SEPTEMBER · 1948

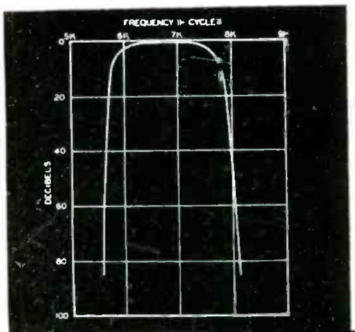
electronics

A McGRAW-HILL PUBLICATION

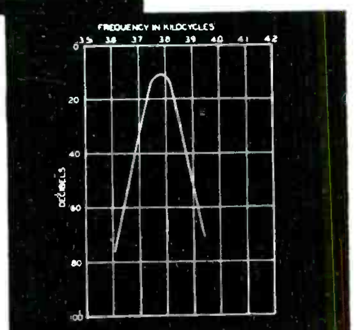
Revolutionary Amplifier
The CRYSTAL TRIODE

We illustrate the units below for the information they bring to engineers of "What can be done." A large part of UTC production, however, is on catalogued and special material of more standard nature. UTC quality has world-wide recognition on ALL types of transformer components.

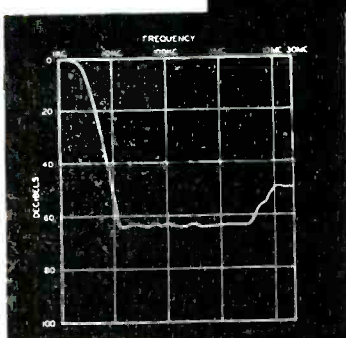
FOR FILTERS



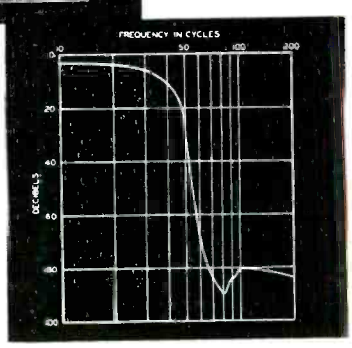
BROAD BAND SHARP CUTOFF FILTER



NARROW BAND SHARP CUTOFF FILTER



ATTENUATES 10KC TO 30 MEGACYCLES



LOW FREQUENCY — LOW PASS FILTER

FOR TRANSFORMERS

This high gain transformer is used in a 60 cycle chopper circuit for measuring small DC voltages—primary inductance 10 Hys. Ratio 250:1 — 100 DB of shielding.

This unit weighs but 1.3 oz. The rectifier in which it is employed delivers 2000 V DC with vibrator-battery input.

This input transformer was the perfect answer for an amplifier with a difficult hum problem. The locking universal joint mounting permits orientation to point of minimum hum level.

This pulse transformer has tight requirements. Frequency response is ±3 DB from 80 KC to 4 MC.

Write for our Catalog PS-408

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

SEPTEMBER • 1948

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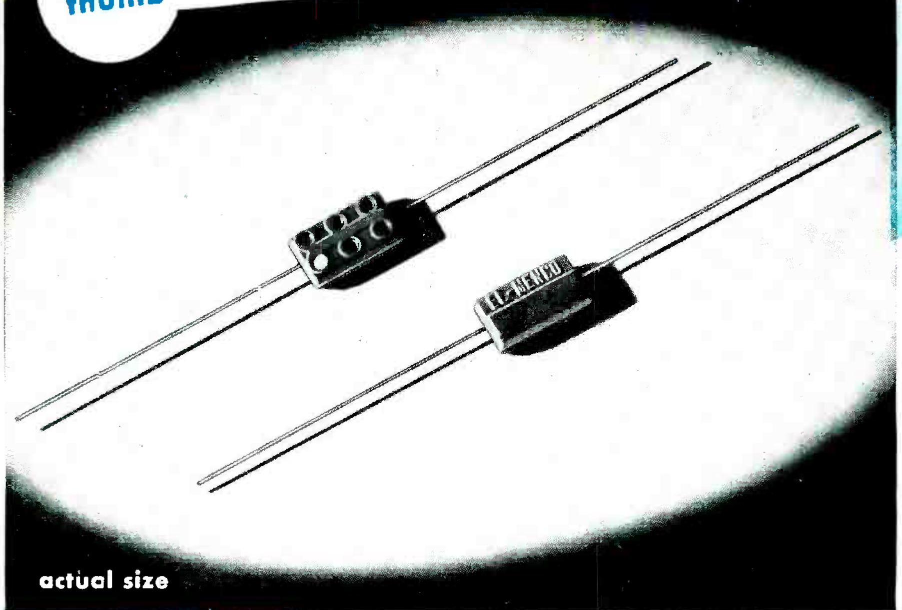
tom thumb **CAPACITOR . . . .** with "ATLAS" performance



EL-MENCO'S NEW CM 15

miniature capacitor

9/32" x 1/2" x 3/16"

This tiny capacitor for radio, television and other electronic applications combines compact design with *proven* performance. Molded in low-loss bakelite the CM 15 is famous for *dependability*. Impregnated against moisture, it delivers at maximum capacity under extreme conditions of temperature and climate.

CM 15 FEATURES

- 500 D.C. working voltage
- 2 to 420 mmf. capacity at 500v. DCA
- 2 to 525 mmf. capacity at 300v. DCA
- Temperature co-efficient 0 ±50 parts per million per degree C. for most capacity values
- 6-dot color coded to Joint Army-Navy Standard Specifications JAN-C-5

SPECIFY EL-MENCO **for your product . . .**

from the Tom Thumb CM 15 to the CM 40, all El-Menco capacitors give you – and your product – dependable performance, endurance, and accuracy. *Send* for catalog — *Specify* El-Menco Capacitors.

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WILLIMANTIC, CONNECTICUT

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Sole Distributors for Jobbers and Retailers in U. S. and Canada

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MOLDED MICA **El-Menco** **MICA TRIMMER**

CAPACITORS

HELIOS new, better BLACK line prints

DRY DEVELOPED

Here are positive line working prints that are amazingly clear and easy to read. Every detail on the original pencil drawing is reproduced in crisp, dense black lines that stand out in sharp contrast against the white background.

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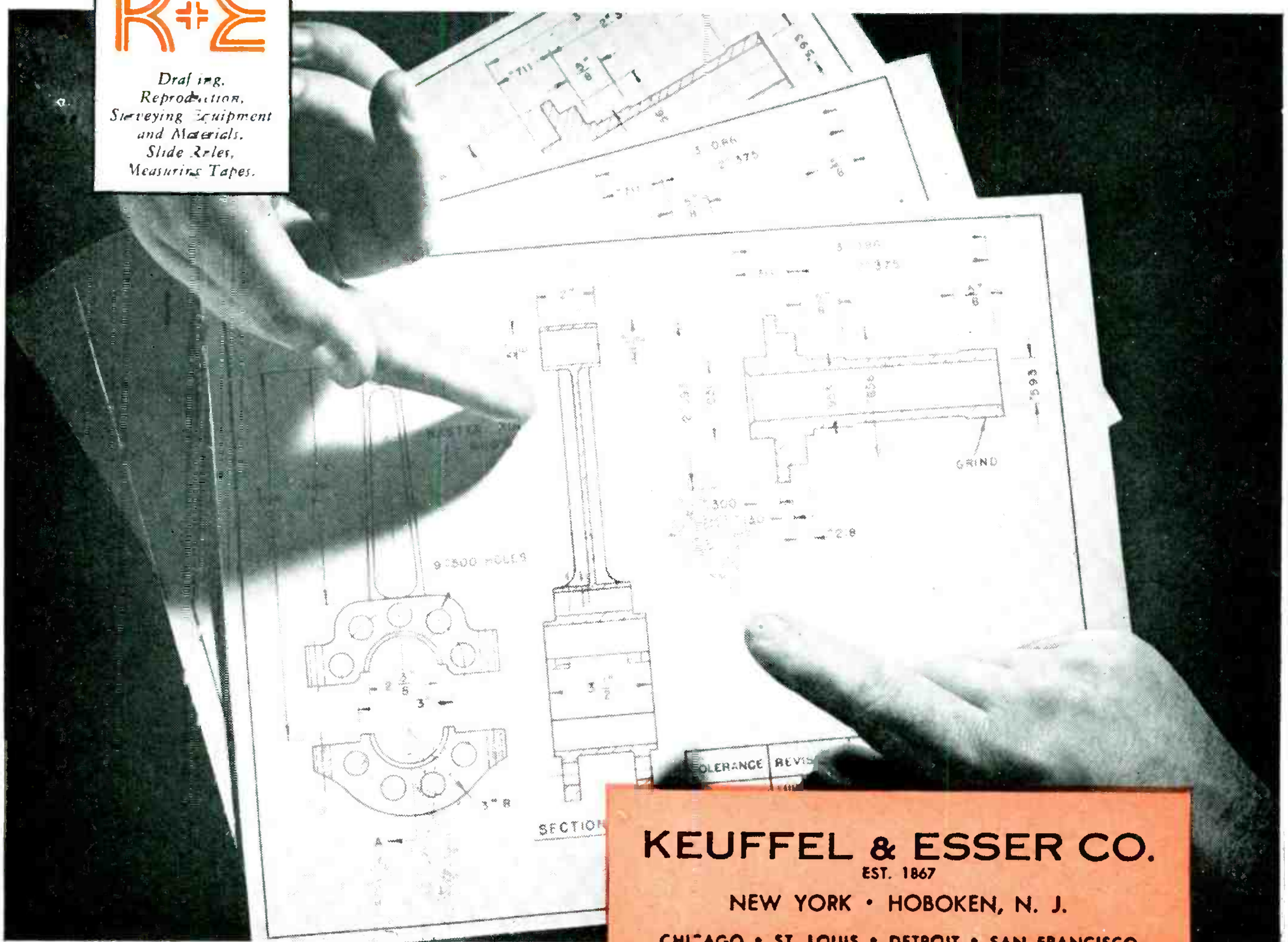
Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes.



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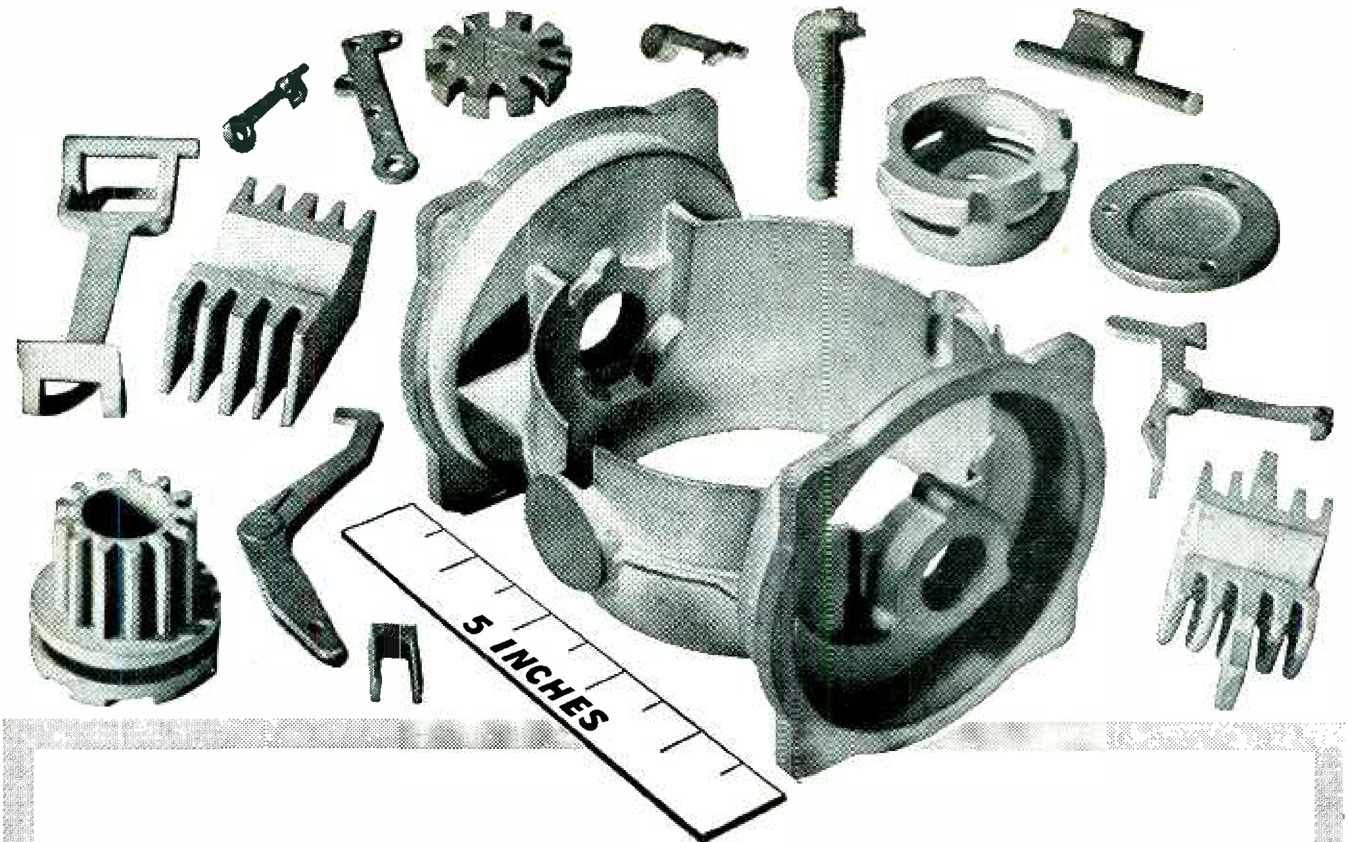

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Lower production costs, design flexibility, resistance to rust and corrosion...you get them ALL when you use INCO Nickel Alloy precision castings!

Casting, instead of forging, forming or machining saves shop time and tool costs. INCO precision castings of Monel*, Nickel, and Inconel* can usually be used *just as they come from the foundry.* The sand blast finish is so fine that additional machining is rarely required.

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Another important advantage...Inco Nickel Alloys can be used to greatly extend the life of a product. These rustless, strong materials are highly resistant to heat, corrosion, abrasion and fatigue.

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Simply send a print and a sample, if available, with the quantities needed. We will be glad to tell you whether or not precision casting is practical for your problem.

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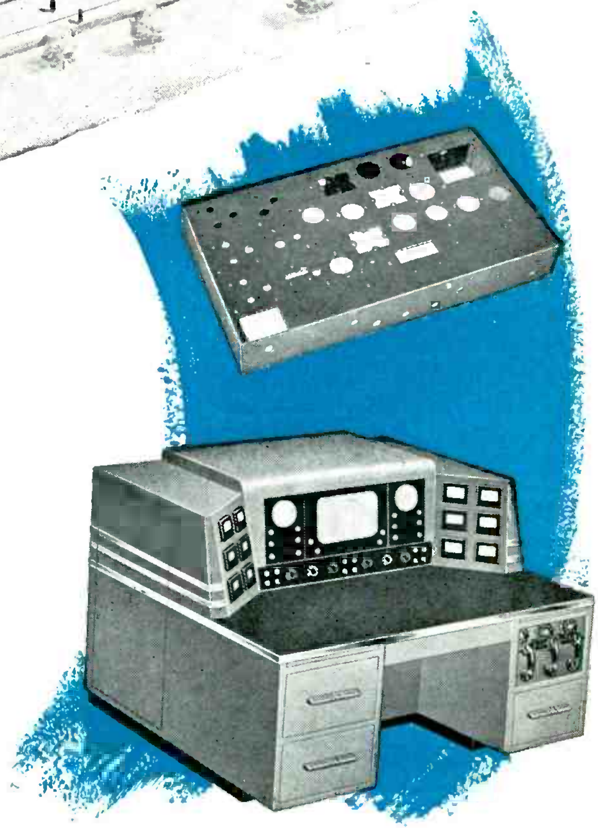
MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

we're

It's sweet music to us...and to our customers, we think, to know that Karp Metal Products Co., Inc. soon will move into a brand new streamlined building of 70,000 square feet of space, with a 600 foot frontage.

Our new plant will be the last word in modern manufacturing quarters, equipped with the newest and most efficient machinery and facilities, including the most complete and up-to-date paint and finishing department, scientifically air conditioned and dustproof. These advancements will enable us to extend the scope of the precision service we render the leaders of the radio and electronics industry.

Your loyal patronage has helped make possible this expansion, and you may be sure the favor will be returned in the form of greater production and better-than-ever Karp service . . . from the simplest chassis to the most elaborate console.



Ask For Our Informative New Catalog

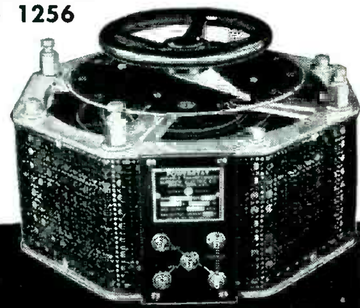
KARP METAL PRODUCTS CO., INC.

124 - 30th Street, Brooklyn 32, New York

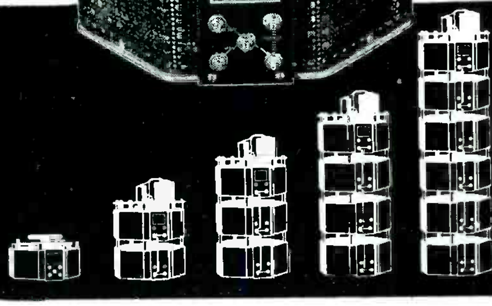
Custom Craftsmen in Sheet Metal

POWERSTAT
VARIABLE TRANSFORMERS

POWERSTAT
Type 1256



FOR HEAVY DUTY



POWERSTAT variable transformers are not limited to laboratory, test panel or low power applications. As single units or as ganged assemblies, POWERSTAT types 1156 and 1256 provide smooth, precise, continuously adjustable variable a-c voltage for heavy duty requirements.

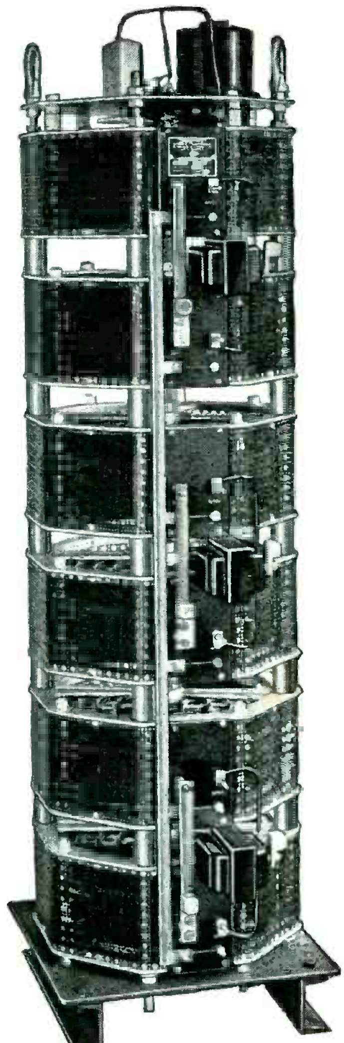
Type 1156 operates from a 115 volt, single phase, 50/60 cycles source to deliver 0-135 volts, 45 amperes output. Type 1256 delivers a variable output of 0-270 volts, 28 amperes from a 230 volt, single phase, 50/60 cycles line.

To obtain higher single phase ratings, types 1156 and 1256 are series, parallel or parallel-series connected, in ganged assemblies of 2, 3, 4 and 6 — operating on a common shaft. POWERSTATS in this arrangement can be supplied in 115, 230 or 440 volt ratings with output currents as high as 270 amperes. Three phase units are available in the same ratings. As many as 18 individual POWERSTAT types 1156 or 1256 can be employed in a three phase assembly. Type 1256-18Y (18 POWERSTATS with a single control) delivers 0-515 volts, 168 amperes from a 440 volt, three phase 50/60 cycles source.

Motor drive is recommended for heavy duty POWERSTATS. It gives finger-tip operation from a conveniently located push-button station, with the same smooth control found in the smallest manually-operated unit.

Whether your variable voltage requirement is 1 or 150 KVA, there's a POWERSTAT variable transformer to do the job.

The Superior Electric Co., 409 Meadow St., Bristol, Conn.



POWERSTAT
Type MW 1156-6Y

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

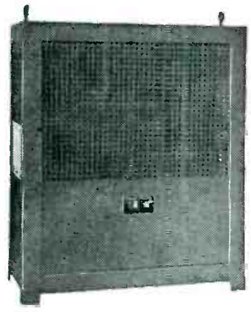
Superior Electric catalog — Bulletin 547 — is yours for the asking. Write today.

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLY • STABILINE VOLTAGE REGULATORS

3-Phase Regulation

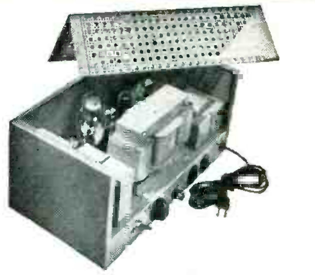
MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
3P15,000	1500-15,000	0.5%
3P30,000	3000-30,000	0.5%
3P45,000	4500-45,000	0.5%

• Harmonic Distortion on above models 3%. Lower capacities also available.



Extra Heavy Loads

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
5,000+	500 - 5,000	0.5%
10,000+	1000-10,000	0.5%
15,000+	1500-15,000	0.5%



General Application

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
150	25 - 150	0.5%
250	25 - 250	0.2%
500	50 - 500	0.5%
1000	100-1000	0.2%
2000	200-2000	0.2%

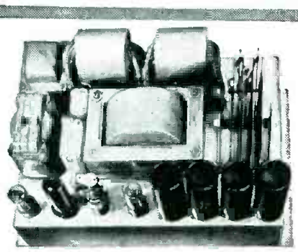
400-800 Cycle Line

INVERTER AND GENERATOR REGULATORS FOR AIRCRAFT.

Single Phase and Three Phase

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
D500	50 - 500	0.5%
D1200	120-1200	0.5%
3PD250	25 - 250	0.5%
3PD750	75 - 750	0.5%

Other capacities also available



The NOBATRON Line

Output Voltage DC	Load Range Amps.
6 volts	15-40-100
12 "	15
28 "	10-30
48 "	15
125 "	5-10

• Regulation Accuracy 0.25% from 1/4 to full load.

SORENSEN

The First Line of standard electronic AC Voltage Regulators and Nobatrons

GENERAL SPECIFICATIONS:

- Harmonic distortion max. 5% basic, 2% "S" models
- Input voltage range 95-125: 220-240 volts (—2 models)
- Output adjustable bet. 110-120: 220-240 (—2 models)
- Recovery time: 6 cycles: + (9 cycles)
- Input frequency range: 50 to 65 cycles
- Power factor range: down to 0.7 P.F.
- Ambient temperature range: —50°C to +50°C

All AC Regulators & Nobatrons may be used with no load.

*Models available with increased regulation accuracy.

Special Models designed to meet your unusual applications.

Write for the new Sorensen catalog. It contains complete specifications on standard Voltage Regulators, Nobatrons, Increvolts, Transformers, DC Power Supplies, Saturable Core Reactors and Meter Calibrators.

SORENSEN & CO., INC.
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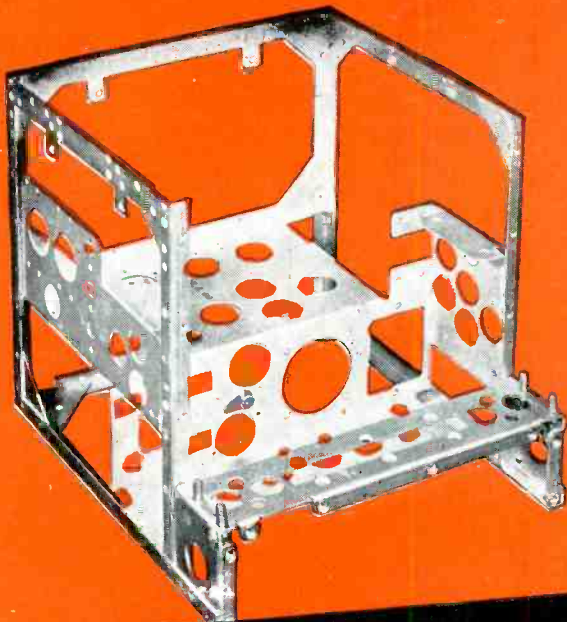
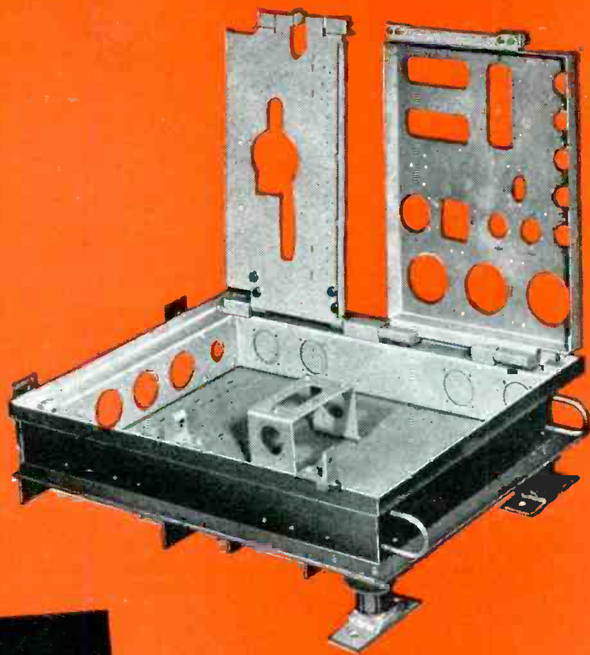
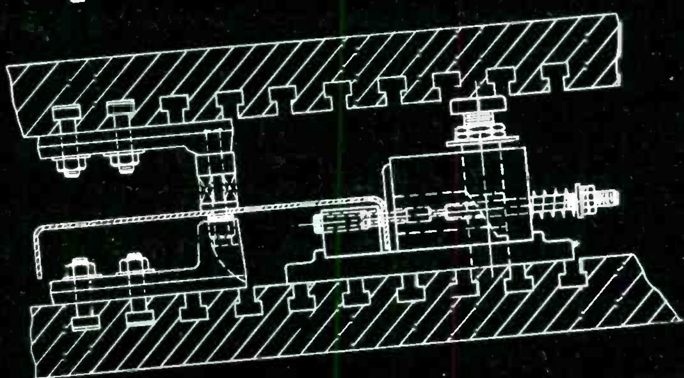
Represented in all principal cities.

WHISTLER ADJUSTABLE DIES...USED BY OVER 1000 MANUFACTURERS





Simplifying Complicated Piercing Operations...



LEADING manufacturers find it fast, simple, accurate, and economical to use Whistler adjustable dies for the tough jobs. Complicated patterns can be set up quickly. It's easy to change hole arrangements too...without waiting and at no extra die cost. New HU-50 units, that pierce at 90° angle, can be used in conjunction with standard perforating equipment. Fewer press operations are necessary.

Savings, through continued re-use of the same dies in different arrangements on many jobs, are most important.

Whistler adjustable dies can be used in practically every type press. Standard sizes of punches and dies up to 3" are available in a hurry. Only a few days are necessary to get special shapes made to order.

S. B. WHISTLER & SONS, INC.

742 Military Road Buffalo 17, N. Y.

HU-50 Perforating unit used in conjuction with standard Whistler adjustable dies on the same job.

For more details **on this modern way to speed production and save money, write for your copies of the Whistler catalogs.**

See us at Booth 1502 National Metal Exposition
October 25 to 29—Convention Hall—Philadelphia

Watch Master

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(.001%)

Type 2121 A.

TERMINATION
Front and Rear

CONSTRUCTION
Standard 8¾" x 19" Panel

HOUSING
8¾" x 19" x 8" Metal Cabinet

WEIGHT
25 pounds

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 2121A.

Name..........

Company..........

Address..........

City.......... State..........

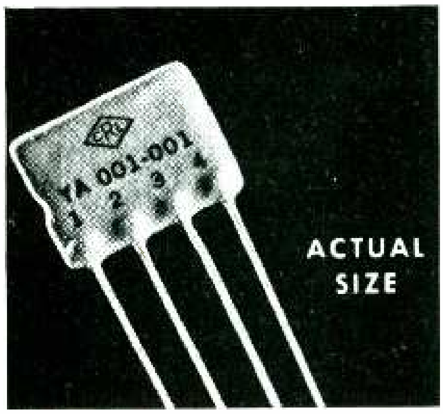
product of

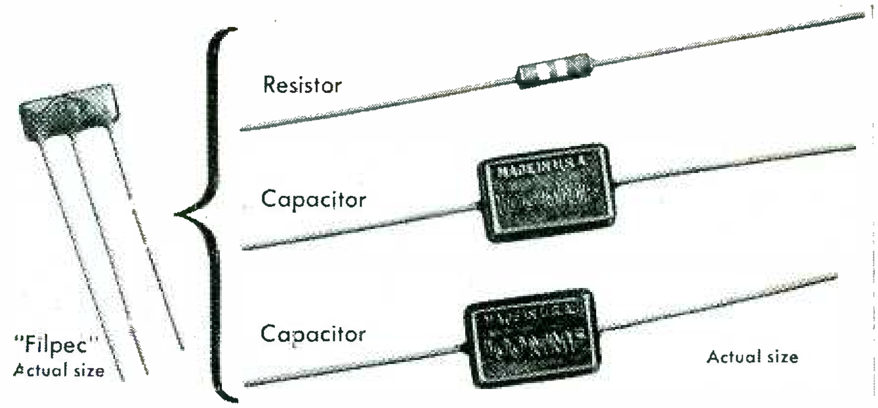
AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue New York 19, N. Y.

