of Operation

The basic circuit of an addition counter appears in Fig. 1. Each stage consists of a glow-discharge diode T, a crystal diode X, and a resistor R in series.

Suppose that each of the glow tubes ignites at a voltage v_i and operates at a lower voltage v_o. Suppose further that tube T_0 in Fig. 1 is conducting at time t_0 in Fig. 2. Current flows from the source of supply voltage through R_b, through X_0 in the forward direction, through T_0 and R_0 to the ground bus. The values of R_b, R_0 and supply voltage are so chosen that the potential of point b_1 is maintained less than the striking voltage of the glow tubes so that there is no tendency for any other tube to strike. Capacitor C_1 is charged as shown in Fig. 1 to the voltage appearing across R_0. Since S_t is normally open, C_1 is charged as shown to the difference between the potential of the positive bus b_1 and the potential of the point p in the voltage divider R_x and R_y.

If switch S_t is closed the potential of p becomes zero instantaneously and the potential of the bus b_1 is depressed by an amount equal to the original potential of point p. This drop in the bus voltage is shown at time t_1 in Fig. 2, curve b_1. The bus voltage is made to drop below the operating voltage of T_0 with the

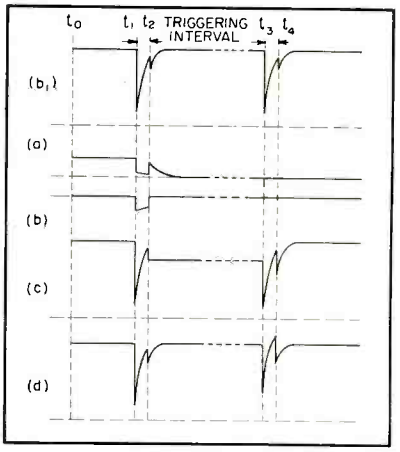


FIG. 2—Waveform of voltages at lettered points in Fig. 1

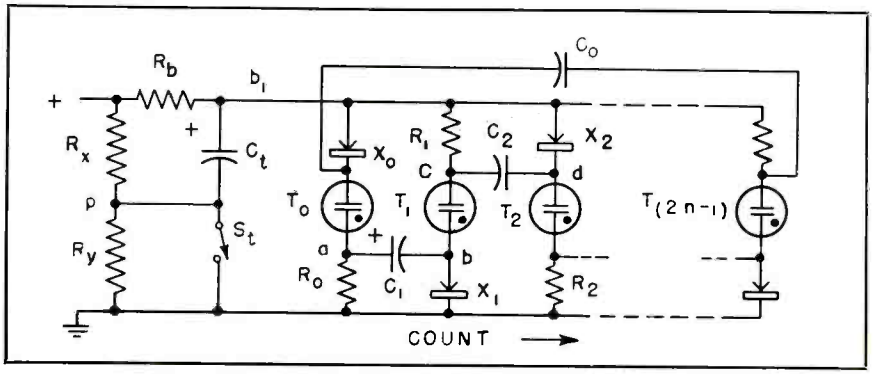


FIG. 1—Basic circuit of addition counter

Ring Counter

Relatively slow speeds up to 30,000 impulses per minute can be counted in ring circuits using neon tubes and germanium diodes. The counter can be reset instantaneously, presetting and predetermining circuits can be added and the counting action can be reversed to permit subtraction

result that T_0 is extinguished Then while S_t remains closed, capacitor C_t charges through R_b and the potential of b_1 increases exponentially toward the value of the supply voltage.

The time constant R_bC_t is made sufficiently long that the potential across T_0 remains below the operating voltage of the tube for an interval which allows its complete deionization. Meanwhile no one of the glow tubes is conducting and the discharge current of capacitor C_1 flows through R_0 and through X_1 in the inverse direction.

Voltage Distribution

Since the value of R_0 can be made much smaller than the inverse resistance of X_1, a large proportion of the voltage across C_1 appears across X_1. The resulting voltage wave forms at points a and b are given in the corresponding lines of Fig. 2. Thus while C_t is charging and the potential of the upper electrode of each glow tube is becoming more positive with respect to ground, the potential of the lower electrode of T_1 assumes a negative potential with respect to ground, and hence a greater voltage appears across T_1 than across any other tube.

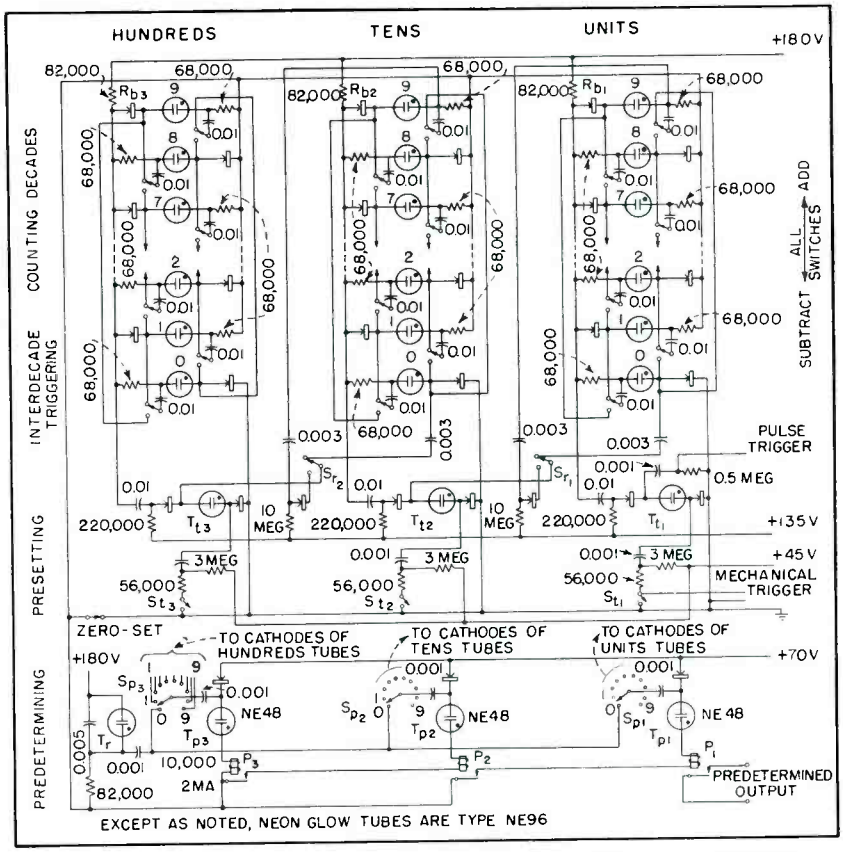


FIG. 4—Circuit of three-decade counter arranged for addition and subtraction

As soon as T_1 strikes, current flows through R_b, R_1, T_1 and through X_1 in the forward direction. This prevents further increase in the voltage of the bus b_1 and actually causes a transient drop in this voltage. Capacitor C_2 charges positive + polarity at d in Fig. 1 and C_1 discharges relatively rapidly through a resistance essentially equal to R_0. Thus the counter has recorded one pulse, since T_1 is now conducting rather than T_0. Figure 2 shows the voltage wave forms at significant points in the circuit. After switch S_t is opened, the potential of point p returns to its normal value.

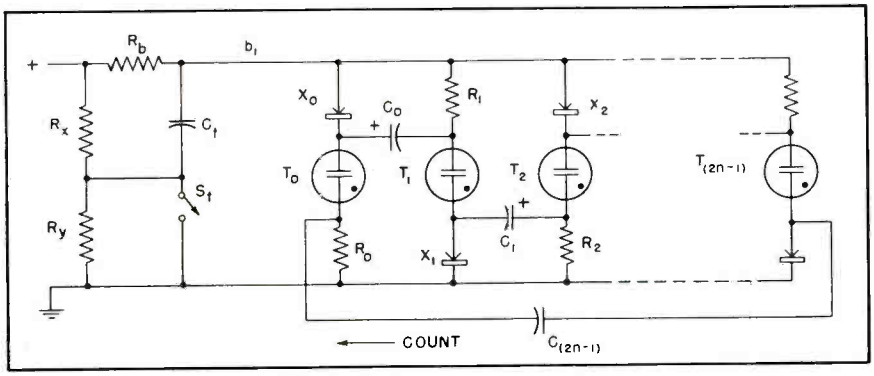


FIG. 3—Basic subtraction circuit

Succeeding Cycles

If switch S_t is closed again after the normal potential has been restored at point p, the bus voltage is again depressed, as at time t_s in

Fig. 2, and causes T_1 to be extinguished. Capacitor C_2 then discharges through X_2 in the inverse direction and through R_1. Hence as C_t charges again the positive potential of point d with respect to ground exceeds that of bus b_1, and the potential across T_2 exceeds that across any other tube. Hence T_2 strikes as shown at time t_4, and the counter has recorded two counts.

Each subsequent operation of the switch S_t advances the count one stage until tube T_{2n-1} becomes conducting. The next operation of the switch causes the ignition of T_0 again through the capacitor C_0 which closes the ring-of-2n. Value n may be any integer greater than unity, and if $n = 5$ the counter forms a decade or ring-of-ten.

The operation of the circuit depends essentially on two inherent characteristics of the circuit elements. The first of these is the difference between the striking and operating voltages of the glow tubes which insures that whenever any one of the tubes is conducting the potential across all of the others is maintained lower than the striking potential. Thus no more than one tube is conducting at one time and the count is unambiguous.

The second inherent feature of importance is the significant difference between the forward and backward resistance of the crystal diodes which allows each coupling capacitor to charge quickly whenever its corresponding tube is conducting, but which allows that capacitor to discharge only very slowly after its tube is extinguished.

Subtraction

An attractive feature is the essentially simple rearrangement of the coupling capacitors which will cause the circuit to subtract rather than add. Figure 3 shows the coupling capacitors rearranged and connected between the upper electrodes of T_0 and T_1, between the lower electrodes of T_1 and T_2, and so forth. Suppose that T_2 is originally conducting. Then when switch S_t is operated T_2 is extinguished, the lower electrode of T_1 becomes negative with respect to ground and T_1 strikes. Hence the count proceeds from right to left in the diagram and the circuit subtracts.

Figure 4 shows a complete circuit diagram of a three-decade counter in which a switch is used in each stage of each decade to alter the connection of the coupling capacitors. This switch may be either a gang of wafer switches with leads connecting it to the electrodes of the tubes, or preferably a long sliding switch which parallels each row of tubes to reduce the length of the connecting leads. In order that the circuit hold its count during transitions between addition and subtraction it is imperative that the fixed connection of each coupling capacitor be made at the resistor of one of the stages. This precaution insures that neither of the tubes adjacent to the one which is conducting before the switch is operated will be ignited by the operation of the switch.

Trigger Circuits

In addition to the trigger circuit shown in Fig. 1 and 3, the circuits of Fig. 5 may be used. That of Fig. 5A requires fewer components but must have a double-pole switch. This switch is normally closed on the upper contact and the charge on the capacitor C_t is then zero. If the switch is suddenly closed on the lower contact, the potential of the bus b_1 is depressed to zero and thereafter increases exponentially as C_t charges through R_b. The voltage waveform at b_1 is therefore essentially the same as shown in Fig. 2 except for the magnitude of the original depression. The triggering switch S_t in either this circuit or the one described previously may be actuated by a rotating shaft or by the motion of any mechanical member whose movements are to be counted.

For operation of the counter at speeds higher than those obtainable with moving contacts, such as in recording impulses from a photoelectric cell, the triggering circuit of Fig. 1 can be adapted to the use of a glow tube as shown in Fig. 5B. Switch S_t is replaced by a glow tube T_t. The potential across this tube is maintained normally a few volts less than its striking potential through the resistor R_z connected to an appropriate tap on the voltage divider R_x and R_y. Either positive voltage pulses injected at a or negative voltage pulses injected at b will cause tube T_t to strike. The potential of b_1 is thus depressed an amount equal to the difference between the original voltage at point p and the operating voltage of T_t, and thereafter increases exponentially as shown in Fig. 2 during a triggering interval.

The succeeding depression of the potential of b_1 which results upon the striking of the primed tube in the associated ring, such as is shown at t_2 or t_4 in Fig. 2 (b_1), is sufficient to extinguish T_t so that it is ready to respond to the next triggering impulse as soon as the normal potential at point p is restored. The crystal diodes X_{ta} and X_{tb} are employed respectively to increase and to provide the impedance across which the triggering voltage is developed. Two glow tubes may be used in series if desired to increase the initial depression of the bus voltage.

For counting speeds greater than about 150 cps glow tube T_t should be replaced by a thyratron such as a 2D21, which may be ignited by any convenient positive signal on its control grid, and which will be extinguished in the same manner as the glow tube. The time constant R_bC_t may have to be adjusted in

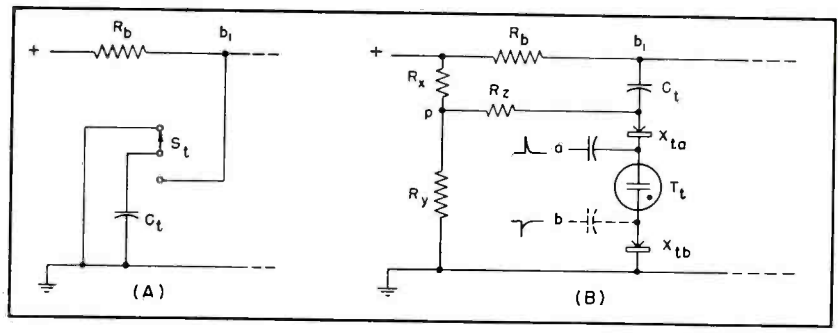


FIG. 5—Alternative trigger circuits

each of the possible trigger circuits to accommodate the particular value of the initial depression of the bus voltage. This initial depression is much less in the circuit of Fig. 5B than in that of Fig. 5A, and a longer time constant may be necessary to allow deionization of the conducting tube in the associated ring.

Complete Counter

The three-decade counter of Fig. 4 can be preset to any required number before input signals are applied, and can produce an output signal after the counter has reached any given number up to 999.

All the add-subtract switches within the three decades and the two interdecade switches S_{r1} and S_{r2} are ganged. These switches are shown in the add position. Note that glow-tube triggering circuits of the type shown in Fig. 5B are used to interconnect the decades. For example, when the counter is adding, positive signals are taken from the cathode of the 0 tube of the units decade to trigger tube T_{t2}, which in turn advances the count in the tens decade by one digit.

When the counter is subtracting, positive signals are taken from the cathode of the 9 tube of the units decade to trigger the tens decade. Similar considerations apply to the circuit interconnecting the tens and hundreds decades.

Since positive voltage pulses are used for interdecade triggering, the time constant of the interdecade coupling circuit connected to each 0 tube must be made sufficiently short that the falling edge of the waveform of Fig. 2B is effectively differentiated. In this way the rising edge, which follows later in time, can be used to supply the positive pulse required to ignite the triggering tube.

When interdecade triggering pulses are taken from the cathode of a 9 lamp, the rising edge of the waveform which results when the lamp ignites must be used as the triggering signal. However, after the 9 tube is extinguished at the following count, the waveform of Fig. 2A is generated, and in this case the falling edge, such as that shown at time t_1, must not be differentiated, else the rising edge, such as at time t_2, will again ignite the triggering tube. Hence the interdecade coupling capacitor associated with each 9 tube is connected in series with a crystal diode so poled as to increase the time constant of the coupling circuit on negative-going input pulses.

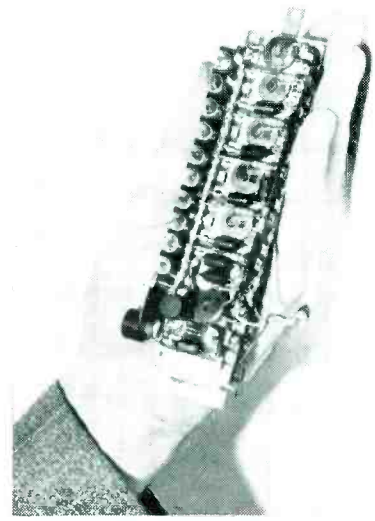
Switch-triggering circuits involving the switches S_{t1}, S_{t2}, and S_{t3} are provided so that each decade may be preset manually to any desired number before input pulses are applied. The resistance-capacitance networks associated with these switches apply negative voltages to the cathodes of the triggering tubes when the switches are closed. Each 0.001-μf capacitor is charged to 45 volts while the associated switch is open, and when the switch is closed, the cathode of the corresponding triggering tube becomes negative with respect to ground and the tube ignites from the capacitor discharge.

The time constant of the discharge of each of these capacitors is made sufficiently small that the discharge is essentially complete before the associated triggering tube is extinguished. This prevents the tube from firing a second time.

Predetermining

A very simple predetermining circuit is shown in Fig. 4. As noted previously the purpose of this circuit is to activate some external circuit or produce a signal when the counter reaches any desired number within its range. Such a signal might be required in a packaging process, for example, to halt the process after the accumulation of a given number of units. Three 0.25-watt neon glow tubes T_{p1}, T_{p2} and T_{p3} are arranged as shown, each in series with the operating coil of a sensitive relay.

Suppose that the circuit is to detect the number 123. The switches S_{p3}, S_{p2} and S_{p1} would be set to connect the anodes of the three predetermining tubes through their coupling capacitors to the cathodes of the tubes 1, 2 and 3 of the hundreds, tens and units decades respectively. The coupling capacitors are sufficiently small that waveforms of the type shown in Fig. 2B are differentiated and hence positive pulses are always available to trigger the predetermining tubes.



Relative size of a single decade

The anodes of the predetermining tubes are connected to a source of voltage which is a few volts below their striking voltage, but only the relay in series with tube T_{p3} is permanently connected to ground. Tube T_{p2} cannot be ignited until the relay in series with T_{p3} operates, and T_{p1} cannot be ignited until the relay in series with T_{p2} operates. Hence at the instant the counter records the number 100, T_{p3} is triggered by the positive pulse from the cathode of the 1 tube in the hundreds decade. Relay P_3 then closes and primes tube T_{p2}.

After 20 more pulses T_{p2} is ignited by the positive pulse from the cathode of tube 2 in the tens decade and relay P_2 operates. Similarly after three more pulses, relay P_1 operates and generates the required predetermining signal.

Special provision must be made in order to obtain a predetermining pulse after a number such as 100, or more specifically, after any number containing the digit 0.

The authors wish to acknowledge their indebtedness to the James L. Entwistle Co., Pawtucket, R. I., for cooperation and facilities.

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Acoustic Anemometer-Anemoscope

Instantaneous visual presentation of wind direction and velocity on a cathode-ray tube screen. Sixty-cycle pulses from an acoustic transmitter are received at four transducers equally spaced from the transmitter at cardinal points. Doppler effect of wind velocity actuates a discriminator and indicator

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ELECTRONIC instrumentation involving acoustic effects has invaded many fields in the measurement of physical phenomena. Currently, investigation is being conducted to extend this invasion into the measurement of wind velocity and determination of wind direction.

The acoustic anemometer-anemoscope to be described is based on a Doppler phenomenon effectively relating wind velocity with the difference between upwind and downwind acoustic velocity. The components of the instrument, shown in Fig. 1, include a pulse generator which drives a sound head creating acoustic pulses, four electromechanical-transducer listening stations that are oriented at the cardinal points of the compass around the sound head, an amplifier, a discriminator to sort the information coming from the listening stations and an indicator for presenting the information in convenient form.

Operating Principle

The sound head is placed in a convenient location exposed to the free flow of the wind, and the listening stations are arranged as shown at a known distance s from the head. The orientation of the listening stations with compass directions is necessary for determining the direction of the wind.

The sound head, driven by a 60-cycle pulse generator, emits acoustic pulses with nearly vertical wave fronts. The pulses propagate at the speed of sound in all directions and arrive at all the listening stations at the same instant under quiescent conditions, that is, when there is no wind.

Consider a wind as shown in Fig. 2A with the velocity vectors involved in a pulse reaching the listening stations for the east-west component, V_e. Because of the greater acoustic velocity downwind, there will be a time differential between the arrivals of the acoustic pulses at the listening stations.

$$\Delta t = \frac{2sV_e}{v^2 - V^2} \simeq \frac{2sV_e}{v^2} \qquad (1)$$

when v is speed of sound, V is wind speed and t is time. The approximate expression is in only slight error amounting to less than

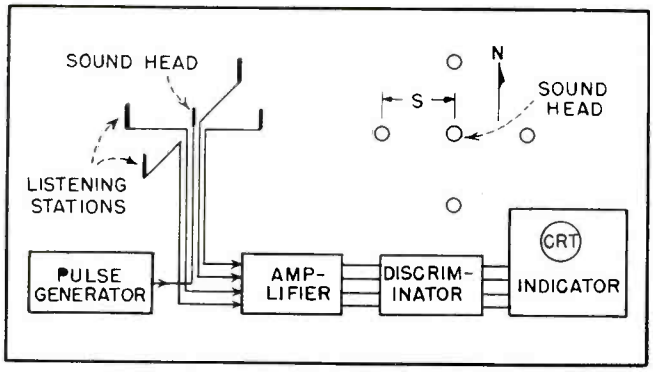


FIG. 1—Block diagram of the acoustic wind direction and velocity indicator

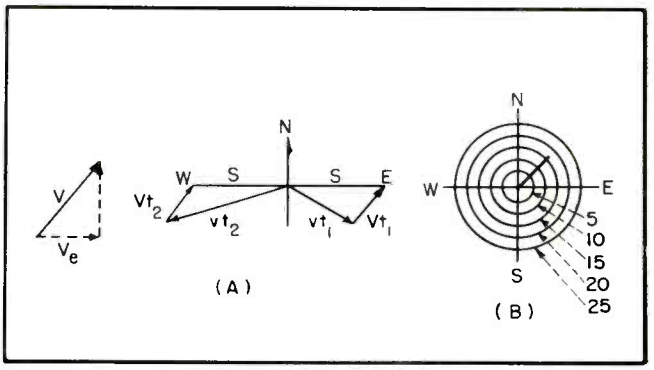


FIG. 2—Vector relationships for a wind from a southwesterly direction (A) and crt presentation (B)

The sound generator is connected to the center-pillar transducer or sound head. Simultaneous transmission to four directions is picked up by the four surrounding receiver transducers. Wind retards or accelerates the normal velocity of sound

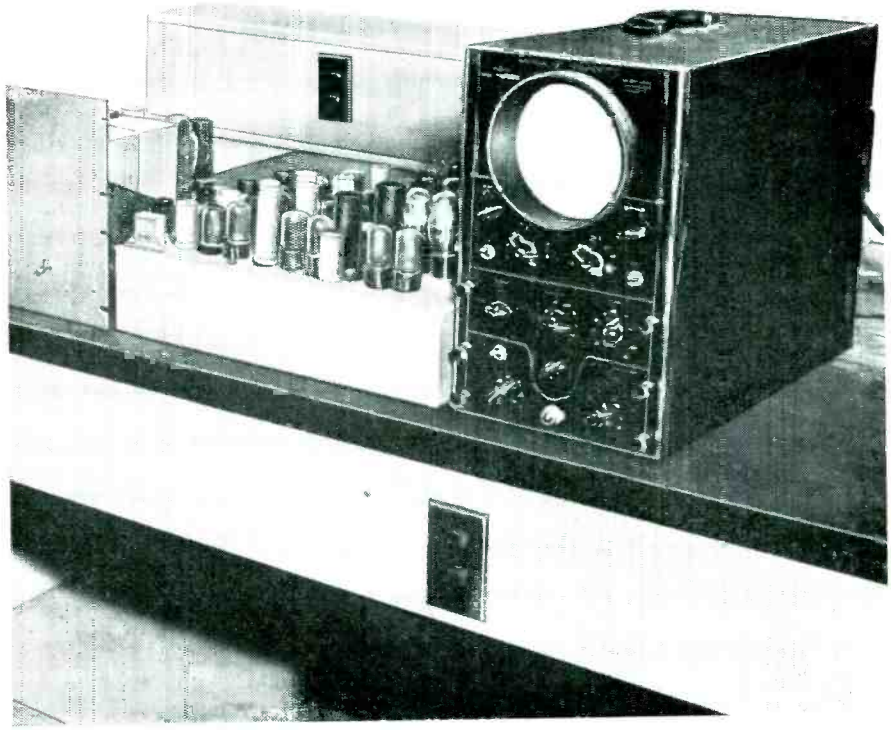
0.5 percent at a wind velocity of 50 miles per hour.

It is evident that a given pulse will arrive at the east station before reaching the west station and that the time differential is proportional to the speed of the wind as indicated in Eq. 1. By approximation, assuming that s equals 5 feet, it can be found that Δt is in the order of 15 microseconds per mile per hour.

Winds coming in from other than cardinal-point directions are divided into east-west and north-south components automatically by virtue of the placement of the listening stations. These components, as determined by the discriminator, are recombined in quadrature by the indicating unit to yield the wind velocity, as shown in Fig. 2B.

The Apparatus

The electronic apparatus, in general, is conventional. The discriminator, however, performs an inter-



Laboratory setup of the electronic elements of the wind instrument comprises power supply, chassis with twice the equipment shown in Fig. 3 and cro

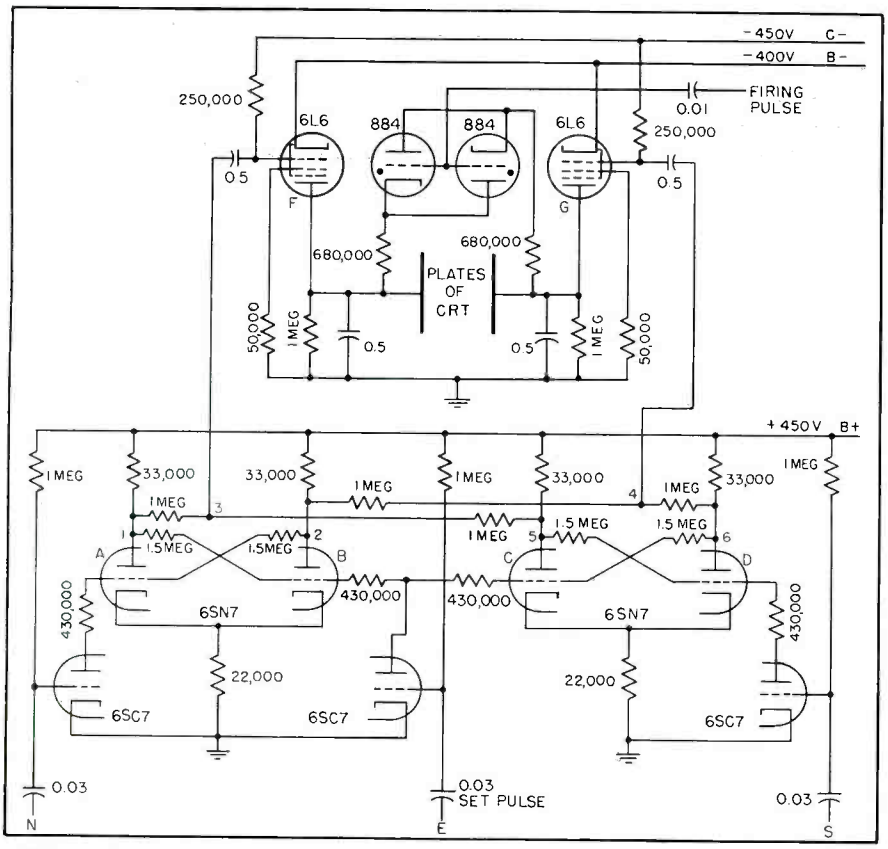


FIG. 3—Circuit of discriminator and indicator for one component of a cross wind

esting function and will be discussed considering the north-south component only.

The purpose of the discriminator is twofold: To determine whether the pulse from the north or the south listening station is received first (which must be known in determining wind direction), and to produce a square-wave pulse with its width proportional to the time differential noted above in determining wind velocity.

The discriminator shown in Fig. 3 is identical for each of the components and consists of an Eccles-Jordan trigger circuit, using a 6SN7, and a 6L6 output tube for each listening station. The 6SC7's shown are used as keying tubes to improve the stability of the trigger-circuit operation. The trigger circuits are set by a negative pulse at *E*, so that tubes *B* and *C* are conducting and *A* and *D* are cut off. In this situation points *1* and *6* are at a higher potential than *2* and *5*. Because of the voltage-dividing network, points *3* and *4* are at an intermediate potential. Points *3* and *4* are of particular interest since they control the type 6L6 output tubes which are biased only slightly below cutoff.

Under quiescent conditions the pulses from the north and south listening stations arrive simultaneously at *N* and *S;* both trigger circuits flip at the same time and the voltages at *3* and *4* remain at the same value. However, if a wind is blowing from the south, a pulse will arrive at *N* a few microseconds before a corresponding pulse reaches *S*. This causes a negative pulse to appear at *3* and a positive pulse to appear at *4*. Consequently, tube *G* puts out a pulse with its width proportional to wind velocity. If the wind blows from the north the situation reverses and tube *F* puts out the pulse. In this manner the circuits discriminate between a north and south wind and produce pulses with widths proportional to the wind velocity.

Circuit Details

The heart of the indicating unit is an electrostatic cathode-ray tube with deflection plates oriented vertically and horizontally. The wind velocity scale in miles per hour consists of concentric circles with zero at the center. The east-west component is applied to the horizontal plates and the north-south component is applied to the vertical plates so that the cardinal points of the compass are in their conventional locations.

The output of the 6L6 tubes consists of a 60-cycle series of square-wave pulses with widths depending on wind velocity. By filtering this output with an r-c filter, a d-c voltage appears across the load resistor that is proportional to the width of the pulses and therefore also proportional to wind velocity. It is this d-c voltage that is applied to the crt.

When there is no wind, a spot appears at the center of the concentric circles. When there is a wind, say from the northeast, the spot moves out the proper distance from the center in the first quadrant (as shown in Fig. 2) and indicates the direction and the speed of the wind. In order to have the indicator draw a vector the 884 thyratron tubes are fired by a 60-cycle pulse so that the plates of the crt are essentially shorted 60 times each second and the spot is returned to the center. This action causes the spot to trace the desired vector. Since the wind velocity is sampled 60 times per second (determined by the repetition rate of the pulse generator), the indicator is capable of following rapid changes of the wind. The deflection sensitivity of the indicator can be varied as desired because oscilloscope deflections of one-eighth to one-half inch per mile per hour are easily obtained.

The acoustic anemometer described is capable of reliable continuous operation and presents the information in a form easily assimilated. It can be sent over transmission lines to the indicating unit in any desired location.

Acknowledgement

This project was financed by Research Corp., New York, and the author was assisted by two University of Arizona students: Edward Wood and John W. Busby, now with General Electric and RCA respectively.

Phototube Controls R-F WELDING

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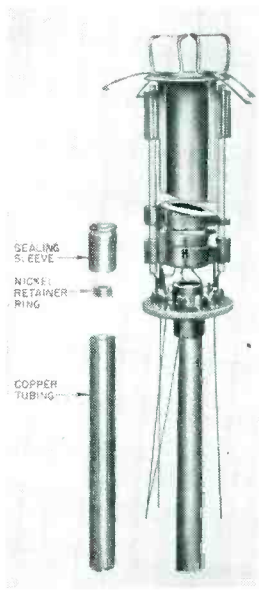
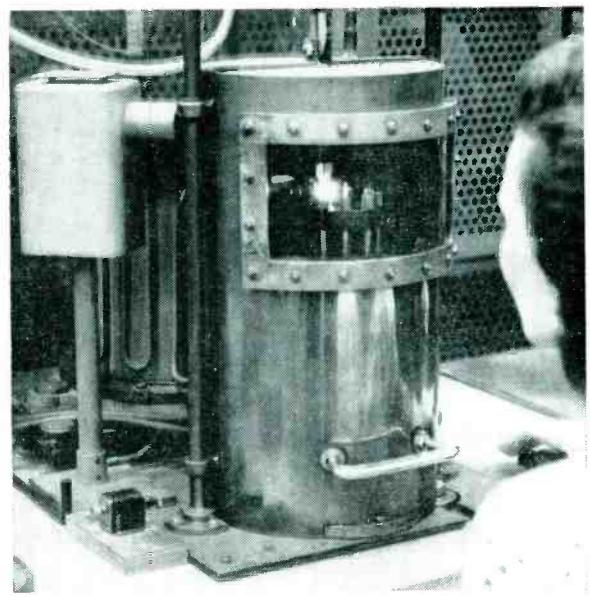


Three pieces at left are welded together to form the exhaust tubulation assembly of a kinescope tube



Automatic welding is done in an atmosphere of hydrogen under the hood to prevent oxidation. Phototube in housing at left is illuminated by radiation from the heated tubulation assembly

Precise automatic control of welding of small parts is provided by a phototube that monitors the weld temperature and shuts off the generator a half second after copper flows. Used in making kinescopes, the technique is applicable to other manufacturing processes

IN MANUFACTURE of picture tubes, a vacuum-tight weld is required in the exhaust tubulation assembly to join the copper tubing to the sealing sleeve. This exhaust tubulation is part of the kinescope gun assembly.

The sealing sleeve is nickel-chromium-iron alloy and it fits over the end of the copper tubing. A nickel retainer ring fits inside the end of the tubing. The three parts and an assembled unit are shown in the small photograph.

The parts to be welded are pressed together to form the tubulation assembly and placed in a radio-frequency welding unit in such a manner that the top is just below the single-turn output coil of the generator. After the radio-frequency generator is energized, the upper edge of the sealing sleeve begins to show color in less than one second. The temperature of the sealing sleeve rises faster than that of the copper tubing because it is closer to the welding coil, shields the tubing from the welding coil and has greater resistance along the path of the radio-frequency currents.

Because of radiation the copper tubing heats in step with temperature of the glass-sealing alloy, but lags behind it. The copper, having a lower melting point (1,083 C) than the alloy (approximately 1,470 C), fuses first and flows to fill all the space between the retainer ring and the sealing sleeve.

The flow of copper produces a seal between the copper tubing and the sealing sleeve. If the radio-frequency energy is cut off at this point the copper freezes and a weld is formed. Because of uncontrollable variance in the size of parts and in the position of the work with respect to the r-f work coil, the time required to bring the work up to the welding point will vary. Hence a fixed time cannot be used.

Fortunately, a change in temperature of the alloy which occurs simultaneously with the copper fusion can be used as an index for control of the radio-frequency generator. The flowing copper makes good thermal contact with the glass-sealing alloy sleeve and cools the latter suddenly. This temperature drop is easily observable by the eye. When a phototube is set up to observe the weld from the top, a curve of photocurrent versus time is obtained as shown in Fig. 1. The current rises to a peak at 5 seconds and then drops 50 or 60 percent.

To determine the relationship between phototube current and temperature, one must consider the spectral sensitivity of the phototube and the spectral character of the radiation. The dotted line in Fig. 2 gives the spectral sensitivity of the S-1 phototube surface used. This surface has a maximum sensitivity at 8,000 Angstroms, which is beyond the luminous range in the infrared region. Because incandescent bodies in the temperature range under consideration (below 1,500 C) radiate predominantly in

the infrared region, this photosurface is most effective. The peak of radiation from the weld lies far in the infrared but a good portion of the radiation extends into the sensitive region of the phototube.

Figure 2 also gives the radiation from an incandescent body at several temperatures. To compute the phototube current, the radiation curves must be multiplied by the phototube spectral sensitivity. The resultant current curves are also shown in Fig. 2 as the solid lines. The phototube current measured is proportional to the area under the calculated photocurrent curves.

As determined by an optical pyrometer, the temperature of the sealing sleeve at the first peak of Fig. 1 is about 1,200 C. Visual comparison of the areas under the 1,227 C and 1,127 C curves of Fig. 2 shows that the phototube current should drop about 50 percent for the drop of about 100 C when the

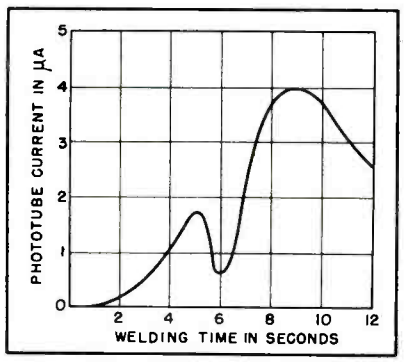


FIG. 1—Curve shows drop in phototube current due to cooling effect of molten copper after six seconds of welding time

melted copper flows to the sealing sleeve. If the r-f energy is not shut off, the temperature continues to rise to the melting point of the sealing sleeve (1,470 C). At this temperature the sealing-sleeve alloy flows out of range of the welding coil and the phototube current drops off.

Control Circuit

Figure 3 is a block diagram of the arrangement devised to utilize the drop in temperature to control the r-f welding generator. The operator loads several of the exhaust tubulation assemblies in a jig. By means of a press, the three parts

are assembled together. The jig is then transferred to the welding unit. A hood is lowered over the work and hydrogen passed through to prevent oxidation. After the initiating switch is thrown the operation is automatic.

The generator induces about five kilowatts of power into the assembly. Radiation from the assembly is reflected by the prism and focussed by the lens into the phototube. The drop in photocurrent, passing through the amplifier as a voltage, is reversed and appears as a rising wavefront at the differentiator. Upon differentiation the wave becomes a positive pulse. This trips a thyratron which in turn starts an electronic delay stage.

The delay stage produces a delay of about one-half a second. This arbitrarily-set delay period ensures that the copper has melted around the entire circumference of the weld. At the end of the delay period a relay shuts off the radio-frequency generator. The initiating switch, in addition to starting the generator, also triggers a safety relay. This safety relay is set for a delay of about 12 seconds, which is greater than the time required for the longest weld. The relay shuts off power in case of a faulty weld or a failure of the electronic circuit.

A complete schematic diagram of the control circuit is given in Fig. 4. The initiating switch S_1 is a foot switch by means of which relay coil RL_1 is energized. Capacitor C_1 serves to quench the resultant transient so that it does not affect the thyratrons in another part of the circuit. Holding relay coil RL_2 is energized by the momentary current through the contacts of RL_1; RL_2 is held by its own contacts. Contacts of RL_1 also start the timing of safety relay TD_2 which, in turn, energizes RL_5 thus starting the radio-frequency generator. Holding relay RL_2 permits the operator to remove her foot from the initiating switch during the weld.

Optical System

A double-element lens one inch in diameter, with a 4.8-inch focal length, is placed three inches from the phototube. The use of a prism permits a top view of the work so that the area of initial fusion is observed regardless of its location on the periphery. A housing and cylindrical tube are used to reduce the stray light. Normal room light-

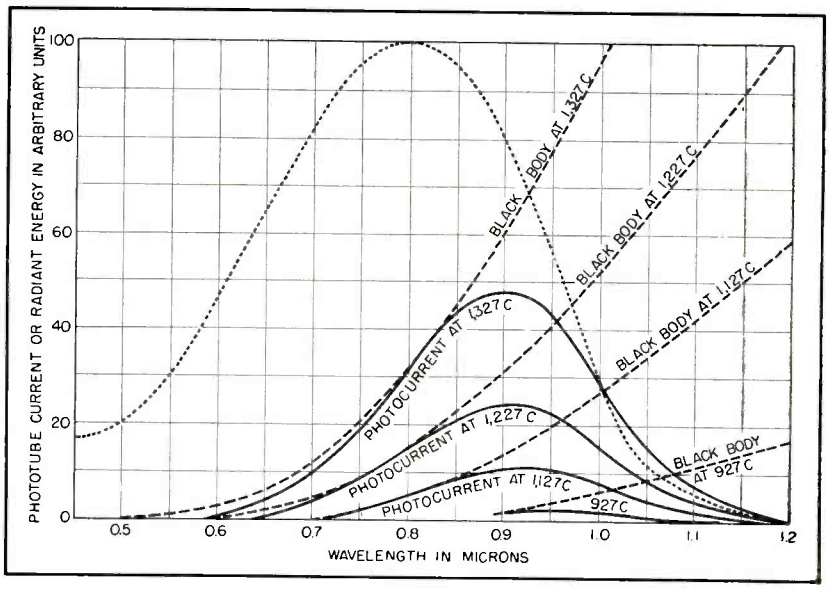


FIG. 2—Graphical determination of phototube current due to incandescent body at several temperatures. The dotted curve shows the spectral sensitivity of phototube having S-1 response

ing produces a current of only 0.02 microampere.

The 918 phototube is used because of its infrared sensitive S-1 surface. The fixed bias on the 6J7, operated at cut off, is about −6.0 volts. At the first peak of 1.7 volts, the anode voltage of the 6J7 drops to about 150 volts. The drop in signal of 1.0 volt at the time of the copper fusion causes the anode voltage to rise to about 220 volts. A change of 70 volts is realized. The waveform of the signal obtained at the anode of the 6J7 is an amplified negative of the phototube current wave shown in Fig. 1.

The temperature drop of the weld is rapid (0.1 second) and the output of the differentiator circuit C_3R_7 is a positive pulse of 44 volts magnitude, more than enough to fire T_3. When T_3 fires, the anode current energizes relay RL_3 and one set of contacts interrupts the anode current. If the grid is still sufficiently positive the 2050 will reignite and then again be interrupted in the fashion of a relaxation oscillator.

Potentiometer R_9 controls the sensitivity of the tube. When T_3 fires, the grid current during conduction lowers the terminal grid voltage to a value less than the bias. Capacitor C_3 holds this less negative value over into the period when the contacts of RL_3 reapply anode voltage. Thus, after the bias is decreased to the value at which the circuit starts to oscillate, a large increase in bias at the potentiometer is necessary to stop the oscillation.

Specifically, with R_6 shorted out, the 2050 starts to oscillate at a bias of −3 volts and stops oscillating at −22 volts. The addition of R_6, however, reduces this lower limit to −10 volts, which is satisfactory. Resistor R_6 isolates the differentiator from the grid current of the thyratron.

Capacitor C_4 stabilizes the operation of T_3 by bypassing any transient pickup. The neon tube T_4 indicates when this 2050 fires.

Relay RL_3 has a second set of normally-closed contacts in series with the coil of RL_2. Because the latter is a holding relay, one operation of RL_3 causes RL_2 to deenergize and remain deenergized. Relay RL_2, therefore, may be energized by the initiating switch S_1 and deenergized by a drop in intensity of radiation on the phototube.

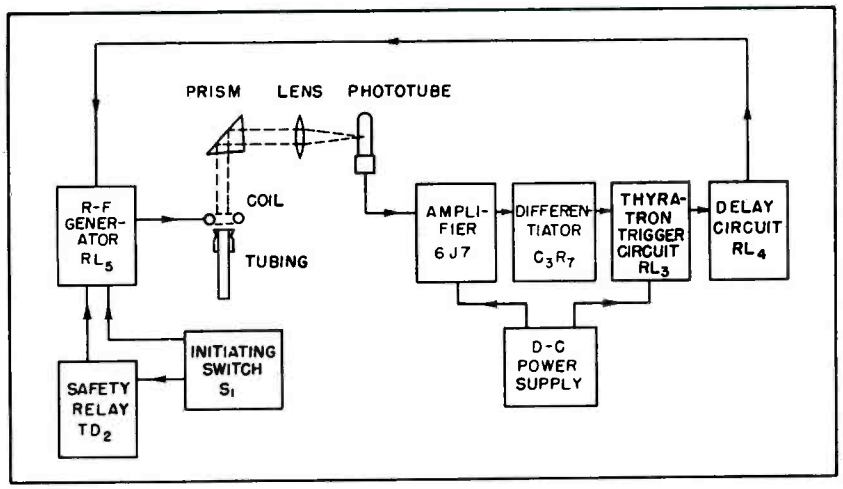


FIG. 3—Arrangement of optical system and welding control units

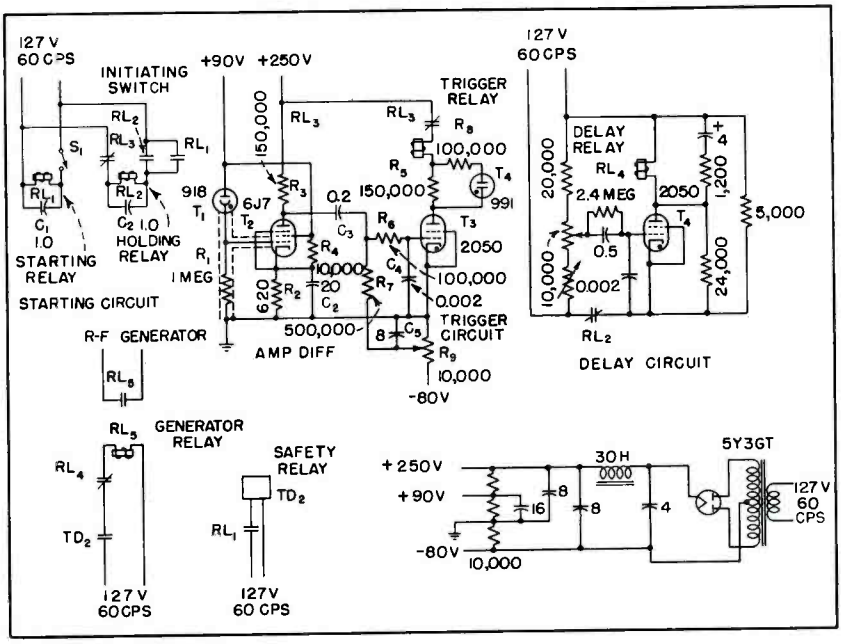


FIG. 4—Complete circuit of welding control system

It has been found desirable to allow the generator to remain on for a short period after the temperature drop occurs. This additional time allows the copper to flow around the entire periphery, making a tight seal. A delay of 0.6 second has been determined to be optimum for the purpose. This delay is produced by a commercial thyratron time-delay relay (G.E. CR7504-B102G2) consisting of thyratron T_4 and associated circuit. At the end of the delay period, the current through T_4 energizes relay RL_4, which in turn shuts off the generator through RL_5.

If a defective tubulation assembly fails to exhibit a temperature drop, or if a fault develops in any of the circuits, the r-f generator would remain on. As a result, either the work coil would overheat, or molten globules from the work would drop down and ignite the hydrogen. To prevent such an occurrence, a safety time-delay relay TD_2 is included. This relay is electromechanical and has a range of 60 seconds. It is normally set at 12 seconds, which covers the longest weld. It is started at the beginning of each weld by the initiating switch S_1 and relay RL_1. If it should time out, its contacts deenergize RL_5, thus turning off the r-f generator.

An ULTRA-LOW

THE NEED for a sine wave oscillator with frequency range below one cycle per second is often felt in electronic research laboratories. Such an oscillator would be useful, for example, in the measurement of recurrent natural phenomena such as the study of ocean wave motion, or in medical research for the measurement of heartbeat and breathing frequencies.

A low-frequency electrical oscillation, closely approximating a sine wave, can be obtained by utilizing the thermal lag of a thermistor in resonance with an electrical capacitance. The coupling link that allows a thermal variation to resonate with an electrical one is the relation between the temperature and resistance of a thermistor:

$$R = R_0 e^{K(1/T - 1/T_0)}$$

where R is the resistance of the thermistor at absolute temperature T, R_0 is the resistance of the thermistor at absolute temperature T_0, and K is a constant.

Examination of this relationship shows that the resistance of a thermistor decreases as its temperature rises. When the increase in temperature is caused by an increase in current through the thermistor, instability may result. This occurs because the increasing current lowers the resistance which, in turn, causes the current to increase still further. To insure a stable condition, the current must be the controlled variable.

The static curve for a thermistor, as shown by the heavy line in Fig. 1, is a plot of voltage drop versus direct current. The current is held constant at each point plotted until the thermistor reaches thermal equilibrium. If the thermistor is not allowed to settle to thermal equilibrium as each point is plotted, but has its current continuously varied, the static curve varies in position depending upon whether the current is being increased or decreased. An increasing current would produce voltage values above those of the static points, while if current were decreasing, the voltage points would fall below the static curve.

This effect is similar to hysteresis lag in magnetism, and appears because the temperature of the thermistor, and therefore the voltage drop, lags behind changes in the I^2R loss. The effect is only apparent when the currents are large enough to heat the thermistor appreciably.

The amount of hysteresis is proportional to the rate of current variation. The faster the current changes, the more the variation in temperature of the thermistor lags behind changes in I^2R losses. The voltage points then plot further above and below the static curve.

Sinusoidal Input

If a sinusoidal current is impressed on the thermistor, the voltage variation is sinusoidal only if the amplitude is small enough so that the static curve is straight over the region. For example, in Fig. 1, the straightest part of the static curve is in the region of negative slope. A direct current of 2 ma will place operation in about the center of this region. An alternating current may be impressed with peaks as large as a milliampere on either side of the bias point, and the voltage wave will be sinusoidal.

If the frequency of the sinusoidal current is low, the hysteresis effect is negligible. The operating curve then closely follows the static curve for both increasing and decreasing currents.

By increasing the frequency slightly, the operating curve can be made slightly oval. Hysteresis is no longer negligible, because the temperature of the thermistor never gets a chance to catch up with the heat dissipated. If the static curve were perfectly straight, the oval would resemble an ellipse with major axis along the static curve, as shown by F_2 in Fig. 1.

In the case of a still higher frequency, the thermistor temperature is not able to vary with individual cyclic changes. It then assumes an average value; the resistance becomes constant and equal to the slope of a line on the static curve which passes through the origin and through the static curve at 2 ma. This is represented by the

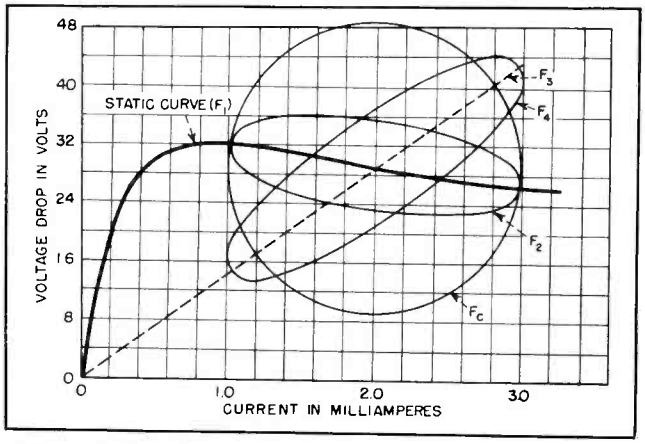


FIG. 1—Static voltage-current curve for thermistor and operating lines for sinusoidal currents of various frequencies with peak values extending between 1 and 3 ma

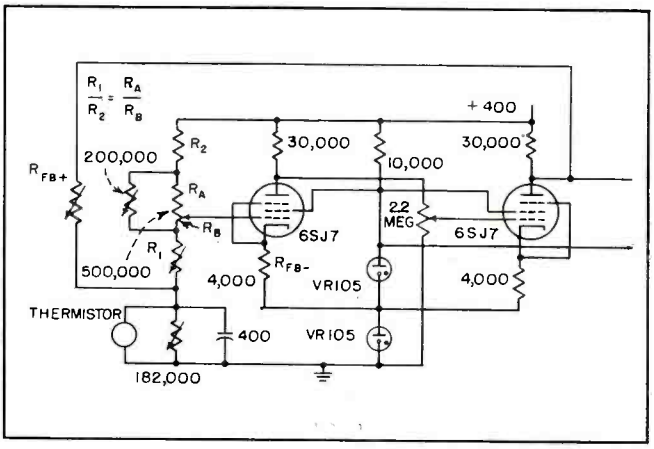


FIG. 2—Operating frequency can be altered by changing the amount of positive feedback or the value of capacitance in parallel with the thermistor

FREQUENCY OSCILLATOR

The thermal lag of a current-carrying thermistor enables it to be used as an inductance in the resonant circuit of a subsonic oscillator. Approximately sinusoidal waveform is obtainable, over a frequency range of from 0.1 to 0.02 cycle per second

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dashed line of Fig. 1 labeled F_3. The operating line approximates this line between 1 and 3 ma.

If the value of frequency F_3 is lowered sufficiently, the operating line becomes slightly oval in shape, because the thermistor is now able to vary its temperature with each individual oscillation. The oval is shown as F_4 in Fig. 1; it approximates an ellipse with the dashed line as major axis.

As the frequency is lowered below F_4, the oval becomes wider, and the slope of its major axis becomes less. This major axis approaches the slope of the static curve as the frequency approaches F_2.

At a frequency somewhere between F_4 and F_2, the slope of the major axis becomes horizontal. At this frequency, F_c, the operating line approximates a circle.

Inductance Analogy

The similarity between a thermistor and an inductance may now be noted. If the operating curve at frequency F_c were a perfect circle, it would look exactly like the instantaneous voltage-current variation of a pure inductance with a pulsating direct-current impressed. At frequency F_c only, then, the thermistor may be shown as a pure inductance. At frequencies between F_1 and F_c, the thermistor can be regarded as a negative resistance and an inductance in parallel. As the frequency approaches F_c, the negative resistance increases to infinity and then reappears as a positive resistance above frequency F_c. The value of the positive resistance approaches the slope of the dashed line in Fig. 1 as the frequency approaches F_4.

At a frequency slightly below F_c, the equivalent circuit of the thermistor is an inductance and a negative resistance in parallel. If a capacitance is added in parallel, in a value that will resonate with the equivalent inductance, the circuit will be free to oscillate by itself at the frequency where the equivalent negative resistance exactly equals any positive external resistance. This external resistance is usually the internal resistance of the direct-current biasing source, and any succeeding stages of amplification. When the negative resistance cancels the external circuit losses, any disturbance will cause the resonant circuit to oscillate.

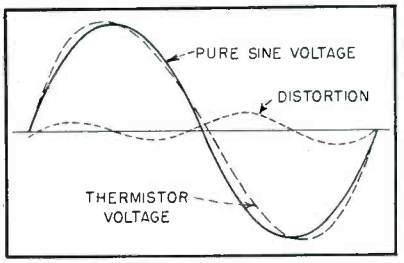

FIG. 3—The oscillator's close adherence to sinusoidal output may be seen by comparing its output to a pure sine wave

Oscillator Circuit

The oscillator shown in Fig. 2 is a refinement of the circuit just explained. It operates in the frequency band of 0.02 to 0.1 cps. A Western Electric 1-B thermistor, in parallel with about 400 microfarads capacitance appears in the grid circuit of a conventional direct-current amplifier. The thermistor is biased with a direct-current of 2 ma which places operation on the static voltage-current curve over a portion where the slope is negative. Alternating current variations do not exceed 1 ma on either side of the quiescent point.

The equivalent inductance of the 1-B thermistor used is 4,100 henries at a frequency of 0.102 cps. This inductance resonates with a capacitance of 594 microfarads. With an external resistance of 9,000 ohms, the resonant frequency is about 0.01 cps.

The a-c peak-to-peak voltage that can be generated across the resonating circuit is slightly less than 10 volts. Best operation occurs when the bias current is just slightly in the region of negative slope. With this condition, amplitude of oscillation is smallest, and the least number of nonlinearities distort the sine wave output. Care must be taken not to load the circuit by succeeding stages, as both frequency and waveshape will be affected.

For comparative purposes, Fig. 3 shows the output voltage of the oscillator plotted on the same axis as a pure sine wave of the same amplitude and frequency. Also shown is the locus of the difference of the two curves.

It is possible to vary the oscillator frequency over a range of about 30 percent of the center frequency by changing the value of the tuning capacitance. This method is cumbersome, and partly unsatisfactory, since changes in capacitance affect the output amplitude.

Increasing the amount of positive feedback to the oscillating combination from the output of the amplifier has the effect of increasing the frequency, but again affects the output amplitude. The increase in frequency occurs because less of the energy must be supplied by the negative resistance of the thermistor. The thermistor then seeks out an operating point at which its equivalent parallel negative resistance is higher, which occurs at a higher frequency.

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Dot Systems of COLOR

Sampling and multiplexing techniques permit transmission of color television pictures in the presently assigned channel bandwidth. Several systems of dot sequential color that may be compatible with black and white are described

EXPERIMENTS with the previously described interlace monochrome television system show that the resolution of patterns corresponding to modulating frequencies as high as 7.5 mc may be obtained (as compared to noninterlaced and conventional resolution of 4 mc) without deterioration of the resulting picture.

The same techniques of field sequential interlacing described for monochrome television can be utilized in field sequential color transmissions so that a maximum utilization of assigned channel bandwidth can be made. With a three-color system, a new set of field and line frequencies are probably desirable to maintain a good flicker threshold.

Values such as the following might be appropriate: sixty fields per color per second or 180 fields total per second; 202½ lines per field with alternate fields vertically interlaced for a 405-line picture; 36,450 horizontal lines per second and a gate frequency of 8.05 mc.

These numbers will reveal a picture having 441 dots per horizontal line when both line and field interlace. The horizontal resolution would be about 80 percent of the vertical resolution with a 4 to 3 picture aspect ratio. This is about twice the horizontal resolution which could be achieved using the same field and line rates, but without horizontal interlacing.

This system would be entirely free of color crosstalk resulting from any possible defects of the transmission system. However, the revised synchronizing standards would require a conversion of existing monochrome receivers if these receivers were to be used to receive transmission from a color signal transmitter of the system.

A second type of color system is also important. In the system just described, field sequential dot interlacing was used to increase the resolution but a color shift was made only at the field rate. By omitting this field color shift and using multiplex techniques, it is possible to have a system having dot interlacing for resolution and dot sequential color. Examples of such systems follow.

Basic System

Figure 6 is a possible color television transmitter block diagram. The color camera could be of the simultaneous three-color type having three video outputs, each corresponding to the color pattern of the viewed scene, and preferably including mixed synchronizing and blanking signals such that all three video signals are conventional composite video waveforms. This camera may operate on a conventional 60-field, 30-frame basis.

Each of the video channels is sampled in sequence (Fig. 6A) by a narrow sampler driven by a carrier generator at a rate of approximately 2.68 mc per second into a a pulse train of 8.04×10^6 pulses per second (2.68 mc is the 170th harmonic of the horizontal line frequency of 15,750 lps). The composite pulse train is amplitude modulated but the amplitudes of adjacent pulses are unrelated since they were derived from three independent input signals. However, the amplitude of every third interleaved pulse has been derived from the same input signal. Thus a horizontal line of the picture will be sampled into 170 dots of each color per scan. This pulse train is next filtered to a bandwidth of 4 mc by a low-pass filter of good transient response and is now prepared for transmission by a conventional television transmitter and for reception by a conventional receiver arrangement.

To reconstruct the original input pulse train so that the original modulations may be derived, the receiver includes means to resample the transmission system output as it appears at the receiver video detector. For this purpose the receiver must generate a gating carrier which can be frequency and phase controlled by additional synchronizing information supplied from the transmitter.

Figure 7 is a block diagram of a possible receiver arrangement. A conventional monochrome television receiver system may be used for the detection of the transmitted signal and the detected video signal may be applied directly to a gate. The gate is similar to the transmitter sampler (Fig. 6A) and is driven by a carrier such that the detected signal is gated in sequence to three amplifier chains each with their picture tubes, or to a single three-color line tube. From the picture tubes, each of which may correspond in color to requirements established by the color camera, the color images may be optically superimposed.

The receiver gate thus essentially reproduces the original composite pulse train and simultaneously may separate the pulses to their respective color channels. Into each channel, therefore, a 2.68-mc pulse train is supplied, with the amplitude of the pulses being translated by very wide-band circuits into dots of various colors and luminosities on the picture tube or tubes.

The modulating signals from the camera for the pulses of any of the color channels have not thus far

TELEVISION

Part II
of a two-part paper

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been limited to any specific bandwidth. In a noninterlaced system, the modulation would be limited to 1.3 mc but interlaced sampling may be used to permit input modulating frequencies up to 2.5 mc. That is, the samples taken from the three color camera signals are sampled in sequence in multiplex fashion continuously throughout the two vertically interlaced fields of the picture scanning, then during the next two fields the samples of each signal are interlaced with the last set of samples.

A typical dot scanning structure resulting from this might be as shown in Fig. 8, wherein the green, red and blue channel sampling locations on a raster are indicated by the letters *G*, *R*, and *B*. Thus each color channel is sampled in interlaced fashion and input modulation frequencies up to the frequency of the sampling carrier (or more practically, up to 2.5 mc) can be faithfully reconstructed on the respective picture tubes.

The dot structure of Fig. 8 is interesting from a further viewpoint. It is an outstanding feature of a dot sequential color system that a colored line phosphor tube makes possible single-tube direct-view color reception. That is, since the dot signals for each color fall in vertical alignment when the fields are superposed, a three-color display could be obtained by using either a tube with colored phosphor stripes or with colored filter stripes so that the respective channel signal pulses register with the appropriate color strip locations.

Circuit Arrangement

One circuit means to obtain the aforementioned interlace may be as follows: the carrier generator at

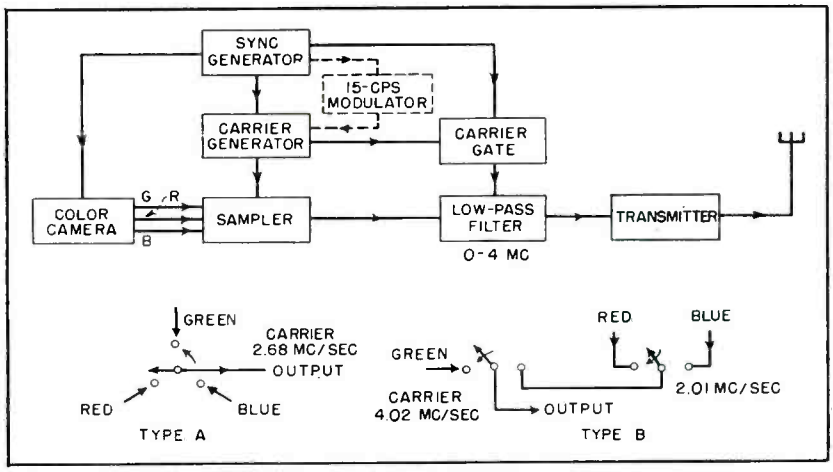

FIG. 6—Stages of color transmitter

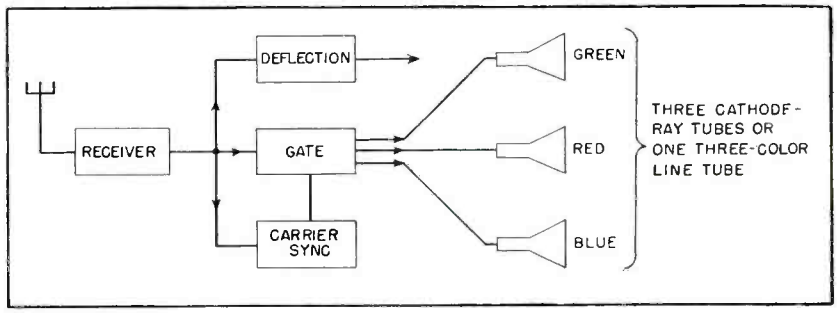

FIG. 7—Additional stages required at receiver

2.68 mc may be modulated at a 15-cycle rate in such fashion that it undergoes a phase reversal during every second vertical blanking interval. This phase reversal is used to interleave the picture sampling points frame by frame. Thus 170 dots per color per line may be passed in one scan and interlaced to form 340 dots per color per line in the completely scanned picture. This resolution will therefore be that of the admitted modulation or 2.5 mc per color.

It appears to be more desirable to modify the sampling frequency so that it is not an integral multiple of the horizontal line rate but so that a one-half sampling interval shift is obtained on alternate lines. For instance, a sampling frequency of 2.685 mc, which is 170.5 times the hoizontal line rate, might be used for sampling each input signal. If this is done with a picture having an odd number of horizontal lines in two fields (such as a conventional 525-line picture) it will be found that dot interlacing will be entirely automatic and will require four fields for an interlace cycle. Hence no carrier phase-reversing apparatus will be required. This is the pattern shown in Fig. 8.

To maintain good system characteristics it is necessary to supply the receiver with a gating carrier synchronizing signal from the transmitter. One means for accomplishing this synchronizing is as follows: During the time of the horizontal blanking interval, the signal at the transmitter filter input resulting from sampling the three modulations will be without appreciable 2.67-mc carrier frequency information due to the identity of the three camera signal waveforms. Hence during this interval a burst of 2.68 mc gating carrier of a phase corresponding to the transmitter sampler phase may be added to the transmitted signal. At the receiver an oscillator nominally

operating at the gate carrier frequency may be synchronized line by line by gating to it this carrier burst. During vertical retrace, this gating carrier may also be applied. In this way the receiver gate may readily be controlled from the transmitter.

Systems with High Sampling Frequencies*

The basic system is an illustrative example of a straightforward method of color interlacing using multiplex techniques. Through its use a three-color, 340-dot per color per line signal is transmitted without any inter-color cross-modulation through a 4-mc modulation bandwidth at half the conventional frame speed. This is, in fact, the limit predicted by Hartley's law and cannot be exceeded without some compromise. However, to obtain a finer dot structure, the sampling rate might be increased although it is recognized that some form of intersample (inter-color) crosstalk would result.

It is seldom that the practice of engineering permits a clear definition of an optimum system and relative weights must usually be attached to conflicting requirements. In this case the conflict is between resolution, and color crosstalk in a color receiver; both the color receiver and a monochrome receiver operating on a signal from a color transmitter benefit from increased resolution, while only the color receiver suffers picture deterioration from color crosstalk.

This compromise probably should be resolved on the basis of further theoretical investigation and field tests of large subjective scope in which the carrier rate and modulation bandwidths are raised to increase the system apparent definition until color crosstalk becomes objectionable. For example, the carrier rate might be raised as high as 3.5 mc per color with per-channel modulation frequencies being raised to 3.3 mc. Operating in this fashion (or at any other sampling rate between 2.68 mc and 4.0 mc) with a

*A system having some resemblance to systems described in this paper has been announced by the Radio Corporation of America. Similarities and dissimilarities between the RCA system and those described here are not known to the author and the two developments have been independent.

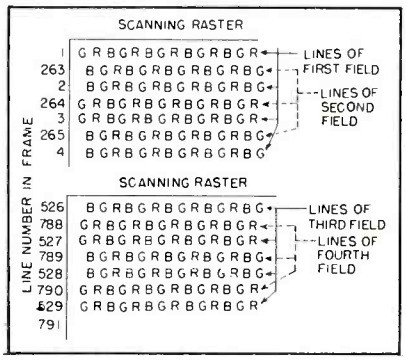

FIG. 8—Interlaced scanning pattern

4-mc passband, the filtered pulse train derived from the low pass filter would be characterized by having interdot crosstalk for per-channel modulating frequencies greater than twice the difference between the filter cutoff frequency and the channel sampling frequency. For modulating frequencies below this difference frequency, interdot crosstalk would be negligible. Hence, a transient change in the amplitude of any one color signal would affect the other signals.

For example, assume that three unmodulated video channels are sequentially sampled at a rate of F cycles and that the resulting pulse train is then filtered by a filter F cycles in bandwidth. Then the terms of a Fourier series of the pulses resulting from sampling each channel are given by

$$\frac{A}{3}\left(1+2\cos\frac{2\pi t}{T}\right) \tag{12}$$

$$\frac{B}{3}\left[1+2\cos\left(\frac{2\pi t}{T}+\frac{2\pi}{3}\right)\right] \tag{13}$$

$$\frac{C}{3}\left[1+2\cos\left(\frac{2\pi t}{T}+\frac{4\pi}{3}\right)\right] \tag{14}$$

If these series are summed it will be observed that no two add any value where the third is a maximum. This is a unique steady-state condition wherein interchannel signal errors do not exist. Now suppose the second channel is modulated. Then its signal becomes

$$\frac{B}{3}\left[1+2\cos\left(\frac{2\pi t}{T}+\frac{2\pi}{3}\right)\right]\left[1+m\cos\left(\omega_a t+\phi\right)\right] \tag{15}$$

where ω_a is the modulating frequency. Then expanding and filtering to a bandwidth $F = 1/T$ we get

$$\frac{B}{3}\left[1+2\cos\left(\frac{2\pi t}{T}+\frac{2\pi}{3}\right)+m\cos\left(\omega_a+\phi\right)+m\cos\left(\frac{2\pi t}{T}+\frac{2\pi}{3}-\omega_a t-\phi\right)\right] \tag{16}$$

Now at time $T = 0$, corresponding to the maximum of channel A, we get

$$\frac{B}{3}\left[1-1+m\cos\phi+m\cos\left(\frac{2\pi}{3}+\phi\right)\right] \tag{17}$$

or

$$\frac{B\,m\cos\left(\phi-\frac{\pi}{3}\right)}{3} \tag{18}$$

This maximizes at $\phi = \pi/3$ to a value of $Bm/3$. Where $m = 1$, $B/A = 1/3$.

This indicates a maximum interchannel crosstalk of 33 percent, and a further calculation assuming a random phase (or a random frequency) variation indicates that the crosstalk would be within 80 percent of maximum over 40 percent of the time. However the choice of a channel sampling frequency could be tempered to a satisfactory degree by the use of an intermediate value.

For sampling frequencies less than F cycles, Eq. 15 is valid but new terms will appear in Eq. 16 as a function of modulating frequency. Thus the degree of crosstalk exhibited is a function of the sampling and modulating frequencies and can be calculated for any example. The subjective nature of color may be such that color crosstalk, if not too pronounced, may be immaterial or even beneficial to resolution. However, other systems such as those which follow must also be considered.