Operating under patents of the Western Electric Company

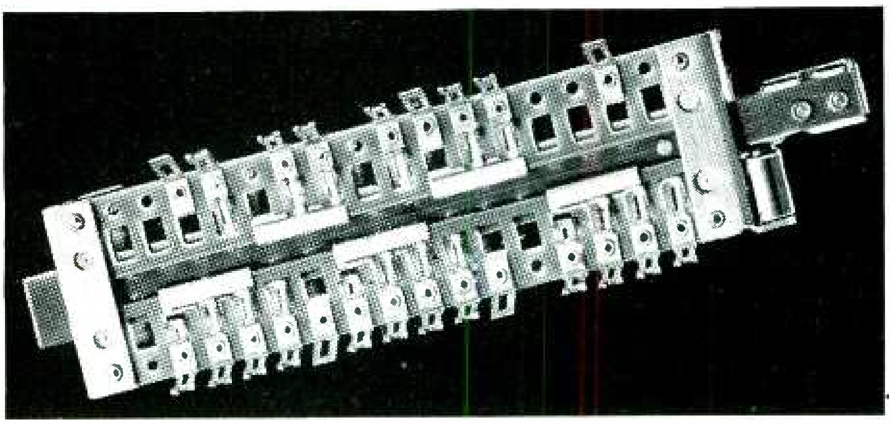
Electronic Industry

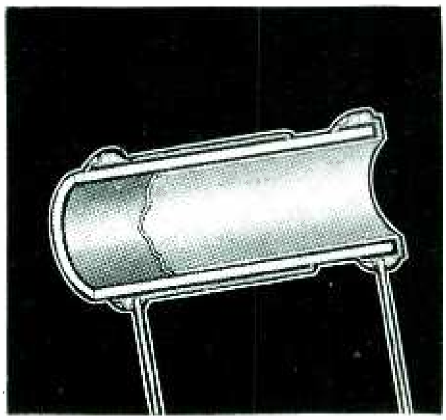




2 CRL's *Couplate* consists of a plate load resistor, grid resistor, plate by-pass capacitor and coupling capacitor. Write for Bulletin 943.

3 Centralab's *Filpec* is for use as a balanced diode load filter. It combines up to three major components into one tiny filter unit, lighter and smaller than one ordinary capacitor. Also available for other applications. Write for complete information about *Filpec*, as well as other *Printed Electronic Circuits*.





4 Centralab's revolutionary, new *Slide Switch* offers improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

5 High quality, long life, dependability—that's the reason more manufacturers are switching to CRL's *Hi-Kap* Ceramic Capacitors.

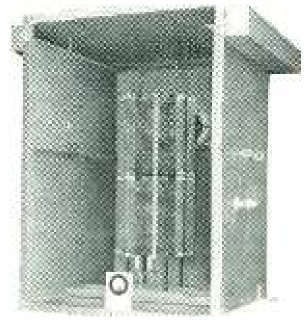
LOOK TO CENTRALAB IN 1948! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

Centralab

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

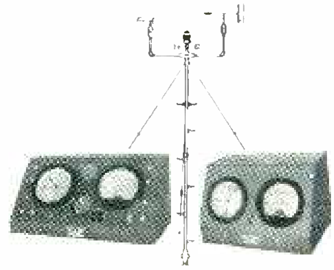
4 PROBLEMS 4 ANSWERS

You, as a Communications Engineer, will be interested in the four *Aerocom* products illustrated below. They are designed and built to solve your communications problem. They are the result of engineering knowledge and experience gained during 18 years of manufacturing communications equipment for more than 200 installations throughout the world.



WEATHERPROOF LOW FREQUENCY ANTENNA TUNER. Sturdily constructed; using heavy aluminum sheet and rustless hardware. Ample ventilation provided, yet insect and vermin proof. Suitable for 1-2 kw carrier, 200-415 kcs; coupling coil matches either coaxial or 2 wire line. Illustration shows cabinet with protective and weatherproof (no gaskets) covers removed. Locking facility provided.

AUTOMATIC KEYER provides continuous or interrupted identification signals for beacon or aerophare service. Small, compact ($6\frac{5}{8}$" x 9" x 7") and fully enclosed, this keyer will give long trouble-free service. Two synchronized cams, which can be milled to your specifications, provide several keyer combinations. Motor -- 105/115 v-50/60 cy.



METEOROLOGICAL INSTRUMENTS -- Aerocom's group assemblies; anemometer and wind direction indicator on mast for outside installation, and reading instruments in cabinet or standard rack panel, give constant and reliable weather information. Instruments available: wind direction, wind speed, Kollsman station barometer (altimeter), 24 hour clock, or any combination thereof. Mast assembly may be remotely located from instruments.

LINE MATCH INDICATOR: Made in two models (a) LMI-72 for coaxial lines and frequencies from 0.2 to 10 mcs; (b) LMI-500 for balanced pair lines and frequencies from 0.2 to 2 mcs., or 2 to 20 mcs. These instruments permit adjustment of load for optimum line match. Sturdy and rugged, engineered for field use.

FOR OVER EIGHTEEN YEARS CONSULTANTS, DESIGNERS, AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT.

AER-O-COM
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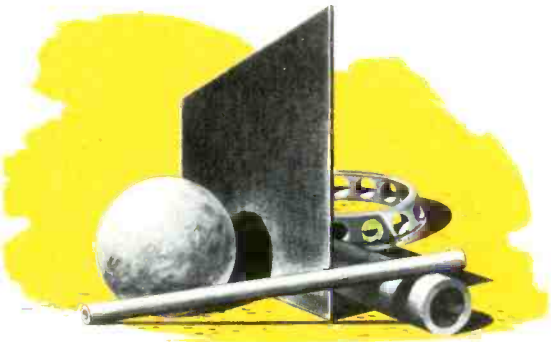
AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

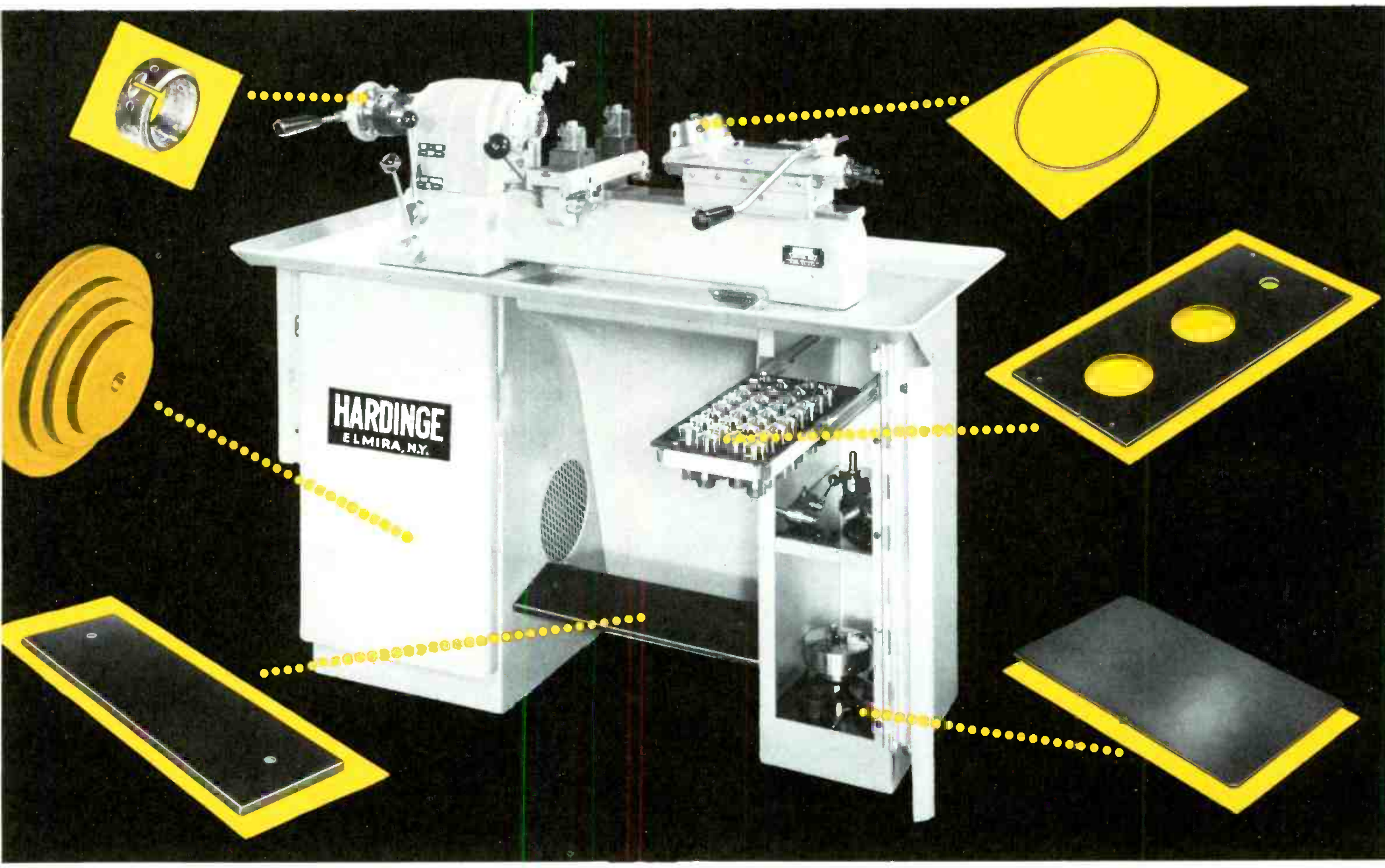
DEALERS: Equipeletro Ltda., Caixa Postal 1925 Rio de Janeiro, Brasil ★ Henry Neuman, Jr., Apartado Aereo 138, Barranquilla, Colombia

Plastics where plastics belong ***for strength, light weight; wear resistance and anti-frictional qualities.***



Most important of Synthane's advantages is its unusual combination of chemical, electrical and mechanical properties. Structural strength, moisture and corrosion resistance and light weight are only a few of these characteristics that fit Synthane for so many applications. An excellent electrical insulator, our type of laminated plastics is hard, dense, durable, quickly and economically machined . . . it's the set plastic, stable over wide variations in temperature.

Synthane's versatility is demonstrated by its use for seven different parts and purposes in this Second Operation Machine.



Photograph Courtesy of Station WNEW, N.Y.C.

The High Speed Precision Second Operation Machine (above), plays an important role in the high speed finishing of automotive accessories, aircraft fittings and fine instrument parts. In the rotating members especially, Synthane's light weight means quicker starting and stopping and higher speeds with less friction.

If these few of Synthane's many properties suggest its use in your product, let us help you with design, materials or completely fabricated parts. Write today for complete Synthane plastics catalog. 6 River Road, Oaks, Pa.

SYNTHANE ***where Synthane belongs***

DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES
FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED

Against these Common Corrosives

you're safer with Synthane

A desirable property of SYNTHANE Laminated Plastics is the ability to withstand comparatively high concentrations of many common corrosives over long periods of time. While not 100% corrosion proof, SYNTHANE is used in hundreds of applications because it often retains its shape, size, and strength for a longer time, and has a longer life per dollar invested, than other materials.

Parts fabricated from SYNTHANE resist the action of corrosive waters and atmospheres, chemical salts and solutions, gasoline and other petroleum products. In addition, SYNTHANE is light in weight, mechanically strong, an excellent electrical insulator and easy to machine.

If these properties suggest new uses for SYNTHANE let us help you before you design; we may be able to save you time, trouble and money. Send for your free copy of the SYNTHANE Plastics Catalog. Use the handy coupon.

SYNTHANE CORPORATION, 6 River Road, Oaks, Pa.

Gentlemen:

Please send me without obligation a complete catalog of SYNTHANE technical plastics.

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Company ______________________________

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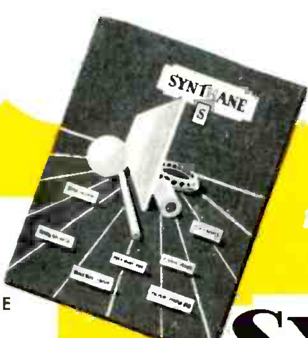
Zone ______________ *State* ______________



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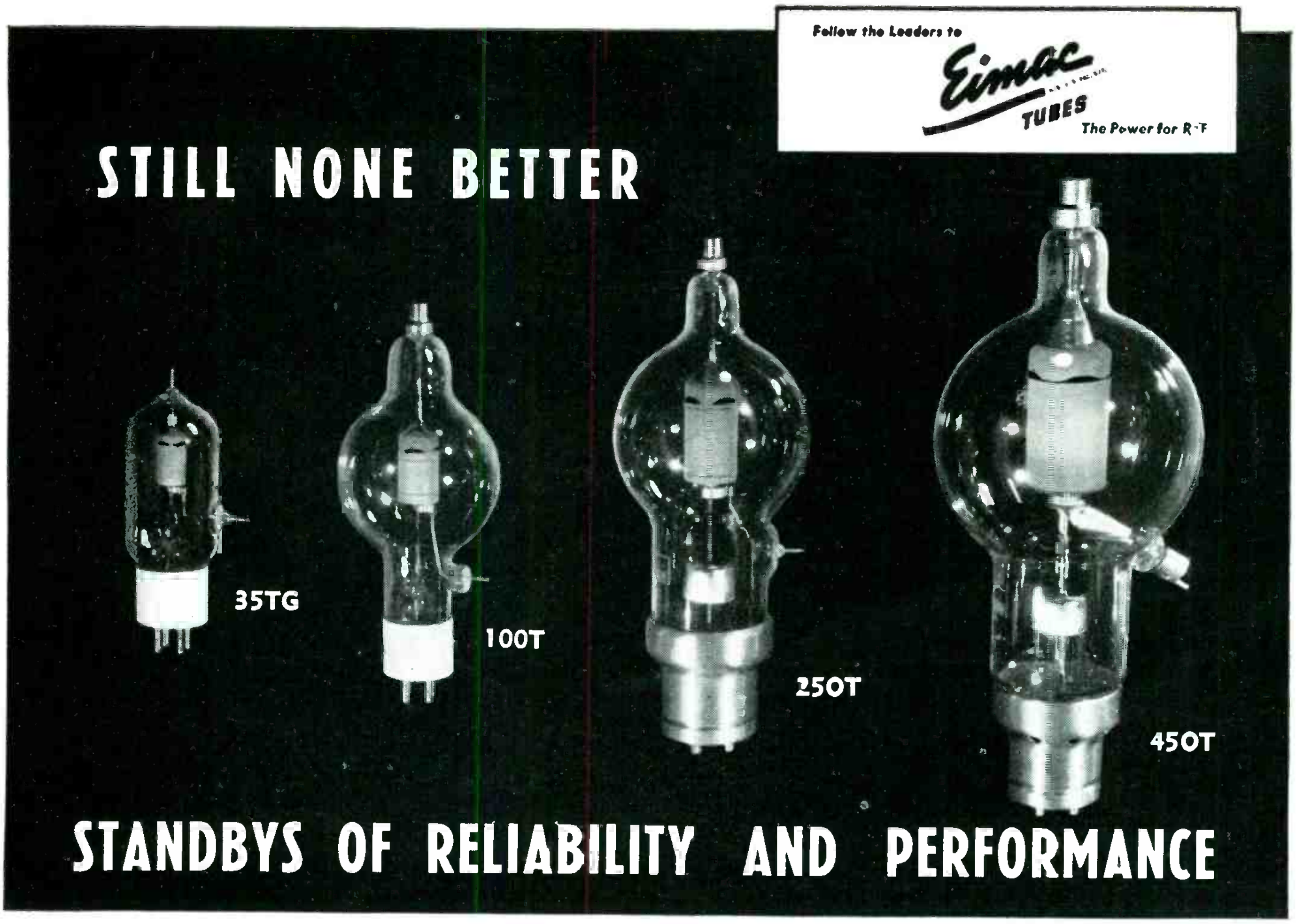

After more than a decade of proven service these Eimac triodes are still the workhorses of electronic equipment . . . from communication to industrial applications.

Recently improved by post-war developments, these tubes provide a big plus in performance, dependability and life expectancy.

As future replacements in the hundreds of thousands of applications in which they now function and as components in new equipment yet to be developed Eimac triodes are the wise buy. Remember when you specify an Eimac tube . . . you don't gamble . . . their performance is **proven** and **guaranteed,** and future procurement is assured . . . they're carried by better dealers everywhere.

Eitel-McCullough, Inc.
202 San Mateo Ave., San Bruno, California

EXPORT AGENTS: Frazar & Hansen—301 Clay St.—San Francisco, Calif.

Tube Data

ELECTRICAL CHARACTERISTICS	35TG	100TH	250TH	450TH
Filament: Thoriated Tungsten				
Voltage	5.0 volts	5.0 volts	5.0 volts	7.5 volts
Current	4.0 amperes	6.3 amperes	10.5 amperes	12.0 amperes
Amplification Factor (Average)	39	40	37	38
MAXIMUM RATINGS				
Plate Dissipation	50 watts	100 watts	250 watts	450 watts
D-C Plate Voltage	2000 volts	3000 volts	4000 volts	6000 volts
D-C Plate Current	150 ma.	225 ma.	350 ma.	600 ma.
Grid Dissipation	15 watts	20 watts	40 watts	80 watts
RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR				
Class-C Telegraphy (Key down conditions) Typical Operation—1 Tube				
D-C Plate Voltage	1500 volts	2000 volts	3000 volts	4000 volts
D-C Plate Current	125 ma.	165 ma.	333 ma.	450 ma.
D-C Grid Current	40 ma.	39 ma.	90 ma.	85 ma.
D-C Grid Voltage	—120 volts	—80 volts	—150 volts	—200 volts
Plate Power Output	141 watts	235 watts	750 watts	1350 watts
Plate Input	188 watts	335 watts	1000 watts	1800 watts
Plate Dissipation	47 watts	100 watts	250 watts	450 watts
Peak R. F. Grid Input Voltage, (approx.)	250 volts	230 volts	395 volts	410 volts
Driving Power, (approx.)	9 watts	8 watts	32 watts	35 watts

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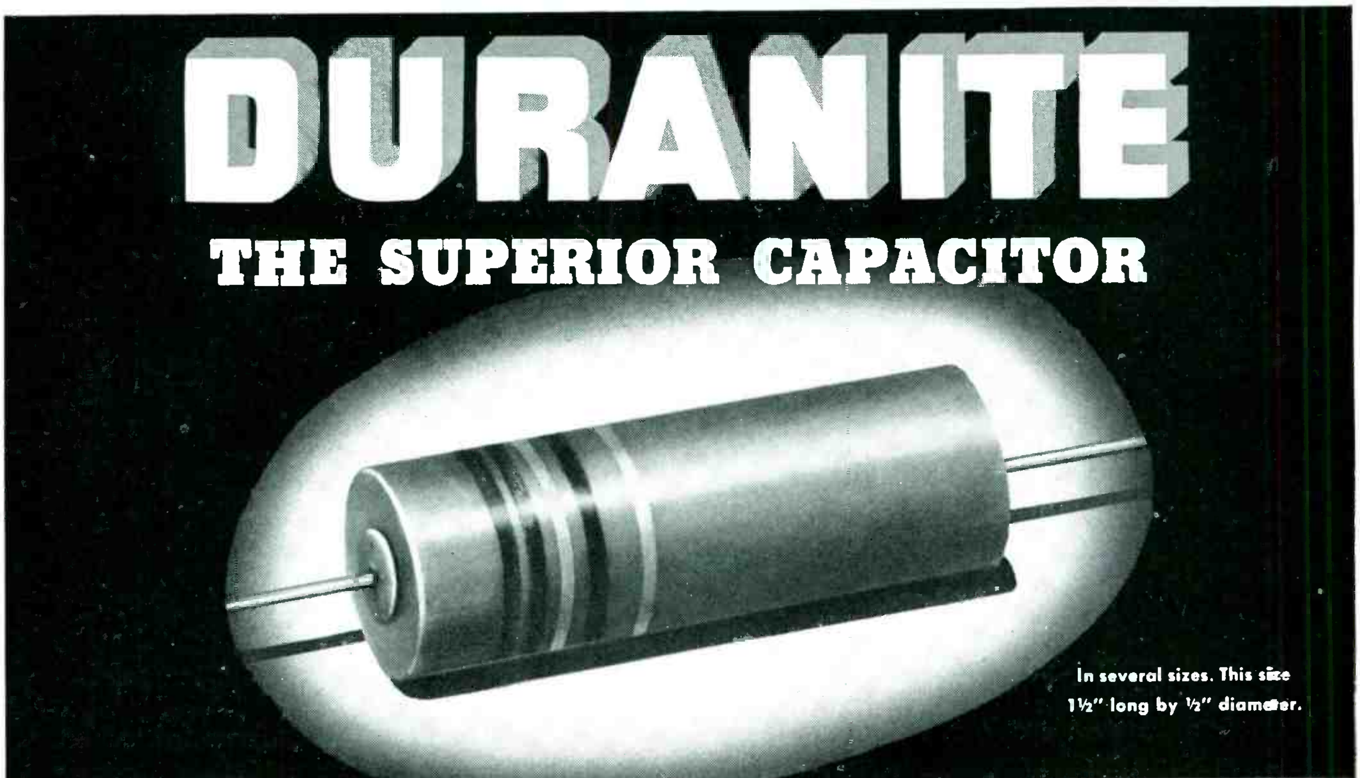
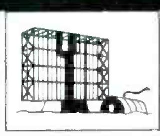
The Star Performer—

in assemblies that must stand the gaff . . . day-in-and-day-out . . . for months and years to come:

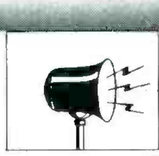


TELEVISION
Minimizes costly service calls. Shows greater profit on usual maintenance deals.



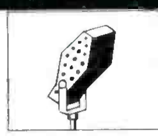
MILITARY
Roughest handling without failure. Withstands climatic conditions without flinching.

AUTO RADIO
Unaffected by temperatures from sub-zero to 212° F. Nothing to melt. Humidity-proof.

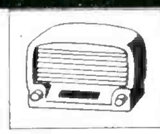


SOUND SYSTEMS
No "noise" troubles due to moisture penetration and electrical leakage. Dependable.

INSTRUMENTS
No shelf deterioration. Can be stocked well ahead of use, yet remain "fresh" and reliable.



BROADCASTING
Greatest freedom from component-breakdown troubles and "off-the-air" spells.



HOME RADIO
Smaller than usual paper capacitors. Contribute to more compact chassis. Build good will.

AIRCRAFT
Withstand wide temperature ranges, varying air pressures, vibration, shock.

● Component-breakdown *insurance. That's precisely* why assemblies that must stand up—regardless of humidity, heat, cold, mechanical or electrical abuse—are featuring Duranite capacitors.

Duranite means *different.* Not just another plastic tubular. Not just an improvement over previous paper tubulars. Duranite stands for an *entirely new* concept of the capacitor art—*new* impregnant, Aerolene, doing the work of both wax and oil; *new* casing material, Duranite, providing rock-hard, non-varying, impervious sealing throughout; *new* processing methods insuring quality with economy. You will never know how dependable radio-electronic components can be until you have tried Duranite capacitors.

• Write on your business letterhead for samples. Detailed literature on request. Let us quote on your requirements.

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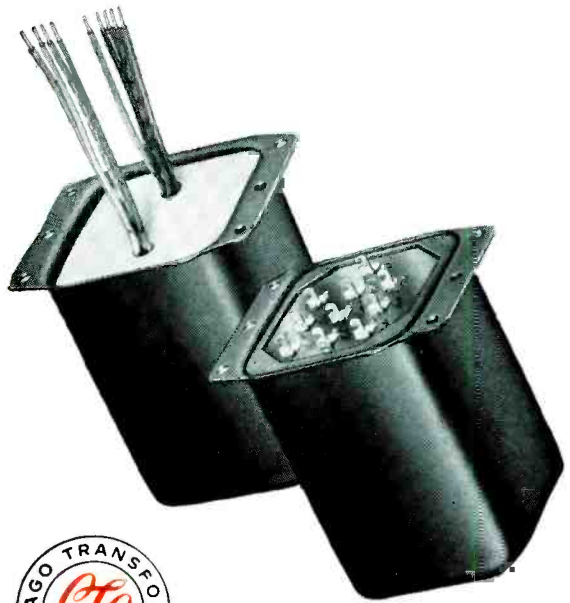
AS NEW AS THE FUTURE!

. . . the only transformer line of its kind

Advanced, practical engineering gives you **THESE OUTSTANDING FEATURES**



1 SEALED IN STEEL CONSTRUCTION

Chicago Transformer's drawn steel cases provide convenient, compact mountings; seamless steel-wall protection against atmospheric moisture and corrosion; unsurpassed strength and rigidity to withstand shock and vibration; clean, streamlined appearance that adds eye-appeal to any equipment.

2 CHOICE OF CONNECTORS

Solder lugs or wire leads. Most units are available with identical ratings in two base styles to fit your price and/or wiring preference.

3 CHARACTERISTICS KEYED TO MODERN TUBES

Voltage, current, and output ratings have been designed for one purpose only—to fill the requirements of the receiving, transmitting, and industrial electronic tubes currently most in demand. No listings wasted on obsolete circuit needs. Result—a condensed, yet comprehensive, line that's right in step with today's new circuit designs.

4 EXACT MATCHING OF REACTORS

with power transformers. Current ratings of plate and filament supply transformers and of the high voltage plate transformers are matched by choke capacities specially designed for the purpose. Mountings match, as well, for uniform, "tailored" good looks.

5 TRUE HIGH FIDELITY THROUGHOUT 3 RANGES

Frequency response within $\pm\frac{1}{2}$ db; distortion exceedingly low, even at low frequencies. These are the characteristics of the input and output transformers. Driver and modulation transformers provide response within ± 1 db. All audio units are designed for frequency ranges that fit three classes of up-to-date audio application. Full Frequency Range: 30-15,000 cycles (good up to 20,000 cycles, where required). Public Address Range: 50-10,000 cycles. Communications Range (voice): 200-3,500 cycles.

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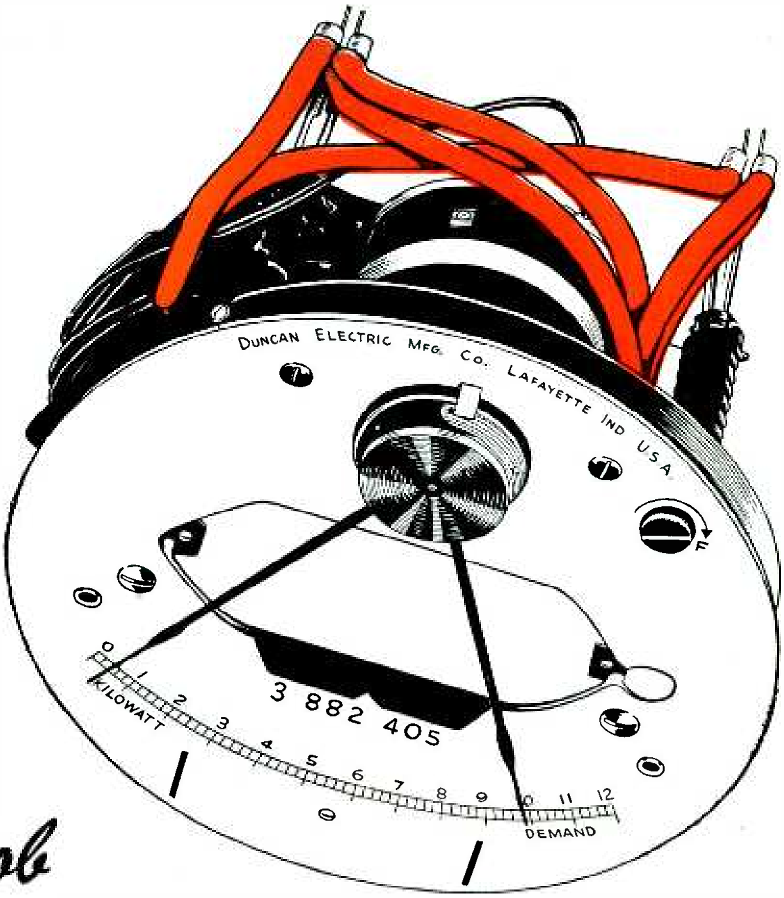


Ben-Har does the job in this Duncan Meter

The makers of Duncan Electric Meters required an insulation able to withstand soldering temperatures up to 400° F. Read what they say:

"We selected Ben-Har Special Treated Fiberglas Tubing for the heater leads in our thermal demand meters because it withstands soldering on the lead wire without discoloration. Temperatures encountered in the soldering operation are 300 to 400 degrees F. The results are completely satisfactory.

"The smooth, attractive appearance of Ben-Har and the fact that it does not unravel at the ends give extra value in our product."

See for yourself how Ben-Har speeds assembly because it cuts without fraying; prevents insulation breakdown because it combines toughness and flexibility. Knot it, twist it, pound it with a rawhide mallet—there's no loss of dielectric strength. If you require an insulation with these extra advantages, get a sample of Ben-Har without delay.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH Fiberglas* SLEEVINGS

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

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-26, Conshohocken, Pa.

I am interested in Ben-Har Special Treated Fiberglas Tubing_____for__________
(size) (product)
operating at temperatures of_____°F. at_____volts. Send samples so I can see for myself how Ben-Har will not crack in a bend, will not support combustion.

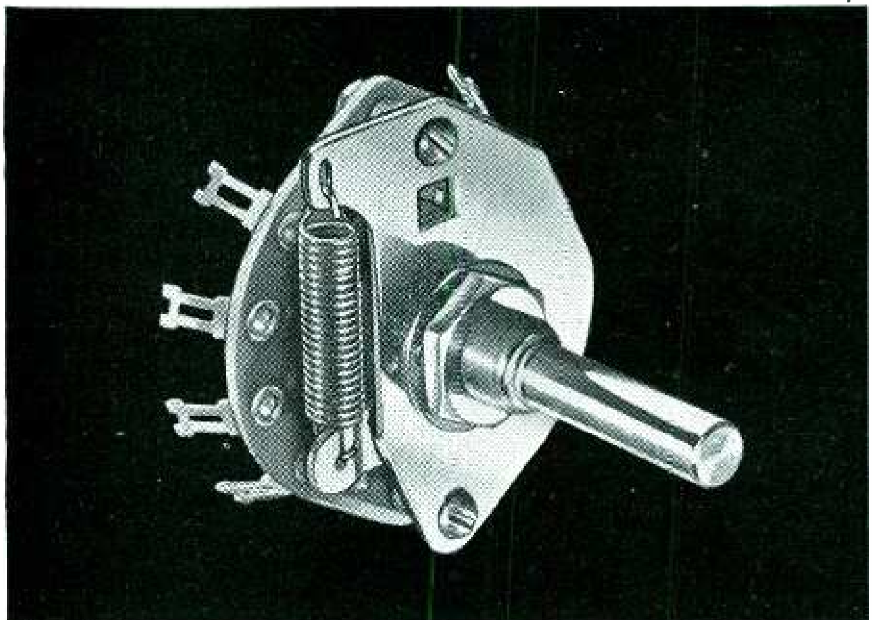
NAME ____________________ COMPANY ____________________

ADDRESS ____

Send samples, pamphlet and prices on other BH Products as follows:

- ☐ Cotton-base Sleeving and Tubing
- ☐ Non-fraying Fiberglas Sleeving

CENTRALAB ANNOUNCES A NEW AND REVOLUTIONARY ROTARY SWITCH WITH A MINIMUM LIFE TEST OF 150,000 CYCLES



New Coil Spring Design Means Smoother Action, More Positive Indexing, Longer Life

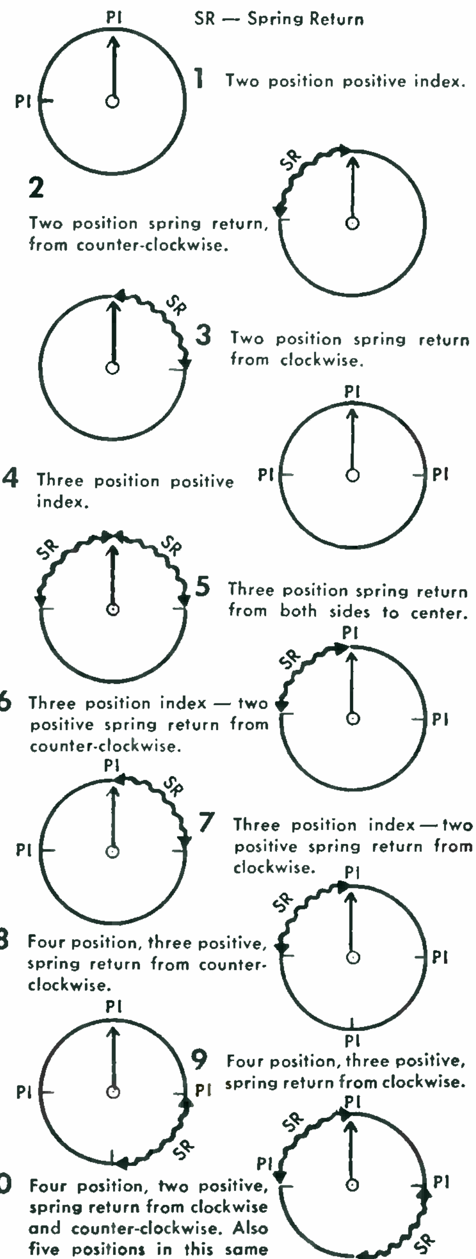
YOU ASKED for it — and here it is! Centralab's new Rotary Coil and Cam Index Switch sets an all-time record for ruggedness, long life, flexibility, installation and maintenance convenience. Check these design and operation features, and you'll see why this new switch is one of the important switch developments of the year! (1) 30° index with 11 indexing combinations permit handling up to three sections. (2) New, tested stop-strength of 48 inch pounds. (Standard RMA stop-strength — only 24 inch pounds.) (3) Guaranteed minimum life — 150,000 cycles. (RMA Standard — 10,000 cycles.) (4) Only ¼" spacing between front plate and first section gives you decreased depth behind panel. (5) Removable spring can be replaced without removing switch from chassis. Write today for complete information on this great new switch. Order Bulletin 995.

LOOK TO **Centralab** IN 1948

DIVISION OF GLOBE-UNION INC., MILWAUKEE

Four Positions Give You Wide Choice of Switching Combinations

PI — Positive Index
SR — Spring Return



1 Two position positive index.

2 Two position spring return, from counter-clockwise.

3 Two position spring return from clockwise.

4 Three position positive index.

5 Three position spring return from both sides to center.

6 Three position index — two positive spring return from counter-clockwise.

7 Three position index — two positive spring return from clockwise.

8 Four position, three positive, spring return from counter-clockwise.

9 Four position, three positive, spring return from clockwise.

10 Four position, two positive, spring return from clockwise and counter-clockwise. Also five positions in this same combination.

ELECTRONICS

Designers

a panel instrument for every need

These general-purpose panel instruments are particularly suitable for use in radio equipment and industrial applications where accuracy and quality are required and space is at a premium. Many of the instruments have been newly styled for better readability and for the smooth, modern appearance that will help give your panels a well-engineered look.

Thermocouple-type instruments, for measurements of high-frequency alternating current in radio or other electronic circuits, are available. There is also a complete line of rectifier types (a-f), for measuring alternating current or voltage at high frequencies or where the source is not sufficient to operate conventional a-c instruments. Typical applications include television transmitters, radar wave meters, testing equipment for electronic circuits. For a full story of G-E instruments, send for Bulletin GEC-227.

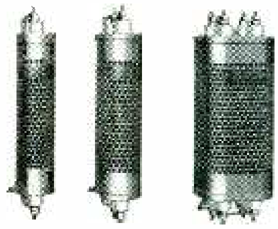
GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

CAGED FOR PROTECTION

Suitable for wall or panel mounting, these cage-type, enameled resistor units employ a strong, high-heat-resisting silicate-compound body which withstands sudden and extreme temperature changes without weakening or in any



way being injured. The resistance wire has a low temperature coefficient so that the resistance remains nearly constant as the temperature increases. Ample protection to the units is provided by the perforated metal case. Each unit is rated at 85 watts and is available in resistance values from 0.5 to 100,000 ohms; one to four units in a cage. For more complete information please contact your G-E representative.

NEED A "LOW VA" VOLTAGE STABILIZER?

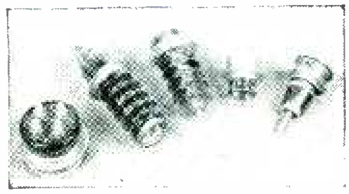
General Electric's latest additions to its line of automatic voltage stabilizers are three 115-volt, 60-cycle designs in 15-, 25-, and 50-va ratings. Check the low prices—you may now be able to utilize the advantages of an automatic voltage control for your application. The price consideration plus the low case height and small size will make these units especially applicable to radio chassis and other shallow-depth installations. Other features include totally insulated design, which is necessary where isolation is required between primary and secondary circuits, and universal lead construction which makes these units adaptable to various wiring and mounting arrangements. If you have an application problem, contact your G-E representative, or check bulletin GEA-3634B.

SOMETHING NEW IN CIRCUIT CONTROL DEVICES

Simplify your circuit designs by replacing complicated and costly components with simple, economical G-E Thermistors. These electronic semiconductors are unique in that the resistance changes rapidly with slight variations in temperature—electrical resistance decreases as temperature rises, and increases as temperature falls. G-E Thermistors give you these five advantages: flexible in application, small in size, available in various shapes, indefinitely stable, and they are economical. These new circuit devices are especially adaptable as sensitive elements in flow meters, liquid-level gages, time-delay relays, vacuum gages, switching devices, and modulating thermostatic circuits. Check coupon for technical report CDM-9.

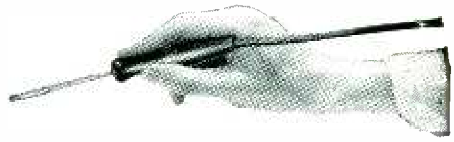
HERMETIC SEAL ELIMINATES MOISTURE PROBLEMS

The new cast-glass bushings with their sealed-in metal hardware can be readily welded, soldered, or brazed directly to the apparatus, thus eliminating gaskets and providing a better seal than ever before. The small, compact structure of the bushings often makes it possible to reduce the overall size and weight of the electric apparatus. Bushings are practically unaffected by weathering, micro-organisms, and thermal shock. Their great mechanical strength makes them well suited for use in airplanes, etc., where they are subject to continual vibration. Available in ratings up to 8.6 kv and for currents to 1200 amperes. Check bulletin GEA-5093.



MORE SOLDERING WITH LESS POWER

G.E.'s midget soldering iron can do a big job for you with only one-fourth the wattage usually used. This handy 6-volt, 25-watt iron is only 8 inches long (with ⅛″ or ¼″ tips) and weighs but 1¾ ounces. It was especially designed for close-quarter, pin-point precision soldering. The "midget" offers you all these advantages: low-cost soldering; "finger-tip" operation; quick, continuous heat; easy renewal; long life; low maintenance. The iron is a real aid in manufacturing radios, instruments, meters, electric appliances, and many other products requiring precision soldering. Irons and specially designed 115/6-volt transformers are available from stock. Check bulletin GES-3488.



GENERAL ELECTRIC COMPANY, Section A642-18
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

- ☐ GEC-227 Instruments
- ☐ GES-3488 Midget Soldering Iron
- ☐ GEA-3634B Voltage Stabilizer
- ☐ GEA-5093 Cast-Glass Bushings
- ☐ CDM-9 Thermistors

Name ....

Company ....

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NEW **INDIANA** PERMANENT MAGNET MANUAL

Not a catalog. Not a reprint. It's an up-to-date DESIGNER'S HANDBOOK!

Here's a new reference book that you'll want within arm's reach. From front to back, it contains helpful information about *permanent magnets*—what they are and how they're used. Air gaps and their functions . . . new magnet materials . . . energy curves and formulae . . . design procedure and construction data. All in simplified form for easy use.

This new 32-page manual, complete with 92 illustrations and graphs, reflects the design experience of more than 25,000 different permanent magnet applications. Prepared for you by the research and design staffs here at INDIANA—world's largest *exclusive* permanent magnet manufacturer. A request on your company letterhead will bring a copy to *your* desk. Write today—ask for free book No. 4-E-9.

THE INDIANA STEEL PRODUCTS COMPANY

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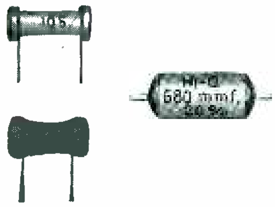
Specify HI-Q COMPONENTS

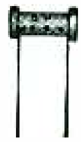


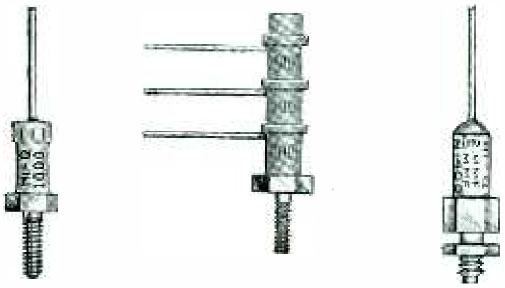
HI-Q TEMPERATURE COMPENSATING CAPACITORS

HI-Q temperature compensating capacitors are available in three types. CN & SI types with capacities from .25 mmf to 1830 mmf and CI types from .25 mmf to 595 mmf with a temperature coefficient range from P 100 to N 1400. All of these **HI-Q** styles are of tubular ceramic construction with pure silver electrodes precision coated. Style SI is insulated with a synthetic coating of Durez, style CN is of Styrene and CI is Steatite covered.

HI-Q GENERAL PURPOSE CERAMIC CAPACITORS

HI-Q General Purpose Ceramic Capacitors readily replace mica and paper condensers of corresponding values. **HI-Q** General Purpose Ceramic Capacitors should not be confused with the **HI-Q** line of close tolerance temperature compensating units. **HI-Q** General Purpose Ceramic Capacitors are available in capacity ratings from 5 mmf to 33,000 mmf.

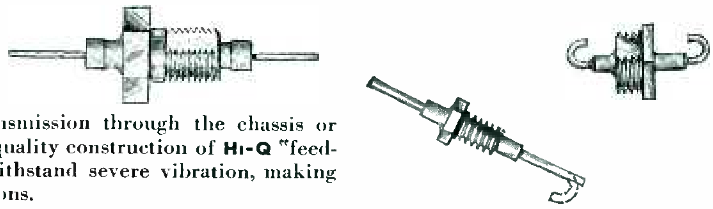




HI-Q STAND-OFF CAPACITORS

HI-Q "stand-off" capacitors are basically tubular with a screw fixture for mounting to the chassis or common ground. Close coupling and their unique construction make them an excellent choice for by-passing RF in the high frequencies. Standard capacity tolerances are ±10% and ±20% for "stand-off" capacitors and −20% and +30% for multiple tap units. Closer tolerances available wherever economical manufacturing permits. All units flash tested for 1000 volts DC with power factor under 3% maximum and insulation resistance is above 10,000 megohms. All units stamped for capacity.

HI-Q FEED-THRU CAPACITORS



HI-Q "feed-thru" capacitors provide perfect transmission through the chassis or ground, as well as by-passing to ground. The high quality construction of **HI-Q** "feed-thru" capacitors, is extremely rugged and will withstand severe vibration, making them ideal for use in mobile and aircraft applications.

HI-Q HIGH VOLTAGE CAPACITORS

HI-Q HV Capacitors are a sturdy unit, capable of withstanding high voltages, operating at extreme humidity and raised temperatures. They are a natural television component. The basic dielectric is body 20, encased in a low loss, mineral filled bakelite. Available in capacities 50 mmf to 1,000 mmf. Specify desired capacity after type HV when ordering.

HI-Q DISC CAPACITORS

HI-Q Disc Capacitors are high dielectric by-pass, blocking or coupling capacitors. Designed for application where its physical shape is more adaptable than tubular units. The placement of leads is such that close connections are easily made, thus reducing inductance to a minimum, a much desired feature in high frequency designs, such as television and FM. Available in three types: BPD-5: .005 MFD guar. min., BPD-10: .01 MFD guar. min. and BPD-1.5: .0015 MFD guar. min.

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HI-Q *Electrical Reactance Corp.*

FRANKLINVILLE, N. Y.

Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

Introducing the *New* DU MONT CATHODE-RAY OSCILLOGRAPH Type 250

FEATURING...

- ✓ a-c and d-c amplifiers
- ✓ Built-in voltage-calibrator
- ✓ Three horizontal and three vertical input choices
- ✓ Recurrent or driven sweep
- ✓ Z-axis modulation
- ✓ Provision for photography
- ✓ Brilliant traces
- ✓ Automatic beam blanking
- ✓ High-sensitivity amplifiers
- ✓ High-impedance input probe

TYPICAL APPLICATIONS REQUIRING TYPE 250...

Application No. 1: If a machine component is to be studied for its reaction under shock-load conditions, what characteristics must the oscillograph have?

Characteristics required:

1. Single sweep, variable in duration. The single sweep of the Type 250 is continuously variable from 1 second to 20 microseconds.

2. Adequate light output. The Type 5CP-A Cathode-ray Tube in the Type 250 operates at 3000 volts accelerating potential for brilliant traces.

3. High-sensitivity amplifier. Type 250 provides either d-c to 200 kc at 1 d-c volt/in. sensitivity, or 5 cps to 200 kc at .02 rms volt/in. sensitivity.

4. Automatic beam blanking, so that the fluorescent screen is excited only when signal is present on driven sweeps. This too is a feature of the new Type 250.

Application No. 2: Quantitative measurements and permanent records are to be made of the waveforms at various points in an electronic circuit.

Additional characteristics required:

1. Built-in voltage-calibrator that can be switched in before attenuator and gain control of Y-axis amplifier — a feature of the Type 250.

2. Provision for photography. Du Mont Types 271-A and 314 Oscillograph-record Cameras are designed to fit the Type 250.

3. d-c levels, a-c signals, or both, can be recorded with the new Type 250.

Other possible applications of the new Type 250 . . . Since the Type 250 was designed as a versatile general-purpose oscillograph of laboratory quality, it therefore has a wide range of applications in such fields as medicine, biology, welding, mechanics, and many other fields where a high-quality instrument for medium- and low-frequency work is required.

➧ Why not consult us now about the possibility of applying the new Type 250 to your particular problem? Detailed specifications on request.

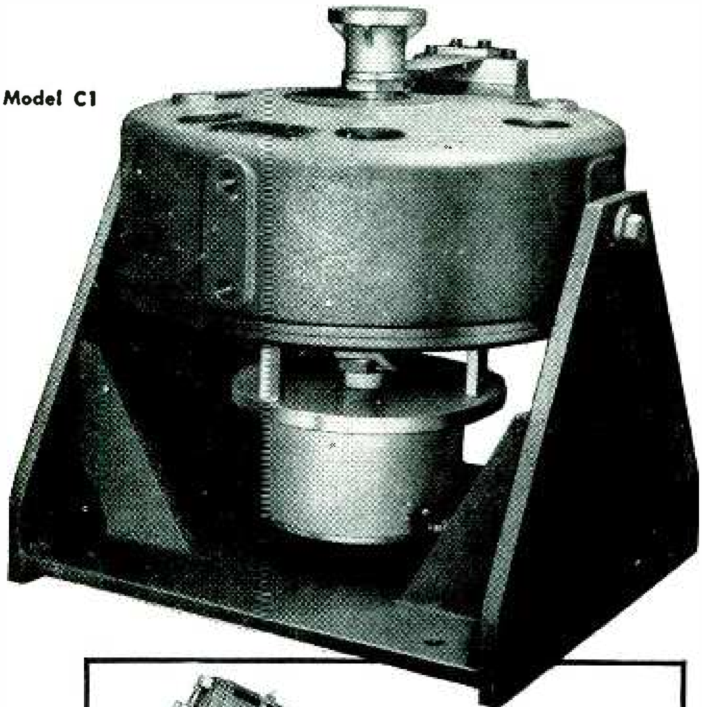
➧ PRICE: $635.00 with Type 5CP1-A tube. Cat. No. 1303-E.

DUMONT *for Oscillography*

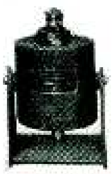
ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

Product faults found in minutes with MB vibration exciters!

Model C1



Model S3



Model SA

Note that MB Exciters can be swung to any convenient angle on the trunnion mounting.

SOME TIME AGO, a large automotive manufacturer was attempting to learn whether gas tanks could be strengthened.

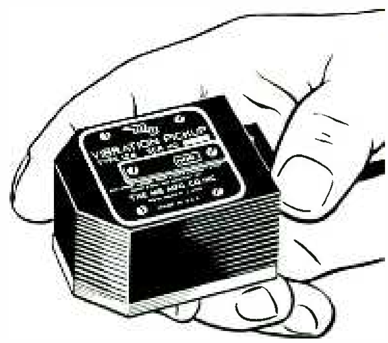
They first used a mechanical shaker on a test tank in an attempt to discover possible trouble—but days went by without signs of failure. However, when an MB Exciter was attached, the tank was vibrated to destruction in a matter of *minutes!* A repeat test produced a similar failure. Based on the *visual* evidence, *which eliminated the need for any dynamic computations*, the tank was redesigned, and it was made not only *stronger*, but materially *lighter*—cutting costs as well as saving steel.

In another case, where one manufacturer's headlight bulbs were failing in great numbers, an MB Exciter fixed the blame at once—on the filament supporting arm, which was resonating at a frequency within the operating range of the car.

These cases illustrate a technique of testing that you'll find increasingly valuable as experience shows you new applications for this product improver. MB vibration exciters are now being used by many of the country's largest companies—for fatigue testing, for location of noise sources, for determining the vibratory response of products—*and the corrective measures.*

Would you like to know more about how to use this shaker in your own work? An MB engineer will be glad to give you the benefits of our specialized vibration experience.

If your product has any vibration at all—this MB VIBRATION PICKUP will detect it!



There's no practical lower limit on the amplitude of vibration you can detect with the MB Vibration Pickup—it's that sensitive! And there's no engine it can't be used on — it's that durable under high-powered pulsations!

It is a velocity-type pickup, electrically damped, with a range of 5 to 1000 c.p.s. and usable in any position. When the pickup's electrical output is fed to standard voltage measuring equipment, it can be used to check products for operating smoothness and for quality-control.

WRITE FOR FREE BULLETINS

Ask for bulletin "Vibration Testing Technique" which describes how MB Exciters are used. And Bulletin 124A will give you more details on Pickup. Write Dep't. D5.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.

VIBRATION ISOLATOR UNITS · VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

HOW MANY OF THESE PRODUCTION PROBLEMS ARE YOURS?

RADIO INSULATION

Looking for high insulation resistance, low radio-frequency losses, high mechanical strength, resistance to extremes of temperature or humidity? Note the following properties of Taylor Grade XXXP-1.

24 hour water absorption—1/16" thickness	0.35%
Loss Factor 10^6 cycles—after 24 hours in water	0.12
Dielectric Strength—1/16" thickness (V.P.M.) short time test	690
step by step test	640
Insulation Resistance 4 days at 90% R.H., 96°F. (megohms)	500,000

ARC RESISTANCE

Have you experienced equipment breakdowns due to tracking or arcing? Taylor Vulcanized Fibre, Melamine Laminates, and combinations of Taylor Vulcanized Fibre and Phenol Fibre Grades XP-2 and C-2 have proved very satisfactory for many applications. Where high temperatures prevail, Taylor Glass Base Melamine Laminates, Grades G-5 and G-6, are particularly recommended.

HIGH STRENGTH PLUS HEAT RESISTANCE

Taylor Grade AAA asbestos mat laminate is offered for applications requiring high heat resistance plus high mechanical strength, at a low cost.

Note these properties of Grade AAA:

Tensile Strength—Lengthwise 20,000 p.s.i.
Crosswise 13,000 p.s.i.
Flexural Strength—Lengthwise 25,000 p.s.i.
Crosswise 19,000 p.s.i.
Compressive Strength — Flatwise 50,000 p.s.i.
Heat Resistance—Continuous 300°F.—Intermittent 350°F.

CORROSION RESISTANCE

For applications requiring high resistance to the chemical action of acids and alkalies, plus high mechanical strength . . . such as barrels for plating solutions . . . Taylor Grades C-5 and L-5 (fabric base Melamine Laminates) are outstanding. For moderate concentrations of acids or weak alkalies, Taylor Grades C-4 and L-1 (fabric base Phenol Laminates) are equally effective and cost less.

FORMING TO INTRICATE SHAPES

Taylor Phenolastic Fibre, Grade C-7, adapts easily to compound curves, and other intricate shaping operations . . . yet retains all the desirable physical properties of Taylor Grade C. Among these properties: high tensile, flexural, and impact strength; good resistance to wear; dimensional stability.

INSULATION OF ARMATURE SLOTS, FIELD COILS

High in dielectric strength, Taylor Insulation (Fish-paper) withstands severe bending without cracking, resists abrasion from contact with rough spots in machined slots. Available in sheets, continuous rolls, and ribbon rolls.

Regardless of the problem . . . if Laminated Plastics can help solve it, Taylor Fibre engineers are at your service. Please make your inquiry as specific as possible.

TAYLOR FIBRE COMPANY

LAMINATED PLASTICS: PHENOL FIBRE • VULCANIZED FIBRE • Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNA. **Offices in Principal Cities** **Pacific Coast Plant: LA VERNE, CAL.**

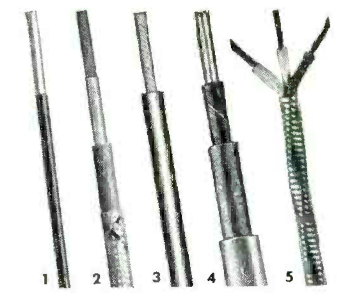
Age-Resistant Wire Keeps Your Products Young ...and Keeps Your Customers SOLD!

Let's suppose you make a television set, a range, a waffle iron or some other electrical product . . . and Mrs. Jones buys one.

Her friends like its smooth modern design, dependable operation . . . and enthuse over its novel features.

But after awhile wire-trouble rears its ugly head, performance goes haywire, again . . . and again.

Then Mrs. and Mr. Jones tell all their friends, and you can say goodby to a customer . . . *and a lot of prospects.*



1. Magnet Wire. 2. Firewall Hookup Wire. 3. Appliance Lead Wire. 4. A.V.C. Switchboard Wire. 5. Thermostat Control Wire.

TOUGH BREAK?

Maybe . . . but it could have been prevented with wire designed for years of dependable operation under even the most severe conditions. For many products that means *permanently insulated* Rockbestos wires, cables and cords.

Rockbestos wires, cables and cords—insulated with impregnated felted asbestos and other enduring materials — are the best insurance you can buy against wire-failure caused by heat, flame, fumes, grease, oil . . . and age.

WRITE TODAY — for your copy of the new No. 10-F Catalog, sectioned for easy reference to Appliance, Aircraft, Electronic, Fixture, Lighting and Magnet Wires; Apparatus Wires and Cables; Power and Control Cables.

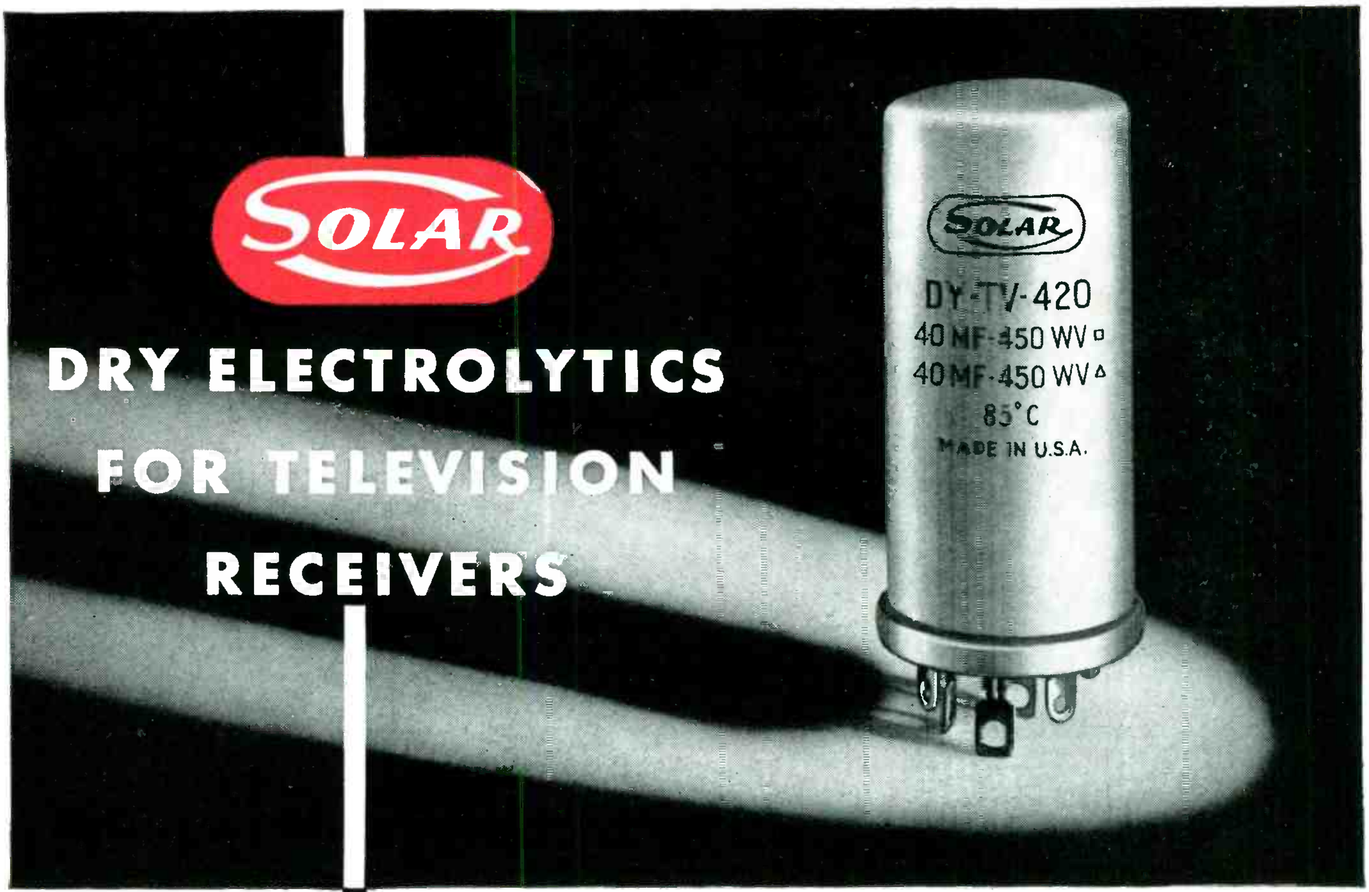
ROCKBESTOS PRODUCTS CORP.

463 NICOLL ST., NEW HAVEN 4, CONN.

New York, Cleveland, Detroit, Chicago, Pittsburgh, St. Louis, Los Angeles, Oakland, Calif.

ROCKBESTOS

THE WIRE WITH PERMANENT INSULATION



...stand up under 85°C operation

Solar's new Type DY-TV series of dry electrolytic capacitors assures dependable operation under the severest conditions found in television receivers.

An especially developed Solar processing technique makes possible small yet sturdy capacitors designed for high temperature operation with no sacrifice in long life or electrical characteristics.

Because of the remarkable film stability of Solar's DY-TV series of electrolytics, there is but an extremely small change in power factor and leakage current from room temperature to 85°C.

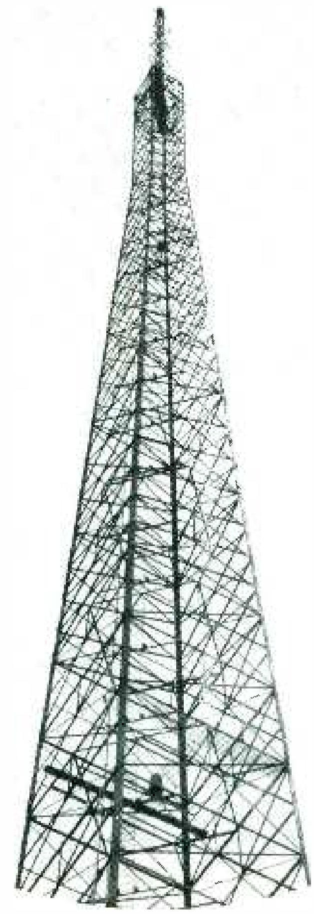
Type DY-TV capacitors, with their special film formation, do not "run away" when voltage is applied after idling under no-voltage conditions at 85°C. These characteristics are retained even after extended shelf life.

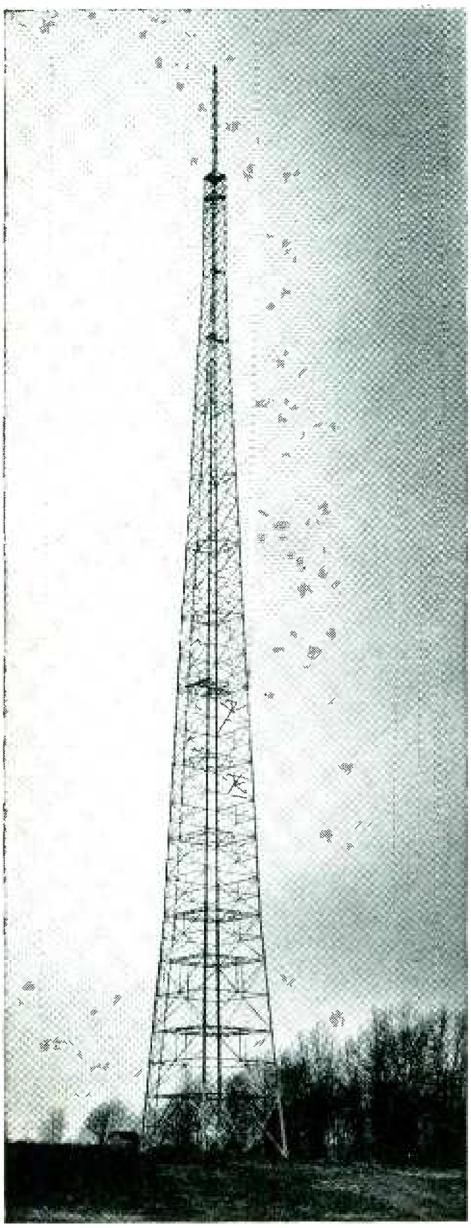
Investigate this remarkable achievement in capacitor design today! Write today for catalog.