System with Increased Resolution of One Color

All of the foregoing has been based on equal resolution (sampling intervals) for all three colors. This is not a necessity and perhaps is actually not desirable. For example, while maintaining the 8.04-mc combined sampling rate let the color sampling sequence be green, red, green, blue, with a sampling rate of 4.02 mc for the green and 2.01 mc for red and blue. In this case the modulating frequencies should probably be limited to 3.8 mc for green and 1.9 mc for red and blue. The system functioning would be the same as before except for the color sampling sequence as noted. Sampling might be done with a dual commutator (Fig. 6B), the carrier rate being 4.02 mc, and alternate

red and blue switching being obtained by a secondary mechanism operated at one-half carrier frequency.

However, the principal result of this scanning sequence is an arrangement entirely within the Hartley limit (thus avoiding intercolor crosstalk) wherein high resolution can be obtained on a single color channel (as for example, green) and on monochrome reception. A typical dot scanning structure resulting from this scanning might be as follows:

Line 1 GRGBGRGB first and second
Line 2 GBGRGBGR fields
Line 1 BGRGBGRG third and fourth
Line 2 RGBGRGBG fields

The color alignment between the first and second fields and the third and fourth fields may be accomplished automatically by the proper selection of carrier frequency relative to line frequency, while the color shift from second and third fields and fourth and first fields may be accomplished by gate carrier phase reversal during every other vertical blanking interval.

Other sampling mechanisms are possible but the one indicated includes the advantages of simplicity while retaining the 180-degree phase shift of the carrier between scanning frames for interlacing.

Compatibility

Since there is an existing monochrome television broadcasting service it is probably required that any standards for color transmission be such as to secure a maximum utilization of existing monochrome transmitters and receivers. Therefore the above-described color system characteristics must be considered from this viewpoint.

Since the bandwidth of the modulation signal may be limited to 4 mc before transmission there is no question as to the detection of the transmitter signal at a conventional receiver. Questions appear to center around the utilization of the various possible signals by a conventional monochrome receiver. For the basic color system as described, the monochrome receiver detector output signal would be a waveform resulting from the filtering of the sample pulse train.

This signal is the resultant of the linear addition (superposition) of the signals due to the sampling and filtering of the three camera signals. It may be found by taking the three channel signals and multiplying each by the sampling terms (Eq. 1) and then filtering by means of a filter of bandwidth equal to half the composite rate. However, since the bandwidth of the modulation in each channel and the per-channel sampling rate is approximately 2/3 of the bandwidth of the transmission system it is not convenient to collect the terms of this expression for the signal after filtering.

A satisfactory physical insight into monochrome reception probably can best be obtained here by examining a typical video waveform within a color transmitter. This signal is shown in a representative case by Fig. 9. At *A* there is shown a sketch of the three modulation waveforms which might be derived from the color camera. At *B* and *C* there are shown the pulse amplitudes as the three waveforms are sampled in succession, the sample times of *C* being interposed with those of *B* as required for sample interlacing. The letters indicate the color channel being sampled.

The indicated envelope of the pulses is the resultant video waveform which would be obtained from the receiver detector and would be used to modulate the cathode-ray tube of a monochrome receiver. The envelopes of *B* and *C* would be superimposed on successive scans. Inspection shows that while the waveforms do include the original modulation there is also in one portion a strong carrier-frequency signal (at 2.68 mc for the previous basic color system example).

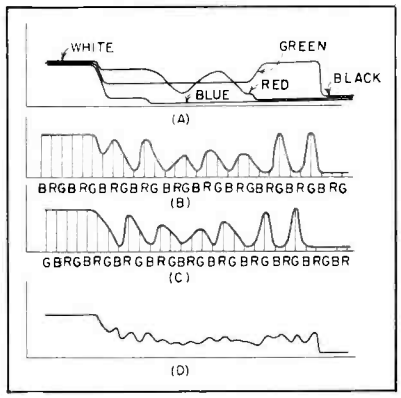

FIG. 9—Color transmitter—monochrome receiver waveforms

Sketch *D* shows the sum of the two envelopes *B* and *C* and is the envelope of the resultant waveform which would be viewed on the picture tube if suitable integration be provided. This signal is observed to include original modulations with the 2.68-mc carrier being doubled to a 5.36-mc carrier which would not ordinarily be resolved by the viewer.

A further comparison of waveforms *A* and *D* illustrates another property of a color transmitter—monochrome receiver combination. On black and white portions of a picture or in any region where modulation of the three color channels is approximately the same, the monochrome resolution and contrast range is adequate but in regions of essentially single-color modulation the monochrome contrast is impaired. Further, it is apparent that the loss of contrast in the monochrome channel can be made small if the relative gains of the three color channels are adjusted at the transmitter (and in the color receiver) so as to emphasize a particular modulating signal such as the green channel signal.

The ability of a monochrome receiver to obtain a satisfactory picture depends upon the color content of the subject and certain conditions within the color transmitter apparatus. Exhaustive field tests would be required to reach an optimum. At this time it is clear that monochrome receivers will function satisfactorily but that some optimization of system parameters for compatibility is desirable.

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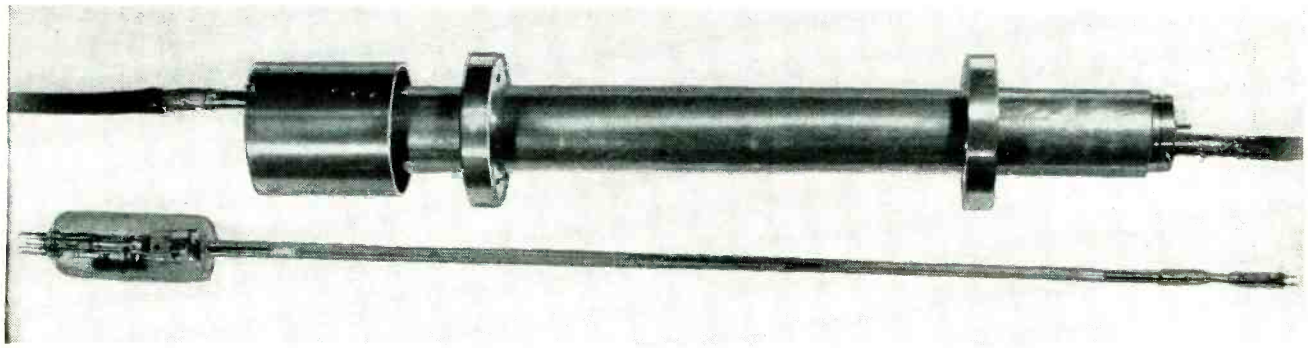

FIG. 1—Low noise traveling-wave tube for operation in the 3,000-mc range

Recent Developments

Since their appearance several years ago, traveling-wave tubes have been the subject of much discussion and research. As a result, their characteristics have been improved and their operating ranges extended considerably. Several of the more important advancements are presented here in survey form

APPRECIABLE PROGRESS in the development of various types of traveling-wave tubes has been made in the interval since the first tubes of this type were announced.[1,2,3] Extension of the amplification pass band, use of the traveling-wave principle from as low as 200 to above 25,000 megacycles, decrease in the noise power output of the tubes from 1,000 to 14 times the theoretical minimum, and increase in the available power output from 1 to 60 watts at 3,000 megacycles and up to 1,200 watts at lower frequencies are among the developments. In addition, new forms of traveling-wave tubes have been invented including the remarkable electron wave tube which uses no metallic wave carrying circuit, the transverse current traveling-wave tube, traveling-wave klystrons and reflex tubes, and traveling-wave magnetron amplifiers.

It will be remembered that the traveling-wave tube makes use of a new principle of amplification in which the signal to be amplified is sent along a circuit at low velocity for an appreciable number of wavelengths (foreshortened wavelengths because of the low velocity). At the same time an electron stream is sent near the circuit in the same direction and at nearly the same velocity as the signal. The signal field and the electron stream interact in such a manner that energy is fed from the electron stream to the signal in consequence of which the signal rises exponentially in amplitude or linearly in decibels above input level as it travels. A description of this interaction has been given in several of the references at the end of this article. [1,2,3,4,5]

The continuous interaction of signal wave and electron stream over a long distance, an extended interaction which may take place over tens to hundreds of cycles as compared with the fraction of a cycle used in tubes with grids or in cavity resonator beam tubes, results in sufficient amplification that low-impedance circuits can still give high gain. Consequently, such a circuit as the wrapped up transmission line or helix can be used to give amplification over bandwidths of thousands of megacycles where only tens of megacycles were achievable in non-traveling-wave devices because of their need for high-impedance resonant elements.

The following is a representative selection of the more important advancements being made in the traveling-wave tube art in recent years. An all inclusive survey is, of course, out of the question, since much of the work being done is classified and cannot be discussed.

Low Noise Figure Tubes

The possibilities of traveling-wave tubes as low-noise devices have been of interest since Kompfner first discussed low noise performance on his tubes.[1] Indeed, his article discusses the device principally as a low noise amplifier Although the noise figures quoted for those first tubes were very low, the tubes were described as having self-oscillation, low power output and a relatively narrow amplification pass band. The Bell Laboratories tubes announced at about the same time gave relatively wide bandwidth amplification (800 mc), were free of oscillation, and operated up to about one watt output power, but may be calculated as having had the order of 30-db noise figure, which represents a noise out-

Research described in this article as having been carried out at Stanford University was made possible by the support of the Office of Naval Research and the Army Signal Corps.

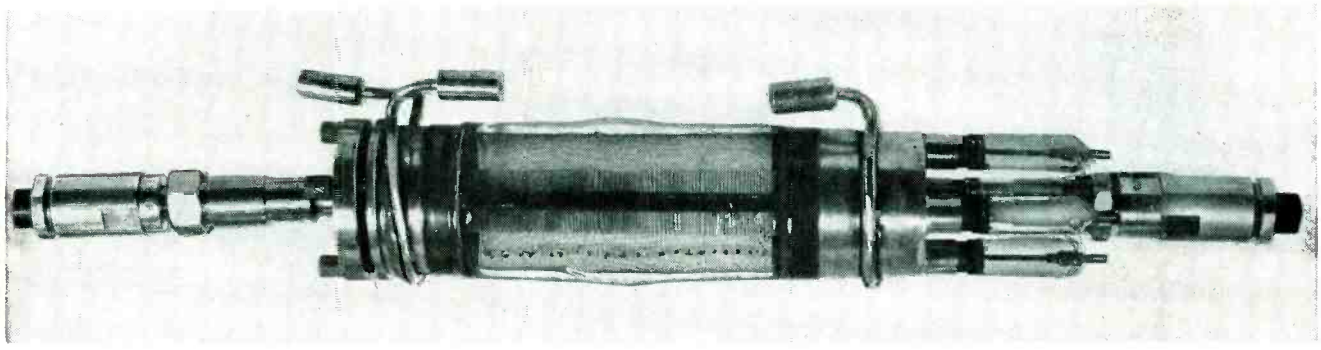

FIG. 2—The disc-on-rod type traveling-wave tube furnishes two watts output at 10,000 mc

in Traveling-Wave Tubes

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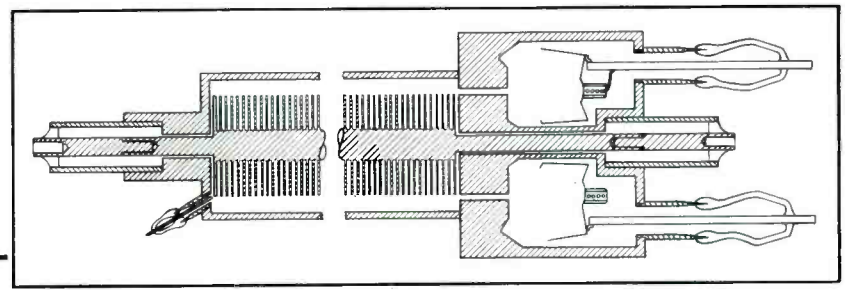

FIG. 3—Cross-section of an early form of the disc-on-rod type traveling-wave tube built at Stanford University

put 1,000 times the lowest possible theoretical noise power output.

Stanford University, Sylvania Research Laboratories, Bell Telephone Laboratories and many other organizations have been concerned with understanding the causes of noise in t-w tubes and producing lower noise tubes. Very wide band, stable, low noise tubes with as low as 11.5-db noise figure at 3,000 mc have resulted from this effort to date, and a few db further improvement may be forthcoming. This value of 11.5-db noise figure for a radio-frequency amplifier at 3,000 mc may be compared with such typical values as 14 to 16-db noise figure obtained by using very close spaced triodes and 20 to 30-db noise figure for most electron beam devices such as early traveling-wave tubes and klystron amplifiers. It is extremely likely that the klystron can be improved to the same order of noise figure as the t-w tube for possible use as a narrow band amplifier.

At present, narrow band systems at 3,000 mc or higher generally make use of a crystal mixer and do their amplifying at i-f frequencies with a resulting noise figure of 8 to 15 db. The low noise traveling-wave amplifier now appears to be almost competitive with the crystal mixer on a noise figure basis and has some advantages, notably very great bandwidth, no permanent damage from r-f overloads and minor mechanical shocks, and possible reduction in complexity in some systems by removing the need for i-f amplification entirely.

Possible applications for this low noise t-w tube arise in such devices as radar receivers, search receivers and microwave relay link receivers.

Gun Noise

Unfortunately, no extensive theoretical treatment of the reduction by space charge of the shot noise content of an electron beam from a gun at microwave frequencies was available at the beginning of this work on noise reduction in the t-w tube.

The diode and multigrid tube had been the subjects of extensive analysis[6,7,8], but an electron gun whose electron beam output might have velocity and current noise content, both of importance in noise calculation, has only recently been analyzed in sufficient detail to account for observed variations at low noise figures in operating tubes. J. R. Pierce of the Bell Telephone Laboratories recently proposed a theory of noise in such guns, including the effects of transit angle, and velocity and current noise content in streams, which has accounted for many observed effects. C. F. Quate in a doctoral dissertation at Stanford University has modified this analysis somewhat to obtain one possible explanation of the observed minimum in noise figure as beam current is varied.

It appears likely from this work that our present guns produce beams which contain a small but significant temperature limited content.

Typical Tube

A typical low-noise tube for the 3,000-mc region is shown in Fig. 1. This tube has been measured at 11.5 db minimum noise figure and uses a type of construction now quite common at the Stanford University laboratory. The helix is wound of tungsten wire, copper coated for

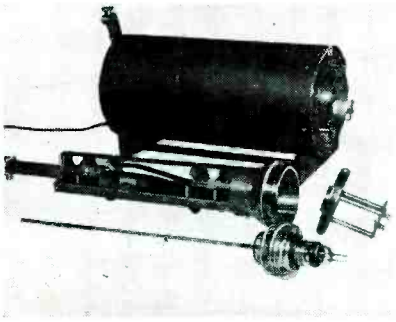

FIG. 4—A 3,000-mc t-w tube capable of producing 60 watts output

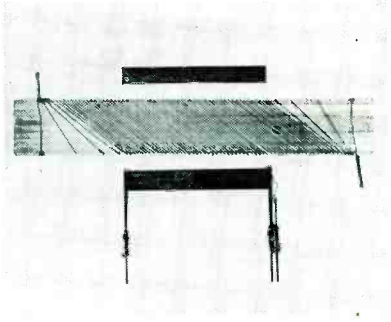

FIG. 5—Skewed helix permits adjustment of electron speed

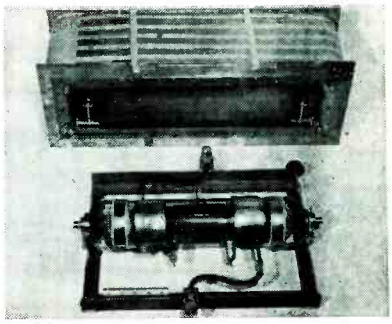

FIG. 6—A complete tube using the skewed helix shown in Fig. 5

low r-f loss, and is directly supported by the quartz tube envelope. The envelope is shrunk to precise size on a centerless-ground tungsten seal rod of the proper diameter. At each end of the quartz structure grading glasses are used to uranium glass presses through which tungsten leads are sealed for applying operating potentials.

The electron gun for producing a low-noise beam uses a Pierce gun[10] with the special feature that the beam edge is defined by a negative electrode surrounding the cathode. This causes the space charge potential minimum in front of the cathode to deepen rather than disappear at the edges and hence cuts off the emission at the edges in an attempt to minimize the temperature limited beam content.

Tube operating parameters are as follows:

Beam voltage	675 volts
Beam current	200 μa
Interception current	1 μa
Gain	20 db
Bandwidth	600 mc
Noise figure	11.5 db

As shown in Fig. 1, coaxial-cable-to-helix matching devices have been developed which take the place of the waveguide-to-helix matches of earlier tubes.[2] Because these matches permit magnetic field structures of small diameter to cover the tube ends, they are now used extensively.

Other low-noise problems now being worked on at several research laboratories include direct study of the noise content of beams produced by electron guns, noise reducing schemes involving initial resonant cavities or helices, and transverse field or beam deflection devices.

The maximum power output available from the tubes described in 1947 was the order of one watt at 3,000 mc. Although this is sufficient power to be useful in the output stage of a microwave relay link transmitter, higher output power would be welcome in such an application, and would be essential if the tube were to receive wide use as a radar jammer, high-level signal-generator output tube, or at lower frequencies, a very wide band television output amplifier or phase modulator.

The earliest work on high power t-w tube development concerned itself with attempting to find wave carrying circuits of higher power dissipation and possibly with appreciably higher gain or higher efficiency than the simple helix. One of the types of circuits used for this purpose is that used in the disc-on-rod tube shown in Fig. 2 and 3. These figures show an early form of the tube built at Stanford University which produced about two watts at 10,000 mc using a hollow cylindrical electron beam. A more advanced form of disc tube has been reported by the Federal Telecommunication Laboratories to give 100 watts at 4,700 mc.

Other forms of circuits have also been described[11,12] and compared with a helix in a very general way by J. R. Pierce.[12] The helix is shown to give relatively high gain as compared with lumped element circuits unless the lumped element circuits are adjusted for narrow bandwidths. Circuits other than the helix have also been considered for higher frequency applications as will be described later.

Several high power t-w tube developments have made use of the helix form of circuit. One of these, a tube reported from the General Electric Research Laboratories, has produced 1,200 watts output power at about 500 mc with 100-mc bandwidth.

Another development, for the 3,000 mc region and covering 2,000 to 4,000 mc, uses a helix and produces over 60 watts output power. This tube, recently produced at Stanford and shown in Fig. 4, makes use of a remarkable gun designed at the Sperry Gyroscope Co. which in this application sends an electron beam of 200 milliamperes at 3,000 volts down a tube or helix 0.110 inch in inner diameter and thirteen inches long with a loss of only one milliampere. This is ten to twenty times the beam density used in the 1947 tubes. Space charge repulsion is overcome by a magnetic field applied according to the principles described by A. L. Samuel and by C. C. Wang in papers delivered before the March 1949 IRE Convention at New York City, and previously derived mathematically by L. Brillouin.

Other devices for the production of high power at microwave frequencies are being developed which are related to the traveling-wave tube to a greater or lesser extent.

T-W Magnetrons

A very close relative is the traveling-wave magnetron amplifier. One version of this is reported by Warnecke and his associates at C.S.F. in France as having relatively high output power and efficiency.[13] Several hundred watts output at 40-percent efficiency at 25 cm are to be expected according to the publication. This device is similar in general configuration to the multicavity magnetron. However, it is an amplifier, uses a flattened helix in place of the resonant cavities, and separates the input from the output by a metallic partition so

that electrons never travel more than once around the circumference. Multiple cathodes placed at various points on the circumference of the single small cathode region are reported as being used.

Another form of traveling-wave magnetron is being worked on in this country at the Raytheon research laboratory and outputs of 20 watts at 125 mc were realized in a first low-frequency model.

T-W Klystrons

The klystron and reflex tube are being modified somewhat to include a traveling-wave feature by replacing their resonant cavities with nonresonant waveguides. Such tubes are reported as being worked on at Oxford and at the Microwave Laboratory at Stanford. Although these tubes do not have the continuous interaction between electrons and waves traveling in the same direction common to all the other tubes discussed in this article, they do have traveling waves in the waveguides rather than the standing waves associated with resonant waveguides or cavities.

They differ from other forms of traveling-wave tubes most radically in that electron stream and signal interact only in a short gap and then the electrons coast through an r-f field free region where they undergo klystron type or reflex bunching rather than the waveform of bunching of other t-w tubes. It is at least evident that the term traveling-wave tube is not sufficiently descriptive to distinguish between these two widely different types of interactions.

The klystron type traveling-wave devices are of necessity very high power tubes (order of megawatts) since the low waveguide impedance coupled with klystron type bunching requires very high beam currents to achieve sufficient amplification to be useful but when operated at high beam voltage gives reasonable efficiency. The reflex type device being worked on at Stanford is useful at appreciably lower power levels. It has a severe feedback or oscillation problem since it has equal gain in each direction unless electron paths are warped appreciably.

The traveling-wave klystron is somewhat similar in principle to the distributed amplifier[11,12] which has used ordinary pentodes coupled to loaded transmission lines to give gain below the video range and up to 100 mc as a pass band. The comparison is sufficiently close that the terms distributed klystron, and distributed reflex tube might possibly be applied to these devices.

Transverse Current T-W Tube

At least one form of tube is now known in which the electron beam is sent across a tube transverse to the principal direction of wave or signal travel as in the traveling-wave klystron or reflex tubes just described, but which produces a component of wave velocity in the electron travel direction. This permits electron speed to be adjusted to equal wave speed and hence give continuous interaction over the entire electron path. The device makes use of a skewed, race-track shaped helix as shown in Fig. 5, and the interaction gives fields which rise essentially exponentially across both the width and length of the helix. A finished tube, produced at Stanford and shown in Fig. 6, has been tested and found to give relatively high gain for a small device. The helix shown, approximately one and one-half inches wide and three and one-half inches long, is only 3 foreshortened wavelengths wide and 9 foreshortened wavelengths long at 190 megacycles for the beam velocity corresponding to 50 volts. Yet under these conditions the tube has demonstrated over 20 db of amplification and operates well from about 150 to 400 mc with 60 ma in the beam corresponding to only 3 watts beam power.

The very high current for such a low voltage is one of the advantages of this form of construction. Most t-w tubes and other tubes using electron beams suffer from too high beam impedance; in other words, they can get only relatively low currents at high voltages. Another advantage of the transverse current construction is the very low beam density and consequent easing of cathode and space charge repulsion problems. In addition, the tube can be extended indefinitely normal to the direction of electron flow without adding to electron beam production or focusing problems since all new electron paths which are added are of the same form and length as previous paths.

The theory of operation of this device indicates that the gain in db will not rise as the one-third power of the current as it does for the usual one dimensionally extended t-w tube.[3] Rather for low currents it will first increase as the square of the current, and increase then with progressively diminishing exponent, until for high currents, the gain asymptotically approaches a value independent of current. Measurements on the tube just described appear to verify the theory both in the form and the absolute magnitude of the gain—current curve.

It may be hoped that further development of the transverse current amplifier may make it an important contender for medium or high power levels at relatively high efficiencies because of the high beam current at low voltage available in this tube.

Bandwidth and Frequency of Operation

Appreciable strides in increasing the bandwidth or amplification passband have been made since the earliest t-w tubes, and even greater strides have been made in changing the frequency of operation of these tubes. Much improvement in bandwidth has resulted from the use of

FIG. 7—Much improvement in bandwidth has resulted from the use of tapered matching sections from helix to a coaxial line

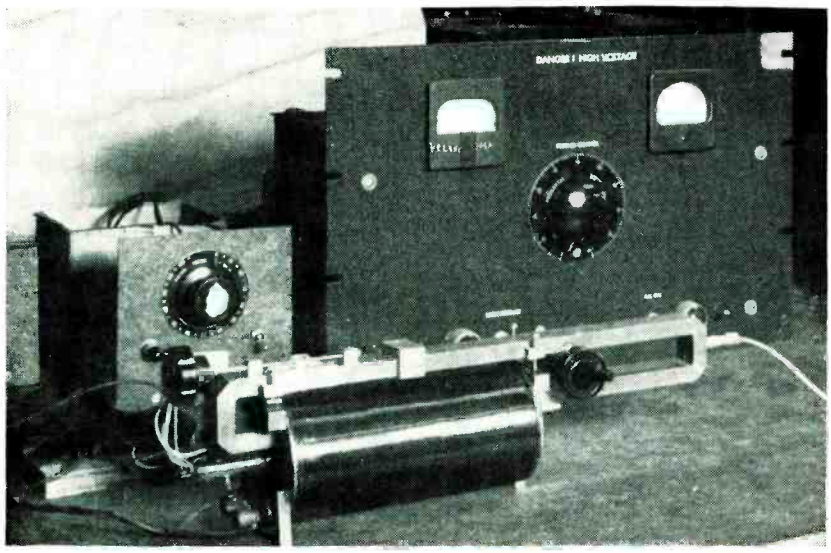

FIG. 8—Photograph showing feedback circuit of a traveling-wave tube oscillator which gives continuous tuning from 15,000 to 24,000 mc

tapered matching sections from helix to a coaxial line as shown in Fig. 7. Such matching sections were developed at RCA Laboratories and Stanford. The tube shown is a Stanford type for relatively low frequency amplification and has operated well over slightly greater than a 3 to 1 range in frequency. The tube has given the order of 40 to 50 db gain from 300 to 1,000 megacycles and at near saturation power levels has operated at 500 megacycles with 26-percent efficiency (r-f output power to d-c beam power). With reduced collector potential, 50-percent efficiency has been measured.

The same type of match was used in the tube described previously as giving 60 watts output in the 2,000 to 4,000 megacycle range. The lowest frequency t-w tube known to the author is the transverse current tube which has amplified at 150 megacycles. The tube of Fig. 7 is a more common variety and goes down to 300 megacycles as previously mentioned. Of course, distributed amplifiers using pentodes cover from a few megacycles to 150 or 300 mc.

In the direction of higher frequencies, early model 4,000-mc helix tubes have been scaled to 10,000 mc and 25,000 mc. Fair gain levels at 10,000 mc and just greater than unity gain at 25,000 mc appear to be the best results to date. Tubes with foreshortened dimensions have been built for 12,000 mc. With 10 milliamperes at 2,000 volts, tubes of this type have produced at least one milliwatt of power at 24,000 megacycles, second-harmonic output. Such tubes have been used in feedback circuits giving continuous tuning of the oscillation frequency from 15,000 mc to 24,000 mc. Such an oscillator is shown in Fig. 8. Up to fifth-harmonic output has been observed in other tubes. Tubes using a repetitive or loaded transmission line consisting of a slotted metal block are reported by Bell Telephone Laboratories to have given gain at about 25,000 mc. Also, a helix type tube has given gain at 6.25 mm at the Bell Laboratories.

There is some hope that the type of gun and beam used in the 2,000 to 4,000 mc tube may be scaled down in size and open up a whole new field of possibilities for t-w tubes at above 30,000 megacycles.

The Electron-Wave Tube

This article is not intended to include a complete description of electron-wave tube developments, but no summary of progress on t-w tubes could avoid some discussion of this important new development.[14] The electron-wave tube, which uses an additional electron beam to replace the metallic wave carrying circuit of the t-w tube, will probably surpass the t-w tube in some applications. At the moment it appears to be a much lower r-f power device and may be capable of only comparable noise performance. It appears to be capable of very high gain per unit length as compared with most t-w tubes, although recently, high-gain-per-unit-length t-w tubes have been made, for example the tube of Fig. 7.

The most promising field for the electron-wave tube seems to be its possible use for millimeter wave oscillators and amplifiers, for the range 30,000 to perhaps 100,000 mc.

Theoretical Studies and Conclusion

Finally, there should be mentioned the large amount of theoretical study on various t-w tube problems now engaging the attention of many workers here and abroad. Such problems as the noise in beams, the noise figure of various forms of t-w tubes, and methods of holding beams together against space charge repulsion have been mentioned. Other problems being studied, among many, are the effects on tube gain of space charge, helix attenuation, and helix or structure gaps; nonlinearity and saturation at high power levels; effects of finite beam size on noise; gain and noise in transverse field and transverse current tubes; higher order modes on helices; and electron-wave-tube gain for various beam velocity distributions and spatial separations.

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Design of ABSORPTION TRAPS

Universal response curves show the ratio of the response of a tuned circuit to which a trap is coupled to the response without the trap for typical values of attenuation and trap-circuit frequency separation. Nomograph permits rapid determination of coupling factor

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THE PROBLEM of obtaining attenuation at critical frequencies arises frequently in the design of amplifiers employing tuned circuits. One widely used method of obtaining this attenuation is by means of absorption traps.

The type of absorption trap analyzed in this paper consists of a circuit tuned to the rejection frequency and coupled to a tuned circuit which is fed by a constant-current source such as a pentode tube. An analytical expression is derived to show the attenuation introduced by the trap and its effect on the variation in amplification with frequency. This information is presented by universal curves which show the ratio between the response obtained with a trap to the response obtained without the trap, as a function of the following parameters: (1) the rejection at the trap frequency, (2) the generalized frequency separation between the trap and the circuit to which it is coupled, and (3) the ratio between the Q of the trap and the Q of the circuit to which it is coupled.

Application

A typical application is found in the design of video intermediate-frequency amplifiers of television receivers which employ staggered tuned circuits as coupling elements. In these receivers rejection at the accompanying sound carrier frequency and at the picture and sound carrier frequencies of the adjacent channels is frequently obtained by means of absorption traps which are inductively coupled to the staggered tuned circuits. The universal response curves presented show the effect of the absorption traps on the response over the pass band as well as the magnitude of the after response which impairs the skirt selectivity.

Response Curves

Although universal response curves have long been used for the simple resonant circuit and for synchronous double-tuned circuits, analogous curves heretofore have not been available for absorption traps. The universal response curves presented here enable the same simplification in the design of absorption trap circuits as results from the use of universal response curves for single and double-tuned circuits. Since as many as three absorption traps are frequently used in the video intermediate-frequency amplifier of a television receiver, the saving in design time is significant.

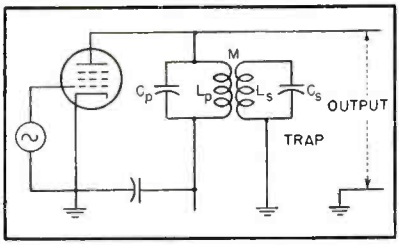


FIG. 1—Circuit diagram and equivalent circuit of a typical amplifier employing an absorption trap

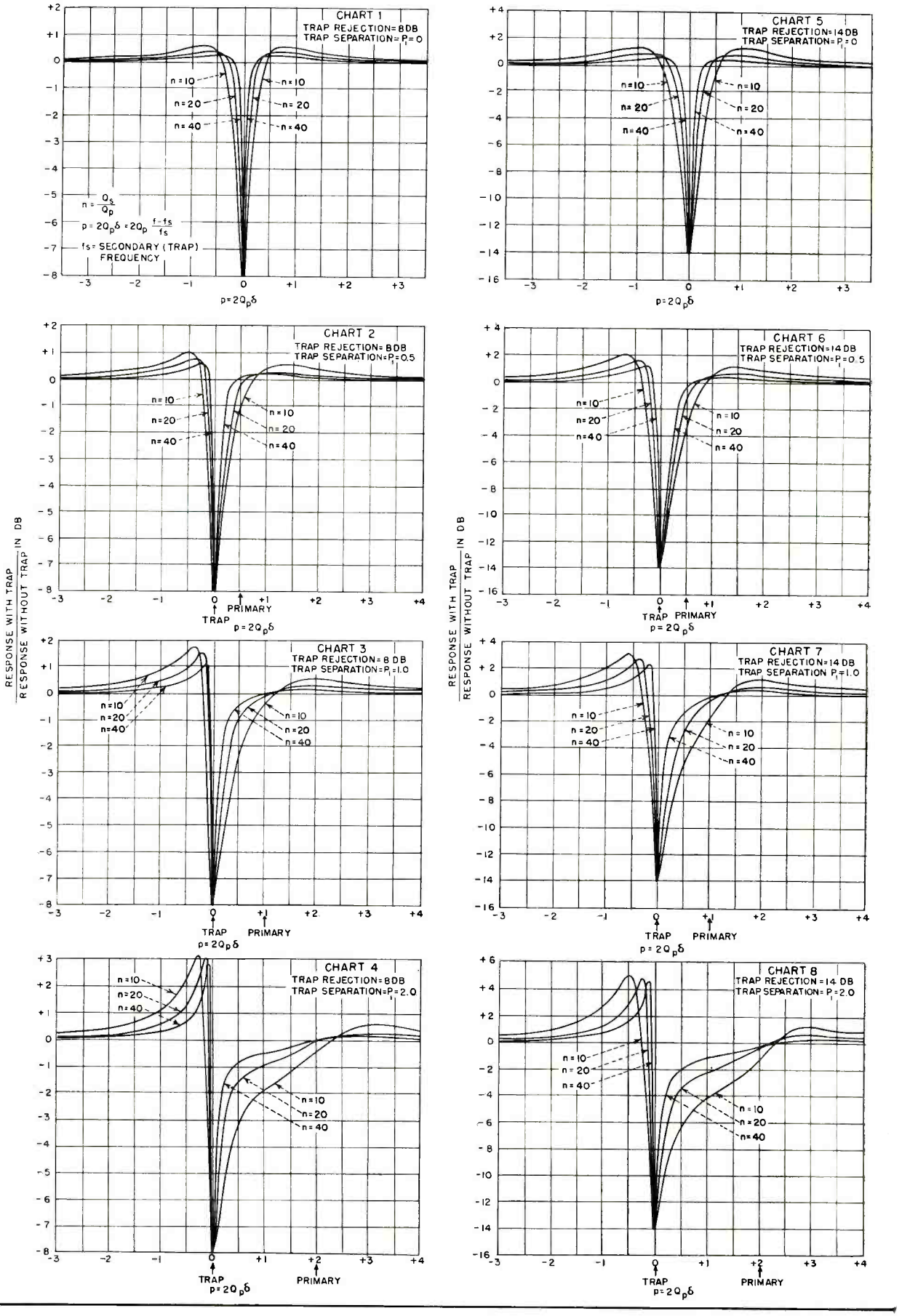
It is of interest that the universal response curves indicate that optimum performance is obtained when an absorption trap is coupled to a circuit which is relatively close in frequency. A misconception that the circuits should be widely separated has led to the design of some amplifiers having relatively high distortion of the pass band and high after responses for a given rejection.

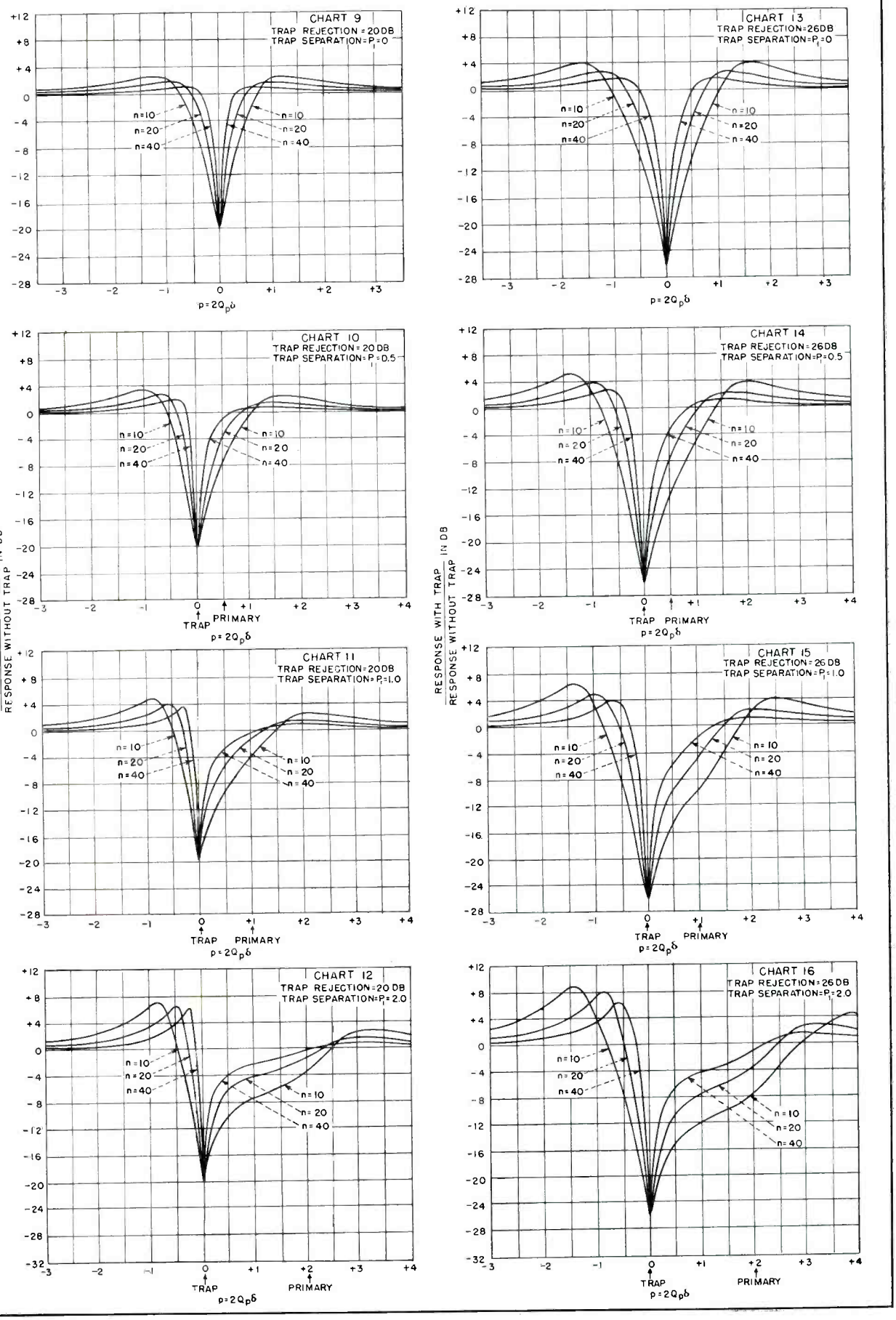
Determination of Response Ratio

A typical circuit employing an absorption trap is shown in Fig. 1. The amplifier plate load consists of the tuned circuit L_pC_p which is inductively coupled to the trap circuit L_sC_s. In addition to the simple inductive coupling shown in Fig. 1, it is possible to use other forms of coupling such as high-side capacitive coupling. As with synchronous double-tuned circuits, results are equivalent in the narrow-band case.

The effect of the trap on the overall response is conveniently expressed by determining the ratio of the response with the trap to the response without the trap. This ratio is particularly convenient in applying the results to the design of stagger-tuned amplifiers. It permits the conventional procedure to be followed in the design of the staggered circuits and the effect of the traps can then be added to de-

DESIGN OF ABSORPTION TRAPS (continued)





termine the overall response.

Definition of Terms

The following terms are defined:

f_p = resonant frequency of the primary

f_s = resonant frequency of the trap

$\delta = (f - f_s)/f_s$ = fractional detuning with respect to trap

$\delta_1 = (f_p - f_s)/f_s$ = fractional detuning of primary with respect to the trap

$p = 2Q_p\delta$ = generalized fractional detuning

$p_1 = 2Q_p\delta_1$ = generalized fractional detuning of primary with respect to trap

$\alpha = 4\pi^2 f_s^2 M^2/R_p R_s$ = (coupling/critical coupling)^2

$n = Q_s/Q_p$ = trap Q/primary Q

R = desired attenuation at the trap frequency

If $2\delta \ll 1$, it can be shown that the impedance reflected by the trap is $\alpha/(1 + n^2p^2) - j\,\alpha\, np/(1 + n^2p^2)$

It can further be shown that the effect of the trap can be represented as a function of three parameters by the following expression:

$$\frac{\text{Response with trap}}{\text{Response without trap}} = \left[\frac{1 + (p - p_1)^2}{\{1 + \alpha/(1 + n^2p^2)\}^2 + \{p - p_1 - \dfrac{\alpha\, np}{(1 + n^2p^2)}\}^2}\right]^{\frac{1}{2}} \qquad (1)$$

The three parameters are p_1, n, and R as previously defined.

The coupling factor α is related to the attenuation introduced by the trap at its resonant frequency by the equation $(1 + \alpha)^2 = R^2(1 + p_1^2) - p_1^2$. As is to be expected the value of the coupling factor depends not only on the desired attenuation but on the generalized tuning separation p_1.

The analytical solution (Eq. 1) may be expressed in a more useful form by plotting the response ratio for suitable values of the three parameters.

Representative Charts

The families of curves shown in Charts 1 to 16 are the result of plotting Eq. 1 as a function of p for representative values of the parameters: frequency separation p_1, attenuation at the trap frequency R, and Q ratio n.

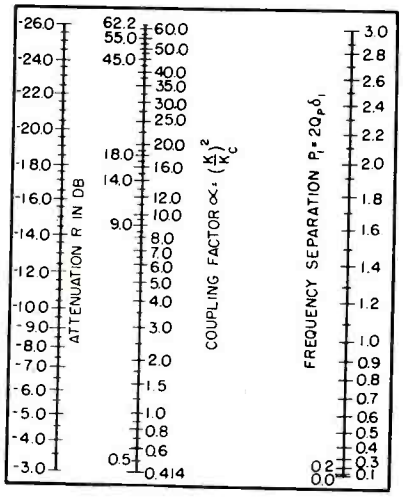


FIG. 2—Nomograph for determination of coupling factor between absorption trap and tuned circuit

Four values of p_1 are chosen; these are 0, 0.5, 1.0, and 2.0. The curves for $p_1 = 0$ show the response for the limiting case as the frequency separation approaches zero. The curves for $p_1 = 0.5$ correspond to the trap being tuned to the frequency at which the response of the primary by itself is 90 percent of its maximum response. Similarly, $p_1 = 1.0$ corresponds to the 70.7 — percent point and $p_1 = 2.0$ corresponds to the 44.7 — percent point. These values cover the range normally encountered in the application of absorption traps.

Curves are drawn for four values of the attenuation R. These are $R = 8$, 14, 20, and 26 db, corresponding to an attenuation of from 2.5 to 20 times in voltage ratio.

For each value of p_1 and R, curves are drawn for three values of n: $n = 10$; $n = 20$; and $n = 40$. These values of the ratio between the secondary and primary Q correspond to the values encountered in the design of stagger-tuned amplifiers at television intermediate frequencies.

A decibel scale is used in plotting the response ratio to permit the effect of several traps to be determined by addition of the individual response ratios. The overall response is then determined by the addition of the total response ratio curve to the response obtained in the absence of the absorption traps. Care must be taken to combine the curves with respect to an absolute frequency scale.

The response curves are all plotted on the basis that the trap or secondary frequency is lower than the frequency of the circuit to which it is coupled. If the opposite is true, the curves still apply provided the positive direction of the p frequency scale is reversed. The desired response is then the mirror image of the response shown in the charts.

Nomograph for Coupling Determination

The coupling factor

$$\alpha = \frac{\omega_s^2 M^2}{R_p R_s}$$

is related to the attenuation introduced by the trap at its resonant frequency by the equation

$$(1 + \alpha)^2 = R^2(1 + p_1^2) - p_1^2 \qquad (2)$$

As is to be expected, the value of the coupling factor depends not only on the desired attenuation but also on the generalized tuning separation p_1.

A nomograph constructed from this equation to enable the rapid determination of α, when p_1 and R are known, is shown in Fig. 2.

To determine experimentally the coupling corresponding to a given value of α, the trap is initially tuned to the same frequency as the primary. The coupling is then adjusted until the response R' drops to $1/(1 + \alpha)$ of the original response.

Conclusions

The universal response curves presented in Charts 1 to 16 significantly reduce the labor required to solve problems involving absorption traps. An examination of these curves reveals that so far as the circuit design permits, it is desirable to have the frequency separation as small as possible; and a high trap Q is desirable.

It is clear that neither the L/C ratio of the primary nor the L/C ratio of the trap have any effect on the response of the circuit, provided the proper coupling is used. In general the value of trap inductance is determined so as to obtain the maximum Q consistent with a convenient physical coil size.

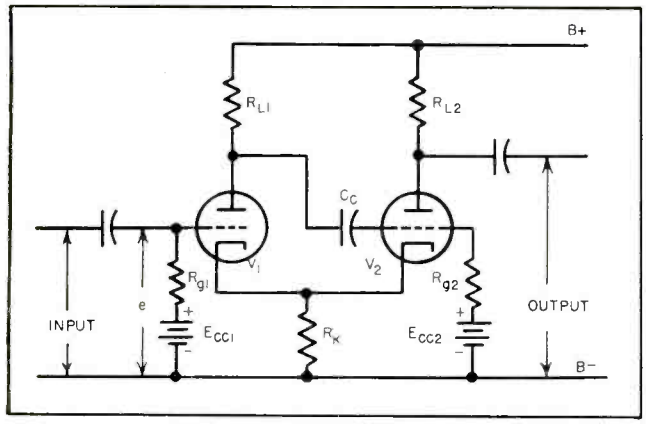


FIG. 1—Basic cathode-coupled clipper circuit with regeneration provided by C_c and R_{L1}

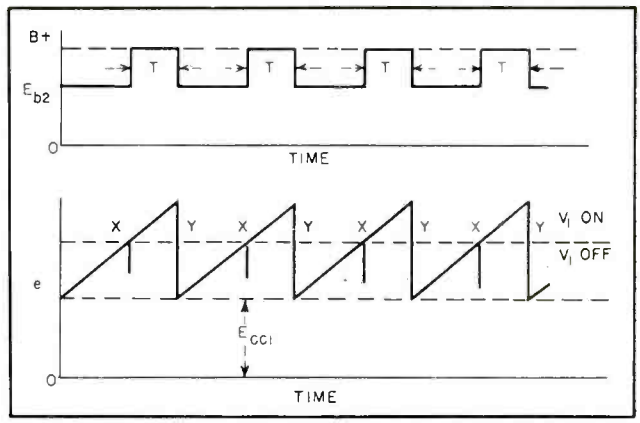


FIG. 2—Applied-voltage wave showing mechanism of pulse generation

Variable Pulse-Length Generator

Regeneration added to a cathode-coupled clipper provides linearly variable pulses ranging from 0.5 to 24 microseconds in width and peak-to-peak voltage values between 4.5 and 6.5 volts

By J. C. MAY

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THE SEVERAL AVAILABLE TYPES of variable-pulse-length generators use two basic circuits for obtaining a variable output. The first differentiates a square wave and clips the resulting pulse. By varying the time constant of the differentiating circuit, the length of the clipped pulse is controlled. The other circuit is a one-shot multivibrator in one of its forms. Here the time required for the circuit to return to equilibrium, after receiving an input pulse, determines the pulse length.

In some applications, such as pulse-width modulation, it would be convenient to vary the pulse width linearly over a wide range as a function of some voltage or current. The phantastron[1] gives a linear variation controllable by a voltage but provides an extremely limited width variation. The cathode-coupled multivibrator[2] can be designed to give large variations in pulse width. But it is difficult to make this variation linearly proportional to the control voltage, especially as the frequency of operation is increased. The generator circuit to be presented here was developed to improve the linearity between pulse width and control voltage while permitting the widths to be continuously varied throughout the repetition period. The circuit operates by adjusting the level at which a sawtooth voltage is clipped.

Basic Circuit

The basic circuit of the generator, shown in Fig. 1, is the cathode-coupled clipper developed by Goldmuntz and Krauss[3] with regeneration provided by C_c and R_{L1} to improve the rise time of the output pulse. Regeneration also decreases the required input level necessary for satisfactory clipping.

With the input voltage at zero, and a low value of bias, E_{cc1}, on the grid of V_1, V_2 conducts and V_1 is cut off. As the bias is made less negative V_1 starts to conduct. Its current causes a rise of cathode potential, which subsequently causes V_2 to be cut off. Regeneration aids this switching process. Tube V_2 will remain cut off until the grid bias on V_1 is decreased to a point below cut-off. While it is not physically possible to provide sufficient regeneration to cause V_2 to cut off exactly as V_1 starts to conduct, the change required in grid 1-to-ground voltage, e, necessary to change V_2 from "on" to "off" can be made in the order of a volt. For this reason, the switching level is indicated as a single line in Fig. 2.

Now suppose that the applied voltage, e, is a sawtooth voltage

plus the d-c bias E_{cc1}. If the peak value of e is never sufficient to cause V_1 to conduct, no change occurs in the plate circuit of V_2. In Fig. 2, e causes V_2 to start conducting at point x, to continue conducting for a time, T, and then to cut off at point y. A positive pulse of duration T will appear at the plate of V_2. By further increasing e, T can be made to increase linearly with E_{cc1} if the sawtooth voltage is linear. When the time, T, is equal to the period of the sawtooth, the output pulse will drop to zero because V_2 will be cut off for the full period.

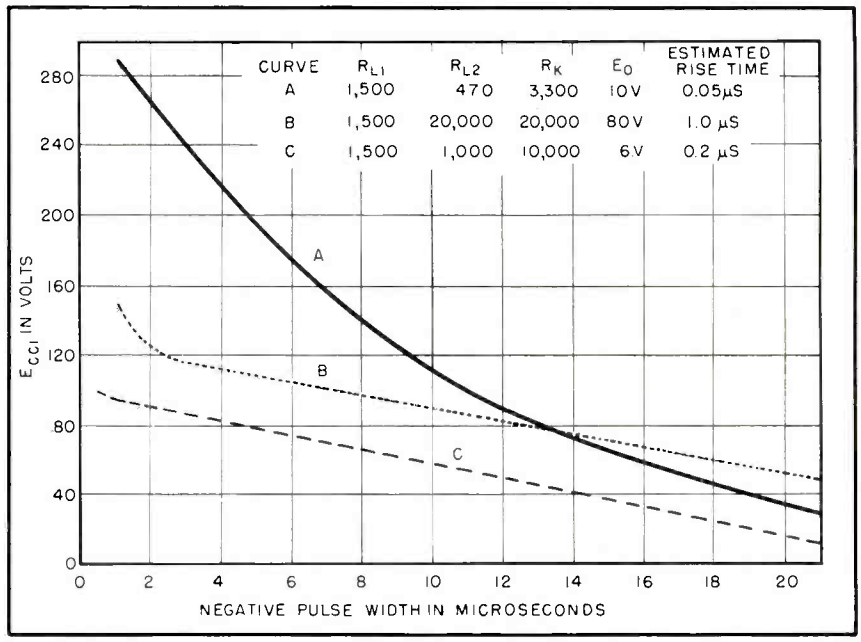

FIG. 4—Pulse width as a function of grid bias for various circuit constants

Applied Voltage Requirements

The minimum sawtooth voltage required is about 10 volts peak-to-peak and may be obtained from any convenient source such as the time-base voltage from an oscilloscope. However, for experimental purposes, a simple blocking-oscillator saw-tooth generator[4] was built and is shown, together with the variable-length pulse generator in Fig. 3. The waveform of the sawtooth generator, as taken from the display on a Tektronix Model 511 oscilloscope, is not ideal but its linearity is sufficient for its intended purpose. A triangular waveform would also be suitable but it is usually more difficult to obtain.

The minimum pulse width attainable with the circuit constants of Fig. 3 is 0.5 microsecond. This is limited primarily by the sharpness and jitter of the sawtooth voltage. The maximum pulse width with a 40-kilocycle repetition rate is 24 microseconds. Voltage E_{cc2} is initially adjusted to a value that will permit E_{cc1} to control the pulse over the full width range. The pulse height varies from 4.5 volts peak-to-peak at maximum pulse width to 6.5 volts at minimum pulse width. The variation in height could be further decreased by a decrease in regeneration at the expense of increased rise time of the output pulse.[3]

Pulse width as a function of E_{cc1} is shown in Fig. 4. Curve A rise time is good but the width varies in a nonlinear manner since grid current flows in V_1 for a portion of the cycle. To prevent grid current from flowing, a larger cathode resistor is used and, to offset the decrease in output, a larger load resistor is used in the plate circuit of V_2. Linear output of large amplitude and poor rise time of curve B is thus achieved. The compromise solution gives the results of curve C which has sufficiently good linearity, reasonable output, and rise time satisfactory for most purposes. The sensitivity of the pulse generator (sensitivity being defined as the ratio of change in pulse width to the change in control voltage E_{cc1}) will vary inversely with the magnitude of the sawtooth voltage. By reference to Fig. 2 it will be seen that E_{cc1} has to change by a small amount, roughly equal to the peak-to-peak value of the sawtooth voltage, to get 100-percent change in width when the amplitude of the sawtooth is small. As the sawtooth amplitude is increased the change in E_{cc1} must also be increased to provide 100-percent change in pulse width.

As shown in Fig. 2 the trailing edge of the pulse remains fixed and the leading edge is moved out as E_{cc1} increases in magnitude. If it should be desirable to reverse this operation the polarity of the sawtooth voltage should be reversed. The leading edge will then remain fixed and the trailing edge of the pulse will move.

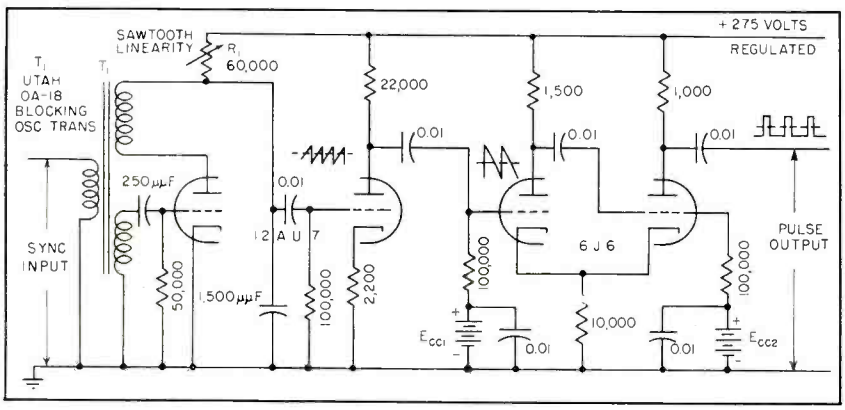

FIG. 3—Blocking-oscillator sawtooth generator feeding the variable-length pulse generator

Measurement of Pulse Width

The point-by-point accuracy of the pulse-width measurement is

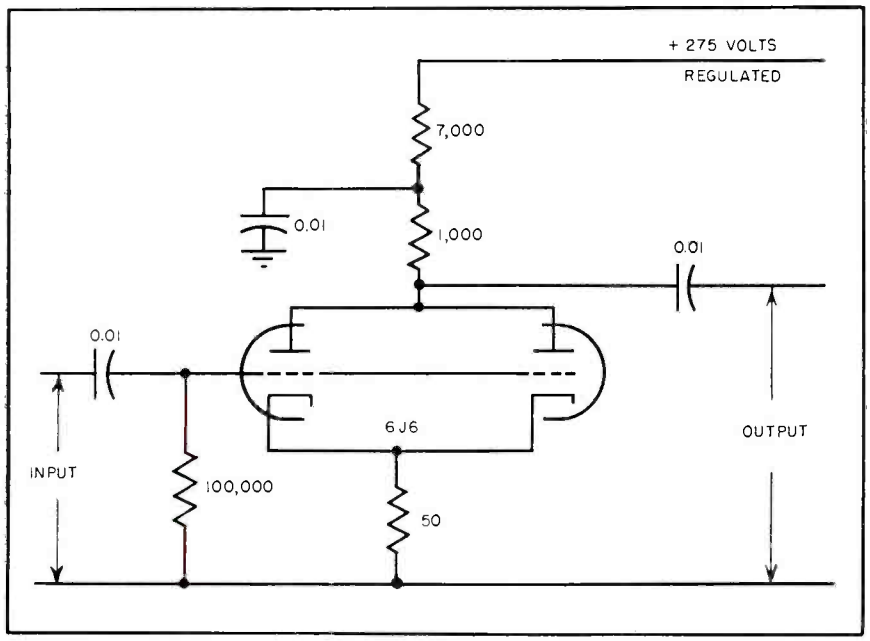

FIG. 5—Pulse amplifier with gain of 5, giving maximum output of 25 volts peak-to-peak

limited by the procedure used in this investigation. A Browning Sweep Calibrator Model GL-22 with 0.5-microsecond markers was used as the width indication. Markers of 0.1-microsecond width are available with this instrument but they had insufficient amplitude for this particular work. With reasonable care, the 0.5-microsecond markers give reliable, repeatable data.

A d-c amplifier may conveniently be provided to supply E_{cc1} so that a relatively small change in voltage is necessary to change the pulse width. Grid supply voltages E_{cc1} and E_{cc2} were supplied from suitably bypassed voltage dividers connected to the regulated plate supply in this experimental model.

The unit described here was designed to operate only in the vicinity of 40 kilocycles. Lower-frequency operation is easily achieved by merely decreasing the frequency of the sawtooth voltage and increasing the size of the coupling capacitors. Linearity could be further improved by giving the design of the sawtooth generator more attention. Conventional series and shunt peaking methods may be employed if improvement of the rise time or an increased repetition rate of the pulses is desirable. Without any changes the unit has been operated at 100 kilocycles.

A simple pulse amplifier is shown in Fig. 5. This has been used where larger pulse output has been desirable. It introduces no perceptible pulse distortion when the external shunt load capacitance is 20 micromicrofarads.

Synchronization of this pulse generator with some voltage is easily accomplished by synchronizing the sawtooth generator with the desired voltage. In this particular unit a three-winding blocking-oscillator transformer was used, the third winding being used for the insertion of the synchronizing voltage.[5] The input impedance is fairly high but it will be necessary to use an isolating amplifier if it is desirable to prevent the blocking-oscillator firing pulse from being superimposed on the synchronizing voltage.

Applications

The variable-pulse-length generator shown here was developed primarily for use in a multiplier circuit which will produce an output voltage whose instantaneous amplitude is a product of two instantaneous input voltages. The circuit may be used for pulse-width modulation where the modulating voltage is superimposed on E_{cc1};[6] it also can produce variable pulse delay where the pulse to be delayed is used to synchronize the pulse generator and the delayed output pulse is obtained from the differentiated generator output. This operation is analogous to conventional flip-flop delay multivibrator action but has wider, more linear control of the delay time. Variable pulse delay can be used as a basis for modulation (pulse-position modulation).[6] Two of these pulse generators could be connected in cascade to provide an extremely flexible variable-delay, variable-width gating circuit. The first unit would supply variable delay, the second variable gate width. The movable edge of the variable-width pulse may be differentiated to provide a pulse variable in time to be used to control the ignition time of a thyratron or ignitron circuit.[7] Control by a d-c voltage of the thyratron or ignitron current is readily assured over a full half-cycle of anode voltage.

In any of the above systems the pulse output can be made to be a triggered output. That is, if a sawtooth generator were employed that was not free-running but delivered a sawtooth only upon the reception of a synchronizing pulse, pulse output would depend directly on the repetition rate of the synchronizing voltage. This is not readily accomplished with the blocking-oscillator sawtooth generator shown here but several other forms are available.[8, 9]

The author wishes to thank H. L. Krauss of Yale University for suggesting this type of circuit and for his help and criticism during the investigation.

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(9) Radiation Laboratory Series, 21, "Electronic Instruments," Section 18-7, p 641, McGraw-Hill Book Co., New York, N. Y.

Q-Meter Impedance Charts

Three nomographs speed utilization of data obtained with standard Q meter when numerous measurements have to be made. Effective series R, effective parallel R and effective parallel and series reactances of an impedance are given directly

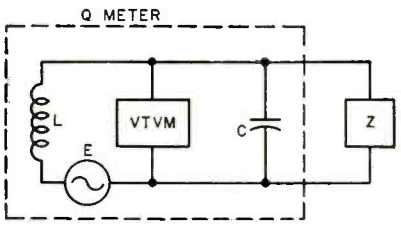

FIG. 1—To obtain required data, impedance being studied is connected in parallel with C of Q meter as shown

By ROBERT MIEDKE
Collins Radio Co.
Cedar Rapids, Iowa

THE accompanying nomographs are designed to give the effective parallel resistance R_p, the effective series resistance R_s and the effective parallel and series reactances X_p and X_s of an impedance Z when parallel connection to a standard Q meter is used, as shown in Fig. 1.

Limitations of the nomographs are the same as for standard Q-meter equations: R_p is accurate for any impedance; R_s is accurate for impedances with Q greater than 10; the difference between the effective series and parallel values of reactance may be neglected and the values obtained from Fig. 4 may be considered to be the effective reactance when the Q of the impedance being measured is greater than 10. For more accurate values of R_s the unknown impedance should be connected in series with the L of the Q meter.

Instructions for Use

To get R_s, use Fig. 2 after computing values of $Q_1 - Q_2$, Q_1Q_2 and $(C_2 - C_1)^2$. Join pairs of values as indicated by dashed lines *1* and *2* to get turning points on scales A and B, join these points as per dashed line *3* to get a turning point on scale C, then join the point on C with the value of f as per dashed line *4* to get R_s.

To get R_p, use Fig. 3 in essen-

(continued on page 114)

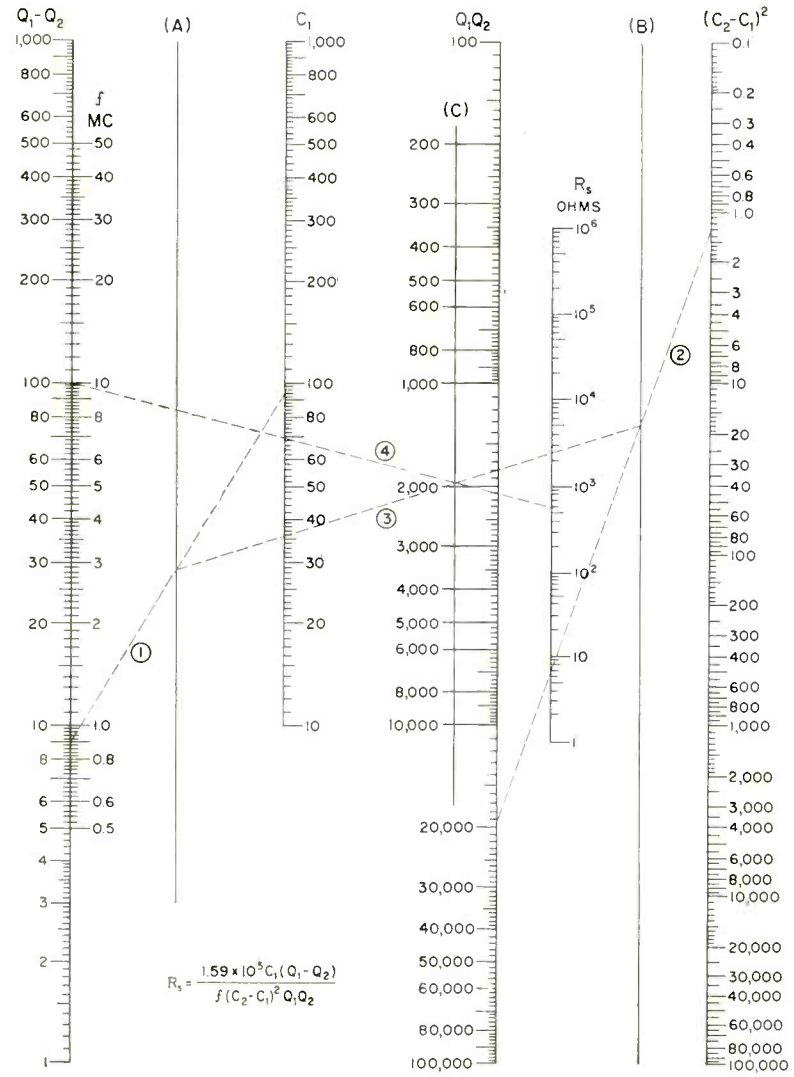

FIG. 2—Nomograph for determining effective series resistance R_s from measurements made with Q meter, using parallel connections

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Q-Meter Impedance Charts (Continued from page 112)

tially the same way, as indicated by the numbered dashed lines.

To get X_s or X_p, use Fig. 4 in the conventional manner.

Example of Use

Suppose an r-f choke is to be used in the shunt-fed plate circuit of a tube. It is desirable to know the effective parallel resistance R_p and reactance X_p that this choke will shunt across the plate circuit.

Set up the Q meter on the frequency at which measurements are to be made. Record the Q and capacitance as Q_1 and C_1 respectively. Connect the choke between the capacitor terminals on the Q meter, readjust C for resonance, and record Q_2 and C_2. Typical data obtained might be: $f = 10$ mc; $Q_1 = 145$; $C_1 = 92.6$ $\mu\mu$f; $Q_2 = 136$; $C_2 = 91.5$ $\mu\mu$f. Then $Q_1 - Q_2 = 9$, $Q_1Q_2 = 19{,}720$, $C_2 - C_1 = 1.1$ and $(C_2 - C_1)^2 = 1.21$.

To find the effective series resistance with Fig. 2, draw a line from 9 on the $Q_1 - Q_2$ scale to 92.6 on the C_1 scale. Mark the intersection of this line with line A. Draw a line from 19,720 on the Q_1Q_2 scale to 1.21 on the $(C_2 - C_1)^2$ scale. Mark the intersection of this line with line B. Connect the points marked on lines A and B and mark the intersection with line C. Connect the point on line C with 10 mc on the frequency scale and read R_s (560 ohms) at the intersection of this line and the R_s scale.

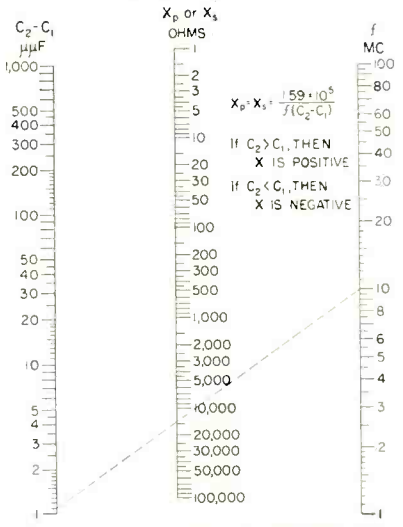


FIG. 4—Determination of effective parallel or series reactance

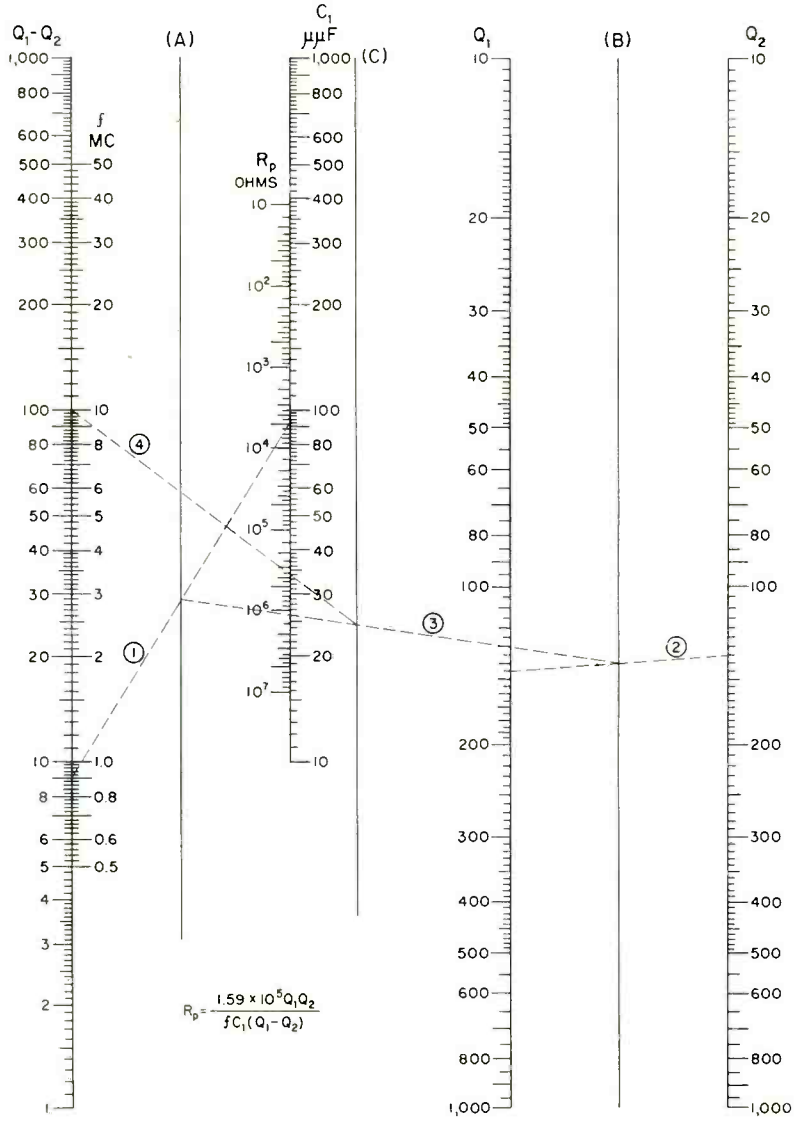
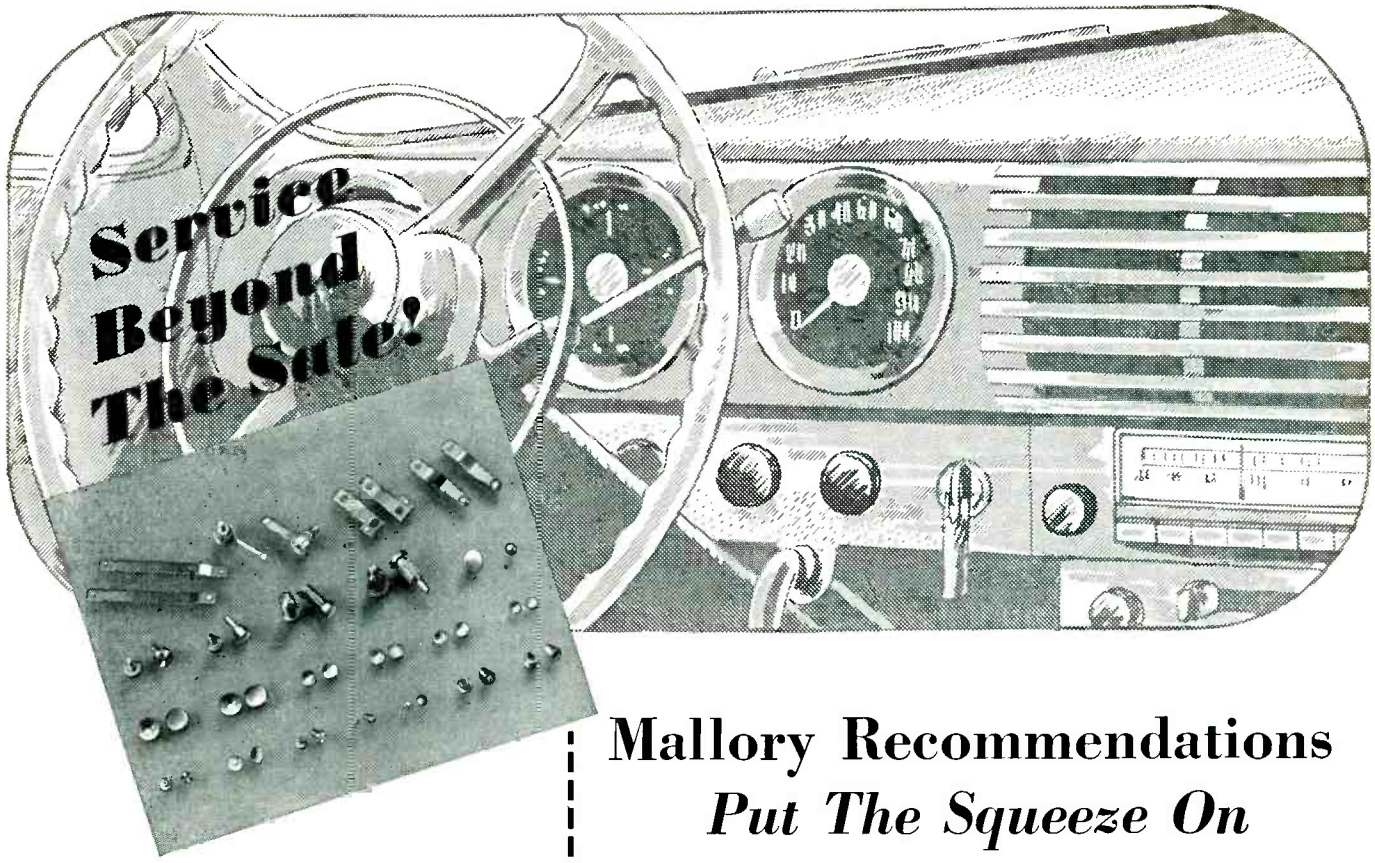


FIG. 3—Determination of effective parallel resistance R_p

Using the above data and Fig. 3, draw a line from 9 on the $Q_1 - Q_2$ scale to 92.6 on the C_1 scale. Mark where this line crosses vertical line A. Next, draw a line from 145 on the Q_1 scale to 136 on the Q_2 scale. Mark the intersection of this line with vertical line B. Connect the points marked on lines A and B and mark the intersection of this line with vertical line C. Draw a line from the point marked on C to 10 mc on the frequency scale and read the effective parallel resistance (370,000 ohms) where this line intersects the R_p scale. Since this value is much larger than the average tank circuit impedance, it will have little effect.