SOLAR MANUFACTURING CORPORATION
NORTH BERGEN, NEW JERSEY

SOLAR CAPACITORS
"Quality Above All"

SOLAR





For Quality and Performance Use FREED
INSTRUMENTS and COMPONENTS

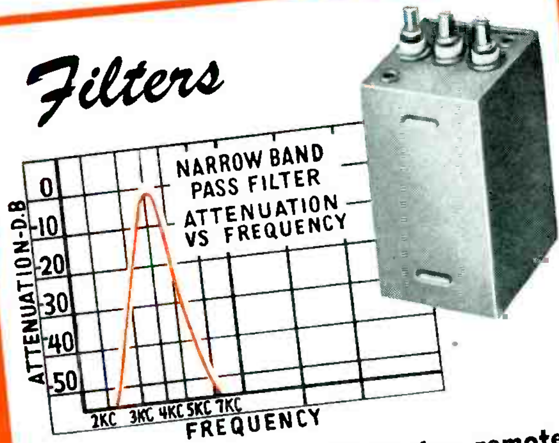
"Q" INDICATOR
NO. 1030 by FREED

Frequency range from 20 cycles to 50 kilocycles. "Q" range from .5 to 500.

"Q" of inductors can be measured with up to 50 volts across the coil.

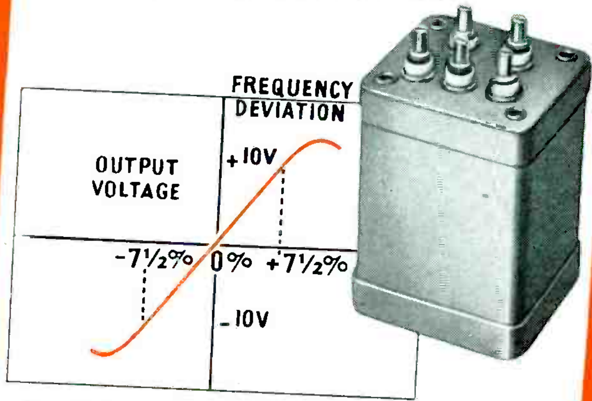
Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dialectric losses, and power factor of insulating materials.

Filters



Narrow band pass filters for remote control and telemetering applications. High pass, low pass, band pass and band elimination filters for communication and carrier systems.

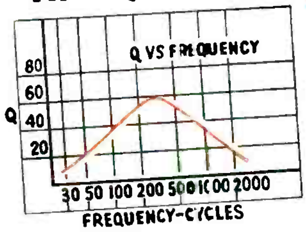
Discriminators



For telemetering and remote control applications using audio and supersonic frequency subcarriers.

Low Frequency HI "Q" COILS

#1900	100 HY
#1901	75 HY
#1902	50 HY
#1903	25 HY
#1904	10 HY
#1905	5 HY
#1906	1 HY

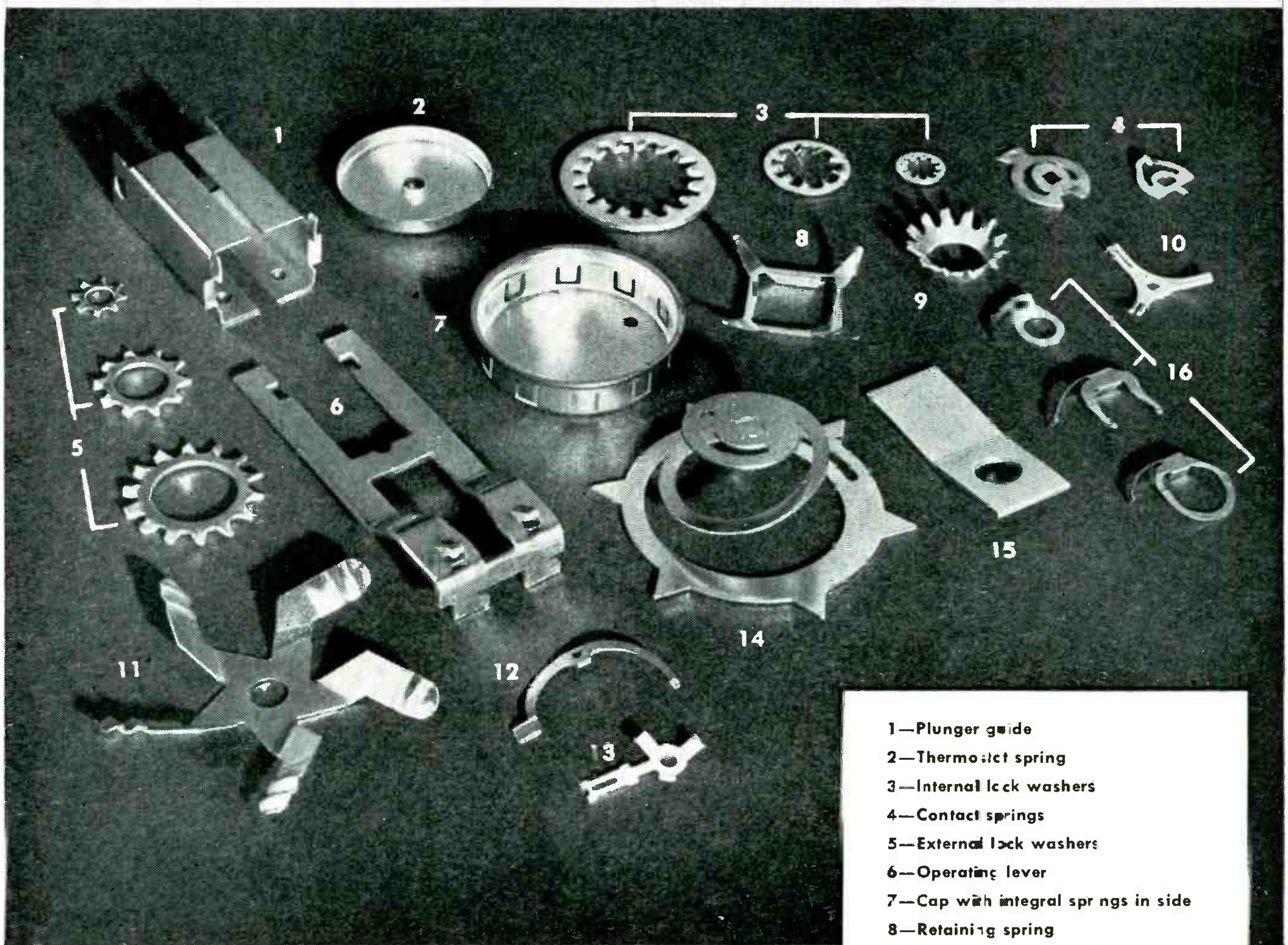


Available from stock in the indicated inductance values

FREED
TRANSFORMER CO., INC.
DEP'T SE
72 SPRING ST.
NEW YORK 12, N. Y.

REVERE PHOSPHOR BRONZES

OFFER MANY ADVANTAGES



1—Plunger guide
2—Thermostat spring
3—Internal lock washers
4—Contact springs
5—External lock washers
6—Operating lever
7—Cap with integral springs in side
8—Retaining spring
9—Countersunk external lock washer
10—Pressure spring for capacitor
11—Five-contact spring
12—Contact spring for radio part
13—Pressure spring and terminal
14—Involute spring
15—Contact point for solenoid
16—Contact springs
—made of Phosphor Bronze strip supplied by Revere

STRENGTH — Resilience — Fatigue Resistance — Corrosion Resistance—Low Coefficient of Friction—Easy Workability—are outstanding advantages of Revere Phosphor Bronzes, now available in several different alloys.

In many cases it is the ability of Phosphor Bronze to resist repeated reversals of stress that is its most valuable property. Hence its wide employment for springs, diaphragms, bellows and similar parts. In addition, its corrosion resistance in combination with high tensile properties render it invaluable in chemical, sewage disposal, refrigeration, mining, electrical and similar applications. In the form of welding rod, Phosphor Bronze has many advantages in the welding of copper, brass, steel, iron and the repair of worn or broken machine parts. Revere suggests you investigate the advantages of Revere Phosphor Bronzes in your plant or product.

REVERE

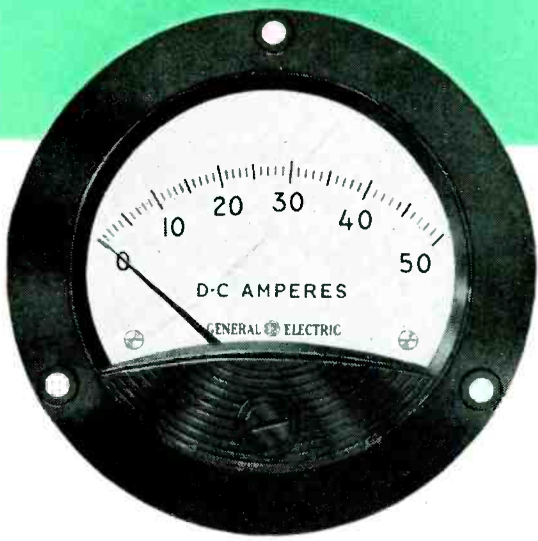
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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

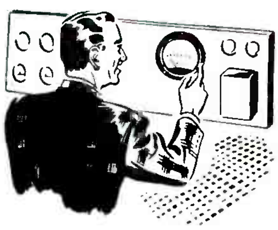
GE announces a new thin 3½" panel instrument



better readability

improved performance

New Styling For Better Readability



The New DO-71 Panel Instruments are easy to read—correctly—because they have been designed specifically for that purpose. This new design has also resulted in a smooth, modern, appearance. Take a look at these features to see how these instruments will improve the appearance of your panels and at the same time assure you of easier more accurate readings:

- **Lance type pointer for rapid, precise reading.**
- **Absence of arc lines make scale divisions stand out by themselves.**
- **Simplified scale layout for improved readability.**
- **Numerals shaped and sized for greater legibility.**

New Engineering For Improved Performance

A new high in performance and readability has been achieved by the engineering advances in the DO-71 Panel Instruments. Depth behind the panel has been reduced to less than 1 inch. The use of high-strength Alnico magnets results in high torque, good damping, and quick response. This allows the use of larger radius pivots, giving the instrument a greater sturdiness. The large clearance between stationary and moving parts helps assure years of trouble-free performance. And, all main components are rugged integral units which mean fewer repairs and less servicing.

Now is the time to improve the quality and appearance of your products by the incorporation of these new panel instruments. And, you can do it right now, because the DO-71 line is in full production for quick delivery. Contact your nearest G-E Sales Office, or *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

602-122

for mobile two-way radio

ALLIED'S NEW CO•AXIAL RELAY

NEW RELAY GUIDE
This new folder shows 24 small, compact Allied Relays with a carefully detailed table of characteristics and specifications. Write for YOUR free copy today.

The new Allied "RA" relay transfers 52 ohm antenna transmission line (type RG-8U Cable) from receiving to transmitting position. It is now used in police car radios and is highly recommended for both mobile and stationary applications.

This new relay is equipped with two Co-Axial cable fittings and one insulated transmitter line terminal. Co-Axial fittings for antenna and receiver connection are die cast as part of the metal housing. They will accommodate Signal Corps cable connector PL-259. Auxiliary double-pole, double-throw contacts can be supplied when specified.

ENGINEERING FEATURES OF THE ALLIED TYPE "RA" RELAY

Contact Rating: Antenna transfer contacts will handle a maximum of 75 watts of radio frequency up to 150 megacycles when inserted in a properly terminated 52 ohm line. Auxiliary contacts have a non-inductive rating of 1 ampere at 24 volts D.C. or 115 volts A.C.
Coil Rating: Up to 110 volts D.C. and 115 volts A.C. 60 cycles.

Coil No.	D.C. Volts	D.C. Current	D.C. Resistance
31	6.	.46	13.
34	12.	.22	54.
38	26.5	.083	320.
40	48.	.060	800.
43	110.	.026	4100.

(This table is based on an average power rating of 2.5 watts. Minimum operating voltages are 80% of voltages shown above.)

Dimensions: 2"x2⅞"x1¾". Weight: 4 oz.

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

The search is ended *Permanent Flexibility*

TURBO

In his search for the fountain of perpetual youth, Ponce de Leon would have found a perfect analogy in the improved Turbo Varnished Sleeving in which there is inherent, in its flexibility constituted insulating varnish, the antidote to hardening of the arteries.

Besides this great step of advance in the varnishing process of cotton sleeving, there are insured in this Turbo Varnish Impregnant topmost electrical insulating requisites—stabilized increased dielectric values, greater resistance to elevated temperatures, practical resistance to the effects of soldering-iron operations, acids, oils, alkalies, and electro-chemical influences.

Non-cracking, non-chipping, non-peeling regardless of angle of bend or twist. A knock-out to commonly encountered insulation failures accruing from embrittlement resulting due to the effects of aging.

Thermoplastic Insulated Wire;
Thermoplastic Insulated Sleeving;
Mica, block, films; Mica-Plate,
segments. Markers; Wire

WILLIAM BRAND & COMPANY

276 FOURTH AVENUE, NEW YORK 10, N. Y.—325 W. HURON STREET, CHICAGO 10, ILL.

The H-2-P

A NEW PURIFYING JET OIL DIFFUSION PUMP,

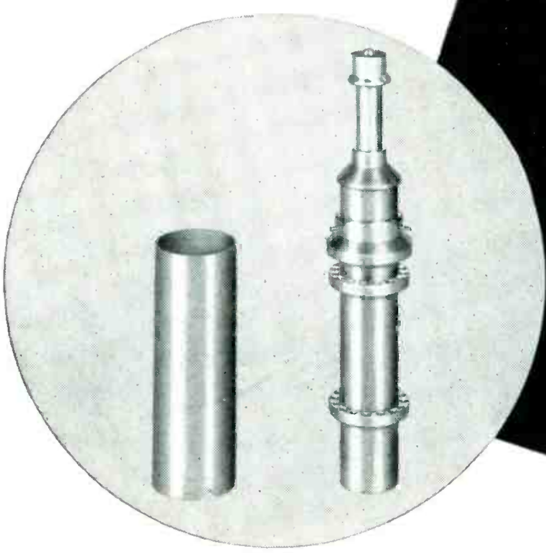
for electronic tubes and general laboratory use.

The blank-off pressure of this all-metal pump, untrapped, is 2×10^{-7} mm of Hg, measured on an ionization gauge.

The speed and forepressure characteristics of the pump are remarkable. Speeds at three significant points follow—
50 litres per second at 10^{-5} mm Hg. 60 litres per second at 10^{-4}
35 litres per second at 2×10^{-3}

High Vacuum of 2×10^{-7} *mm Hg. is maintained when the forepressure is increased to* 0.34 *mm Hg.*

This pump is designed for *unlimited continuous service.* The jet tube is so constructed that it may be completely disassembled in a few moments with an Allen wrench. This makes every part of the pump freely accessible for cleaning. The heater is buttoned to the bottom of the pump and can be replaced easily. The permanent maintenance of this pump in condition to achieve the pressures and speeds listed above is assured by its construction. Recommended particularly for the requirements of Cathode Ray Tube production. Special models for exhaust equipment will be made to customer's specifications. For further details, please write—Vacuum Engineering Division, National Research Corp., Cambridge 42, Mass.

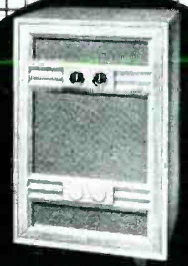


HIGH VACUUM FOR INDUSTRY

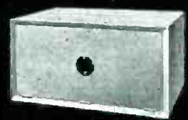
NATIONAL RESEARCH CORPORATION

Vacuum ENGINEERING DIVISION

Jensen Customode presents four basic units



Reproducer Cabinet. Bass Reflex design utilizes any 15" Jensen coaxial speaker.



Medium Utility Cabinet. For large equipment, small television sets, amplifier racks, etc.

Small Utility Cabinet. For tuner, amplifier, recorder, record changer, etc.

Record Cabinet. Holding more than 200 records.

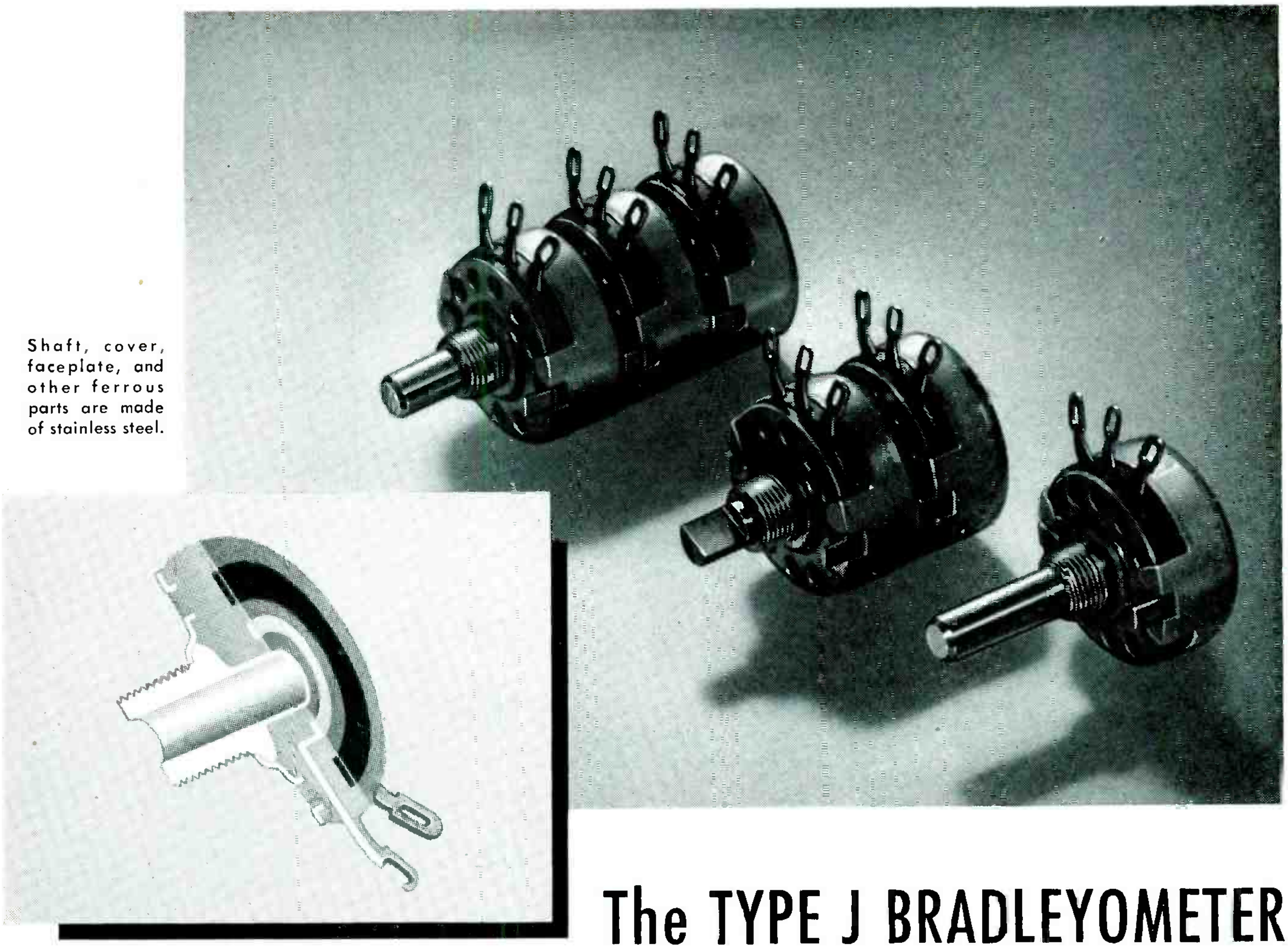
Assemble your own *Entertainment Center* with distinctive functional decorator-designed Customode

Jensen Customode was created to solve the custom-builder's problem—how to integrate fine sound reproducers and associated audio-video equipment into the space and decorative scheme of the home. Customode's universal "building block" flexibility permits stacking in literally hundreds of different combinations insuring maximum utility for all layout arrangements. In blond or Cordovan mahogany.

Write today for full information and scale cut-up illustrations

Jensen MANUFACTURING COMPANY
6601 S. Laramie Ave. Chicago 38, Illinois

Shaft, cover, faceplate, and other ferrous parts are made of stainless steel.



The TYPE J BRADLEYOMETER

. . . an adjustable resistor of superior quality for jobs that demand superlative performance

FIXED RESISTORS

Bradleyunit resistors are small in size but "tops" in load and life tests. Under continuous 100% load for 1000 hours, resistance change is less than 5%.

The leads are differentially tempered to prevent sharp bends near the resistor.

Available in ½-watt and 2-watt sizes in standard R.M.A. values from 10 ohms to 22 megohms. One-watt units are available from 2.7 ohms to 22 megohms.

Allen-Bradley fixed and adjustable radio resistors are sold exclusively to manufacturers of radio and electronic equipment.

● When you have a circuit which requires a top-quality adjustable resistor . . . rated at 2 watts with a big safety factor . . . with a solid-molded resistor element not affected by heat, cold, moisture, and age . . . then specify the Allen-Bradley Type J Bradleyometer.

The resistor element is molded as a single unit to provide any resistance-rotation curve. Insulation, terminals, faceplate, and threaded bushing are molded in one piece. There are no rivets, welded, or soldered connections.

Type J Bradleyometers are available in single-, dual-, and triple-unit constructions. Built-in line switch can also be furnished.

Send for dimension sheet and performance curves.

Allen-Bradley Co., 110 West Greenfield Avenue, Milwaukee 4, Wisconsin

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

...the way Air Conditioners do it with AMERICAN PHILLIPS SCREWS

DEFLATE COSTS . . . like one of the largest refrigerator and air conditioner manufacturers . . . who says: "Our present high production would not have been possible without American Phillips Screws . . . *which permitted the efficient use of power drivers."* And which *did not permit* any more driver skids, spoiled work, dropped screws, burred screw heads, slashed hands. Now, labor costs keep in line, as do material costs. And time savings run as much as 50%.

INFLATE SALES with the modern, inviting look of American Phillips Screws. The clean-edged, tapered recess flashes the message of quality *instantly* to the buyer's eye. And remember, too, that in any motorized merchandise, the special vibration-resistance of American Phillips Screws has a lot to do with *keeping customers sold.* Let American engineers translate these Phillips advantages *in specific terms of your own product.* Write.

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

Chicago 11: 589 E. Illinois St. *Detroit 2: 502 Stephenson Building*

AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

HERE'S

On-the-Job Proof of Instrument Performance!

where Westinghouse reliability and readability *REALLY COUNT!*

Radio stations can take no chances on "outages"—time off the air is costly. For split-second timing, efficiency, and continuity, all vital operating information must be readily available to the control engineer at a glance.

For these reasons, instruments of unfailing performance and quick readability are a *must*. The Westinghouse instruments at KMOX solved these problems. They also provide co-ordinated styling and smart appearance.

What are YOUR electrical measuring problems?

Would they include—reliable performance . . . styling . . . size . . . readability or different types of service . . . portable . . . switchboard . . . panel . . . recording?

The vast lines of Westinghouse electrical measuring instruments provide you with the answers to all of these problems. Every Westinghouse instrument is backed up by more than 60 years of skill, "know-how", and experience in every field of industry. J-40362

Westinghouse Instruments Also Provide You With

- Dials that stay white under all conditions
- Magnets that stay permanent
- Pivots with high shock capacity and low friction
- Springs that remain constant for life
- Quick delivery of more different ratings and types
- Complete Nationwide Service

Westinghouse instrument specialists are available in the field for consultation on your instrument problems. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

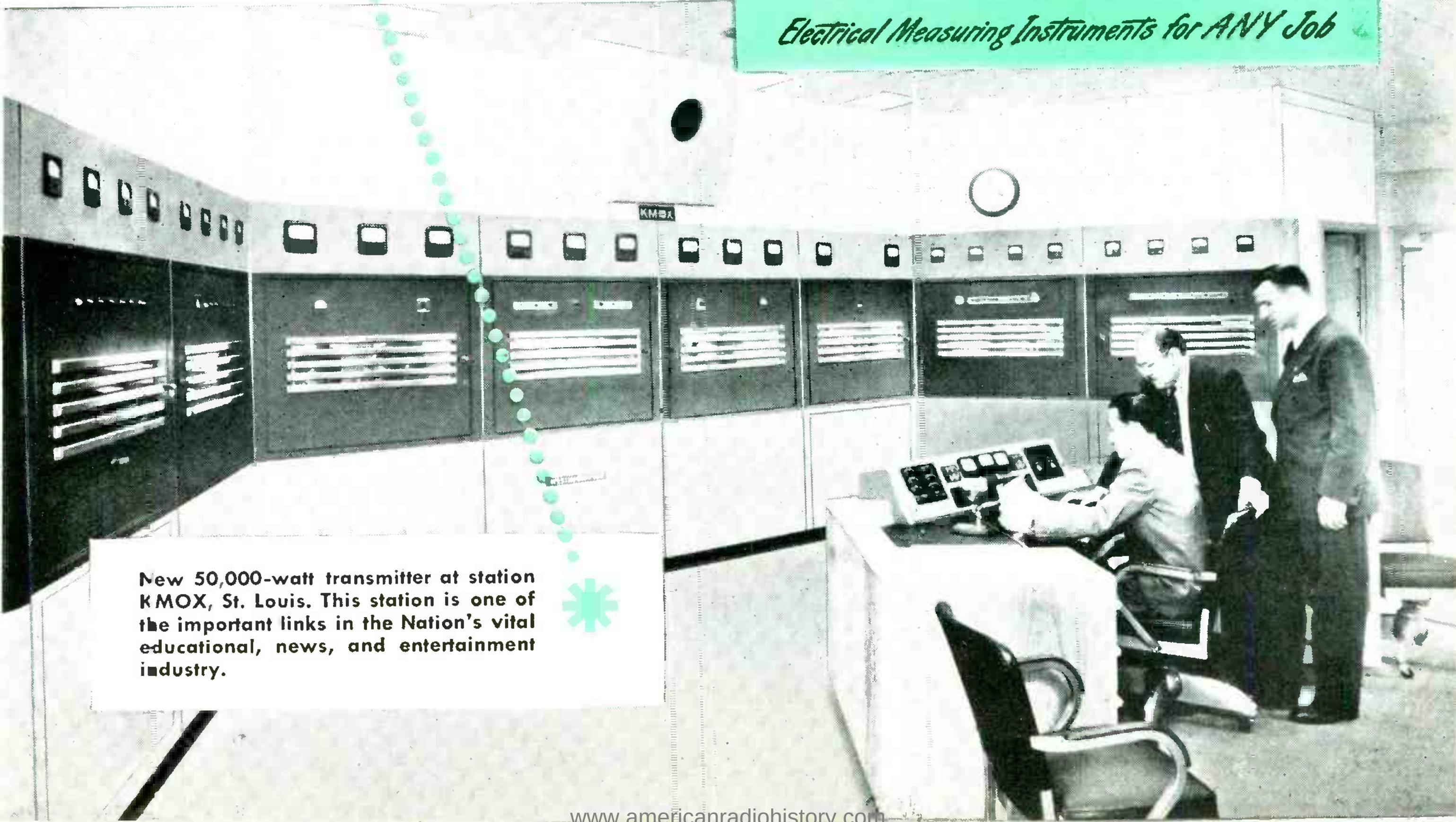
Send for Booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-3363.

YOU CAN BE SURE... IF IT'S

Westinghouse

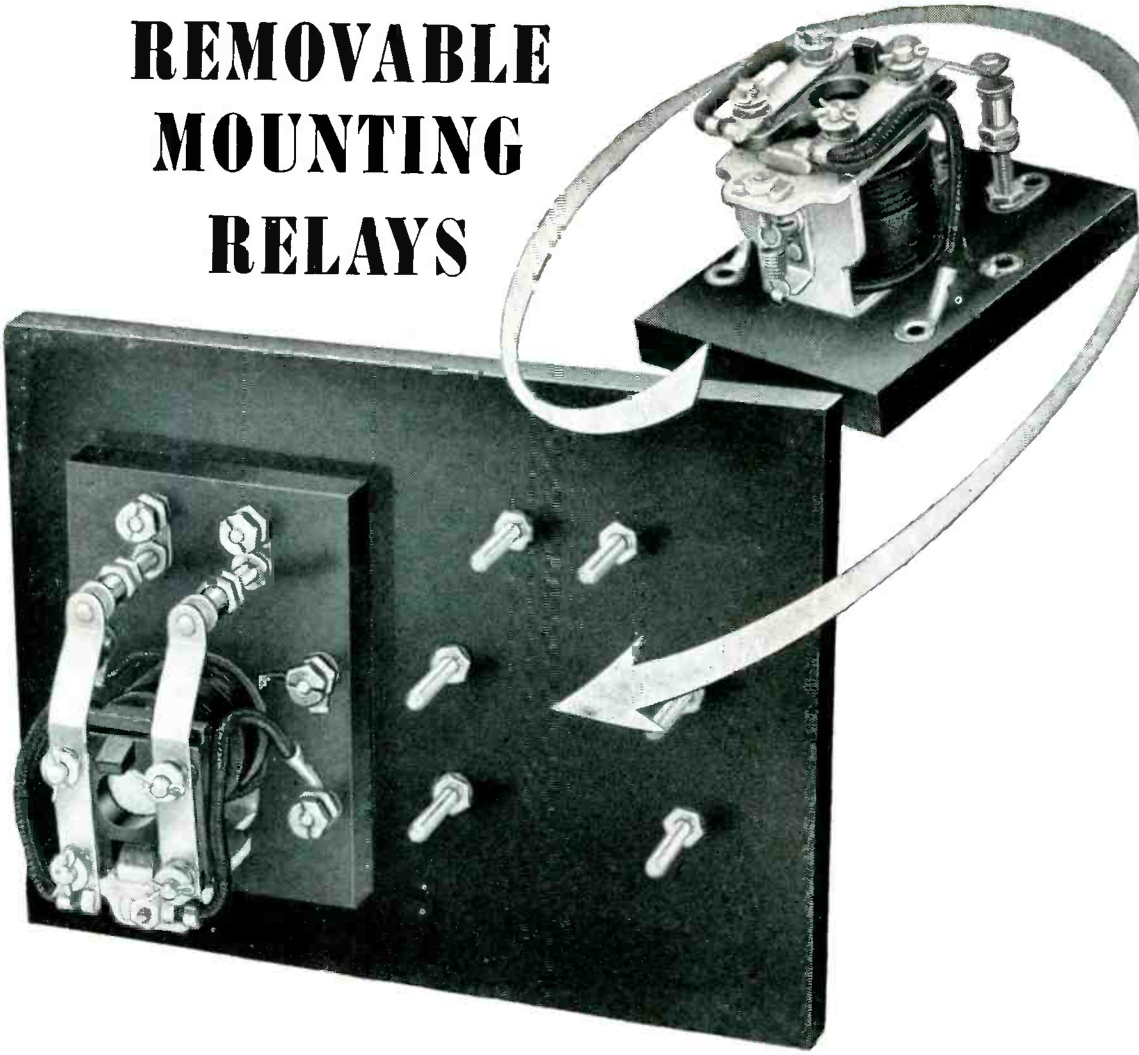
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electrical Measuring Instruments for ANY Job



New 50,000-watt transmitter at station KMOX, St. Louis. This station is one of the important links in the Nation's vital educational, news, and entertainment industry.