To find X_s on Fig. 4, connect 1.1 on the $C_2 - C_1$ scale with 10 mc on the frequency scale and read the effective parallel reactance (14,200 ohms) on the X_s scale. Since C_1 is greater than C_2 the reactance is capacitive. This then represents a capacitance of approximately 1 $\mu\mu$f at 10 mc, which will detune the circuit very little.



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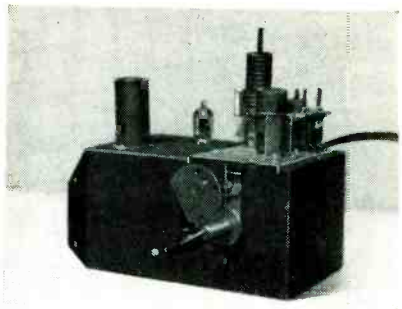

A deep chassis is required to house the front end

Television Remote Tuner

A CONSIDERABLE PORTION of the author's spare time has been spent in experimental work on television receiver circuits. Several times a need has arisen for a quick comparison-check of the on-the-air performance of a newly built front end. Removal of one front end and temporary wiring and mechanical mounting of a second unit whose performance is known has consumed valuable time.

A front end that can be quickly connected or coupled to the i-f stages of a receiver under test obviates this difficulty. A unit constructed for the purpose contains its own power supply for heater and plate voltage and provides output at the picture signal i-f frequency. This self-powered front end serves equally well as a signal source for testing experimental i-f strips.

Other Use

Use of large-screen picture tubes in home television receivers imposes difficulty in critical tuning of the receiver while standing at the tube screen. Because of the large picture near to the eye, adjustments made at the set often result in dissatisfaction when the owner goes to his seat at the proper viewing distance. He must then return to the set location to readjust or change the station.

A more convenient arrangement results if a remote tuning unit is installed at the viewing position. Selection of station and fine tuning can then be done while comfortably seated at this location.

Ideally, such a tuner would require a minimum of connections to the receiver and would be removable to allow the receiver to operate normally with its own front end when desired.

Because this is also required of the comparison front end contemplated, it was decided to construct a tuner that would serve both purposes. As representative of the most popular design, the receiver selected to be controlled was an RCA 630 type.

A 630 front end was fitted into a small aluminum box and a selenium-rectifier power supply added.

Coupling Problem

The major barrier to operation of a separate self-powered tuner is the difficulty of coupling the high-impedance plate circuit of the converter stage to the grid circuit of the first i-f stage with leads of possibly several feet in length. Link coupling from the remote converter tube to the first i-f stage appeared most convenient because it required no direct connection to the receiver except for a possible common ground lead.

The bar to link coupling is the mechanical arrangement of the plate coil in the coupling system between the converter plate circuit and the grid circuit of the first i-f stage. This coil is mounted inside of a large diameter form on which the sound trap and sound i-f take-off coil is mounted. Any link coil would need to be wound on this outer form, at a considerable distance from the inside coil. In addition, it would need to be fixed

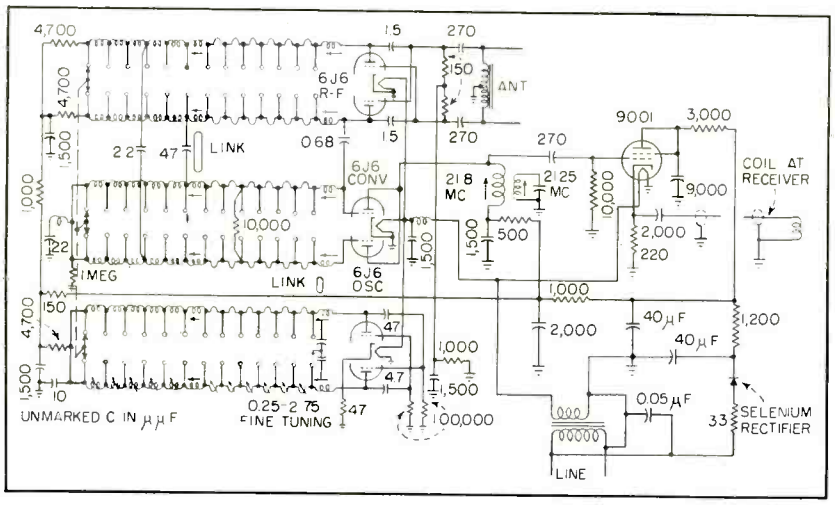

FIG. 1—Circuit of self-powered tuner. If used with transformerless receivers an isolation transformer is needed

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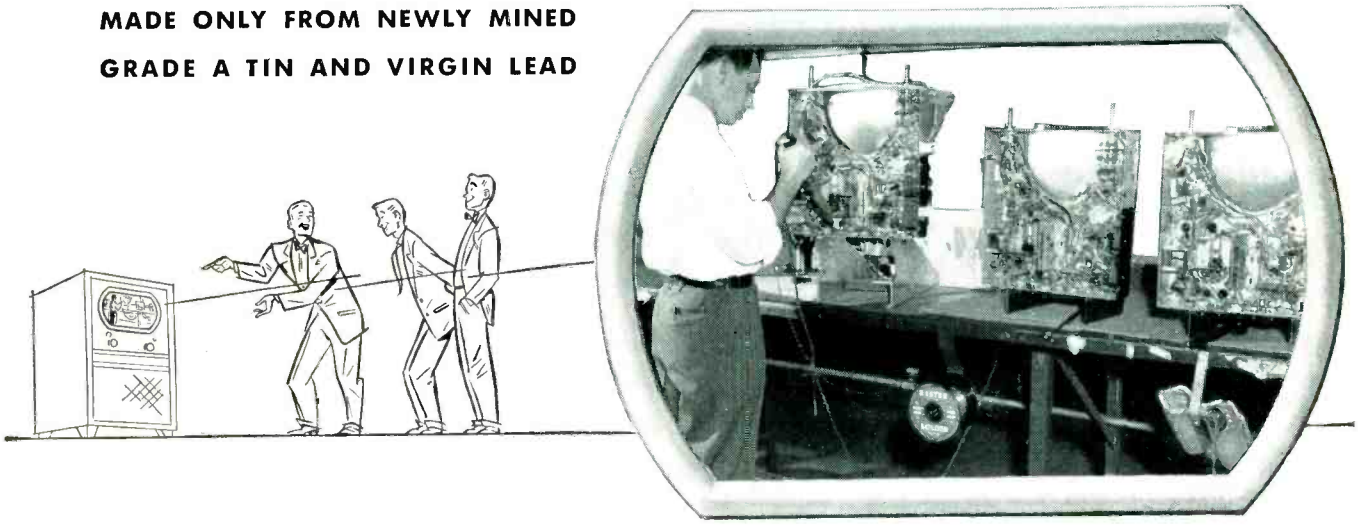

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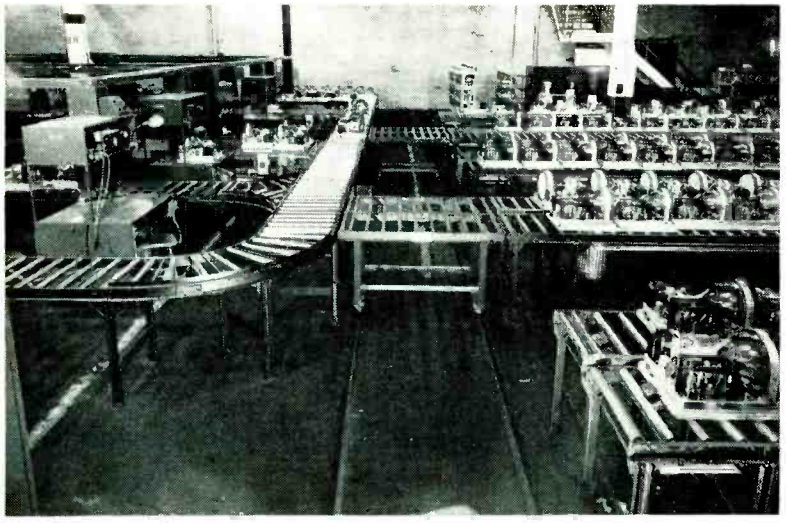

FROM alignment and test booths on conveyor lines at the left, completed television receivers roll onto the cross-conveyor and thence are pushed onto the rail car (center) two at a time for shifting to the head of the desired aging line at the right. Here each set is plugged into a power outlet and operated for a minimum of two hours with normal unsynchronized raster on its screen. Experience has shown that this aging period eliminates one service call during the guarantee period. Commonest troubles encountered are due to defective tubes and components.

After aging, each chassis goes to a phasing position. Here it is checked for tuning dial calibration, correct positioning of all controls and adequate ranges of all sync circuit controls. Using an Indianhead test pattern, fed to all test positions from a central signal cage, the horizontal phasing controls are then set to get correct blanking on each side of the picture frame. If necessary, i-f transformer adjustments are also touched up to correct for overshoot.

Over 1¾ miles of moving and roller conveyor lines are used in this new Du Mont television assembly plant located in East Paterson, New Jersey. When all three of the 465-foot moving chassis assembly lines are running at full capacity the plant turns out a new television receiver every 22 seconds. These can be different models, though at the time of taking the above photo and the cover color shot all lines were turning out the 12½-inch picture-tube models shown.

in position and would not be readily removable if the remote tuner were to be operated on another receiver. Experimental link coils wound on both the converter plate coil of the tuner and the receiver proved that the degree of coupling was insufficient; not enough signal voltage was developed at the grid of the first i-f stage.

A simple method of obtaining low-impedance output and sufficient voltage from the remote unit is the addition of a cathode follower to its converter output. The circuit of the complete remote tuner unit is shown in Fig. 1. No components in the RCA front-end need to be changed; it is only necessary to complete the grid return of the r-f amplifier and supply operating potentials to the tubes. The normal capacitor coupling from the converter plate circuit feeds the grid of the cathode-follower stage. Although the latter presents lower capacitance than the grid of the usual i-f stage there was no noticeable effect on the tuning of the plate coil.

Link coupling is used at the receiver. The signal produced in the cathode follower output circuit is fed through 75-ohm RG-59/U coaxial cable to a four-turn coil wound on a fiber form. Its diameter is 1⅝ inch and length is 3 inches. This form fits readily over the large sound trap coil of the 630-type chassis.

The considerably greater field produced by the cathode driver stage provides signal voltage at the grid of the first i-f stage nearly equal to that of the directly connected front-end in the receiver. The selector switch of the latter is usually set to an unused high-band channel to prevent beat interference.

Cable length has been as great as forty feet when used for demonstration purposes. Open test leads up to five feet long have been used on a bench and fed between other chassis and equipment cabinets without affecting the picture received.

Smaller coupling coils have been used in feeding other types of i-f systems and occasionally the open coaxial lead has been connected to the grid of the first i-f stage when picture quality was not a factor but it was necessary to determine whether the i-f stages were operating. When used with a receiver having an intercarrier sound system, the 21.25-mc trap on the tuner coil can be open circuited. This may also be advisable with receivers having conventional sound i-f systems unless they are tuned to 21.6 or 21.8 mc.—V. Z.

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(continued on page 132)

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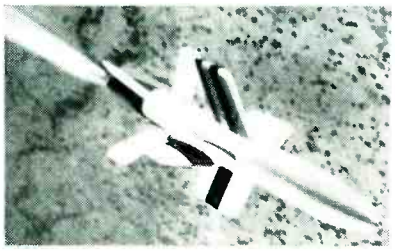
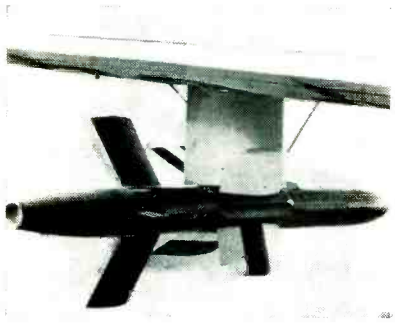
Edited by JOHN MARKUS

Radar-Homed Missile

THE ROCKET-PROPELLED Firebird guided missile developed by Ryan Aeronautical Company engineers for the Air Force carries a complete radar system for homing automatically on maneuvering targets and a fragmentation explosive charge large enough to insure destruction of the target. Designated the XAAM-A-I (experimental, air-to-air missile, Air Force, first model), the Ryan Firebird is capable of heading off and destroying its objective in a matter of seconds when launched from a jet fighter plane. It has all the speed first generated by the parent fighter, plus the added power of its own booster rocket and finally its flight rockets. Little more than half a foot in diameter, it is about 10 feet in length and 7½ feet long after dropping its booster rocket. With its high speed and small size, the pilotless missile is extremely effective against piloted aircraft and is difficult to track even on radar scopes. Development cost to date was approximately $2,000,000.



Model of Firebird in flight, being propelled by booster section of rocket



Firebird air-to-air guided missile in bomb rack on wing of launch plane. Radar homing equipment was left out during flight tests in interests of economy

The missile's mother plane is the first to detect the target, and directs the launching of the missile. Thereafter, the Firebird is designed to home on the enemy target. At night or in inclement weather the launch plane must have a search/tracking radar capable of spotting the enemy aircraft. The host fighter plane can carry one or more missiles on external launching racks which fit standard bomb installations.

Except for the plastic radome and wings of about 3-foot span, the basic missile structure is conventional aluminum-alloy sheet. Both wings and tail surfaces serve to control the flight of the missile.

After the missile is launched from the parent plane, a booster rocket takes over. When maximum speed is reached, the spent booster is jettisoned by an explosive charge. Thereafter, during the latter phase of interception, power is supplied by flight rockets. The warhead is designed to explode when it is close enough to an enemy aircraft to insure destruction. Should the missile miss its target, the warhead is automatically detonated in the air.

Lemon Breath Analyzer

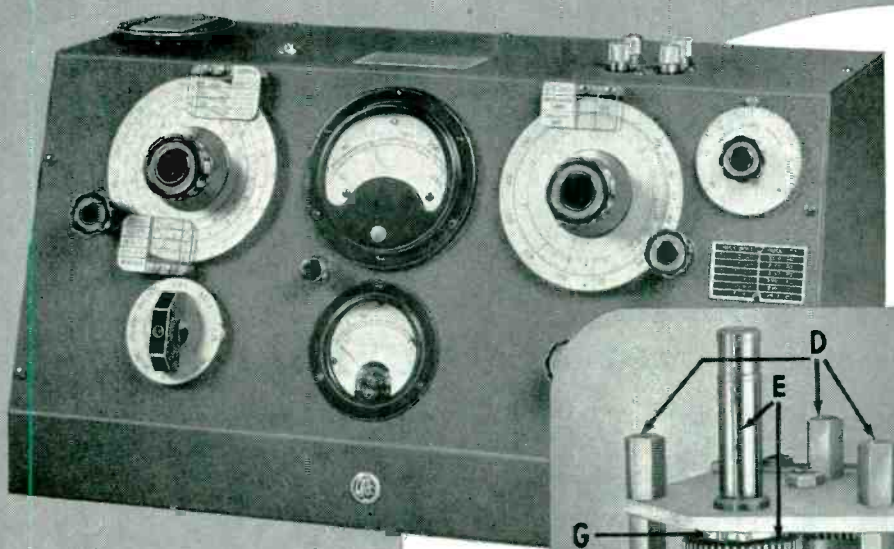
THE AMOUNT of oxygen taken in by lemons during storage is automatically recorded with an accuracy within 0.01 percent by a special oxygen analyzer developed at the University of California in Los Angeles. Fruits breathe like humans, inhaling oxygen and exhaling carbon dioxide, and the rate of breathing is related to the length of time the fruit can safely be stored. The ideal breathing rate appears to be maintained at temperatures around 55 F. Flow meters are attached to jars each containing 50 lemons, for measuring the gas flow.

Lemon life in storage can be prolonged by checking fruit regularly with this special oxygen analyzer and recorder, which determines whether breathing is at a healthy rate

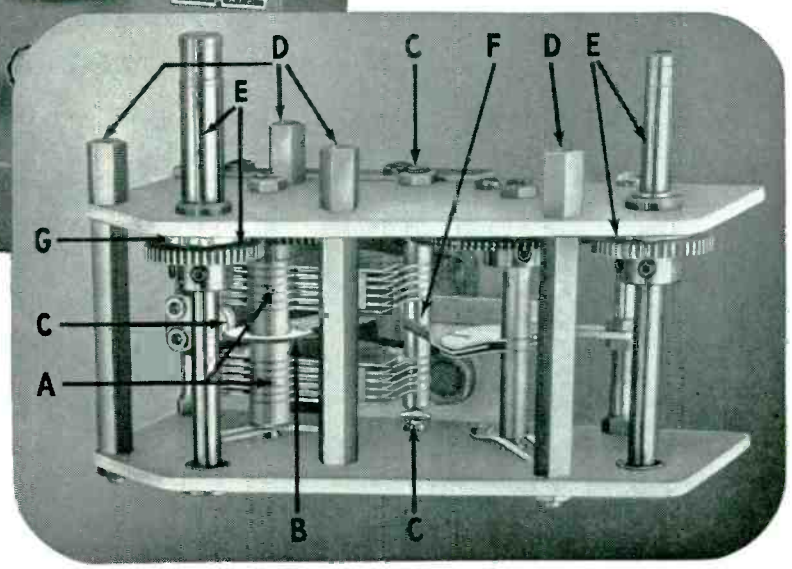
Mystery Whirlpool Exhibit

AN ATTENTION-GETTING exhibit of blue solution rotating several revolutions per minute in a glass container without a mechanical propellor can be set up with a surplus magnetron magnet and a few simple parts arranged as shown. A d-c voltage of 10 volts or thereabouts produces current flow radially outward through the copper sulfate

For the MEASUREMENT of
Q, INDUCTANCE and CAPACITANCE



The 160-A Q-METER
50 KC. to 75 MC.



Radio frequency circuit design often requires the accurate measurement of Q, inductance, and capacitance values. For this application, the 160-A Q-Meter has become the universal choice of radio and electronic engineers throughout the country.

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.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached only after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

This is but one of the many desirable features of the 160-A Q-Meter which contribute to its outstanding accuracy and dependability.

Be sure to include the 160-A Q-Meter in your new equipment plans.

A number of these instruments available for immediate delivery.

Shown above is the Q tuning capacitator assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Parallel connection of dual rotor and stator assemblies minimizes internal inductance and resistance.
B. Spring silver fingers contact both sides of silver disc to provide low series resistance.
C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.
D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.
E. Precision-cut brass spur gears and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.
F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.
G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

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.

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

85° BELOW ZERO

would freeze an eskimo

. . . WON'T FREEZE

VARGLAS SILICONE

500° ABOVE

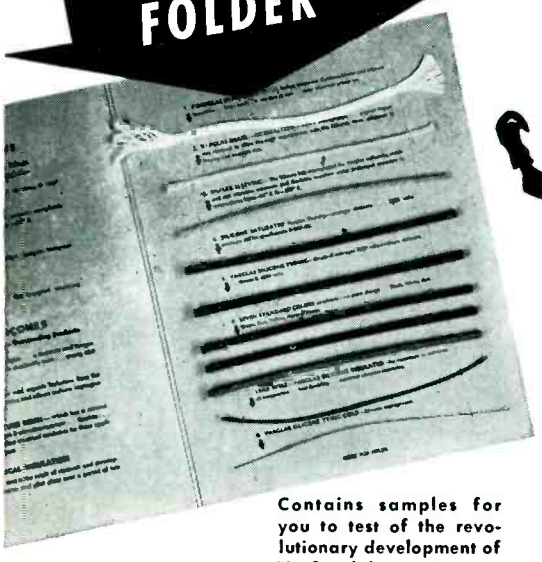
would roast the devil

. . . WON'T ROAST

VARGLAS SILICONE

Electrical Insulating Tubing and Sleeving lead wire and tying cord

SEND FOR THIS FREE SAMPLE FOLDER



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

Efficient at 500° F. or more in some applications—yet completely flexible at —85° F. Resistant to moisture and lubricating oil—flame resistant and self-extinguishing—this pioneer silicone tubing and sleeving developed by Varflex is the *strongest of all accepted insulating materials.*

Varglas Silicone is a combination of *Varglas*—continuous filament Fiberglas; moisture and fungus proof; will not burn; strong and flexible at high and low temperatures; chemically inert . . . and *Silicone High Temperature Resin*—which has a natural affinity for Fiberglas; renders it abrasion-resistant, flexible and non-fraying. Normalizing process removes binder and organic inclusions from the Fiberglas; improves electrical qualities and allows uniform impregnation—YET COSTS NO MORE THAN COTTON.

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Investigate the NEW, low cost VARFLO Sleeving and Tubing if you do not have to allow for an unusually high operating temperature. Samples and prices on request. It's flexible. It takes rough handling without loss of dielectric. It won't fray out. Made with a Fiberglas braid, it won't support combustion.

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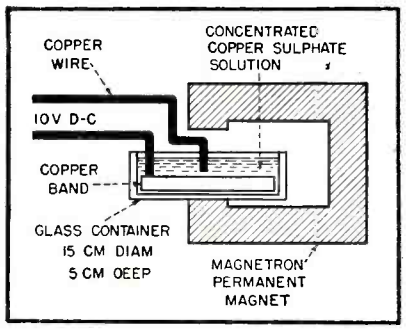
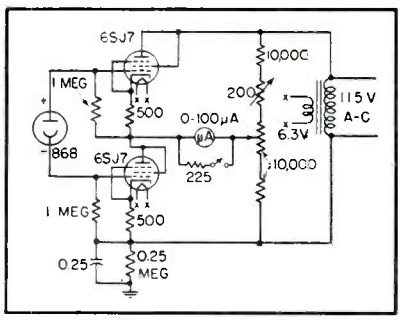


Solution rotates without moving parts

solution from the wire in the center to the copper band around the inner periphery of the container. The fluid is propelled by the action of the vertical magnetic field on the moving ions. Reversing the battery polarity from time to time reverses the direction of rotation of the fluid, adding further to the mystifying effect. The exhibit was produced by J. L. Ryerson of Evansville College for a campus open-house day.

Exposure Meter for Photomicrography

THE ACCOMPANYING balanced bridge phototube circuit was developed by V. T. Clemens and S. S. Brar of Argonne National Laboratory for measuring the intensity of illumination at the eyepiece of a microscope to determine the correct exposure for photomicrography.



Exposure meter circuit operating from a-c line without rectifier

When there is no illumination on the phototube, plate currents of the two tubes are equal but opposite through the microammeter. Illumination unbalances the bridge circuit, giving a meter deflection proportional to light intensity. Coarse and fine potentiometers facilitate the initial zero adjustment, and a range switch shunts a resistor across the meter to increase its range by 5.

The phototube is mounted in a cylindrical holder that fits over the barrel of a microscope. A type 1P42 phototube may be used instead if space conservation is of importance. A twin-triode 6SN7 can be used in place of the two pentodes if desired. Phototube leads to the separate amplifier unit should be twisted and as short as possible. Circuit parts associated with the phototube should be adequately insulated and phototube surfaces should be kept clean to minimize leakage.

Graph for Smith Chart

BY R. L. LINTON JR.
Antenna Laboratory, Division of Electrical Engineering
University of California, Berkeley, California

WORKERS concerned with r-f impedance measurements have need for frequent conversion of standing-wave ratio into reflection coefficient and vice versa. Generally, information finds its way onto a Smith chart[1], which may be considered a polar plot of reflection coefficient k_r in magnitude and phase. Although standing wave ratio r_v can be estimated from the normalized resistance circles on the chart, a more accurate determination may be desired. Particularly at high reflection coefficients, estimates of standing-wave ratio are extremely difficult.

The graph in Fig. 1 provides a simple graphical means of obtaining standing-wave ratios up to 99 in terms of reflection coefficient, or vice versa. Of even greater convenience is the feature whereby the

(continued on page 158)

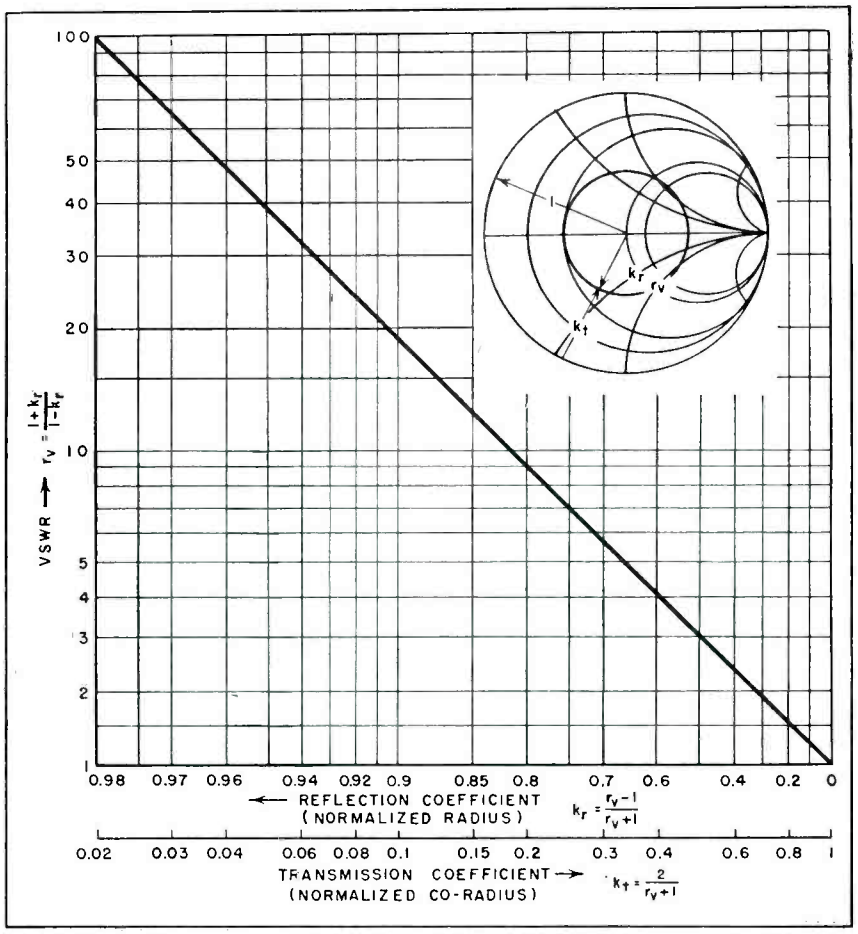


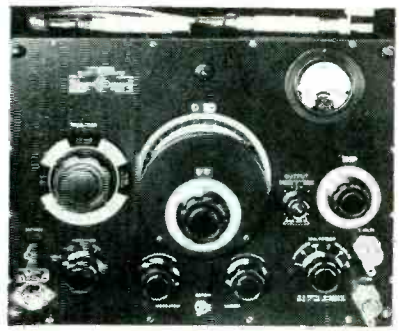
FIG. 1—Graph giving voltage standing-wave ratio vs reflection coefficient based on normalized radius on Smith chart. Graph also gives transmission coefficient based on normalized co-radius, often more useful

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

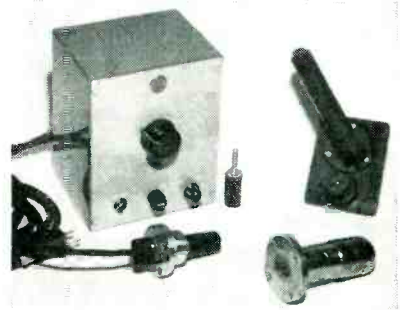
Recording Spectroradiometer

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The recording spectroradiometer is a new color-sensitive instrument for aid in the study of fluorescent materials, the search for new phosphors, and the design and manufacture of light sources. The device consists of a grating monochromator, photometer, recorder and power supply. Measuring 25 × 27 × 23 in. and weighing 150 lb, the equipment can scan the complete spectrum from 230 to 650 millimicrons at speeds varying from 1 to 10 minutes, depending on the nature of the spectrum. A curve is produced on a chart 9⅞ × 24 in. Phototube voltage from a d-c supply, regulated to better than 0.2 percent, can be varied between 200 and 1,000 volts. Power required is 100 watts, 115 volts (± 5 percent), 60 cycles.



Standard-Signal Generator

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Model 1001-A standard-signal generator is a general-purpose, amplitude-modulated instrument used for performing standard IRE and RMA tests on radio receivers. It also has many other laboratory and field uses. Frequency range is 5 kc to 50 mc; output voltage range is 0.1 microvolt to 200 millivolts at the panel. Incidental frequency modulation is below 38 parts per million at 30-percent modulation. Stray fields are less than one microvolt per meter at a distance of 2 feet from the signal generator.



Electron Microscope Accessories

RADIO CORP. OF AMERICA, Camden, N. J. Three attachments designed to improve performance of the electron microscope are the EMN-1 charge neutralizer for eliminating the effects of charges produced on diffraction specimens by the primary beam of the microscope; the EMX-1 focusing magnifier that provides for precision focusing and greater magnification; and the self-bias gun (lower right) that pro-

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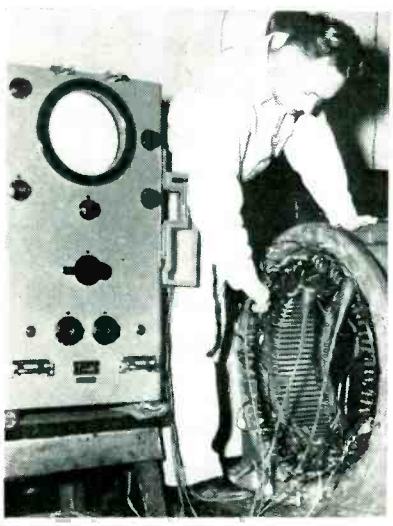


CUTTING COSTS through reduced testing time is made possible with this winding-insulation tester. Any defects in rewound or reconditioned motors are quickly brought to light with the cathode-ray oscilloscope. The equipment is available from *General Electric Co., Schenectady 5, N. Y.*

HAM OPERATORS who like to QSO on the road can use the all-band mobile antenna that comes tuned for 3,600 kc. Other plug-in coils make it possible to obtain good efficiency at 20 and 40. Shorting the coil puts the rig on 10 meters. Available from *Master Mobile Mounts, Inc., Los Angeles, Calif.*

TELEVISION RECEIVERS can be protected from lightning strokes and static discharges by this twin-lead lightning arrester. The leadin is quickly fastened in place, without cutting, by a pair of cap nuts. A product of *JFD Mfg. Co., Inc., 6101 Sixteenth Ave., Brooklyn 4, N. Y.*

WHEN IT'S GAS FILLED TUBES YOU WANT

Remember RAYTHEON HAS ALWAYS HEADED THE PROCESSION

Cold Cathode Rectifier Tubes

Ionically Heated Cathode Rectifier Tubes

Voltage Regulator and Reference Tubes

HERE ARE SOME OF THESE TUBES:

COLD CATHODE RECTIFIERS

Type	Construction	Max. Dimensions Height (inches)	Max. Dimensions Width (inches)	Absolute Maximum Ratings: AC Plate Voltage (rms)	Absolute Maximum Ratings: Inverse Peak Voltage	Absolute Maximum Ratings: DC Output Current (ma.)
0Z4	METAL	2.63	1.32	300	880	90
0Z4G	GLASS	2.63	1.07	300	880	90
0Z4A/1003	METAL	2.63	1.32	265	880	85
BH	GLASS	4.38	1.81	350	1000	125
CK1006	GLASS	4.69	1.81	570	1600	200
CK1007	METAL	2.63	1.32	350	980	110
CK1012	GLASS	4.69	1.81	425	1200	300
CK1024	METAL	2.63	1.32	350	1000	160*
CK5517/CK1013	MINIATURE	1.97	0.75	1200	2800	12

*Intermittent push-to-talk service in mobile equipment

Note: All of the above are full wave rectifiers except CK5517/CK1013 which is half wave.

— *Raytheon has supplied more of them than all other tube makers combined.* That statement holds true for each and every year over the past twenty-five years or more!

•

ASK US if you don't find the gas filled tube you need in the above charts. Raytheon engineers are prepared to develop whatever tube types fit your needs, if you have an application requiring several thousand tubes per year.

VOLTAGE REGULATOR AND REFERENCE TUBES

Type	Construction	Max. Dimensions Height (inches)	Max. Dimensions Diameter (inches)	Starting Voltage	Operating Voltage (approx.)	Operating Current (ma) Min.	Operating Current (ma) Max.	Max. Regulation Volts
1B46	Special metal	1.66	0.63	225	79-85	1.0	2.0	3
1B47	Special metal	1.66	0.63	225	75-90	1.0	2.0	3
CK1017	Miniature	2.69	0.75	800	700	0.005	0.055	20
CK1022	Miniature	2.69	0.75	1100	1000	0.005	0.055	20
CK5651†	Miniature	2.13	0.75	115	82-92	1.5	3.5	3
CK5783†	Subminiature	1.63	0.4	115	80-90	1.5	3.5	3
CK5787	Subminiature	2.06	0.4	135	100	5.0	25.0	3

†Voltage reference types

In addition to the gas filled tubes listed above Raytheon also manufactures several Radiation Counter (Geiger-Mueller) Types, Hot Cathode Rectifiers and Thyratron types.

RAYTHEON

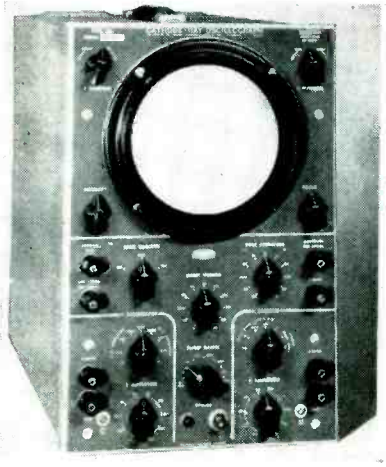
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

vides intense illumination with lower beam current.



C-R Oscillographs

ALLEN B. DU MONT LABORATORIES, INC., 1000 Main Ave., Clifton, N. J. has announced the types 304 and 304-H cathode-ray oscillographs as replacements for the type 208-B. Recurrent and driven sweeps are variable from 2 to 30,000 cps. Slow sweeps of 10 seconds or more are available by the connection of external capacitors between the X-input terminals on the front panel. Stabilized synchronization of the pattern is maintained by a sync-limiting circuit. Type 304 c-r tube operates at an overall accelerating potential of 1,780 volts; in type 304-H an additional intensifier power supply increases the potential to 3,000 volts.

Analog Computer

SPECIAL PRODUCTS DIVISION OF PHILLIPS PETROLEUM CO., Bartlesville, Oklahoma. An electronic analog computer for solving the flash vaporization equilibrium equation has been announced. It facilitates solution of such petroleum problems as analysis of optimum gas-liquid separator operating conditions, evaluation of gas-condensate reservoirs and gas saturated crude oil fields under conditions of pressure decline, analysis of many fractionation column operations, and estimations of K values. Overall vapor or liquid fraction calculations may be determined to a probable error of 0.002.

Ion Trap and Focus Unit

QUAM-NICHOLS CO., 1 North La Salle St., Chicago, Ill. Two new television components now in production are an ion trap and so-called focalizer. Both units employ a special mechanical arrangement of permanent magnets that supplant wire-wound current-carrying coils in order to adjust deflection of ions and focus respectively.

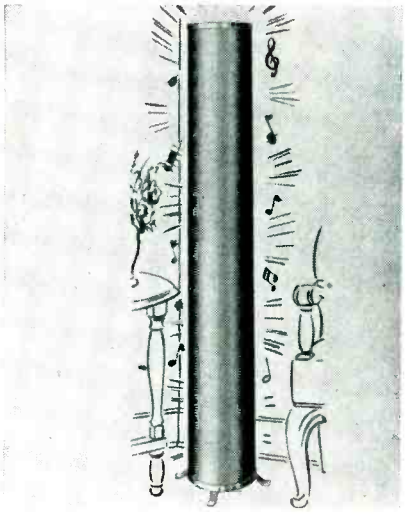
Ceramic Capacitors

SPRAGUE ELECTRIC CO., North Adams, Mass. The Bulplate wafer-thin ceramic capacitors are furnished with either multiple capacitor sections alone or in combination with printed wiring, shielding and other printed details. Typical Bulplates are 1⅛ in. long by ⅝ in. wide (exclusive of leads) and may combine five capacitors of 0.002, 0.0001, 0.00015 and two of 0.005 $\mu\mu$f, or other values as desired within the available limits. Bulletin 601A gives full details.

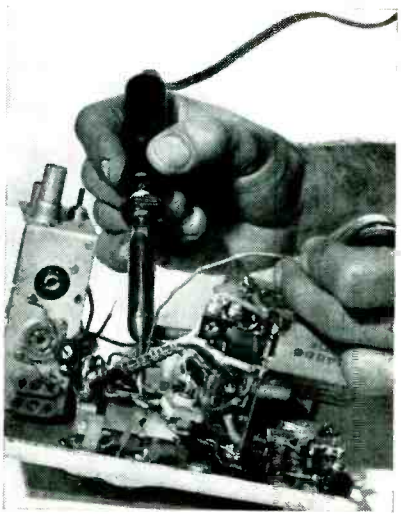
New Receiving Tubes

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York, N. Y. Three new receiving type tubes now available include type 12AY7 miniature audio amplifier duotriode particularly designed for first audio stages. An r-f amplifier, type 6BC5 is a miniature sharp-cutoff pentode with high mutual conductance designed for r-f and i-f applications in television receivers. The tube is roughly equivalent to a higher-gain type 6AG5. The horizontal deflection amplifier, type 6BQ6GT is de-

(continued on page 175)



HOMOGENIZED SOUND without beaming or dead spots is assured with this fountain speaker placed in the top of a five-foot plastic column. The sound radiating surface has been effectively increased to three times that of a conventional eight-inch speaker according to *Bell Sound Systems, Inc., 555 Marion Road, Columbus 7, Ohio.*



TINY SOLDERING IRON designed by the manufacturers of new air navigation equipment is now available for general purchase. Despite its heavy heat capacity for adequately soldering multiple connections it has a fin radiator that efficiently dissipates heat. *Vasco Manufacturing Div., Mitchell Industries, Inc., Mineral Wells, Texas.*

12 Reasons Why audiotape* can help you get the most out of your tape recorder!

1. AUDIOTAPE is wound on precision, *all-aluminum reels.*

2. AUDIOTAPE is cut by a *superior straight-line slitting process* which makes it track and wind absolutely flat.

3. AUDIOTAPE has *no curl* — lies flat on the magnetic head without increased tension, giving better frequency response and more uniform motion.

4. AUDIOTAPE has exceptionally *low surface friction*—reduces wear on heads.

5. AUDIOTAPE has definitely *superior dispersion* of oxide particles—no lumps, no bumps. This can be checked with any good microscope.

6. AUDIOTAPE is completely *free from any tendency to stick,* layer to layer.

7. AUDIOTAPE coating is specially formulated to give *strong adherence* of the oxide to the base.

8. AUDIOTAPE is designed to give *maximum signal to noise* ratio.

9. AUDIOTAPE has a *wider bias range* for optimum results — less sensitive to bias changes.

10. AUDIOTAPE has excellent *high frequency response.*

11. AUDIOTAPE has *low distortion.*

12. AUDIOTAPE has *unequalled uniformity* — within the reel, and from reel to reel. No magnetic weak spots that can cause fluctuations in output.

We *know* that every reel of AUDIOTAPE offers you all of these plus values — because all AUDIOTAPE is made in our own plant, under our own supervision and control, on machines designed by our own engineers. AUDIOTAPE is backed by over ten years of experience in producing professional quality recording discs. What's more, every foot of AUDIOTAPE is monitored for output, distortion and uniformity — your assurance of the same consistent, uniform quality that has characterized AUDIODISCS for the past decade.

But why not try out a reel and let AUDIOTAPE speak for itself? Your AUDIODISC and AUDIOTAPE distributor will be glad to fill your requirements. And you're sure to be pleased with the *professional discounts* available. Or — we will be pleased to send you a 200 ft. sample reel of plastic or paper base AUDIOTAPE.

*Reg. U.S. Pat. Off.

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NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Over 3,000 Register at First Audio Fair

FINAL registration figures for the Audio Fair and First Annual Convention of the Audio Engineering Society showed that a total of 3,022 persons signed up for admission badges to the exhibits at the Hotel New Yorker, New York City, Oct. 27-29. At the technical sessions each day, attendance ranged from 200 to 400. Total membership of the Society in the U. S. and elsewhere is approximately 700.

One highlight of the Fair was the demonstration of twelve different makes of loudspeakers one after another, using program material recorded on magnetic tape especially for the purpose, at the Thursday evening banquet. A performance score card on the back of the banquet menu enabled listeners to check their preferences for future personal guidance, no poll of results being taken.

As toastmaster at the banquet, Norman C. Pickering made the presentation of the Audio Engineering Society Annual Award to C. J. LeBel, retiring first president of the society. The John H. Potts Memorial Award was presented to Harry F. Olson of RCA Laboratories, and Honorary Memberships were presented to F. V. Hunt of Harvard, Harvey Fletcher of Bell Labs and V. O. Knudsen of U.C.L.A.

Election of new officers was announced, as follows: President—Theodore Lindenberg of Fairchild Recording Eqpt. Corp.; executive vice-president—J. D. Colvin of A.B.C.; western vice-president—John G. Frayne; secretary—Norman C. Pickering; treasurer—R. A. Schlegel. Newly-elected governors were C. A. Rackey, C. J. LeBel and Sumner Hall.

Exhibits were staged in individual hotel rooms, to permit demonstration of audio equipment at normal or full volume whenever so desired by visitors, without interference between exhibitors. All products exhibited were related in some way to the recording and reproduction of sound on magnetic tape, discs and film. The list of exhibitors follows, with representative examples of the equipment they showed.

Altec-Lansing Corp., Peerless Electrical Products Division, New York, N. Y.—iron-core transformers and chokes; demonstration of hi-fi musician's amplifier feeding Altec 800 theater speaker.

Audio & Video Products Corp., New York, N. Y.—Ampex tape recorders, Minnesota Mining & Mfg. Co. magnetic tape; Altec-Lansing equipment.

Ampex Electric Corp., San Carlos, Calif.—Ampex tape recorders.

Audak Co., Inc., New York, N. Y.—phono pickups, etc.

Audio Development Co., Minneapolis, Minn.—amplifiers; a-f and power transformers; jacks and plugs.

Audio Facilities Corp., New York, N. Y.—specialized audio apparatus; theater sound systems; artificial reverberation equipment.

Audio Instrument Co., New York, N. Y.—logarithmic amplifier; intermodulation analyzer; artificial ears; preamplifiers; disc-noise meters; custom-built audio test equipment.

Ballantine Laboratories, Inc., Boonton, N. J.—electronic voltmeters.

Burlingame Associates, Ltd., New York, N. Y.—manufacturers' representatives—Klipsch loudspeakers; Brush Soundmirror magnetic tape recorders; Prestoseal magnetic tape splicers.

Frank L. Capps & Co., Inc., New York, N. Y.—Recording and reproducing styli.

Cook Laboratories, Floral Park, N. Y.—Feedback recording heads; recording equipment; 20,000-cps frequency record.

The Daven Co., Newark, N. J.—attenuators; potentiometers; switches; vu indicators; test equipment.

Electric Indicator Co.—electric motors and generators.

The Electronic Workship, Inc., New York, N. Y.—a-f amplifiers; hi-fi audio components; audio instruments.

Electro-Voice, Inc., Buchanan, Mich.—microphones; pickups; transformers.

Fairchild Recording Eqpt. Corp., Whitestone, L. I., N. Y.—tape recorders; synchronous transcription turntables and tape recorders; transcription cutting and playback equipment; equalizers; amplifiers; mixer panels; complete amplifier systems.

Gawler-Knoop Co., Newark, N. J.—manufacturers' representatives—Clough-Brengle sweep-frequency generators; DuMont cathode-ray oscillographs, voltage and time calibrators; Minnesota Electronics amplifiers, filters, Noiserasers.

General Electric Co., Syracuse, N. Y.—speakers; tone arms; pickups; preamplifiers.

James B. Lansing Sound, Inc., Los Angeles, Calif.—speakers.

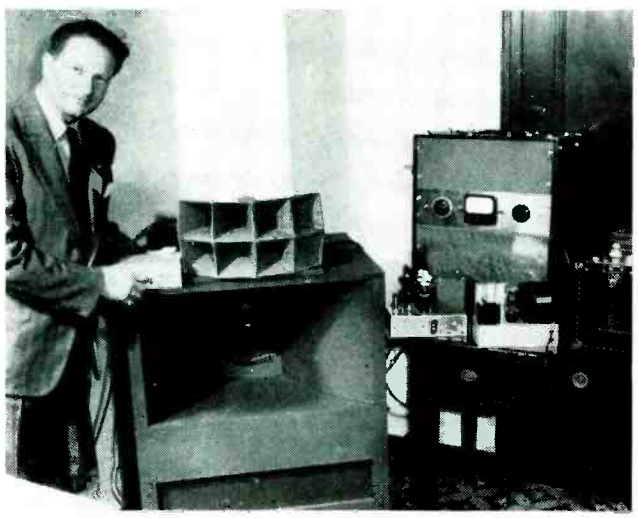
H. J. Leak & Co. Ltd., London, England—audio amplifiers; dynamic pickups; speakers.

Livingston Electronic Corp., Livingston, N. J.—phono pickup arms, loudness controls; stylus pressure gages.

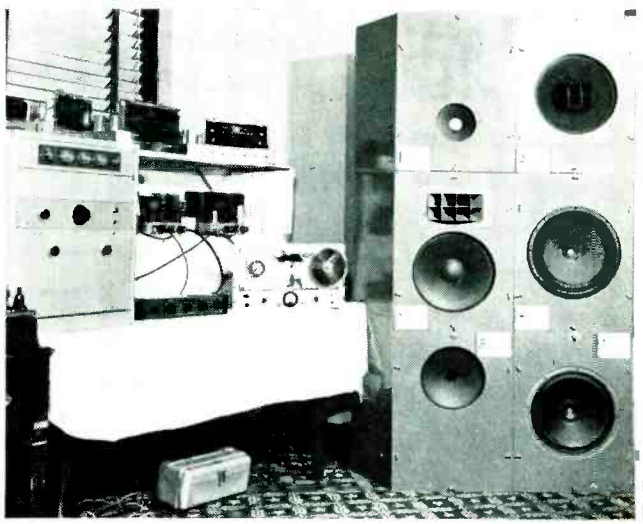
Magnecessories, Washington, D. C.—Carson tape splicer; Visi-Mag.

Magnecord, Inc., Chicago, Ill.—tape recording equipment.

(continued on page 130)



Corner of Peerless Electrical Products Division's exhibit room, with H. M. Morris adjusting tone control unit of musician's sound system. Sound source is magnetic tape recorded off the air; amplifier (on table) uses Williamson circuit developed in England, with Peerless transformers; speaker is Altec 800, theater unit

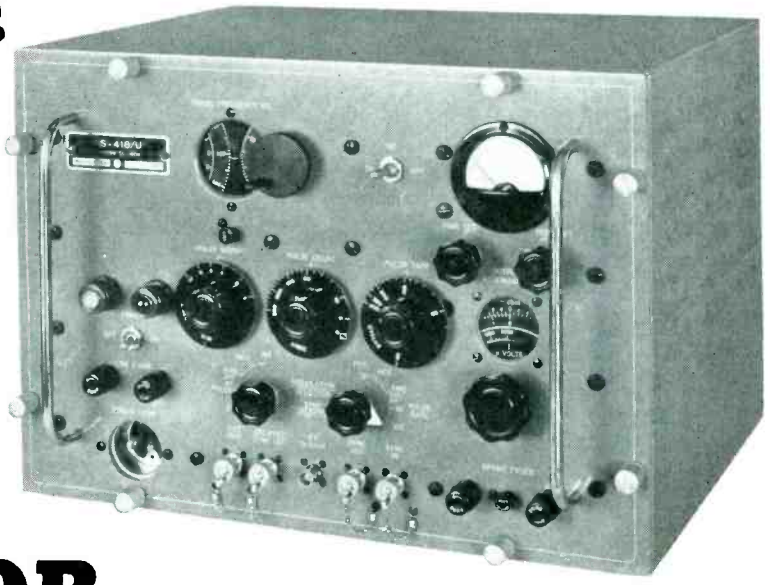


Corner of Electronic Workshop's exhibit room, showing setup for demonstrating different combinations of tuners, amplifiers and speakers. For speaker demonstrations, which attracted most interest, Magnecorder tape recorder on table was used as sound source. Patchboard was used for quick switching

New!

ACCURATE! CONVENIENT!

PORTABLE!



UHF SIGNAL GENERATOR

Covers the Range of 400–1000 MC.

★ ★ ★ The LAVOIE LA-418 Signal Generator, newest addition to the LAVOIE LABORATORIES' line of precision electronic equipment...

Provides:

- ☆ **DIRECT READING Frequency Dial.**
- ☆ **DIRECT READING Attenuator calibrated in D B (0 TO - 120 DBM) U Volts.**
- ☆ **INTERNAL and EXTERNAL Pulse Modulation sine wave modulation external.**

A complete descriptive folder is available promptly on request.

WRITE FOR TECHNICAL BULLETIN LA-418

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

***Specialists* in the Development and Manufacture of UHF Equipment**

Mark Simpson Mfg. Co., Inc., Long Island City, N. Y.—Masco magnetic tape recorders and speakers.

J. A. Maurer, Inc., Long Island City, N. Y.—16-mm cameras; 16-mm sound-on-film recording system; 16-mm film phonograph.

McIntosh Engineering Lab., Washington, D. C.—audio amplifiers.

The Migel Distributing Corp., New York, N. Y.—Bolsey portable microfilmer and reader.

Newark Electric Co., Inc., New York, N. Y.—distributor of audio equipment and accessories.

Panoramic Radio Products Inc., Mount Vernon, N. Y.—Panadaptor; Panalyzor; sonic analyzer; ultrasonic analyzer.

Permoflux Corp., Chicago, Ill.—speakers; baffles; headphones; microphones; amplifiers; tape recorders.

Pickering and Co., Oceanside, N. Y.—phono pickups; preamplifiers; equalizers; audio amplifiers; intermodulation distortion measuring equipment.

Presto Recording Corp., Hackensack, N. J.—recording and transcription turntables; tape recorders; recording amplifiers.

Proctor Soundex Corp., Mt. Vernon, N. Y.—turntables; pickup arms; audio equipment.

Racon Electric Co., Inc., New York, N. Y.—speakers; reentrant trumpets; driver units; tweeters; marine speakers.

Rek-O-Kut Co., Inc., Long Island City, N. Y.—cutters; transcription turntables; recording and playback amplifiers and equipment.

Radio Corporation of America, Camden and Harrison, N. J.—tubes; sound products; broadcast audio equipment; tape recorders; turntables; speakers; microphones.

Rangertone, Inc., Newark, N. J.—magnetic tape recorders.

Recogram Recorders Co., North Hollywood, Calif.—Magnagram magnetic film recorder; Centogrip splicers.

Somerset Laboratories, Inc., Union City, N. J.—amplifiers; dynamic noise suppressor; preamplifier.

Sonar Radio Corp., Brooklyn, N. Y.—tape recorders; amateur equipment.

Stancil-Hoffman Corp., Hollywood, Calif.—magnetic recorders and reproducers; automatic tape splicer.

Stephens Mfg. Corp., Culver City, Calif.—speakers and microphones.

Sun Radio & Electronics Co., New York, N. Y.—distributor of audio equipment and accessories.

Tech Laboratories, Inc., Palisades Park, N. J.—attenuators; potentiometers; tap switches; fixed pads; gain sets; resistance measuring equipment.

University Loudspeakers, Inc., White Plains, N. Y.—speakers; driver units; tweeters; accessory sound equipment.

U. S. Recording Co., Washington, D. C.—Consolette.

IRE Elections Announced

THE BOARD of directors of the IRE recently announced the election of Raymond F. Guy, manager of radio and allocations engineering for NBC, and Sir Robert Watson-Watt, governing director of Sir Robert Watson-Watt and Partners, Ltd., of London, England, as president and vice-president, respectively, of the IRE for 1950.

R. F. Guy

R. Watson-Watt

Candidates elected as directors-at-large for the 1950-1951 term are: William R. Hewlett, vice-president of Hewlett Packard Co., Palo Alto, Calif., and James W. McRae, director of electronic and television research at Bell Telephone Laboratories, Inc., Murray Hill, N. J.

W. R. Hewlett

J. W. McRae

Regional directors for 1950–1951 are as follows: North Atlantic Region—Herbert J. Reich of the electrical engineering department, Durham Laboratory, Yale University; Central Atlantic Region—Ferdinand Hamburger, Jr., of the school of engineering, Johns Hopkins University; Central Region—John D. Reid, manager of research of Crosley Div. of Avco Mfg. Corp., Cincinnati, Ohio; Pacific Region—Austin Eastman, head of the department of electrical engineering of the U. of Washington, Seattle, Wash.

MEETINGS

JAN. 10–12: Conference on Industrial and Safety Problems of Nuclear Technology, New York University, New York, N. Y.

JAN. 30–FEB. 3: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

FEB. 27–MARCH 3: ASTM Committee Week and Spring Meeting, Hotel William Penn, Pittsburgh, Pa.

MARCH 6–9: IRE Convention and Radio Engineering Show, Hotel Commodore and Grand Central Palace, New York City.

APRIL 4–8: National Production Exposition, sponsored by the Chicago Technical Societies Council Stevens Hotel, Chicago, Ill.

APRIL 26–28: Fourth annual meeting of the Armed Forces Communications Association, Astoria, New York City, and Fort Monmouth, N. J.

JUNE 26–30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

Engineering Research Projects

OVER 4,000 college and university research projects in engineering subjects were recently announced in the 1949 *Review of Current Research*, published by the Engineering College Research Council of the American Society for Engineering Education. Studies of particular interest to electronic engineers and the institutions where they are currently active are as follows:

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
- Measurements of power and attenuation at microwave frequencies
- Study of radio interference problems
- Evaluation of r-f cable connectors
- Experimental investigations of impedance measurement
- Electromagnetic properties of obstacles and slots in waveguides
- Theory of communication
- Theory of variable-frequency circuits
- Theoretical and experimental investigation of electron tube performance
- Study of ferromagnetic circuits and magnetic amplifiers
- Microwave lens antennas
- Application of conformal mapping to high-voltage properties
- Synthesis of broad-band networks
- Studies of transistor circuits
- Design of an electrostatic transformer
- Study of multivibrator synchronization
- Influence of harmonics on design of rotating electrical machinery

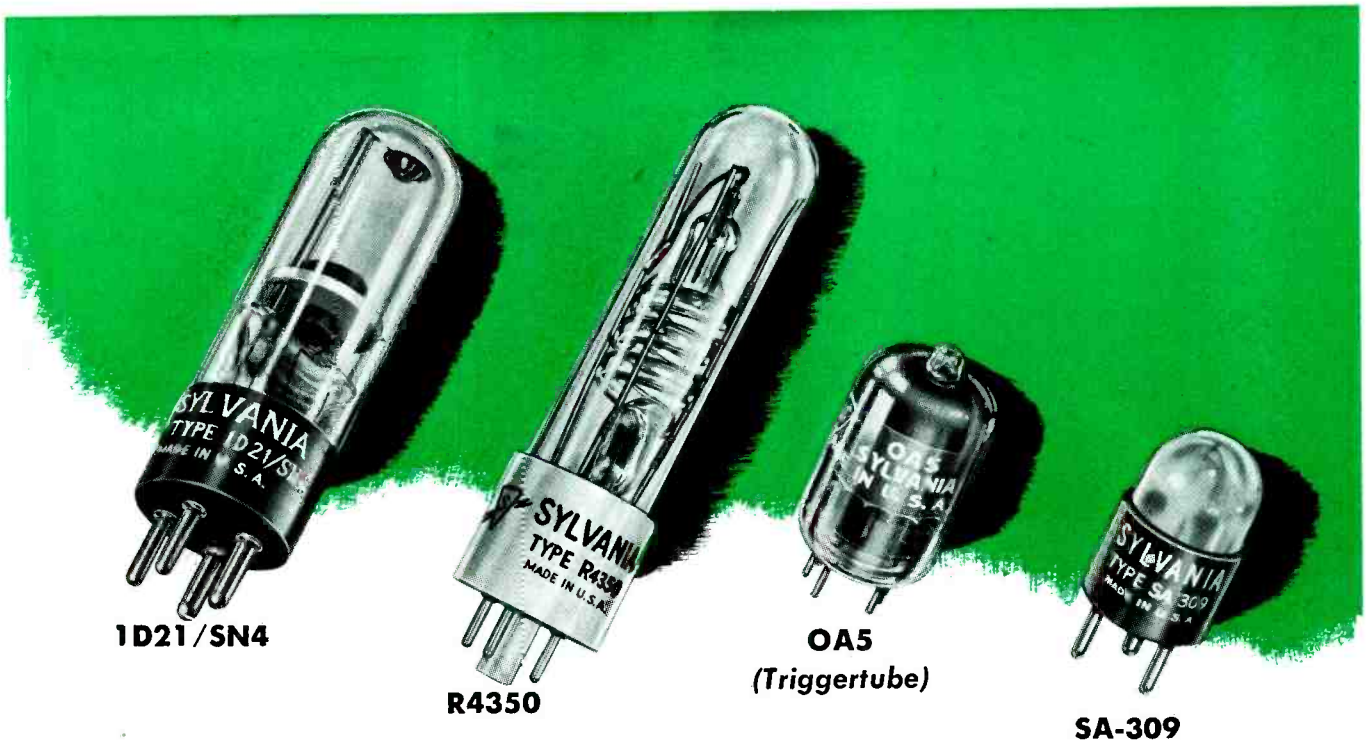
Bucknell University, Lewisburg, Pa.
- X-ray studies of aluminum welds

University of California, Berkeley, Calif.
- Electric shock
- Supersonic flaw detector
- Recording instruments and servomechanisms
- Electrical computer
- Study of collimated beams and of diffraction by apertures and discs
- Study of scattering and absorption by receiving antennas
- Thermistor research
- F-M studies
- Permanent magnet alternators
- Radiation detectors
- Audio-frequency project
- Very-low-frequency oscillators
- Magnetic amplifiers
- Dynamoelectric amplifiers
- F-M detection systems
- Improvements in phototubes by insertion of a grid
- Microwave tube development (AMC)
- Microwave laboratory (USAF)
- Antenna research (BuS)
- Electronic computer project (ONR)
- Transistor study
- Distortion in f-m systems
- Magnetic fluid clutch
- VLF instrumentation

Catholic University of America, Washington, D. C.
- Electronic smoke detector
- Potentiometer-type sine-cosine calculator
- Use of magnetic amplifiers for instrument reading amplification

University of Colorado, Boulder, Colorado
- Radio reception (USAF)
- Mass spectrometer

(continued on page 199)



1D21/SN4

R4350

OA5
(Triggertube)

SA-309

If it's a STROBOTRON it's made by SYLVANIA

THERE'S just *one* source of supply for the Strobotrons you need for "freezing" the motion of reciprocating or rotating machinery —Sylvania Electric!

Sylvania Strobotrons SA-309 and R4350 produce high-intensity, bluish-white light pulses . . . are ideal for applications where true-color viewing is essential. The R4350 flashes at rates up to 15 per second; the SA-309, up to 100 per second.

Type 1D21/SN4 provides a source of neon-red light, at frequencies up to 240 flashes per second.

Typical applications of Sylvania Strobotrons include: automotive timing; wheel balancing; adjustment of packaging machinery; regulation of high-speed multi-color printing presses.

TRIGGERTUBE TYPE OA5 provides a convenient means of triggering the SA-309, R4350 or 1D21/SN4 from current sources of very low value. The OA5 may also be used for electronic relay and switching applications as well as for other regular Strobotron purposes.

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Sylvania Electric Products Inc.
Electronics Division, Dept. E-1001
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:

Please send me descriptive bulletins on Sylvania Strobotrons and Triggertubes.

I am also interested in receiving literature covering applications of your other products in the fields of:

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Electronics Division, 500 Fifth Avenue, New York 18, N. Y.

ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS.

Mercury and gas-filled tubes are tested in 30 seconds by the recently developed machine shown

methods used previously.

A photograph of the machine in operation is shown above. A series of lights in front of the operator indicates whether or not a tube has passed certain requirements. The meters shown in the background indicate the voltages applied to the tube during the test, and they also permit rapid changing of voltages when a different type of tube is put through the test.

The machine tests each tube for grid emission, peak arc drop (cathode emission), filament resistance, anode breakdown voltage, and grid bias to control breakdown. The latter test is made under two voltage conditions.

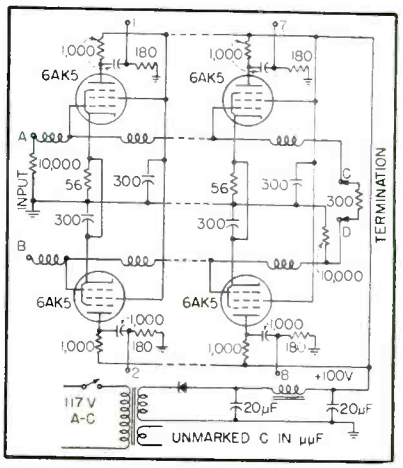
Multiple TV Antenna Coupler

BY LEONARD MAUTNER
President
Television Equipment Corp.
New York, N. Y.

THE PROBLEM OF OPERATING a number of television receivers from one antenna has been with us for a long time, and indications are that it will become more of a problem in the future. The use of a master receiver with slave monitors, which was first proposed, is not an economical solution because the high production and consequently low cost of standard receivers makes a system employing regular sets preferable from cost considerations.

Radio-frequency distribution sys-

Check the 1949-1950
ELECTRONICS BUYERS' GUIDE
FOR TECHNICAL DATA AND LISTINGS
ON THE COMPLETE PRODUCT LINES OF THESE MANUFACTURERS
Page number of their advertisements are shown after each name



Circuit diagram of four of the eight stages in the eight-position television isolation amplifier for multi-receiver reception with a single antenna

tems fall into three general classifications:

First, there is the resistor-attenuator scheme which may be useful for a very limited number of sets in a high-signal area. This system has little merit because in an effort to obtain high isolation between sets, one must attenuate the signal so severely that the application is quickly limited in scope.

The second classification involves the use of a single antenna with a central isolation amplifier or a group of individual isolation amplifiers—all employing vacuum tubes to provide the necessary isolation over the tv bands with minimum of introduced loss. The offhand suggestion of a cathode-follower in this application is, however, an incorrect one. It is not possible to maintain uniform gain characteristics at 216 mc by the use of this technique. The use of a distributed line type wide-band isolation amplifier, however, provides a satisfactory economical solution. A typical equipment of this type is described below. Such a scheme finds wide application in all but the lowest signal areas, and this solution, when coupled with a wide-band amplifier having a gain of the order of 20 db, then provides an economical solution for nearly all locations.

The third method, which by its nature is the most costly and elegant, involves the use of a separate antenna and channel amplifier for each station. The mixed signals may then be piped at relatively high level around the building proper with bridging take-offs for each of

3 record-making problems...

and how photography helps solve them

...with savings

Reducing Office Copying Costs

SOLUTION: Make photocopies with Kodagraph Contact Paper. Anyone, with simple equipment, can easily make accurate, lasting photocopies of documents and letters. Kodagraph Contact Paper is durable, uniform in quality. Developed specifically for use with existing contact photocopy machines, it has wide latitude . . . assures crisp copies of unsurpassed legibility.

Photocopies save the costs of copying by hand . . . insure absolute accuracy.

More legible photocopies at low cost with Kodagraph Contact Paper.

Preserving Engineering Drawings

SOLUTION: Make *photographic* duplicates in one printing on Kodagraph Autopositive Paper, and get file prints or intermediates that will stand the wear and tear of handling and machine feed-throughs . . . that won't yellow, smudge, or fade. Kodagraph Autopositive Paper can be handled in ordinary room light, and can be exposed on familiar direct-process or blueprint equipment.

Photographic intermediates make better prints . . . and save your originals.

Longer lasting, higher quality intermediates on Kodagraph Autopositive Paper.

Making Room for More Records

SOLUTION: Put inactive records on microfilm, destroy the obsolete originals, and use the file space so obtained for newer records. Microfilming can reduce the bulk of files by as much as 98%—a sensational saving in space. Record your smaller papers, your larger documents and drawings with Kodagraph Micro-File Machines and Recordak microfilming equipment and service.

Microfilming protects your records, keeps them in order . . . saves space.

Space savings—up to 98% —through Kodagraph and Recordak microfilming.

Photography reproduces detail exactly, completely—even improves quality; photography preserves—and, if you wish, condenses or enlarges. It can help you lower costs, increase efficiency, speed operations . . . in factory, laboratory, office.

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☐ better photocopies ☐ better engineering prints
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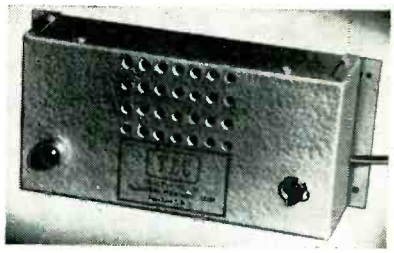


Commercial version of apartment house television distribution amplifier

the receivers. In this case it is less difficult to orient the separate antennas to minimize ghost patterns which arise in certain difficult locations due to the large neighboring buildings. However, such a solution with its expensive and complicated terminal equipment is only practical and economical for the largest and most elaborate installations.

Wide-Band Amplifier

A typical example of a wide-band isolation amplifier is the Telecoupler shown in the accompanying diagram. Only four of the eight plate-loaded output stages are shown. The grid circuits in each stage provide the shunt capacitance for a low-pass filter network. Its operation is readily apparent. Using a pair of 150-ohm unbalanced lumped-constant transmission lines for the low-pass filter, one can arrange to drive them back-to-back to provide a 300-ohm input. Alternatively, operating them in parallel provides a 75-ohm input. In the case of 300-ohm operation, each pair of tubes on opposite sides of the line provides a 300-ohm source looking back into their plate circuits. Thus, one can provide outputs from one antenna to four 300-ohm tv sets with an accurate match available. Since the conventional receiver may be considerably unbalanced in its input, it is often possible to use the eight 150-ohm outputs to drive eight 300-ohm or 75-ohm receivers.

By removing the termination at the far end of the line, one can add a number of units in cascade, providing more outputs. As many as 24 output lines have been successfully used in practice. Precautions must be taken to make sure that local oscillator radiation from one set with an unbalanced or radiating front end will not radiate back through the system and interfere

ALWAYS SET UP AND READY TO MEASURE

Inductance • Resistance • Capacitance

Here's the handiest piece of equipment for any laboratory where electrical components are used.

- It is completely self-contained except for headset for a-c measurements
- It measures the basic quantities of Inductance — Resistance — Capacitance — over very wide ranges
- Its accuracy is high enough for most routine measurements of these quantities
- It has built-in standards
- It contains both d-c and a-c power sources
- It has a panel-mounted d-c zero-center galvanometer for d-c null indication
- It is very simple to operate

RANGES

INDUCTANCE: 1 microhenry to 100 henrys

RESISTANCE: 1 milliohm to 1 megohm

CAPACITANCE: 1 micromicrofarad to 100 microfarads

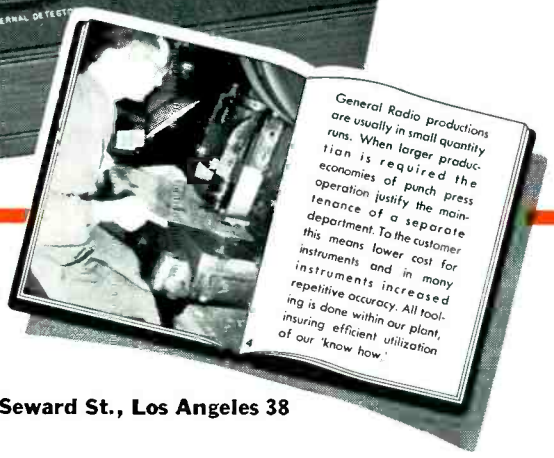
STORAGE FACTOR (X/R: 0.02 to 1000

DISSIPATION FACTOR (R/X): 0.002 to 1

With the G-R Type 650-A Impedance Bridge you have for once and forever abolished the time-consuming project of assembling a makeshift bridge from an oscillator, detector, arms and power source for routine measurements of an unknown coil or condenser. That's why thousands of these versatile instruments are daily in use in laboratories throughout the world.

TYPE 650-A IMPEDANCE BRIDGE: $240.00

Write for Complete Data



GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

with other sets. Little interference may be expected through common impedance in the circuit, but poor installation technique may provide cross radiation between sets, and this must be watched carefully. This trouble, however, will be reduced considerably when more sets use the new 40-mc RMA standard intermediate frequency.

Although the foregoing techniques appear involved, it would appear that master antenna distribution systems will continue to be necessary in the future because, in spite of the manufacturers' efforts to provide new sets with built-in antennas, their performance is only satisfactory in a small minority of installations, where exceedingly large signal strengths are encountered. The effective shielding of buildings with steel frame construction seem to make the hope of a really antenna-less set a slim one at this time. A commercial model of the Telecoupler is shown in the photograph.

Automatic Moisture Content Control

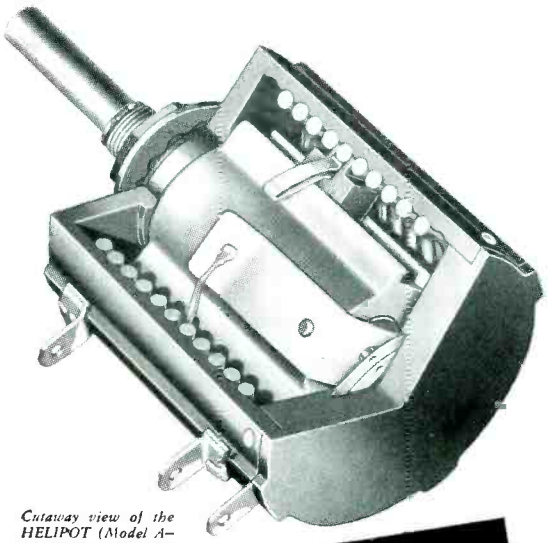
BY DAVID A. UTLEY
Barber-Colman Company
Rockford, Illinois

ONE OF THE MOST CRITICAL conditions in the manufacture of textiles is the moisture content in the warp threads, or longitudinal threads supplied to the loom after the application of the size to the threads. Correct moisture content in the sized threads enables them to withstand the flexing and abrasion imposed by the weaving process in the loom.

If the moisture content of the warp is excessive, the entire warp spool or beam will mildew and spoil during storage prior to weaving. Excessively low moisture content results in low weaving efficiency due to time consumed in fixing breaks in brittle warp threads, and low quality finished fabric because of excessive ties in the warp. Furthermore, since the moisture content is determined by a drying operation, low moisture content is indicative of a needlessly slow dryer.

The moisture content of the threads is determined by the speed

For new simplicity, wide range, and high accuracy in the control of modern electronic circuits...



Cutaway view of the HELIPOT (Model A–10 Turn–1¾" Diameter)

THE BECKMAN Helipot

(Trademark of the HELical POTentiometer)

Provides *many times* greater resistance control in *same* panel space as conventional potentiometers!

IF YOU are designing or manufacturing *any type* of precision electronic equipment be sure to investigate the greater convenience, utility, range and compactness that can be incorporated into your equipment by using the revolutionary HELIPOT for rheostat-potentiometer control applications...and by using the new DUODIAL turns-indicating knob described at right.

Briefly, here is the HELIPOT principle...whereas a conventional potentiometer consists of a *single* coil of resistance winding, the HELIPOT has a resistance element *many times* longer coiled *helically* into a case which requires no more panel space than the conventional unit. A simple, foolproof guide controls the slider contact so that it follows the helical path of the resistance winding from end to end as a single knob is rotated. Result...*with no increase in panel space requirements*, the HELIPOT gives you as much as 12 times* the control surface. You get far greater accuracy, finer settings, increased range—with maximum compactness and operating simplicity!

COMPLETE RANGE OF TYPES AND SIZES

The HELIPOT is available in a complete range of types and sizes to meet a wide variety of control applications...

MODEL A: *5 watts, 10 turns, 46" slide wire length, 1¾" case dia., resistances 10 to 50,000 ohms, 3600° rotation.*

MODEL B: *10 watts, 15 turns, 140" slide wire length, 3¼" case dia., resistances 50 to 200,000 ohms, 5400° rotation.*

MODEL C: *3 watts, 3 turns, 13½" slide wire length, 1¾" case dia., resistances 5 to 15,000 ohms, 1080° rotation.*

MODEL D: *15 watts, 25 turns, 234" slide wire length, 3¼ case dia., resistances 100 to 300,000 ohms, 9000° rotation.*

MODEL E: *20 watts, 40 turns, 373" slide wire length, 3¼" case dia., resistances 150 to 500,000 ohms, 14,400° rotation.*

Also, the HELIPOT is available in various special designs...with double shaft extensions, in multiple assemblies, integral dual units, etc.

Let us study *your* potentiometer problems and suggest how the HELIPOT can be used – possibly is already being used by others in your industry – to increase the accuracy, convenience and simplicity of modern electronic equipment. No obligation, of course. Write today outlining your problem.

**Data for Model A, 1¾" dia. Helipot. Other models give even greater control range in 3" case diameters.*

THE BECKMAN Duodial

The inner, or Primary dial of the DUODIAL *shows exact angular position of shaft during each revolution. The outer, or Secondary dial shows number of complete revolutions made by the Primary dial.*

A multi-turn rotational-indicating knob dial for use with the HELIPOT and other multiple turn devices.

THE DUODIAL is a unique advancement in knob dial design. It consists essentially of a primary knob dial geared to a concentric turns-indicating secondary dial—and the entire unit is so compact it requires only a 2" diameter panel space!

The DUODIAL is so designed that – as the primary dial rotates through each complete revolution – the secondary dial moves one division on its scale. Thus, the secondary dial counts the number of complete revolutions made by the primary dial. When used with the HELIPOT, the DUODIAL registers *both* the angular position of the slider contact on any given helix as well as the particular helix on which the slider is positioned.

Besides its use on the HELIPOT, the DUODIAL is readily adaptable to other helically wound devices as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. It is compact, simple and rugged. It contains only two moving parts, both made entirely of metal. It cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stop. It is not subject to error from backlash of internal gears.

TWO SIZES—MANY RATIOS

The DUODIAL is now available in two types – the Model "R" (illustrated above) which is 2" in diameter, and the new Model "W" which is 4¾" in diameter and is ideal for main control applications. Standard turns-ratios include 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating *fewer* than 10 revolutions and is recommended for the 3-turn HELIPOT. In all types, the primary dial and shaft operate with a 1:1 ratio, and all types mount directly on a ¼" round shaft.

Send for this HELIPOT AND DUODIAL CATALOG!

Contains complete data, construction details, etc., on the many sizes and types of HELIPOTS...and on the many unique features of the DUODIAL. Send for your free copy today!

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

at which they pass over the steam heated rolls of the sizing and drying machine, the slasher. To obtain maximum slasher efficiency, an electronic moisture content control has been developed. This instrument continuously measures and records the moisture content of the warp and automatically adjusts the speed of the slasher by an amount proportional to the magnitude of the moisture content deviation.

Detector Unit

The control makes use of the principle that the resistance in the warp thread is a function of the warp moisture content. The resistance of the warp is measured as it passes between the insulated detector and a grounded roller shown as *A* in Fig. 1. This resistance is high (sometimes several thousand

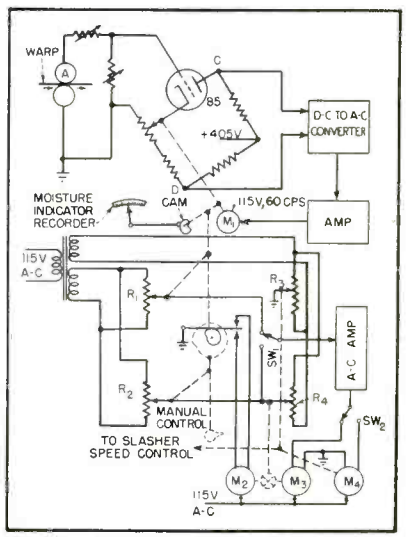
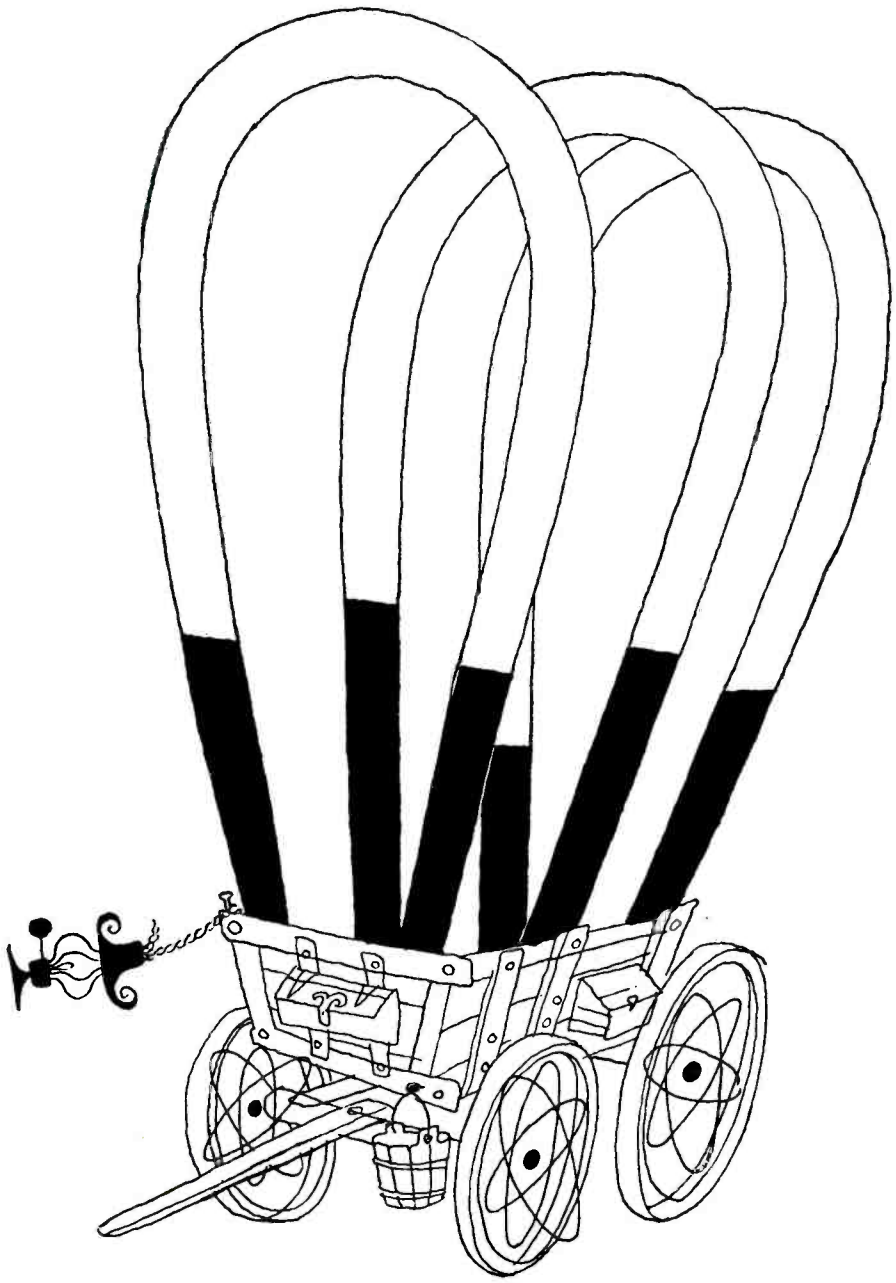


FIG. 1—Schematic of automatic moisture content control unit for use in the textile industry

megohms) and can be measured accurately only by a vacuum tube. Variations in moisture content of the warp change the resistance in the circuit through the detector rolls. As the warp resistance varies, the tube grid bias changes to alter the resistance of the tube. This change in tube resistance unbalances the measuring unit bridge and produces a d-c potential across points *C* and *D*. The magnitude of this potential is proportional to the change in warp moisture content and the polarity is determined by the direction of the change.

The relative d-c potential between



PIONEERS ARE PARTICULAR PEOPLE

If you want a better Permanent alnico magnet with *higher gap flux per unit weight*, call on Crucible.

CRUCIBLE STEEL COMPANY OF AMERICA,
Chrysler Building, New York 17, New York.

CRUCIBLE first name in special purpose steels

PERMANENT ALNICO MAGNETS

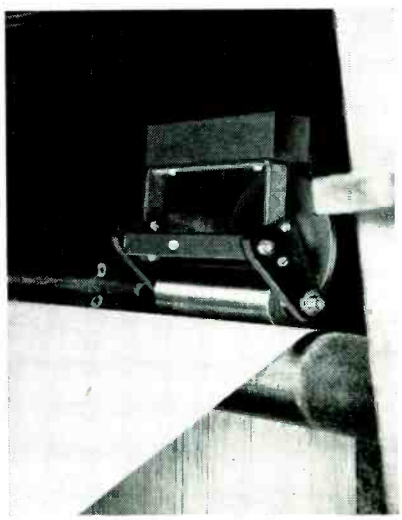
STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE • STEELS

points C and D is first converted to a-c with a phase relationship to the a-c supply determined by the unbalance of the bridge. This a-c voltage is then amplified and impressed across the wound shading coils of the reversible shaded pole induction motor, M_1. When energized, this motor actuates the moisture indicator pen arm to indicate the new moisture content; it adjusts a bridge resistor to rebalance the measuring circuit bridge which was unbalanced by the change in warp moisture content; and it actuates R_1 to bring about a change in slasher speed.

Unfortunately, the warp resistance does not vary linearly with the moisture content. This nonlinearity necessitates a tapered bridge resistance and a pen drive through a specially shaped cam which makes possible the use of a linear indicator chart calibrated in terms of percent moisture.

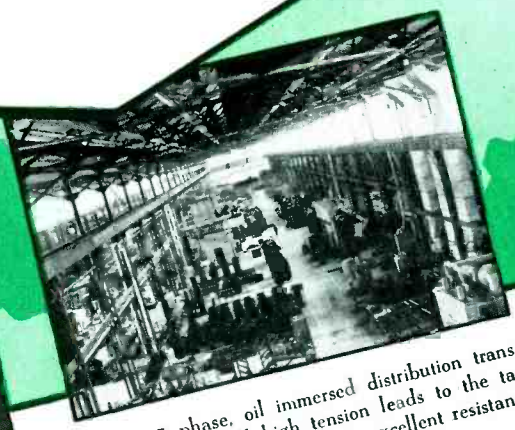
Speed Control

Direct control of the slasher speed from the shaft of M_1 with simple floating control is impossible, because, due to the amount of yarn in the slasher, the full effect of a speed change is not immediately apparent at the detector. Therefore, the rate of speed change must be decreased to prevent control hunting and the resulting wide swings around the control point which may cause wet spots in the warp. To eliminate this hunting full proportioning speed control is



Recorder in upper right-hand corner keeps record of moisture content of warp

NATVAR *in* MEXICO



Core-and-coil assemblies for three 45 kva, 15200-240/480 volt, 3 phase, oil immersed distribution transformers built by IEM for an industrial company in Northern Mexico. All high tension leads to the tap switch are insulated and protected with Natvar 400 extruded vinyl tubing, because of its excellent resistance to both heat and oil, and its good dielectric strength.

This is the largest electrical manufacturing company in Latin America, and is located in Tlalnepantla, just north of Mexico City. This interior view of one of the center bays of this huge, thoroughly modern plant shows the Tank Shop where core-and-coil assemblies are housed.

Industria Electrica de Mexico, S.A., (IEM) produces motors, transformers, switchgear and household appliances in accordance with designs and specifications of Westinghouse Electric Corporation. Natvar 400 Extruded Vinyl Tubing is used for all applications requiring a combination of good dielectric strength, with high resistance to both heat and oil. This tubing and all Natvar products are supplied in the Republic of Mexico through our agent, Jules Mattarelli, Paseo de la Reforma #157, Mexico, D.F. Telephone 14-02-13.

Principal manufacturers of electrical equipment here and abroad are standardizing on Natvar insulations because of their superior electrical and mechanical performance characteristics and uniformity. They are available for prompt delivery either from your wholesaler's stock, or direct from our own.

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necessary. With full proportioning control, a speed adjustment proportional to the moisture content deviation is made.

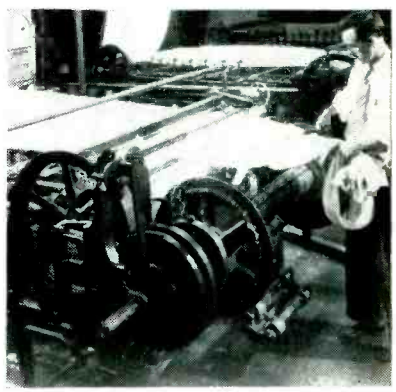
The circuit which provides for this proportioning control is the lower half of the circuit shown in Fig. 1. It controls motor M_4 which drives the slasher speed adjusting mechanism. Motor M_4 is similar to M_1 in construction, and like M_1, is controlled by an amplified voltage supplied from R_1 and R_3, which are connected through R_2 and R_4. Any voltage which exists between the sliders of R_1 and R_2 must be opposed by an equal and opposite voltage between the sliders of R_4 and R_3. If the slider of R_1 is moved, a voltage is applied to the amplifier.

When the warp moisture content changes, the slider of R_1 is moved by M_1, producing a voltage across the input of the amplifier the output of which operates M_4, to change the slasher speed. This motor also operates R_3, moving the slider in a direction to reduce the input voltage to the amplifier. Thus, the system will again be brought into balance at a new slasher speed.

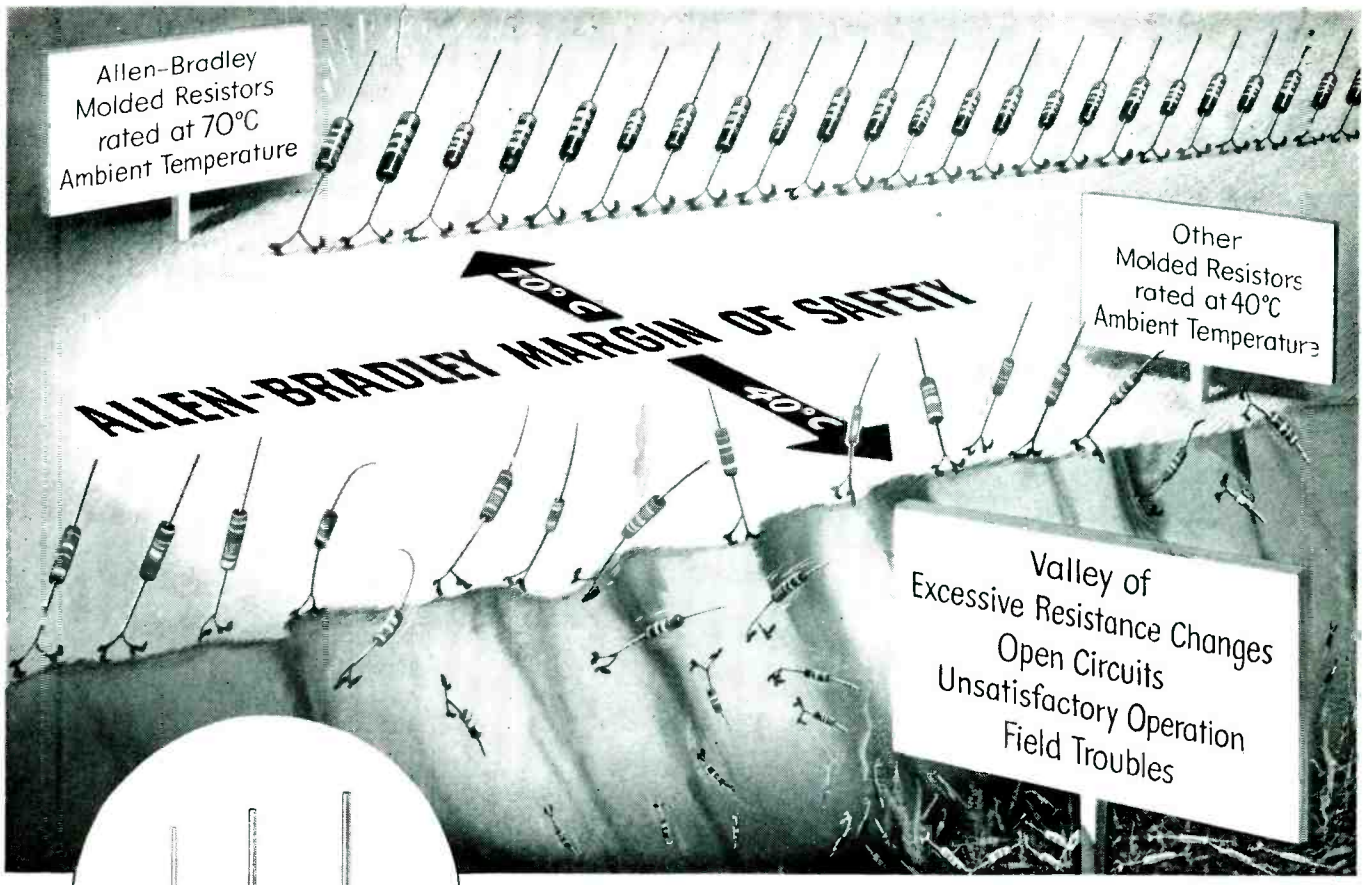
Resetting Device

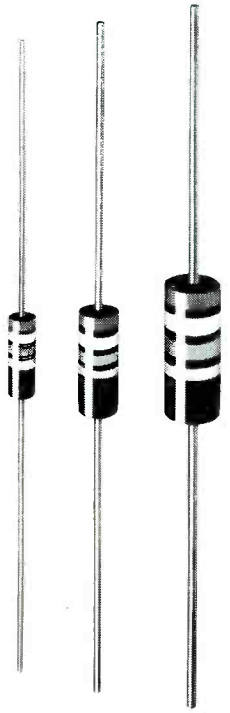
The entire control circuit operates to attain a new balance that will maintain the slasher speed at a point which will produce a new moisture content of the warp. The purpose of the control, however, is to alter the slasher operation to restore the original moisture control point. This function is effected by the resetting device.

The desired moisture control point is preset by means of a manual adjustment which positions R_2 and a cam-operated double-throw switch with a central "off" point. When the warp moisture content is



The moisture content detecting element measures the resistance of the warp





SIZES OF UNITS		
Rating	L	D
½-w	3/8"	9/64"
1-w	9/16"	7/32"
2-w	11/16"	5/16"

The honeycomb carton prevents tangling of leads and saves time.

NO OTHER FIXED RESISTORS
have this margin of safety

Bradleyunits are rated ultra-conservatively. Composition resistors are usually rated at an ambient temperature of 40 C . . . but Bradleyunits are rated at 70 C. That means a big margin of safety in Allen-Bradley resistor performance. It explains why, in wartime service, Bradleyunits were accepted in every combat zone as "tops" in quality.

Bradleyunits operate at full rating for 1,000 hours with less than 5% resistance change. They withstand all extremes of temperature, pressure, and humidity.

Available in all standard R.M.A. values as follows:

½-watt — 10.0 ohms to 22 megohms
1-watt — 2.7 ohms to 22 megohms
2-watt — 10.0 ohms to 22 megohms

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A-B Quality

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FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

at the desired point the switch does not make contact, but when the moisture content varies from the desired control point, this switch operates to set the reset M_2 in operation to slowly move the slider of R_1. This adjustment produces a further unbalance of the control circuit bridge in such a direction as to correct the original shift from the control point. The operation of M_2 is then not only dependent upon the position of R_1, but upon the combined positions of R_1, R_2, R_3 and R_4. When the moisture content varies, R_1, driven by M_1, assumes a new position which produces a change in slasher speed. As the slasher speed is changed, R_3 is repositioned to balance the control circuit at a new moisture content. However, the variations from the control point of the warp moisture also operate R_4 in a direction to cause further unbalance of the balancing unit. This further unbalance causes the M_2 to continue to operate until a slasher speed has been reached which will produce warp of moisture content which is again equal to the desired control point.

Converter Circuit

The d-c to a-c converter is shown in Fig. 2. The potential across points C and D, which was mentioned above, is used to obtain a 60-cycle voltage. The amplitude of the a-c output voltage varies with the magnitude of the d-c voltage, and its phase depends upon the polarity of the d-c voltage. The 60-cycle voltage is then fed through a conventional two-tube amplifier to the wound shading coils of M_1 which is connected as a single-phase shaded-pole induction motor. With the field winding of this motor connected directly to the supply line, the di-

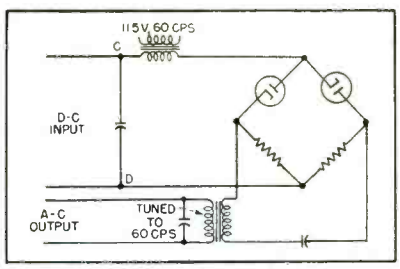

FIG. 2—The magnitude and phase of the a-c output of the converter is determined by the magnitude and polarity of the d-c input voltage

Your telephone uses ceramics, too!

Five thousand years ago, potters were making household vessels of clay. As skill grew, grace of shape and ornament were added. The beauty of fine china has been recognized by every civilization, while the availability, ease of manufacture and durability of other ceramics have given them wide use.

Your telephone, too, uses ceramics. Behind its dial is a metal plate, glazed as carefully and in much the same manner as this fine piece of pottery. It carries the letters and numbers you dial, so it must resist both fading and abrasion. You will find other ceramics as insulators, supporting wires on pole lines; in eighty thousand miles of underground conduit, where fired clays defy decay and corrosion.

Today at Bell Telephone Laboratories scientists utilize ceramics in ways undreamed of in ancient times. Thermistors, made of a ceramic, provide automatic controls for electric current, to offset fluctuations in temperature and voltage. One kind of ceramic makes low-loss insulation at high frequencies, while another supplies controlled attenuation for microwaves traveling in waveguides.

Each use demands a special composition, scientifically controlled and processed. Basic studies in the chemistry and physics of ceramics have shown how to utilize their versatile properties in electrical communication. And research continues on ceramic materials as well as on every other material which promises better and cheaper telephone service.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

rection of rotation of the rotor depends upon the phase relation of the supply voltage to the 60-cycle voltage supplied to the shading coils by the converter unit.

Manual Control

The control unit is equipped with provision for manual as well as automatic operation. When the control is set for manual operation, speed of the slasher can be changed only by manually depressing either the fast or slow speed adjustment buttons located on the control case; however, the recorder portion of the control continues to operate the same as for automatic control. The change from automatic to manual control is effected through the change in position of a multipolar transfer switch. This manual-automatic switch, schematically shown as SW_1 and SW_2, changes the amplifier input from R_1 and R_3 to R_4 and R_5. The amplifier output is also changed from the shading coils of M_4 to those of the follow-up motor M_3.

In manually adjusting the control, the operator varies the speed of the slasher until the recorder indicates the desired control point setting which has been preset at R_2. As previously described, under the automatic operation of the control, R_1 varies with the moisture content of the warp and the indication of the recorder. When the control point moisture content is reached, R_1 and R_2 are in balance. Switch SW_2 now connects the amplifier output to the follow-up motor M_3. Simultaneously with the manual slasher speed adjustment, M_3 operates to actuate R_4 and to keep it in balance with R_3. These potentiometers are automatically maintained in balance to eliminate unnecessary repositioning of the speed adjusting motor M_4 when the control is switched back to automatic operation. When automatic control takes over, the control starts off in a balanced condition.

Although this control was developed to control the moisture content of yarn, its application by no means ends in the textile industry. With several minor adjustments, this instrument can be adapted to the control of the moisture content in the manufacture and coating of paper or the drying of some types of food

stuffs. In fact, this instrument is adaptable to any application where control through resistance changes is possible and continuous full proportioning control is desired. The control is covered by patents or patents pending.

A High-Speed Collator

SORTING LARGE NUMBERS of pages of paper into sets or booklets can be very tedious and time-consuming to office personnel. The Thomas Mechanical Collator Corporation has come up with a machine that does the job automatically and accurately and at speeds of up to 18,000 sets per hour for a ten-page unit. A similar volume of collating would take the average hand collator about six hours to complete.

The machine operates with a vacum pickup arrangement which gathers pages from their individual piles and arranges them in sets in their correct sequence. The finished sets are deposited on a conveyor belt and moved to another pile.

Electronics is responsible for the complete accuracy of the device. Should the vacuum device fail to pick up one of the sheets of paper, the machine is automatically reversed, so that the pages already picked up for the set that would have been incomplete are returned to their original piles for the next pickup.

According to the manufacturers, the machine not only saves money,

High-speed collator's accuracy is assured by electronic controls which supervise its operation

TRIPLE "A" BATTERY LIFE OF YOUR 1950 PORTABLES

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A complete tube complement for longer-service portables

Sylvania—and *only* Sylvania—brings set manufacturers this group of low-drain battery-type tubes that consume only half as much heater current as previously available types. Requiring only 25 ma filament current, they will triple life of present "A" batteries!

These new tubes also offer opportunities for the design of *smaller* "A" batteries, which will permit manufacture of more compact portables without sacrifice of performance.

The four types include a pentode amplifier, a converter, a diode pentode and an output pentode—forming a complete tube complement for portables. They offer comparable power output and sensitivity to previous types...and give excellent performance with a plate supply of only 45 volts.

Remember . . . these new tubes come to you from the *same* company that first made the 1.4 volt battery tube available!

Typical Operating Conditions

Characteristic	1AF4	1AF5	1U6	3E5
Filament Voltage (volts)	1.4	1.4	1.4	2.8
Filament Current (ma)	25	25	25	25
Plate Voltage (volts)	90	90	90	90
Transconductance (μmhos)	950	600	275*	1100
Plate Resistance (megohms)	1.8	2.0	0.6	0.12
Power Output (mw)	—	—	—	175

*Conversion Transconductance

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time, and effort, but it creates "Happier, more inspired, more creative and more productive employees."

Photoelectric Timing Equipment

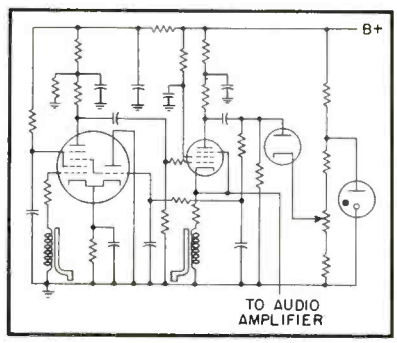
IS ELECTRONICS going to the dogs? A recent installation of electronic timing equipment at Hackney Wick Stadium in London indicates that it has. The apparatus is designed to time greyhound races. It operates from the a-c distribution lines and provides accuracies far greater than would be possible with conventional hand timing methods. It incorporates a control desk with a six-inch diameter clock graduated to 1/100 second which, compared with a stop watch is very easy to read.

The clock is clutch operated from the driving motor which runs continuously. This mode of operation avoids entirely the mechanical strains which are so frequently present when stop watches are operated from an electrical solenoid or armature movement.

The apparatus is designed to be automatic in operation and to eliminate errors as far as possible. The frequency of the supply line even though reputedly controlled is far too variable over short periods to provide the accuracy required by the equipment and in consequence a special tube-maintained tuning fork guaranteed to provide a supply frequency correct to less than 1 part in 6,000 is included as a separate unit.

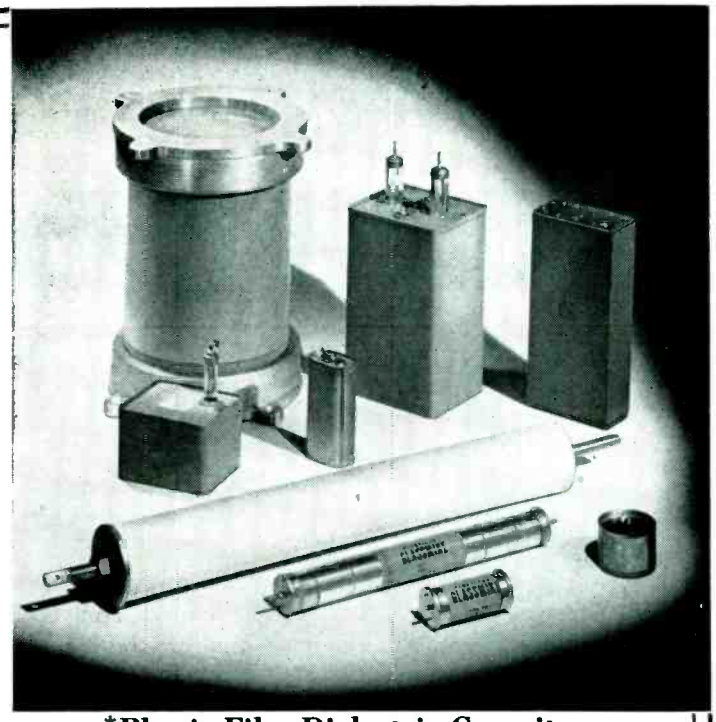
Tuning Fork Control

This instrument is mounted on a rack panel and housed in a metal case. All controls except the line switch and fuses are mounted at the rear of the instrument. Two preset



Circuit diagram of tuning-fork-maintaining amplifier

Special PLASTICON* Capacitors



*Plastic Film Dielectric Capacitors

We manufacture capacitors to specifications for many unusual applications. *A few examples are:*

- High voltage filter capacitors for compact X-Ray equipment
- Ultra high resistance capacitors for radiation counters
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In addition to our capacitors, we manufacture a standard line and build special high voltage, low current power supplies.

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potentiometers are provided to give a frequency adjustment of ± 50 parts in 10⁶.

The tuning fork is made of special steel with an extremely low temperature coefficient. The fork is accurately balanced on a resilient mounting to absorb antimodal vibrations thereby eliminating the need for a heavy metal frame.

The maintaining amplifier shown in the circuit diagram is a conventional two-tube cathode-follower drive circuit and no negative feedback is used. The gain of the first tube is controlled by an age circuit with the normal diode arrangement to provide the control bias. This

British race-timing unit provides accuracies far greater than hand timing with stop watch

circuit minimizes the effect of amplitude instability inherent in all low frequency forks. The output amplifier is designed to deliver about three watts at 200 to 250 volts for operating the clock motor.

The frequency instability from all causes is less than ± 50 parts in 10⁶. The amplitude does not change by more than ± 1 db for a change of ± 10 percent in supply voltage.

Clock Control Circuit

An elaborate system of switches and relays makes the device almost foolproof. The clock clutch is operated by a starting switch which also initiates a 10-second delay. This delay prevents the photoelectric control from coming into operation until all the competitors have passed the finishing line on the first lap. When the finishing-line light beam is interrupted by the winner, another relay operates, and an unlocking circuit prevents subsequent interruptions of the light beam from actuating the clock. A reset button prepares the circuit

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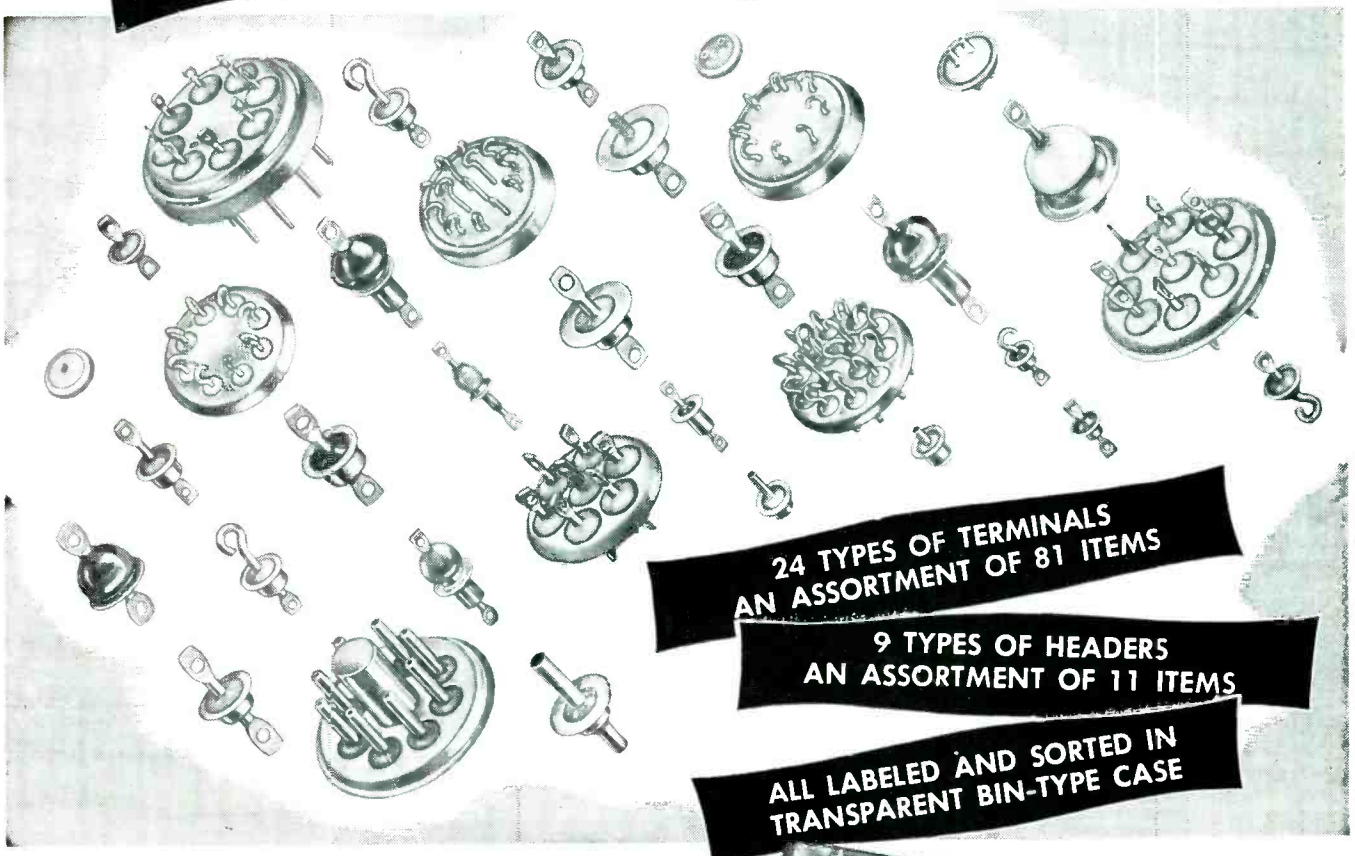

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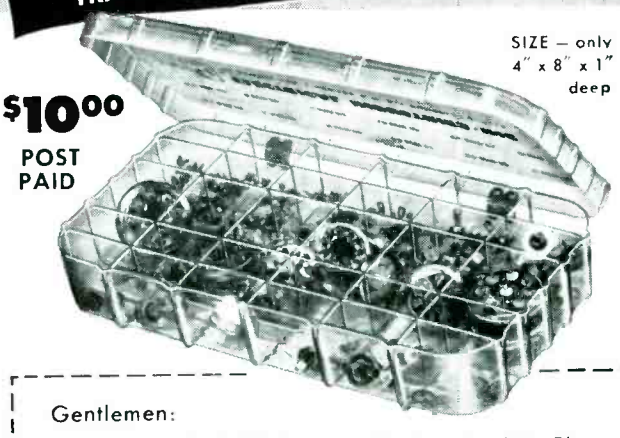

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Enclosed is $10.00 for my E-I Sample Kit. Please send it at once.

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for the next race.

A testing button is provided, but to prevent the possibility of its being left on during an actual race and causing false readings, it is spring loaded so that it must be held during the testing process.

Radar Tester

ACCORDING to engineers of the North American Aviation Company of Los Angeles, California, 360 manhours were originally required for completing a check of the radar equipment contained in the Air Force's new B-45 four-jet bombers. Realizing that this amount of labor was entirely too much, the engineers set about developing an electronic instrument for doing the job in less time. As a result, the time has been cut from 360 manhours to eight by a device which is essentially a continuity and megger checker designed specifically for this particular job.

The equipment can be run from the plane's battery supply or from any power generator. According to information released by the company, the radar system, which normally operates as a 24-volt system, is checked by applying 500 volts. Leaks that would normally be difficult, or impossible to find are thus readily isolated and can be repaired. The checker developed for the B-45 can be adapted for use on any Air Force bomber and 29 have been ordered for other aircraft.

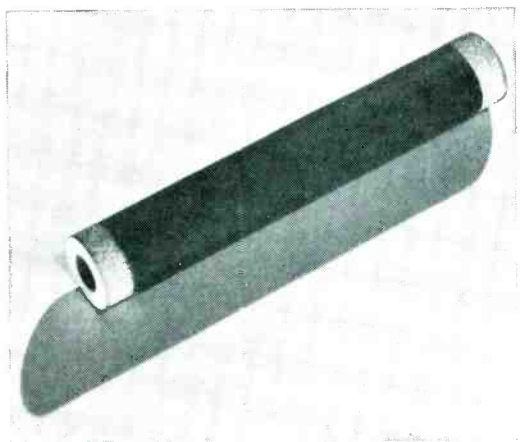
North American engineers check a B-45's radar equipment with their recently-developed continuity and megger checker

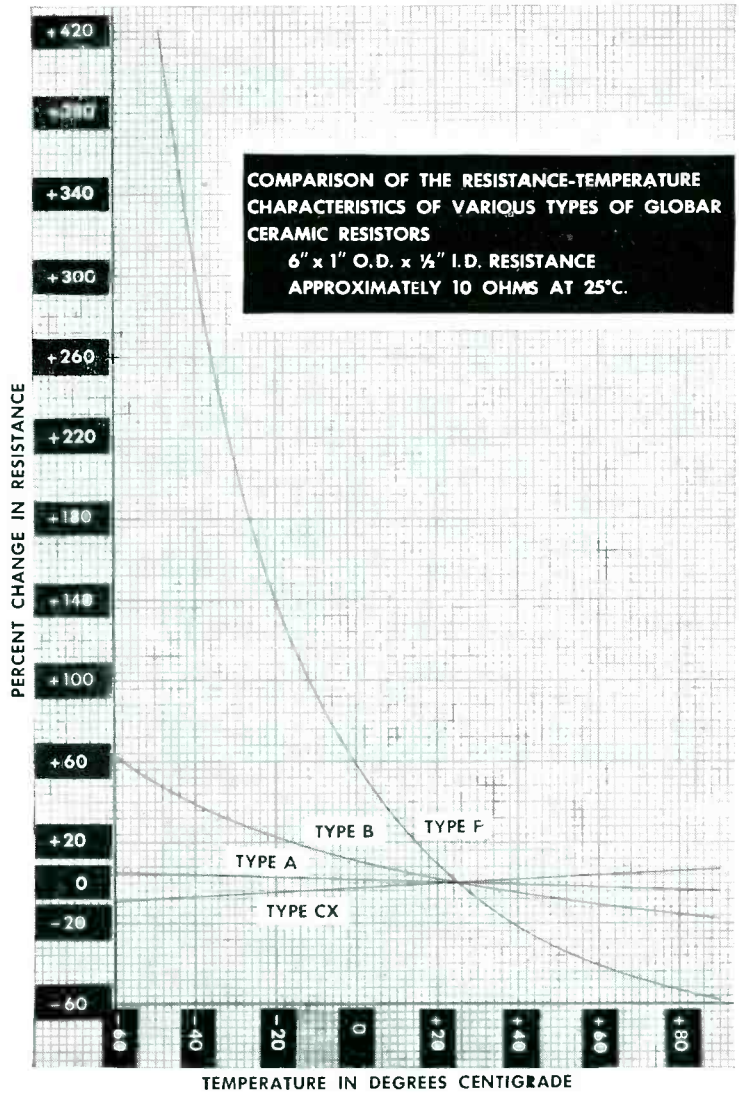
GLOBAR TEMPERATURE SENSITIVE RESISTORS

To CONTROL Circuit Performance

Variations in temperature need not affect the performance of delicate instruments and machines having coils or windings. To compensate for these variations, GLOBAR Brand Ceramic Resistors—having a negative temperature coefficient of resistance—provide an excellent solution. Connected in series with the coils or windings, they reduce the overall change in performance that occurs with change in temperature. Accurate and dependable circuit performance is assured.

GLOBAR ceramic NTC resistors are obtainable in a variety of types for applications requiring temperature ranges from 120°F to -60°F. The characteristics of these types were plotted on the accompanying graph from data secured from tests made in our laboratory.





TYPICAL SUGGESTED USES ARE:

1. Temperature correction for voltmeters, ammeters and other meters.
2. Compensation for increase in resistance of motor and generator field coils.
3. Compensation for increase in resistance of relay coils.
4. Direct measurement of temperature up to 400°F.
5. Protection of the cathode heaters of vacuum tubes.
6. Protection of pilot lights in A.C.-D.C. radio receivers.
7. Pilot flame protection.

Dept. V-10, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

GLOBAR Ceramic Resistors BY CARBORUNDUM

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(continued from p 122)

standing-wave ratio may be obtained in terms of transmission coefficient k_t. This parameter is equivalent to the normalized distance in from the outside circumference of the chart, a very easy value to use in dealing with high standing-wave ratios.

The graphical construction may be prepared from memory whenever needed. All that is required is a sheet of two-cycle log paper and a straight edge. The construction is derived as follows.

The well-known formula for voltage standing-wave ratio is written:

$$r_v = (1 + |k_r|)/(1 - |k_r|) \quad (1)$$

Add one to each side of the equation:

$$1 + r_v = (1 + |k_r|)/(1 - |k_r|) + 1 \quad (2)$$

Multiply by $(1 - |k_r|)$:

$$(1 - |k_r|)(1 + r_v) = 2 \quad (3)$$

Replace $(1 - |k_r|)$ by $|k_t|$, the transmission coefficient:

$$|k_t|(1 + r_v) = 2 \quad (4)$$

Let:

$$|k_t| = 1 - |k_r| = x \quad (5)$$
$$1 + r_v = y$$

obtaining for Eq. 4

$$xy = 2 \quad (6)$$

This is the equation for an equilateral hyperbola in Cartesian coordinates. A hyperbola plotted on logarithmic coordinates is a straight line at 45 degrees to the axes. We are interested only in the first quadrant and in abscissas (transmission coefficients) of unity and less. Figure 1 is a plot of such portion of a hyperbola back to $x = 0.02$. The abscissas have been labeled also in units of $1 - x = |k_r|$ and the ordinates have been labeled in units of $y - 1 = r_v$ more useful than y itself. The simple, easily constructed conversion chart results.

REFERENCE

(1) P. H. Smith, An Improved Transmission Line Calculator, ELECTRONICS, p 130, Jan. 1944; J. Markus and V. Zeluff, "Electronics for Engineers," McGraw-Hill Book Co., New York, p 326, 1945.

Paper-Thin Ceramic Sheets

FABRICATION OF CERAMIC dielectric plates comparable in thickness to that of paper and mica has been achieved in the National Bureau of Standards by a special technique for dry-pressing and firing. Special

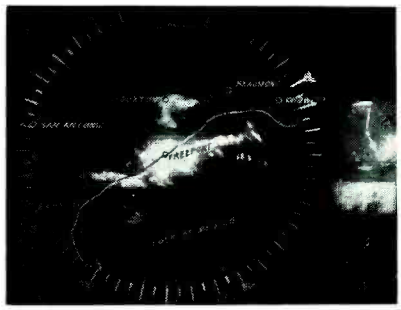
treatment is given the mixtures of calcines and bonding agent. A pressure of 20,000 psi on a layer of powder in a hardened steel mold converts the powder into a plate. Despite their thinness, these plates are sufficiently strong to be ejected from the mold without cracking and can be transferred without breakage to a sheet of glass for drying.

To preserve flatness during firing for 1 hour at 1,445 C, the 0.003 to 0.006 inch thick plates are stacked and are weighted with a refractory disc. To prevent adherence at high temperatures the stacked plates are separated from each other by thin layers of air-floated zirconium dioxide. The new plates make possible the construction of capacitors that can stand temperatures above 500 C yet are smaller than those made of paper or mica.

Radar Tracks Hurricanes

A MODIFIED SCR-784 radar set installed at Freeport, Texas by the Dow Chemical Co. in cooperation with the U. S. Weather Bureau has been found to be accurate and reliable in providing early warning data for Gulf Coast Dow plants as well as for the Weather Bureau's hurricane tracking program. The equipment detects the rainstorm associated with the hurricane, at reliable ranges up to 200 miles.

Vulnerability of Gulf Coast sites and nature of Dow plant operations necessitate that shutdown be started about 12 hours before occurrence of hurricane winds. Although Weather Bureau service usually provides one to several days warning of a storm's approach, it is not practical to keep the plant shut down at all times that a hurri-



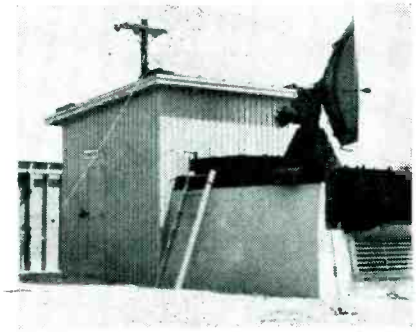
Radar ppi scope picture of line squall at Freeport, with geographical features dubbed in

cane exists in the Gulf. Accurate tracking by radar permits normal operation until the storm comes within a critical radius of the plant.

Energy returned by radio reflection from a drop of water varies as the sixth power of the ratio of drop diameter to wavelength. This means that 10,000-mc or 3-cm radar will indicate the presence of light rain or fog droplets with minimum diameter of about 1.2 mm. Such dispersions of water drops may produce a radio echo and still transmit a large percentage of the signal; at times, as many as three rainstorms in a row radially from a radar have been seen on the scope screen.

Modification of the SCR-784 automatic-tracking gun-laying radar involved slowing the pulse repetition frequency to 188 pulses per second to permit reception of echoes from objects up to 300 miles distant, reducing the ppi sweep speed, changing the range marker circuits to show 20-mile increments, using a larger parabolic antenna reflector to get a sharper beam, and doubling the original 0.8-microsecond pulse width. Automatic camera equipment was arranged to take a picture every minute for projection as a movie film. A 24-hour clock and date tab alongside the ppi tube identified each picture as to day and hour.

Hurricane data obtained thus far on the Texas coast has been of a negative nature because no hurricanes presented themselves for observation within the detecting range. This has permitted uninterrupted plant operation during two seasons of threatening hurricanes, according to W. F. Gerdes

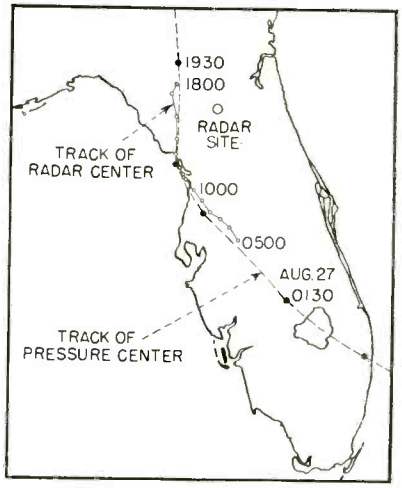


Modified SCR-784 installation by Dow Chemical Co. at Freeport, Texas, on level land about 18 feet above sea level and two miles from the open Gulf. Trailer is supported on concrete foundation. Emergency gasoline power unit is separately housed nearby

and R. C. Jorgensen of The Dow Chemical Co. in their paper presented at the 1949 National Instrument Conference.

Florida Hurricane

Positive results in tracking a hurricane with radar were announced by M. H. Latour and D. C. Bunting of the University of Florida in Bulletin Series 29 of the university's experiment station. Using an SCR 615B radar set on loan from the U. S. Air Force, they successfully tracked the Florida hurricane of Aug. 26-27, 1949 and obtained over 2,500 pictures at intervals of approximately 30 seconds to provide a continuous record of the storm as it passed within the 120-mile maximum range of the radar station near Gainesville, Florida. Equipment used operated in the 10-cm microwave band, with a peak transmitted power of approximately 1 megawatt.



Solid line is route of Aug. 1949 Florida hurricane as tracked with radar at Gainesville, and dashed line is track of pressure center as determined from U. S. Weather Bureau data

Two-Anode Phototube

A NEW vacuum phototube with a photoemissive cathode and two anodes has been designed for use in circuits where the phototube transfer constant must be rapidly altered, such as in fast-acting electro-optical pyrometers and in other applications that can utilize a large but linear variation in gain with voltage on the control anode. The tube and its applications were de-

scribed by J. H. Crow and V. C. Rideout of the University of Wisconsin at the 1949 National Electronics Conference in Chicago.

The new tube, designated CE 70V, is a vacuum version of a gas phototube manufactured by Continental Electric Co. for quite a different purpose. It is an end-on type of tube with two ring anodes and a flat disc-type cathode. The outer ring is used as the main or load anode, and the inner control anode is used to vary the amount of emission current reaching the load anode.

Static response curves for this tube are shown in Fig. 1. The output is quite linear with control voltage over an appreciable range for the various values of light intensity used. A combined curve of microamperes per foot-candle versus control voltage would illustrate the uniformity of the multiplier characteristic of this tube.

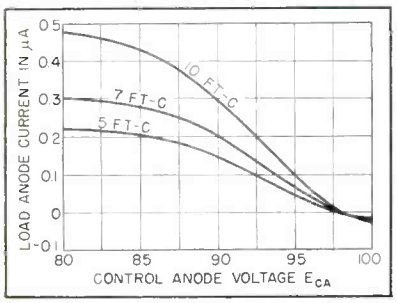
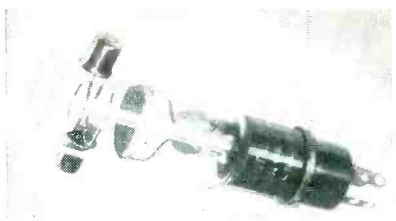


FIG. 1—Static response curves of CE 70V vacuum phototube with load anode voltage of 91.4 volts and load resistance of 2.88 megohms

The control action resembles that in a pentode such as the 6AS6 in which the variation of suppressor voltage causes plate current to be diverted to the screen. Here the control anode combines the functions of the suppressor and screen in the 6AS6. The small amount of current diverted from the load anode will not affect a low-impedance source driving the control



New CE 70V double-anode vacuum phototube with end-on construction

anode of the new tube.

This phototube can be used for the modulation of light intensity signals on a much higher-frequency carrier than is possible by mechanical light-chopping methods. Tests have indicated that with capacitance neutralization, carrier frequencies of over 100 kilocycles are possible; this figure can probably be raised to over one megacycle.

Other applications are possible in the field of instrumentation whenever the instantaneous multiplication of the value of a varying light intensity by a voltage is required.

Three-Component Magnetometer

By John W. Seaton

Naval Ordnance Laboratory
Washington, D. C.

Precise measurement of steady magnetic fields was greatly aided by the development of the high-permeability alloys such as Permalloy and Mumetal. Two desirable properties which these alloys have for this application are low saturation point and high second derivative d^2B/dH^2 at the knee of the B-H curve. The former property permits the use of low-power oscillators and amplifiers, along with coils of relatively few turns for producing the alternating magnetic fields which will drive high-permeability cores to the knee of the B-H curve.

The flux in the core may be carried into and beyond the knee of the magnetization curve by each half cycle of a sinusoidal exciting current.

If a steady magnetic field is now applied to the core, the excursion into saturation will be greater on one half of the cycle than on the other, resulting in an unsymmetrical flux pattern in the core, inducing voltages in the coil winding of even harmonics of the fundamental. The amplitude of these even harmonics will depend on the degree of unsymmetry and hence on the steady magnetic field intensity. The phase of any one of these even harmonic voltages will change 180 deg if the direction of the steady magnetic field is reversed.

If the maximum amplitude of the

exciting current is adjusted so that the core is magnetized to the point on the knee of the B-H curve where d^2B/dH^2 is a maximum, maximum unsymmetrical distortion of the flux will result when a small steady magnetic field ΔH is applied to the long axis of the core. The second harmonic voltage induced in the coil or the resulting current may be used as an indication of the direction and magnitude of a steady magnetic field.

General Description

This article describes an electronic device designed to measure three orthogonal components of steady magnetic field with an accuracy of plus or minus 0.1 milligauss. The block diagram is given in Fig. 1. It was designed for the U. S.

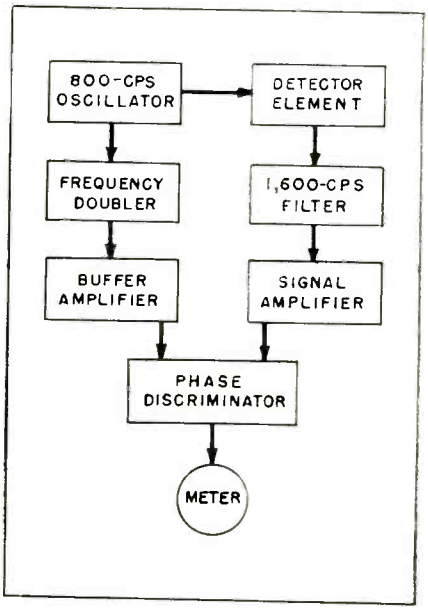


FIG. 1—Block diagram of 3-component magnetometer

Navy at the Naval Ordance Laboratory, White Oak, Maryland, to satisfy a need for an extremely small instrument capable of measuring the magnetic field in and around ships' binnacles, particularly at the compass position.

From a simple geometric rule that the resultant of three mutually perpendicular vectors is the square root of the sum of the squares of each of the three vectors, the magnetic-field intensity at the desired point can be obtained.

The function of the electronic cir-

cuit in this device is to isolate and measure the second harmonic signal which is a function of the steady magnetic field. The winding around the saturable core is supplied with an 800-cps current from an oscillator. The distortion of the flux due to saturation generates harmonics in the winding. Since the driving point impedance is low, currents at harmonic frequencies flow around the series loop consisting of the driving point impedance, the coil winding and a small series resistor. The voltage across this resistor is of the same waveform as the current flowing through it. This voltage is filtered so that only the second harmonic component passes. This is amplified and applied to a phase discriminator where it is compared with a second harmonic voltage of constant phase and amplitude. A zero-center meter indicates the direction of the magnetic field and the deflection is a measure of its amplitude.

This would be sufficient to indicate the field were it not that the meter indication is not linear with the magnetic field. To prevent error, a null method is used. This involves placing another coil around the core as in Fig. 2 and passing direct current through this coil to produce an opposing field which can be calculated from the measured current. When the net field on the core is zero, the null meter at the output of the phase discriminator will read zero.

Errors and Their Compensation

Second harmonic distortion in the exciting voltage applied to the sat-

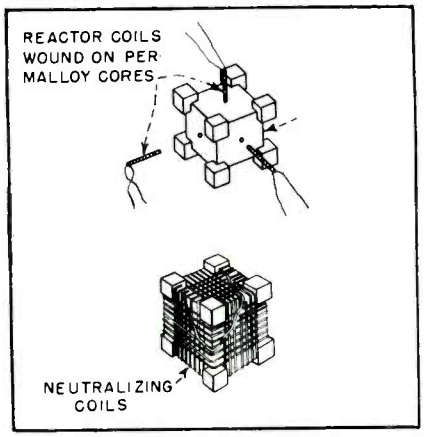


FIG. 2—Detector unit with and without neutralizing coils. Drawing is approximately full scale. Control block is Synthane

urable reactor appears as a false field indication. Only that component of the distortion which is in phase or 180 degrees out of phase with the true field signal appears as field indication. The other component of this distortion, which would be 90 degrees out of phase, will appear equally in both sides of the discriminator and hence balance out. The false field indication is corrected by passing a small direct current through the exciting winding, producing a field of such amplitude and direction as to generate second harmonic voltage in the coil winding which will exactly cancel the signal due to input voltage distortion. By placing a reversing switch at the input terminals to the saturable reactor, the false field signal can be alternately added to and subtracted from the true field signal; the true field reading will be half way between the readings obtained for the two positions of the reversing switch.

A false field reading may also be obtained due to unbalance between the two tubes of the phase discriminator. This can be corrected by eliminating the detector signal from the grids of the discriminator tubes and adjusting the output of one discriminator tube until the null meter reads zero.

Description of Equipment

The 800-cps oscillator is of the push-pull tuned-grid type, as indicated in Fig. 3. A series arm in the output is antiresonant to the second harmonic, and a shunt arm (which includes the output transformer) is antiresonant to the fundamental. The 5-ohm secondary of the output transformer produces four volts of fundamental frequency with 0.1-percent second harmonic. Each saturable reactor consists of a 4–79 molybdenum Permalloy tube of 1/16-inch diameter, 5/8-inch long, formed by rolling up a sheet of Permalloy 1/4 x 5/8 x 0.001 in. The winding, consisting of two layers of No. 38 Formex magnet wire, is wound directly on the Permalloy.

A three-position switch SW_1 selects detector element L_1, L_2 or L_3. Compensating resistors R_1, R_2 and R_3 permit adjustment of the direct current in the detector elements. This direct current is blocked from transformer T_1 and T_2 by capacitors C_1, C_2 and C_3. Switch SW_4 permits reversal of both the output voltage of T_1 and the compensating direct current through the exciting winding while making the zero adjustment. One set of contacts on

FIG. 3—Circuit diagram of three-component magnetic field measuring instrument

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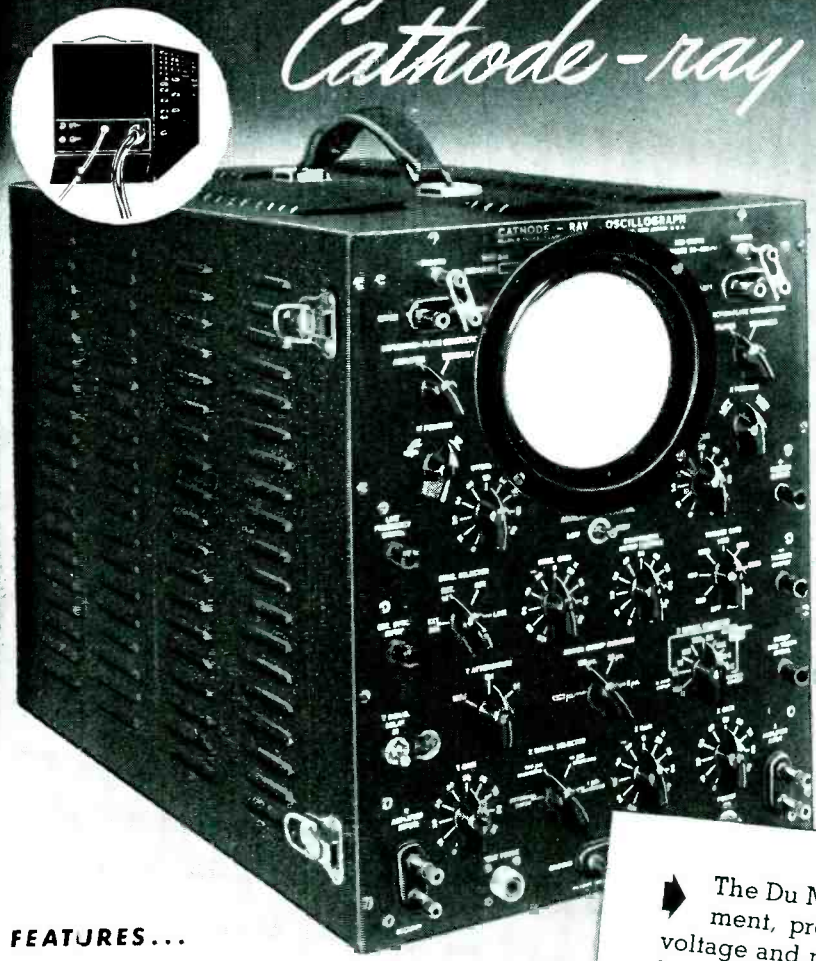

Type 248-A

at a greatly reduced price

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The Du Mont Type 248-A, in a single instrument, provides the utility of both a high-voltage and medium-voltage cathode-ray oscillograph.

For the study of high-speed transient phenomena no modification is necessary to operate the instrument's Type 5RP-A Cathode-ray Tube at an overall accelerating potential of 4,000 volts with the Du Mont Type 263-B High-Voltage Power Supply.

Operated at a potential of 4,000 volts by an internal supply, the Type 248-A is useful in general-purpose research applications including detailed study of low-frequency signals containing high-frequency components.

FEATURES...

Wide-band amplifier—response to 5 mc. (down 3 db)—useful to 10 mc.

High overall deflection sensitivity.

High-vacuum sweep circuit.

Recurrent sweeps variable from 15 to 150,000 cps.

Driven-sweep durations of 5, 25, 100, 1000 microseconds.

High light output even at 4,000 volts

0.5 microsecond delay for complete display of short duration pulses.

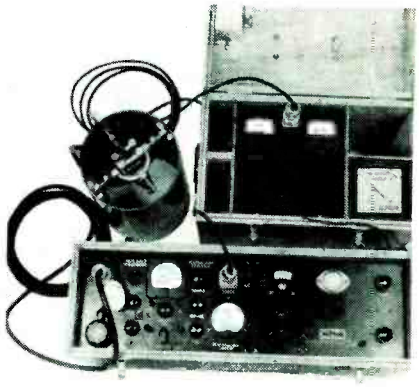
Intensity modulation.

Timing markers on driven sweeps at intervals of 1, 10, or 100 microseconds.

Pulse output for use as a synchroscope.

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY



Magnetic field detector unit is shown mounted in a substitute binnacle alongside the control unit and battery case

SW_4 is used to short-circuit the input of the signal amplifier to ground when balancing the phase discriminator. The variable resistor R_4 permits adjusting the exciting current through the reactors to a very small value before any switching. A snap-action switch is operated by rotating R_4 to its minimum-resistance position, insuring that no resistance remains in the circuit when R_4 is at the USE position.

The voltage developed across R_5, R_6 or R_7 by the current which passes through the saturable reactors is applied to F_1, a 1,400 to 1,800-cps pass-band filter with attenuation outside the pass band at 60 db.

The 1,600-cps output of the frequency doubler and buffer amplifier is applied push-pull to the screen grids of the discriminator tubes. The 1,600-cps voltage from the signal amplifier is applied simultaneously to the control grids of both discriminator tubes. Since this voltage changes phase 180 degrees with reversal of magnetic field, and is approximately proportional to the field strength, the tube current in each discriminator tube will depend on the algebraic sum of the two 1,600-cps grid voltages.

The discriminator tubes are biased near cutoff, hence the d-c component through each tube will be a function of the phase and amplitude of the 1,600-cps signal. A bypass capacitor C_1 eliminates the 1,600-cps component from the null meter. The meter will then indicate the difference in the d-c voltage drops across R_8 and R_9. The direction of deflection will indicate the magnetic field orientation, and the magnitude of deflection, within

limits, will indicate the magnetic field strength.

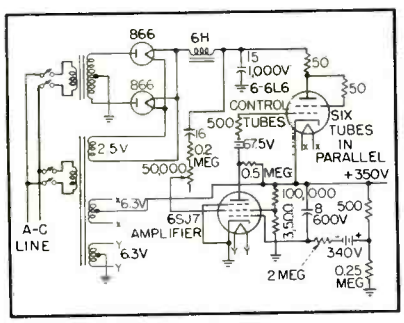
The neutralizing circuit controls the direct current in a winding around the detector housing. This permits a known magnetic field to be applied to each of the saturable reactors with such a direction and magnitude as to exactly cancel the field component being measured.