REMOVABLE MOUNTING RELAYS



Eyelet terminal types for stud or compression plug mounting

- Faster, easier relay installations
- All wiring confined to backs of panels
- Wiring can be completed before relays are installed
- Relays can quickly be removed or changed without disturbing wiring

Practically any Struthers-Dunn Relay having an insulated base can be supplied—AT NO EXTRA COST—with eyelet terminals for quick, easy mounting on studs extending through the panel. Wiring is confined to the rear of the panel and the studs form the electrical connection to the relays, permitting fast installation, removal or change.

In installations where the relays are small and where no vibration exists, compression-type plugs may be used instead of studs and nuts. Then the relays are simply pushed into place on the plugs.

STRUTHERS-DUNN

5,348 RELAY TYPES

STRUTHERS-DUNN, INC., 150 N. 13th STREET, PHILADELPHIA 7, PA.

GL-5663, glass
(Supersedes Type GL-546)

MIDGET THYRATRONS MEAN *ECONOMY*

. . . of space . . . of first cost . . . of power to operate

THEY'RE DOING "BIG-TIME" WORK THROUGHOUT INDUSTRY

LOTS of performance in a tiny tube envelope, so you can design for extreme *compactness* . . . that's the GL-5663 glass thyratron, only 1¼ inches in seated height! For circuits requiring a larger tube current capacity, General Electric offers the self-shielding metal GL-502-A, 2¹⁄₁₆ inches high when seated. This space-saving type will replace the twice-as-large 2050.

Applications of General Electric's capable midget thyratrons? . . . Too many to specify here; however, these uses are frequent:

- Photoelectric-relay work . . . either to actuate a mechanical relay, or to drive a larger thyratron for that purpose.
- Timing and time-delay relay operation.
- Control of small aviation and other fractional-h-p d-c motors.
- Use in welder-control panels.
- Temperature-control work—in electric thermostats, and in the chemical and other industries where vats, retorts, and furnaces need automatic regulation. Note the wide ambient-temperature range of both tubes!

Much of the popularity of G-E midget thyratrons stems from General Electric's policy of continuously improving design. For instance, the GL-5663 is a better tube than the GL-546 it supersedes, in that the new type will hold for life its initially low control-grid and shield-grid currents. This especially fits the GL-5663 for timing-circuit work, where a rise in grid current caused by electrical leakage would mean inaccuracy.

Now—while your new electronic-control circuit is in the planning stage—is the time to consider the saving in space, the economy of first cost, the low power requirements of G-E midget thyratrons! For full particulars phone your nearby G-E electronics office, or address *General Electric Company, Electronics Department, Schenectady 5, New York.*

GENERAL ELECTRIC

161-G29-8850

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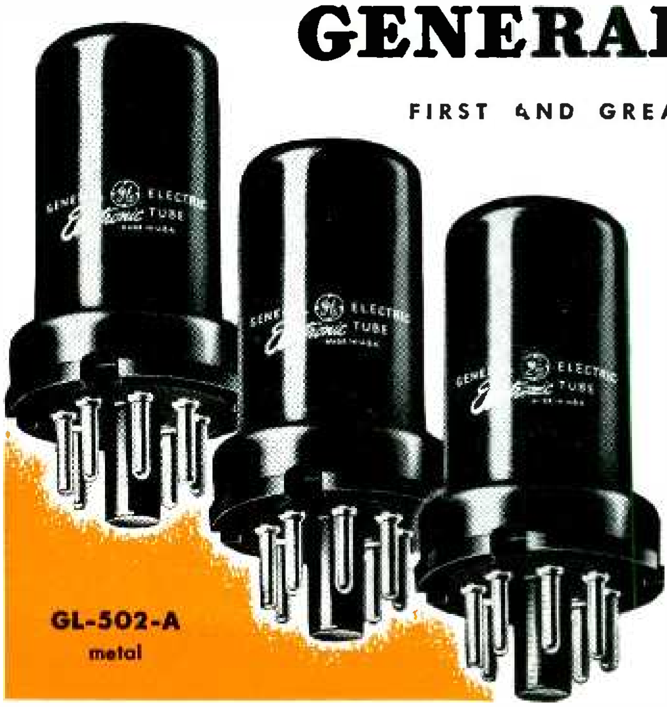


GL-502-A
metal

CHARACTERISTICS

	GL-502-A	GL-5663
Max over-all height	2⅝ inches	1½ inches
Max over-all diameter	1⁵⁄₁₆ inches	¾ inch
No. of electrodes	4	4
Cathode voltage	6.3 v	6.3 v
current, approx	0.6 amp	0.15 amp
heating time, typical	10 seconds	10 seconds
Peak voltage drop, typical	11 v	11 v
Average anode to control-grid capacitance	0.2 mmfd	0.1 mmfd
Ambient temperature limits	−55 to +90 C	−55 to +90 C

MAXIMUM RATINGS

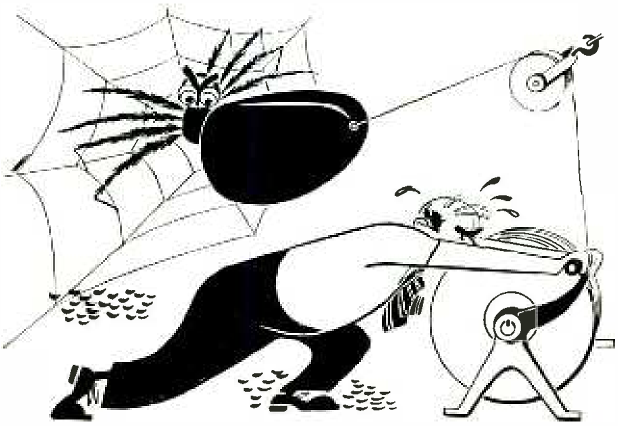
	GL-502-A	GL-5663
Peak anode voltage, inverse	1,300 v	500 v
forward	650 v	500 v
Anode current, instantaneous	1 amp	60 ma
average	100 ma	20 ma
Time of averaging anode current	30 seconds	15 seconds

What's your problem?

Fine Wire? Tungsten? Molybdenum?

Problem 1

MR. N. AMMELLING needed 339,000 feet of .001 enamelled copper wire. He called North American Philips and in good time received a one-pound package . . . his 64 miles of wire enamelled to his specifications.



Problem 2

The firm of AL LOYS & AL UMINUM were in urgent need of fine aluminum and aluminum alloy wire for a delicate production job. Fine Wire Headquarters assured them that it was no problem at all. The order was placed, the Fine Wire delivered, and it performed to the complete satisfaction of all concerned.

Problem 3

MR. MUST B. PLATED, who required metal-clad wire for a specific application, phoned Fine Wire Headquarters. We supplied the base material to provide the physical characteristics desired, and plated it to meet his exacting specifications for special surface qualities.

the answer

WHY not call Fine Wire Headquarters when you have a question about fine wire? We can't do the impossible, but we can do lots of things that can bring you the right fine wire for the job.

So—when you have a problem on Fine Wire, Tungsten or Molybdenum—wire, phone or write to North American Philips, makers of NORELCO Fine Wires, and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.

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Export Representative • Philips Export Corporation • 100 East 42nd Street, New York 17, N. Y.

RADIO NOISE-PROOFED WITH C-D QUIETONES

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Here at Cornell-Dubilier you'll find *your* answer — in a modern and complete laboratory, devoted to RADIO NOISE AND SPARK SUPPRESSION DEVICES — the industry's most experienced engineers — the thirty-seven-year C-D background, unequalled in the capacitor field. They're all at your disposal — NOW. Whether you want to Radio Noise-Proof equipment already in production — or if you're engineering a new product from the ground up — C-D Quietones will do the job efficiently and permanently. YOUR INQUIRIES ARE INVITED. Cornell-Dubilier Electric Corporation, Dept. K9, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Mass., and Providence, R. I.

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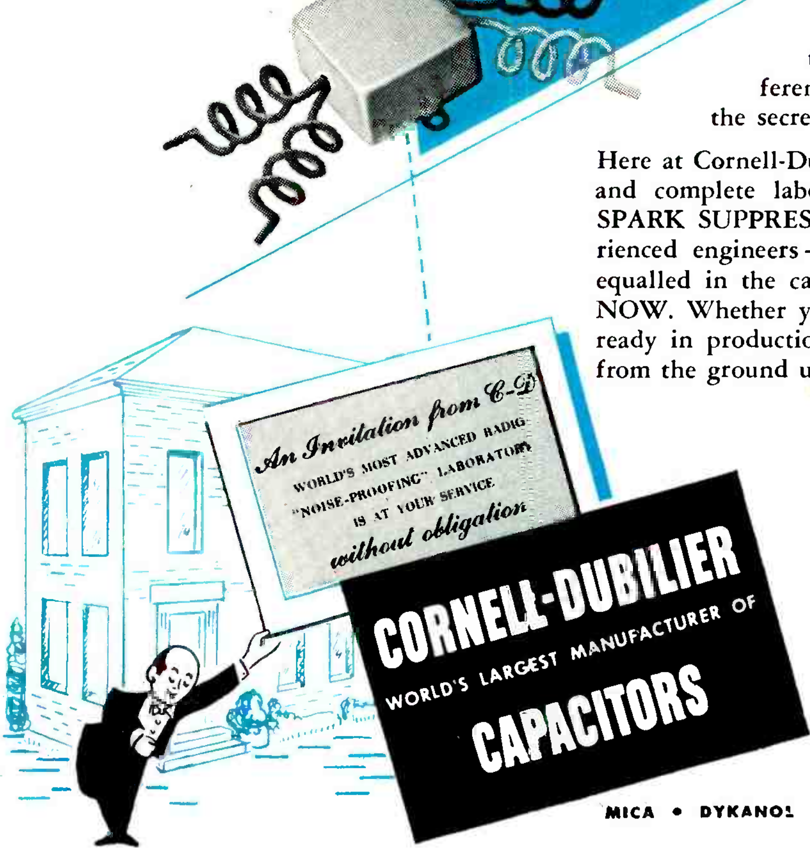

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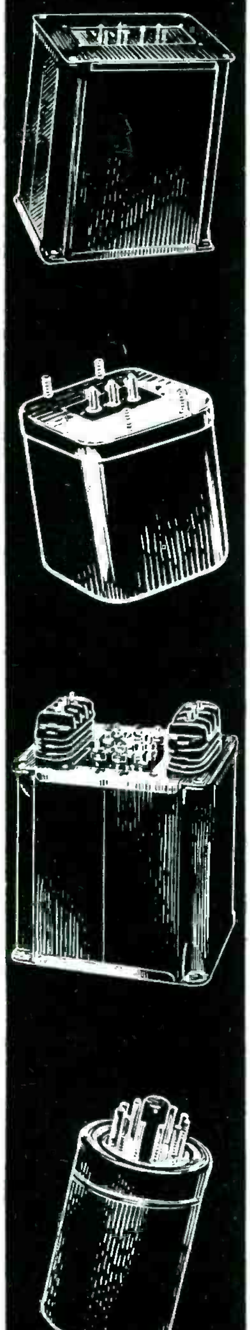
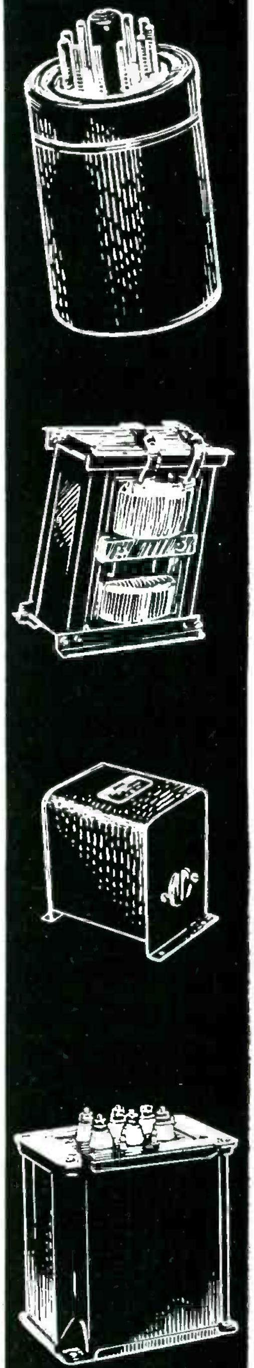
KENYON one of the oldest names in transformers, offers high quality specification transformers custom-built to your requirements. For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.



KENYON now serves many leading companies including: **Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.**

Yes, *electronification* of modern industrial machinery and methods has been achieved by KENYON'S engineered, efficient and conservatively rated transformers.

For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! *Inquire today for information about our JAN approved transformers.*



Check Your Requirements

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"A" LINE TRANSFORMERS

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- FILAMENT TRANSFORMERS
- REACTORS
- CHOKES
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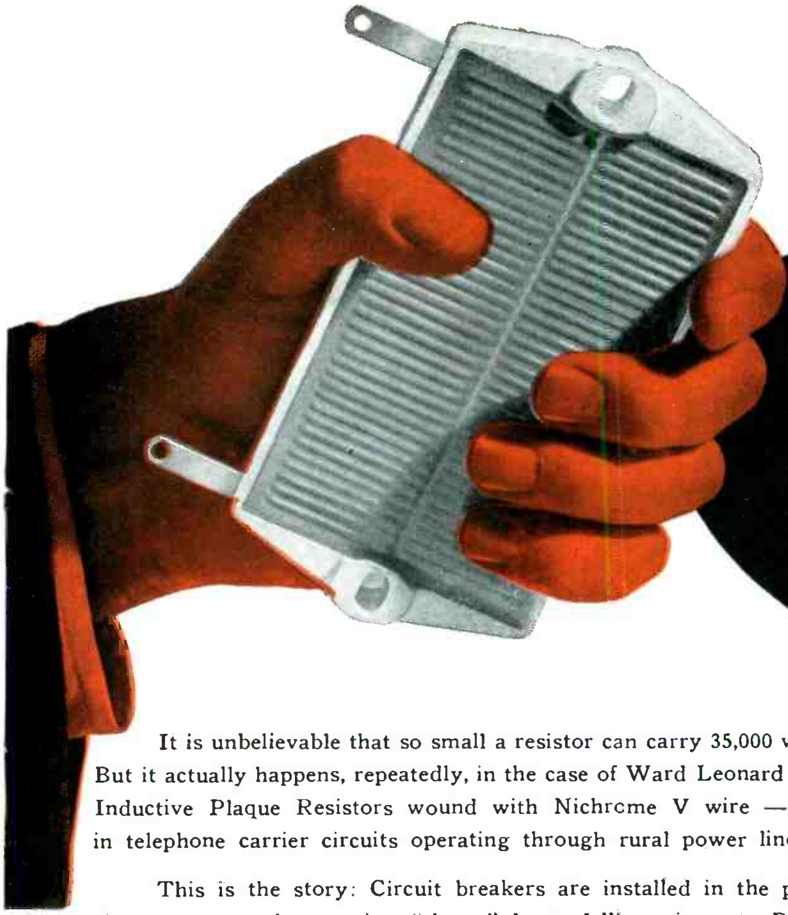


HAND-SIZE 50-OHM NICHROME* RESISTOR SHRUGS OFF 35,000-WATT WALLOPS!

It is unbelievable that so small a resistor can carry 35,000 watts! But it actually happens, repeatedly, in the case of Ward Leonard Non-Inductive Plaque Resistors wound with Nichrome V wire — used in telephone carrier circuits operating through rural power lines.

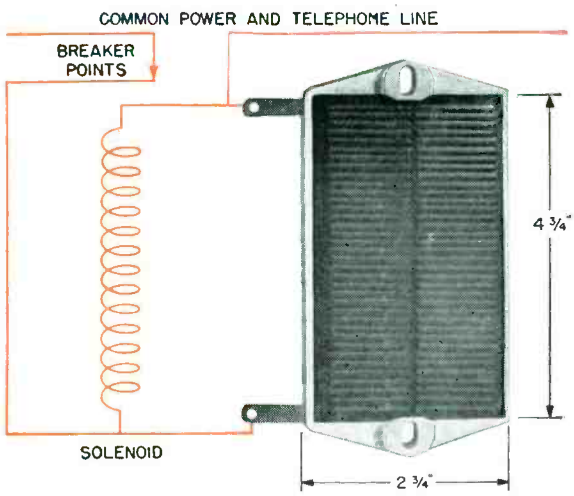
This is the story: Circuit breakers are installed in the power lines to protect them against "shorts" due to falling wires, etc. But the telephone carrier currents are blocked by the high impedance of the breaker solenoids. A low-impedance resistor is therefore used as a by-pass at each solenoid.

When a "short" occurs, the resistor must be momentarily able to carry amperage far in excess of its normal rating, because mechanical lag prevents the circuit breaker from opening instantly. The same applies when lightning, or accumulated static charges, discharge to the ground.

Tremendous strain is imposed upon the winding of the resistor during the instant of high current impact, yet it must stand up.

To assure maximum performance and dependability, Ward Leonard uses windings of Nichrome V. This superlative Driver-Harris alloy sustains tremendous voltage surges without loss of characteristics, retains its superb stability in spite of severe thermal shock, stays on the job even though "jolted" again and again . . . when a breaker makes several attempts to restore an open circuit.

Whatever *your* electrical resistance problems — conventional, unusual, or seemingly impossible of solution — send your specifications to us. We manufacture and draw the most complete line of electrical resistance alloys in the world.



Designed to protect telephone circuits that utilize power supply lines, this resistor, rated at 50 ohms and 125 watts, is intended normally to carry a current of about 1.6 amperes. In the event of short-circuit, however, it will tolerate 16 times this amperage, and a voltage increase producing 35,000 watts, for the fraction of a second required by a power line circuit breaker to operate. Cooling in less than a second after sustaining such an abnormal current impact, the winding, of .010 in. diameter Nichrome V wire, remains unimpaired. In fact, this severe treatment can be administered for 3/100ths of a second per second for 3 successive seconds without damage to the resistor. Made by Ward Leonard Electric Co., Mount Vernon, N. Y.

SPECIAL PURPOSE ALLOYS SINCE 1899 · D H · TRADE MARK REG. U. S. PAT. OFF.

Nichrome is Manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

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

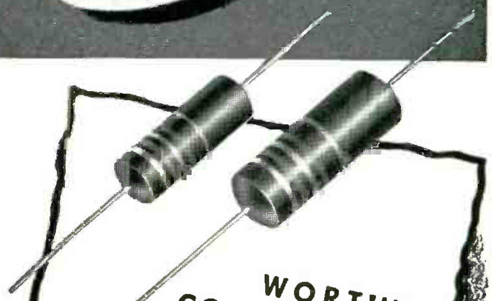
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

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

Designed for Television Use
(for operation up to 450 volts at 85° C.)

With some 7 times as many components in a television receiver as in the average radio, the possibility of service calls is greatly increased. The new SPRAGUE ELECTROLYTIC line offers the first practical solution to this problem.

Designed for dependable operation up to 450 volts at 85° C. these new units are ideally suited for television's severest electrolytic assignments. Every care has been taken to make these new capacitors the finest electrolytics available today. Stable operation is assured even after extended shelf life, because of a new processing technique developed by Sprague research and development engineers, and involving new and substantially increased manufacturing facilities. More than ever before your judgment is confirmed when you *SPECIFY SPRAGUE ELECTROLYTICS FOR TELEVISION AND ALL OTHER EXACTING ELECTROLYTIC APPLICATIONS!* Sprague Electric Company invites your inquiry concerning these new units.



WORTHY COMPANIONS FOR THE NEW ELECTROLYTICS! SPRAGUE MOLDED TUBULARS . . .

Highly heat- and moisture-resistant
Non-inflammable • Moderately priced
Conservatively rated for −40°C to +85°C operation
Small in size • Completely insulated
Mechanically rugged

Write for Engineering Bulletin No. 210A

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASS.

SPRAGUE Capacitors
* Koolohm Resistors

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

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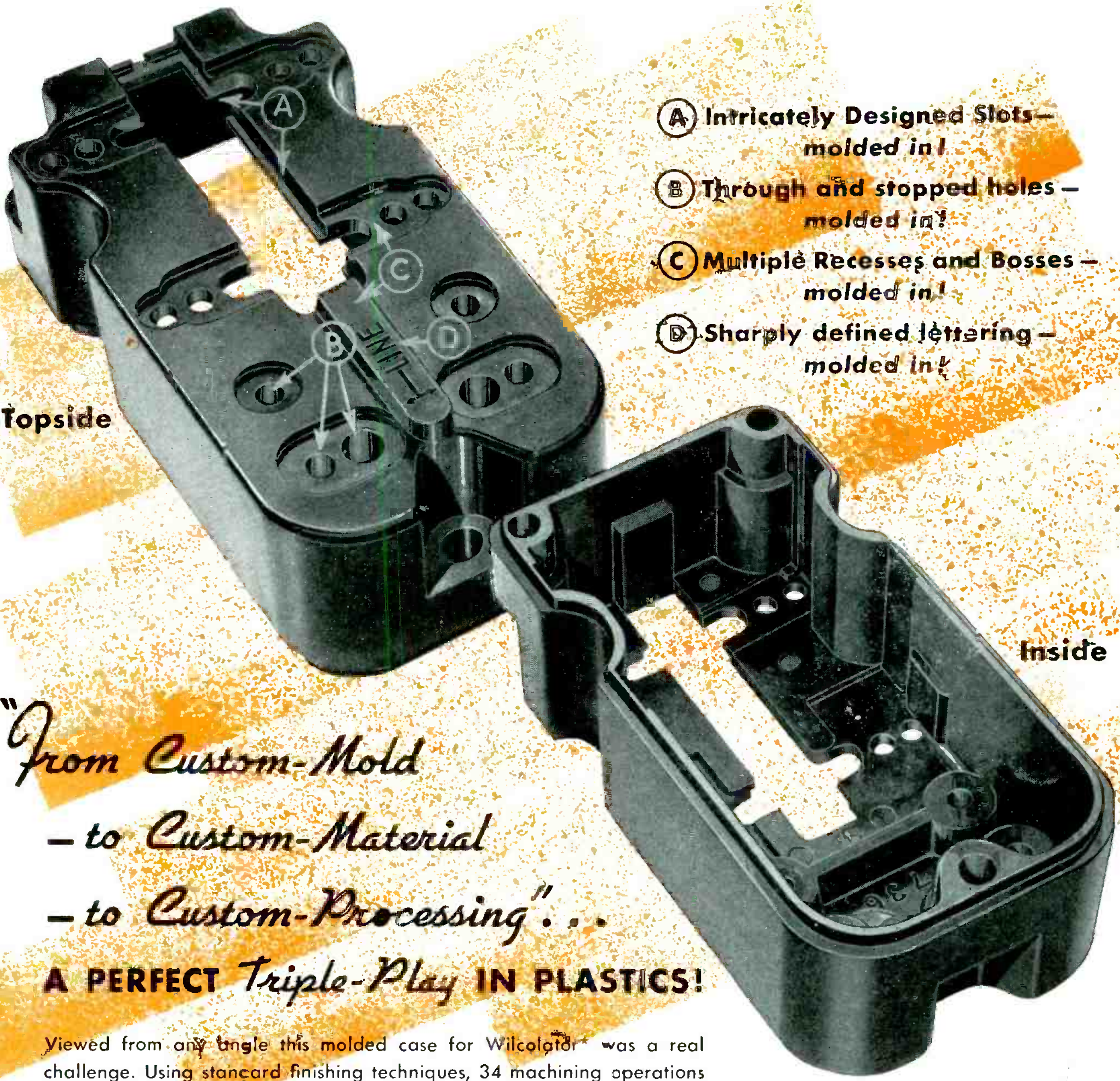

Topside

Inside

Ⓐ Intricately Designed Slots— *molded in!*

Ⓑ Through and stopped holes— *molded in!*

Ⓒ Multiple Recesses and Bosses— *molded in!*

Ⓓ Sharply defined lettering— *molded in!*

"*From Custom-Mold — to Custom-Material — to Custom-Processing*"...

A PERFECT *Triple-Play* IN PLASTICS!

Viewed from any angle this molded case for Wilcolator* was a real challenge. Using standard finishing techniques, 34 machining operations would have been needed to produce the intricate pattern of holes, recesses, slots and lettering appearing on the *topside* alone! Not less than a dozen additional operations could have provided the fillets, bosses and stepped-planes of the inside contour. Yet by careful engineering, this part was precision molded as it appears above without recourse to a single after-molding operation. To meet the demands of the application for a heat-resistant material, we used a compound, custom-formulated in our own plant. And for speed and economy in production the cases were molded *eight-at-a-time* in an enclosed type semi-automatic mold.

In baseball parlance, facing this "tough line-up" Consolidated came up with a perfect triple play . . . from Custom-Mold to Custom-Material to Custom-Processing . . . scoring complete customer satisfaction. We will be glad to meet the challenge of your next plastics application with an equal display of brilliant teamwork. Inquiries invited!

***Illustration: Housing for Type "B" Electric Switch, compression molded for the Wilcolator Company, Elizabeth, N. J.**

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MOLDED PRODUCTS *Corporation*
309 CHERRY STREET, SCRANTON 2, PA.