The null meter reads zero when this condition is achieved. The accuracy of field measurement then depends on the sensitivity of the null meter near zero, and also on the accuracy of the potentiometer or the current meter M_1, in indicating the current necessary for neutralizing. The neutralizing current must be calibrated in a known field—in oersteds per ma.

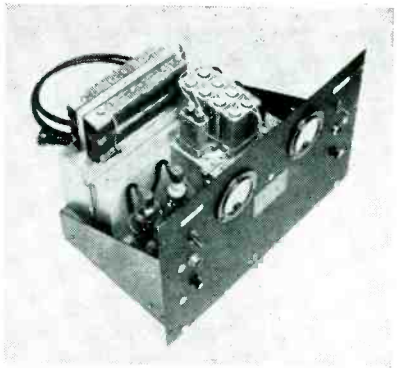
Heater-Compensated Supply

IN A NEW METHOD of compensating for line-voltage changes in stabilized d-c power supplies, developed by R. C. Ellenwood and H. E. Sorrows at the National Bureau of Standards, heater-voltage fluctuations are used to compensate for line-voltage fluctuations. A type 6SJ7 pentode can be used as the amplifier. Small portable dry batteries provide a reference voltage nearly equal to the output voltage, so the full change in output voltage is applied to the control grid of the amplifier tube.

The control function is performed by several 6L6's connected in parallel. Six tubes can carry a load current of 250 ma and present an internal impedance of only 2 ohms. When a change occurs in the heater voltage of the amplifier tube, the re-



Heater-compensated stabilized power supply providing 350 volts d-c output at 250 ma



Miniature batteries at rear provide 340 v d-c for reference, in no-drain grid circuit giving long battery life

sulting change in the amplifier plate current produces a proportional change in the voltage across the grid resistor of the control tube. This effect produces an additional compensation for line-voltage changes. For a 10-volt change in a-c line voltage, the heater-compensated power supply shows a maximum deviation of only 0.01 volt from the nominal 350-volt d-c output. This is a variation of less than 0.0005 percent in output voltage for a one-percent change in the line.

The compensating voltage exhibits a time lag dependent on the time necessary for the cathode temperature to come to equilibrium. The effect of this time lag can be reduced by connecting a series RC circuit between the input terminal and the screen grid of the amplifier. When a sudden change of line voltage occurs, this RC circuit applies the proper voltage to the screen grid of the amplifier to compensate for the thermal time lag of the cathode temperature. The time constant of the RC network was chosen to equal that of the cathode temperature change.

Balloon Altitude Controls

NEW CONTROLS which hold meteorological balloons at remarkably constant altitude levels were described by James R. Smith of the New York University College of Engineering, at a joint session of the A.A.A.S. and the American Meteorological Society in Vancouver, B. C. on June 14.

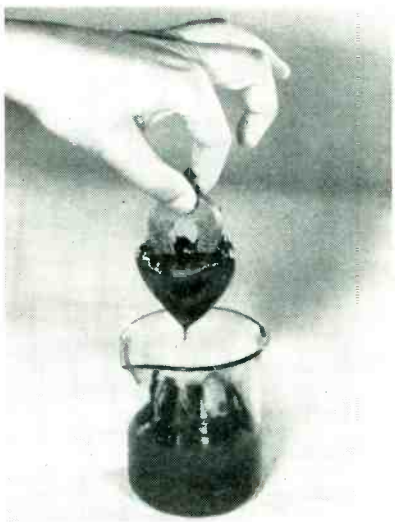
Controls have been developed to keep plastic instrument-carrying

balloons at one or more selected constant pressure altitudes. The balloons have carried loads to 100,000 feet, have held within 2 millibars of a constant pressure and have remained aloft 75 hours.

SURVEY OF NEW TECHNIQUES

RADIOACTIVITY is being used to trace the movement of atoms in metals at the General Electric Research Laboratory. In one experiment, it was found that silver atoms within a block of silver may move between the grains as fast as 0.1 inch per week at 500 C. Radioactive isotope silver-110 was electroplated on the surface of an ordinary silver block. After heating several hours, the specimen was cooled and layers the thickness of tissue paper were shaved from the block. Each layer was checked for radioactivity with a Geiger counter, to determine how far into the block the tagged atoms had gone. In another experiment a solution holding radioactive iron is electroplated onto the surface of the metal to be studied, and a photographic plate is placed against this surface for several days. As the test metal rusts, a decrease in radiation results, showing up graphically as lighter areas on the photographic plate.

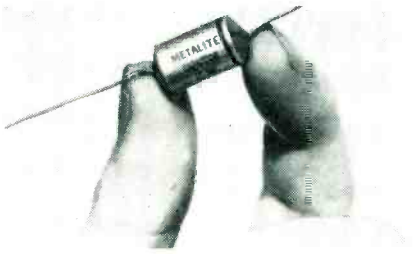
MAGNETIC FLUID that forms heart of NBS magnetic fluid clutch can be lifted with permanent magnet. Fluid mixture of fine iron powder and oil solidifies by mutual attraction of iron particles when acted on by magnetic field.



signed for transformer operated television sets with high peak inter-electrode voltages.

Five-Gun Tube

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa., has developed the 55JG five-gun type c-r tube that registers five independent phenomena on a single five-inch, flat-face screen. The individual electron guns are of the A or zero-first-anode type and are adequately shielded from each other. Overall length of the tube is 18§ inches, and it is available in any of the standard phosphors.



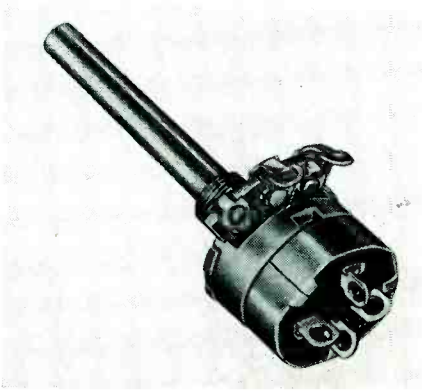
Midget Capacitors

ASTRON CORP., 900 Passaic Ave., East Newark, N. J. The Metalite midget metallized paper capacitor is approximately one-third the size and weight of conventional paper and foil designs. It features self-healing after rupture of the dielectric and is available in voltage ratings up to 600 volts, either hermetically sealed or in a cardboard tube.

D-C Power Supply Kit

OPAD-GREEN CO., 71 Warren St., New York 7, N. Y., announces a line of d-c power supply kits for obtaining 24 to 28 volts from a 115-volt, 50 or 60 cycle a-c source. Primarily designed for testing and ground

operation of aircraft and marine equipment, the kits are available in 2, 5, 10, 15 and 20-ampere capacities, and are also suited for installation in existing equipment, for operation of broadcast control relays and signal lights. All units feature a primary tapped transformer which permits adjustment of the d-c output voltage, a full-wave bridge-type rectifier and a filter network which maintains ripple within 2 percent under full load conditions.



Line Switch

STACKPOLE CARBON CO., St. Marys, Pa. Type A-10 small-size double-pole line switch for volume, tone and other variable resistor controls is rated 1 ampere at 250 volts or 3 amperes at 125 volts a-c and d-c. Other ratings are also available. The switch is 0.888 inch in diameter by 0.312 inch thick. Adaptable to many uses, it is particularly suited for portable and auto radios.

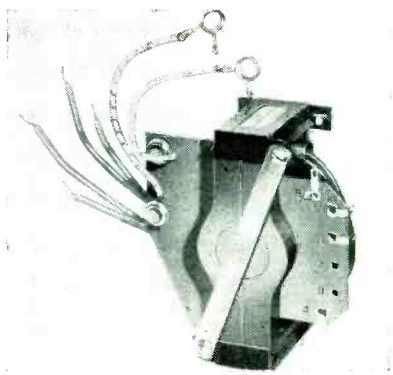
Transmitter Transfer

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC., 3090 Douglas Road, Miami, Florida. A new automatic transfer unit recently developed can be used for radio transmitters and beacons that use standby equipment. The transfer can be set to function on either low carrier power or low modulation level for

equipment using either keyed or continuous modulation.

Tele Multiplier Probe

INSULINE CORP. OF AMERICA, 3602-35th Ave., Long Island City 1, N. Y. The Kilovolter multiplier probe provides positive protection against the highest television voltages. It is 8½ inches long and is fitted with a 5-foot heavy-duty test lead. Three models are available, for 50, 100 and 200 μa meter movements.



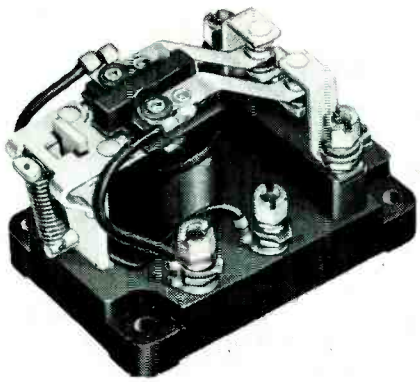
Television Replacements

STANDARD TRANSFORMER CORP., 3580 Elston Ave., Chicago 18, Ill. The deflection and high-voltage transformer shown above is illustrative of a line of exact RCA-type replacement parts available. Complete description and prices are supplied in bulletin DP-354.

TVI Wave Traps

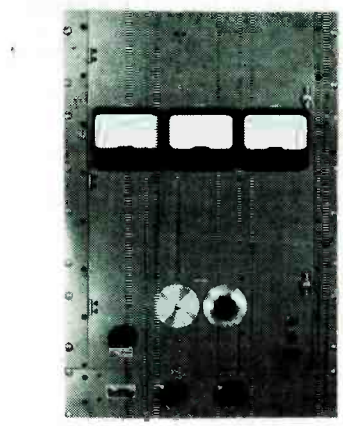
DECIMETER, INC., Denver, Colorado. A series of three tvi wave traps is

designed to be applied to the 300-ohm lead-in to television sets to alleviate interference from any source in the ranges of 20 to 26 mc, 25 to 35 mc, and 88 to 108 mc. The traps kill interference from f-m broadcast, diathermy, 10-meter amateur, and reject spurious i-f signals. The devices slide around the antenna lead-in requiring no cutting of the lead-in and no ground connection.



Midget Magnetic Relays

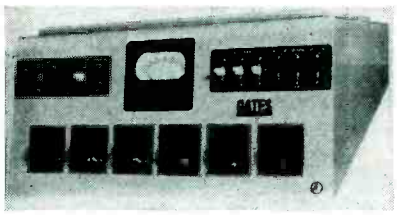
WARD LEONARD ELECTRIC CO., 31 South St., Mount Vernon, N. Y. Bulletin 110 multipole midget magnetic relays are designed for such applications as traffic signal, machine tool, alarm heater and similar controls. Coils are available for operation on all standard voltages and frequencies up to 115 volts a-c or d-c. Noninductive ratings for n-o and n-c contacts are 10 amperes, 24 volts d-c or 115 volts a-c, 60 cycles.



R-F Phase Monitor

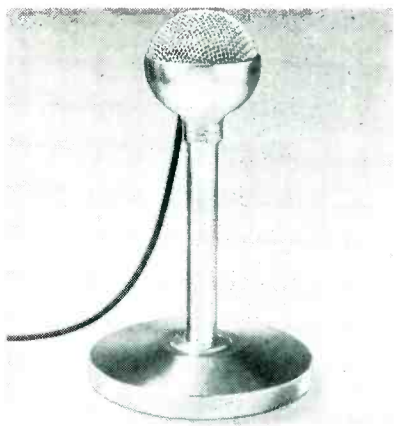
CLARKE INSTRUMENT CORP., 910 King St., Silver Spring, Md. Model

109 high-precision phase monitor was designed for measuring phase relations at radio frequencies. The instrument has an absolute accuracy of ±1 degree and resolution and repeatability of ±0.1 degree. Phase is read directly from two dials calibrated in 0.1-degree increments, with no manipulation required on the part of the operator. Provision is also made to indicate antenna current in the various towers of a directional array.



Studio Control Console

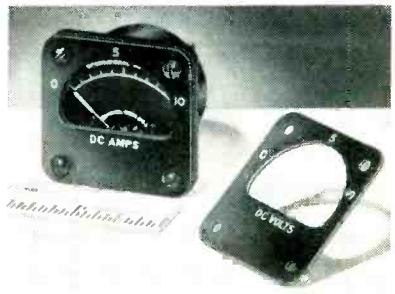
GATES RADIO CO., Quincy, Ill. Model 52-CS Studioette is a medium-size studio control console that may be used for a-m, f-m or tv in main or sub-studio service. The unit is a complete speech input system with provisions for four microphones, two transcription turntables, network and remote lines. It is provided with preamplifiers for microphones plus line and monitoring amplifier for the high-level circuits. A complete descriptive brochure is available.



Crystal Microphone

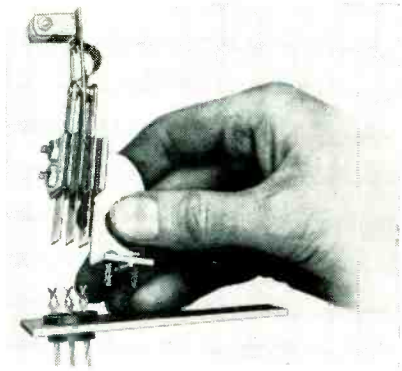
ELECTRO-VOICE, INC., Buchanan, Mich. The Model 920 Spherex crystal microphone features a 360-deg omnidirectional polar pattern, substantially flat frequency response from 60 to 7,000 cps, output

level of −60 db and high impedance. It is designed for use in conference recording, round table discussions, home recording, amateur radio, public address and similar applications. It is available with either 8 or 20-ft cable.



Panel Meter

INTERNATIONAL INSTRUMENTS, INC., 331 East St., New Haven 11, Conn., announces a new 1½-in. diameter panel meter with interchangeable face plates. One basic meter can be used for several ranges by adding external accessories and by changing the face plate. The d-c self-contained instrument ranges from 50 to 500 μa, from 1 to 500 ma and from 1 to 15 amperes. As an a-c meter of the rectifier type the range is 1 to 500 volts completely self-contained. Accuracy is ±2 percent of full scale for d-c, ±5 percent when used as an a-c instrument.



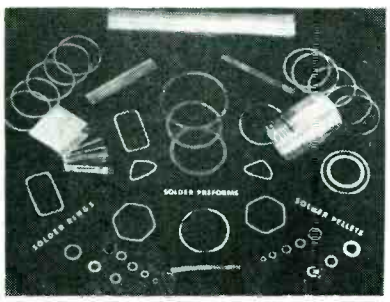
Interrupter Machine Switch

STROMBERG-CARLSON, 108 Carlson Road, Rochester 3, N. Y. The snap-action switch shown has application in timing machines for interrupting electrical currents in cycles from 0.50 second to two minutes. Contacts have a rating of 7½ amperes at 110 volts a-c. The switches oper-

ate in conjunction with a standard speedreducer motor for 110-volt a-c or for 24-volt or 48-volt d-c.

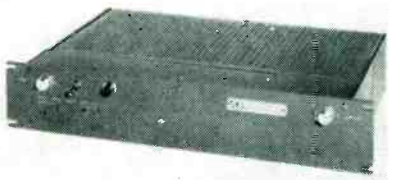
New Core Material

NORTH AMERICAN PHILIPS CO., INC., 100 East 42nd St., New York 17, N. Y. The new ferro-magnetic ferrite, Ferroxcube, has recently been announced as a new transformer core material available for such components as horizontal output transformers in television receivers. The material has a high permeability, greater than ten times that of powdered iron, and at the same time a high electrical resistivity, ten million times as great as that of iron. Eddy current losses are reduced by virtue of this latter characteristic.



Solder Preforms

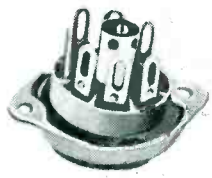
KESTER SOLDER CO., 4201 Wrightwood Ave., Chicago 39, Ill., announces availability of solder preformed in rings, pellets, washers, unusual shapes and sizes to specifications. It is designed to provide uniform results where continuous or repetitious soldering is required. By supplying the same amount of solder and flux on every unit soldered, waste is eliminated and rejects are reduced.



Wide-Band Chain Amplifier

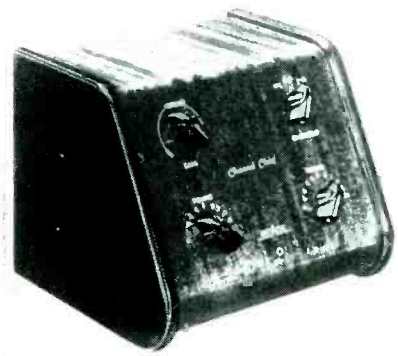
SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 202 P chain

amplifier has a bandwidth of 200 mc, an impedance of 200 ohms and a gain of 20 db. The regulated power supply insures constant gain within ±1 percent for line voltage variations of ±10 percent. Using a traveling-wave circuit composed of two stages of six 6AK5 tubes, the amplifier has a transmission characteristic of ±1.5 db.



Miniature Tube Sockets

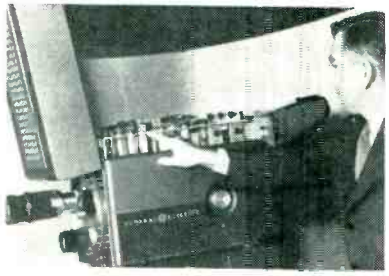
MYCALEX TUBE SOCKET CORP., 30 Rockefeller Plaza, New York 20, N. Y. A line of seven-pin miniature tube sockets is obtainable on Mycalex 410, developed for applications requiring close dimensional tolerances not possible in ceramics and at lower loss factor than mica-filled phenolics; and in Mycalex 410X, with a loss factor of only about one-fourth that of general purpose bakelite. Sockets are manufactured to precise specifications.



Television Booster

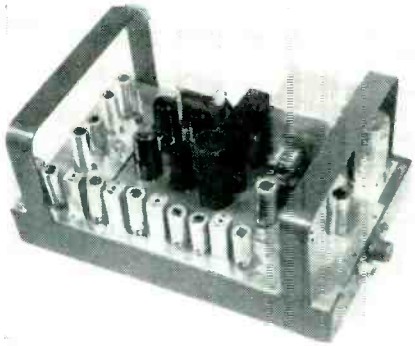
THE ASTATIC CORP., Conneaut, Ohio. The Channel Chief, Model AT-1 Booster uses four tubes to produce high gain uniformly over all 12 television channels. The instrument features dual tuning controls permitting separate adjustment for best picture definition and best sound, and also increasing the front-end selectivity of receivers. The unit also has a variable gain

control. A self-contained power supply operates from 115-volt, 60-cycle a-c power line.



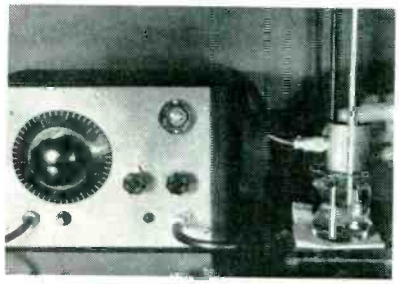
Electronic Viewfinder

GENERAL ELECTRIC CO., Syracuse, N. Y. A new viewfinder capable of 500-line definition is now available for television cameras. Video response is uniform to 7 mc within plus or minus half a db. As normally used with mixed blanking, there is no observable tilt in a 60-cycle square wave. Construction and placement of the new unit allows easy servicing.



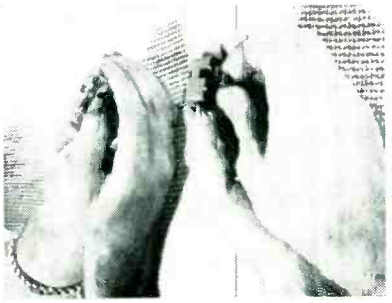
Bus Broadcast Receiver

COLLINS AUDIO PRODUCTS CO., INC., P. O. Box 368, Westfield, N. J. Model T-20-A f-m receiver, designed



DIELECTRIC CONSTANT of liquids can now be quickly and accurately measured from unity to 85 with the equipment shown. The magic eye winks at you when the proper adjustment has been obtained and the desired information is read from the dial, according to *Yellow Springs Instrument Co., Inc.*, of *Yellow Springs*, Ohio.

especially for use in contract bus reception has a sensitivity of 5 microvolts, an image ratio of better than 1,500-to-1, and an i-f bandwidth of 150 kc. Ultrasonically controlled relays that are actuated by tones from the broadcast station can either raise the audio level of the receiver (during announcements) or cut off the audio section entirely (for commercial announcements not paid for over the transit system).



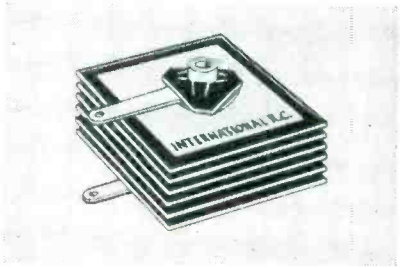
Twin-Stylus Cartridge

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced Model RPX-050 twin-stylus variable reluctance phonograph cartridge, capable of playing conventional and microgroove records. Changing from one stylus to the other is accomplished by depressing and turning a knob on the top of the cartridge, which projects through the tone arm of the player. It is not necessary to disturb the cartridge itself. The cartridge shows a wide-range frequency response curve over the useful range of 40 to 10,000 cycles.

Circuit Tester

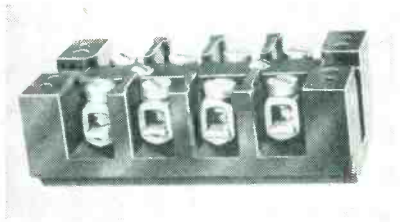
GITS MOLDING CORP., 4600 West Huron St., Chicago 44, Ill. The Cord Visual Circuit Tester is designed for use on all low-resistance circuits of 50 ohms and under. Using two penlight battery cells, the device resembles a pocket flashlight. A test clamp is fastened to the rubber-covered wire which connects

with the battery through the screw button at the back end. At the other end, next to the bulb, is a test prod about 1 in. long. In use the bulb lights up if the circuit is good.



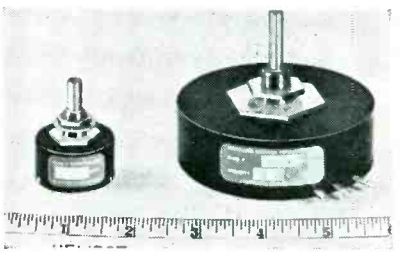
Miniature Dry Rectifiers

INTERNATIONAL RECTIFIER CORP. 6809 South Victoria Ave., Los Angeles 43, Calif. A new line of miniature selenium rectifiers has been developed for half-wave use having a maximum peak inverse voltage of 380 volts. Current ratings available are 75, 100, 150, 200, 250, 300 and 350 ma.



Barrier Terminal Block

BUCHANAN ELECTRICAL PRODUCTS CORP., 1290 Central Ave., Hillside, N. J. A new solderless molded terminal block handles wires in sizes from 16 to 6 AWG, affording a compression type connection. It is available in 4, 8 and 12-circuit sizes. Other types suitable for radio and electronic terminations are described in a catalog sheet.

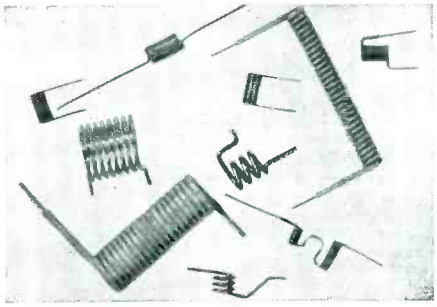


Linear Potentiometers

THE HELIPOT CORP., South Pasadena, Calif. A new line of single-turn precision linear potentiometers

TELEVISION Coils

STRIPPED AND TINNED, READY FOR ASSEMBLY



Take advantage of the time and money-saving features of these television coils made to your specifications and ready for immediate assembly.

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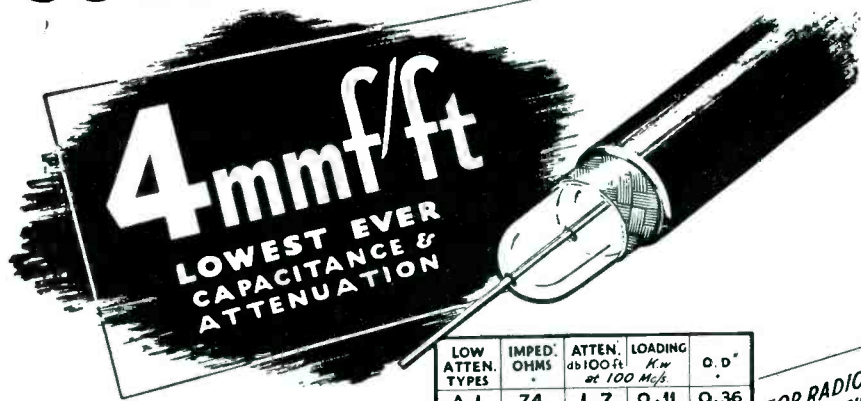
TELEX DEPT. B-20-1, TELEX PARK MINNEAPOLIS, MINNESOTA

In Canada, Atlas Radio Corp., Toronto

HEARING AT ITS BEST — TELEX ELECTRO-ACOUSTIC DIVISION TELEX PARK Minneapolis, Minn.

CO-AX AIR-SPACED ARTICULATED R.F. CABLES



FOR RADIO FREQUENCIES

	LOW ATTEN. TYPES	IMPED. OHMS	ATTEN. db 100 ft at 100 Mc/s.	LOADING Kw	O.D"
HIGH POWER FLEXIBLE	A.1	74	1.7	0.11	0.36
	A.2	74	1.3	0.24	0.44
	A.34	73	0.6	1.5	0.85

FOR VIDEO and SPECIAL APPLICATIONS

	LOW CAPAC. TYPES	CAPAC. mmf/ft	IMPED. OHMS	ATTEN. db 100 ft. 100 Mc/s.	O.D"
PHOTOCELL CABLE	C 1	7.3	150	2.5	0.36
	P.C 1	10.2	132	3.1	0.36
VERY LOW CAPACITANCE CABLES	C.11	6.3	173	3.2	0.36
	C.2	6.3	171	2.15	0.44
	C.22	5.5	184	2.8	0.44
	C.3	5.4	197	1.9	0.64
	C.33	4.8	220	2.4	0.64
	C.44	4.1	252	2.1	1.03

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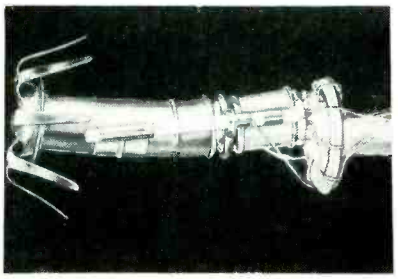
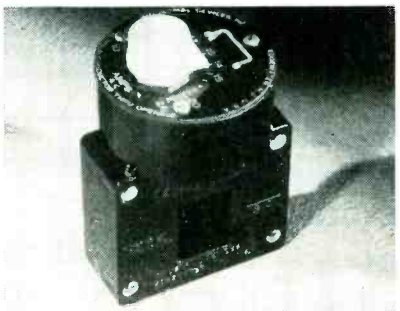
feature continuous rotation. The smaller potentiometer, Model G, is particularly adapted to transmitting use and aircraft installation; the larger, Model F, is designed and engineered for various types of computer systems. Nominal resistance values of both models are normally held within ±5 percent but can be maintained at tolerances as low as ±1.0 percent if required. Power dissipation rating of each is determined at a maximum continuous operating temperature of 80 C, which represents an internal temperature rise of 40 C above an ambient of 40 C.



Bent-Gun Ion Trap

ALLEN B. DU MONT LABORATORIES, INC., 2 Main Ave., Passaic, N. J., now features a bent-gun ion trap in its 12½, 15½, 16 and 19-in. television tubes. The electron and ion beam is aimed by bending the gun so that the ions will be trapped by the anode barrel structure, and the electron beam is then brought to the axis by the action of a single magnetic field. This design eliminates screen blemishes due to ion bombardment and offers short neck length.



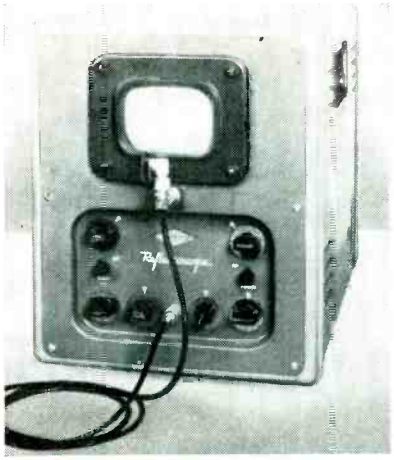
Current Indicator

INDUSTRIAL DEVICES, INC., Edgewater, N. J. The Mini-Amp indicates load current of motors and other a-c operated electrical devices. It is less than 2 × 2 × 1 inch thick

with an opening in the center through which is passed the line carrying the current. Depending upon the number of turns through the center, a neon indicator lamp glows at minimum amperage flow. Accuracy is held within 5 percent. The neon indicator is guaranteed for a service life of at least 25,000 hours.

Tele Signal Generator

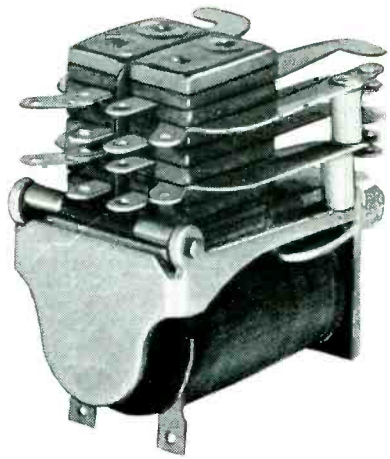
SUPERIOR INSTRUMENTS CO., 227 Fulton St., New York, N. Y. Model TV-30 television signal generator enables alignment of television i-f and front ends without the use of oscilloscope. Four frequency ranges are 18 to 32 mc, 35 to 65 mc, 54 to 98 mc, and 150 to 250, without switching. Audio modulating frequency is 400 cycles (sine wave).



Nondestructive Tester

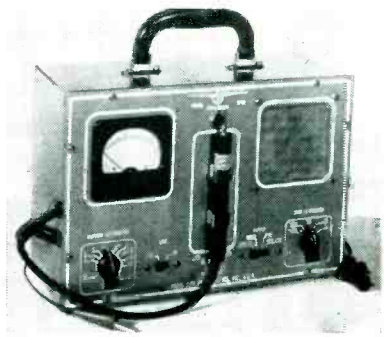
SPERRY PRODUCTS, INC., Danbury, Conn. The new type UR ultrasonic Reflectoscope can be used for metals and many other materials in quality control. The device employs the reflection of ultrasonic waves to indicate on a cathode-ray oscilloscope the presence of flaws or cracks in

castings, shafts, gears, and forgings. A complete description and method of use are given in bulletin 50–105.



Miniature Relay

AMERICAN RELAY & CONTROLS, INC., 4926 West Flournoy St., Chicago 44, Ill. Type TKL miniature, telephone-type relay is available in contact combinations up to four-pole double throw in either silver or palladium contacts. Contacts are rated at 1 ampere at 115 volts a-c or 1 ampere at 32 volts d-c noninductive. The relay is $1\frac{13}{32}$ in. long, $\frac{61}{64}$ in. wide, and height varies in accordance with contact combinations, normally $1\frac{17}{32}$ in. A four-page illustrated bulletin is available.



Signal Tracer

RADIO CITY PRODUCTS CO., INC., 152 W. 25th St., New York 1, N. Y. Model 777A Dynatrace provides a speedy type of trouble-shooting tool for tracing any type of disturbance or circuit defect from the antenna to the speaker. It indicates noise pickup at the antenna, checks avc, afc, link and filter circuits. Input capacitance is 3 $\mu\mu$f. Attenuation

is 10,000 to 1 by means of a ladder attenuator with vernier control. Sensitivity is 10,000 μv for full scale deflection of meter or 200 μv per division. Frequency range covers approximately 160 mc.

Voltage Stabilizers

RAYTHEON MFG. CO., Waltham, 54, Mass. The new multiple-unit type voltage stabilizers were designed for capacities in excess of 2 kva. Multiple sections of 500 or 625-watt capacity are built up on rails and connected in parallel with input and output connections located in a separate junction box. Capacities can be built up to 10,000 watts. The stabilizers deliver controlled output voltage to $\pm\frac{1}{2}$ percent over their full rating.

Radioactive Counter Tubes

N. WOOD COUNTER LABORATORY, Box 76, Route 1, Chesterton, Ind. Mica end window counters are now available having a $1\frac{1}{16}$-in. window, 2 to 3 milligrams per square centimeter sealed to a stainless steel cathode by means of fused glass. The seal is unaffected by heat or filling vapors and remains tight since there are no gaskets or resins. The counter tubes have long flat plateaus, low backgrounds and long life.

Literature

Facsimile Accessories. Alfax Paper and Engineering Co., 46 Riverside Ave., Brockton, Mass. Use of facsimile techniques is practically unlimited in the fields of signal recording, data memory, monitoring, analysis studies and telemetering. Suggestions along these lines and lists of materials necessary for facsimile recording are presented in two new brochures.

Industrial Electronic Coatings. Microcircuits Co., New Buffalo, Michigan. The manufacturers of micropaint, magnepaste, and magnepaint will gladly send copies of a new publication that covers pos-

sibilities and applications of conducting, resistance and magnetic paints. Those working with printed circuits should not fail to obtain a copy.

V-T Voltohmmeter. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill. The new model 303 vacuum-tube voltohmmeter can be used as an electronic d-c voltmeter, and ohmmeter, an a-c voltmeter, and a-f voltmeter, and r-f voltmeter, an output meter and an f-m indicator. Read all about it in the single catalog sheet.

Power Cables. General Electric Co., Bridgeport 2, Conn. The proper selection of power cables is just as important to the electronics engineer as the decision whether or not to use Litzendraht. Save yourself some trouble by asking for Publication No. 19–269.

Selenium Stacks. Federal Telephone and Radio Corp., 900 Passaic Ave., East Newark, N. J. A single catalog sheet goes a long way towards clearing up confusion as to which selenium rectifier stack to use for which application. Dimensions, type numbers, voltages and currents are all given in Form F-400-A.

Wide-Band Amplifiers. Spencer-Kennedy Laboratories, Inc., 186 Massachusetts Ave., Cambridge 39, Mass. Several bulletins are now available for those seeking information on amplifiers with bandwidths approximating 200 mc. Described are type 200A wide band chain amplifier, model 104 regulated power supply, type 202 wide band chain amplifier (dual stage) and the model 202P wide-band chain amplifier.

Radioactive Publication. Tracerlab, 130 High St. Boston 10, Mass. The Tracerlog, mentioned before in these columns, should not be overlooked by those interested in an dealing with nuclear materials and techniques. Current issue as of this writing runs to 12 pages and describes survey meters, tells methods of preparing beta and gamma samples for radioassay and lists, on

separate sheets, the variousTracerlab products and services that make this particular organization unique.

Metal Detector. Allis-Chalmers, Milwaukee, Wisconsin. A well-illustrated 20-page bulletin just released describes the operation and practical use of this electronic sentry for manufacturers of goods ranging from plastics to ceramics.

Voltage Measurements at H-F. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. National Bureau of Standards Circular 481 is an up-to-date presentation of the fundamental principles and techniques used in high-frequency voltage measurements. Myron C. Selby is the author. Price is 20¢ (do not send stamps, foreign or defaced coins to the Superintendent of Documents).

House Organ. American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill. Amphenol Engineering News may be of great use both to the engineer and the engineering executive. Besides frankly plugging the newer company products, each issue generally contains an application story and lists typical uses and production techniques.

Rectangular Video. American Structural Products Co., Toledo 1, Ohio. Tube and television set manufacturers had better write for the two-color brochure directed towards them by a subsidiary of Owens-Illinois. Many of the dimensional and applications details are given relative to rectangular television tube bulbs.

Electronic Control Book. Photoswitch Inc., 77 Broadway, Cambridge 42, Mass. Cutting Production Costs with Electronic Controls is the title of a 65-page book that contains 45 case studies describing actual cost-saving production techniques.

Precision Ceramic Forms. Steatite & Porcelain Products Ltd., Stourport-on Severn, Worcestershire, England. Leaflet 40 describes the facilities now existing for the pro-

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Du Mont Type 248-A
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***DIFFERENTIAL COMPUTING POTENTIOMETER**

NOW—add or subtract two variables in one instrument—with one voltage source! This compact unit does work of two potentiometers—saves cost by eliminating one—has high inherent accuracy of a single potentiometer.

When one variable rotates shaft and other rotates body of this Type 748 Potentiometer, net voltage sum or difference is brought out through coin-silver precision slip rings in cover plate, shown above.

Linearity of 0.10% is guaranteed—and the high resolution, long life, low noise level, and low torque found in all Fairchild Precision Linear Potentiometers can be depended upon as always.

Suggested applications for this new precision instrument include use in servomechanisms for computing or power amplification, direct replacement of 2 single potentiometers when one is being used for compensation or correction purposes, etc. For details, address: Dept. N, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

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Custom Built To Exacting Industrial and Electronic Requirements

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TINNED STEATITE TERMINALS

HERMETICALLY SEALED

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

- ...THAT WITHSTAND HIGH SOLDERING TEMPERATURES
- ...ARE IMMUNE TO ROUGH SHOP HANDLING
- ...HAVE TINNED SHOULDER FOR RAPID ASSEMBLY
- ...FOR 200°C SERVICE ON SPECIAL ORDER

A tinned surface, permanently bonded to the glazed body of these terminals permits rapid soldering to any metal enclosure. Exceptional strength of the steatite body practically eliminates assembly rejects that frequently result when other types of terminals are subjected to soldering temperatures or rough handling. Leads are brought out through an axial hole in the center of the bushing and terminated on the tinned lug. A drop of solder on the hole effects a complete hermetic seal. For complete information concerning tinned steatite terminals, call or write today.

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MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

duction of low-loss ceramic forms in which the winding grooves are held to close tolerances.

Insulating Tape. Bishop G. P. Co., 420 East 25th St., New York 10, N. Y. Bi-seal is a self-bonding electrical insulating tape with high dielectric strength. A four-page bulletin has been prepared to give engineering data in detail.

Half-Octave Filter. Gertsch Products, Inc., 11846 Mississippi Ave., Los Angeles 25 California. The applied Acoustics model SA-2 one half octave filter comprises separate high and low-pass filters each having seventeen different cutoff frequencies ranging from 37.5 to 13, 300 cycles on one-half octave steps. Selection of each cutoff frequency is made by pushbuttons. Get the single-page catalog sheet for complete details.

Mica Capacitors. Arco Electronics, Inc., 135 Liberty St., New York, N. Y., has just published the 1949–50 catalog of El-Menco capacitors. While they are predominantly mica types, some tubular paper and ceramic trimmer types are also included.

Pressurized Capacitors. E. F. Johnson Co., Waseca, Minnesota. Fixed, fixed variable and variable pressurized capacitors are now available in many types and sizes at somewhat lower costs. Send for data sheet for the complete dope.

Precision Potentiometers. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. Six pages are required to tell the story on type RV2 high precision potentiometers. Special problems are welcomed for analysis and quotation.

Industrial Control Relay. Niagara Electron Laboratories, Andover, N. Y. The Thermocap, a capacitance-actuated electron relay mechanism previously described in these columns now rates a 23-page booklet (Bulletin T2/8–49) in which various applications are described or pictured. Other industrial electronic equipment by the same company is also covered.

NEWS OF THE INDUSTRY

(continued from p 130)

The University of Connecticut, Storrs, Conn.
Study of ultra-audion oscillator instability
Theoretical study of transmission lines
Space charge capacitor of a vacuum tube

Cornell University, Ithaca, N. Y.
Investigation of extra-terrestrial radio frequency radiation (ONR)
Development of a wide-range oscilloscope
Solar noise
Troposphere electromagnetic propagation studies (USAF)
Development of electronic instrumentation for cardiovascular research (USPHS)
Development of method of measuring clotting properties of blood by dielectric properties (ONR)

University of Delaware, Newark, Del.
Investigation of the effects of noise in uhf reception

University of Florida, Gainesville, Florida
Development and testing of microwave lens antennas
Detection and location of atmospheric disturbances (SC)
Electromagnetic wave propagation and noise studies in the low-frequency range (USAF)
Classified research (NBS)
Attenuation studies on radar signals in the presence of rain, fog and clouds (USAF)
Development of a vibrator-type motor
Antenna for f-m

Georgia Institute of Technology, Atlanta, Ga.
Design and construction of an electronic marker for synchronizing motion picture and electrocardiographic tracing of heart action
Correlation of microwave propagation with meteorological data
Television transmission studies
Development of special radar components
Studies of basic radar phenomena
A-C network calculator studies
Oscillator circuit studies

Harvard University, Cambridge 38, Mass.
Transients in ferro-resonance circuits
High-tension voltage dividers for short-time measurements
Electromagnetic energy transformation
Interruption of arcs in inductive and capacitive circuits
Focal properties of cathode-ray guns
Impulse surge analyzers
Time and frequency domains in control systems

Illinois Institute of Technology, Chicago, Ill.
Linear electron accelerator

Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.
Amplifiers for photoelectric control system
Electron tube ruggedization
Electronic blanket control
Mobile oscillograph laboratory (OD)
Permanent magnet generator (SC)
Torquemeter (NAMC)

University of Illinois, Urbana-Champaign, Ill.
Study of the effects of ultrasonics on nerve tissue
Development of a network analyzer for antenna problems having circular symmetry in one direction
Development of a search receiver antenna for high-speed aircraft (USAF)
Research and investigation on streamlined and flush-mounted airborne antennas (USAF)

Iowa State College, Ames, Iowa
Expansion of a-c network analyzer to a 16-generator unit

The State U. of Iowa, Iowa City, Iowa
Development and use of the SUI polyphase oscilloscope in harmonic analysis
Development and use of the SUI polyphase oscilloscope in symmetrical component analysis
Development of an improved power angle indicator and recorder
Investigation of transmission line transients under the effect of an impressed square emf wave (experimental)
Application of Laplace transform to the calculation of transmission line transients
Theoretical and experimental investigation of slotted-pipe and slotted-cylinder high-frequency resonators
Investigation of multi-tube ring-type high-frequency amplifier circuits

Kansas State College, Manhattan, Kansas
Analysis and research on electronics materials
Development of television broadcasting

and receiving apparatus

University of Kansas, Lawrence, Kansas
Network analyzer operating account

University of Kentucky, Lexington, Ky.
An investigation of the operation of multi-grid high-vacuum tubes at electrode voltages other than recommended values

Lehigh University, Bethlehem, Pa.
Transients
Filtering networks (AMC)

University of Louisville, Louisville, Ky.
Mathematical study of machine harmonics
Modification of mobile units to operate in the ten-meter band
Design and construction of a rotating-beam multiple-element antenna
Construction of a special feature cathode-ray oscilloscope
Development of a new high-frequency tube

University of Maine, Orono, Maine
Synchronized oscillating detector for f-m reception
Construction and test of a 3-phase artificial transmission line
Square-wave analysis of compensated amplifiers

University of Maryland, College Park, Md.
The general design of triple and quadruple tuned circuits
Design of magnetic amplifiers
General design of distributed amplifiers

Massachusetts Institute of Technology, Cambridge, Mass.
Strain-gage techniques for use in flight instruments
Development of an electrical analog computer for simulating flight
Investigation of single crystals of ferroelectric titania ceramics, and applications to communications equipment
Synthesis of new crystal types
Ferromagnetic semiconductors
Perfecting the operation of a differential analyzer
New applications of the techniques of short-flash photography
Project Whirlwind: electronic-digital computers
Studies of electron emission problems
Microwave gaseous discharges and breakdown characteristics
Microwave spectroscopy: molecular beam and magnetic nuclear resonance research
Studies of the statistical theory of communication
Multipath transmission through traveling-wave tubes
Development of a vacuum spectrograph
Development of magnetrons for high power and efficiency
Construction of a linear accelerator for nuclear particles
Development of an electronic differential analyzer

University of Michigan, Ann Arbor, Mich.
Study and design of pulsed magnetrons
Study of brightness control
Interdigital magnetrons and related tubes
Cathode follower and amplifier circuits

University of Minnesota, Minneapolis, Minn.
Study of transmission of transverse acoustic waves in pipes of rectangular section
Experimental study of electrical contact phenomena
Stabilization of microwave oscillators employing feedback principles
On the mechanism of recording and reproducing signals; noise reduction in magnetic paper tape
Study of noise in transistors
Design and performance of distributed constant amplifiers
Study of electronic pulse generator
Electrical computer for solving linear simultaneous equations
Experimental study of electron guns

University of Missouri, Columbia, Mo.
Efficiency of transfer of high-frequency power
Study of folded dipole antenna
Conversion of high-frequency power
Gas and vacuum tube multivibrators
A table of transforms for steady-state operational calculus
Analysis of pulse storage networks delivering one to ten milli-second square pulse
Small phase-angle measurement at high audio frequencies
60-cycle frequency tripler
Response of circuits to pulses

The University of Nebraska, Lincoln 8, Nebraska
An investigation of the use of reduced-scale models at high frequency for determining the zero-sequence impedances of

single and parallel power-transmission lines

The transient response of M-derived filters

The University of New Mexico, Albuquerque, N. M.

Timing circuits for c-r oscillography

North Carolina State College, Raleigh, N. C.

Automatic plotting of electrostatic fields between arbitrary electrode shapes

Evaluation of long-range radio-navigational AN/FRN-5 (phase I) (AMC)

Development of a broad-band electrical integrating circuit

Investigation of broad-band, low-frequency antennas (phase II) (AMC)

Northwestern University, Evanston, Ill.

Two contract research projects in electronics (USAF)

One contract research project in electronics (USAF)

Northwestern University, Evanston, Ill.

Dielectric lenses for microwaves (SC)

Multimode propagation in waveguides (SC)

Effect of waveguide openings on beam angles (SC)

Fundamentals of microwave transmission in dielectric tubes (SC)

Aerial measurements laboratory (BuA)

Amalgam cathode materials for power tubes

Correlation of electric, temperature and radiation fields in the heating of dielectric materials

Electromechanical filters for low frequencies

Circuit analysis of polyphase electronic frequency converter circuits

Experimental studies of industrial process controllers

Correlation of transient and frequency response by means of RC analog computer

Symbolic analysis of relay circuits

Mapping of potentials in the brain

Electronic computer for roots of tenth degree algebraic equations

Analog-computing machines for computations of multicomponent fractional and flash distillations

Impedance-matching circuits

University of Notre Dame, South Bend, Ind.

Study of second order differential microphones

Investigation of non-linear oscillatory circuits

Study of harmonics in 3-phase transformers

Design of an electric analyzer

Characteristics of some unusual pentode connections

The Ohio State University, Columbus 10, Ohio

Antenna development

Antenna radiation characteristics

Pulse transformers

Microwave oscillators

Electronic circuitry research

University of Oklahoma, Norman, Oklahoma

High-frequency heating and control

The University of Oklahoma Research Institute, Norman, Oklahoma

Applied electronics

Oregon State College, Corvallis, Oregon

High-frequency dielectric heating of insulating materials

The Pennsylvania State College, State College, Pa.

Bandwidth measuring instrument

Precision firing control of ignitrons for servo applications

Study of ionospheric effects on radio wave propagation

Application of transistors to railway cab signal amplifiers

The University of Pittsburgh, Pittsburgh 13, Pa.

University cyclotron—various researches

Electrical apparatus for mental tests

Princeton University, Princeton, N. J.

Research in controllable reactors

Traveling-wave electronic tube

Radio-frequency measurement devices (ONR)

Sound transmission through liquid-filled tubes (ONR)

Purdue University, Lafayette, Ind.

TV research

Industrial instrument research

Rensselaer Polytechnic Institute, Troy, N. Y.

Color filters in tv

C-W magnetron operation

Broadband coupling circuit for use with dielectric heating units

Network analyzers

Narrow-band highly stable amplifiers

D-C amplifiers and d-c phase inverters

Half-wave electronic controls for series

motors, shunt motors and W-L systems
Saturable reactors and d-c components in iron-cored transformers
Application of double-single sideband transmission to broadcast station WHAZ for transmission of binaural sound
Guidance of missiles in free space
Frequency chracteristics of glow discharge voltage regulator tubes
Crystal Colpitts-Hartley oscillator
Magnetic amplifiers
Transfer function loci for servomechanisms and their components

Rutgers University, New Brunswick, N. J.
Modulation system (USAF)
Automatic measuring circuit (USAF)

The University of Southern California, Los Angeles, Calif.
Development of apparatus for conversion of 6-cycle power to power at continuously variable frequencies from 60 cycles per second to 500 cycles per second
Development of a device for direct modulation of a high-velocity air stream
Development of apparatus for continuous electric logging in oil well drilling
Biological effects of high-intensity sounds
A new type electronic organ

Stanford University, Stanford, Calif.
Omnibus project covering electronics (t-w tube, spectrum analyzer tube, local oscillator studies, meteoric ionization of the upper atmosphere, etc.) USN
Single-sideband modulation systems (USAF)
Low-frequency loran studies (USAF)
Ionosphere studies (NBS)

Stanford Research Institute, Stanford, Calif.
High-level single sideband transmitter
Development of tv transmitter
Microwave propagation measurement
Tube laboratory to include projection electron optics, c-r and other electron tubes
Aircraft radio systems laboratory, to contain research and development in antennas, propagation and aircraft communications

Syracuse University, Syracuse, N. Y.
Electronic electrocardiographic diagnosis
Analysis of waveguide antennas and feeds
Directional antenna analysis for direction finding (USAF)

The U. of Tennessee, Knoxville 16, Tenn.
Non-linear solutions for circuits containing iron-core reactances
Development of rotatrol speed control system
Fundamental study of the mercury arc rectifier
Mathematical research on network and filter theory
Project on new type of recording process
Project on servomechanisms

Agricultural and Mechanical College of Texas, College Station, Texas
A-C network calculator laboratory
Mass spectrometer laboratory

Texas Engineering Experiment Station, College Station, Texas
Mass spectrometer development
Electron microscope development
Characteristics of oscillations produced in gaseous discharges

The University of Texas, Austin, Texas
A study of microwave propagation in the lower atmosphere (ONR)
A study of the signal strength received from commercial f-m radio stations (NBS)

Tufts College, Medford, Mass.
Air-borne magnetometer for measuring the earth's magnetic field at high altitudes
Saturable reactor means of registering small d-c voltages
Construction of air-borne telemetering equipment
Construction of a modified television receiver to display both television and telemetering signals
Measurement of properties of the upper air which have to do with the presence of free ions (USAF)

University of Utah, Salt Lake City, Utah
Upper air research
Solution of circuits for periodic non-sinusoidal waves
Analysis of instability of voltage regulators

State College of Washington, Pullman, Wash.
Noise meter
Corona at high altitude
Electronic heat pattern
Fruit processing by dielectric heating

Engineering Experiment Station, Washington State U.
Corona discharge interference with radio navigation aids

(Continued on p. 204)

NEWS OF THE INDUSTRY (continued)

Corona discharge in supersonic air velocity
A flat gain r-f voltmeter

University of Washington, Seattle, Washington
Experimental field strength survey in the Seattle area
Design and construction of a high-speed cathode-ray oscillograph
R-F heating at high frequencies
Design and construction of a network analyzer

Wayne University, Detroit, Mich.
Telemetering temperature impressors
Automatic and remote altitude selector

West Virginia University, Morgantown, West Va.
Study of servomechanisms used in automatic pilots

University of Wisconsin, Madison, Wisc.
Development of an ignitron frequency converter for induction heating
Network analyzer project
Infra-red detector for locating hot spots on electric conductors
Phototube amplifiers for stellar photometry
Magnetic amplifiers
Surveys and analysis of f-m propagation
Frequency dividers
Application of multiple Laplace transforms in electric circuit analysis and electromagnetic field theory
Basic theory and experimental confirmation of the percent limit capacitance bridge
A critical review of the theory and application of the Schwarz-Christoffel and Bickley transmutations in electromagnetic field theory
Measurement of dielectric constants of gases at 9,000 mc per sec
Electronic multipliers using mixer tubes
Electronic carrier-type multipliers
Carrier-type d-c amplifiers
Metallic delay lenses for microwaves
Distributed-type band-pass amplifiers
Servo amplifier design
Intermediate-frequency power amplifiers
Reactance-tube f-m oscillator
Low-noise television pre-amplifiers
High-gain television antennas
Non-linear circuit phenomena
Synchronizing circuits for tv

Yale University, New Haven, Conn.
Vacuum tube research; klystron and magnetron (USN)
Optimum phase and attenuation of electrical networks
Pulse modulation (SC)
Electrical storage methods (AMC)
Transient recording (BuO)
Flight simulator control

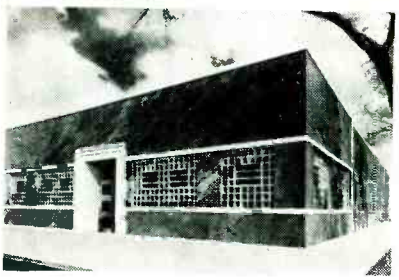
BUSINESS NEWS

BURNDY CANADA LTD., electrical connector manufacturer, has opened a new factory at 381 Greenwood Ave., Toronto, Canada, to expand manufacturing and engineering facilities.

THE BRUSH DEVELOPMENT CO., Cleveland, Ohio, manufacturers of piezo-electric devices and precision instruments, recently began the production of high-power ultrasonic units.

ELECTRICAL REACTANCE CORP., Franklinville, N. Y., has established an undergraduate fellowship at the New York State College of Ceramics of Alfred University, Alfred, N. Y., to carry on research and development work relative to ceramic dielectrics.

ELECTRO PRODUCTS LABORATORIES, INC., manufacturers of d-c power



New Electro Products Plant

supplies, recently moved to a new plant at 4501 North Ravenswood Ave., Chicago 40, Ill.

SERVO-TEK PRODUCTS CO., INC., Paterson, N. J., has acquired full ownership of Kent Laboratories, Inc., Hawthorne, N. J., a group specializing in electromechanical design, development and production.

AIRBORNE INSTRUMENTS LABORATORY, INC., Mineola, N. Y., will move about Feb. 1st to its new building immediately east of its site on Old Country Road.

AEROVOX CORP., New Bedford, Mass., capacitor manufacturers, recently purchased the entire outstanding stock of the Electrical Reactance Co., Franklinville, N. Y.

MARS TELEVISION INC., Long Island City, N. Y., television receiver manufacturers, have moved to larger quarters at 112-33 Colonial Ave., Corona, N. Y.

PERSONNEL

EVERHARD H. B. BARTELINK, formerly head of the radio department of the General Telephone Corp., has been named assistant to the director of research at General Precision Laboratory, Pleasantville, New York.

R. T. CAPODANNO, after 11 years with Philco Corp., has been appointed director of engineering at Emerson Radio and Phonograph Corp., New York City.

WILLIAM VASSAR has been promoted to chief engineer of Emerson Radio and Phonograph Corp., New York City.

LEWIS M. CLEMENT, director of engineering and research of the Crosley Division, Avco Mfg. Corp.,

Cincinnati, Ohio, has been named chairman of the executive committee of the Receiver Section, RMA Engineering Department.

ALEXANDER ELLETT, in charge of the research laboratories since 1946, has been elected vice-president in charge of research at Zenith Radio Corp., Chicago, Ill.

A. Ellett

G. G. Edlen

GEORGE G. EDLEN, previously associated with Johns Hopkins in Baltimore as an instrumentation research engineer, recently joined the sales organization of M. J. Shapp and Co., Philadelphia, Pa.

EDWARD E. SCHULTZ, formerly associated with the Belmont Radio division of Raytheon Mfg. Co., has been appointed to the developmental engineering staff of Magnecord, Inc., manufacturers of professional tape recording equipment.

RAY A. RUGGE, formerly head of the electrical design and development departments of the Airplane Division of Curtiss-Wright Corp. at Columbus, Ohio, has been appointed chief engineer of Lear, Inc., Grand Rapids, Mich.

L. J. N. DU TREIL, radio engineer with the FCC and its predecessors for the past 30 years, has retired from government service, and will engage in consulting radio engineering and will establish a frequency measuring service.

HARVEY FLETCHER, with Bell Labs since 1916, has retired as physical research director to become an honorary professor in the electrical engineering department of Columbia University, New York, N. Y., where he will establish a department of acoustical engineering.

NEW BOOKS

Networks, Lines and Fields

By John D. Ryder, *Head, Department of Electrical Engineering, University of Illinois. Prentice-Hall, Inc., New York,* 1949, 462 *pages,* $7.35.

To include a rather complete treatment on the undergraduate level of elementary network theory, filters, transmission lines at low and high frequencies, Maxwell equations, reflection of waves and waveguides in less than 450 pages is not an easy task. It can be said that the author of this book has succeeded in solving the problem that he proposed himself. The resulting textbook is one which will be useful not only to undergraduates but also to an average engineer for direct consultation.

Beginning with the usual T and π networks and elementary network theory, the author devotes a substantial percentage of the book to the study of resonant and coupled circuits. The importance of these results in ordinary communication work is obvious. The only criticism which could be raised is that some of the results which are obtained in the text could be considered as direct consequences of previous theorems and relegated to the position of problems.

The study of ordinary constant-K filters precedes the study of transmission lines which is based on the conventional approach but carefully emphasizes the errors likely to be made by the indiscriminate assumption of purely ohmic characteristic impedance.

Maxwell equations are briefly discussed with some of their immediate consequences, and particular emphasis is given to reflection of plane waves because of its application to the study of waveguides. The book ends with the study of the fundamental transmission modes in rectangular and cylindrical waveguides and with a few remarks regarding resonant cavities.

In dealing with such a large mass of results it was obviously impossible to avoid some omissions or some unbalance. It appears, for instance, that the introduction of matrices in the first chapter on networks is somewhat inconsistent with the procedures employed in the remaining part of the book where matrices are seldom if ever

employed; the student may be left to wonder about the usefulness of this very important symbolism.

In several chapters, on the other hand, the author seems to go too much into details. The study of resonant circuits, for instance, covers one-sixth of the total number of pages, and a paragraph on the Maxwell and Wien bridges is inserted as a part of the basic treatment of network theory. These and other similar objections cannot, however, detract from the value of the book. It is an excellent example of textbook writing and should be recommended as such.—E. G. FUBINI, *Supervising Engineer, Airborne Instruments Laboratory, Mineola, N. Y.*

Chimes and Electronic Carillons

BY PAUL D. PEERY. *The John Day Co., New York,* 1948, 146 *pages,* $3.75.

THOUGH aimed at aiding organists and others in adapting their musical knowledge to the art of campanology, this book also fills an important gap for the electronic engineer whose vocation or hobby is electronic synthesis of music. Available instruments for duplicating the sounds of bells are described and discussed in general terms, without comments on the merits of individual instruments or improvements. Much emphasis is placed on the general technique of playing bells and chimes from a keyboard.

The author defines a bell as any instrument of any shape or material that gives forth a ringing sound on being struck. An electronic carillon is a set of bells, tuned chromatically, playable from a clavier, and employing electronics in any or all of three steps—production, transmission and amplification of tones. The bells are generally carefully designed and machined rods or tubes rather than traditional bells, though a few electronic instruments do use small campaniform tonal sources. Differences in methods of hanging, points of suspension, tuning, striking, dimensions, pickup of tones and in location of speakers are the distinguishing marks of the different manufacturers. The bell tone is picked up either by microphone or by electronic pickup. It is also pos-

sible to generate bell tones electronically, but according to the author no such set has been commercially successful.

All manufacturers construct automatic players for their instruments, for use when a carillonneur is not available. Some use punched rolls much like those for player pianos, while others use slowly rotating discs that actuate the contacts of striking circuits. In addition, manufacturers make Angelus bells and automatic clocks that strike the quarters, halves and hours on the carillons.—J.M.

Basic Electronics

By Royce G. Kloeffler and Maurice W. Horrell. *John Wiley & Sons, Inc., New York and Chapman & Hall, Limited, London*, 1949, 435 *pages*, $5.00.

The infiltration of electronics into virtually every branch of science and industry has created a demand for mechanical, chemical, civil and aeronautical engineers with a basic knowledge of electronic fundamentals. *Basic Electronics* furnishes an excellent test and reference book for college-level courses of this type. The reader need only have a knowledge of basic physics to understand the material presented.

Coverage of the field of electronics from high-powered industrial circuits to low-level communications circuits is complete and comprehensive without being sketchy. Liberal references to the literature suggest further study for those whose interests or needs go beyond the scope of the general text.

The first eight chapters of the book, covering basic physical concepts, electron emission, vacuum diodes, linear and nonlinear elements, and vacuum tubes and vacuum tube amplifier circuits, are taken almost verbatim from Kloeffler's previous book, *Industrial Electronics and Control*. These chapters are, however, up to date and thoroughly suitable for repetition in this book, since it is unlikely that any one reader would have need for both books.

The remaining half of the book presents the practical side of the subject with numerous circuits, curves and photographs to familar-

ize the nonelectronic man with the tools used by the electronic engineer. A college course built up around the information presented in this book might conceivably become a required part of the curriculum at colleges.—J.F.

TV Picture Projection and Enlargement

BY ALLAN LYTEL. *John F. Rider, Publisher, Inc., New York,* 1949, 192 *pages,* $3.30.

THE optics involved in television picture projection is becoming required knowledge for many electronic engineers engaged in this rapidly expanding field. This book presents a technician-level discussion of the various systems appearing in commercial receivers.

The physical concepts of light, including reflection and refraction, are presented first. The effects of lenses and mirrors, such as those used in projection television systems, are then explained and various systems are discussed.

To date, relatively few different projection television systems have received much attention. The Schmidt system, and modifications of it employed by North American Phillips, RCA, GE and others, furnishes material for a whole chapter. Another chapter deals with commercial applications of refractive projection systems, and a special section is devoted to the not yet commercially adapted dark-trace system.

The book also includes a brief discussion of theater television, and lists the obstacles that must first be overcome before such possibilities become realities.—J.F.

Radio Technology

BY ERNEST J. VOGT. *Pitman Publishing Co., New York,* 1949, 556 *pages,* $6.00.

THIS book represents a unique approach to the preparation for new FCC radio operators license examinations. The author has combined the objectives of a basic radio text book with a limited but representative number of actual FCC study guide questions at the end of each chapter. The objectives appear to be to give the reader a more com-

prehensive treatment of the technical aspects of the FCC examination questions. Although the text gives a substantially detailed explanation of many actual examination questions it is obvious that a detailed treatment of all examination questions would be impossible within the limits of conventional text book size. However, the author has presented the subject matter in a clear and concise manner throughout, together with a generous quantity of well-coordinated illustrations. A chapter on the elements of radio mathematics is also included to provide a good foundation for circuit and problem solutions.

It is the opinion of this reviewer that *Radio Technology* is a valuable supplemental contribution to the field of radio operating, particularly to the new student preparing to qualify for the radio operators examinations.—J. L. HORNUNG, *Supervisor, Radio Electronics, Walter Hervey Junior College, New York, N. Y.*

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Books Received for Review

BEAMA CATALOGUE 1949-50. Published for The British Electrical & Allied Manufacturers' Association Inc. by Iliffe & Sons Ltd. for private distribution to principal buyers, distributors and other prospective customers of British industry, 868 pages, cloth bound. Compilation of detailed information and illustrations of British electrical products ranging from heavy power plant apparatus to domestic appliances, with comprehensive reference data for rapid identification of supply sources.

INTERNATIONAL RADIO TUBE ENCYCLOPEDIA. Edited by Bernard B. Babani. Bernards (Publishers) Ltd., The Grampians, Western Gate, London, W. 6, England, 410 pages, 42/—. Operating characteristics and pin connections of some 15,000 different radio tubes of all types manufactured throughout the world, including types used by the Armed Services of the British Commonwealth, U. S. and Europe. Instructions for using the tables are given in 14 foreign languages as well as in English. Pin connections are given in columns adjacent to tube characteristics, eliminating need for reference to other sections. Major sections, each complete in itself, cover: radio receiving tubes; triode transmitting tubes; other transmitting tubes; rectifiers; thyratrons; regulator and control tubes; tuning indicators; cathode-ray tubes and phototubes. A tenth section covers rare tubes and their equivalents, without giving data. Six pages of diagrams of tube bases give pin numbers for the different types of bases used throughout the world. A final section gives tube manufacturers' abbreviations and addresses.

STYLE MANUAL FOR AMERICAN STANDARDS. American Standards Association, 70 E. 45 St., New York 17, N. Y., 1949, 28 pages, $1.00. Primarily intended to bring about greater uniformity in presentation of technical data by ASA technical committees. Principal sections cover: outline form and numbering; capitalization; punctuation; spelling; abbreviations for technical terms; handling tables and illustrations; standard bibliographical style; general format for illustrations. Useful to any organization responsible for editing and publishing technical documents.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

You Make 'Em— We'll Buy 'Em

DEAR SIRS:

IN THE APRIL, 1949 ELECTRONICS, under *Business Briefs* there was an article to the effect that computer manufacturers are making their own tubes. This fact is of considerable interest to us, inasmuch as the aircraft industry has seemingly been a "lone cry in the wilderness" for over nine years, in an attempt to arouse some interest amongst the tube manufacturers toward some really reliable tubes. They have finally come out with a few of what they call a "ruggedized" line which, as far as we can determine, is simply hand picked from the regular production runs, and embody no real improvements. It isn't as if they couldn't make them. For example: The telephone company has had some repeater tubes buried in the middle of the Atlantic Ocean, operating for years. Another example, the manufacturer of the first aircraft radio had felt that specially designed tubes were essential, and, some of these are still good after 19 years of practically continuous operation. However, they stopped making them because they cost too much and the market was too small. In this connection we did not complain about the price. In fact we have indicated our willingness to pay many times the usual cost in order to get reliable tubes. We have not even insisted on an extra long life, as long as we can be sure that they will run a certain length of time so we can change them before they fail.

The problem of reliable tubes is one of the most serious confronting the airlines (and the air forces) today. The modern airplane is an

"electronic" airplane, from fuel gage to radio, and by far the major portion of our trouble with electronic equipment is from tube failures.

Incidentally, we would be happy to find out just exactly who is making reliable tubes. If they are types we can use, we would be glad to buy them.

A. F. TRUMBULL
Radio, Electrical, & Instrument Engineering Supt.
United Airlines
Chicago, Illinois

Too Many Irons

DEAR SIRS:

THIS LETTER is to comment on a portion of the article entitled, "Reducing Costs in Receiver Manufacturing" published in ELECTRONICS for October. I was especially interested in the problem of soldering irons which cooled off too rapidly, due to high speed production-line soldering, and the way the problem was solved.

It seems to me that a simpler and better solution would be to continue using the same irons, but hook them all to a supply line, and power this line through a transformer to raise the voltage of all irons just enough to keep them at the necessary temperature. As long as the irons are being used so rapidly that, with normal supply voltage they become too cool, it would not damage them any to run up the supply voltage so that they would supply enough heat and stay at a sufficiently high temperature.

If there were any question about an iron getting too hot, if a worker should pause a little, thermostat irons could be used, or thermostat iron stands, so that if any iron on this higher voltage supply line should be left without use for a while, its temperature will not become excessive.

Two advantages of this system over the system described in the article would be: (1) the worker would not need to be changing irons periodically, and (2) one iron only for each worker would mean only ⅓ as many irons operating, reducing the cost of electricity required to heat the irons.

PAUL E. SMAY
Chicago, Illinois

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(Classified Advertising)

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Positions Open For:

PHYSICISTS

TV ENGINEERS

ADVANCED CIRCUIT DEVELOPMENT ENGINEERS

VACUUM TUBE ENGINEERS
TECHNICIANS
SENIOR MECHANICAL ENGINEER
PULSED CIRCUIT ENGINEERS

Minimum of 5 years recognized experience in addition to formal education in TV, advanced circuit development, vacuum tube research and mechanical engineering.

Experienced microwave, servomechanism and analog computer engineers.

Salary commensurate with experience and ability—insurance plan—paid vacations—excellent opportunity for suitably qualified personnel.

Please furnish complete resume of education, experience and salary requirements to:

Industrial Relations & Personnel Department
CAPEHART-FARNSWORTH CORPORATION
FORT WAYNE 1, INDIANA

SENIOR ELECTRONIC CIRCUIT PHYSICISTS

for

Advanced Research and Development

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
(Mr. Jack Harwood)
CULVER CITY, CALIFORNIA

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Wanted for interesting and professionally challenging research and advanced development in the fields of microwaves, radar, gyroscopes, servomechanisms, instrumentation, computers and general electronics. Scientific or engineering degree or extensive technical experience required. Salary commensurate with experience and ability. Direct inquiries to Mgr., Engineering Personnel, Bell Aircraft Corporation, P. O. Box 1, Buffalo 5, N. Y.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

ENGINEER, EXPERIENCED electronic design. Expanding electronic consulting firm. Michigan. P-1566, Electronics.

ENGINEERS—CROSLEY Division, Avco Manufacturing Corporation is expanding its Engineering Department and has openings for Junior, Senior, and Project Engineers in R.F. Circuit Development, Advanced Development, Product Design, and Cabinet Design and Development. College engineering degree is required. We will only consider men with Industrial Television experience. Do not apply unless you have these qualifications. Write to Placement Supervisor, Crosley Division, Avco Manufacturing Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

SERVICE TECHNICIAN: Radio Service Dealer requires capable mechanic. Should be qualified to service all types radio and television equipment. Also supervise mechanics installing TV aerials, servicing refrigerators, air conditioning, ranges, etc. Must assume responsibility for managing repair department. Salary open. Applicant should submit complete resume showing educational background, positions, and salary. All replies confidential. P-1418, Electronics.

PHYSICIST WANTED—For design and development of electronic and mechanical instrumentation equipment used in the pursuit of flight research work. Several years of theoretical and practical experience necessary. Salary commensurate with qualifications. Permanent position. Give details in first letter. Cornell Aeronautical Laboratory, Inc., 4455 Genesee Street, Buffalo 21, New York.

(Continued on page 219)

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.

DESIGN ENGINEERS

- **RADIO**
- **TELEVISION**
- **FM**

Hoffman Radio Corporation has positions open for junior and senior radio and television design engineers. Write Engineering Department, giving education, experience and salary desired.

HOFFMAN RADIO CORPORATION
3761 SOUTH HILL STREET, LOS ANGELES 7, CALIF.

SELLING OPPORTUNITY OFFERED
(Continued from page 218)

SALES ENGINEER Wanted: A good technical man with background in the electrical, electronic and instrument fields. Sales experience necessary, and a reasonably good connection in the Industrial Electronic and Instrument Industry. Position involves the sales and promotion of a recognized line of Industrial Electronic Components. State age, background and salary requirements. Applicants already located in New York area preferred. SW-1523, Electronics.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (39 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 278 Dun Bldg., Buffalo, N. Y.

SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

SOUTH AMERICA. Electronic Engineer (Television), age 35 years, at present chief engineer of research, 10 years industrial experience, 21 patents, publications, German, French and Portuguese technical languages, wants executive position. PW-1485, Electronics.

TELEVISION ENGINEER, B.S. in E.E., Northwestern. Tau Beta Pi, Eta Kappa Nu. Some graduate work. Age 23. 1½ years Television Broadcast. Former Navy R.I. Interested television development or field work. Midwest. PW-1672, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

SELLING OPPORTUNITY WANTED

SALES REPRESENTATIVE in Chicago area now handling electronic product, interested in similar lines. Will serve area properly. RA-1509, Electronics.

WANTED

ANYTHING within reason that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

Wanted
ADDITIONAL LINE
Established New Eng. Sales Representative, Mechanical Engineer, desires ONE additional line.
R.A.-1547, Electronics
330 W. 42nd St., New York 18, N. Y.

CONTRACT
ENGINEERING—MANUFACTURING
electronic and electro-mechanical devices
- developed to meet your specifications
- manufactured per sample or drawings

TELETRONICS LABORATORY, Inc.
Westbury, L. I., N. Y.—Westbury 7-1028

TELEVISION ENGINEERS

Television Engineering Department requires the services of five project engineers for advance circuit development and product design for television receivers. These vacancies are the result of the ever-expanding television activities in this department.

Company is a major producer of finer television receivers and is well established. Company is located in northwestern New York State.

Opportunities for advancement are excellent. Salaries commensurate with experience.

Our employees know of this advertisement.

P-1707, Electronics
330 West 42nd St., New York 18, N. Y.

RADAR
ENGINEED-PHYSICIST
WANTED

Must have heavy experience in basic study and research on new radar systems and similar electronic equipment.

Excellent opportunity for Senior man. Juniors please do not apply.

State full particulars. Replies confidential.

Write: A. Hoffsommer

W. L. MAXSON
CORPORATION
460 W. 34th St., New York 1, N. Y.

SALES KNOW-HOW
CHICAGO AREA

Established manufacturer's agents with contacts in Radio, Electronic and Telephone industries, seek one additional line.

(1). Sixteen years continuous representation for 2 largest manufacturers in their field.

(2). Highly successful background in product development.

(3). Adequate personnel and office for customer service.

Hard intelligent sales effort guaranteed for your product.

RA-1120, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

Time is money. Save it by referring to our
ACCUMULATIVE INDEX FOR
ELECTRONICS BIBLIOGRAPHY
Simple and Dependable
Write for descriptive literature
TECHNICAL INDEX SERVICE
Box 632 Asbury Park, New Jersey

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 155, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

SALES POSITION

with excellent future possibilities with a new, progressive concern. Must have intimate acquaintance with engineers and buyers in aircraft and electronic industries. Give full resume of experience, earnings, etc.

P-1701, Electronics
330 West 42nd St., New York 18, N. Y.

NATIONAL UNION RESEARCH DIVISION

There are several desirable openings for experienced

PHYSICISTS
and
ENGINEERS

capable of handling the design and development of electron tubes and UHF circuits.

Our growing organization can offer excellent prospects for security and advancement to qualified personnel.

Interested applicants are invited to send their resume to:

Divisional Personnel Manager
National Union Research Division
350 Scotland Road, Orange, N. J.

OWNERS: *Let factory-trained experts treat your ailing receiver*

HALLICRAFTERS, HAMMARLUND, COLLINS, NATIONAL, PIERSON, RME

Communication and television receivers and transmitters

- Complete realignment
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R.F. COMPONENTS–MICROWAVE–TEST EQUIPMENT

10 CENTIMETER

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED, BROAD BAND. $37.50 **EACH**
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABY-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
Crystal Mixer with tunable output TR pick up loop, Type "N" connectors. Type 62ABH $14.50
Slotted line probe. Probe depth adjustable, Sperry connector, type CPR-14AAO $9.50
Coaxial slotted section. ⅝" rigid coax with carriage and probe $25.00
Right Angle Bend 6" radius E or H plain..$15.00
Right Angle Bend 3" radius E or H plain—Circular flanges $15.00
AN/APR5A 10 cm antenna equipment consisting of two 10 CM waveguide sections, each polarized, 45 degrees ..... $75.00 per set
APN-7 McNally Cavity for 707B, with tuning slugs ..... $5.50 each
PICKUP LOOP, Type "N" Output $2.75
TR BOX Pick-up Loop $1.25
POWER SPLITTER: 726 Klystron input dual "N" output $5.00
MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated $27.50
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. CRP 24AAS. New and complete. $150.00
"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output $3.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50
10 CM. McNally Cavity Type SG 3000 Mc..... $3.50
WAVEGUIDE SECTION MC 445A Rt. Angle bend, 5⅛ ft. OA. 8" slotted section..... $21.00
10CM OSC. PICKUP LOOP, with male Homedell output $2.00
10 CM DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fittings..... $4.50
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
PHASE SHIFTER. 10 CM WAVEGUIDE. WE TYPE ES-683816. E PLANE TO H PLANE MATCHING SLUGS. MARK 4 RADAR...$95.00
721A TR cavities. Heavy silver plated....$2.00 ea.
10 cm. horn and rotating joint assembly, gold plated ..... $65.00 ea.
AS14A/AP 10 CM dipole pickup ant. w/10 ft. cable type N fittings $3.25

⅞" RIGID COAX.—⅜" I.C.

⅞" rigid coaxial tuning stubs with vernier stub adjustment. Gold Plated $17.50
⅞" RIGID COAX ROTARY JOINT. Pressurized. Sperry #810613. Gold Plated $27.50
Dipole assembly. Part of SCR-584..... $25.00 ea.
Rotary joint. Part of SCR-584..... $35.00 ea.
RIGHT ANGLE BEND, with flexible coax output pickup loop $3.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00
RIGID COAX to flex coax connector..... $3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00
RT. ANGLES for above $2.50
RT. ANGLE BEND 15" L. OA $3.50
FLEXIBLE SECTION: 15" L. Male to female $4.25
MAGNETRON COUPLINGS to ⅞" rigid coax. with TR pickup loop, gold plated $7.50
FLEX COAX SECT. Approx. 30 ft..... $16.50

⅞" RIGID ¼ "I.C."

CG 54/U—4 foot flexible section ¼" IC pressurized $15.00
⅞" **RIGID COAX.** Bead Supported per ft..... $1.20
SHORT RIGHT ANGLE BEND $2.50
Rotating joint, with deck mounting..... $15.00
RIGID COAX slotted section CU-60/AP..... $5.00

MISCELLANEOUS

Type "N" patching cord UG11/U female to UG9/U using RG5/U cable 12" long...$2.25 ea.
AN/TPS-1B flanged nipple and insert assembly for rotary coupling..... $3.75 ea.
Pulse connector Navy type 49579..... $1.50 ea.
Transmission line pressure gauge, 2" 15 lbs. ..... $1.85 ea.
Pulse cable assembly Western Electric type D163262, 10 feet long..... $4.50 ea.
Holmdell Jack Western Electric BO-12962-1 D. B. #J-102X ..... $3.75 ea.
Adapter type "N" RG8/U to RG17/U or 18/U cable ..... $4.50 ea.
ADAPTER TYPE "N" TO RG-71/U CONNECTOR $5.50
F-29/SPR-2 HIGH PASS FILTER P/O AN/APR-5AX. TYPE "N" CONNECTORS...$12.50
Magnetron coupling to ⅝ rigid coax..... $5.00 ea.
MAGNETRON COUPLING 1⅞" to 10 CM Waveguide $84.50

3 CENTIMETER

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

723 A/B Klystron mixer section with crystal mount, choke flange and Iris flange output..... $22.50
TR-ATR Section for above w/ 724 ATR Cavity $8.50
90 degree twist, 6 inches long..... $8.00
723 AB Mixer—Beacon Dual Oscillator Mount with crystal holder..... $12.00
2 Way Wave directional coupler, type N fitting 1⅛ x ⅝" guide 26DB..... $18.50
CG 98B/APG 13, 12" flexible section 1¼" x ⅝" OD $10.00
TR-ATR Section, APS-15, for 1B24, with 724 ATR Cavity with 1B24 and 724 tubes. Complete $21.00
Crystal mount in waveguide..... $17.50
SO3 ECHO BOX XMSN type cavity w/bellows $28.50
3 cm, 180° bend with pressurizing nipple..$6.00 ea.
3 cm. 90° bend, 14" long 90° twist with pressurizing nipple ..... $6.00 ea.
3 cm. "S" curve 18" long..... $5.50 ea.
3 cm. "S" curve 6" long..... $3.50 ea.
3 cm. right angle bends. "E" plane 18" long cover to cover ..... $6.50 ea.
3 cm. Cutler feed dipole. 11" from parabola mount to feed back..... $8.50 ea.
DUPLEXER SECTION for 1B24..... $10.00
CIRCULAR CHOKE FLANGES, solid brass. .55
SQ. FLANGES, FLAT BRASS..... ea. 55
FLEX. WAVEGUIDE ..... $4.00/Ft.
TRANSITION 1 x ½ to 1¼ x ⅝, 14 in. L. $6.00
"X" BAND PREAMPLIFIER, consisting of 2-723 A/B local oscillator-beacon feeding waveguide and **TR/ATR** Duplexer sect. incl. 30 MC Pre Amp w/Tubes $57.50
Random Lengths waveguide 6" to 18" Lg...$1.10/Ft.
WAVEGUIDE RUN, 1¼" **x** ½" guide, consisting of 4 ft. sections with Rt. angle bend on one end 2" 45 deg. bend other end..... $8.00
12" SECTION 45 deg twist, 90 deg bend..... $6.00
11" STRAIGHT WAVEGUIDE sect choke to cover. Special heavy Const. silver plated..... $4.50
15 DEG. BEND 10" choke to cover..... $4.50
5 FT. SECTIONS choke to cover. Silver Plated $10.00
TR CAVITY For use with 724 A TR Tube..... $3.50
3" FLEX SECT. sq. flange to Circ. Flange Adapt $7.50
724 TR TUBE (41 TR 1)..... $2.50
SWR MEAS. SECTION, with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated $10.00
WAVEGUIDE SECTION, 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend..$4.50
SLUG TUNER/ATTENUATOR, W. E. guide, gold plated $6.50
TWIST 90 deg. 5" choke to Cover w/press nipple $6.50
WAVEGUIDE SECTIONS 2½ ft: long silver plated with choke flange..... $5.75
ROTARY JOINT choke to choke..... $17.50
ROTARY JOINT choke to choke w/deck mtg. $17.50
3 cm. mitred elbow "E" plane unplated..$6.50 ea.

1.25 CENTIMETER

"K" BAND FEEDBACK TO PARABOLA HORN, with pressurized window..... $30.00
MITRED ELBOW cover to cover..... $4.00
TR/ATR SECTION, choke to cover..... $4.00
FLEXIBLE SECTION 1" choke to choke..... $5.00
ADAPTER, rd. cover to sq. cover..... $5.00
MITRED ELBOW S sect. choke to cover..... $4.50
WAVE GUIDE ½ x ¼ per ft..... $1.00
K BAND CIRCULAR FLANGES..... 50¢
3J31 K BAND MAGNETRON..... $55.00
K BAND MIXER SECTION..... $55.00

RADAR SETS

SL 10 cm Surface Search, PPI. Exc. Cond. $1600
SF-1 10 cm Surface Search. New..... $2800
SE 10 cm SS "A" Scope. Thyratron Kicker. New $1200
APS-4 3 cm Airborne. Exc. Cond. Complete $1850
APS-2 10 cm Airborne. New. All Major Units $450
APS-15 3 cm Airborne. New. All Major Units $450
APS-3 3 cm Airborne. New. Complete Less Cables $750

WAVEGUIDE

½" x ¼" ID..... $1.00 per foot
1" x ½" OD..... 1.50 per foot
⅝" x 1¼" OD..... 1.65 per foot
⅝" x 1¼" OD Aluminum..... .75 per foot
1½" x 3" OD..... 3.00 per foot
2½" x 3" OD..... 3.50 per foot
1" x 1½" OD Flexible..... 4.00 per foot
⅞" rigid coax ¼" IC..... 1.20 per foot
(Available in 10 ft. to 15 ft. lengths or smaller.)
UG 65/U 10CM flanges..... $6.75 each
UG 53/U Cover..... 4.00 each
UG 54/U Choke..... 4.50 each

RADAR DIV. MR. P. PLISHNER

Rated Concerns Send P.O.

3CM WAVEMETER Coverage 9000-9500 Mcs w/ Calib. Chart Absorb. Type w/Circ. Flange or XMSN. Type w/Sq. Flanges. New..... $75.00

MODEL TS-268/U

Test set designed to provide a means of rapid checking of crystal diodes **IN21, IN21A, IN21B, IN23, IN23A, IN23B.** Operates on 1½ volt dry cell battery. 3x6x7.
New **$35.00**

CRYSTAL DIODES

No.	Each	2 for	10 for
IN21	$1.00	$1.79	$ 8.30
IN22	1.50	2.79	14.00
IN23	1.50	2.79	14.00
IN26	3.00	5.90	27.50

SL WAVEMETER Type Cw60ABM..... $125.00
10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS, direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10 CM Directional Coupler..... $385.00
10 cm. horn assembly consisting of two 5" dishes with dipoles feeding single type "N" output. Includes UG28/U type "N" "T" junction and type "N" pickup probe. Mfg. cable. New....$15.50
10 cm. cavity type wavemeters 6" deep, 6½" in diameter. Coax output. Silver plated **$64.50 ea.**
10 Cm. echo box part of SF radar w/115 volt DC tuning Motor sub sig 1148A..... $47.50
THERMISTER BRIDGE: Power meter 1-203-A, 10cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case.....$72.50
W.E. I 138. Signal generator, 2700 to 2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter, 115 VAC input reg. Pwr. supply. With circuit diagram..... $75.00
3 CM. HORN AT-48/UP model 710. Type "N" input Hvy. silver plated..... $6.50
AT-68/UP 3 CM Horn with type N fitting...$5.00
TS-89/AP Voltage Divider: Ranges 100 : ½ for 200 to 20000 V 10: 1 for 200 to 2000v. Input Z 2000 ohm, output Z 4 meg. flat response 150-5 meg. cys. $42.50
10 CM WAVEMETER WE type B-435490 Transmission type. N fittings. Veeder root mic. dial gold plated w/calib chart. P/O WE Freq mtr X66404A New $99.50

R. F. EQUIPMENT

LHTR. LIGHTHOUSE ASSEMBLY, Part of RT-20/APG-5 & APG 15. Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Rcvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver plated..... $49.50
APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser. 714 Magnetron 417A Mixer all ⅞" rigid coax. incl. rcvr. front end $210.00
Beacon lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice $47.50 ea.
T-128-/APN-19 10 cm. radar Beacon transmitter package, used, less tubes..... $59.50 ea.
Pre-Amplifier cavities type "M" 7410590GL, to use 446A lighthouse tube. Completely tunable. Heavy silver plated construction..... $37.50 ea.
RT32/APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR 723 A/B local osc. and beacon mount. pre amplifier. Used $75.00
AN/APS-15A "X" Band compl. RF head and mod. incl. 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1B24. TR, rcvr ampl. duplexer, HV supply blower, pulse xfmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5-2 microsc., apx. 13KV, PK. Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg...$210.00
S BAND AN/APS2. Complete RF head and modulator, including magnetron and magnet, 417A mixer. TR receiver duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00
10 CM RF Package. Consists of: SO Xmtr. receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer..... $150.00
ASB 500 Megacycles Radar Receiver with two GL 446 lighthouse cavities, new less tubes...$37.50
10 CM Rec Assy. Less Local OSC. Tube. Consists of mixer stabilizer cavity 30 MC. preamp AFC. Ind. Amp. plugs & cables p/o APS2..... $37.50

200 MC COAXIAL PLUMBING

20' Lengths 1⅝" $2.50/FT
Right Angle Bend 1⅝ OD..... $35.00
T Section 1⅝ OD..... $55.00
T Section with Adapter to ⅞" in rigid coax..$65.00

MAGNETRONS – RADAR – PULSE EQUIPMENT

SA SC SD SE SF SG SL SN SO 1 SO 3 SO 8 SO 1 SO 13 SQ SU TAJ TBK TBL TBM APG5 APR APS2 APS3 APS4 APS6 APS10 APS15 ABA QBF QBG QCQ WEA RAK CPN3 CPN6 DAB RC145

DIRECTION FINDERS

DAB 3 & 4 2 to 18 Mc mfg. Collins, like new $850.00
DAK Direction Finder Automatic
bearing indicators $185.00
complete receiver $225.00
loops $125.00
RG 23U Twin conductor rf cable 250 ft reel ..$50.00
DP12 Direct. Finder 100-1500 kc. $250.00
DF Rec. only Bludworth Standard Arrow..$150.00

RADAR SETS (Many Others)

Radar Set R36 TPS2 Rec Indicator units, new. $325.00
J9/APG2 Junction box for use w/APG2 radar $55.00

400 CYCLE TRANSFORMERS

Input	Ratings	Price Each
115V	6.3V 1.8A P/o APG2	$1.49
57.5V	2x57.5V/.0001 A. P/o APG2	1.95
115V	2x145V/.000145A.	1.49
115V	780V 27V/4.3, 6.3V/2.9, 1.25V/.20A.	3.95
115V	6.4V/11 Amp. P/o APQ7	2.25
115V	2x6.3V/1.25a. P/o APQ 13	1.95
80V	6.3V/1A. 2.5V 2A. P/o PE172A	3.95
115V	15.35VCT/1A	1.95
115V	59.2V/.118, 63V/8.1, 5V/2A P/o APQ 13	3.95
118V	6.3/.9, 6/3V/.6, 5V/6, 640/200 MA	4.95
115V	2x140V/.00014A, 120V/ .00012a. P/o APG2	1.95
115V	3460V/400 Ma. P/o APT 4	7.95
115V	23.5V Tanned 22V/47 MA.	1.95
115V	600VCT/36 Ma.	1.95
115V	408VCT/.11a, 120VCT/.250a, 6.3V/6.15, 5V/2A 45V Tanned 28V/.8 and .3a.	4.95
115-80V	6.4V/2.5, 400VCT/35Ma, 6.4/ 150a.	3.95
115V	6.4V 7.5, 6.4/3.8, 6.4/2.5a	3.49
115V	780V — 27V/4.7, 6.3/2.9, 1.25/.2a.	2.49
115V	6.4V/8a, 6.4V/1A.	1.95
115V	6.3V 9.1A. 6.3VCT/6.5a, 2x2.5 3.5a.	2.49
115V	5V/2a, 6.3V 2a, 5V/2a, 6.3/.5a	2.29
80-115V	5V/15A 5000V Ins.	3.95
115V	6.3/2.7, 6.3/.66 6.3VCT/21A	5.95
118V	760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A	
110V	220V	
110V	3V	
55V	20V/20V.	1.49
115V	6.4/7.5, 6.4/3.8 6.4/2.5	2.95
115V	592V/118Ma. 6.3/8.1a, 5V/2a W.E.	4.95
115V	6.3V/9.1, 6.3VCT/.65a, 2x2.5V/3.5A	2.95
115V	6VCT/.00006 KVA	.98
115V	6.4V/8a, 6.4V/1a	1.49
115V	1034 VCT/.11a, 6.9V/10, 2x6.3V/1, 5V/2, 6.3/2, 63/1	6.49
115-80V	526VCT/.50a, 6.3VCT/2a, 5VCT/29	3.49
80-115V	409VCT/35Ma, 6.4/2.5, 6.4/ 15a.	3.25
115V	2300VCT Large Qty.	2.25
115V	600VCT/36Ma.	1.49
80-115V	2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5 2a. For SCR729.	3.95
115V	640V/500Ma, 2.5V/1.75a P/o APS 15B	2.95
80-115V	360VCT/20Ma, 1500V/1Ma, 2.5V, 6.3/2.5 6.3V/.6a, P/o 729A.	3.95
115V	2x2 .5V/5A, 2.5V/10A. P/o APT 4	4.95
118V	2x2.5V/2.5a, 6.3V/2.25a 1200V Tap 1000V-750V P/o AN/APS-15.	4.95
115V	742.5V 50 MA, 709V 47 MA, 671V/45 MA	2.95
115V	600VCT/36 MA, 2 3/4x2 1/4 x3 1/4	
115V	1150-1150 2 3/4x2 1/4x3 1/4.	
115V	640 VCT 250 MA, 6.3V/.9, 6.3V/.6, 5V/6A.	3.95
115V	6.3V 9.1a 2.5V/3.5a 6.3VCT/ .65a 2.5V/3.5a.	3.25
115V	9800V or 8600V/32 MA.	12.50
115V	592 VCT/120 MA, 6.3V/8a, 5V 2a.	3.50
115V	4540VCT/250 MA.	7.50
115V	5V 3a, 6.3V/2a.	1.75
115V	70 to 111V @ 247-622VA.	1.35
115V	5000V/290 MA, 5V/10A.	12.50
115V	2200V/350	5.45
115V	2.5V/5, 5200V/2 MA.	14.95
115V	13.5 KV/3.5 MA.	11.50
115V	734 VCT/.177a, 1710VCT/ .177a.	6.95
115V	6.3V/.9A, 7.7V/.365A	2.79
100/110 / 120/130	2.5/20A.	4.85
115V	6.3V 12a, 6.3V 2a, 6.3V/1a P/o AN/APQ-5	5.85
115V	6.4VCT 7.5, 6.4VCT/3.8, 6.4VCT/2.5a.	4.35
115V	6.3V/2.7, 6.3V/.66A, 6.3VCT/ 21A.	2.95
115V	6.5V/12A, 250V 100 MA, 5V/ 2a P/o AN/APS-15.	3.50
115V	400VCT/35 MA, 6.4V/.15a, 6.4V/2.5a.	2.25
80-115V	650VCT/50 MA, 6.3VCT/2A, 5VCT/2a P/o R58/ARQ8	2.45
115V	2400CT/.5MA, 640V/.5MA, 2.5V/1.75A.	3.85

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QK 61 2975-3200 mc. $65.00
QK 60 2800-3025 mc. $65.00
QK 62 3150-3375 mc. $65.00
QK 59 2675 2900 mc. . $65.00
QK 915 Raytheon. . . $150.00

FILAMENT TRANSFORMER

for above 115V/60 cy Pri: four 6.3V/ 4A Sec. 5000VT $27.50
Magnetron Kit of four QK's 2675-3375 inc. w/trans special $250.00

BRAND NEW ORIG. PACKED GUARANTEED GOOD

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2J21-A	5J30	WRITE
2J22	714AY, A	OR
2J26	718DY	PHONE
2J27	720BY	
2J32	720CY	
2J34	725-A	
2J37	730-A	
2J38	728-AY, BY, CY, DY, EY, FY, GY	
2J39	700-A, B, C, D	
2J40	706-AY, BY, DY, EY, FY, GY	
2J49	Klystrons: 723A/B 707B W/Cavity	
2J61	417A 2K41	

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	3/4 in.	5/8 in.	$12.50
4200	21/32 in.	3/4 in.	$15.50
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 700A $24.50 ea.
GE Magnet type M7765115. GI distance between pole face variable from 2 1/16" (1900 gauss) to 1½" (2200 gauss). Pole dia. 1⅝ P/o SCR 584. New $34.50

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QCU Magneto striction head RCA type CR 278225— New $95.00
Stainless Steel streamlining housings for above $18.50
QBG Driver Amplifier. New $200.00
QCU Magneto striction head, coil plate assembly, new $14.50
QCQ—2/QCB Magneto striction head coil plate assembly $14.50
QCQ2 Sonar complete set. Write for details.
QCK RCA magnetro striction head assy. consists of coil, plate, nickle diaphragm plate, milled steel body unassembled $65.00
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QJA Sonor QBF w/QJA adapter kits w/cathode ray tube indication. Write.

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BC 931B 420-50-100 mile range 5" scope w/mtg rack, indicator, amplifier, BC 932B, visor, new w/tubes $24.50
BC 704A 9-36-90 mile range 5" scope. Write
BC 987A & BC 988A 12" PPI & "A" scope. Complete desk &rack assy w/osc., control unit, rec., pwr. supls., in unused cond. but shelf worn. $350.00
Radar Indicator RW #31 mfg by Research Enterprise Ltd. 5" scope $30.00

ASD Indicator
ID30 APS2 Indicator
929 Indicator
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Many others in stock

3 CM RECEIVER

Front end, 723A local oscil., 723A Beacon oscil., mtd. on wareguide sect. w/matching slugs, tunable termination xtal mt. includes 2 stage 6AC7, i.f. preamp., tr/atr duplexer assy, complete w/all Klystrons tr/atr, amplifier, tubes, new P/o ASD radar mfg. Sperry. $49.50

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D-167613 (button)....$.95
D-164600 for MTG in "X" band Guide..$2.50
D-167018 (tube).....$.95

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D-168687	$.95
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D-171528	$.95
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D-99428	$2.00
D-16187A	$2.85
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G.E. #3E (3-84-150; 8-24-405) 501P4T: 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
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7.5E4-16-60-6TP, 7.5 KV, "E" Circuit, 4 sections, 16 microsec. 60 PPS, 67 ohms impedance..$15.00
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G.E.K.-2744-A. 115 KV high Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 micro sec. or ¼ microsec. @ 600 PPS. $39.50
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W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core. $6.00
G.E. #K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp. 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW Rifflar 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 deliveries 14KV. Peak Power out 100KW G.E. $14.50
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G.E. 9318 Pulse Xfmr 1:1:1 ..... $1.50
UX 1350 ..... $5.95
Pulse 132-AWP-L421435 ..... $6.00
Pulse 134-BW-2F-L440895 ..... $2.25

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MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: 001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses 1-715B, 4-829-B, 3-'72's, 1-'73. New $110.00
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TPS-3 PULSE MODULATOR. Pk power 50 amp. 24 KW (1200 KW pk); pulse rate 200 PPS, 1.5 microsec. pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v, 400 cycle input. New with all tubes. $49.50
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BC 1203B Loran pulse modulator. $125.00
BC 758A Pulse modulator. $395.00
APS-10 Low voltage power supply less tubes. $18.50
725A magnetron pulse transformers. ..... $18.50 ea.

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D-168184: .5 microsec, up to 2000 PPS, 1800 ohm term $1.00
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FOR AIRPORT CONTROL GROUND STATION—Standard relay rack housing, monitor loud speaker, dual channel receiver amplifier. Type 109 A control panel, microphone speech amplifier, etc., spare parts, new and complete ..... $750.00 each

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T.S. 35/AP	TS 62/AP
T.S. 36/APM	CS 60/APW
Sig Generator	804 Federal

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SCR 584

BC 1056A	BC 1090A
BC 1058A	BC 1090B
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Price $3.00 ea. net.

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Type 1600 Haydon Timing Motar—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

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Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 each net.**

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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.**

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.**

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FPE-25-11, Diehl, Low-Inertia, 75 to 115 V., 60 cycle, 2 phase. **Price $16.00 each net.**

FPE-49-7 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, 3.0 amps., 10 w., output. **Price $34.50 each net.**

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MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 Cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $8.50 each net.**

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Price $17.50 ea. net, with tubes.

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Schwein Free & Rate Gyro, type 46800. Same as above except later design.
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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.**

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.**

Norden Type M7 Servo Motor. 26 V., D.C. **Price $20.00 each net.**

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5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $3.90 each net.**

A-7155, 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 Shunt Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $3.75 each net.**

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General Electric Type 5BA10AJ37C, 27 V. D. C., .5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

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5069456, Delco, 27.5 V., 10,000 r.p.m. **Price $4.70 each net.**

5069600, Delco, 27 V., 250 r.p.m. **Price $5.00 each net.**

5069466, Delco, 27 V., 10,000 r.p.m.
Price $3.50 each net.

5069370, Delco, 27 V., 10,000 r.p.m. **Price $4.70 each net.**

5069230, Delco, 27 V., 145 r.p.m. **Price $5.00 each net.**

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

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8TJ9-PDN Transmitter, 24 V.
Price $3.75 each net.

8DJ11-PCY Indicator, 24 V. Dial marked—10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

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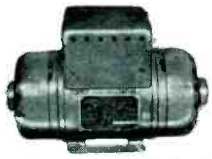

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter.
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12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A.
Price $22.50 each net.

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A.
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Weston Frequency Meter. Model 637, 350 to 450 cycles, 115 volts.
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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.
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With ext. shunt $9.00 each net.

Westinghouse Ammeter. Type 1090-D120, 120-0-120 amps. D. C.
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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.

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Price $15.00 each net.

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AY31, 26 V., 400 cycle. Shaft extends from both ends.
Price $10.00 ea. net.

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Price $35.00 each net.

AY130D, new. **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 $30.00 each net.
Type 12604-3-A.
Price $30.00 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.
Type 12077-1-A, single tube Amplifier, Autosyn input, 115 V., 400 cycle.
Price $49.50 each net, with tube.

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, 67000 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

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.

Weston Tachometer Generator (aircraft type) model 752-J4 single phase. A.C. output. **Price $17.50 each 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.

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 $4.50 each net.

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 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 $15.30 each net.**

1CT Control Tronsformer. 90/55 volts, 60 cycle. **Price $35.00 each net.**

ALL PRICES, F.O.B. GREAT NECK, N. Y.

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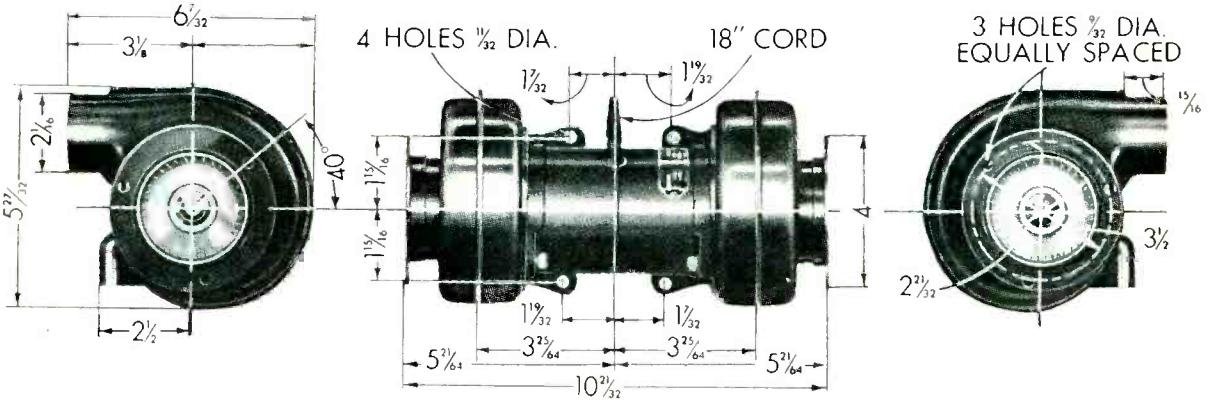
37 EAST BAYVIEW AVE., GREAT NECK, N. Y.
Telephone IMperial 7-1147

Write for Catalog NE100

Western Union address: WUX Great Neck, N. Y.

A ONCE-IN-A-LIFETIME SURPLUS SALE OF BRAND NEW DELCO DUAL BLOWERS!!



- AC Shaded Pole Motor!
- 2750 FPM Velocity!
- 2800 RPM Operation!
- Dual Multi-Blade Fans!
- Dual Outlet Blowers!
- Quiet, Continuous Duty!

IDEAL FOR:
Darkrooms, Kitchens, Cooling Transmitter Tubes, Home Use, Humidifiers, Furnace Draft Boosters, Hair Dryers, Marine and Commercial Ventilation, etc.

A lucky special-purchase by Boston's famous RADIO SHACK, enables you to SAVE over half on these BRAND NEW (in original shipping carton) dual blowers made by the Delco division of GENERAL MOTORS! They have a multitude of uses wherever air is circulated in heating, cooling and ventilating services — with innumerable commercial, household and marine applications. Blowers are finished in durable, satin-black lacquer, have universal type mounting brackets (see sketch), and an 18" rubber cord with plug. Snail-type blower housings on each end of the double-shaft Delco Appliance motor employ multi-blade fans for quietness and maximum air volume. Motor will operate continuously with no attention except for lubrication. Convenient size for limited mounting spaces!

THE BLOWER BUY OF A LIFETIME AT ONLY....

$14.85 Each lots of 1-9
$13.95 Each lots of 10-49
$12.75 Each lots of 50-99

MANUFACTURERS! EXPORTERS!
Write for discount on lots exceeding 100 blowers.

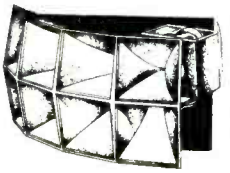
MOTOR SPECIFICATIONS:
Die cast alloy case and housings. Stator: 2 field coils, machine wound enamel wire, taped, dipped and baked in insulating varnish for complete protection. Starting Coil: single-turn copper hairpin. Rotor: squirrel-cage type, skewed for quietness. High-grade silicon steel laminations. High-grade precision-ground steel armature shaft. Self-aligning bronze bearings. Universal-type mounting brackets. Lubrication: felt washers in large oil reservoir with sealed oil holes. Operates on 115 volt 60 cycle AC.

BLOWER SPECIFICATIONS:
Pressed steel housings, welded two piece, snail type. Two multi-blade squirrel-cage type fans.

CHARACTERISTICS:
2800 RPM operating speed. Rotation clockwise from right-hand end. 62 watts input 2750 feet per minute velocity. Air delivery 120 cu. ft. per min. free volume. ½" water static-pressure. Weight 11 lbs.

STILL SOME LEFT! HURRY

SAVE $80.50 NOW on STEPHENS TRU-SONIC HIGH FREQUENCY SPEAKER with electro-dynamic driver!



List Price ~~$110.00~~

$29.50 net

Modernize PM or dynamic speakers into *800 cycle cut-off* (flat to 15,000 cps) dual tweeter-woofer systems of incomparable fidelity! *True-Sonic horn #824H* has 8 cells, each 4 x 4 x 11". *True-Sonic 20-watt electro-dynamic driver unit E15* has 16-ohm aluminum voice coil; 3 lb. 150-ohm copper field coil; field dissipation 15 watts. Shipping wt. 26 lbs. Perfect for hi-fi enthusiasts, small theatres, schools, labs, sound studios. WRITE, PHONE or WIRE your order today, because bargain-hunters will immediately recognize this as the most unusual audio "buy" since the war! New (not surplus)! Limited quantity!

800 Cycle Crossover Network Kit $9.95
Driver Unit Field Supply Kit $5.55

Write for free schematic
FREE 138 pg. CATALOG and SURPLUS BULLETIN

TERRIFIC VALUE! RCA SOUND-POWERED HEAD-AND-CHEST SET

Type MI-2045-E, Worth Over $50 ONLY

$27.50 per pair

IDEAL FOR TV REPAIR AND INSTALLATION CREWS, TELEPHONE LINEMEN, INTERCOM SYSTEMS — especially suited for chemical and other plants where battery or line-operated systems are not allowed. NO BATTERIES or POWER ARE NEEDED. Just connect units and talk! These sets were built for naval use and are BRAND NEW IN ORIGINAL CARTONS! Each set includes: pair of earphones with rubber cushions and metal headband; telephone type metal chest-plate with straps, connecting block and transmitter with swivel adjustment; all rubber-covered cords, including 25 foot rubber connecting cord and brass plug. These powerfully constructed RCA sets have NEVER BEFORE been offered for civilian use (to our knowledge), and are not to be confused with inferior or gadget-type products. Useable range computed in MILES, not feet! Quantity LIMITED — only 200 pairs available! Order today!

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167 Washington St., Boston 8, Mass.
Please RUSH me the following:

- ☐ Delco Dual Blowers @ $.....
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The RADIO SHACK Corp.
167-E WASHINGTON ST., BOSTON, MASS., U.S.A.

RADIO SHACK SCOOP! FOR SCHOOLS, LABS! HAMS, LIMITED QUANTITY!

SENSATIONAL PRICE CUT

$87.50 RCA WV-65A VOLTOHMYST FOR $39.50

The Battery VoltOhmyst is a push-pull VTVM with 2-tube bridge circuit, possessing excellent linearity and stability characteristics. Circuit innovations that include zero grid current and controlled inverse feedback produce accurate readings over all ranges.

A 1-meg. shielded signal-tracing probe makes possible dynamic voltage measurements in signal-carrying circuits. The WV-65A is exceedingly stable in operation, requires no adjustment of zero controls when changing ranges and is essentially independent of changes in both tube characteristics and battery voltages during normal life. A neon lamp mounted on the panel flashes whenever the battery is on. This indicates the condition of the battery, and reminds one that the instrument is on.

The Battery VoltOhmyst may be used for accurate measurements of a-c and d-c voltage, for d-c current and for resistance. It may be used for measuring AVC, AFC and FM discriminator voltages; d-c supply and bias cell voltages; oscillator strength; and resistance of coils, resistors, and insulation. This VoltOhmyst is quite helpful for measuring the d-c voltage developed across the picture channel of a television receiver when making antenna adjustments. It also is applied to determining when gassy tubes are present. D-C measurements may be made when a-c is present. In addition, it is a useful tool for servicing all types of electronic equipment.

Battery Kit $2.52 EXTRA IF DESIRED

GUARANTEED!

D-C Voltmeter:
- Six Ranges . . . . . 0-3, 0-10, 0-30, 0-100, 0-300, 0-1000 volts
- Input Resistance . . . . . 11 megohms constant for all ranges
- Sensitivity (max.) . . . . . 3.7 megohms per volt on 3-volt range

A-C Voltmeter:
- Five Ranges . . . . . 0-10, 0-30, 0-100, 0-300, 0-1000 volts
- Sensitivity . . . . . 1000 ohms per volt

Ohmmeter:
- Six Ranges . . . . . 0-1000, 0-10,000, 0-100,000 ohms, 0-1, 0-10, 0-1000 megohms

D-C Ammeter:
- Six Ranges . . . 0-3, 0-10, 0-30, 0-100, 0-300 milliamp. and 0-10 amp.
- Voltage Drop . . . . . 450 mv. for full scale deflection

Power Supply:
- Batteries . . . . . Two 45 volt . Four 1½ volt

Tube Complement . 9½" high, 6¼" wide, 5½" deep

2 RCA-1C5GT, 1 GE-NE51 9 lbs. (incl. batteries)

BIG SPECIAL PURCHASE OF TOP QUALITY RADIO PLIERS

Below Dealer Net!

World-famous KLEIN, KRAUTER, WAYMOTH and PEXTO radio pliers! Thanks to a very special purchase, we are able to offer precision pliers below cost for the first time in many years. Experts who are familiar with the name KLEIN, will recognize it as the hallmark of quality. These are NOT the common variety of pliers found in most radio stores. Quantity prices on request.

Mfg. No.	*Type*	*Price*
KLEIN 245-5	Vest-pocket oblique-cutting 5"	$2.50
KLEIN 240-5	Oblique-cutting, wire-strip 5"	2.50
KLEIN 201-6NE	Side-cutting 6"	2.98
KRAEUTER 1801-6	Side-cutting 6"	1.53
WAYMOTH TL-13A	Side-cutting, wire-strip 6"	1.49
PEXTO 40	Side-cutting, lap-joint 6"	1.23

Lowest Price in the U.S.A. on Brand New TACHOMETER GENERATORS

ROTATION GENERATOR (Elinco B-68), operates from 110V 60 cy source to provide constant frequency output whose amplitude varies lineal with speed. Use up to 6600 RPM. Voltage output at 1000 RPM is minimum of 1.2V. Size 2½x3".

Stock No. RS-904 .....ONLY $9.50

AC RATE GENERATOR (Elinco F-16), 2 phase AC, 1.3V per 100 RPM. 60 cy output at 1800 RPM. Size 2½x3"

Stock No. RS-905 .....ONLY $8.95

WESTERN ELECTRIC MERCURY CONTACT RELAY, ONLY $3.95

List Price $28.00

Type D-171584. Glass-sealed, mercury-wetted contact switch surrounded by operating coils and encased in metal housing mounted on an octal tube base. APPLICATIONS: high-speed keying, tabulating-sorting-computing machines, relay amplifiers, vibrator power supplies, servo-mechanisms. CHARACTERISTICS: high speed of operation, constant operating characteristics, freedom from chatter, high current capacity. SPECIFICATIONS: SPDT, two coils of 250 ohms and 4500 ohms, operating current with coils connected in series 6 ma. Over-all size: 3⅜" long, 1-5/16" in diameter. A check through current relay advertisements will show you that our price of $3.95 each is the LOWEST in the U.S.A. Order Stock No. RS-837.

Famous-Make 220 VOLT $8-List SOLDERING IRON SPECIAL AT ONLY $2.95

100 WATT irons with ⅜" tips, made by America's most famous maker! Our special purchase from an over-stocked user of these 220 V irons enables you to save over $2 each on their Dealer net price. Designed primarily for production and maintenance work. Each has baffle plate at shank for cool handling, and separate heat-insulating stand!

$52 SOLA CONSTANT VOLTAGE Transformer

FOR ONLY $17.50

Type 30864 is designed to maintain output voltage to within less than plus or minus 1% for a total primary variation of 30%. It has many lab, industrial and amateur applications. Input 190-260 VAC, output 115 VAC at 1.7 amps. Size 15"x8"x6". Net wgt. 80 lbs. Order Stock No. RS-721.

SOLDER!

- Dutch Boy
- Kester

$5 VALUE!

Save over 33⅓ % 5 lb. spools only

Alloy	Size	Type
40/60	.062	rosin core
40/60	.125	solid

5 lb. spools either type: **$3.50**

SUPER-SPECIAL! FG27A THYRATRON
In lots of 100 $4.45 each
In lots of 50 $4.95 each

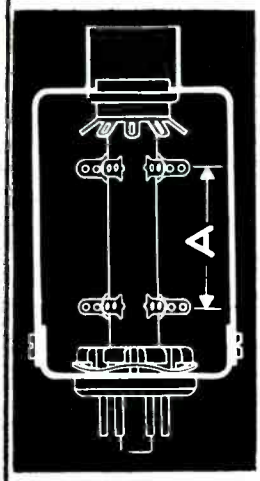
ORDERS FILLED PROMPTLY

TERMS - cash or 20% deposit, balance C.O.D.

The RADIO SHACK Corp.

167-E WASHINGTON ST., BOSTON, MASS., U.S.A.

VECTOR Socket Turrets For Immediate Delivery



New Plug-in units combine tube socket, terminal post, octal plug and shield can--

Just think -- all the condensers and resistors in any tube circuit mounted right on the socket of that very tube! You'll find it so simple, so logical an improvement, that you'll wonder why you never dreamed up such a gadget yourself. This new development in electronic wiring is catching on like wildfire and already is to be found in use wherever modern design is truly modern.

Permits use of sub-assemblies which can be installed quickly with minimum of connections. Cuts number and length of leads -- reduces stray capacitance. Components may be mounted from socket to turret, entirely on or within the turret, or from one turret to another. With some types, coils may be wound on the turret with iron cores inside. A great time-saver for the experimenter -- if an assembly does not operate as expected it can be removed as a unit and another quickly installed. Cuts cost on the production line -- eliminates terminal strips, mounting parts. Saves chassis space. Improves high frequency performance, makes parts more accessible and gives neat appearance.

Typical Assembly On a VECTOR Socket Turret

PLUG-IN UNITS

Dimensions		Catalog Numbers					
Can Size	A	Octal	Price	7 pin	Price	9 pin	Price
1.37" sq. x 2.0" h.	0.87"	B8-0	$1.43	B8-M	$1.52	B8-N	$1.57
1.37" sq. x 2.5" h.	1.37"	B10-0	1.45	B10-M	1.55	B10-N	1.60
1.37" sq. x 3.0" h.	1.87"	B12-0	1.48	B12-M	1.57	B12-N	1.62
2.0" sq. x 2.0" h.	0.87"	C8-0	1.64	C8-M	1.76	C8-N	1.81
2.0" sq. x 2.5" h.	1.37"	C10-0	1.67	C10-M	1.79	C10-N	1.84
2.0" sq. x 3.0" h.	1.87"	C12-0	1.69	C12-M	1.81	C12-N	1.86
No Can	0.87"	A8-0	.89	A8-M	.94	A8-N	.97
No Can	1.37"	A10-0	.91	A10-M	.96	A10-N	1.00
No Can	1.87"	A12-0	.94	A12-M	.98	A12-N	1.02

Add 'H' to number for 9 pin plug; 'K' to number for 11 pin plug.

Plug-in units also available in two-tube types and in types without sockets but with terminal turrets and plugs-- useful in plug-in applications where tubes are not involved. Write for free copy of Sun Radio "Monthly Mailer" for November which lists these units in full.

— STANDARD SOCKET-TURRETS —

Mica-Filled Miniature Socket (7 pin) with crimp-on saddle, 7/8" mtg. centers. Requires 5/8" socket hole. Military dome type socket is standard but flat top type obtainable by addition of letter "F" following "M" in number as #8-MF-9T. Turret 1/2" dia., 1/16" wall appx.: Grade XX natural tan laminated phenolic tube joined to socket with tubular rivet thru center of socket and turret. One lug at end of rivet for shield ground. Six terminals at far end of turret plus three terminals near socket for 2" type only.

Cat. No.	Ht.	Description	Price
8-M-9T	2"	9 Terminals in 2 rings spaced 1"	$ .63
8-M-9TS	2"	8-M-9T plus standard shield mounting base	.71
6-M-6T	1 1/2"	6 Turret Terminals at far end only	.60
6-M-6TS	1 1/2"	6-M-6T plus standard shield mounting base	.68
4-M-6T	1"	6 Turret Terminals at far end only	.59
4-M-6TS	1"	4-M-6T plus standard shield mounting base	.67

Mica-Filled Octal Socket, wrap-around contacts, steel saddle with 1 1/16" mtg. centers, 4 ground lugs. Requires 1" dia. socket hole. Turret 1/2" dia., 1/16" wall appx.; Grade XX natural tan laminated phenolic tube set into recessed hole in socket and bonded with phenolic adhesive. Six terminals at far end of turret plus three near socket except in shortest type.

Cat. No.	Ht.	Description	Price
10-0-9T	2 1/2"	9 Turret Terminals in 2 rings spaced 1 7/16"	$ .59
8-0-9T	2"	9 Turret Terminals in 2 rings spaced 1"	.57
6-0-6T	1 1/2"	6 Turret Terminals in 1 ring only far end	.54

Mica-Filled Noval Socket (9 pin) with crimp-on saddle, 1 1/8" mtg. centers. Requires 3/4" dia. socket hole. Turret 1/2" dia., 1/16" wall appx.; Grade XX natural tan laminated phenolic tube joined to socket with tubular rivet thru center of socket and turret. One lug at end of rivet for shield ground. Six terminals at far end of turret plus three terminals near socket for 2" type only.

Cat. No.	Ht.	Description	Price
8-N-9T	2"	9 Terminals in 2 rings spaced 1"	$ .68
8-N-9TS	2"	8-N-9T plus standard shield mounting base	.77
6-N-6T	1 1/2"	6 Turret Terminals at far end only	.66
6-N-6TS	1 1/2"	6-N-6T plus standard shield mounting base	.74
4-N-6T	1"	6 Turret Terminals at far end only	.63
4-N-6TS	1"	4-N-6T plus standard shield mounting base	.71

Heights measured from chassis to far end of turret.

RCA Battery Type VOLTOHMYST (WV-65A)

Limited Quantity

Only $39.50

formerly $87.50!

FEATURES

Power supply completely self-contained.
Measures voltage, current, and resistance.
11-megohm input resistance for all DC ranges.
1-megohm isolating resistor in DC dynamic probe.
Electronic circuit--meter protected against burnout.
Polarity reversing selector switch.

DC Voltmeter:
Six Ranges: 0-3, 0-10, 0-30, 0-100, 0-300, 0-1000 V.
Input Resistance: 11 megohms constant for all ranges.
Sensitivity (max.): 3.7 megohms per volt on 3 V range.

AC Voltmeter:
Five Ranges: 0-10, 0-30, 0-100, 0-300, 0-1000 volts.
Sensitivity: 1000 ohms per volt.

Ohmmeter:
Six Ranges: 0-1000, 0-10,000, 0-100,000 ohms, 0-1, 0-10, 0-1000 megohms.

DC Ammeter:
Six Ranges: 0-3, 0-10, 0-30, 0-100, 0-300 milliamp. and 0-10 amp.

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AND ELECTRONICS COMPANY, INC.
122-124 DUANE STREET
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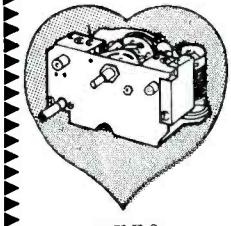
TELEPHONE BARCLAY 7-1840

ONLY ONE NIAGARA FOR GREAT RADIO VALUES

NIAGARA HAS ONE OF THE LARGEST STOCKS OF NEW, SURPLUS TUBES IN THE WORLD

1B22	$4.59	3BP1	3.95	9C23	250.00	274B	1.15	700B	29.50	832	4.95	975A	14.95	C100A	1.50	R200	7.95
1B23	9.50	3C23	4.95	9GP7	15.00	275A	7.95	700D	29.50	832A	4.95	991	.75	CEQ72	1.95	R1130	12.95
1B24	4.95	3C24	.69	9JP1	7.95	282A/B	9.95	701A	4.95	833A	34.50	1611	1.50	CG38172A	2.95	REL36	.98
1B25A	4.95	3C30	1.50	9NP1	7.95	283A	10.95	702A	2.95	834	5.95	1612	1.98	CK1005	.35	RK12	3.95
1B26	7.95	3C31	4.95	10BP4	24.95	286A	10.95	703A	4.95	836	1.15	1613	.75	CK1090	4.95	RK19	.98
1B27	4.95	3C45	14.95	10CP4A	29.50	287A	9.95	704A	1.00	837	2.50	1614	1.75	CV38	49.50	RK20A	7.50
1B29	.89	3CP1	3.00	10Y	.69	290A	4.95	705A	2.95	838	3.95	1616	1.39	CX 300	17.50	RK21	1.15
1B32	4.95	3DP1	3.95	12DP7	14.95	291A	4.95	706AY	49.50	841	.69	1619	.75	EF50	.79	RK22	4.95
1B38	49.50	3D21A	1.49	12FP7	14.95	294A	4.95	706CY	18.95	843	.69	1620	4.95	EL1C	4.95	RK25	3.50
1B40	4.95	3EP1	3.95	12GP7	14.95	297A	3.95	706GY	49.50	845	4.95	1622	1.75	EL3C	4.95	RK28A	14.95
1B60	4.95	3E29	4.95	12HP7	14.95	300A	3.95	707A/B	24.95	849	69.50	1624	1.75	EL225	12.95	RK31	2.50
1N21	1.00	3FP7	3.95	12KP4	49.50	301A	6.95	708A	7.95	849A	69.50	1625	.49	F123A	12.95	RK32	4.95
1N23/		3HP7	4.95	12TP4/		304B	5.95	709A	4.95	849H	69.50	1626	.49	F128A	79.50	RK39	1.75
1N34	1.00	3JP7	7.95	12LP4	49.50	304TH	6.95	710A	2.95	850	22.50	1628	4.95	F660	150.00	RK48A	19.95
1S21	2.49	4A1	.98	15E	1.50	304TL	1.49	713A	1.65	851	75.00	1629	.69	FG17	3.25	RK51	3.95
2AP1	3.95	4B25	12.95	15R	.98	307A	4.95	714AY	6.95	852	5.95	1631	1.50	FG27A	9.95	RK52	4.50
2B22	5.95	4C35	19.95	23D4	.49	310A	7.95	715A	7.95	860	3.00	1633	.89	FG32	5.95	RK59	5.95
2C4	1.18	4E27	14.95	24G	.98	311A	6.50	715B	9.95	861	49.95	1634	.79	FG33	8.95	RK60/1641	.79
2C21	.98	4J26	110.00	35T	4.95	315A	6.95	715C	24.95	864	.69	1635	1.35	FG81A	6.95	RK62	1.98
2C22/		4-65A	14.50	45 Spec.	.49	316A	.69	717A	.99	865	2.98	1636	5.95	FG104	16.95	RK63	12.95
2C26A	.28	4x-100A	24.95	53A	24.95	323A	9.95	719A	24.95	866A	.99	1638	.98	FG105	19.95	RK65	24.95
2C34	.59	4-125A	27.50	75TL	3.95	327A	4.95	720DY	34.98	866Jr.	1.19	1642	.98	FG166	49.50	RK72	1.95
2C40	2.98	4x150A	24.95	100TH	12.95	328A	6.50	721A/B	4.35	872A	2.95	1644	1.49	FG190	14.95	RK73	3.95
2C43	9.50	4-250A	37.50	100TS	3.00	337A	7.50	722A	9.95	874	2.49	1645	1.93	FG172A	32.50	RX21	3.95
2C44	1.75	4AP10	4.95	101D	3.95	338A	4.93	723A/B	7.95	876	2.50	1649	1.25	FG235	59.50	RX120	10.00
2C51	6.50	5AP1	4.95	101F	4.95	348A	5.95	724A/B	4.95	878	2.49	1654	2.00	FG238B	160.00	RX233A	4.95
2D21	1.18	5AP4	4.95	114A	.69	350/A/B	2.95	725A	9.95	884	1.49	1655	.98	GA4	4.95	T20	1.50
2E22	1.50	5BP1	2.95	114B	1.25	353A	2.75	726A	23.50	885	.98	1665	1.19	GL146	11.00	T21	1.75
2E24	4.95	5BP4	4.95	120	5.95	WE 355A	19.95	726B	23.50	889R	140.00	1846	600.00	GL415	21.00	T200	10.95
2E25A	4.25	5C22	49.50	121A	2.65	357B	49.50	726C	23.50	891	110.00	1851	1.25	GL451	3.95	T250	19.95
2E30	2.39	5CP1	3.95	203A	16.95	371A/B	.89	728GY	24.95	892R	175.00	1960	.95	GL473	65.00	UH50	5.95
2J21A	12.95	5CP7	8.95	205B	4.50	374A	2.50	730A	24.95	902P1	7.95	2000T	125.00	GL502A	1.98	UX120	1.98
2J26	8.95	5D21	29.95	205F	4.50	383A	7.50	750TL	49.50	905	11.95	2050	1.19	GL530	49.50	UX200	.75
2J30	19.95	5FP7	3.95	207	110.00	385A	4.95	800	2.25	913	4.95	2051	.98	GL559	5.35	UX6653	4.95
2J31	19.95	5GP1	9.95	211	.98	388A	2.75	801A	.98	917	1.50	5514	4.95	GL673	11.50	V70D	6.95
2J32	24.95	5HP1	3.95	211D	6.95	393A	7.95	802	4.25	918	1.50	5516	5.95	GL697	150.00	VR75	.98
2J33	24.95	5HP4	9.95	211E	6.95	394A	7.50	803	8.95	920	2.70	5562	10.00	HF100	3.95	VR78	.75
2J37	24.95	5JP2	10.95	215A	3.00	399A	2.50	804	12.95	923	.98	7193	.39	HF200	17.95	VR90	.75
2J38	24.95	5J23	100.00	217C	7.30	400A	3.25	805	5.95	925	1.40	8003	5.95	HF210	17.95	VR91	1.49
2J49	24.95	5J29	100.00	218	49.50	401A	1.95	807	1.25	927	1.25	8005	4.95	HF300	17.50	VR105	.98
2JB51	4.95	5LP1	11.95	221A	2.95	6AK5/403A	1.75	808	1.89	929	2.50	8011	2.95	HV18	12.95	VR150	.75
2J54B	24.95	5MP1	4.95	227A	4.95	403B	1.75	809	2.93	930	1.00	8012	4.95	HY31Z	4.95	VT127A	3.00
2K23	24.95	5NP1	1.98	231D	1.49	417A	24.95	810	7.95	931A	4.95	8013	2.95	HY40Z	3.95	VU111	1.19
2K25	24.95	6AS6	2.95	244A	3.95	434A	7.95	811	2.45	934GT	1.58	8014A	24.95	HY69	4.95	WL460	14.95
2K28	24.95	6CF	12.95	247A	3.95	446A	1.95	812	2.95	938	3.95	8016	1.49	HY114B	1.95	WL468	14.95
3AP1	4.95	6C21	24.95	249C	3.49	446B	1.95	812H	6.90	949H	69.50	8020	3.95	HY615	1.25	WL532A	4.95
3B22	4.95	6J4	4.95	250R	7.95	450TH	24.95	813	8.95	950	.98	8025	7.95	HYE1148	.48	WL562	150.00
3B23	4.95	7BP1	4.95	250TH	19.50	450TL	45.00	814	3.95	954	.75	8026	12.95	HY1269	4.95	WL616	105.00
3B24	1.98	7BP7	4.95	252A	4.95	464A	9.50	815	2.95	955	.75	BH	4.95	KU23	15.00	Z225	1.95
3B24W	2.95	7C23	75.00	254	17.95	527	12.95	826	.69	956	.75	BR	2.50	KU610	9.95	ZB120	6.95
3B25	7.95	7C24	80.00	259A	4.95	531	24.50	829	4.95	957	.75	BW11	5.95	ML101	150.00	ZB3200	150.00
3B26	1.89	7C25	90.00	262A/B	3.50	532A	4.95	829A	5.95	959	2.95	C1A	4.95	MX408U	.49	ZP477	14.95
3B27	3.95	7DP4	17.95	271A	9.95	631P1	4.95	829B	8.95	966A	.99	C5B	12.95	PJ23	1.35		
3B28	5.95			274A	2.25			830	2.95	972A	2.95	C6A	9.95	R100	3.75		
								830B	5.25			C6J	12.95				



HEART OF THE BC-221 FREQ. METER

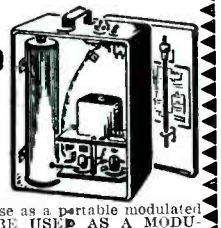
This VFO Sub-Assembly, used in BC-221 Freq. Meter is ideally suited for home construction of:

1—Amateur V.F.O.
2—Freq. Mtr. Foundation
3—Portable Transmitter
4—Replacement for BC-221

Unit contains two temperature & moisture compensating coils, water switch, 3 variable condensers, carbon resistors, & silver mica condensers. FULLY WIRED & mounted on sturdy aluminum subchassis, ready for installation. Brand new—in original packing. E-276.

Very special **$6.95**

NIAGARA'S GOLD-PLATED SPECIAL



An ultra-high freq. Gold-plated Cavity Resonator with a range of 234-248 Mcs! Fully wired, including two 955 acorn tubes. Designed by the navy for use as a portable modulated test oscillator. CAN BE USED AS A MODULATED SIGNAL GENERATOR. Battery compartment is large enough to house speech equipment, and power supply, making it a desirable portable UHF Transmitter for Ham use. Complete with tuning wrench, tubes, whip antenna, and circuit diagram on inside cover. Black wrinkle finished cabinet measures 9½ x 6½ x 6¾".

The Buy of a Lifetime!
Cat. No. E-257 SPECIAL..... **$3.95**

ATTENTION! SCHOOLS, LABS, MILITARY INSTALLATIONS!

A NIAGARA EXCLUSIVE

The 5NN Automatic Film Rater

The 5NN Automatic Film Rater is designed for individual self-rating by the question and multiple choice answer system. The basic feature is a 35MM slide film projector, projecting a series of illustrated questions on the rear of a 9"x12" translucent screen. Each question is combined with six possible answers for selection. Scoring is automatic and based upon correctness, plus rapidity of selected answer.

Operating panel consists of rear projection screen, 10 numbered timing lights, 6 answer selection buttons, score-question number, correct and incorrect indicators and starting button.

Film consists of about 200 frames of 35MM film in a continuous loop.

Manufactured by Mills Industries, Inc. for use in training military personnel with speed and efficiency. Device is 24" wide, 19" deep and 50" high. Shipping weight 225 lbs. Complete with *SVE* Projector, 110V.A.C. Supply Spare parts and film. . . Used but in excellent condition

Cat. #FR-280 **$49.50**

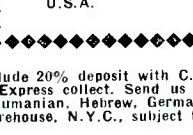
Does Your Set Droop from Interference Bloop?

BANISH INTERFERENCE With New NIAGARA HI-PASS FILTER!

Positive protection against interference from amateur transmitters, ignition noises, diathermy and all other devices generating RF interference. Designed to fit any 300 ohm antenna feeder. Absolutely no loss in brightness or clarity. Easily assembled. Complete instructions, FCC findings under test, included.

$1.95 per kit anywhere in U.S.A. Plus 15¢ postage and handling.

ATTENTION AMATEURS!



Don't be blamed for TVI. FCC tests have proven that Niagara's new LOW PASS filter attenuates all frequencies above 40Mc. The skillfully engineered M-Derived Filter for 10, 20, 40, 80 and 160 meters prevents TVI while you're operating. Eliminates all harmonics above 30 Mc. Kit contains all parts, nothing else to buy. Full instructions, entire factual FCC report included with each kit.

No. N-279 only..... **$4.99**
plus 25¢ shipping charges in U.S.A.

IMPORTANT NOTICE: Minimum order $2.00. Please include 20% deposit with C.O.D. orders unless rated. Orders received without postage will be shipped Railway Express collect. Send us your inquiries today. We correspond in English, Spanish, French, Italian, Polish, Rumanian, Hebrew, German, Portuguese, etc. Prices subject to change without notice. All stock F.O.B. our warehouse, N.Y.C., subject to prior sale.

Niagara Radio Supply Corp.

Phone Digby 9-1132-3-4

Dept. E10 — 160 Greenwich Street, New York 6, N. Y.

SPECIAL METERS

SENSITROL RELAY, 0-50 Microampere sensitivity, Weston 705 type 5. Single fixed contact with 110 volt AC solenoid reset and adjustable index to indicate operating point. Has two scales, one for setting index, the other for reading pointer position. Contact closes on decreasing value and has a capacity of 5 Watts at 110 volts.
List Price $68.50 Your cost ONLY $27.50

FREQUENCY METER, 55 to 65 cycles, James Biddle Co., type MF-11 Frahm vibrating reed type, 11 reeds, 100 to 150 volt operation, 3½" round flush bakelite case $7.50

FREQUENCY METER, JBT 30-F, Dual Range covers frequency ranges from 48-52 cycles and 58-62 cycles: Dual element, vibrating reed type 115 volt, 3½" rd flush metal case $5.95

DECIBEL METER, Weston 301 type 61, minus 10 to plus 6 DB, 3½" rd fl bake case, 6 MW 600 ohms, High speed type, with 3 external wire wound multipliers to extend range $11.50

DECIBEL METER, Weston 506, minus 10 to plus 6 DB, 2½" round flush bakelite case, Black scale, luminous markings $5.50

PORTABLE A.C. AMMETER 0-3 and 0-15 Amps A.C. Weston Model 528. Complete with leather carrying case and test leads $12.50

AIRCRAFT METERS

All aircraft meters listed are 2½" type with black scales.

30 Volt Weston 606 ..... $4.50
30 Volt Westinghouse AX-33 ..... $4.50
30-0-30 Amp Weston 606 ..... $5.00
120 Amp Weston 606 W/ext shunt $5.00
120 Amp Westinghouse AX-33 W/ext shunt $5.00
240 Amp Westinghouse AX-33 W/ext shunt $6.50
240-0-240 Amp General Electric W/ext shunt $6.50
30 Volt 60 Amp, G.E. W/ext shunt, AN Conn. Type $5.50
30 Volt 120 Amp, Westinghouse AX-33 W/ext shunt $6.00
30 Volt 120 Amp, General Electric W/ext shunt, AN Conn. Type $5.50
30 Volt 240 Amp, Westinghouse AX-33 W/ext shunt $7.50

D. C. MICROAMMETERS

ZERO CENTER MICROAMMETER ideal for null indicator, Approx. 10-0-10 microampere movement, Scale approx. 1¾" long calibrated 0-20, resistance 1,600 ohms, Weston Model 301, 3½" rd fl bake case @ $6.50

D. C. MICROAMMETER 0-50 Weston Model 801, 4" x 4½" Rectangular bakelite case. Approx. 2,000 ohms resistance. @ $19.50

0-200 W.H. NX-35, 3" R-B MR35W200DCUA.. $ 8.50
0-500 Weston 506, 2" R-B Spec black scale calibrated 0-150%, Luminous Numbers ..... $ 4.00
0-400 microampere movement Welch #3013 7½" Switchboard meter, R-M flush case with internal resistor and scale calibrated for 40 volts D.C. at $17.50

D. C. MILLIAMMETERS

0-1 G.E. DO-41, 3" R-B $6.00
0-1 W.H. NX-35, 3" R-B MR35W001DCMA.. $7.50
0-1 Weston 301, 3" S-B $7.50
0-3 Gruen GW-580, 2" R-B $3.50
5-0-5 Western Electric 3" R-B, concentric style. $3.00
0-20 G.E. DW-55, 2" R-B black scale $3.00
0-30 G.E. DO-41, 3" R-B $3.50
0-80 G.E. DO-41, 3" R-B $3.75
0-150 Gruen 508, 2" R-B $3.00
0-200 G.E. DO-41, 3" R-B $4.50
300-0-300 G.E. DO-40, 3" R.B, ring mtd non-flanged case $3.00
0-500 W.H. NX-33, 2" R-B $3.95

D. C. KILOVOLTMETERS

All meters are furnished complete with precision, wire wound, 1000 ohms per volt, hermetically sealed multipliers and mounting clips.

0-1 Weston 301, 3" S-B $9.00
0-1.5 W.H. NX-35, 3" R-B $7.50
0-1.5 Weston 301, 3" S-B $9.50
0-2 Weston 301, 3" S-B $10.50
0-3 Weston 301, 3" S-B $10.50
0-4 Weston 301, 3" S-B $12.00
0-5 Weston 301, 3" S-B $14.00
0-10 Weston 301, 3" S-B $15.00
0-20 Weston 301, 3 S-B $22.50

A. C. VOLTMETERS

0-15 G. E. AW-41, 2" R-B bl sc, Signal Corps IS-122 ..... $2.50
0-15 G.E. AO-22, 3" R-B bl sc $3.00
0-15 Weston 476, 3" R-B $4.50
0-15 W.H. NA-35, 3" R-B $3.95
0-40 Weston 517, 2" R-M 400 cycles $3.50
0-40 W.H. NA-33, 2" R-B 400 cycles $3.50
0-75 Weston 517, 2" R-M ring mtd $2.95
0-150 Weston 517, 2" R-B $4.50
0-150 G.E. AO-25, 3" S-B $5.50
0-150 Triplett 332-JP 3" R-M $4.00
0-150 Triplett 331-JP, 3" R-B $4.50
0-150 Triplett 331-JP, 3" R-B W/Resistor for 300 volts $5.50
0-300 Triplett 232-C, 2" R-M $6.00
0-300 Burlington 22A, 2" R-M $6.00

A. C. AMMETERS

0-10 G.E. AO-25, 3" S-B, expanded between 4 & 7 Amps. Scale calibrated 0-100 Amps, For Direct Reading divide scale reading by 10 ..... $4.95
0-30 Triplett 331-JP, 3" R-B $4.00
0-30 Triplett 332-JP, 3" R-M $3.50
0-50 G.E. AO-22, 3" R-B $4.50
0-50 W.H. NA-35, 3" R-B $4.50
0-60/120 Burt 32XC, 3" R-B W/Ext Trans $7.50
0-150 G.E. AO-22, 3" R-B, 5 Amp mvt, w/Ext Trans $7.50

R. F. AMMETERS

0-120 MA Simpson 25, 3" R-B $7.50
0-1 G.E. DW-44, 2" R-B bl sc $2.95
0-1 G.E. DW-44, 2" R-B $3.50
0-1 G.E. DW-52, 2" R-B $3.00
0-1 G.E. DO-44, 3" R-B $11.00
0-1.5 G.E. DW-52, 2" R-M bl sc $2.95
0-1.5 Weston 425, 3" R-B $8.25
0-2 Simpson 135, 2" R-B $3.50
0-2 Weston 425, 3" R-B $8.50
0-2.5 Weston 507, 2" R-B $3.95
0-2.5 Simpson 35, 3" R-B $4.95
0-2.5 Weston 425, 3" R-B $8.50
0-2.5 W.H. NT-35, 3" R-B $5.50
0-3 W.H. NT-35, 3" R-B $5.50
0-3 Weston 425, 3" R-B $8.50
0-3 Weston 425, 3" R-B W/Ext couple $9.50
0-5 G.E. DO-44, 3" R-B W/Ext couple $8.50
0-5 G.E. DO-44, 3" R-B $7.50
0-5 W.H. NT-35, 3" R-B $7.00
0-6 G.E. DW-44, 2" R-B, bl sc $2.50

SOCKET SELECTOR SET WESTON 666 TYPE 1C

Designed for purpose of taking readings of currents, voltages and resistance and other electrical measurements in a vacuum tube circuit. It can be used with many Western Analyzers or other make multirange volt-ohm-milliammeters. To test a tube circuit the tube is plugged into the appropriate adapter and the test plug inserted in the tube socket. This brings all currents and voltages out through a cable where they may be measured with an analyzer.