"Your Blueprint in Plastic"

PRODUCT DEVELOPMENT • MOLD DESIGN • MOLD CONSTRUCTION • PLUNGER MOLDING • TRANSFER MOLDING • INJECTION MOLDING • COMPRESSION MOLDING

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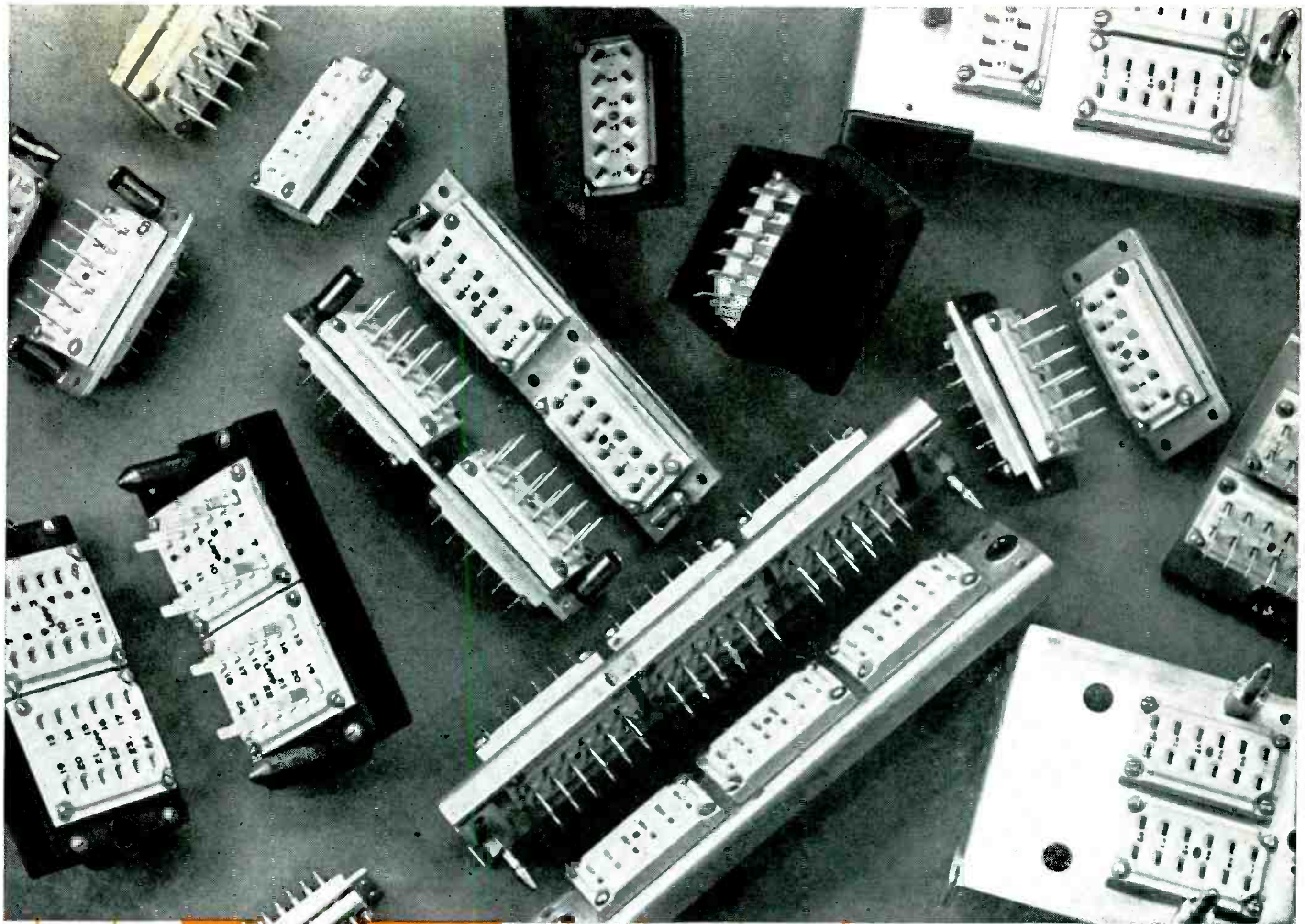
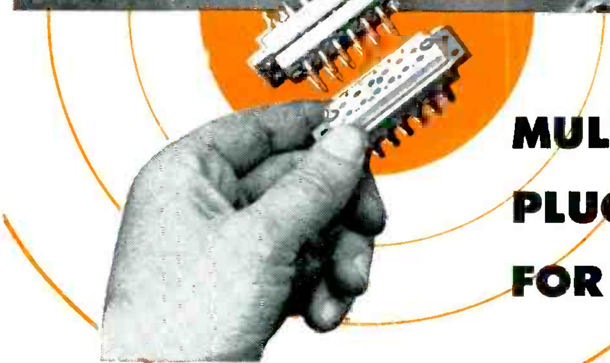




MULTIPLE-CONTACT PLUG-RECEPTACLE UNITS FOR SECTIONALIZING CIRCUITS

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

Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK

ALPETH

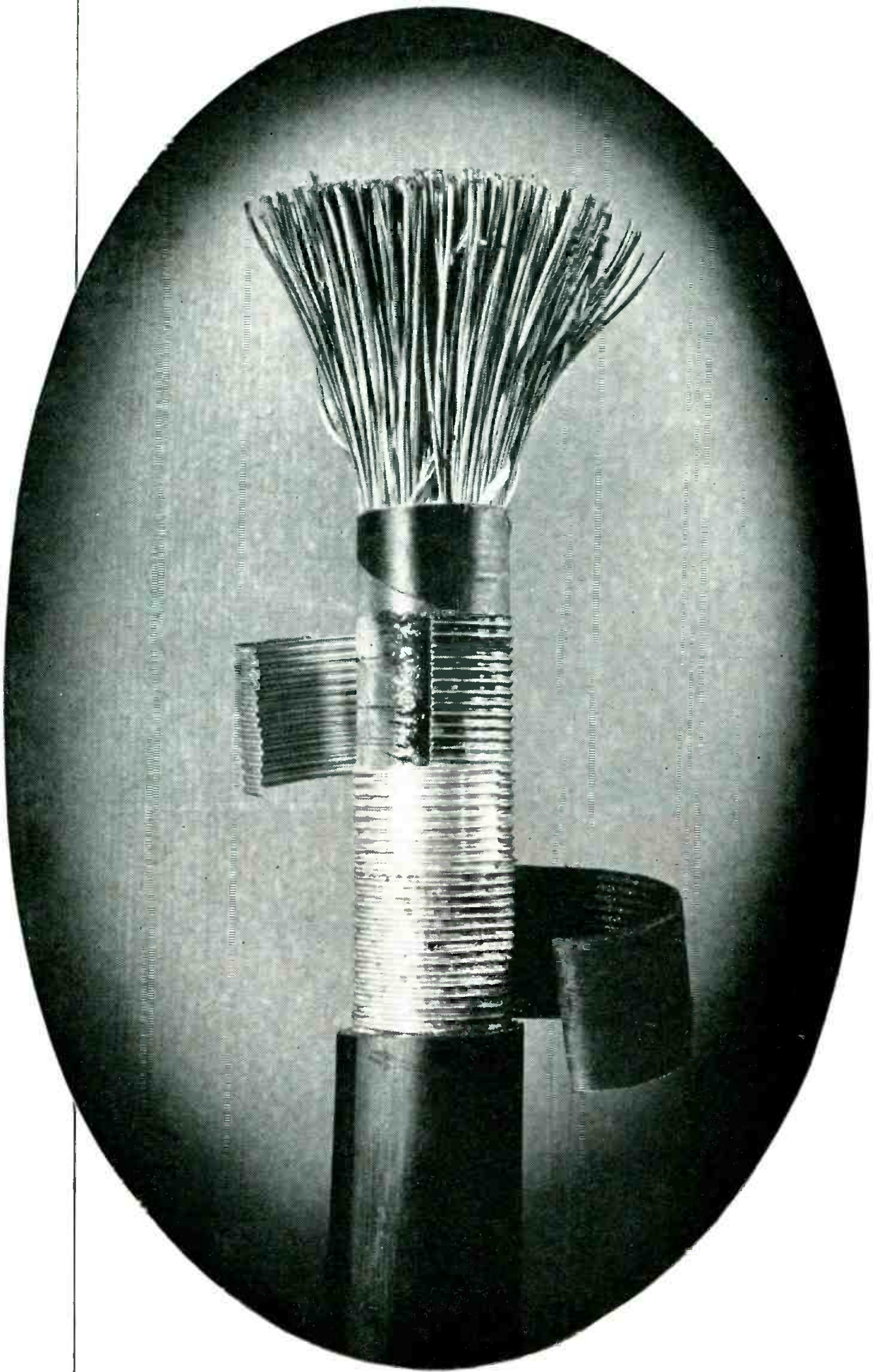
NEW WORD ON TELEPHONE CABLES

Lead makes an excellent sheath for telephone cables — sixty years and thousands of miles in service have well proven that. But lead is useful in other ways—storage batteries and paint, to name only two. So the telephone industry shares the limited available supply with other claimants.

Before the war when there was no lead shortage, Bell Laboratories engineers sought to develop better and cheaper cable sheaths. An ideal sheath is strong, flexible, moistureproof, durable and must meet specific electrical requirements. No single material had all those virtues, so thoughts turned to a composite sheath, each element of which should make a specific contribution to the whole.

Various materials and combinations were studied. Desirable combinations that satisfactorily met the laboratory tests were made up in experimental lengths, and spent the war years hung on pole lines and buried in the ground. After the war, with an unparalleled demand for cable and with lead in short supply, selection was made of a strong composite sheath of *AL*uminum and Poly*ETH*ylene. Now Western Electric is meeting a part of the Bell System's needs with *"ALPETH"* sheathed cable.

Meeting emergencies—whether they be storm, flood or shortage of materials — is a Bell System job in which the Laboratories are proud to take part.

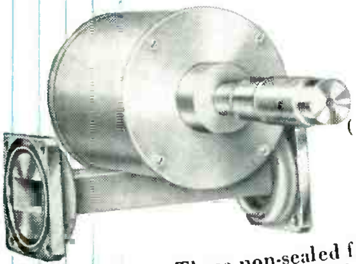


BELL TELEPHONE LABORATORIES

• *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.*

PRD

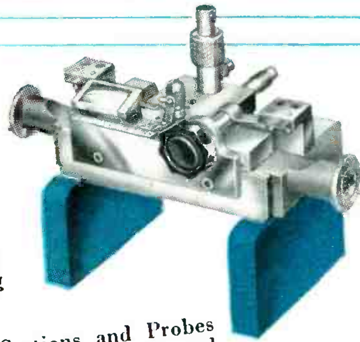
MICROWAVE MEASUREMENT COMPONENTS Now Available..



TYPE 551-A — REACTION TYPE FREQUENCY METER
(1" x ½" waveguide)

High Q cavity; Precise and permanent calibration; Extraneous mode suppression

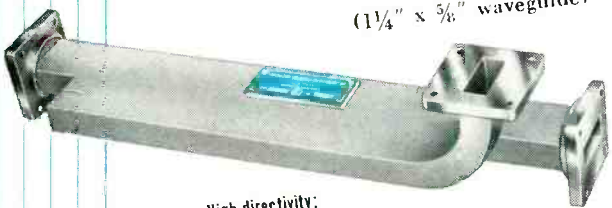
● These non-sealed frequency meters will soon be augmented by a new line of hermetically sealed, temperature compensated units covering the frequency range from 500 to 40,000 megacycles per second. Also available: frequency standarized signal sources.



TYPE 211 — PRECISION WAVEGUIDE SLOTTED SECTION
(0.420" x 0.170" I.D.)

Broadband operation; Crystal and bolometer detection; Ball bearing carriage support

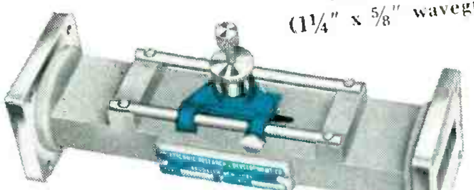
● Similar Slotted Sections and Probes in standard rectangular waveguide and coaxial line sizes make possible precise impedance measurements over the microwave spectrum from 1000 to 40,000 megacycles per second.



TYPE 401 — DIRECTIONAL COUPLER
(1¼" x ⅝" waveguide)

High directivity; Minimum frequency sensitivity; Broadband operation

● This unit is representative of a group of mono-directional broadband couplers covering in four waveguide sizes the frequency range from 4000 to 10,000 megacycles per second.

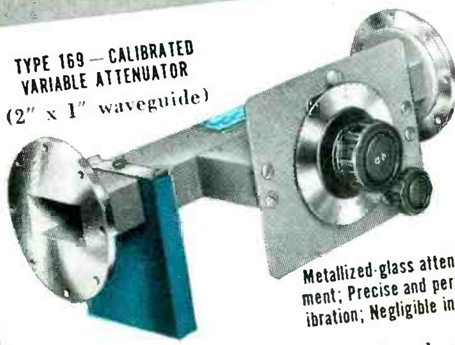


TYPE 302 — SLIDE SCREW TUNER
(1¼" x ⅝" waveguide)

Wide range impedance matching; Simplified rapid adjustment; Broadband operation

● Also available: similar units in standard waveguide sizes, fixed and tunable crystal and bolometer mounts, dielectric tuning devices for coaxial lines.

The items presented above are representative of the complete PRD line of precision microwave measurement and test equipment. These units embody basically new design principles calculated to provide the microwave research engineer with the ultimate in accuracy and reliability. A skilled staff of engineers and physicists is constantly pioneering the advance to the higher frequency regions of the microwave spectrum and stands ready to assist in the solution of your microwave problems. An illustrated catalog may be obtained by writing on company letterhead to Dept. E-6.



TYPE 169 — CALIBRATED VARIABLE ATTENUATOR
(2" x 1" waveguide)

Metallized-glass attenuating element; Precise and permanent calibration; Negligible insertion loss

● A full complement of fixed and variable attenuators and broadband terminations in standard waveguide sizes provides coverage for the frequency range from 2600 to 40,000 megacycles per second. Fixed pads and terminations are available for standard coaxial transmission lines.

PRD Polytechnic RESEARCH & DEVELOPMENT COMPANY, Inc. 66 COURT ST., BROOKLYN 2, N.Y.

BUSINESS BRIEFS

By W. W. MacDONALD

Buttons, badges and keep-out signs are more in evidence in electronic equipment plants turning out military gear than at any time since the war.

Heater-Type subminiature tubes are not far away; at least one manufacturer is known to have them pretty well along in the design stage. Available with 6.3-volt indirectly heated cathodes, such tubes should be useful for voltage amplification in equipment which must be compact, particularly in multistage devices.

Mail-Order Houses miss few bets. They are already advertising, in direct-mail flyers, dual-speed turntables operating at both 33⅓ and 78 rpm, hoping to cash in if and when Columbia's new Microgroove transcriptions for the home (see p 86) become popular.

Business Failures among radio equipment manufacturers in the fiscal year 1947–1948 totalled 29, according to RMA, approximately half having been in business 5 years or less. Of the 29, 10 made radio sets, 5 communications equipment, 3 test equipment, 2 television receivers, 2 recorders, 2 radio parts, 2 phonographs, 1 sound equipment, 1 motors, and 1 projection equipment.

Causes contributing to failure included extensive inventories, excessive plant facilities, inadequate distribution, poor merchandise and inadequate production experience.

Immense Investment required for production of television receivers will change the character of the radio manufacturing industry, according to Zenith's H. C. Bonfig. The trend, he thinks, is toward a smaller number of larger manufacturers.

Stratovision demonstration out in Ohio brought one fact forcefully to our attention: there are hundreds of people in the hinterlands, away from reliable service, with their antennas hanging out in the hope that they will some night pick up a good stray picture. While the program was in progress we heard several telephone calls come in reporting reception and asking when the Westinghouse-Martin B-29 would be up again. And since then we have seen many similar letters.

Klieg Lights needed by movie people more than by television men were responsible for excessive heat generated in Philadelphia at the recent political conventions and reported by many newspaper commentators. Most television pickup cameras used image or studio orthicons, and these tubes do a pretty good job even by the light of a kerosene lamp.

Acrylic Magnifiers (plastic shells filled with a mineral oil like Nujol) are being manufactured for television in substantial quantities, according to Hiram McCann of *Modern Plastics*, but the average price at the fabrication shop has gone from \$30 to \$12, with some production reported at \$8.

Sailboat Men are rarely surprised about anything the powerboat boys do, but we are forced to take note of the fact that out on Long Island Sound quite a few floating palaces are installing f-m sets, complete with elaborate folded dipoles mounted on cabin tops amid other chromium-plated gizmos. Just this last weekend we spotted two seagoing hotels sporting television arrays.

Definition: Radio is television without the pictures.

Britain's Exports are up; twice in the first quarter of this year radio equipment shipments exceeded the £1,000,000 monthly objective. High on the list of reasons is the fact that models are designed with particular overseas markets in mind; bandspread on shortwaves, high sensitivity, freedom from drift and tropicalization are contributing factors.

Australia had 1,737,152 licensed radio receivers on April 30, 1948, an increase of 607,366 since 1939. The ratio of licenses to population was 23.38 percent. More than 125,000 listeners had licenses for more than one set.

College Courses in engineering fully accredited by the Engineers Council for Professional Development in that organization's fifteenth annual report dated September 30, 1947 and released July 1, 1948, total 509, broken down as follows:

Elect. and Comm.	109
Civil	108
Mechanical	102
Chemical	44
Mining	28
Metallurgical	27
Industrial	21
Aeronautical	14
Architectural	14
Petroleum	12
Ceramic	9
General	8
Sanitary	5
Agricultural	3
Naval	3
Electrochemical	2

More men are still trying to break into our field than any other.

Fiscal Year Reports: *Zenith*, $79,406,133 worth of business in the period ending April 30, 1948, up 38 percent over the previous 12 months.

Magnavox, $27,434,019 for the period ending February 29, 1948, as against $24,013,812 in the preceding fiscal year.

Judging a contest for Hytron, we note with interest that a large number of radio servicemen have designed their own trick tube-pullers. Manufacturers, it seems, have mastered the technique of designing tubes that will stay in sockets. Someday they may find it desirable to equip them with wings, or lugs, or handlebars that permit the repairmen to get the things *out*.

Rose Buss Korsgren, formerly with Hallicrafters and now with Alaska Radio Supply, writing from Anchorage, says it seems to her that nearly everyone she's met is either a radio man or connected with the airlines in some way. That would be natural in a territory in which both communications and transportation involve unusual terrain difficulties.

There are 458 amateurs to 80,000 people in Alaska. In the States there are about 6 hams to that many.

It's A Long Way back, but people around New York are still talking about how perfectly f-m performed when local electrical storms blotted out regular broadcasting the night of the Louis-Walcott fight. This sort of experience does more to sell the new service than any amount of industry propaganda.

Coming Attractions: As promised, we're presenting quite a few articles about computers in the feature pages of ELECTRONICS this year. The latest appears on page 110 of this issue.

Transductors are also considered of sufficient importance to keep the editorial heat on. See page 88 There will be more.

The ultimate importance of superregeneration is a matter of speculation, but it is about time somebody separated fact from fiction. Two articles in this issue, on pages 96 and 99, do it.

Speaking of hard, cold facts, we hope to have some in print soon concerning Stratovision.

Wondering what goes on at G-E's ambitiously named "Electronics Park"? Read about it next month in these columns and you'll know more about the setup than many of the people who work in Syracuse.

Story Of The Month: It's late for this one, but only now can it be told.

During the war, a friend of ours who silk-screens panels received an order for a few and started to turn them out on AAA1 priority. Then he learned they were part of a classified item and that a 24-hour guard would be required at the plant.

Several months went by, with production hanging fire, while our friend explained that the cost of the guard would exceed the price of the panels. Finally, the go-ahead was given when government officials reluctantly agreed there was scarcely need for security measures in connection with a panel lettered, simply . . . .*Power. On-Off.*

Mallory Presents the First

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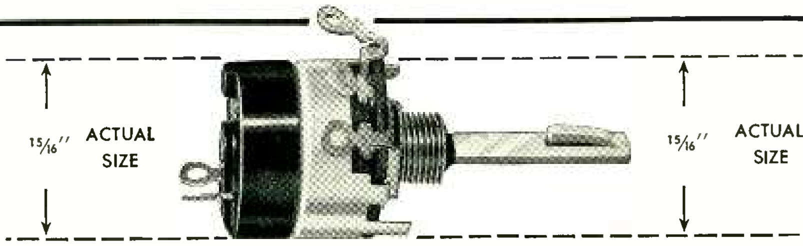
Variable Resistor in Years!



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CROSS TALK

► **OBIT** . . . The death of Harry Diamond, at the height of his career, is a severe loss to the profession and to the Bureau of Standards, where he headed the Electronics Division. His work on radio range beacons, the instrument landing system, the radiosonde and the proximity fuze, are outstanding contributions to aviation and military science. They are matched by an equal contribution to the training of young radio scientists, many of whom received their first inspiration from Mr. Diamond. He saw electronics clear and he saw it whole. One of his last speeches contained a breakdown of the field of electronics:

This was his business; he served it well:

(1) Radio communication and broadcasting, including television and facsimile.

(2) Electronic ordnance, including radar fire control, electronic controls for guided missiles, proximity fuze, and electronic controls for underwater torpedoes.

(3) Radio navigational aids, including radar, loran, and other sea and air navigational aids.

(4) Electronic power conversion, including dielectric and inductive heating.

(5) Electronic instrumentation and controls, including special instruments for physical, chemical, medical and biological research and practice, and the general concept of the servomechanism.

(6) Electronic devices for mathematical computation.

► **TELE-QRN** . . . For years the fight against man-made interference has been conducted by the men of radio against the great outside world, the non-radio domain of electric shavers, telephone dials, ignition systems, and similar impulsive characters. More lately, the battle has assumed the character of a civil war.

In television engineering, at least, the arms of brothers are raised in conflict. A television set lives on impulses, at high level in the scanning and video-amplifier circuits, and these pulses, uncontrolled, raise lots of hob with other radio and television sets in the vicinity. An RMA Committee has given wide circulation to this fact, and urged that adequate shielding be employed to cure the interference. But most sets employing magnetic scanning (the majority at present) are still very noisy out to 10 or 20 feet, much more than the thickness of the wall between apartments. This nuisance, if unabated, threatens to unsell a lot of equipment. Like the oscillator radiation problem, it remains a solvable problem on which not enough money and manpower have yet been spent.

A related miscellany is a letter from the city fathers of Garden City, N. Y., sent to all residents, asking them kindly to refrain from erecting television antennas on the roofs of that as-yet-unspoiled village. Seems they have gone so far as to ask experts, who tell them that the flat terrain of Long Island, close to New York, with no high buildings in the vicinity, is ideal for aerials inside attics.

► **SEMICONS** . . . From audion to orthicon (not forgetting pliotron, kenotron, thyratron, and ignitron) it has been customary to coin names for the vacuum-tube family ending in "on". Now comes another family, practitioners of the art without benefit of vacuum. These are the solid-state cousins, the crystal brethren, the germanium, silicon, copper oxide, selenium boys. For years these crystals have rectified, detected, responded to light and to heat. Now, with the coming of the transistor (described in this issue), they amplify. Seems like the country cousins ought to have a name.

Since these crystals are electronic by occupation, if not by constitution, we beg leave to suggest a name in the vacuum-tube tradition. To wit, semicon: a device employing a semiconducting material in the solid state, through which flows a current capable of being varied by external physical influences. The crystal detector current varies with the direction of the applied potential; it rectifies. The barrier-layer photocell current responds to light, the thermistor current to heat. The transistor current responds to the magnitude of an applied voltage; it amplifies. Respectable brethren, these semicons, and welcome.

Dr. William Shockley, who directed the research, Dr. John Bardeen, who developed the theory, and Dr. W. H. Brattain, whose experiment verified it discuss physics of Transistor

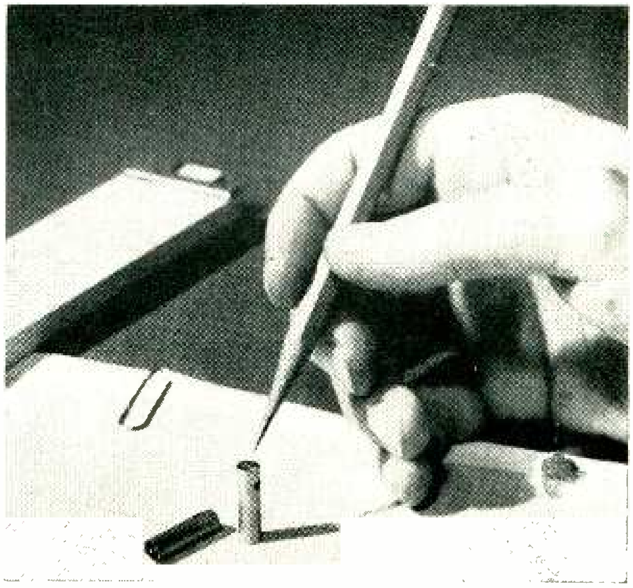

FIG. 1—Because of its simplicity the Transistor is even smaller than most subminiature vacuum tubes. The amplifier itself can be no larger than its associated coupling components

The TRANSISTOR— A Crystal Triode

Germanium crystal with two cat-whisker contacts has characteristics of grounded-grid triode amplifier, provides 20 db gain, 25 milliwatts output at frequencies up to 10 megacycles. It will replace vacuum tubes in many applications and open new fields for electronics

A NEW DEVICE, operating on an entirely new principle and capable of many functions of the electronic vacuum tube, but having neither an evacuated envelope nor a hot cathode, was announced early in July by scientists of the Bell Telephone Laboratories. Known as a TRANSISTOR (TRANSfer resISTOR), the device is essentially a triode form of the well known germanium crystal diode.

In its present experimental form the Transistor is a metal cylinder 3/16 inch in diameter and ⅝ inch long, as shown in Fig. 1. Inside the cylinder, Fig. 2A, is a block of germanium soldered to a metal disc to which it makes low resistance contact and that grounds it to the cylinder. Two 2-mil tungsten wires make contact with the upper face of the germanium at points about 0.002 inch apart.

An input signal, Fig. 2B, in series with a small positive bias voltage, is applied between the grounded face and the input cat whisker (emitter). A large negative bias voltage is applied between ground and the output (collector) point contact. The output signal appears across a load resistor in series with the negative bias. In this manner a power gain of 100 (20 db) is obtained between input and output of a Transistor. The terminal characteristics of an experimental Transistor are shown in Fig. 2C (see the *Phys. Rev.* p 230, July 15, 1948.) This is an early unit having a gain of about 15 db. The characteristics are typical of later units having an average gain of 20 db.

Because of its unique properties, the Transistor is destined to have far-reaching effects on the technology of electronics and will undoubtedly replace conventional electron tubes in a wide range of applications. The Transistor requires no heater or filament power and uses the power supplied by its bias sources with high efficiency. Under typical operating conditions it draws only 0.1 watt from the bias sources (about a tenth the power consumed by a flashlight bulb) and delivers 25 milliwatts of useful output, thus having an overall efficiency

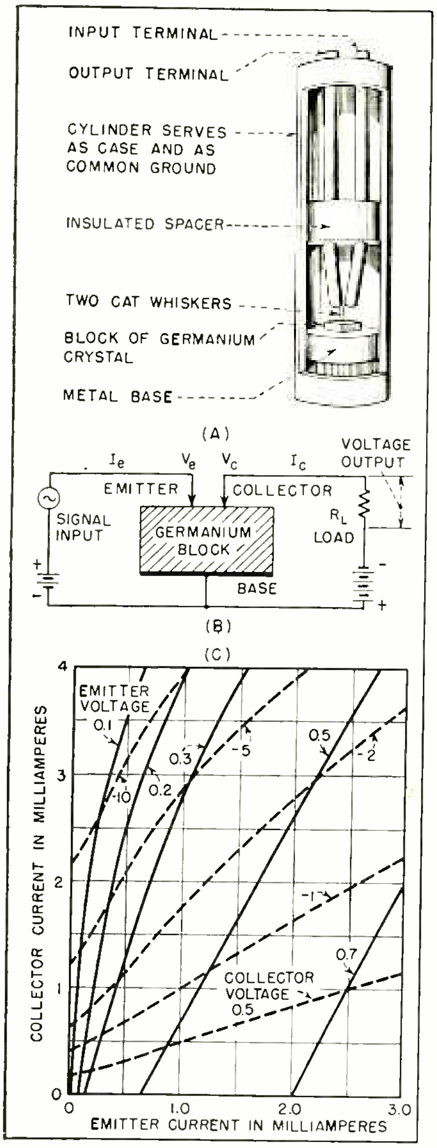

FIG. 2—Crysal triode (A) consists of two cat whiskers connected to separate input and output circuits (B) to give characteristics (C) that produce high amplification

of 25 percent.

The Transistor is smaller than a subminiature vacuum tube. It seems likely to have a useful life of many thousands of hours because of its simple, sturdy construction. Where portability and low battery drain are essential, as in hearing aids and personalized radios, the Transistor appears ideal. In equipment using large numbers of amplifiers, large-scale computers being an extreme example, the absence of a heater makes it possible to place many Transistors in confined space without creating difficulties in heat dissipation.

Although cost factors have not been thoroughly explored, Transistors should be no more costly to manufacture at present than the 1N34 (high back-voltage) germanium diode, which lists for replacement at \$1.20 and is obtainable in large lots by equipment manufacturers at \$0.53 apiece. These prices are slightly higher than the prices of a corresponding vacuum diode (6H6). However, present costs of crystal diodes are not representative of inherent costs. The industry has spent about 40 years mechanizing production of vacuum tubes and has written off engineering and plant costs over that time. If crystal devices (diodes and Transistors) prove as successful in practice as they now appear to be, they too will be put into mechanized production and their cost reduced. Ultimately they should be cheaper than comparable vacuum tubes because of their simplicity and because they do not require evacuation, which is the most difficult step in producing vacuum tubes.

There are limitations to the use of Transistors in their present state of development. The power output is restricted to about 25 milliwatts per unit, or 50 mw from a push-pull stage. A Transistor capable of developing several watts output does not seem feasible at present. Parallel operation of two or more units is possible, however, and could be used to increase the power to a load several fold. The upper frequency of operation is limited to about 10 megacycles by transit time within the germanium. Thus the Transistor is at present useful at audio, video, and the lower radio frequencies, but is unsuited to vhf and uhf applications. Furthermore, the noise generated within a Transistor is appreciably greater than that produced in vacuum triodes.

If the requirements of an application for which the properties of Transistors are suitable justify their cost when they first become commercially available, there remains a temporary obstacle to their immediate use, namely engineering this new device into the circuit. One of the principle problems requiring development is matching the input and output impedances of the Transistor to the circuit. The input impedance of the Transistor is low because the bias in the input circuit causes current to flow in the forward direction through the point contact of the emitter. On the other hand, the output impedance of the Transistor is about a hundred times higher than the input impedance because its bias causes current to flow in the reverse direction through the point contact of the collector. These impedance levels are the opposite of those for vacuum tubes and require a new approach to the coupling circuits between amplifier stages. Intensive work on this problem is underway. The Transistor thus opens new fields for clever design and inventive talent.

Illustrative Applications

In announcing the Transistor, BTL scientists demonstrated several typical electronic devices in which it was used. A booster amplifier for telephony illustrated its application to voice-frequency amplification. A similar video amplifier was also demonstrated. Its low power-supply drain makes it suitable for telephone and television repeater service. In fact, it requires no more power than that usually available at a subscriber's set from the central office batteries that are connected to the line. Use of a Transistor as an oscillator showed the versatility of the unit. Use in a radio receiver for the standard broadcast band illustrated its practicality.

The radio receiver contained no tubes. It consisted of a broad-band r-f amplifier, a tuned r-f stage, local oscillator, mixer, three stages of i-f, second detector, and four stages of a-f amplification, the last being push-pull. A total of 11 Transistors were used in the amplifier stages, with 2 germanium diodes for the mixer and detector stages, and 2 selenium rectifiers for the power supply. The receiver brought in local stations, delivering 25 mw of audio power to its loudspeaker.

At low power levels crystal diodes and triodes, in conjunction with printed circuits, make possible the extension of electronic techniques. Existing equipment can be made more compact. Transistors, having no filament, are operative the instant power is applied.

Research Background

Research work in semiconductor materials began at least 24 years ago. Germanium and other semiconductors have been used as rectifiers because of their unilateral conductivity. These employ a single point contact; the input and output circuits are not separated. The two-contact arrangement is the practical outcome of a long program of scientific research on semiconductors.

Although investigation of semiconductors at BTL dates back a number of years, with the end of the war a concentrated basic research program was undertaken. Groups in the Physics Department were reorganized. Additional personnel were taken on, particularly theoretical specialists. The groups consisted of paper-work men and laboratory experimentalists who could pass problems from office desk to lab bench and back as the program unfolded. The fact that pure research paid off relatively quickly, in so spectacular a way, is testimony to the ability of the men who carried out the program and to the facilities with which they worked.

The group on semiconductors, led by William Shockley, one of this country's leading solid-state physicists, was seeking answers to three basic questions: (1) physically, what is a semiconductor, (2) how does its physical nature produce its observed properties, and (3) how does the fabrication and processing of the material affect its physical nature? Among the semiconductors studied were silicon, copper oxide, and germanium.

A great deal of empirical information had been amassed on these substances during their use, particularly as detectors in microwave equipment ("Crystal Rectifiers," H. C. Torrey and C. A. Whitmer, McGraw-Hill, 1948). In particular it was known that their resistivities were determined chiefly by impurities, and furthermore that their resistivities could be varied over wide ranges by applying various external influences (light in the case of photocells, electric potential in the case of rectifiers and detectors, or temperature in the case of Thermistors).

Theory of Conduction

Modern physics has developed a detailed concept of the construction of matter and consequently an understanding of the mechanism of conduction. In metals there is approximately one free electron that can be used for carrying current for every atom; in insulators there are practically no free electrons. By free electrons is meant electrons so loosely associated with their atoms that they can easily be induced to move to adjacent atoms.