Complete with Tube Base Data Connections and Chart, 15 Adapters, pin leads and test block.
List Price $30.00 ..... Your Cost $9.5

COMBINATION OFFER

150 Volt A.C. Meter Triplett 331-JP, 3½" Rd flush case

30 AMP A.C. METER Triplett 331-JP, 3½" Rd flush case

Both meters for $7.95

WESTON 341

0-150 Volts, Electrodynamometer type, ¼ of 1% Accuracy on D.C. and A.C. FROM 25 to 1200 CYCLES. Indicates true r m s voltage. Shielded movement, 3.9 V.A. power consumption. Complete in mahogany carrying case with cover. Even though these instruments are Brand New Surplus, we had Weston check each and every unit and furnish a NEW Certificate to guarantee the accuracy of each instrument. Ideal for use in conjunction with Model 311 Potential Transformer to extend the range to 750 & 1500 volts.

New in original manufacturers boxes.
List Price $226.50 Your Cost Only $115.00

PORTABLE TACHOMETER

Multiple Range Continuous Indicating

This unit is of the centrifugal mechanical type and is designed to show INSTANTANEOUSLY and CONTINUOUSLY the speed or change in speed of any receiving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M. and three in F.P.M. Low Range 300-1,200 (Each division equals 10 R.P.M.)
  Medium Range 1,000-4,000 (Each division equals 10 R.P.M.)
  High Range 3,000-12,000 (Each division equals 100 R.P.M.)
- Large open dial 4" diameter.
- Rugged constructed for heavy duty service.
- Ball bearing and oilless bearings—require no lubrication whatsoever.
- Readily portable—Fits neatly into hand.
- Gear shift for selecting low, med., high ranges.

Made by Jones Motorola, Stamford, Connecticut. Comes complete in blue velvet lined carrying case: 7⅛"L x 4"H x 5"W. Your cost ..... $24.50.

PORTABLE TACHOMETERS

300-1500, 1000-5000, 3000-15000 RPM, Jones Motorola Co., Multiple Range, Continuous Indicating $25.50

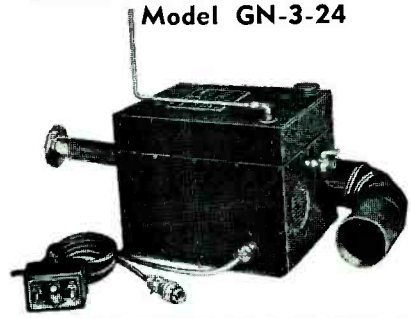
PORTABLE (CHRONOMETRIC) TACHOMETER

Jaegor Watch Co. Model #43A-6

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for lineal speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators turbines, centrifugals, fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequalled Readability 2" Open face dial—each division on large dial equals 10 R.P.M.; each division on small dial equals 1,000 R.P.M.
- Greatest Accuracy—meets Navy specifications—guaranteed to be within ½ of 1%.
- Results of test reading remain on dial until next test taken.
- Push button for automatic resetting.
- Complete with the following accessories.
  1—Large pointed rubber tip
  1—Large hollow rubber tip.
  1—6" circumference Wheel tip
  1—Operating instructions.
  1—Temperature Correction chart.

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. of shafts or the lineal speeds of surfaces without any accessories or timing of any kind. Each unit comes complete in a red velvet lined carrying case 5"x3½"x1½". Net List Price $70.00
Your Cost $24.50

Gasoline Heater Motorola Model GN-3-24



An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volt 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.

Takes very little space—can be readily stored when not in use—measures approximately 12" long x 9⅛" high x 9½" wide, weighs only 30 lbs complete with all accessories.

These units are complete with exhaust pipe, 3" air duct elbow, control switch and cord, as illustrated, and are supplied with Technical Manual and Parts Catalog.

SIMPLE TO INSTALL—SAFE TO USE—NO ODORS
BRAND NEW—IN ORIGINAL CARTONS—READY TO USE
Made by Galvin (Motorola) Mfg. Company.

NET PRICE **$22.50**

ALL ITEMS ARE BRAND NEW-SURPLUS-GUARANTEED UNLESS SPECIFIED OTHERWISE. All materials shipped from stock same day as order received, subject to prior sale. Orders accepted from rated concerns, public institutions and agencies on open account, others please send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

MARITIME SWITCHBOARD

338 CANAL STREET
NEW YORK, 13, N. Y.
Worth 4-8217

TESTED NEW PANEL METERS

EACH METER TESTED BEFORE SHIPMENT. CALIBRATIONS ARE FOR NON-MAGNETIC PANELS. IF METERS ARE FOR USE ON MAGNETIC PANELS SPECIFY PANEL THICKNESS AND WE WILL CALIBRATE ACCORDINGLY AT NO EXTRA CHARGE. All meters have white scale and are flush mounted unless specified otherwise.

S—Square	M—Metal	sc—scale
R—Round	r/v—Ohms per volt	surf—surface
B—Bakelite	bl—Black	mounted

RELIANCE SPECIALS

POWER RHEOSTATS
STANDARD BRANDS

25 WATT

Resist.	Shaft	
10Ω	1/16"	49¢
15	1/16"	59
35	1/8"	59
145	1/2"	49
	with switch	
200	1/16"	49
250	1/16"	59
370	1/2"	49

25 WATT

1,500Ω	1/16"	49¢
2,500	S.D.*	69
3,500	1/16"	69
5,000	S.D.*	69

50 WATT

2Ω	1/16"	69¢
6	1/16"	69
8	S.D.*	69
12	1/16"	69
20	1/16"	69

90Ω	1/2"	59¢
123	1/2"	59
1,250	1/2"	79
2,000	1/2"	79
3,500	1/8"	59

150 WATT

8Ω	1/2"	$1.99
75	1/16"	1.99

*S.D. Screw Driver Slot

FILAMENT TRANSFORMER

For high voltage rectifiers Ameratram type W S.
Primary 115v 50/60 cy.
Secondary 5vc/t @ 10 amp.
35 KV RMS test 12 KV DC operating uses 872-A tube (see our tube list)
New overeseas tacked $10.95

SELSYNS DIFFERENTIAL

115 V., 60 Cyc.
#C78249
$2.25 ea.

Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Mounting Brackets — (Bakelite) for selsyns, and differentials shown above 25¢ pair

PRECISION CONTROLS

6 WATT

20,000Ω	Muter	314A	$1.70
20,000	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70

25 WATT

100,000Ω	GR	433A	$4.98

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
20	GR	301	1.10
12	GR	301	1.10

12 WATT

10K	Muter	471A	2.00
10,000Ω	De jur	271T	$2.00
5,000	De jur	271T	2.00

METERS

0-7.5 V.A.C. 3½" Westinghouse.....$3.29
0-15 V.A.C. 3½" Westinghouse..... 3.49
0-8 Amps. R.F. 3½" Weston..... 3.29
60-0-60 Amps. D.C. 2" G.E..... 1.19

TOGGLE SWITCHES

Bat Handle, S.P.S.T. 6A., 125 V. Off-On plate.....20¢
Ball Handle, S.P.D.T. 6A, 125V.....24¢
Bat Handle D. P. S. T. 6A, 125V.....29¢
BRASS BINDING POST. Eby. screw down with 832 mounting screw .....Per 100 $3.95

RANGE UNIT

From AN/APS-15. Contains 11 Utah X-124-T2 (9280) Pulse Transformers, 12 Prec. Resistors, 28 V.D.C. Blower, metal cabinet and other useful parts.....**SPECIAL $10.95**

SPAGHETTI SLEEVING—Asst. sizes & colors 3 ft. lengths, 99 ft.....**ONLY $1.00**

POWER TRANSFORMER, Pri. 110/220/440; 60 Cyc., 2 Sec. Windings each 300 V., 4 Amp. **SPECIAL $9.95**

ALLEN SET SCREWS

		8-32 x 5/16
4-40 x 1/8	8-32 x 1/8	8-32 x 1/4
4-40 x 3/16	8-32 x 3/16	8-32 x 3/8

ALL SIZES (Cup Point).....**$1.50 per 100**

BC-1072-A TRANSMITTER

115V., 60 Cyc.; 150-200mc. Power supply gives 0-5,000 V.D.C. (Variac control), 312 and 700 V.D.C., 6.3 V.A.C. also contains blower 115 V.A.C., 5 KV meter, condensers, tubes, relays and many other useful parts. Shipping Wt. 245 lb. .....**ONLY $22.50**

CHROMALUX STRIP HEATER, 115 V.A.C. 60 Cyc., 750 Watt, Curved 20" x 1½" Only.....95¢

HARDWARE ASSORTMENT (mostly brass)—screws, nuts, washers, rivets.....3 lbs., $1.00

0-15A BASIC MOVE 12 Ma. 5" x 4" METAL CASE MIRROR SCALE
Lots of 10—$34

DC AMMETER

$3.85 ea.

CHOKE
400 MA
12 Hy.
90 OHM
6,000
V. D. C.
TEST

$3.85
10 for $34.00

SOUND POWERED HANDSET

Brand New! TS-10
Includes 6 ft. cord & spring clips
$8.92 ea. — $17.60 pr.

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	39	82	300	510	.001	.003
10	40	90	330	560	.0012	.0033
20	47	100	350	580	.0013	.0039
22	50	110	370	600	.00135	.0047
24	56	150	400	620	.00136	.0068
25	60	160	470	650	.0015	.0082
	62	220	500	680	.002	.01
	75	240			.0026	
					.0027	

Price Schedule
8.2mmf to .001mfd 5¢ .0026mfd to .0082mfd 12¢
.012mfd to .002mfd 7¢ .01mfd .....18¢

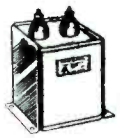
SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
10	62	180	390		.001	.0033
24	66	200	395	560	.0013	.0039
25	68	208	400	600	.0015	.004
30	75	240	430		.002	.0047
40	100	250	466		.0022	.005
47	110	300	470	680	.0024	.0051
	120		488	700		.01
60	125	360	500	750	.0027	
	150	370	510	820	.003	

Price Schedule
10mmf to .001mfd 10¢ .003mfd to .0051mfd 50¢
.0012mfd to .0027mfd 20¢ .01mfd .....65¢

Famous Makes—OIL FILLED—Brand New

MFD	V.D.C.	Price
.1	25,000	$14.95
.03	16,000	1.70
{.375@	16,000 and	
{.75@	8,000 (dual)	$5.95
5	7,500	23.95
.1	7,500	1.35
.1-1	7,000	1.35



2 mfd.
4,000
V. D. C.
#23F47
SPECIAL
$4.50

MFD	V.D.C.	Price
.1	7,000	$1.30
.02-02	7,000	.90
1	6,000	8.50
.1	6,000	1.75
.03-03	6,000	1.65
2	4,000	4.50
.25	3,000	1.75
.2	750 V.A.C. (2,200 V.D.C.)	.39
1	2,000	.95
10	1,000	1.35
4	1,000	.90
3	1,000	.80
2	1,000	.65
1	800	.40
10	600	1.00
4	600	.69
	600	.39

WW PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
11.74	14.98	105.8	366.6	59,148

½ WATT—25c

.250Ω	13.15Ω	235Ω	4,000Ω	14,825Ω
.334	46	260	4,451	15,000
.502	52	270	5,000	15,750
.557	55.1	298.3	5,900	17,000
.627	75	400	6,500	30,000
.76	97.8	723.1	7,000	100,000
1.01	125	2,500	7,500	150,000
1.53	180	2,850	8,000	
2.04	210	3,427	8,500	
11.1				

1 WATT—30c

1.01Ω	5.21Ω	1.250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	55,000
3.39	10.9	7,000	50,000	70,000
5.05	270			

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	522,000Ω
120,000	130,000	320,000	600,000
125,000	160,000	470,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c
100 pieces—10% off; 1,000 pieces—20% off.

Gear Assortment.....**$6.50**
Experimenters dream, 100 pieces, many stainless steel.

GLYPTAL CEMENT 1 qt....75c. 1 gal....**$2.50**

HAYDON TIMING MOTOR. 110V., 60 Cyc. 2/3 R.P.M. Two motors connected on one shaft to make unit reversible. Only $1.95

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	.25
N.D. 38	5/16"	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF 170645	3 11/32"	4 1/8"	7/16"	1.50
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¢

RG 8/U 52 OHM

$50.00 per 1000 ft.

Smaller quantities .....6c per ft.
RG 22/U 95 OHM (2 cond.) per 1,000 ft. $100.00
RG 59/U 73 OHM.....per 1,000 ft. $40.00
RG 62/U 93 OHM per 1,000 ft.....$50.00

COAXIAL CABLE CONNECTORS

Angle-Adapter	Plug	Socket	Hood
15c	28c	28c	9c
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 for 100

83-1SP	$.28	UG 13/U	.60	UG 60/U	.60
83-1J	.80	UG 21/U	.60	UG 61/U	.60
83-1T	1.12	UG 22/U	.60	UG 85/U	.60
83-22AP	.85	UG 24/U	.60	UG 87/U	.50
83-22J	.85	UG 25/U	.60	UG 167/U	2.00
83-2J	1.50	UG 27/U	.60	UG 281/U	.60
83-1F	1.12	UG 59/U	.60		

PRECISION CAPACITOR

D161270 W.E., 1 mfd, 200V; temp. comp.—40 to + degrees C $8.95

Fuse Holder—Littlefuse #342001, 3AG size.....18¢
Fuse Holder—Same as above, for 4AG fuse.....20¢
Telephone Field Wire—W110B, ½ mile reels.....$7.95
Aluminum Tubing—(Ship Rwy, Exp. only)—12 ft. lengths; ¾", $1.00—1¼", $2.10—1½", $2.50—1¾", $3.00—3", $6.00.

CARBON RESISTOR ASSORTMENT

Color coded, insulated.....100 only $1.19

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1⅛" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core **$1.50**
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms.....**$3.00**
352-7178—Spec. 10, 111 Chicago Trans., equivalent to 9262 (above).....**$1.50**
TR 1018 Dinion Coil Co......**$1.25**
TR 1019 Dinion Coil Co......**$1.25**
352-7250-2A, cased 16/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm, 140 cy. to 175 KC.....**$1.25**
352-7251-2A, similar—shorter pulses.....**$1.25**
K89800, Ratio. 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. **$3.50**
D106173, W. E. Freq. response 10KC to 2 MC **$9.80**
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out (250 KVA @ ¼ miscrosecond) **$11.75**
800 KVA G.E. K2731., 28000 Volt pk. output: Bifilar, pulse width; one-microsecond...**$14.50**

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¢

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec.

- 115 V. 60 Cycle
- Adj. 50-70 Seconds
- 2½ seconds recycling time. spring return
- Micro Switch Contact, 10A
- Holds On as long as power is applied. Fully Cased

ONLY **$6.50**

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	4-141Y	$.2	10-141¾W	$.47
3-140¾W	.12	5-141	.19	17-141Y	.78
4-140	.13	5-141¾W	.27	2-142¾W	.15
4-140Y	.17	5-141Y	.25	3-142	.15
7-140	.21	6-141	.23	5-142	.21
8-140	.23	7-141	.27	6-142	.28
10-140¾W	.41	7-141¾W	.37	9-142	.41
13-140	.36	7-141Y	.37	10-142Y	.64
3-141¾W	.17	8-141¾W	.38	11-142¾W	.57
4-141¾	.22	9-141Y	.42	13-142¾W	.82

FUSES

3AG			3AG	
⅛ Amp	$4.00 per 100	2 Amp	$2.50 per 100	
¼	4.00	100	3	2.50
¾	4.00	100	4	2.75
1	2.50	100	10	3.00
1½	2.50	100	15	3.00

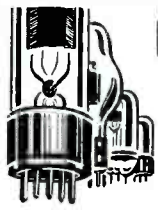
TUBE SPECIAL—New—Guaranteed

2J26	$8.29	6AL5	$.72	6X5 GT	$.57
2X2/879	.44	6SJ7	.59	6Y6	.84
3C24	.49	6SN7 GT	.65		
6AC7	.79	6SQ7 GT	.47	872A	1.88
6AK5	.84	6V6 GT	.59	C5B	6.98

Minimum Orders $3. All orders f.o.b. PHILA. PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. *Telephone RIttenhouse 6-4927*



TUBES

- TRANSMITTING
- RECEIVING
- INDUSTRIAL
- SPECIAL PURPOSE

Guaranteed by WELLS

Check this list for exceptional values in magnetrons, cathode ray tubes, voltage regulators, transmitting tubes—also neon, pilot and flashlight bulbs. These are brand new, standard make tubes. Order enough for future needs directly from this ad or through your local parts jobber.

Type	Price Each
0A4G	$0.95
01A	.45
1A5GT	.65
1B22	4.35
1B23	7.50
1B42	5.25
1C5GT	.65
1D8GT	.95
1E7GT	1.95
1E7G	1.95
1G6	.65
1L4	.75
1LC6	.75
1N5GT	.75
1N21 (Crystal	.65
1N21A Diode)	.95
1N21B " "	.95
1N22 " "	.80
1N23 " "	.80
1N23A " "	.85
1N27 " "	.85
1N29 " "	.85
1Q5GT	.85
1R4/1294	.65
1S5	.70
1T4	.75
2A3	1.05
2A7	.85
2B7	.75
2B22/GL559	3.75
2C22/7193	.35
2C26	.35
2C26A	.45
2C34	.55
2J21A	11.45
2J22	9.85
2J26	8.45
2J27	12.95
2J31	9.95
2J32	14.85
2J33	18.95
2J34	17.50
2J37	13.85
2J38	6.95
2J48	12.95
2J61	27.50
2Y3G	1.20
2X2/879	.65
3A4	.35
3B22	2.65
3B24	1.75
3BP1	3.75
3C24/24G	.50
3D6/1299	.65
3E29	4.95
3FP7	2.95
3FP7A	4.95
3GP1	4.50
3HP7	2.95
3Q5	.90
3S4	.75
REL-5	14.95
5AP1	3.95
5BP1	2.75
5BP4	3.95
5CP1	3.75
5D21	24.75
5FP7	3.25
5GP1	4.95
5HP4	4.75
5J23	13.45
5J29	13.45
5R4GY	.95
6-4	.35
6-7	.35
6A3	.95
6A6	.75
6AB7	.95
6AC7	.90
6AK5	.80
6AK6	.80
6B4G	.95
6B7	.80
6B8	.95
6BE6	.65
6C4	.40
6C6	.70
6C21	19.25
6D6	.60
6E5	.70
6F6	.60
6G6G	.80
6H6	.45
6J5	.45
6J5GT	.45
6J6	.90
6J7GT	.70
6J8G	.95
6K6GT	.55
6L7	.75
6N7	.75

Type	Price Each
6R7G	$0.75
6SA7	.65
6SC7GT	.70
6SF5	.65
6SG7	.65
6SH7	.40
6SJ6GT	.60
6SK7GT	.60
6SL7GT	.60
6SN7GT	.80
6SQ7GT	.60
6SR7	.60
6SS7	.60
6U7G	.85
6V6GT	.75
6Y6G	.75
7-7-11 Ballast	.35
7A4	.60
7A7	.60
7B4	.60
7C4/1203A	.40
7E6	.60
7F7	.70
7H7	.70
7K7	.70
7L7	.70
7N7	.70
7Q7	.60
10	.45
10T1 Ballast	.50
10Y	.45
12A6	.25
12A6GT	.25
12AH7GT	1.10
1208	.50
12F5GT	.65
12H6	.40
12J5GT	.40
12J7GT	.70
12K8	.65
12SF7	.70
12SG7	.65
12SH7	.40
12SK7	.60
12SL7GT	.60
12SQ7GT	.60
12SR7	.60
12X825 2 amp. Tungar	2.10
13-4 Ballast	.35
14B6	.75
15R	1.20
REL-21	2.75
23D4 Ballast	.45
RK24	1.75
24A	.75
25Z6GT	.55
26	.65
27	.50
28D7	.40
30	.75
30 (VT-67) Walkie	.75
33 (VT-33) Talkie	.75
34	.35
RK-34	.45
35Y4	.65
36	.40
37	.40
38	.40
39/44	.35
45 Spec.	.50
46	.75
EF50/VT250	.45
56	.65

Type	Price Each
70L7	$1.05
72	1.75
RKR-73	1.25
76	.55
77	.55
VR-78	.65
80	.45
FG-81A	3.95
83V	.90
89Y	.40
VR-90	.65
VR 92	.65
100R	2.75
FG-105	9.75
VR-105	.85
VU-111-S	.55
1148	1.20
117Z3	.55
VT-127 British	.35
VT-127-A (Triode)	2.95
VR-150	.50
VT-158	14.95
FG-172	19.75
205B	1.45
211 (VT4C)	.60
215A	1.75
221A	2.10
231D	1.20
268A	2.95

Type	Price Each
304TH	$5.75
304TL	1.75
307A	4.25
316A	.75
350B	2.55
354C	14.95
371A	.95
371B	.85
388A	3.95
393A	4.65
395A	4.95
MX408U	.40
417A	14.50
434A	3.40
446A	1.55
450TH	17.95
471A	2.55
527	9.95
530	9.95
531	12.95
532A.1B32	3.55
GL-559	3.75
KU-610	7.45
HY-615	1.05
700B	7.95
700C	7.95
700D	7.95
702A	2.95
703A	3.95
704A	1.75

Type	Price Each
705A	$2.65
707A	17.50
707B	19.50
708A	4.95
710A	2.45
713A	1.55
714AY	3.90
715B	9.75
717A	.85
721A	3.75
723AB	14.95
724A	4.25
724B	4.25
725A	9.95
726A	17.45
730A	10.95
801	.50
801A	.70
803	5.25
804	9.95
805	5.95
807	1.25
808	1.65
811	2.35
813	7.85
814	3.75
815	2.85
826	.75
829B	4.95
830B	3.95

Type	Price Each
834	$5.75
837	1.65
838	3.25
841	.50
843	.50
851	39.00
860	2.40
861	29.25
864	.45
865	2.55
866A	1.30
869	19.95
869B	27.25
872A	2.45
874	1.95
878	1.95
930 Photo Tube	1.00
954	.45
955	.55
956	.50
957	.45
959	.55
991 (NE-16)	.30
1005	.35
1148	.35
1201	.75
1203A/7C4	1.05
1616	1.25
1619	.45
1624	1.25
1625	.45
1626	.45
1629	.40
1630	3.95
1638	.90
1641/RK-60	.75
2051	.75
7193	.30
8011	2.25
8012	3.25
8020	3.25
8025	6.75
9001	.65
9002	.45
9003	.60
9004	.40
9006	.40
38111A	.45

NEON BULBS

NE-11	.24
NE-16	.24
NE-20	.06
NE-21	.24
NE-48	.24

PILOT AND FLASHLIGHT BULBS

Stock No.	Mfr. No.	Volts	Watts	Bulb	Base	Price Each
342-5	1256	6	21CP	S-8	DC Spec.	$0.05
350-41	943	6-8	100CP	G-16½	Auto Soc.	.10
354-76	1491	2.4	.8A	G-7	DC Bay.	.09
LB-200	S6	115	6	S-6	Cand. Screw	.16
350-43	11A/T4C	18	.11A	T-4	Cand. Screw	.14
342-6	1245	6	3CP	G-6	SC Spec.	.08
LB-201	319	3	(Aircraft, metal housing, Amber Lens)			.22
LB-202	328	24		T-1 3/4	Pressure Flange	.40
350-40	64	6-8	3CP	G-6	DC Bay.	.07
350-42	Spec.	12	6A.	S-6	Cand. Screw	.13
350-20	1446	12	.2 amp.	G-3 1/2	Min. Screw	.07
350-14	49	2	.06	T-3 1/4	Min. Bay	.06
348-22	PR-10	6	.5 amp.	B-3 1/2	Min. Flange	.05
350-19	Proj. Bulb	120	500 W.	T-20	Med. Pf.	1.45
LB-17C	24B	24	.035 a.	T-2	Tel. Base	.18
LB-58A	Nite Lite	110	7W	C-7	Cand. Screw	.17
LB-57A	53	12-16	1CP		Min. Bay.	.07
354-78	Airplane Headlite	24	239W	A-19	Med. Pf.	.38
350-55	323	3	(Aircraft)	T-1 1/2	953	.22
342-3	LM-60	115	250W	T-20	Med. Pf.	.40
LB-102	1195	12-16	50CP	RP-11	DC Bay.	.14
342-2	CC-13	110	100W	T-8	DC Pf.	.33
354-76	1491	2.4	.8A		DC Bay.	.14
354-77	302	28	(Airplane Type)		DC Bay.	.14
LB-104	313	28	.17A	T-3 1/2	Min. Bay.	.11
350-24	12A	12	.09-.11A	T-2	Tel. Base	.18
LB-107	24-A2 WE	24	.75-.105A	T-2	Tel. Base	.18
350-63	AR-1 Argon	105	2 1/2W	S-14	Med. Screw	.22
LB-109	5122	Telephone Type Neon		T-2	Tel. Base	.17
350-18	1477	24	17	T-3	Min. Screw	.16

Manufacturers: We carry thousands of electronic parts in stock. Send us your requests for quotation.

Distributors: Our standard jobber arrangement applies. Order directly from this ad.

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Complete listings of all Wells Electronic Components now available for Distributors, Manufacturers and Amateurs. Write for your copy today.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

GUARANTEED BRAND NEW

LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

RECEIVING TUBES		6A6	.87	6SA7GT	.52	12AU6	.72	47	.86
OZ4	.59	6A7	.72	6SB7Y	.79	12AU7	.86	50	1.41
OZ4G	.59	6AB7/1853	.99	6SC7	.66	12AX7	.86	50A5	.79
1A3	.45	6AC5GT	.94	6SC7GT	.61	12BA6	.64	50B5	.69
1A5GT	.54	6AC7/1852	.79	6SD7GT	.79	12BA7	.86	50L6GT	.57
1A7GT	.69	6AC7W	1.45	6SF5	.59	12BE6	.64	55	.79
1AB5	.73	6AD6G	.79	6SF5GT	.59	12C8	.59	BK55B	.18
1B3GT/ 8016	1.18	6AD7G	1.13	6SF7	.72	12F5GT	.65	L55B	.18
1B4P	1.15	6AE6G	.72	6SG7	.69	12H6	.39	56	.59
1B5/25S	1.16	6AF6G	.96	6SG7GT	.68	12J5GT	.49	57	.72
1C5GT	.69	6AG5	.89	6SH7	.44	12K8	.69	58	.72
1C6	.94	6AG7	1.19	6SH7GT	.43	12Q7GT	.59	70L7GT	1.24
1D5GP	1.04	6AJ5	.89	6SJ7	.59	12SA7	.59	75	.59
1D8GT	1.04	6AK5	.89	6SJ7GT	.59	12SC7	.69	76	.59
1E5GP	1.16	WE6AK5	1.35	6SK7	.59	12SF5	.65	77	.59
1E7G	.66	6AK6	.82	6SL7GT	.69	12SF7	.69	78	.59
1G4GT	.79	6AL5	.69	6SN7GT	.64	12SG7	.69	79	.77
1G6GT	.79	6AQ5	.72	6SN7W	1.45	12SH7	.49	80	.45
1H4G	.69	6AQ6	.65	6SQ7	.53	12SJ7	.49	81	1.41
1H5GT	.59	6AT6	.54	6SQ7GT	.53	12SJ7GT	.49	82	.94
1J6G	1.04	6AU6	.72	6SR7	.59	12SK7	.59	83	.79
1L4	.66	6AV6	.55	6SS7	.65	12SK7GT	.59	83V	1.15
1LA4	.94	6B4G	.94	6ST7	.79	12SL7GT	.69	84/6Z4	.65
1LB4	.94	6B8	.79	6T7G	1.15	12SN7GT	.79	89Y	.55
1LC5	.73	6B8G	.79	6T8	1.04	12SQ7	.59	117L7GT	1.24
1LC6	.94	6BA6	.65	6U5/6G5	.72	12SR7	.69	117N7GT	1.24
1LD5	.94	6BA7	.86	6U7G	.65	12X3	.88	117P7GT	1.24
1LE3	.73	6BE6	.65	6W4GT	.65	14A4	.88	117Z3	.54
1LH4	.94	6BG6G	1.72	6V6	1.07	14A7/12B7	.79	117Z6GT	.87
1LN5	.88	6BH6	.72	6V6G	.59	14B6	.79	UV199	.52
1N5GT	.69	6BJ6	.72	6V6GT	.59	14B8	.79	FM-1000	.97
1N6G	.72	6C4	.21	6W7G	.79	14C5	.79	Cathode Ray Tubes	
1P5GT	.59	6C5	.60	6X4	.59	14H7	.79	3AP1	4.63
1Q5GT	.94	6C6	.69	6X5GT	.59	14J7	.89	3AP4/ 906P4	5.94
1R4	.29	6C8G	.89	6Y6G	.88	14N7	.89	3BP1	2.59
1R5	.69	6D6	.59	6Z7G	1.09	14W7	.96	3CP1	1.87
1S4	.86	6D8G	.87	6ZY5G	.79	14X7	.96	5AP1	5.75
1S5	.64	6E5	.79	7A4/XXL	.65	19	1.16	5AP4	4.75
1T4	.64	6F5	.60	7A6	.65	19T8	1.04	5BP1	1.89
1T5GT	.94	6F5GT	.60	7A7	.65	22	1.16	5CP1	2.87
1U4	.72	6F6	.69	7AD7	.95	24A	.66	5CP7	3.76
1V	.69	6F7	.72	7AG7	.79	25L6GT	.59	5FP7	.57
2A3	.89	6F8G	.89	7A8	.65	25Z5	.55	5HP4	2.90
2A7	.89	6G6G	.88	7B4	.65	25Z6GT	.49	5JP4	9.55
2B7	.79	6H6	.49	7B6	.64	26	.59	5MP1	10.65
2E5	.94	6H6GT	.48	7C4	.19	27	.49	5MP5	10.65
2X2/879	.49	6J5	.49	7C5	.64	28D7	.61	7BP1	12.87
2X2A	.79	6J5G	.48	7C7	.65	30 Spec.	.48	7BP7	4.95
3A4	.61	6J5GT	.48	7E5	.29	31	.62	7BP14	14.95
3A5	.96	6J7	.72	7E6	.64	32	.99	9LP7	3.88
3A8GT	1.76	6J7GT	.71	7F7	.79	33	.99	905	4.47
3B7/1291	.29	6J8G	.96	7F8	.92	34	.99	10BP4	24.66
3C6 (XXB)	1.15	6K5GT	.86	7H7	.72	35/51	.72	10FP4	28.88
3D6/1299	.29	6K6GT	.52	7K7	.95	35A5	.65	12DP7	12.85
3Q4	.69	6K7	.54	7L7	.79	35L6GT	.59	12GP7	12.85
3Q5GT	.79	6K7G	.54	7N7	.79	35W4	.45	Photo Cells	
3S4	.61	6K8	.83	7Q7	.65	35Y4	.65	CE-1C/918	.88
3V4	.72	6K8GT	.79	7S7	.96	35Z3	.65	1P24	.29
5AZ4	.48	6L6	1.22	7V7	.96	35Z5GT	.44	923	.97
5R4GY	1.05	6L6G	1.11	7W7	.96	36	.69	927	1.67
5T4	.89	6L6GA	.87	7Y4	.65	37	.59	930	.88
5U4G	.59	6L7	.87	7Z4	.65	38	.69	931A	3.22
5X4G	.59	6N7	.87	10Y	.19	39/44	.49	1645	1.67
5Y3GT	.38	6P7G	1.28	12A6	.24	41	.59		
5Y4G	.46	6Q7	.69	12A7	1.16	42	.59		
5Z3	.59	6R7	.89	12A8GT	.72	43	.59		
5Z4	.79	6S7	.94	12AH7GT	.87	45	.59		
		6S7G	1.02	12AT6	.59	45Z5GT	.65		
				12AT7	.99	46	.84		

Thyratrons	
OA4G	.95
EL-C1A	3.35
2D21	1.18
3C23	3.20
3C31/EL-C1B	3.35
4C35	19.77
EL-C5B	8.95
C6J	4.44
FG-17	2.89
FG-33	11.95
FG-67/1904	8.85
FG-81A	4.95
FG-105	9.95
FG-172	14.50
WE355A	14.15
394A	3.77
KU-610	6.35
KU-634	17.20
WL-652/657	38.00
884	1.35
885	.88
1665	.97
1904	8.85
2050	.83
2051	.49

Transmitting & Special Purpose Tubes	
OA2	1.32
1B22	3.87
1B23	8.95
1B24	4.90
1B26	4.50
1B29	2.90
1B32	3.15
1B36	4.50
1B42	9.80
1H20	.58
2B22	1.41
2C22	.22
2C26	.27
2C34/RK-34	.28
2C44	.79
2E22	1.25
2J21A	8.95
2J22	8.95
2J26	7.80
2J27	13.70
2J31	9.60
2J32	14.45
2J33	19.90
2J34	19.90
2J37	13.70
2J38	12.70
2J48	14.95
2J61	36.20
2JB51	3.89
2K23	23.95
2X2/879	.49
2X2A	.79
3B22/EL-1C	1.12
3B24	1.07
3B27/836A	1.29
3C24	.44
3E29	4.91
SN-4/631-P1	3.77
4A1	.58
4B22/EL-5B	5.20
4B24/EL-3C	2.44
4B25/EL-6CF	8.70
4C28	8.85
4E27	12.75
5D21	26.50
5J23	14.20
5J29	14.20
5R4GY	1.05
6C21	19.88
6J4	5.20
10T1	.58
10Y	.19
15R	.75
REL-21	3.25
HK-24G	.44
RK-25	2.11
RK-34/2C34	.28
REL-36	.78
RK-47	4.92
EF-50	.45
VT-52	.36
53A	3.82
RK-59	2.44
RK-60/1641	.59
RK-72	.92
RK-73	.92
VR-75	.98
VR-78	.34
VR-90/OB3	.81
VT-98 (BR)	29.90
C100E	2.30
100R	2.90
WE-101D	1.65
WE-101F	3.62
VR-105/OC3	.72
WE-113A	1.32
WE-120A	1.47
WE-121A	1.97
WE-124A	3.80
VT-127A	2.40
VR-150/OD3	.72
203A	6.40
203B	4.33
204A	27.90
WE-205B	1.70
WE-205F	2.85
CE-206	2.95
211	.62
WE-215A	.24
221A	1.95
WE-231D	1.25
WE-245A	1.35
WE-249C	1.88
WE-257A	2.77
WE-259A	4.22
WE-271A	6.75
WE-274B	1.06
WE-283A	1.27
WE-293A	3.36
304TH	3.86
304TL	.89
WE-310A	7.50
WE-311A	5.80
316A	.66
350A	1.10
350B	1.95
354C	19.50
WE-356B	4.45
361A	4.75
371B	.82
388A	2.95
417A	10.65
434A	3.65
446A	.79
450TH	19.70
471A	2.75
507AX	1.47
527	9.75
530	17.20
531	17.80
532A	3.15
559	1.41
561	1.45
579B	5.85
HY615	.29
631-P1	3.77
700B	16.90
700C	16.90
700D	16.90
702A	2.95
702B	3.87
703A	3.90
704A	2.75
705A	1.17
707A	5.22
707B	6.95
708A	4.85
710A	2.25
713A	1.45
714AY	6.95
715A	6.75
715B	9.95
717A	.97
721A	3.93
723A/B	16.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
730A	10.95
731A	2.45
WL787	9.80
800	1.88
801A	.48
802	4.25
803	4.87
804	8.95
805	4.75
807	1.15
808	2.19
810	6.55
811	1.71
813	6.95
814	3.79
815	1.72
826	.57
829	3.95
830B	3.35
832	3.95
832A	4.91
836	.89
836A/3B27	1.29
837	1.18
838	2.93
841	.49
843	.59
851	27.50
852	6.40
860	2.44
861	17.70
864	.19
866A	.95
869B	27.00
872A	1.88
874	1.65
876	.39
878	1.85
954	.39
955	.39
956	.49
957	.49
958A	.49
991	.29
1005	.24
1201A/7E5	.29
1203/7C4	.19
1294/1R4	.29
1299/3D6	.29
1602	.68
1611	.77
1613	.61
1616	.87
1619	.19
1624	.69
1625	.19
1626	.29
1629	.29
1630	3.11
1631	1.38
1636	3.77
1638	.70
1641/RK-60	.59
1644	1.17
1960	1.21
UX-6653	.65
7193	.22
8011	.87
8012	1.45
8012A	1.91
8013	.92
8013A	1.42
8016	1.18
8020	1.39
8025	3.17
9001	.42
9002	.39
9003	.39
9004	.39
9006	.29
18904S (6A-Tungar)	3.15

COAXIAL CONNECTORS

83-1AP	.09	UG-30/U	.94
83-1H	.10	UG-33/U	14.80
83-1J	.68	UG-34/U	12.80
83-1R	.28	UG-36/U	12.80
83-1RTY	.45	UG-37/U	12.80
83-1SP	.28	UG-58/U	.57
83-1SPN	.28	UG-85/U	.62
83-1T	1.12	UG-86/U	1.22
83-22AP	.85	UG-87/U	.68
83-22F	.88	UG-171/U	1.33
83-22R	.48	UG-176/U	.16
83-22SP	.48	UG-180A/U	3.82
UG-7/AP	2.14	UG-191/AP	.57
UG-12/U	.63	MX-195/U	.41
UG-21/U	.67	UG-197/U	1.33
UG-22/U	.86	UG-206/U	.58
UG-23/U	.63	UG-254/U	.88
UG-24/U	.67	UG-255/U	.82
UG-27/U	.68	UG-264/U	1.74
UG-29/U	.83	MX-367/U	.15

10H-528	British Pye recept.	.46
10H-529	British Pye plug	.46
10H-628	British Pye feed-thru	.66
D-163950	WE Holmdel plug	.85
ES-685696-5	WE Holmdel 70 ohm jack	.85
ES-689172-1	WE Holmdel plug	.85

Type "J" POTENTIOMETERS

100 (SS) 50K (SS)
500 60K
1000 (SS) 100K
6500 (SS) 100K (SS)
10K 150K
10K (SS) 200K (SS)
15K (SS) 250K (SS)
20K (SS) 500K (SS)
25K 1meg. (SS)
25K (SS)

All shaft lengths min. 3/8" except where marked (SS)—screw slot

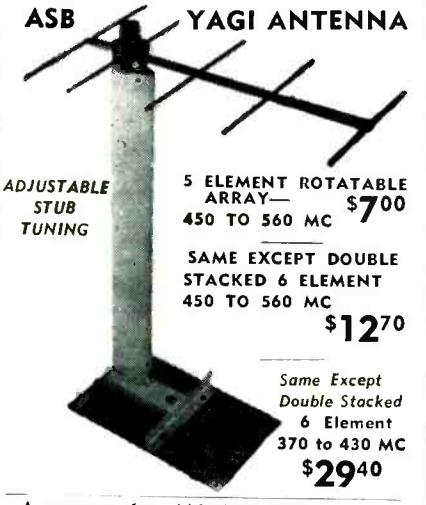
38c Each

RADIATION COUNTER TUBES

AMPEREX 151N GAMMA COUNTER..... 9.85
AMPEREX 100 C BETA COUNTER.....49.50
AMPEREX 200 C ALPHA COUNTER.....59.40

All material brand new and fully guaranteed. Terms 20% cash w/ order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna.

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**

Antennas for AN/APR-4 Receivers

AT-38A/APT—(70 to 400 MC).....$13.70
AT-49/APR-4—(300 to 3300 MC).....$13.70

MODEL ASB-4 — Radar Equipment — Complete — Brand New.....$69.75
CWI-60AAG Range Calibrator for ASB.....$39.95
PHASE SHIFT CAPACITOR—Type D-150734—1 Stator—Single Rotor.....$2.69

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTOR

Type 937-0240

Freq. Cycles	100	Res.—Phase 1	306Ω
Volts—Phase 1	85	Res.—Phase 2	776Ω
Volts—Phase 2	68	No. of Poles	4
Current—Phase 1—110 MA		Speed—RPM	2650
Current—Phase 2—40MA		Weight—Oz.	6.5
Input Watts—No Load 2650 RPM CW			5.8
Input Watts—Stalled			5.0
Torque Stalled—(Oz. In.)			.80
Temp. Rise (°C)—2650 RPM—No Load			54
Temp. Rise (°C)—Stalled			54
Reversing Time—(Seconds)			0.1
Moment of Inertia (G. CM.²)			6.7

Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

GENERAL ELECTRIC
FG-172
THYRATRONS
$14.50

$10.00 EA.
IN LOTS OF 10
BRAND NEW
ORIGINAL CARTONS
FULLY
GUARANTEED

AMERTRAN
FILAMENT TRANSF.
Pri— 115 Volt, 60 cy.
Sec—5 Volt—190 Amp.
35 KV. Insul.
$19.50

AT-48/UP
3 CM HORN ANT.
$3.95
$3.50 each (Lots of 10)
Type N Plug to connect to Probe 67c

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1021-23 CALLOWHILL ST. PHILA. 23, PA.

Telephones - MARKET 7-6590 and 6591

BUY NOW AND SAVE

JANUARY CLEARANCE SALE

PRICES EFFECTIVE THIS MONTH ONLY

HIGH CURRENT PLATE TRANSFORMER

820 Volts CT at 775 MA. Pri. 110/220 Volts 60 Cycles. Wt. 36 lbs. Fully cased.....$5.95

GENERAL PURPOSE TRANSFORMERS

Ideal for Bias, Filament, Isolation, Stepdown, etc. 2 isolated 110V Pri. Sec. 110V at 900 ma plus 6.3 @ 2 amps. Fully cased.....Now $1.49 ea.

Heavy Duty Tap Switch. Ohmite Model 412

Single Pole 6 Positions. Non-Shorting. 50 amp. contacts. Vitreous Enamel case.....Only $2.95

WESTERN ELECTRIC TRANSTAT INPUT 115 V. 60 CY. OUTPUT, 0-130 V 10 AMP MAX. 1.3 KVA. SPECIAL EA.....$15.75

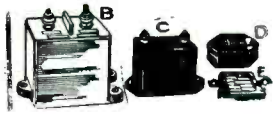
MOSSMAN SWITCHES

4 Pole Single Throw..... 1.10
3 DPT, plus 6 PST.....1.75

MINIATURE HEADPHONES

250 ohms imp. Can be used for sound power Telephones, etc.
Type HS 30.....69 ea.
10 For.....4.99
Hi Imp Transf. for above.....45

BAKELITE CASED MICA



MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	D .005	3 KV	$ .70
E .01	600	.26	C .005	3 KV	1.24
D .02	600	.26	C .006	3 KV	1.50
E .027	600	.26	D .002	3 KV	.70
C .01	1 KV	.45	C .0001	5 KV	.70
C .056	1 KV	.50	C .0005	5 KV	.85
C .07	1 KV	.55	C .0015	5 KV	1.60
D .02	1200	.35	C .003	5 KV	1.90
C .024	1500	.65	C .005	5 KV	2.50
C .033	1500	.75	B .007	5 KV	2.75
C .015	2 KV	.80	B .002	6 KV	3.50
C .02	2 KV	.90	B .003	6 KV	3.75
D .002	2500	.45	B .006	6 KV	4.25
E .005	2500	.55	B .0005	8 KV	2.90
C .025	2500	1.25	B .0012	8 KV	3.25
C .001	3 KV	.90	B .003	8 KV	4.75
C .002	3 KV	.95	B .004	8 KV	5.59

HIGH CURRENT MICAS

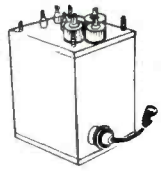
Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better

CAP MFD	Amps 1 Mc	Amps 300 Kc	KV DC	Price Each
.08	60	42	4	$30.50
.1	70	50	4	32.50
.05	60	42	5	27.50
.037	45	35	6	29.50
.02	40	30	9	32.50
.02	55	38	10	34.50
.0117	40	27	14	27.50
.0075	39	27	15	27.50
.009	40	25	15	32.50
.00978	40	25	15	32.50
.01	43	28	15	34.50
.0025	23	15	20	32.50
.00315	26	18	20	33.50
.00411	27	18	20	34.50
.004	30	20	22	38.50
.0033	25	16	25	38.50
.00082	14	8	30	30.50
.001	16	10	30	31.50
.00132	20	12	30	32.50
.00153	21	13	30	33.50
TYPE G3 4" High 5" DIAMETER				
.0013	15	9	15	19.50
G1 2½" High 2-1/16 DIAMETER				
.004	16	11	6	4.95

MEGOHM METER

Industrial Instruments model L2AU 110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter can be extended to 500000 megohms with external supply. Sloping hardwood Cabinet 15"x8"x 10". Brand new with tubes plus running spare parts including extra tubes. Great value. Only $49.50.

SCOPE AND FIL. TRANSFORMER

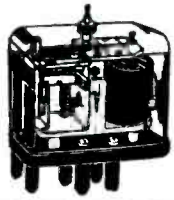


Pri. 115 volts, 60 cycles. Sec. 4400 volts RMS 4.5 MA., 5 volts CT 3 amps., Fil. Ins. 15 KV RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon. 4½ x 5 x 5½.....Only $4.95

SCOPE TRANSFORMERS

Pri 110V 60CY — Hermetically Sealed
2500 V @ 12MA.....$2.95
1050V @ 20MA. 20V 4.5A, 2.5V 5A..... 4.75

WESTINGHOUSE OVERCURRENT RELAY



Type MN Overcurrent Relay. Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $4.95.

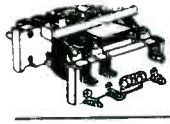
GENERAL ELECTRIC SELENIUM RECTIFIER 32 Volts Input. 28 Volts Output at 2 Amps. Full Wave 3.75

GENERAL ELECTRIC Type PBC Instantaneous Overcurrent Relay. Adjustable from 100 to 200 MA. Electrical and Manual Reset. 4 PDT. Reset 110 Volts 60 Cycles.....7.95

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle

adjustable for other currents. Ter-Breaks at 640 Milliamps but easily rific value at only..... 2.95

10 for 25.00

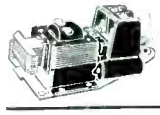


ADVANCE D.P.D.T. ANTENNA RELAY

110 V. 60 cycle coil Steatite Insulation. Only $1.95 each.

DUNCO RELAY. 6 Volt 60 Cycle AC Coil DPDT Ceramic Insulation 1.95

SOLENOIDS



115 Volt 60 Cycle Coil D.P.S.T. 25 Amp Contacts. Model 702 each 3.75

10 For 29.00

FILAMENT TRANSFORMERS

110 V 60 Cy Pri. Fully Cased.
5 Volt 15 Amp.....$2.75
2.5 Volt 10 Amp..... 3.49
2.5 Volt CT 21 Amp..... 4.75
6.3 Volt 10 Amp..... 1.89
5¼ V CT 21A, 7.5V 6A, 7.5V 6A..... 4.95
5 Volt 4A. 6.3V, 3A..... 2.45
2.5V CT 20A, 2.5V CT 20A..... 6.95

CHOKE BARGAINS

6 Henry 50 ma 300 ohms.....3 for $0.99
6 Henry 80 ma 220 ohms.....2 for .99
8 Henry 160 ma 140 ohms..... .99
1.5 Henry 250 ma 72 ohms..... .59
6 Henry 300 ma 65 ohms..... 3.75
Swing 1.6/12 Henry 1 Amp/100 ma 15 ohm.....19.95

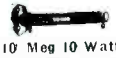
RHEOSTAT

25 Ohms, 675 Watts Max, with Knob and Hardware.... 3.95

10 for 29.50

W. W. POWER RHEOSTATS

150 Ohms 50 Watt..... .59
250 Ohms 50 Watt..... .59
300 Ohms 50 Watt..... .59
Dual 200 Ohms 50 Watt..... .79



50 megohm 35 watt Resistor with mount....$1.49 each; 10 for $9.90
10 Meg 10 Watts...49; 2 Meg 5 Watt..... .35

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps±1 DB. GREAT VALUE.....ea. $2.75

MISCELLANEOUS BARGAINS

.02 400 volt dc tubulars.....15 for .99
G.E. 2mfd 250 volts ac oil cond.....6 for .99
10 meg 10 watt resistor IRC.....2 for .99
Heineman 6 amp 110 volt ac ckt breaker..... .99
Heineman 25 amp 110 volt ac ckt breaker..... 1.19
Ceramicon .0005 mfd.....20 for .99
.01 600 volt dc pigtail micas.....10 for .99
.001 600 volt dc pigtail micas.....15 for .99
.006 600 volt pigtail micas.....12 for .99
Butterfly cond. 2 to 11 mmf ball brngs.....3 for .99
CD type 4 micas .001 600vdc.....10 for .99
Hammarlund 250 mmf variable cond (mc250s).....59
CRL 10,000 ohm potentiometers.....6 for .99
.5 meg potentiometers.....5 for .99
Trimm "Commercial" headphones.....3.75 ea.
CD 16 mfd 450 volt electrolytic (EB9160)....3 for .99
Hammarlund cond. 150 mmf .07 spacing....2 for .99
Variable ceramicon 20 to 125mmf type 823 5 for .99
Western Electric silver variable .5 to 2.5 mmf 8 for .99
G.E. weatherproof switch DPDT 20amp 120vac .99 ea.
CRL steatite switch 3 section—2 pole 5 positions per section, model 2524 centralab... 2 for .99

1% PRECISION RESISTORS W. W.

2000-2500-5000-8500-10,000 ohms .....ea. .25
50002-95000 ohms .....ea. .29
10000-750000-1 meg .....ea. .69

WIRE WOUND RESISTORS

5 Watt type AA, 20-25-50-200-470-2500-4000 ohms .....$.09 ea.
10 watt type AB, 25-40-84-400-470-1325-1000-2000-4000 ohms .....15 ea.
20 watt type DG, 50-70-100-150-300-750-1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms .....20 ea.

30 WATT WIRE WOUND RESISTORS

Ohms: 100-150-1500-2500-3k-4k-4500-5k-5300-10k-15k-18k .....15 ea. 8 for .99

ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms.....25
50 Watt: 80, 100, 500 Ohms.....35
75 Watt: 40, 80, 100, 150, 200 Ohms.....39
100 Watt: 20, 50, 75, 120, 180 Ohms.....49
150 Watt: 50, 100 Ohms.....59

PANEL METERS—BRAND NEW

2" WESTON .0-1 Ma DC 26 ohms res.....$3.50
2" G.E. 0-1 Ma DC (volt scale).....2.95
2" G.E. 0-5 Ma DC (amp scale).....1.95
2" G.E. 0-30 Volts DC 1000 ohm/v.....2.50
2" G.E. 0-30 Amps DC.....2.45
2" GE 0-1 Amp RF (Internal Thermo).....2.45
3" WESTINGHOUSE 0-2 Ma DC.....3.95
3" WESTERN ELECTRIC 0-80 Ma DC.....2.95
3" DEJUR 0-100 Ma DC.....2.95
3" GE 0-200 Ma DC.....3.95
3" WESTON 0-50 Amps AC.....4.95
3" TRIPLETT 75 Amps AC.....2.95
3" WESTINGHOUSE 0-20 Ma DC.....3.95
2" TRIPLETT 0-300 VAC.....2.95

PLUG IN CAPACITOR

8 x 8 Mfd 600 volts DC. Oil filled. Plugs into standard 4 prong socket, 3¾ h x 3 ⅛ w x 1⅞ d.....$1.39

Thermal Time Delay Relay. 15 to 30 seconds, plugs into 4 Prong Tube Socket Glass Enclosed. 250 V. .95 ea.

Mallory Vibropack Kit. 6 Volt Input. Output 300 Volts at 100 MA. Transformer & Vibrator. $5.95 for both

U. H. F. COAX. CONNECTORS

831AP-UG12U, UG-14U-831, R831SP.....35 ea.

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for.....$1.90

OIL CONDENSERS

2/0	mfd	330 vac—1.85	8	mfd	2000 vdc—5.95
5	mfd	150 vac— .49	10	mfd	2000 vdc—6.95
1	mfd	600 vdc— .29	2	mfd	4000 vdc—4.95
2	mfd	600 vdc— .39	1	mfd	5000 vdc—4.50
4	mfd	600 vdc— .59	.1/.1	mfd	7000 vdc—2.25
.6	mfd	600 vdc— .79	.1	mfd	7500 vdc—1.95
3/3	mfd	600 vdc— .79	1	mfd	7500 vdc—9.25
1/0	mfd	600 vdc— .89	.01/.01	mfd	12 kv dc—5.75
2/0	mfd	600 vdc—1.99			
4	mfd	1000 vdc— .95	.005/.01	mfd	12 kv dc—5.50
6	mfd	1000 vdc—1.19			
2	mfd	1500 vdc—1.25	.65	mfd	12,500 vdc—12.95
4	mfd	1500 vdc—2.25			
6	mfd	1500 vdc—2.95	.75/.35	mfd	8/16kv— 7.95
1	mfd	2000 vdc—1.45	2	mfd	18 kv dc—49.50
2	mfd	2000 vdc—2.25	1	mfd	15 kv dc—15.95

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N. Y.

Phone CO 7-6486 6443

DEPARTMENT EA

LINEAR SAWTOOTH POTENTIOMETER

No. 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. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.

$5.75
Brand New

FULL WAVE BRIDGE TYPE SELENIUM RECTIFIER

Input up to 36V A.C.
Output up to 28V D.C. at 1.1 amps.

8 plates 2½" diameter
Fed. Tel. & Tel. Co.

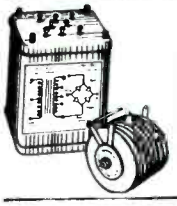
Brand New **$1.75**

MICROWAVE RECEIVERS

Types APR1, APR4, APR5A
(38 to 6000 MCs)

Also Tuning Units in stock
TN1, TN2, TN3, TN16, TN17, TN18

Prices on request



12 and 24 Volt POWER KIT

Consists of Power Trans. and full wave bridge selenium rectifier. Input: 115/230 A.C. Output: 12/24V D.C. at 1.1 amps. Fine for operating relays, small motors dynamotors, or for low voltage D.C. source in laboratories, etc.

Brand New **$7.95**

Filament Transformers

For type 866 tubes

Input: 115 volts. Output: 2.5 volts center tapped, at 10 amps. Glazed porcelain standoff insulated for high voltage breakdown. Mfgd. by Kenon.

Brand New **$3.95**

Micro-Wave Lavoie Freq. Meter

375 to 725 MCS

Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 MIN. 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

Full data on request.

$69.50

MP22 Mast Base Insulator

Ideal for marine, mobile vertical whip antennas. Complete, new with mounting plate and hardware.....$2.75

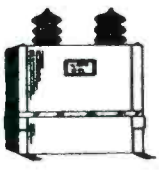
3CM Antenna Horn For receiving or transmitting Type AT-48/UP with coax recept. Brand new $4.75

LINE FILTER

Elimostat 20 amp. 115 volts A.C. or 600 D.C. Brand new $1.75

PILOT LAMP

Aircraft "grain of wheat" 3V Mazda G.E. 323 Brand New .....10¢ ea.



High Voltage Capacitors

Oil Filled

.25 MFD., 20KV., 35 lbs. $15.75
.5 MFD., 25KV., 35 lbs. $23.50
1 MFD., 15KV., 35 lbs. $16.50
1 MFD., 7.5KV., 15 lbs. $5.95

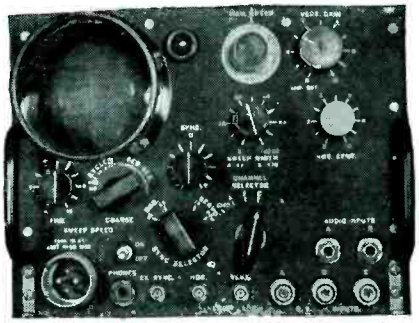
All brand new. Made by prominent manufacturers

BROADCAST EQUIPMENT

Limiter Amplifiers, type BC730C. Rack Mounting with dust covers. Milliameter and D.B. meter on front panel. Brand new with tubes.....$89.50

Attenuator Panel, R.C.A. Type 89-C. Model MI-7515-E. Brand new.....$149.50

MODEL AN/APA 10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:

(1) Panoramic (2) Aural

(3) Oscillographic (4) Oscillosocopic

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.

Includes 80 page T. M..... **$195.00**

LINE VOLTAGE STABILIZERS

Raytheon—Navy Type, CRP-301407 Input: 92-138V., 57/63 CPS., 1 PH. Output: 115V, 0.82 KVA., 1% Reg., 0.96 PF. Weight 250 lbs. Enclosed in Navy Grey Ventillated Cabinet for Wall Mounting.
Brand New $97.50

Raytheon—Spec. No. W 5768 Input: 95-130V., 1.25A., 60 CPS., 1 PH., Output: 115V., 60 watts., Load P.F. 90%.
Brand New $12.50

THERMOSTATIC TIME DELAY RELAY

Amperite type 115 No.—45 Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V-3A., A. C. (or 440V., A.C. 2A) max. voltage on contacts—1000. max voltage bet. contacts and heater—1500. Size 3 9/32 x 1¾" overall. Made for U. S. Navy.....$1.10

AUTO TRANSFORMER

G.E. 400 cy. Cat. No. 80G184 K.V.A. .945S—.520P Volts 460/345/230/115 New $4.50

FILAMENT TRANS.

400/2600 cy.

Input: 0/75/80/85/105/115/125V Output: 5V3A, 5V3A, 5V3A, 5V3A, 5V6A, 5V6A, 6.3V5A, 6.3V5A $3.95

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Raytheon UX8876. 400/1600 cy. PRI: 115V, 1 PH. Sec: 50-0-50V at 0.5A, 6.3V 1.2A Test RMS1780 $2.75

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Westinghouse #145 EWP Fosterized.....$4.95

PULSE

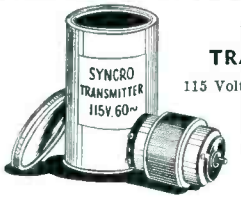
Utah No. 9350.....$1.25

BLOCKING, OSC.

Westinghouse #132 AWP Fosterized $4.95

Synchro Differential

90/90 volts, 400 cycles. Brand new in sealed containers. Ford Inst. type 5SDG. Brand new.....$12.50



SYNCHRO TRANSMITTERS

115 Volt—60 cycle. Brand new in sealed metal containers. No. C78248. Size 5. Brand New. Per Pair $14.75

MERCURY CONTACT VACUUM RELAYS

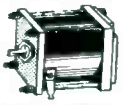
WE Type D-168479

Glass sealed, mercury-wetted contact switches surrounded by operating coils encased in metal housings on octal tube base. S.P.D.T. contacts. 2 coils, 700 and 3300 ohms. Operating current coils serieased 6.6 MA releasing at 5.2MA. Operating life 1000 hrs. at 60 operations per sec. Use for • High speed keying • tabulating • sorting and computing machines • Relay amplifiers • Vibrator supplies • Servo Mechanisms, etc.

$4.75 ea.
Brand New

Send for 4 page technical data

SWEEP GENERATOR CAPACITOR



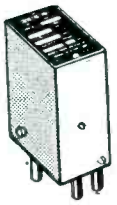
High speed ball bearings. Split stator silver plated coaxial type, 5-10 mmfd. Brand new $1.00

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil. Brand new.$1.00

TWO-IN-ONE CRYSTAL UNITS

Bendix type MX-9E



Each unit contains 2 crystals differing in freq. by 455 kc. Following frequencies available:

2457-2912	4287-4742
2481-2936	4310-4765
2530-2985	4360-4815
2539-2994	4435-4890
2560-3015	4702.5-5157.5
2562.5-3017.5	4713-5168
2407-2862	4930-5385
2945-3400	4935-5390
3820-4275	4975-5430
3860-4315	5080-5535
4002.5-4457.5	6485-6940
4175-4630	6515-6970
4242.5-4697.5	

$1.65
Brand New

Special price in lots of 100

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR

Available in quantity—following frequencies

5910—6350—6370—6470—6510
6610—6670—6690—6940—7270
7350—7380—7390—7480—7580
9720—Kilocycles

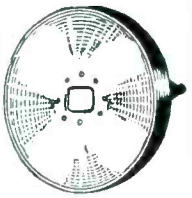
Brand New **$1.00**

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. $19.50

Automatic Elec. Co. No. GLS43-AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable $19.50

PARABOLOIDS



Spun Magnesium, 17½" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center.

Brand new per pair $8.75

TUBE HEATERS

Type WAAGE 100 watts Brand new .50

400 CYCLE INVERTERS

Bendix Pioneer type 12121-A. Input: 24 volts D.C. at 18 amps. 12,000 RPM. Output: 115 volts, 400 cy., 3 PH., 250V.A. Weight: 10.6 lbs. Brand new...$129.50

Bendix Pioneer type 12117-2-B. Input: 24 volts D.C. at 1 amp. Output: 26 volts, 400 cy., 6VA., 1 Ph. Weight: 2.1 lbs.....$17.50

General Electric type 5D21NJ3A. Input: 24 volts D.C. Output: 115V., 400 cy. at 485V.A. Brand new..$12.50

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

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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

SELENIUM RECTIFIERS — and — ELECTRONIC COMPONENTS

THREE PHASE FULL WAVE BRIDGE RECTIFIERS

Type	Input 0–234VAC Current	Output 0–250*VDC Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–15	15 AMP.	120.00

CENTER TAPPED RECTIFIERS

Type #	Input 10–0–10VAC Current	Output 0–8*VDC Price
C1–10	10 AMP.	$6.95
C1–20	20 AMP.	10.95
C1–30	30 AMP.	14.95
C1–40	40 AMP.	17.95
C1–50	50 AMP.	20.95

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6 and Type C1 ..... $ .35 per set
For Types B13 ..... .70 per set
For Types 3B ..... 1.65 per set

SINGLE PHASE FULL WAVE BRIDGE RECTIFIERS

Type #	Input 0–18VAC Current	Output 0–12*VDC Price
B1–250	250 MA.	$ .98
B1–500	500 MA.	1.95
B1–1	1 AMP.	2.49
B1–1X5	1.5 AMP.	2.95
B1–3X5	3.5 AMP.	4.50
B1–5	5 AMP.	5.95
B1–10	10 AMP.	9.95
B1–20	20 AMP.	15.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95

Type	Input 0–36VAC Current	Output 0–26*VDC Price
B2–150	150 MA.	$ .98
B2–250	250 MA.	1.25
B2–300	300 MA.	1.50
B2–2	2 AMP.	4.95
B2–3X5	3.5 AMP.	6.95
B2–5	5 AMP.	9.95
B2–10	10 AMP.	15.95

Type #	Input 0–115VAC Current	Output 0–90*VDC Price
B6–250	250 MA.	$2.95
B6–600	600 MA.	5.95
B6–750	750 MA.	6.95
B6–1X5	1.5 AMP.	10.95
B6–3X5	3.5 AMP.	18.95
B6–5	5 AMP.	24.95
B6–10	10 AMP.	36.95
B6–15	15 AMP.	54.95

CUSTOM DC POWER SUPPLIES

Built to your specifications

We will be pleased to quote on your requirements. Kindly send for our specification form.

RECTIFIER CAPACITORS

CF–14	3000 MFD 12VDC	$1.69
CF–15	6000 MFD 12VDC	2.95
CF–1	1000 MFD 15VDC	.98
CF–2	2000 MFD 15VDC	1.69
CF–20	2500 MFD 15VDC	1.95
CF–3	1000 MFD 25VDC	1.25
CF–4	2X3500 MFD 25VDC	3.45
CF–5	1500 MFD 30VDC	2.49
CF–6	4000 MFD 30VDC	3.25
CF–7	3000 MFD 35VDC	3.25
CF–8	100 MFD 50VDC	.98
CF–19	500 MFD 50VDC	1.95
CF–16	2000 MFD 50VDC	3.25
CF–21	1200 MFD 90VDC	3.25
CF–9	200 MFD 150VDC	1.69
CF–10	500 MFD 200VDC	3.25
CF–12	125 MFD 350VDC	2.49

RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50/60 Cycles

Type #	Volts	Amps	Price
XF15–12	15	12	$3.95
TXF36–2	36	2	3.95
TXF36–5	36	5	4.95
TXF36–10	36	10	7.95
TXF36–15	36	15	11.95
TXF36–20	36	20	17.95
XFC18–14	18 VCT	14	5.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts. XFC type is tapped to deliver 16, 17, 18 Volts Center-Tapped.

RECTIFIER CHOKES

Type No.	Hy.	Amps.	D.C. Res.	Price
HY5	.02	5	.25	$3.25
HY5A	.028	5	.09	3.95
HY10	.02	10	.30	9.95
HY10A	.014	10	.04	7.95
HY15	.015	15	.30	13.95
HY20A	.007	20	.02	12.95

Type "A" low resistance chokes are specially suited to circuits requiring excellent voltage regulation.

ADDITIONAL SELENIUM RECTIFIER TYPES AND GENERAL INFORMATION MAY BE FOUND IN OUR CATALOG No. 719

VACUUM CAPACITORS

Standard Brands

12 Mmfd	20 Kv.	4.95
50 Mmfd	32 Kv.	5.95

EDISON THERMO TIME DELAY RELAY

Heater voltage 115 V. Norm. open SPST contacts, 15-30 sec. delay. Contact rating 115 V. 3A., 440 V. 2A. Size 3¾" x 1⅛" diam. Standard 4 prong tube base ..... **98c ea.**

OIL CONDENSERS

.5 Mfd 400VDC telephone type ..... .20
2X.1 Mfd 600VDC Bathtub ..... .39
6 Mfd 600VDC w/mtg. Clamp ..... .79
8 Mfd 660VAC/2000VDC w/Brkts. 3.50
.15-.15 Mfd 8000VDC Voltage Doubler Type 26F381 w/Brkts 3.95

SPECIAL—LIMITED QUANTITY FAMOUS BRAND VITAMIN Q PHOTOFLASH CAPACITORS

8 Mfd-3000 V.D.C.—36 Watt Sec. 4½" x 3¾" x 1¾". Wt. 1-lb. 12-oz. Price Each $5.95

3 for $15.00

ATTENTION!!!

Bulletin #713, listing various government and commercial surplus items, is now available upon request.

PILOT LIGHT ASSEMBLIES

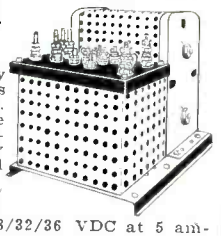
Aircraft type, panel mounting, amber jewel. Knurled rim, controls "Dim-Bright." Bakelite and aluminum construction. Bulb replaceable from front panel. For single contact bayonet bulbs. T-3¼ or G-3½ size. Dimensions: 2¼" overall length, 3¼" diameter, ⅝" panel mtg. hole.

IMMEDIATE DELIVERY—500 to Carton. Request Prices on company letterhead.

G-R VARIAC

Type 100-R 2 KVA. Input: 110 or 220 V.A.C. 60 CPS., Output: 0-220 or 0-270 Volts. Brand new—limited quantity. Shpg. Wt. 36 lbs. $39.50

DC POWER SUPPLY



Limited quantity — Gov't Surplus Ready to operate. Full wave bridge copper-oxide rectifier, heavy duty multi-tapped transformer.
Input: 85/95/105/115/VAC50/60cps
Output: 2.5/24/28/32/36 VDC at 5 amperes, unfiltered
For wall or bench mounting. Overall dimen. 9" x 8¼" x 8½" high. Shpg. wt. 30 lbs. Tested and guaranteed... $36.00
Filter Kit, 2% ripple 6.65

DIEHL MOTOR

Fan duty, brushless induction type (no TV interference). For 115 VAC 60 cycles 46 watts, 1800 RPM. Shaft ¼" diam 1½" long. Noiseless ball-bearings—heavy cast construction. Brand new $4.50

RECTIFIER KIT #612-10

6 and 12 VDC at 10 Amps

This unit will deliver unfiltered direct current for operation of motors, dynamotors, solenoids, electroplating, battery charging and similar equipment.
The two output voltages may be used simultaneously, and varied above and below their nominal ranges.
Complete with schematic diagram and instruction, shpg. wt., 12 lbs. **$15.95**

Filter Kits For #612-10

1 Section choke input, 10% ripple.. $9.64
2 Section choke input, 2% ripple.. 19.28

D-C PANEL METERS

Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%.

0-6 Amperes D-C	Any range
0-12 Amperes D-C	$2.49 each
0-15 Volts D-C	

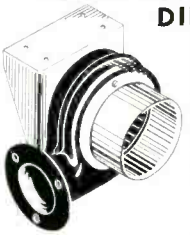
Minimum order $3.00. No C.O.D.'s. Add 10% for Prepaid Parcel Post and Handling. Terms: Net 10 days in the presence of approved credit.

All prices subject to change without notice
All Prices F.O.B. our NYC Warehouse

WESTERN ELECTRIC BLOWER

#KS5881 — Brand New — Heavy Duty Sirocco type blower, capacitor start. 1/40 H.P. 3400 RPM 115 VAC 60 cycles. Displaces 84 C.F.M. Extremely quiet operation. Opening 2¾", overall size 7½" long, 6" diam. Moisture and fungus resistant. With capacitor. Shpg. Wt. 15 lbs. Quantity limited. $13.95

DIEHL BLOWER



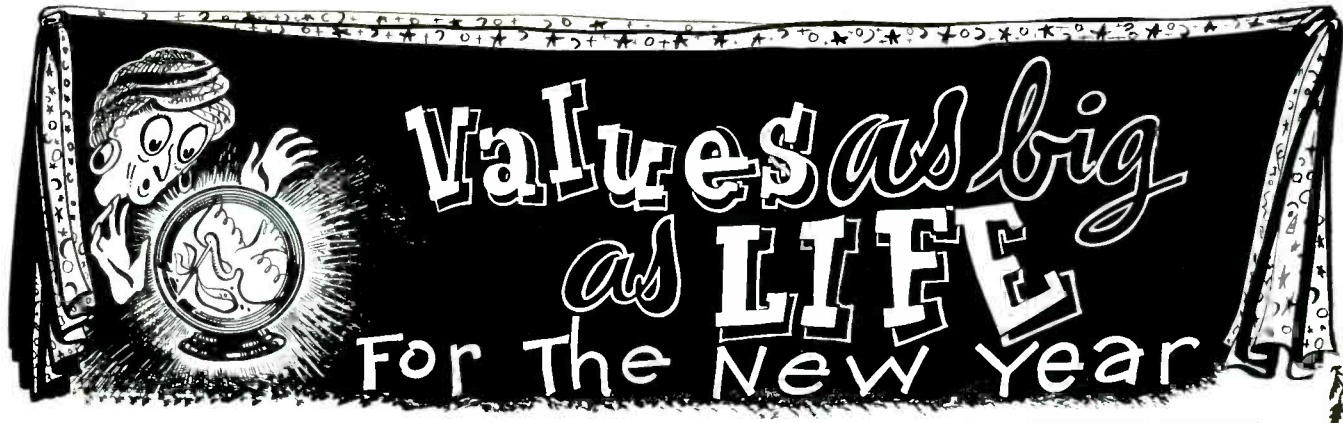
Sirocco type, displaces 100 C.F.M. 115 VAC 60 cps. Moisture and fungus resistant. Flange diameter 4". Overall size 7½" x 6½". Removed from equipment. Tested and guaranteed **$9.95**

Adjustable right angle aluminum extension tube to fit flange $8.98

WESTINGHOUSE AIRCRAFT MOTOR

Brand new—24 VDC or AC, reversible on both. 1/50 H.P. 4800 RPM continuous duty. Length of leads 18". Dimensions 3½" x 2¼" shaft ¼" diam. by ⅝" long.
Price $2.95
Reversing switch with "off" position Each 79c

OPAD-GREEN COMPANY
71 Warren St.
New York 7, N. Y.
Phone: BEekman 3-7385-6



• RESISTORS
EB½, GB1 and HB2

LIFE OFFERS THE MOST COMPLETE INVENTORY OF ½, 1 and 2 WATT RESISTORS IN 5% and 10% TOLERANCES IN THE COUNTRY

Price Schedule*

Stock	Wattage	Tol.	1–49	50–499	500 or over
EB½	½ Watt	10%	.06	.04	.025
EB¼	¼ Watt	5%	.12	.8	.5
GB1	1 Watt	10%	.9	.6	.045
GB1	1 Watt	5%	.18	.12	.09
HB2	2 Watt	10%	.15	.10	.7½
HB2	2 Watt	5%	.30	.20	.15

*Prices shown are per size. Resistor may not be assorted for quantity price.

THE FOLLOWING VALUES ARE AVAILABLE IN 10% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	100	1000	10000	.1	1.0	10.0
12	120	1200	12000	.12	1.2	12.0
15	150	1500	15000	.15	1.5	15.0
18	180	1800	18000	.18	1.8	18.0
22	220	2200	22000	.22	2.2	22.0
27	270	2700	27000	.27	2.7	
33	330	3300	33000	.33	3.3	
39	390	3900	39000	.39	3.9	
47	470	4700	47000	.47	4.7	
56	560	5600	56000	.56	5.6	
68	680	6800	68000	.68	6.8	
82	820	8200	82000	.82	8.2	

THE FOLLOWING VALUES ARE AVAILABLE IN 5% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	68	470	3300	22000	0.15	1.0	6.8
11	75	510	3600	24000	0.16	1.1	7.5
12	82	560	3900	27000	0.18	1.2	8.2
13	91	620	4300	30000	0.20	1.3	9.1
15	100	680	4700	33000	0.22	1.5	10.0
16	110	750	5100	36000	0.24	1.8	11.0
18	120	820	5600	39000	0.27	2.0	12.0
20	130	910	6200	43000	0.30	2.2	13.0
22	150	1000	6800	47000	0.33	2.2	15.0
24	100	1100	7500	51000	0.36	2.4	16.0
27	180	1200	8200	56000	0.39	2.7	18.0
30	200	1300	9100	62000	0.43	3.0	20.0
33	220	1500	10000	68000	0.47	3.3	22.0
36	240	1600	11000	75000	0.51	3.6	
39	270	1800	12000	82000	0.56	3.9	
43	300	2000	13000	91000	0.62	4.3	
47	330	2200	15000	0.1	0.68	4.7	
51	360	2400	15000	0.11	0.75	5.1	
56	390	2700	18000	0.12	0.82	5.6	
62	430	3000	20000	0.13	0.91	6.2	

TYPE "J" POTENTIOMETERS

No better pot at any price, no source more complete than Life Electronic Sales.

Available in screw-driver and regular shafts locking and non-locking type bushings.
When ordering locking type bushing potentiometers, locking nuts are available at $.05 each.
Type "J" pots available in the following values from stock.
Specify whether regular or screw-driver shaft is required.

Single Pots				Dual Pots	Triple Pots
Ohms	Ohms	Ohms	Ohms		
50	1000	10000	60000	3000	150,000
60	1300	15000	70000	10000	500,000
100	1500	20000	100000	25000	
200	2000	22000	200000	50000	Price Schedule
250	2500	25000	250000	100000	Single pots..$.50
400	3000	30000	500000	250000	Dual pots..1.50
500	5000	35000	1 Meg	500000	Triple pots..2.50
600	6500	50000	2 Meg.	1 Meg	
			3 Meg.	5 Meg	

SILICON DIODES

Type	Design Freq. (mc)	Price each
IN21	3,000	$.50
IN21B	3,000	1.00
IN23	10,000	1.25
IN23A	10,000	1.50
IN23B	10,000	2.00

GERMANIUM DIODES

Type	Price each
IN34	$.85
IN35	2.00

"UHF" COAXIAL CABLE CONNECTORS

No.	AN No.	Description	Ea.	Per C.
83-1SP	PL259	Plug	.35	.28
83-168	UG176U	Adapter	.15	.12
83-185	UG175U	Adapter	.15	.13
83-1SPN	PL259A	Plug	.35	.28
83-776	UG203U	Plug	.61	.55
83-1R	SO239	Receptacle	.35	.28
83-1RTY		Receptacle	.50	.45
83-1H	UG106U	Hood	.12	.10
83-1HP		Hood	.27	.24
83-765	UG177U	Hood	.31	.25
83-1AC		Cap and chain	.61	.50
83-1BC		Cap and chain	.38	.34
83-1T	M358	"T" connector	1.12	.98
83-1AP	M359A	Angle adapter	.35	.22
83-1J	PL258	Junction	.85	.70
83-1F	PL274	Feed thru	1.12	.98
83-22SP	UG102U	Twin plug	.50	.55
83-22R	UG103U	Twin receipt	.50	.40
83-22AP	UG104U	Twin ang. adapt.	.98	.80
83-22J	UG105U	Twin junction	1.25	1.12
83-22T	UG196U	Twin "T"	1.65	1.50
83-22F	PL275	Twin feed thru	1.50	1.35
83-2SP	PL295	L'ge twin plug	1.94	1.75
83-2R	SO265	L'ge twin recept.	1.44	1.30
83-2H	M365	L'ge Hood	.24	.22
83-2AC		L'ge CAP and chain	.61	.55
88-2AP	PL325	L'ge Twin angle adapt	2.08	1.88
83-2J	PL305	L'ge twin junction	1.45	1.30

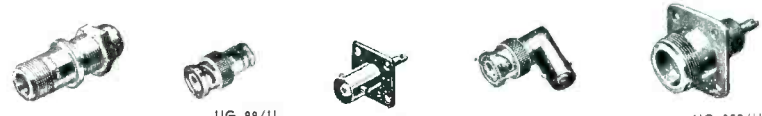
COAXIAL CABLES

BRAND NEW! ! !
JAN APPROVED! ! !

RG No.	Impedance	Price per Thousand Ft.
RG5U	52.5 ohms	$70.00
RG6U	76.0 ohms	150.00
RG7U	97.5 ohms	70.00
RG8U	52.0 ohms	55.00
RG9U	51.0 ohms	135.00
RG9AU	51.0 ohms	125.00
RG10U	52.0 ohms	125.00
RG11U	75.0 ohms	100.00
RG12U	75.0 ohms	190.00
RG13U	75.0 ohms	125.00
RG18U	52.0 ohms	450.00
RG19U	52.0 ohms	350.00
RG20U	52.0 ohms	450.00
RG22U	95.0 ohms	120.00
RG24U	125.0 ohms	240.00
RG25U	48.0 ohms	575.00
RG27U	48.0 ohms	290.00
RG29U	53.5 ohms	50.00
RG34U	71.0 ohms	175.00
RG38U	52.5 ohms	400.00
RG39U	72.5 ohms	180.00
RG41U	67.5 ohms	575.00
RG54U	58.0 ohms	65.00
RG54AU	58.0 ohms	75.00
RG57U	95.0 ohms	100.00
RG58U	53.5 ohms	50.00
RG59U	73.0 ohms	45.00
RG62U	93.0 ohms	50.00
RG65U	950.0 ohms	250.00
RG71U	93.0 ohms	175.00
RG74U	52.0 ohms	250.00
RG78U	48.0 ohms	80.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50% to prices shown.

BRAND NEW!! UG TYPE CONNECTORS JAN APPROVED!!



AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.
UG9/U	$.95	UG23BU	1.29	UG88/U	1.17	UG146/U	2.25	UG235/U	28.50
UG10/U	1.56	UG27AU	2.25	UG89/U	.95	UG155/U	.40	UG236/U	11.75
UG11/U	1.45	UG28/U	2.34	UG90/U	1.05	UG154/U	5.35	UG241/U	2.20
UG12/U	.95	UG29/U	1.22	UG91/U	1.25	UG156/U	4.25	UG242/U	2.50
UG13/U	1.56	UG29AU	1.36	UG91AU	1.05	UG157/U	4.25	UG243/U	2.75
UG14/U	1.45	UG33 U	1.75	UG92/U	1.10	UG160/U	1.90	UG244/U	2.50
UG15/U	.95	UG32 U	20.00	UG92AU	1.35	UG160AU	1.55	UG245/U	1.25
UG16/U	1.56	UG33/U	20.00	UG93/U	1.25	UG167/U	3.00	UG246/U	1.45
UG17/U	1.45	UG34/U	17.50	UG93AU	1.45	UG173/U	.30	UG252/U	4.50
UG18/U	.99	UG35AU	16.00	UG94/U	1.25	UG174/U	16.00	UG254/U	1.82
UG18/AU	1.05	UG36/U	16.00	UG94AU	1.05	UG188/U	.95	UG255/U	1.85
UG19BU	1.09	UG37/U	16.00	UG95/U	1.10	UG195/U	.75	UG259/U	4.10
UG19/U	1.28	UG37AU	16.00	UG95AU	1.35	UG197/U	5.00	UG260/U	.99
UG19AU	1.38	UG57/U	.99	UG96/U	1.25	UG201/U	1.83	UG261/U	.95
UG19BU	1.45	UG58/U	.65	UG96AU	1.45	UG202 U	2.75	UG262/U	1.05
UG20/U	1.17	UG59/U	2.75	UG97/U	3.50	UG204/U	2.25	UG269/U	2.60
UG20AU	1.26	UG59AU	1.70	UG98/U	1.55	UG206/U	1.02	UG270/U	6.50
UG20BU	1.41	UG60/U	1.90	UG100/U	2.34	UG208/U	28.00	UG273/U	1.50
UG21/U	.99	UG60AU	1.30	UG101/U	2.95	UG212/U	4.50	UG274/U	1.98
UG21AU	1.05	UG61/U	2.05	UG107/U	2.25	UG213/U	4.50	UG279/U	2.40
UG21BU	1.09	UG61AU	1.80	UG108/U	1.75	UG215/U	3.35	UG287/U	5.25
UG22/U	1.08	UG62/U	28.00	UG109/U	1.75	UG216/U	8.70	UG290/U	.85
UG22AU	1.38	UG83/U	1.50	UG114/U	1.50	UG217/U	3.10	UG291/U	1.05
UG22BU	1.34	UG85/U	1.65	UG115/U	1.33	UG218/U	6.50	UG306/U	2.03
UG23/U	.99	UG86/U	1.69	UG123/U	.45	UG222/U	35.00	UG333/U	4.70
UG23AU	1.26	UG87/U	1.40	UG131/U	6.00	UG231/U	2.00	UG334/U	5.75
								UG352/U	6.00

TUBE SPECIALS

2K41	$65.00
2J36	125.00
5J29	14.95
5J32	35.00
417A	12.95
1Q26	35.00
9006	.19
955	.29

ODDS 'N' ENDS SPECIALS

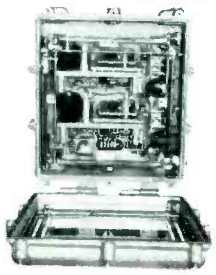
50 Mmfd Air Trimmers	$ .29
.1 mfd 2000 Volt Oil Condensers	.39
#TJU50020 2 mfd 5000 Volt	9.95
Dual 7-45 Mmfd Silver Trimmer	.49
JBT Model 31F 58-62 Cycle Freq. Meter	4.95
1 Pound Roll Linen Lacing Cord	1.65

FREE!
Send for our bulletin J-100

LIFE ELECTRONIC SALES 91 GOLD STREET, N. Y. 7 N. Y. DIGBY 9-4154-5

IMMEDIATE DELIVERY • LOW PRICES • FULLY GUARANTEED

BROWN TELEPLOTTER RECEIVER



Model 791X1R

115 volt 60 cycles

Contains a pen driven by two balancing motors which writes on rear of a translucent chart. Pen arm position is in terms of two co-ordinates supplied balancing motors thru two amplifiers. Originally intended for recording plotted or written data from central plotting board. Writes at one half scale on 18 in. chart. Discriminator input circuit designed to operate unit as function of two varying R.F. frequencies varying about mean of approx. 430 KC. Further data on request. (Shipping weight 435 lbs.)

Price $375.00 each.

D.C. MOTORS

Universal Electric DC

W.E. KS-5603-1-02, 28 v. d-c 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233. **Price $2.95 ea. plus 15¢ p.p.**

OSTER PM MOTOR

Alinco Field

27.5 v. d-c. Can also be used as rate generator. #SA-281 **$3.75 each**

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5 v d-c 3600 rpm. Cont. duty. 2½" diam. x 5½" lg, ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75**

Delco 5069625 Constant Speed DC Motor, 27 v. d-c 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.**

General Electric 2 RPM Motor. Type 5BA10FJ228, 27 v. d-c @ 0.6 amps. 10 lb/in torque at 2 rpm. Shunt wound. L-C noise filter. Stock #SA-274. **Price $6.75 each.**

DC SERVO MOTORS

C-1 Autopilot Servo Unit—28 v. d-c Shunt motor. 2250 rpm. 2 magnetic clutches, reduction gear, differential and 2 magnetic brakes. Output shaft 15 rpm. Torque 225 in/lbs.
Stock #SA-180 **Price $19.50 each**

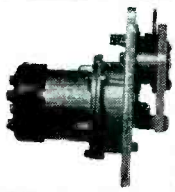
Elinco B-64 DC Servo Unit — armature voltage, 80 v d-c max. 27.5 v. field 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.
Stock #SA-211 **Price $12.50 each**

AC-SERVO MOTORS

Minneapolis-Honeywell

60 cycle Servo Motor Type M623CY1X1 17 watts, 162 rpm. #SA-277.

Price $19.50 ea.



Pioneer Type CK-2. 26 v. 400 cycles fixed phase, var. phase 49 v. max. 1.05 in/oz. Stall torque. Rotor moment of inertia 7 gm/cm: With 40:1 gear reduction.

Stock #SA-97A. **Price $6.50 each.** Also available less gear train as Stock #SA-97. **Price $4.25 each**

KOLLSMAN 400 Cycle RATE GENERATOR

Model 863-04302

Output 4.2 volts per 1000 rpm. #SA-280.

Price $16.50

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver-plated coaxial type. 5-10 mmf.

Stock #SA-167 **Price $1.75 each**

INVERTER SPECIALS

General Electric PE-218 D—Input 28 v. d-c @ 92 amps. Output 115 v. 400 cycles @ 1500 va. Power factor 0.90. Shipping wt. 100 lbs. New—Original Cartons. Stock #SA-112. **Price $39.50 each.**

Leland or Russell PE-218 E or PE-20.8H. Similar to PE-218D. Stock #SA-112A. **Special Price $29.50 each.**

Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209. **Price $79.50 each**

Holtzer Cabot MG-149H—Similar to MG-149F but draws 44 amps DC at 28 v. Output ratings are at 0.90 P.F. Equipped with high altitude brushes. Stock #SA-4. **Price $34.50 each**

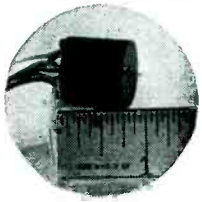
General Electric 5D21NJ3A — Input 28 volts DC at 35 amps. Output 110 volts 400 cycles. 485 V.A. at 0.90 P.F. Weight 15 lbs. Stock #SA-41. **Price $9.95 each**

MERCURY CONTACT RELAY

W.E. D-168479

Millisecond switching at up to 60 cycles per sec. Ideal for servo amplifiers of relay type. 4 page brochure on request. Stock #SA-259. **Price $4.75 each.**

MINIATURE DC SELSYN INDICATOR



Miniature indicator, 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-268. **Price $6.75 each.**

G.E. POSITION TRANSMITTER

Type 8TJ9—continuously rotatable 360 wound potentiometer. Taps every 120 degrees. Two 180° opposed sliders. 24 v. d-c operation with indicator described above. Stock #SA-13. **Price $4.75 each.**

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

LP-21-LM Compass Loops

Motor driven loop enclosed in graphited zeppelin housing includes Autosyn transmitter.

New **$9.50 each**

MAGNESYNS

Pioneer CL-3

Use as transmitter or indicator on 26 v. 400 cy. or 52 v. 800 cy. May be used as indicator with 360° potentiometer on d-c.

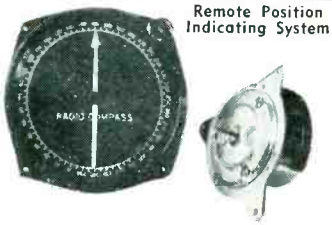
Stock #SA-6 **Price $1.45 each**

DYNAMOTOR

D-101 27 v. d-c in @ 1.5 amps d-c out. 285 v. @ 0.60 amps. Stock #SA-187.

Price $1.50 each

Remote Position Indicating System



6-12 v. 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

Prices F.O.B. Paterson
Phone ARmory 4-3366
Teletype PAT. 199

WRITE FOR LISTING

Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

SWITCHES AND CIRCUIT BREAKERS

Heinemann circuit breakers
110-15 amp. ---------- 1.49
110-20 amp. ---------- 1.49
110-5 amp. ---------- .95

Aircraft ckt. breakers 24V.-20 amp. amp.—AN 3160—Square D Co.----$1.49

DPST 30 amp. toggle switch—bakelite case ---------- .39
DPDT 110V. slide switch---------- .19
DPDT Toggle switch---------- .39

RELAYS

Potter & Brumfield OVERLOAD relay relay No. 1 is 5000 ohms, coil current 10 ma., relay No. 2 is 110V-60 cy. Ac coil. SPDT----------$1.95

Telephone type, plate sensitive relay-7000 ohm, SPDT---------- 1.95

Plate sensitive relay—5000 ohm coil contact DPST ---------- 1.49

BK-22-K relay—used in conjunction with SCR-269-F—contains 28V step relay, 5 deck, 6 pos. switch—12V-DPST ---------- 2.95

REGISTORS and RHEOSTATS

POWER RHEOSTATS—25W-25 ohm—1 amp. max.----------$ .69
POWER RHEOSTATS—25W-25 ohm—1.7 amp. max.---------- .95
75,000 ohm, 200W. bleeder---------- .95
11,296 ohm, 100W. bleeder, IRC type tapped at 750-23-23-7500-3000 ---- .49
1 Meg. multiplier, 1% tolerance------ .89
Thyrite discharge resistor type 5F HE 130V AC/DC ---------- .95
100 assorted ½ watt resistors in popular sizes ---------- 1.49

SILVER CERAMIC CONDENSERS

500 W.V.D.C. 10c ea. 12 for $1.00
Available capacity (MFFD's), 2, 3, 4, 5, 7, 8, 8½, 10, 11, 12, 15, 24, 25, 30, 40, 100, 120, 125, 140, 232, 350, 375, 400, 470, 45, 50, 51, dual 60, 70, 72, 75, 80, 81, 95, 500, 1000 and 5000.

CAPACITORS

2MFD-6000 V. paper oil type--------$8.95
2MFD-7500 V. paper oil type-------12.50
1MFD-5000 V. paper oil type------- 2.95
1MFD-6000 V. paper oil type------- 4.95
.1 MFD-7000 V. tubulars--- 1.95
2 MFD-1000 V.----------$ .89
1 MFD-1000 V.---------- .44
8 MFD-600 V.---------- .95
4 MFD-600 V.---------- .69
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20 MFD-2500VDC PK. Type No. 775, 65W. Sec.-PHOTOFLASH --------- 9.95
32 MFD-2500VDC PK. No. 777, 100W. Sec.-PHOTOFLASH --------14.95
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.008 Buffer 1600-V ---------- .29
Assorted micas-------per one hundred 1.95

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6 Gang variable—silver plated—sec. 1: 350 MMFD, sects. 2, 3, 4, 5: 60 MMFD, sect. 6: 80 MMFD---- .89

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TN-3A 300-1000 MC Detector (uses 1N29 XTAL ---------- 2.95
TN-30 135-485 MC Oscillator
TN 300-1000 MC oscillator (uses 368AS doorknob tube) ---------- 3.95
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IF XFMR-5 MC with air trimmer-impedence coupled, mounted in Alum. shield can ---------- .95
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AN-3106-24-2S	AN-3102-14S-1P
AN-3106-28-2P	PL-147
AN-3057-16	AN-3106-32-101S
AN-3057-8	AN-3102-18-20S
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BC 223 AX Transmitter—BRAND NEW—801 oscillators and 801 PA's, (2) 46 mods. & (1) 46 speech amp. 4 xtal freqs. and master osc. on selector switch—tone voice or CW mod., 10-30 W. output. Ideal for 80 meter band. Complete with 2 coils TU 17A 2000-3000 kc, TU-25 3500-5250 kc.—black crackle case. Two extra cases to store coils. Freq. chart and tubes incl., packed in orig. cases, less xtals.----------$39.95

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BC-AL229 RECEIVER with 6 tubes—aircraft equipment, both units--------$9.95

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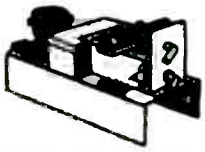

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Compact, beautifully built line oscillator employing two W.E. 368AS (703A) "doorknob" tubes in push-pull. Exceptionally stable. 5W output at 420mc, 2W at 700mc. Independent grid and plate tuning. Adjustable output coupling and tuning assembly. Coaxial output connection. Built-in blower may be operated from 110VAC. Power requirements: 300VDC/150ma, 1.2V/4A, 1.2V/4A. 5¼"x6½"x11½". 7 lb. Supplied complete with tubes. Ideal for 420mc amateur operation or for use in the 460-470mc citizens radio band. **Stock No. APO-66.....$8.95**
Spare 368AS/703A tubes.....**$1.69 ea.**

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*(Except as specified with *)*

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72/3B24	.95	931A*	3.95	OD3/VR150	.69

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Precision wide range butterfly circuit elements. Sturdily constructed. Mounted in ball bearings. Suitable for motor drive. Ideal for use as wavemeters and oscillators (See description below.)

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TN-30	135–485	2, 3	5.95
TN3A	300–1000	2, 5	6.95

Brand new, in original packing.

* NOTES: 1) Aluminum construction
2) Silver-plated brass
3) Designed as oscillator element (955 acorn triode)
4) Has diode socket mounted on unit (955 as diode)
5) Has crystal diode mount for 1N21 crystal

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$1.85: 3 for $5.00

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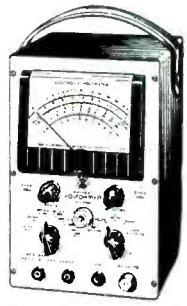

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No. A8, with probe, less batteries
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REGULARLY $591.75

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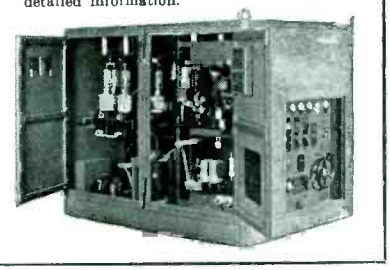

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200 watt wire wound resistors, ferrule ends 160,000 ohm, 5,000 ohm, or 1,000 ohm $1.00

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Type	Price
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6 A. Rectigon (450)	2.75
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Amertran: 17,600 v @ 10.4 K.V.A. cont. $65.00
Amertran: 8,800-0-8,800 v @ 10.4 K. V. A. cont. $75.00
Westinghouse: 18,400-0-18,400 v @ 9 K. V. A., cont., plus 2 WL-531 rect. tubes, fil. transf. & 50 h 575 ma choke $160.00
24 v. @ 1 amp. uncased. $1.60

RELAYS

Westinghouse Type SC-M Overcurrent relay, .2 to 1 A., .8 A. cont. rating 20-40% drop out ratio. $12.95
A-B 810 Overload Relay, 6.3-18.1 A., 600 v. max. $7.95

CHOKES

Amertran: Swinging, 900 h @ 16 ma. 25 h @ 525 ma. 35,000 v test. .$42.00
Kenyon: 20 h @ 300 ma. 15,000 v test $12.00

CONTACTORS

I.T.E.: 115 v. 60 c. coil, Single pole 115 A. 600 v. with barriers, adj. time delay & remote contact control trip $10.95
A-B #RC-3301: 115 v. 60 c. coil D.P.S.T. 15 amp contactor. ..$4.95
Monitor: 115 v. 60 c. coil N.O.D.P. contactor, 100 A 600 v. N. C. 15,-000 v. 1.0A, contact. One N. O. & one N. C. interlock w/150 A & 30A. renewable fuses $8.95

DRY DISC RECTIFIERS

Continuous Duty Ratings

3.5 v a-c, FWB, 1.8 v d-c @ 1.0 amp. $ .90 each, 4 for $3.00
6.5 v a-c, FWCT, 2.2 v d-c @ 3.0 amps. $1.20 each, 5 for $5.00
0-36 v a-c, HW, 200 ma d-c $ .75 each, 2 for $1.00
0-54 v a-c, FWB, 1.6 amps d-c. $4.40
0-154 v a-c, FWB, 600 ma d-c. $6.85
0-180 v a-c, FWB, 400 ma d-c. $6.90

ASD RADAR TRANSMITTER & MODLULATOR

3 centimeter: complete with 725A magnetron, cavity, two 723A/B Klystrons, one RKR73, four 72's, one 715B, one 829B, two 724B's, two 6AC7's, one 1N23 crystal diode, high voltage supply, two cooling blowers, etc. Input: 115 v. 400 c. N-2 condition. $110.00
Preamp assembly: includes plumbing (2) 723 A/B's, (2) 6AC7's, (2) 724B's, 1N23, etc. $37.50
725A Magnetron w/magnet. $12.50

All merchandise in "as new" condition. Add approx. 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C. O. D. All prices f.o.b. Los Angeles Warehouse. Write for additional detail information on any of the above items and for special quantity discounts. Telephone MAdison 6-5391.

1527 E. SEVENTH ST. **EPCO** LOS ANGELES 21, CALIF.

LOWEST PRICES!

AIRCRAFT BLOWERS

Westinghouse Type FL 115 v. 400 cy. with capacitor

Price $1.95

C-1 AUTOPILOT VERTICAL GYROS

Gyro, driven by series motor, provides electrical signals for both the roll and pitch of the aircraft. Has many valuable parts such as precision variable resistors, bearings, contacts, etc. Amphenol connector not included. Original price $1500.00

Special $4.95

EDISON TIME DELAY RELAY

Vacuum sealed in glass, s.p.s.t. contacts normally closed. 30 v. 7 second delay to open. Many experimental applications.

Special Price Three for $1.95

ALNICO FIELD MOTOR

Sampsel Time Control Inc., 27 v. D.C. Overall length 3 5/16" by 1⅜". Shaft ⅝" long by 3/16", 10,000 r.p.m.

Price $4.25 each net.

Synchron Model 600 1 RPM Motor

110 v. 60 cycles timing motor.

Special Low Price $2.45 each

INVERTER SPECIAL—PE-218

Various manufactures. Used condition—repairable. Ideal for spare parts or for reconditioning. Units have been weather damaged.

A bargain at $8.95 each

NOISE FILTERS

3 chokes and three oil-filled AC capacitors mounted in an assembly with 4 pin Amphenol connector.

A Steal at 39¢

NEON BLOWN FUSE INDICATORS

Rated for 110-220 volts either AC or DC. Can also be used for general testing for "opens" "shorts", etc.

Price 39¢

TUBES

6SN7; 7F7; 7N7; 7Y4	$ .59 ea.
6H6	.39 ea.
83	.65 ea.
CIB—Grid control rectifier (thyratron)	1.95

TERMS: 20% cash with order—balance C.O.D. Orders accompanied by payment in full must include sufficient postage, otherwise shipment will be made via Railway Express collect. Minimum order $2.00.

ELECTRO-DEVICES

Incorporated

Box No. 1941 PATERSON, N.J.

TEST EQUIPMENT

X BAND SIGNAL GENERATOR, 8500-9600 mc, calibrated wavemeter and attenuator, for 110 V 60 cps operation.

SPECTRUM ANALYZER FOR X BAND, TSX-3SE, Sylvania, good working order, 110 V 60 cps.

TS-45A/APM-3 SIGNAL GENERATOR. 9200-9600 mc, 110 V 60-800 cps.

X BAND WAVEMETER CAVITY, TRANSMISSION TYPE, 9200-11000 mc.....$15.00

WAVEMETER CAVITY, 8500-9600 mc, **TRANSMISSION TYPE**.....$35.00

TS-155B/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 v, 60 cy. NEW.

TS-155A/UP S BAND SIGNAL GENERATOR, pulsed calibrated output, 110 v, 60 cy. NEW.

SPECTRUM ANALYZER FOR S BAND, TSS-4SE, Sylvania, good working order, 110 V, 60 cps.

TPS-51PB/20, S BAND 20 db PAD.....$20.00

X BAND PICK-UP HORN $10.00

TS-62/AP ECHO BOX FOR X BAND

APR-1 RADAR SEARCH RECEIVER, complete with tuning units for range of 38-4000 mc, 30 mc I.F., 2 mc wide.

TUNING UNITS for **APR-1** or **APR-4 RECEIVERS** (can be used with any 30 mc amplifier):

TN-16, range 30-90 mc

TN-17, range 80-300 mc

TN-18, range 300-1000

TN-19, range 1000-2000mc

TN-54, range 2000-4000 mc

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier direct reading VSWR meter, slotted wave guide with gear drive traveling probe, matched termination and various adapters, with carrying case, NEW. UNITS I AND II are available separately, or together as a test set.

S BAND SIGNAL GENERATOR CAVITY with cut-off attenuator. 2300-2950 mc, 2C49 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 $8.00

X BAND TEST LOAD, TS-108/AP. 150 watts accessories $35.00

LAE-2 SIGNAL GENERATOR, 520-1400 mc, CW & pulse modulation, calibrated output 110 V. 60 cps, used, good condition.

LAF-1 SIGNAL GENERATOR, 100-600 mc. CW & pulse modulation, calibrated output, good condition. 110 V, 60 cps operation.

GENERAL RADIO SIGNAL GENERATOR MODEL 522, 250-1000 mc, good operating condition.

GENERAL RADIO POWER OUTPUT METER, MODEL 583-A $45.00

GENERAL RADIO VACUUM TUBE VOLTMETER MODEL 726, good working order $120.00

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

FEDERAL RADIO SIGNAL GENERATOR MODEL 804C, 7.5-330 mc, good operating condition

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 10 B SIGNAL GENERATOR, 85 kc to 25 mc, calbrated output, good working order $100.00

FERRIS 18 C SIGNAL GENERATOR 5-175 mc, calibrated output, good working order....$250.00

STANDARD SIGNAL GENERATOR MEASUREMENTS 65B 100 kc—30 mc, 1-20,000 microvolts, good working order.....$400.00

HEWLETT-PACKARD:
WAVE ANALYZER MODEL 300A
DISTORTION ANALYZER MODEL 330B and 320B
AUDIO SIGNAL GENERATOR 205A

LABORATORY RECTIFIER, Sylvania 541-A, 3500 volts at 2 amperes DC

LB-3 LIMIT BRIDGE, INDUSTRIAL PRODUCTS $60.00

P-4 SYNCHROSCOPES, made by Sylvania or Browning Lab $175.00

SIGNAL GENERATOR 1-72-K, 100 kc-32 mc, output not calibrated, 110 v, 60 cps....$35.00

AUDIO OSCILLATOR, HICKOK 198, RC tuned, 20-20000 cps $45.00

TEST SET TS-278/AP FOR AN/APG-13, synchronized, delayed pulse signal generator, 400-430 mc, calibrated waveguide below cutoff attenuator, synchronized marker generator, 115 V, 60 cps, NEW, COMPLETE.....$160.00

TS-10/AP FOR APN-1.....$40.00

RCA SCOPE, 5" MODEL 160B, NEW, export packed $125.00

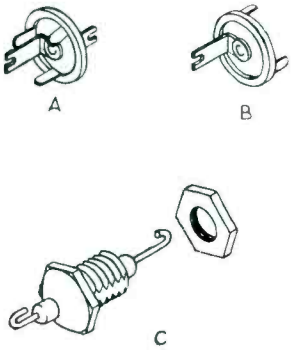
CLOUGH BRENGLE RESISTANCE CAPACITY BRIDGE, model 230A, new.....$50.00

FIXED ATTENUATOR PADS, 20 db + 0 — 2 db, DC—1200 mc, 50 ohms. VSWP 1.3 or less. 2 watts average power.....$30.00

MUTUAL INDUCTANCE ATTENUATOR, Calibrated: frequency range .1 to 1000 mc by means of plug-in coils, attenuation range 120 db $100.00

MUTUAL INDUCTANCE OR PISTON TYPE ATTENUATOR, type N connector's rack and pinion drive, attenuation variable 120 decibles, calibrated 20-120 db. frequency range 300-2000 mc $32.00

MUTUAL INDUCTANCE OR PISTON TYPE ATTENUATOR, similar to above, except upper frequency limit is 3300 mc.....$32.00



CERAMIC FEED-THRU CAPACITORS

Type A.....	300 mmf.....	10 for $2.00
Type B.....	300 mmf.....	10 for $2.00
Type C.....	55 mmf.....	10 for $1.00

TRANSFORMERS, 115 volts, 60 cps primaries:

1. 6250, 3250 and 2000 volts, tapped primary, voltage doubler, 12.5 kv ins.....$14.00
2. 6250 volts 80 ma, ungrounded, G.E. voltage doubler, 12.5 kv ins.....$12.00
3. 2 secondaries at 500 volts 5 amps each, wt 210 pounds $50.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms $3.00

PULSE TRANSFORMER, UTAH 9280.....$1.50

PULSE TRANSFORMER 132-AWP.....$6.00

PULSE TRANSFORMER, GE 68G, 828G-1..$5.00

PULSE TRANSFORMER, Westinghouse 145-EWP $10.00

TS-10/AP CALIBRATED DELAY FOR APN-1 $25.00

TS-203/AP CALIBRATED SELSYN.....$10.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

U.H.F. RIGHT ANGLE ADAPTER 83-1AP 10 for $2.50; 1000 for $125.00

W.E. TELEPHONE NETWORKS: D-161638, 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

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032.....$3.00

PULSE FORMING NETWORK, 20 kv. .92 microsecond, 50 ohms, 800 p.p.s.....$40.00

ANCHOR SCREWS from AB26CR Mast Equipment .....$2.00 each

ELECTRO IMPULSE LABORATORY

P. O. Box 250 *Eatontown 3-0768* **Red Bank, N. J.**

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

ALWAYS BUY TYPE "J"

ohms	shaft	bush.	ohms	shaft	bush.
50	5/8"	1/2"†	10K	1/8"*	1/2"†
60	1/8"*	1/2"†	10K	3/8"	3/8"
60	5/8"	1/2"†	11K	1/4"	1/4"
100	5/8"	1/2"†	12K	3/8"	3/8"
100	1/8"*	1/2"†	15K	1–1/8	3/8"
150	1/8"*	3/8"	15K	1/8"*	1/4"
300	3/8"	1/4"	16K	1/4"	1/4"
400	1/8"*	1/2"†	20K	1/8"*	1/2"†
500	1/8"*	1/2"†	20K	3/8"	3/8"
500	1/2"	1/2"†	22K	1/8"*	1/2"†
500	3/8"	1/4"	25K	1/8"*	1/2"†
600	1/2"	1/2"	30K	1/4"	3/8"
600	1/8"*	1/4"	50K	1/8"*	1/2"†
1000	1/8"*	1/2"†	50K	3/8"	3/8"
1000	5/8"	1/2"†	75K	5/16"	7/16"
1200	1/4"*	1/4"	80K	1/2"	1/4"
1300	1/4"*	1/4"	100K	1/8"*	1/2"†
1500	1/8"*	1/2"†	100K	9/16"	3/8"
2000	1/8"*	3/8"	150K	1/8"*	1/2"†
2100	1/8"*	1/2"†	200K	1/8"*	1/2"†
2200	1/8"*	3/8"	200K	3/8"	3/8"
2500	1/8"*	3/8"	250K	1/8"*	1/2"†
4000	1–1/8	3/8"	250K	7/16"	1/2"
4700	3/8"*	1/2"	300K	1/8"*	1/2"†
5000	5/8"	1/2"†	350K	1/8"*	1/2"†
5000	1/2"	1/4"	1meg	1/8"*	1/2"†
5000	1/8"*	1/2"†	1meg	3/8"	3/8"
6500	1/8"*	1/4"	4meg	1/2"	3/8"

50c each

TYPE "JJ" DUALS

ohms	shaft	ohms	shaft
100/100	1/8"*	130K/130K	1/4"*
200/200	1/2"	150K/150K	3/8"
500/500	1/8"*	200K/200K	3/8"
500/500	2–1/8	250K/250K	1/2"
600/600	1–1/2	300K/300K	1/2"
2K/2K	1/8"*	350K/5K	3/8"
5K/5K	2–1/8	350K/25K	5/16"
10K/10K	3/8"	500K/8K	1/2"
20K/2K	3/8"	500K/500K	1/8"*
25K/10K	2–3/4	560K/560K	1/2"
35K/5K	3/8"	700K/700K	1/2"
40K/7K	3/8"	800K/75K	1/2"
50K/50K	1–1/4	1meg/1meg	3/8"
100K/100K	1/8"*	4meg/4meg	3/8"
100K/100K	1/2"	5meg/5meg	1/2"

$1.25 each

TYPE "JJJ" TRIPLES

ohms	shaft
20K/200K/15K	3/8"
20K/200K/20K	3/8"
45K/27K/2500	1/4"
700K/700K/700K	3/4"
750K/750K/750K	1–3/8"
800K/800K/800K	1–3/8"
1meg/1meg/1meg	3/4"

$1.95 each

*Screwdriver slot.
†Locking bushing.

SELECTOR SWITCHES

Pole	Pos	Deck	Type	Ea.
1	12	1	ceramic	$.55
1	21	3	bakelite	.55
2	11	2	bakelite	.60
4	11	4	bakelite	1.17
6	11	6	bakelite	1.68
8	5	9	ceramic	1.90

OIL CONDENSERS

Mfd.	Volt.	Each
.1	3000	$0.75
.25	2000	.95
.25	3000	1.10
.25	3500	1.15
1	500	.28
1	600	.35
2	400	.35
2	600	.39
4	600	.59
6	400	.75
6	600	.79
10	600	.98
14	600	1.75
15	600	1.98
15	1000	2.75
30	90v AC 3 Phase	3.95
3x4	400 Plug-in	1.49

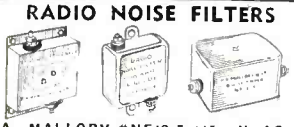
SPECIAL WHILE THEY LAST

PL-55
Lock-In Type
28¢
lots of 100
lots of 1000—25¢
less than 100—35¢

BATHTUBS

Mfd	200V	400V	600V
033	....	17¢	....
.05	17¢	19¢	21¢
.1	18¢	20¢	22¢
.15	....	....	22¢
.25	19¢	21¢	23¢
.35	....	22¢	....
.5	20¢	23¢	25¢
.75	....	....	30¢
1.0	29¢	32¢	35¢
2.0	....	44¢	49¢
4/50V	35¢	2x05/1500V	35¢
8/500V	50¢	2x.1/600V	28¢
16/450V	55¢	2x.25/600V	30¢
25/25V	27¢	2x.5/600V	35¢
25/50V	28¢	2x1/600V	59¢
25/75V	30¢	2x200/9V	49¢
40/25V	27¢	3x.05/600V	40¢
50/25V	28¢	3x.1/600V	45¢
200/12V	25¢	3x.25/600V	50¢
300/6V	35¢	3x1/100V	40¢

RADIO NOISE FILTERS



A—MALLORY #NF12-7, 115 volts AC. Filters hash out of power line. Case 3¼ x 3 x 1 ..... .98
B—SPRAGUE #JX-51, 10amp6-30VDC. Case 2 x 2 x 1⅛ ..... .69
C—MALLORY #NF1-1 Batt-Motor. Case 3⅛ x 3⅞ x 2⅜ 1.49

POWER RHEOSTATS

ohms	watt	ea.	ohms	watt	ea.
5	50	$1.24	378	150	$2.74
5	150	2.74	400	25	.98
6	25	.98	500	25	.98
6	50	1.24	500	75	1.97
7	25	.98	585	150	2.74
7.5	100	2.25	750	25	.98
8	50	1.24	750	150	2.74
10	25	.98	1000	25	.98
12	25	.98	1200	225	3.25
15	25	.98	1250	50	1.24
16	50	1.24	1250	150	2.74
22	50	1.24	1500	50	1.24
25	25	.98	2000	25	.98
50	25	.98	2000	50	1.24
50	50	1.24	2500	100	2.25
60	25	.98	3000	25	.98
75	150	2.74	3000	100	2.25
80	50	1.24	3500	50	1.24
80	500	4.95	5000	25	.98
100	50	1.24	5000	50	1.24
125	25	.98	7500	50	1.24
150	50	1.24	7500	100	2.25
200	25	.98	10000	50	1.24
250	25	.98	10000	100	2.25
350	25	.98	20000	150	2.74

(Discounts to Quantity Users.)

BIRTCHER TUBE CLAMPS

#926-A
#926-A1
#926-B
#926-B1
#926-B22
#926-C
#926-C5

18¢ ea.

AMPHENOL "AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

"UHF" Coax Cable Connectors

83-1R 83-1AP 83-1SPN

Cat. No.	Army No.	Type	Ea.	Per/C
83-1AP	M-359	Plug	.35	.28
83-1D	PL-271	Adap	1.25	1.00
83-1F	PL-274	Feed	1.10	.90
83-1R	SO-239	Rec.	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-22R	SO-264	Rec.	.50	.40
83-22SP	UG-102/U	Plug	.45	.40

Open Accounts to Rated Concerns
Prices net FOB our whse NYC
Send for our Catalog

AIRCRAFT RADIO EQUIPMENT and TEST SETS

I-96 UHF Sig. Gen. (Record) $200.00
AN/ARM-1 Test Set for ARC-3 ..... 150.00 set
A-27 Phantom Antenna ..... 5.00 ea
A-58 Phantom Antenna 100 w, 200 kc—12mc ..... 15.00 ea
A-98 Phantom Antenna with special R-F Meter, for testing Gibson Girls ..... 15.00 ea
I-100 Test Set for ARN-7 or 269 Compass ..... 850.00 set
I-139 Test Motor for SCR-522 ..... 12.00 ea.
IE-19 Test Set for SCR-522 complete ..... 200.00 set
TS-10A/APN Altimeter Delay Line ..... 40.00 set
TS-16/APN Altimeter Test Set 24-v AN/APN-1 ..... 125.00 set
TS-16X/APN Altimeter Test 12-v AN/APN-1 ..... 150.00 set
TS-80/U Test Meter for AN-ARC-1 ..... 12.00 each
I-86 Test Set 95.00
RC-54 Test Set for ARC-5 or 274-N Receivers ..... 150.00 set
RC-55 Test Set for ARC-5 or 274-N Transmitters ..... 250.00 set
I-95 UHF Field Strength Ind. (100-150 MC) 35.00
A-83 Phantom Antenna 2.50
PP-29/CRN-2 Rectifier Power Supply for SCS-51 ILS Glide Path Xmitter. (used) ..... 200.00 ea
W. E. Type 27B Marker Receivers 12-v (complete and reconditioned) ..... 150.00 set
Bendix RTA-1B Transmitter only (recond. L. N.) ..... 500.00 ea

Some of the above Test Sets are one of a kind in stock.
Also in stock: AN/ARC-1, AN/ARC-3, AN/ART-13, BC-348, AN/ARN-7, MN-26, SCR-269-G.

LARGEST DYNAMOTOR LIST AT LOWEST PRICES

DM-32 (24V)	$ 2.00	DM-18 (MN-26 12V)	$10.00
DY-2/ARR-1 (24V)	3.00	DY-21/ARC-3	10.00
DM-32-AZ (12V)	12.00	DY-22/ARC-3	7.00
DM-33 (24V)	5.00	DM-53-A (24V) ea.	5.00
DY-8/ARC-5 (24V)	5.00	DM-53-AZ (12V) ea.	12.00
DM-28 w/filt	3.50	PE-86 w/filt (24V)	3.00
DM-28 less filt	3.00	PE-86-AZ w/filt (12V)	12.00
DM-24 w/filt (12V)	10.00	DY-12/ART-13 w/filt	35.00
DM-24 less filt	8.00	DY-12/ART-13 I/filt	15.00
PE-73 (24V)	10.00	BD-77 (12V)	10.00
D-101 (APN-24V) ea.	5.00	PE-109 Inverter (12V)	50.00
D-101 (APN-1 12V)	10.00	MG-149-H Inverter (24V)	39.00
PE-94-C (522 24V)	5.00	ZA Dyn. for 12V R-89 Rec.	5.00
PE-98 (522 12V)	20.00		
DA-7A (Bendix TA-21)	25.00		
DA-1A (MN-26 24V)	10.00		
DA-1B (MN-26 12V)	10.00		

ABOVE MATERIAL ALL BRAND NEW IN MANUFACTURERS ORIGINAL BOXES. DELIVERY STOCK, SUBJECT TO OMISSIONS, CORRECTIONS, PRIOR SALE.

AIRCRAFT RADIO INDUSTRIES

780 State Street, New Haven, Conn.
N.Y.C. Office—274 Madison Ave.
Phone LExington 2-6254

ALEXANDER MOGULL CO., INC.

161 Washington St., N. Y. 6, N. Y. WOrth 4-0865

WESTINGHOUSE HIPERSIL CORES

OVER 40,000 UNITS IN 20 DIMENSIONS, SEVERAL GAUGES; UP TO 16,000 UNITS IN SOME SIZES. AVAILABLE FOR IMMEDIATE DELIVERY. SEND FOR LIST WITH COMPLETE DESCRIPTIONS.

RAYTHEON MFG. CO.
Surplus Sales Dept., Waltham, Mass.
Tel. Waltham 5-5860—Ext. 2

D.C. MICROAMMETERS

0-200 ua 3" sq. G.E. DO 50 ..... $ 8.00
0-100 ua 3" sq. G.E. DO 50 ..... 10.00
0-50 ua 3" sq. G.E. DO 50 ..... 12.00

R.F. MILLIAMMETERS

0-115 Ma 3½" Weston 425 ..... $12.00
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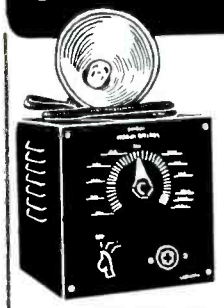

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100VCT	.017	5VCT/3A	2.25
2300V	.004	2.5/2A	7.49
100VCT, 65V	.100	6.3VCT/10, 40V/.1, 18VCT/.1, 18-6/.1 6.3/.1	3.49
1500V	.160	2.5VCT/12, 30V/.01	6.95
1100V, 400V	.250	6.3V/6A	6.95
78V	.300	6.3V/2A	1.79
825VCT	.190	5VCT/3A	3.95
800VCT	.150	5V/3A, 2.5V/2	3.98
2 x 300V	.042	55V/.125, 45/3.5	3.95
585	.086	5V/3, 6.3V/6	3.95
1080VCT	.055	6.3V/1.2, 6.3/1.2	5.95
600VCT	.155	6.3VCT 5, 5VCT/3	3.95
1120V	.600	2 x 5VCT/6-2A, 6.3VCT/3, 6.3/.300	14.95
215VCT	.300	5VCT 6A	2.29

Plate Transformers—115V/50-60 cps input

Volts Out	Amp.	Each	Volts Out	Amp.	Each
65V	.500	$1.49	70V	1	$1.95
500VCT	.150	3.00	100V	3	1.95
650VCT	.015		1620VCT	.400	11.95
2 x 150V	2 x .940	4.25	216VCT	.800	3.95
600VCT	.0165	2.49	121V	1.5	
250VCT	.077		126.5V	1.5	2.25
690V	.450	4.95	132V	1.5	
1470VCT	1.2	24.00			

Filament Transformers—115V/50-60 cps input

Rating	Each	Rating	Each
2.5V/5A HV ins.	$1.79	30VCT/.330, 34VCT/.380	$1.95
6.3V/2A, 78/300	1.79		
36V, 1.11	1.49	6.3V/2.5, 2 x 2.5/7	3.25
5VCT/20A	5.49	2 x 2.5VCT/6.5A	3.25
4V/16A, 2.5V/1.75 HV ins.	4.75	2.5V/1.75, 5V/3A, 6.5/8A, 6.5V/6A	3.85
5V/115A	12.95		
7.2V7, 6.4/10, 6.4/2, 2 x 26.2 2.5, 16V/1	5.95	10VCT/13A, 10VCT/3.25	6.95
6.3VCT .20, 6.3V/1.8, 6.3V/.6	5.25	5CVT/13.5, 2 x 5VCT/6.75, 1.3V/.0091 Kva	6.95
6.3VCT/1, 6.3 VCT/7	2.95	6.3VCT/.6A, 5V/2A	2.95
6.3/5, 6.3/1A	2.75	6.3VCT/2A, 5.3VCT/2A	1.85
6.3VCT/3.2, 6.3VCT/1	2.25	6.3V/1A, 6.3V/1A	2.45
5V/6A	2.25	6.3/2.5/7A, 2.5V/7A 6V/3A	1.95
6.3VCT/1A, 5V/2A	1.65		3.25
			1.10

SPECIAL TYPES

Input	Output	Each
6, 12, 24 or 115VDC, or 230VAC	420VCT/85Ma, 6.3V/1.9, Univ Vibrator Xfmr	$2.39
230V 60 cy	230V/.05A	1.10
115V 60 cy	115V/78V-410A/.600MA	1.59
110/115/120/125	13.5V/1.11A	1.49
210 220/230	2.5VCT/4A	1.49
230V 60 cy	2.5V/6.5A	1.95
230V 60 cy	200V/20A, 4 x 6.3/.900A	2.95
220/440V	286VCT/290MA	2.95
220V 60 cy	260V/.03, 100/1, 6.3/4.2	2.95
200V 60 cy	700VCT/.75, 40VCT/.1A 15/10/15V/.1A	2.39
45/78/90	Tapped 1V to 10V	2.95
220V 60 cy	2 x 40V/.05, 2 x 5V/6A, 12.6V/1A	2.95
220V 60 cy	24V/6A, 5V/3, 2 x 6.3/1A	2.29
43/78/90/115/180/230	2.5V/6.5A, 2.5, 6.5, 6.3/4A	3.95
110/115/120/125	6/12/18/24/75/100/115V/150A	2.49
230V 60 cy	5V/9A MV INS	4.25
200V 60 cy	700VCT/.08A, 110VCT/.08A 24V/.08, 6.3V/.3, 6.3VCT/1.5V/3A, 5V/5A, 2.7V/5A	4.25
230V 60 cy	400V/.03, 190V/.03A, 5/2.5, 5V/2.5A, W/2-866 Sockets	4.25
50V 60 cy	2 x 750V/.901A	1.95
6V & 12V	84V.009, 51V/.003, 1.4V/500 Vibrator Transformer	1.95
230V 60 cy	250V/.1A, 5V/2A, 5V/9A	4.95
220–440	3 x 2.5V/5A, 2.5V/15A	5.95
230V–115V	5VCT/7.5, 5V/7.5, 5VCT/15A	10.95
440V/60 cy 3PH	220V 30W 3 phase or 220V & 6V 1 phase 60 cy	5.95
230V 60 cy	110V/200, 33V/200, 5V/10A, 2.5–1.4/10A, 1500V/.160	7.95
95–130V 60 cy	115V, 3.6A, 40.9V/3/3A	10.95
220/440V	115V/6.52A	12.95
220–440V	115V 110/105/–7A	13.95

T.V. Transformer, 7" or 9" scope. 3000v/5MA, 720vct/200MA, 6.4/8.7A, 6.4/6A, 5/3A, 1.25/.3A, 115 V 60 cy input. Price **$4.95**

TUBES:

01-A
1B36
2C21
2C22
2J21-A
2J22
2J26
2J27
2J31
2J32
2J38
2J39
2J34
2J40
2J49
3J3
2K41
2X2/879
3BP1
2C24
3C30
3D6
3CP1
3D21-A
3DP1
3EP1
3FP7
3Q5
5BP1
5CP1
5FP7
5130
6G
6SC7
7C4
7E5
7E6
10Y
12A6
12K8Y
12SF7
12SR7
15P
28D7
30 (Spec)
45 (Spec)
39/44
35/51
227A
225
268-A
355-A
417A
530
531
532
559
562
615
700 A,B,C, D
703-A
704-A
705-A
706 AY, BY,DY
706 EY, FY,GY
†707-B
714AY
715-B
720BY
720CY
721-A
723-A/B
724B
725-A
726-A
728 AY, BY,CY
728 DY, EY,FY, GY
730A
800
801-A
804
815
836
837
843
860
861
874
876
1005
1619
1624
1629
1961
9002
9004
CEQ 72
EF 50
F-127
FC 258A
GL 532
FC 271
GL 562
GL 623
GL 697
ML 100
QK 59
QK 60
QK 61
QK 62
VR 91
VR 130
VR 135
VR 137
VU 120
VU 134
WL 532
WN 150
WT 260

HeinemanCkt Bkrs. For AC DC Operation Amperes .010, 3, 7, 10, 50, 80, 100, 150. Ea. $1.45
Klixon 25A 98c
Dual 8 & 25 Amp....$2.49
De Ion 35 Amp.....$3.75

BC-605 Interphone Amplifier

Easily converted to an ideal inter communications set for office-home-or factory. Original New..$4.75

AN/GSC—TI Code Training Set

Operates on 6V-12V-24V-115 V DC 115V-230V AC with 6 keys. Contains a blinker system and frequency adjustment. A real buy for Boy Scouts and students. Enclosed in trunk. Brand New Complete.$23.95

TRANSTAT AMERTRAN

Input: 0.115 v. 50-60 cycle. Max. output: 115 v. 100 amp.
All units are new, guaranteed $95
2 KVA: 90 130v input 50-60 cycles, output 115v 2 kva type RH Amertran. 29.95 each

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 $19.95

EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/3Q5 tube. Phone supplied (Featherwt.) $9.75

Loading Coil C114

Same as WE No. 632 but in waterproof case to counter balance cap. in line gives clearer signal. Army used W/W110 & W130 wire. 85¢ ea.

Kellog Microphone

PBX T28 Excellent condition swivel bracket...$2.95

ROTARY BEAM COUPLER

RF Coupler 360° rotation 1 turn coupling link. Easily adpt 200 to 300 Mc. Plastic case mount on side. Price **$2.95**

Soldering Iron 200W

121-130V iron ⅝"r emovable copper tip. Heats in a minute. Complete with cord & plug. New with stand..$4.95

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DY-2/ARR-2
DM 36
DM 53AZ
PE 73CM
DM 21
DM 25
DM 28R
DM 33A
DM 42
PE 101C
BD AR 93
23350
35X045B
ZA .0515
ZA .0516
B-19 pack
D-104
DA-3A
5053
CW 21AAX
BD 77KM
PE 94
DY12

Birtcher Tube Clamps

926C
926–16
926–B1
926–B2
926–B8
926 C15
926–C–13
926B
926C–19
926B–16
926A–14
926A
926C1
926–A11
Each 15¢
10 $1.40
100 12.00

Ceramicons

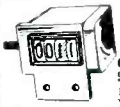
Mmt	
1	25
3	27
3	35
4	30
5	47
6	50
7	57
8	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	000
200	
100 for	$7.50

Button		Feed Thru
140	100	50
180	200	500
175	500	470
185		
100 for		$9.50

WRITE OR PHONE FOR QUANTITY AND PRICE OF ITEMS REQUIRED

BATHTUB CONDENSERS

ALL SIZES TOP
Side and Bottom Mts.
Phone or Write Specifications
22¢ ea.
RADIO PARTS DIV.
ATT. MR. ROSEN



VEEDER Counter

Counts to 9999 and repeats. Many uses ¼" shaft Front meas. 1" x 1¾"..... 98c

VFO Capacitor

High grade unit consists of 3 gang cap. 420 MMF per sect. ceramic ins. low drift, w/worm reduction gear 120:1 w/ext. shaft and 4 digit Veeder counter..$3.95

XMTR COILS AIR WOUND

80 MTR Bar Prong 100 W $1.19
40 MTR 5 Prong 50w plug in socket $1.19
160MTR 5 Prong 50w plug in socket $1.19
40 MTR 3 Prong Bar 100w $1.19
#C538 2-3.5 MC 300w Fix Link $1.19
#1735 2-3.5 MC. 300 w Var. Link $1.49
#C390 5-7 MC. 300w Fix. Link $1.19
160 MTR Bar Type 100 w $1.19

Basic Photoflash Condensers & Paper

6 Mfd 330VAC 1200VDC Int....$1.95
.5 Mfd 750 VAC 2500DC 1.75
1 Mfd 1500VDC.... .89
1 Mfd 2000VDC.... 1.00
2 Mfd 1500VDC.... 1.00
10 Mfd 1000VDC.... 1.95
15 Mfd 1000VDC.... 2.25
3 Mfd 2200VDC.... 1.95
6 Mfd 1500VDC.... 2.15
45 Sec Time delay Relay 110V Input 1.95
14 Mfd 330VAC 200VDC Int. ...$2.95
1 Roll 35MM Photo Paper 1⅜x250 Ft. Lg. EKCo #2 Pkd in Tin. Perfect Condition. List Price $2.50. Our Price 75c ea.

CROSS POINT INDICATOR

1D24-ARN9 Dual 0-200 microamp move. in 3" case. Each move. brought out to 6 term. in rear. Use in ILS equip. New. Price $5.95

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1,000,000 Bathtubs
4,000,000 Micas
300,000 Sil. Micas
100,000 Oil Cond.
4,000,000 Resistors
400,000 Electrolytics
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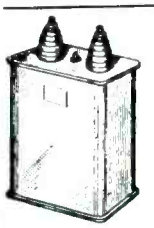
1,000,000 An. Connectors
50,000 Dynamotors
20,000 Power Xfrmrs
20,000 Chokes
100,000 Antennas
50,000 Audio Xfrmrs
100,000 400 Cy Xfrmrs
100,000 Shock Mts.
25,000 Magnetrons
5,000 Magnets
50,000 Pulse Xfrmrs
50,000 Control Boxes
500,000 Tubes
300,000 Relays
500,000 Pots
35,000 Vibrators
200,000 UG Connectors
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 Wafer Switches
300,000 Ceramicons
500,000 Ferrule Resis.
50,000 PL 54
25,000 JK 26
25,000 PL 68



OIL CONDENSERS

1.5 MFD	6000 VDC	$10.00
1 MFD	15000 VDC	30.00
.5 MFD	25000 VDC	35.00
1 MFD	25000 VDC	83.00
.1 MFD	10000 VDC	15.00
.06 MFD	15000 VDC	8.00
.25 MFD	20000 VDC	17.50
15 MFD	5000 VDC	25.00
15 MFD	1000 VDC	2.25
10 MFD	1000 VDC	1.95
6 MFD	1500 VDC	2.25

Sound Power FIELD PHONES

EE-108 Talking range 9 to 12 miles without batteries or current. Has crank and generator for signaling. In fine leather case. Weighs 9½ lbs. Brand New. A wonderful buy. 2 phones...$37.50

AMPHENOL "AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS
Send your specs and let us quote

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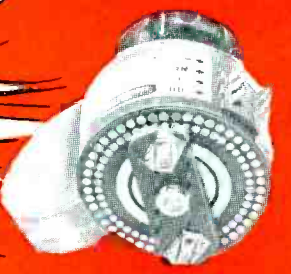
ADVERTISERS INDEX

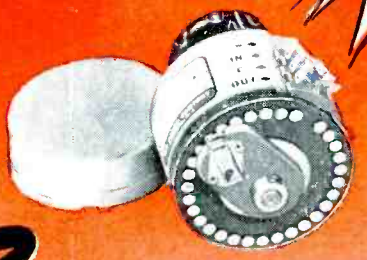
THEY'RE NEW!

30 step "T" networks, T-730 series, 2¼" diameter



45 step "T" networks, T-345 series, 2¾" diameter

30 step ladder, LA-130 series, 1¾" diameter (also available as potentiometer)



THEY'RE SMALL!

3 ADDITIONS to the most complete line of Attenuators in the WORLD!

- Multiple Input & Output Networks
- Potentiometers
- "T" networks
- Balanced "H"
- Ladder Networks
- R. F. Attenuators
- Fixed Pads

Daven offers a new group of Attenuators which are designed for compactness and light weight. This has been done as an aid to Design Engineers—in line with the growing trend to miniaturization of components.

By combining all the other well-known Daven features, these units are ideal where space and weight are at a premium.

Let Daven fill your needs from over *5,000 types* of standard attenuators. Our Engineering Department will be glad to work with you in selecting a unit for your specific requirements.

- Impedance matching networks
- Rheostats
- Balanced Ladder Networks
- Video Attenuators
- Dual Potentiometers
- Power Attenuators
- Decade Attenuators

Write to Dept. E-1 for additional information

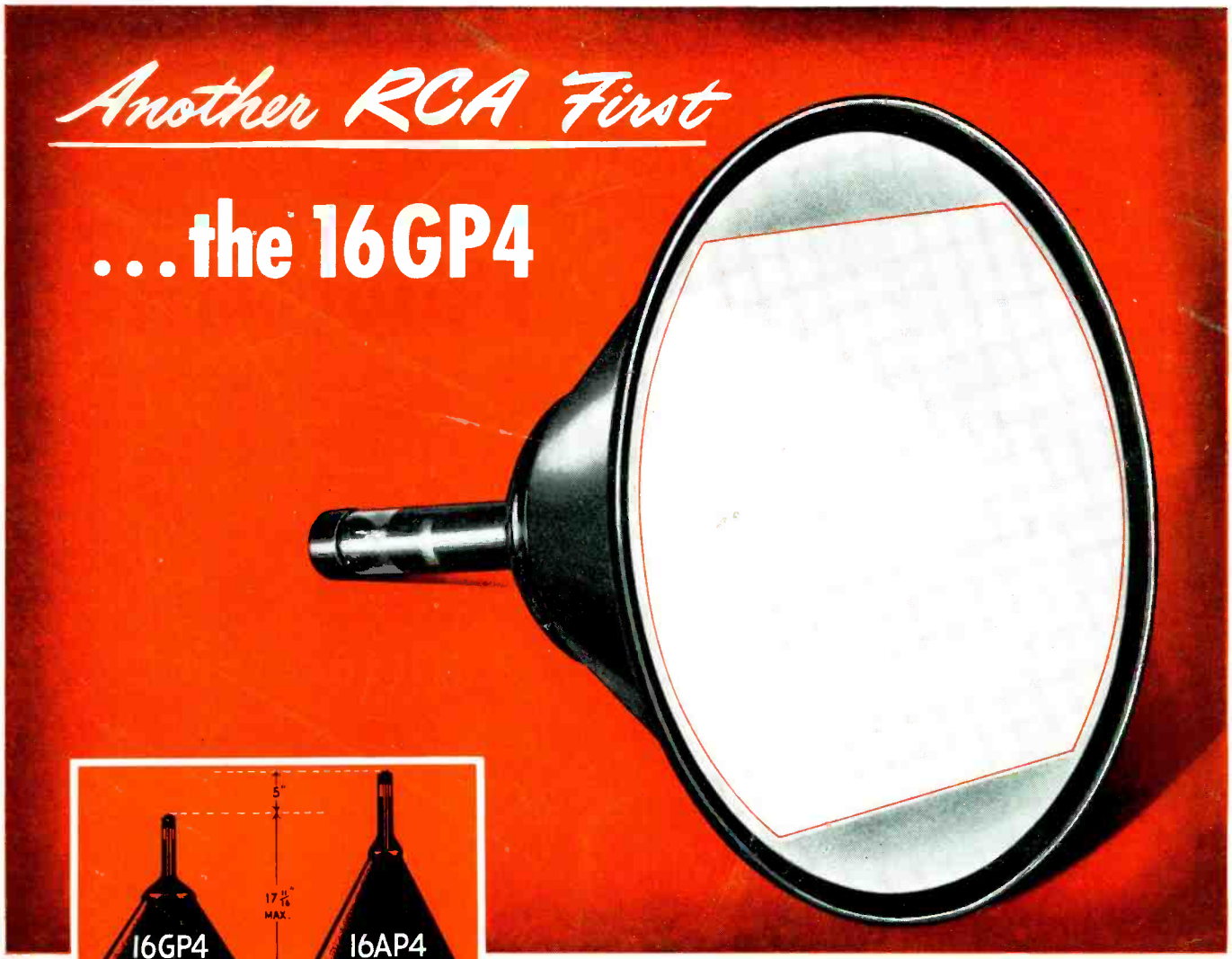
"The best equipment deserves the finest attenuators— . . . Always Specify Daven!"

THE DAVEN CO.

191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

Another RCA First

...the 16GP4



...the new, short metal-cone kinescope with "Filterglass" face plate

The new RCA-16GP4 offers special advantages to designers of large-screen television receivers:

Shorter—Nearly 5" shorter than the 16AP4, the new, wide-angle RCA-16GP4 permits reduction in depth of chassis and cabinet, and thus makes possible greater compactness in receiver styling. In addition, the 16GP4 permits economies in tube stocking, packaging, and shipping.

"Filterglass" Face Plate—Of high-quality glass and almost flat, the "Filterglass" face incorporates a neutral light-absorbing material to give improved contrast by minimizing ambient-light reflections and reflections within the face plate itself. The circular face plate provides a large picture with full scan.

Tilted Ion-Trap Gun—New tilted gun requires only a single-field, external magnet.

Duodecal 5-Pin Base—Permits use of lower-cost segment socket.

Less Weight—The RCA-16GP4 weighs substantially less than a comparable all-glass tube so that, with ordinary precautions, it can be safely shipped in the receiver.

RCA Application Engineers are ready to co-operate with you in applying the 16GP4 and associated components to your specific designs. For further information write RCA, Commercial Engineering, Section A42R, Harrison, N. J.

ANOTHER new RCA tube . . .

. . . **the RCA-6AU5-GT Horizontal-Deflection Amplifier for 10BP4 and 12LP4 Systems:** RCA-6AU5-GT is a high-perveance, beam power amplifier of the single-ended type for use as a horizontal-deflection amplifier in low-cost, high-efficiency deflection circuits of television receivers. In suitable circuits, only one 6AU5-GT is required for the 10BP4 or 12LP4.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

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