In semiconductors there is only about one current-carrying electron for every millions atoms, but this number of carriers can be varied 1,000-fold by changing the physical environment of the material. Such a change in the number of carriers is effectively a change in the resistance of the material. For example, light falling on a barrier layer changes its resistance. Alternating voltage applied to a selenium rectifier or a germanium diode changes its resistance so that current flows predominantly in one direction. Likewise, a high potential applied externally (without making contact) to a semiconductor should change its resistivity. Using a sheet of germanium as one plate of a capacitor, Shockley and his colleagues measured the change in resistance produced by changing the voltage across the capacitor. The change in resistance was much smaller than anticipated in the light of prevailing theory. Conclusion: something wrong with theory. So John Bardeen, a theoretical physicist in the group, devised a theory of surface states that would account for the measured change as well for older known effects unexplained by previous theories.

To review the old theory for a moment, it was known that conduction in semiconductors could take place by two mechanisms, operating either separately or simultaneously. In some types of semiconductors the electrons, as usual, moved under the influence of applied voltages and thus provided a current flow. Such semiconductors are called N-type because conduction is by negative (electron) charges. In other types of semiconductors, in which there is a deficiency of electrons, the current flow consists of the movement of virtual positive charges (images of electrons) that are actually empty places from which electrons have been removed. Such semiconductors are called P-type because conduction appears to be by positive charges, are shown in Fig. 3.

The two types of conduction had been identified with impurities. For example, as shown in Fig. 3B, silicon alloyed with a minute percentage of phosphorus is an N-type (electronic) conductor. Physically, the effect is explained by the fact that phosphorus has five valence electrons. Four of these form bonds with the four valence electrons in a silicon atom (thus binding the atoms together), leaving one electron free for carrying current.

If the impurity is boron (Fig. 3C), which has only three valence electrons, there is one incomplete bond between each boron and its neighboring silicon atom, leaving a hole in the structure. Because the percentage of boron impurity is very low, not many silicon atoms are so bound. Hence the hole in the bond of one silicon atom with a boron atom can be filled with an electron from an adjacent silicon atom under the influence of an external electric field. However, this action leaves a hole from which the electron came. This hole is free to be passed from atom to atom and hence to carry current. Whereas a negative electron will migrate from a negative region toward a positive region when voltage is applied, a hole will migrate from a positive region to a negative one. (In P-type —hole—conductors the electrons would have no place to go if it were not for the hole, so, although the electrons do move when current flows, it is the presence of the hole that makes their motion possible. Thus, to physicists, conduction is by (owing to the presence of) holes. Such action takes place in germanium.

The new theory suggested new experiments, which, when performed, called for refinements in the theory. While W. H. Brattain and John Bardeen were following up the consequences of the refined theory of surface states they invented the Transistor. With it they discovered a surface layer having peculiar characteristics.

To account for these characteristics, they postulated and later showed by experiment that there is a thin layer of electrons at the surface of germanium. This surface layer would prevent the penetration into the body of the semiconductor of an externally applied field and thus account for the smallness of the changes in resistance observed in the capacitor experiment. The field created by these surface electrons causes the formation of holes in the adjacent material, and these holes conduct current. The conducting layer may be caused by an excess of impurities near the surface such as boron that accept electrons into bonds and thus create holes, or by a space-charge barrier layer. Between this P-type layer and the N-interior is a rectifying barrier.

When a single point contact is made, the surface layer determines the conductivity for reverse currents or small forward currents. For large forward currents there is an increase in the concentration of carriers (electrons and holes). In either case (forward or reverse current) a large part of the current is carried by the surface conducting layer within an area of interaction very close to the point. Within this area the conductivity, which is mainly by holes, is much greater than elsewhere in the semiconductor. The second point contact for the Transistor is added within this area of interaction.

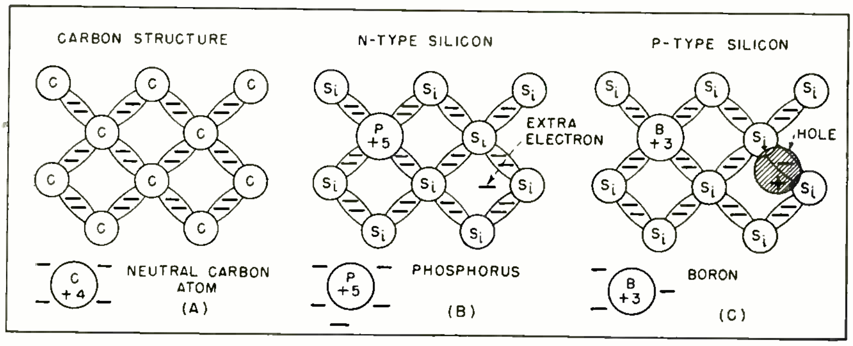

FIG. 3—Conduction within a semiconductor depends on the interatomic bonds formed by the electrons. Current flow in a pure semiconductor is difficult to produce (A). If an impurity having an excess electron (B) is added then that electron can carry current. On the other hand, if the impurity lacks the required number of electrons for the bonds (C) the hole thus created also makes conduction possible

Transistor Characteristics

In a Transistor, the positive point contact causes the release of holes in the surface layer of the germanium, which is prepared in a similar manner to a high back-voltage rectifier. These holes spread away from the point, flowing in all directions along the surface (but not into the body of the semiconductor). The holes reach the other contact point 0.005 cm away, in less than a ten-millionth of a second. This is the transit time that limits present performance to frequencies below about ten megacycles. From this observation, it is estimated that the holes travel at the order of 100,000 centimeters per second. Higher applied potentials and smaller spacings, as used in vacuum tubes to increase high-frequency performance, may reduce this transit time. That there are holes capable of moving from 10 to 100 times this speed is known from estimates of their thermal velocities.

The negative bias applied to the collector causes a very small current to flow from the germanium in the absence of hole conduction produced by the emitter. When the positive bias is applied to the input, however, holes are attracted to the output point contact, which is biased negatively, and these are absorbed, thus increasing the current in the output circuit. Variations in the input current change the number of holes released toward the collector and thus vary the output current proportionately. The Transistor circuit thus closely resembles a grounded-grid triode circuit.

In a grounded-grid vacuum triode the current from the cathode is controlled chiefly by the potential between it and the grid (ground); the plate potential has little effect. In the Transistor the positive bias (about 1 volt) of the emitter (cathode) causes a small current to flow into the semiconductor. The negative bias (up to 50 volts) of the collector (anode) is made large enough so that it withdraws about the same current (a few milliamperes) from the semiconductor. While the collector is a poor emitter of electrons, it is a good collector of holes. A variation of the number of holes in the surface around the two point contacts is produced by changes in the input voltage of the emitter. This variation changes the current (carried by holes) to the collector by a factor of from one to two times the change in emitter current, depending on the operating bias. Furthermore, this change in current flows in the high impedance of the output circuit, of the order of 10,000 to 100,000 ohms. The voltage change produced in this high-impedance circuit by the change in current is thus proportionally large, of the same order of magnitude relative to the signal voltage input as the ratio of reverse to forward impedance of the point contact. There is a corresponding power amplification of the signal.

Because the output circuit can influence the input circuit only by electronic conduction, for which the surface resistance is high, there is little coupling from output to input, and the circuits, one of low impedance (low power) and one of high impedance (high power), are properly isolated for use in unilateral amplification.

The d-c characteristics of a typical experimental Transistor, Fig. 2C, show the interrelation of the four variables, the two currents and the two voltages. If two are specified the other two are determined. The effect depicted by these characteristics shows that, in addition to the forward amplifying action, the collector current lowers the potential of the surface in the vicinity of the emitter in proportion to the collector current times a constant internal resistance, and thus increases the effective bias on the emitter. This describes the nature of the back coupling that exists. Under certain operating conditions this coupling, which represents positive feedback, can cause instability. Thus, although the principle of operation is vastly different, the Transistor has the properties of vacuum tube amplifiers in many respects.—D.G.F. and F.H.R.

RALPH BOWN
(Bell Labs)

MELVILLE EASTHAM
(General Radio)

DONALD G. FINK
(Electronics)

JTAC Its Purpose and Program

The Joint Technical Advisory Committee, eight engineers appointed by RMA and IRE, has the important job of advising government bodies and industry groups on the wise use and regulation of the radio spectrum

THE CENTRAL PROBLEM of the radio industry is the fact that its domain, the radio spectrum, must be administered and policed by agencies subjected to commercial and political pressures, while the by-laws governing the domain are based on technicalities which cannot be changed by commercial or political argument. In each of the major forms of broadcasting for example, this fundamental conflict has led to an improper use of the spectrum, or to faulty administration of it.

Standard broadcasting, put on an orderly basis first in 1925, has suffered ever since from a channel separation too narrow to permit high-fidelity transmission, and the multiple assignment of frequencies (to approximately 2,000 stations at present) has so congested the spectrum that serious interference is the rule in all but urban areas. Television, ready to start in 1939 on standards not radically different from those now used, was stopped dead in its tracks in 1940 by an intra-industry fight which the FCC was unwilling to referee. Frequency modulation was first assigned a band from 44 to 50 mc, and later moved wholesale to 88–108 mc, to the consternation of broadcasters and set owners alike. Whatever the

JOHN V. L. HOGAN
(Interstate Broadcasting)

EWELL K. JETT
(Baltimore Sun)

HARADEN PRATT
(Mackay Radio)

PHILIP F. SILING
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DAVID B. SMITH
(Philco)

LAURENCE G. CUMMING
Secretary (IRE)

merits of the arguments in each case, the fact remains the public has suffered from an inadequate understanding of the radio spectrum and its standards of use, on the part of regulating bodies and their advisers.

One of the first attempts to rectify this situation was the formation in 1940 of the National Television System Committee, to advise the FCC on television standards. The success of this effort led to an extension to cover additional classes of radio service. This was the Radio Technical Planning Board, which presented evidence to the FCC on the post-war allocation of frequencies. Other groups, notably the Radio Technical Commission for Aeronautics and similar groups for marine (RTCM) and land-mobile (RTCLM) services have been formed to study the problems of particular services and to recommend standards and allocations for them.

On July 1st, 1948, the RTPB was dissolved, and its panels were absorbed in the committee structures of the RMA and the IRE. This action was based on the realization that the administration of the spectrum could no longer be guided solely by groups devoted to particular services, as were the RTPB panels. The competition for additional ether space had reached fever pitch and the FCC despaired of refereeing between panels recommending opposed allocations based on conflicting technical evidence. What was needed was an impartial committee to act as a buffer between the regulating body and the proponents of individual services.

Formation of JTAC

The signal for the formation of such a group came soon after the appointment of Wayne Coy to the chairmanship of the FCC. At the IRE annual convention in March 1948, Mr. Coy pointed to the FCC's need for assistance in arriving at an adequate national allocation of television facilities, and mentioned the needs of other services, notably the land-mobile service, as conflicting factors.

At that time the IRE was considering the formation of a technical committee on spectrum utilization, which would gather evidence on the characteristics of different portions of the spectrum and correlate them with the needs of particular classes of service. This committee was the brainchild of the incoming IRE president, B. E. Shackelford. Acting on Mr. McCoy's request, Shackelford met with W. R. G. Baker, outgoing IRE president and Director of the RMA Engineering Department. Together these men roughed out the plan for a joint IRE-RMA committee to consider problems of spectrum utilization and to assist the FCC as required. The idea was presented to the Boards of Directors of the IRE and RMA, and received their blessing.

Two men were appointed to the committee initially, Philip F. Siling, representing IRE, to serve as the first chairman, and Donald G. Fink, representing RMA, to serve as vice chairman. These men met with a group of interested engineers on May 12th to develop the basic philosophy of the new committee. Based on this discussion a charter was drawn up, amended and finally approved by IRE and RMA June 20th.

The charter, the full text of which is appended here, establishes a committee of eight members, each to serve for two years. While JTAC will find that, most of its actions relate to FCC activities, it will assist other government bodies, such as the Interdepartment Radio Advisory Committee, and the Civil Aeronautics Authority, on request, and is also available to industry groups, such as railroad, aviation and marine interests. If the load gets too heavy, JTAC has the power to decide on its own motion what problems it will tackle first.

Established IRE and RMA technical committees will be called on to supply information and make detailed studies for JTAC, and special ad hoc committees may be appointed to do so. Other groups or individuals who may have information will be encouraged to pass it to the JTAC. To this end, notices of problems under consideration will be published regularly in the technical press. JTAC's findings will be available to all who request them.

The basic information collected by JTAC will thus come from informed sources, including recognized specialists in particular fields. JTAC's overriding responsibility will be to sift the information for internal inconsistencies or conflicts, to separate facts from opinions, and to remove commercial bias. To assist in this job, it has the power to appoint technical consultants. Moreover, the JTAC members are chosen as individuals of high professional standing, and are expected to conduct themselves completely outside the sphere of company politics and commercial interest. In fact, it is only by so operating that the JTAC can earn the reputation for complete objectivity, impartiality and accuracy which its charter sets up as a goal.

Television Hearing

The need for the JTAC is underlined by the fact that before its charter was approved and the membership assembled, an urgent request for assistance was presented by the FCC. Early in May, the FCC announced that it would hold a hearing beginning September 20th on the question of utilizing the television frequencies in the region from 475 to 890 mc. These frequencies are currently available for experimentation in improved systems of television, and are reserved for future commercial use when such an improved system is ready for the public. But pressure for additional television channels, plus the demands of other services for space, had forced the FCC to step up its schedule and to inquire, at once, how this space might be used. Accordingly, the FCC requested the JTAC to provide authoritative information on the ways in which these uhf channels might be employed. Questions relating to available equipment and propagation characteristics, were prepared by Commission engineers and were circulated through the JTAC secretariat to the television system committees of the RMA and IRE for detailed study. Reports from these committees, and from other interested groups, were available in mid-August for the critical scrutiny of the JTAC members and their consultants in time for presentation at the hearing in September.

JTAC Charter

The text of the JTAC charter, excepting the preamble and portions relating to administrative procedure, is as follows:

Objective. The JTAC shall obtain and evaluate information of a technical or engineering nature relating to the radio art for the purpose of advising Government bodies and other professional and industrial groups. In obtaining and evaluating such information, the JTAC shall maintain an objective point of view. It is recognized that the advice given may involve integrated professional judgments on many interrelated factors, including economic forces and public policy.

Duties. The duties of the JTAC shall be as follows:

(a) To consult with Government bodies and with other professional and industrial groups to determine what technical information is required to insure the wise use and regulation of radio facilities.

(b) To establish a program of activity and determine priority among the problems selected by it or presented to it in view of the needs of the profession and the public.

(c) To establish outlines of the information required in detailed form. These outlines will be submitted to qualified groups, as hereinafter defined, who shall study the requirements and supply the required information.

(d) To sift and evalute information thus obtained so as to resolve conflicts of fact, to separate matters of fact from matters of opinion, and to relate the detailed findings to the broad problems presented to it.

(e) To present its findings in a clear and understandable manner to the agencies originally requesting the assistance of the Committee.

(f) To make its findings available to the profession and the public.

(g) To appear as necessary before Government or other parties to interpret the findings of the Committee in the light of other information presented.

Membership. The JTAC shall consist of eight (8) members.

The members shall be chosen on the basis of professional standing, integrity, and competence to deal with the problems to be considered by the Committee. The members shall be chosen from among all qualified engineers irrespective of the organizations to which they belong or the companies by whom they are employed and shall operate without instruction. Half of the members shall be nominated by IRE and half by RMA, and the appointment of all members shall be confirmed by both bodies. None of the members shall receive any regular compensation for services from the National or any State Government. There shall be no alternate members.

Members shall serve for a term of two (2) years, commencing July 1 and terminating June 30. To assist in maintaining the continuity of action of the Committee, half the initial roster of members of the Committee shall be appointed to serve two consecutive terms.

Officers. The officers of the Committee shall be a Chairman, a Vice-Chairman, and a Secretary. The Chairman and Vice-Chairman shall be appointed from among the eight members of the JTAC by the Boards of Directors of the IRE and of the RMA on alternate years and will serve for a term of one year, except as may be otherwise determined by the Boards.

The Secretary shall be a qualified individual appointed by the members of the JTAC and shall serve for a term of one year. The Secretary shall not be a member of the Committee.

Committees and Consultants. The JTAC shall make use of existing committees in the IRE and RMA organizations wherever possible. Where a qualified group does not exist, the JTAC shall appoint ad hoc committees to study and report on particular subjects. Such ad hoc committees shall be disbanded upon completion of their assignments. The Committee shall also make use of qualified sources of information outside the IRE and RMA organizations, including the engineering staffs of Government bodies as well as professional, educational, and industrial groups qualified to assist in its program. Technical consultants may be invited to assist upon occasion, by the Committee as a whole.

JTAC'S FIRST ASSIGNMENT

The FCC hearing scheduled for September 20th, 1948, has the following objectives:

(A) To obtain full information concerning interference to the reception of television stations operating on channels 2 through 13 resulting from adjacent-channel operation of other services, from harmonic radiations, and from man-made noise.

(B) To receive such additional data as may be available since the close of previous hearings (Dockets 6651 and 7896) concerning the propagation characteristics of the band 475 to 890 mc.

(C) To obtain full information concerning the state of development of transmitting and receiving equipment for either monochrome or color television broadcasting, or both, capable of operating in the band 475 to 890 mc.

(D) To obtain full information concerning any proposals for the utilization of the band 475 to 890 mc, or any part thereof, for television broadcasting and the standards to be proposed therefor.

At the request of JTAC, members of the Commission staff prepared the following list of detailed questions:

(1) What is the present state of development of equipment in the band 475 to 890 mc, in regard to (a) transmitters, tubes and components, (b) receivers and components, (c) antennas, transmission lines and related equipment for transmission and reception?

(2) How much experimental work has been undertaken in television systems in this band, with respect to field operation (transmitter hours operated, number and distribution of receivers, and propagation tests) and laboratory work (development of receivers, transmitters and tubes)?

(3) What consideration has been given to the costs of television systems for this band, particularly to the reduction of receiver costs, and the transfer of cost burdens to the transmitter?

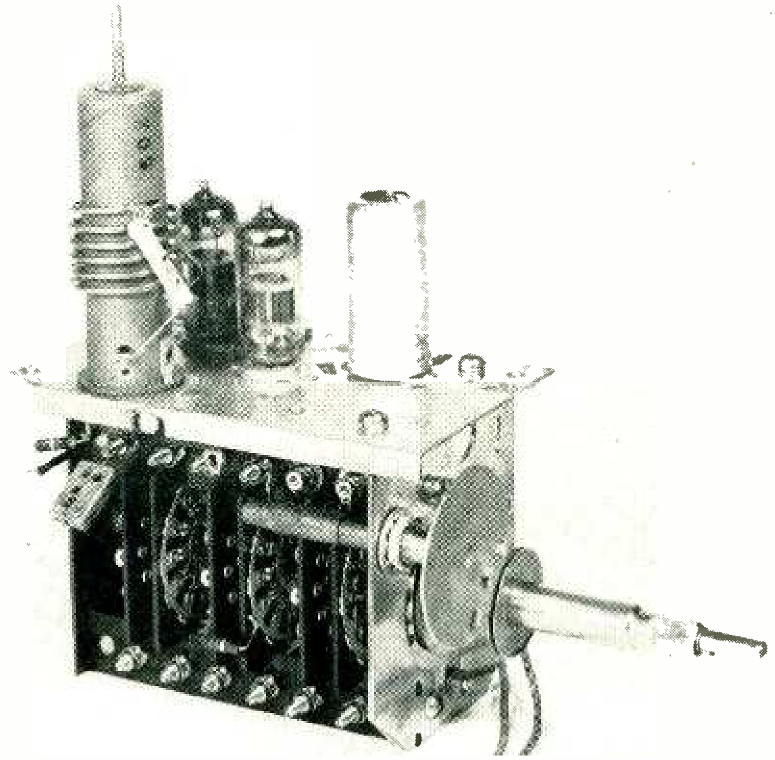
(4) What areas of service might be expected in this band, based on the following assumptions: (a) a particular system, using one of the following typical bandwidths: 6 mc, 13 mc, 20 mc; (b) radiated power, available now and expected to be available, say, 10 years in the future, (c) receiver sensitivity, and (d) at each of the following typical frequencies: 475, 600 and 890 mc?

(5) What co-channel and adjacent-channel separations would be appropriate under the assumptions made in item 4, above?

(6) How many channels would be available in the band 475-890 mc, on the assumptions of item 4, above, and how might they be allocated among the 140 metropolitan districts of the United States?

JTAC has transmitted these questions to RMA and IRE committees as well as many other groups, such as NAB and TBA, who may contribute to the store of knowledge. Any reader of *Electronics* who has information on these matters is urged to communicate it at once to the JTAC Secretary, L. G. Cumming, care of the Institute of Radio Engineers, 1 East 79th Street, New York 21, N. Y.

—THE EDITORS.



RCA rotary-switch type front end uses transmission lines and push-pull circuits

Television FRONT ENDS

R-f, oscillator and mixer problems are discussed, and current design trends noted. Suggestions for measuring performance are given, and tuning methods at present in use and on the drawing boards are covered in detail

By A. D. SOBEL

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TELEVISION receiver front-end design is one of the most difficult problems engineers face today. The quality and cost of receivers depends to a large extent upon its solution.

Front ends must have sufficient bandwidth for acceptance of both picture and sound on each of the twelve available channels; almost everything else is optional and at the discretion of the designer.

R-F and Converter

There is, first, the question of gain; this is at present achieved by the inclusion of a stage of r-f amplification.

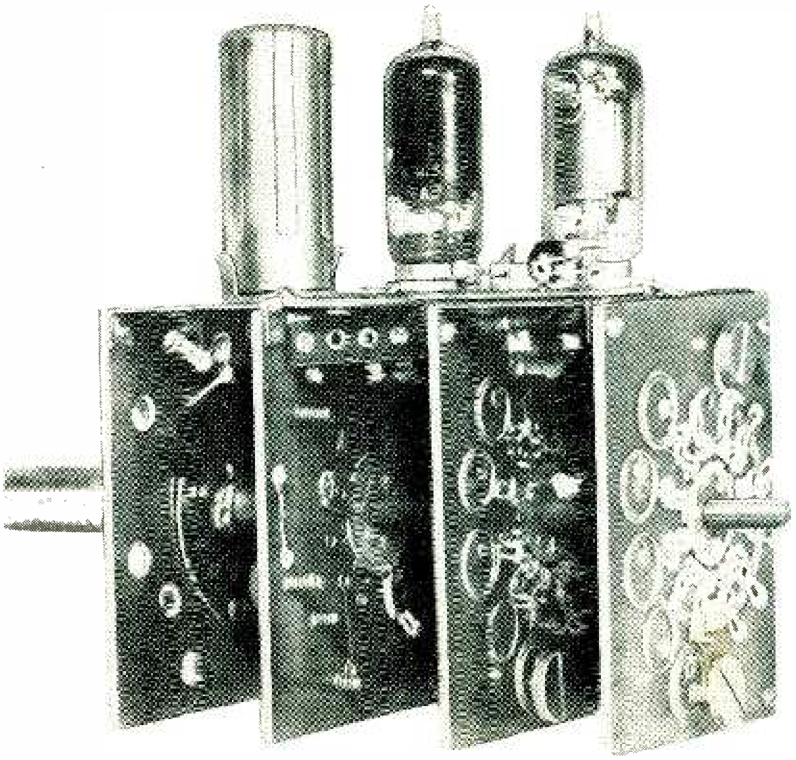
A triode used in the r-f stage gives a better signal-to-noise ratio than a pentode but provides less isolation; there is a possibility of more oscillator voltage passing through the tube and appearing across the antenna terminals. There is, therefore, a trend toward the use of pentodes. The 6BH6 provides adequate gain on the seven highest-frequency channels and also reduces circuit loading.

Theoretically, the greater the number of tuned circuits the better the performance. However, multiple-tuned circuits cannot always be used due to mechanical design considerations and cost, so either grid or plate-circuit tuning is currently employed. Where grid tuning is used, separate antenna coils must be provided for each channel, with the disadvantage that more switch points are needed. Where plate tuning is used the transmission line must be fed into the grid and cathode of the r-f tube, inasmuch as an input circuit balanced for both signal and noise is essential.

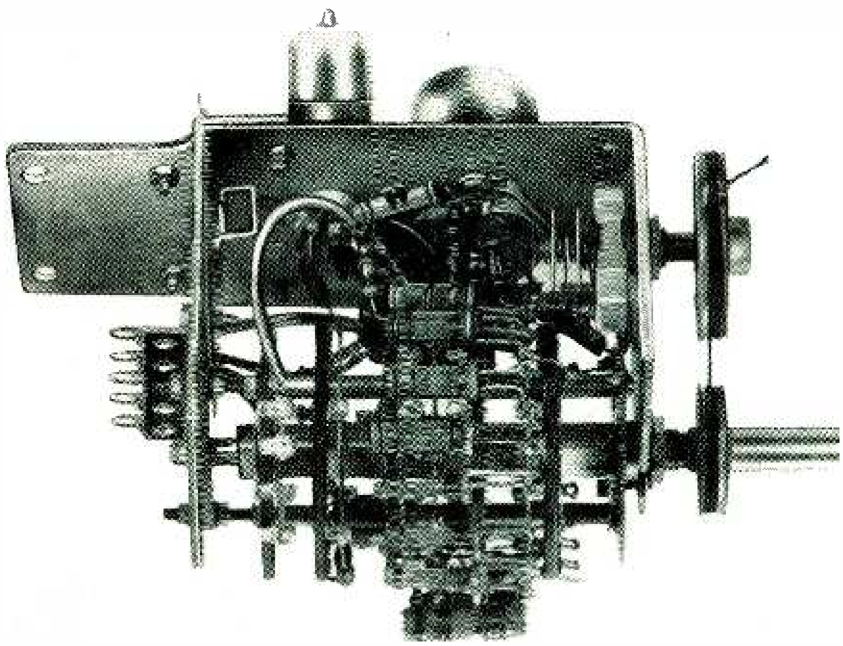
A gain of 6 db is considered satisfactory at the present time for the r-f stage of a television receiver designed for use in the average location. An image-rejection ratio of 40 db can readily be maintained on all channels.

Conversion can be achieved with a triode, pentode, diode, or even a crystal. The 6AG5 pentode performs well as a converter. The oscillator circuit must be chosen carefully; a plate circuit grounded with respect to r-f, with a floating cathode and tuned grid, is probably the easiest to use as there is only one switch point involved.

Some sort of vernier appears to be essential, unless automatic frequency control is incorporated into the design. This is not too difficult to add if a dual triode such as the 12AT7 is used. One half of the tube functions as the oscillator and the other half is used as a reactance



Franklin rotary-switch assembly with die-stamped transmission lines



GE rotary-switch arrangement has conventional inductances

tube. Control voltage is taken from the discriminator or ratio detector in the sound i-f section of the receiver.

An excellent and recommended way to make front-end gain measurements is to figure gain to converter plate, on the basis of gain per 1,000 ohms of converter plate load.

Possibly the greatest drawback today in making accurate measurements is mismatch due to the feeding of a signal from an unbalanced signal generator or sweeper into the balanced input circuit of a receiver.

Measurements

To observe and adjust r-f gain, bandwidth, and coupling, the author feeds a suitable sweeper into the antenna terminals through a correct match for 300 ohms. The output is taken at the converter grid or, better still, at its screen, and connected to an oscilloscope. If the inductances are correct for the different channels a curve can be observed on the oscilloscope screen and frequency markers inserted. Coupling can be adjusted while observing the curve on the oscilloscope.

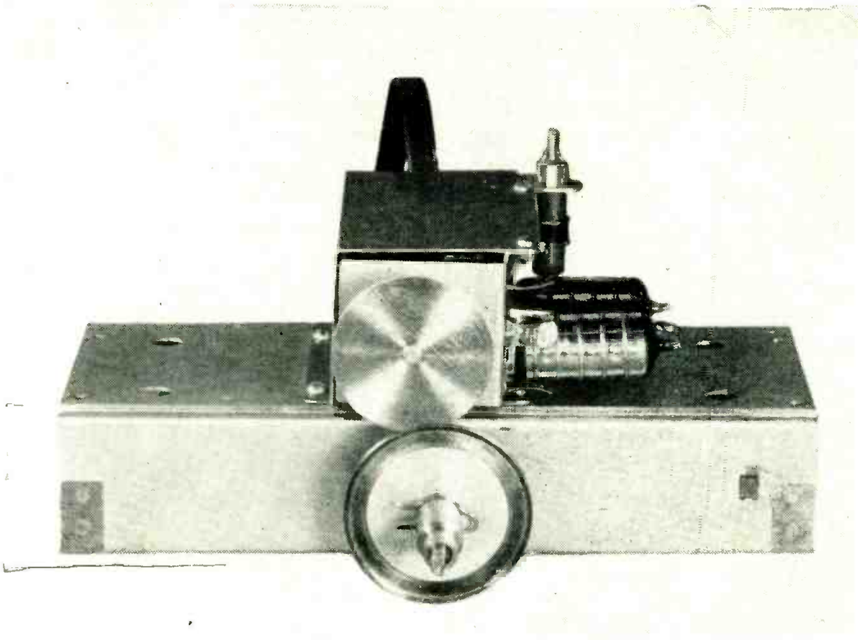
Drift measurements on a front-end unit should never be made in the open. The unit should be installed on the chassis with which it is to be used and in the cabinet in which the chassis is to be placed. The proper temperature-coefficient capacitors can then be incorporated into the design to counteract the effects of heating.

In designing a tuner the most unexpected conditions are encountered at frequencies between 50 and 250 megacycles. All sorts of resonances can be expected. These frequently manifest themselves as absorption circuits, cutting gain or actually blotting a frequency out entirely. An oscillator may refuse to operate entirely at certain frequencies. Probably the worst offenders in this respect are heater chokes which, with their by-pass capacitors, often resonate in the television band. Switch shafts and plates, frameworks, wiring, and other innocent-looking items also give trouble.

Tuning Methods

There are several methods of tuning television receiver head ends, and sometimes they are used in combination. Typical methods are enumerated in the following paragraphs.

Rotary Switch. The rotary switch has met the needs of radio design engineers for nearly twenty years. It has successfully been applied to



Hazeltine sliding turret has individual inductances

television, sometimes using conventional inductances and sometimes resonant transmission lines.

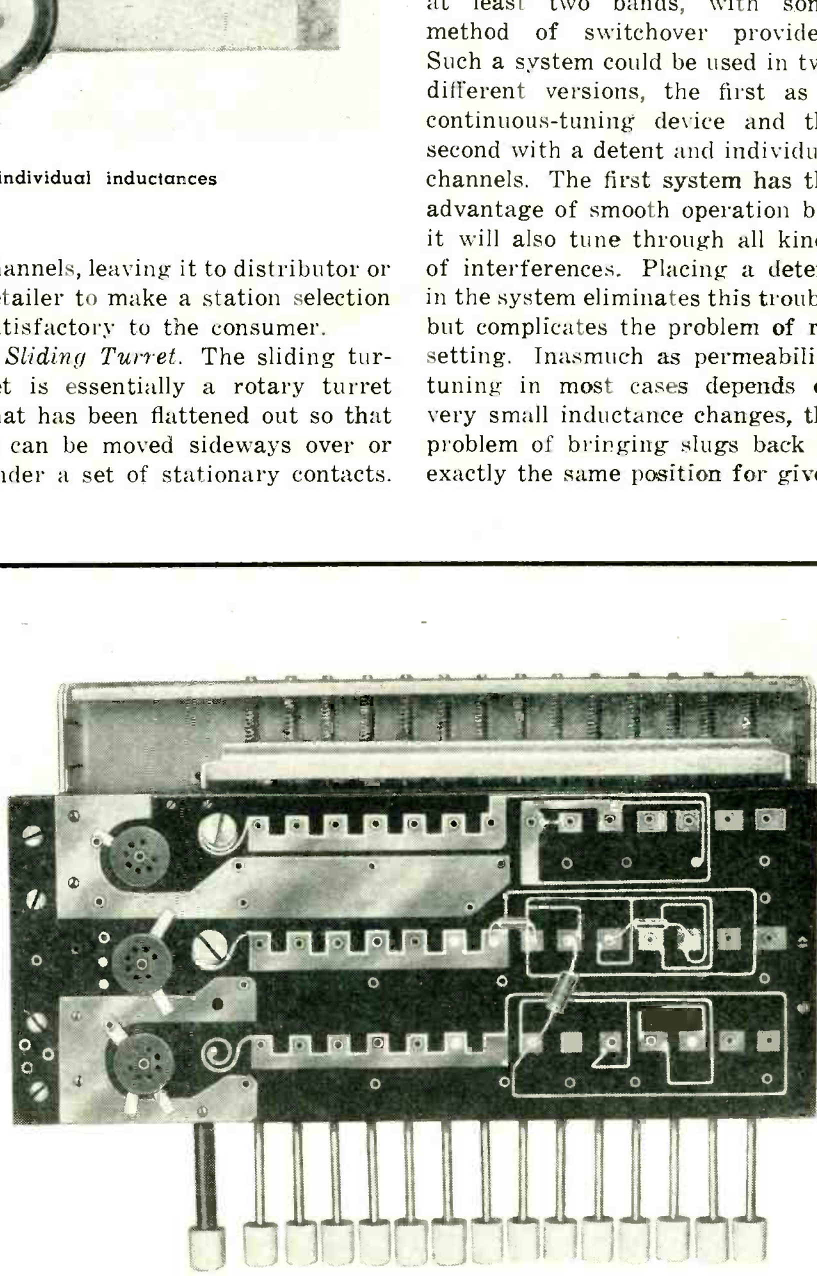
On the plus side of the ledger, rotary-switch advantages include low cost, sturdy construction, and noise-free operation. The spacing between the contacts is small, lending itself to high-frequency operation. Switches of this variety are compact and therefore keep the overall size of a unit to a minimum. But this is the very feature that sometimes causes trouble. Because of its compact construction, the average rotary switch is not too accessible in production. Also, the concentration of conventional inductances in a small enclosed area in which there are warm resistors and hot tubes contributes to the drift problem. Use of printed or stamped inductances as shown in the upper photograph on the preceding page eliminates most of this trouble.

Rotary Turret. Theoretically, the rotary turret represents excellent television head-end design. By rotating coils, lead lengths can be kept constant for all channels, providing a good LC ratio. But this system, too, has disadvantages. Contacts are difficult to design and, if satisfactory, are generally very expensive. Also, size easily gets out of bounds if all twelve channels are provided. Some manufacturers circumvent this by providing eight channels, leaving it to distributor or retailer to make a station selection satisfactory to the consumer.

Sliding Turret. The sliding turret is essentially a rotary turret that has been flattened out so that it can be moved sideways over or under a set of stationary contacts. Among turrets, it is probably a good type as contacts are not too difficult to design. However, it has still greater size and more complex mechanical structure.

Permeability Tuning. Permeability tuners have been used successfully for years in radio receivers, and there is no reason why they cannot be adapted for television if the designer is willing to take the disadvantages along with the advantages.

To begin with, in order to cover the entire television band, the tuning spectrum has to be divided into at least two bands, with some method of switchover provided. Such a system could be used in two different versions, the first as a continuous-tuning device and the second with a detent and individual channels. The first system has the advantage of smooth operation but it will also tune through all kinds of interferences. Placing a detent in the system eliminates this trouble but complicates the problem of resetting. Inasmuch as permeability tuning in most cases depends on very small inductance changes, the problem of bringing slugs back to exactly the same position for given



Franklin push-button-type tuner formed of stampings channels is very difficult indeed.

Inductive Tuning. Inductive tuning has the advantage of smooth operation. On the other hand, it is mechanically complex and expensive. The idea ordinarily involves use of a rotating cylinder upon which wire is wound in grooves. A small contact wheel engages the first turn when the coil form rotates, and travels over its entire length as the cylinder is turned.

Variable Capacitance. The old reliable workhorse of radio, the variable capacitor, has not been forgotten. Although most designers have not employed such devices because of the wide frequency range that must be covered in a television head end, one has actually been developed. The unit referred to requires a high-low bandswitch.

Pushbutton. Two different pushbutton tuners have been developed. The first uses a conventional pushbutton switch and the three associated tubes are mounted on the main television receiver chassis rather than in the head-end unit. To overcome the normal high inductance of the contacts, a series capacitor is placed in the transmission line and a small variable capacitor at each pushbutton position to ground. The capacitors act as padders. For 12 channels, 36 trimmers are thus used.

The second pushbutton switch referred to comprises a framework designed to accommodate tubes and wiring. Space is provided near the converter tube for the first i-f coil or trap, while more space is available for broadcast or f-m components. Contacts are large and heavy and their inductance at the frequencies used is low. The moving contacts are welded to the pushrods and are self-aligning. Incorporated in this unit, and an important part of its design, are die-stamped circuits.[1]

Pushbutton Tuner Details

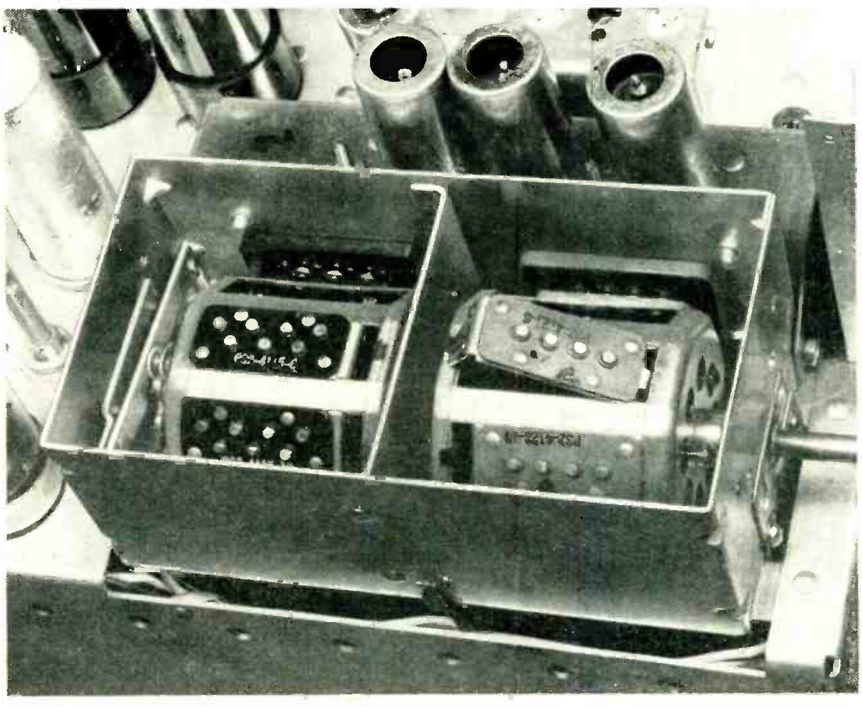
In the Franklin Airloop Corporation pushbutton tuner referred to above only four adjustments are necessary. Three coils have an inductive-tuning arrangement consisting of a 4/32 brass screw with a $\frac{3}{8}$ head. Moving the head of the screw closer to or farther away from the die-stamped coil provides necessary frequency adjustment. A similar device in the oscillator circuit tunes the low-frequency channels.

The oscillator has a vernier capacitance adjustable through the front of the tuner. In cases where automatic frequency control is used the vernier becomes an internal adjustment to compensate for different tube capacitances when and if the oscillator tube is replaced.

A 6BH6 tube is incorporated in the r-f stage. The antenna input is between grid and cathode terminals and is balanced and matched for a 300-ohm line. The grid of the tube may be used with automatic gain control. The plate is tuned and overcoupled to the grid of the converter, which is a 6AG5. The grid of the converter is tuned and the two circuits are coupled with fixed capacitors before channel 13 and at channel 7. Injection voltage at the grid averages 3 volts.

The oscillator is a conventional 6C4 with plate grounded with respect to r-f and a choke in the cathode circuit. The grid of the oscillator is tuned.

The heavy framework of the tuner readily dissipates heat, while the stamped inductances are comparatively far away from the heat sources. Oscillator drift is readily compensated for by means of temperature-coefficient capacitors when the tuner is used in different chassis and cabinets. Should a situation arise in which spurious signals are received in particular locations a trap for the offending signal, or an additional tuned circuit to bring up the wanted signal, or both, can be readily added. Threaded holes are provided on the rear of the switch for this purpose. However, no spurious responses have been found so far.



Philco rotary turret using replaceable coil assemblies

Future Trends

Present-day tuners serve their purpose well, considering the economics of the market, but already new and better front ends are on the drawing boards for 1949 and 1950. It will take time to complete design, field test and tool up.

The trend is toward more gain, greater stability and, particularly, greater freedom from interfering signals. Multiple stages of r-f are possibly in the offing. Certainly more tuned circuits are coming.

REFERENCE

(1) Stamped Wiring, ELECTRONICS, p 82, June 1947.

High-Speed Revolution Counter

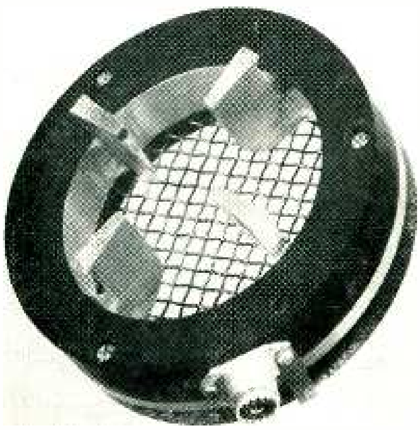


FIG. 1—Pickup unit, showing dural vanes

Supercharger impellers for DC-6 and DC-9 aircraft cabins are tested up to 30,000 rpm by means of a capacitance pickup, a transducer, and a frequency meter. No mechanical connection is made to the impeller shaft, and no load is added to the system

By **ALVIN B. KAUFMAN**

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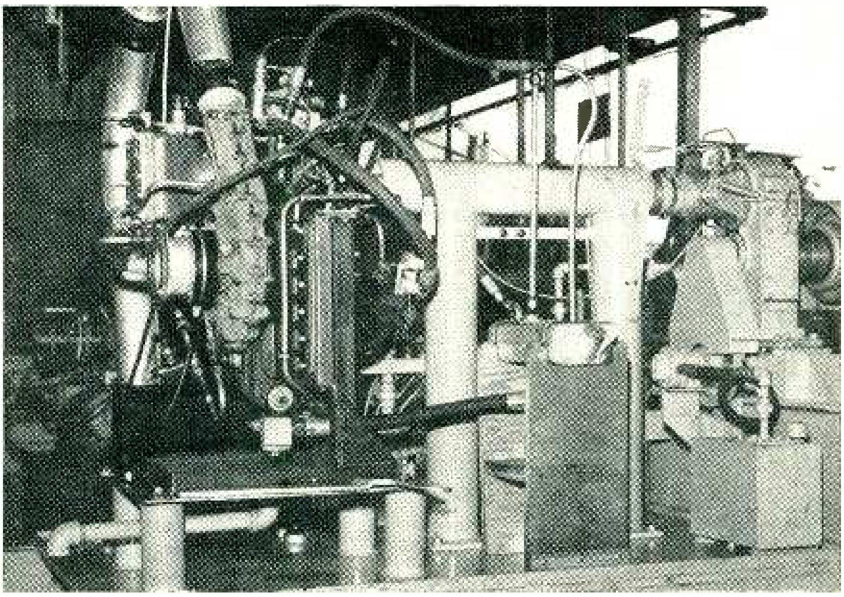
THERE has long been a need for a revolution counter for high-speed machinery which does not attach to the rotating shaft or load it in any way. A device which fulfills these requirements and which is particularly suited for indicating rpm or rps of rotating fan, propeller or impeller blades is described.

The units illustrated are presently employed for determining the rpm of engine-driven cabin superchargers. The impeller of such superchargers operates at 30,000 rpm or more. Similar units can be adapted for use with turbines, or any rotary-blade machinery, without altering or adding anything to the machine.

Three items of equipment are required. These are: the pickup, a capacitance transducer, and an electronic frequency meter or tachometer. The pickup consists of one or more insulated vanes, located adjacent to the rotating shaft or attached blades so as to vary its capacitance to ground with rotation of the shaft. The capacitance-transducer supplies an alternating voltage whose frequency is proportional to shaft rpm. The alternating voltage is applied the electronic frequency meter or tachometer which employs a scale calibrated in terms of rpm revolutions per minute.



Test stand for an aircraft cabin supercharger

Pickup

As the pickup works on a capacitance principle, it is necessary to use a connecting cable whose capacitance is low and yet constant despite movement or vibration. A suitable cable is RG8/U coaxial.

The variation of pickup capacitance should be at least five percent of the total input capacitance, but operation on smaller percentages is possible under low vibration conditions. A one-vane pickup was originally used and proved satisfactory up to 10,000 rpm, but was later discarded in favor of a four-vane pickup pictured in Fig. 1. It should be noted that the number

Control panel for the revolution counter

of pickup elements does not change the output frequency, which is determined by the number of vanes or blades on the rotating shaft. However, under extremes of vibration or weaving of the rotating blades a high degree of hash may be produced. These stray variations in capacitance are corrected by the use of a multielement pickup which automatically balances them out. As one blade weaves closer to a vane its increase in capacitance is balanced by another blade, 180 degrees away, moving away from a vane or pickup element. With the four-element pickup, good waveform is delivered to the electronic frequency meter.

There are several other factors that must be considered in the design of the pickup. In theory it is nothing but an insulated metal plate. The size and shape is not critical, but is chosen so that the impeller blade is not under the plate for more than 50 percent of its travel before the next blade passes under the plate. This gives roughly a 1-to-1 low to high capacitance cycle, delivering through the transducer a substantial sine wave. The electronic frequency meters or tachometers require an on-to-off or vice-versa alternation of input voltage preferably 1 to 1 but not to exceed 4 to 1 for a highly accurate indication.

The spacing of the plate or pickup vane to the element depends upon input cable capacitance, spacing between impeller blades, and transducer sensitivity. Using a two-foot RG8/U cable with the pickup illustrated, spacings up to one-quarter inch have been employed. Spacing may best be determined by test, but in any case close tolerances are unnecessary. Airflow restriction may be limited to a low value by proper design of the pickup. This again hinges upon use of the pickup in different fields.

Transducer

The transducer unit changes variation in pickup capacitance into useful audio-frequency voltage suitable for application to the electronic frequency meter or tachometer. It consists of the familiar capacitance relay or radio-frequency oscillator, a detector and a one-tube amplifier, as shown schematically in Fig. 2.

The r-f oscillator is adjusted to oscillate feebly. The pickup is connected so that every time its capacitance increases it shunts the oscillator-feedback circuit more, and thus causes the oscillator to drop its r-f output voltage. The r-f carrier is rectified and the a-c component caused by variations in signal due to changing pickup-plate capacitance is amplified. Output must be over two volts, but not over two hundred, to operate the frequency meters or tachometers in use. As the output voltage is not critical and does not affect the rpm indication, the transducer requires no gain stabilization.

The oscillation frequency of the

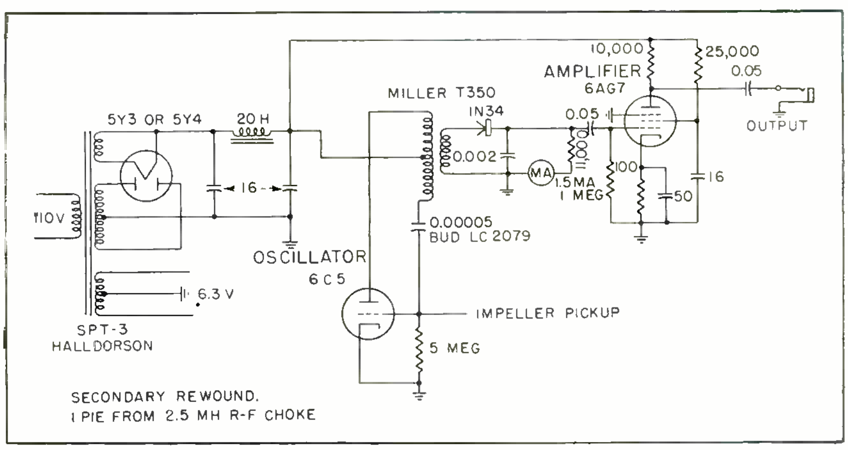


FIG. 2—The capacitance transducer. Plate series capacitor is variable

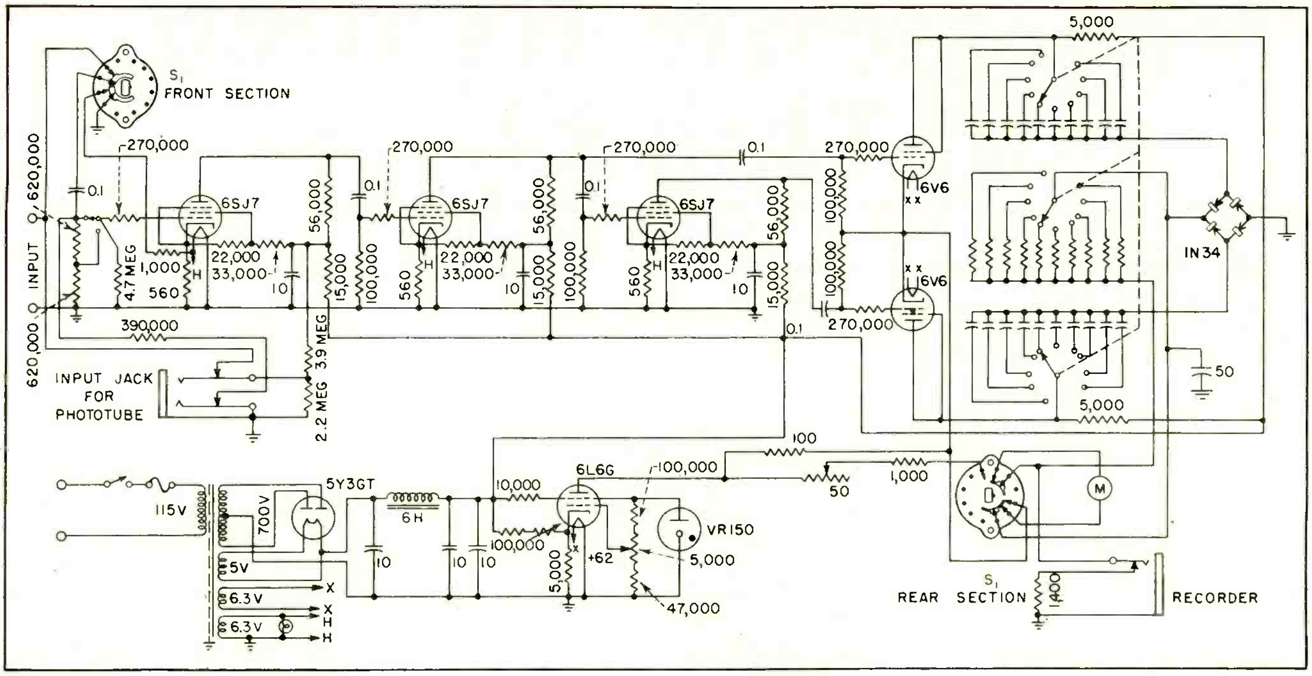


FIG. 3—Circuit of Hewlett-Packard frequency meter and tachometer used as a speed indicator for testing cabin superchargers

transducer is not critical and for this reason the oscillator coil is not tuned. Where the particular coil specified in the drawings is not available, the oscillator should preferably be set to operate between 500 and 2,000 kilocycles. This, in part, depends upon the capacitance change available in a particular application. Input capacitance as well as the size of the feedback variable capacitor determines optimum frequency.

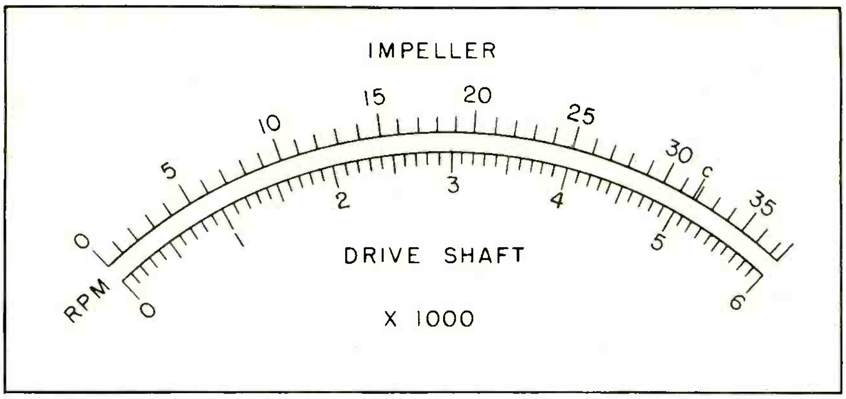


FIG. 4—Redrawn frequency-meter scale, giving rpm directly

The setting of the variable capacitor will depend upon three feedback functions: frequency of oscillation, feedback ratio in tank coil, and cable and pickup shunting capacitance. Optimum capacitor setting may best be determined experimentally for each individual application. The capacitor is adjusted to the point where the oscillator is not oscillating strongly. This is accomplished with the aid of the 1.5-ma meter, which indicates rectified r-f current from the detector. The output winding on the tank coil is wound so as to give a 1.0 to 1.5-ma indication on the meter when the oscillator is functioning correctly.

The output impedance of the original transducer was not considered critical, as the output voltage was high and a shielded cable was to be used. However, this developed into a critical point because of the high output frequency. A sixteen-blade impeller, rotating at 30,000 rpm, has an output frequency of 16 times 30,000 divided by 60. This gives an output frequency of 8,000 cycles. Therefore, in the first units is was necessary to use RG7/U cable (14 μμf per ft.) to connect the transducer to the frequency meter. The amplifier tube and circuit components were then changed to give lower output impedance.

It would be desirable, in new units, to use a plate-to-500-ohm-line transformer in the transducer and a 500-ohm line to grid transformer at the frequency meter or tachometer. Thus there would be no limitations on cable length between the two units.

The rpm may be read directly on the electronic tachometer diagrammed in Fig. 3. One cycle is produced per revolution at the pickup. Where many-bladed devices are used it is preferable to use an electronic frequency meter. In this case, rpm may be read by using the calculation rpm = freq. × 60 ÷ no. blades. This calculation may be reduced to chart form, but it is preferable to draw a new scale to be used with the instrument, as shown in Fig. 4.

Acknowledgment

The author wishes to thank Bruce Duncan of Douglas Aircraft for his cooperation in the mechanical designs and helpful criticism leading to the successful completion of this device.

Dielectric Heating of Thin Films

Development of electrode structures for applying high power to dielectric films is described. Limitations imposed by air gap for usually encountered applications are analyzed. It is also shown that average power should be close to instantaneous peak power

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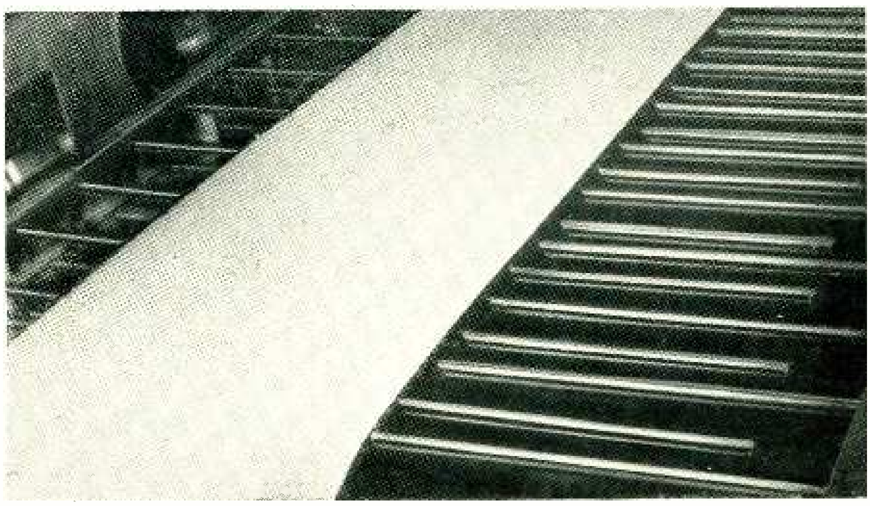


Solvent, used to flow film onto a cellulose backing, is preheated before being removed in an oven. Using the electronic preheater increased productivity of the plant 40 percent

ALTHOUGH DIELECTRIC HEATING has established itself as an industrial process, its application in some fields has been limited by difficulties in load matching; that is, the design of appropriate electrode structures for the efficient transfer of power to the work to be heated.

One field of application in which load matching has been particularly troublesome is the heating of thin films or sheets of either liquid or solid material. This field embraces a large group of industrial processes, as shown in Table I.

Difficulties of Heating Films

To appreciate the problems presented by loads consisting of thin films, consider Fig. 1A. A typical film, often less than ⅛-inch thick and several feet long and wide, constitutes the dielectric of a flat-plate capacitor. The dielectric constant of the load material is rarely less than four, and the power factor is generally not very high, perhaps five percent. If the film remains dry and solid during the heating process, so that it may touch the electrodes, the electrodes may be of the conventional parallel-plate type.

An examination of such a load shows: (1) high capacitance, due to close spacing and large area of the plates, (2) short air gap between plates, (3) necessity for flat, rigid, and parallel electrodes (to avoid air spaces which cause cold spots in the load), (4) loss of heat because the electrodes have high thermal capacity, (heating the plates by external means helps in eliminating this problem), (5) necessity for a high frequency to obtain rapid heating, because the short plate-to-plate spacing will not permit the use of high voltages, (6) difficulty of obtaining uniformity of field with h-f and long dimensions due to standing waves across the electrodes. Stubbing is helpful in reducing nonuniformity, but does not eliminate the problem. If the load is moving through the electrodes, standing waves in that one direction are unimportant (7) generation of sufficient power at h-f required by a short cycle may be difficult (8) transmission of power to, and establishment of voltage across such a low capacitance at the desired h-f is often impractical (resonating the load by parallel stub inductances is sometimes possible), and (9) circulating currents required are often prohibitively high, because these loads raise allowable minimum generator tank-circuit current.

TABLE I—Principal Applications

Drying Plastic Coatings
- Waterproofing textiles
- Manufacturing artificial leather
- Glazing cloth and paper

Drying Liquid Films
- Baking paint and lacquer
- Drying printing inks
- Heating adhesive films (such as bookbinding and adhesive tapes)
- Setting flocked coatings

Heating Solid Films
- Curing sheets of resin (such as gutta-percha)
- Heat-sealing laminates (such as glass to paper, paper to wood, paper to paper and cloth to paper)

Drying Impregnants
- Sizing cloth and yarn
- Setting impregnated paper and cloth

Air Gap Lowers Load Voltage

The parallel-plate problem is even more severe in loads which may not be touched on one or both surfaces by the electrode plates. There are several reasons for such a restriction. The surfaces may be wet, as

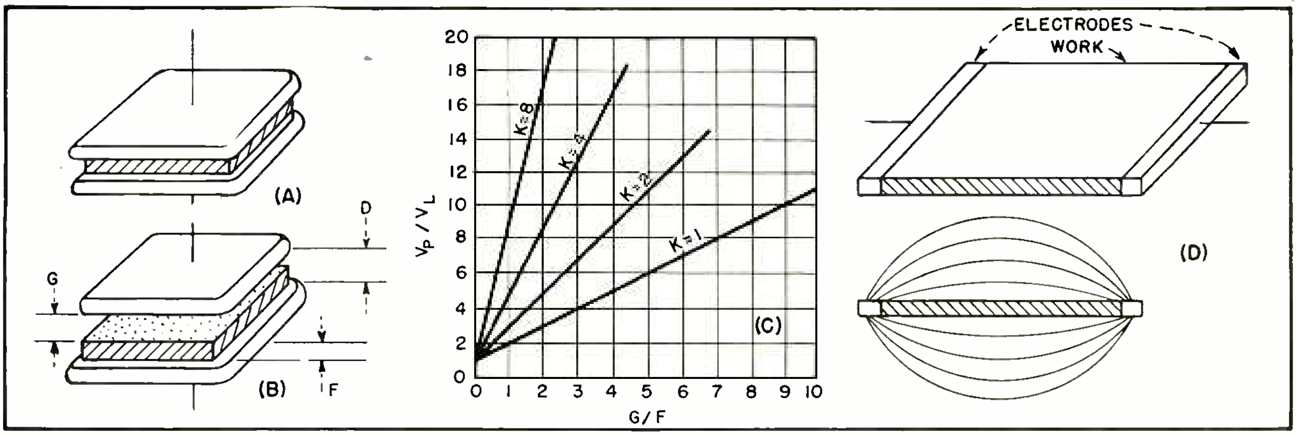


FIG. 1—Heating thin films by making them the dielectric of parallel plate capacitors (A) is difficult if there is an air gap (B) comparable to the thickness of the film, the ratio of applied voltage to load voltage is rising rapidly (C) with gap width. If it were not for excessive leakage (D) the electrodes could be placed at the edge of the film

in the case of adhesives and paints. The surfaces may give off water or other solvent vapors while heating which must escape freely. In the case of curing sheets of natural resins, the material is often too fragile to withstand pressure.

In the above examples, an air gap (Fig. 1B) must be maintained between load and one or both electrodes. This air gap creates further load-matching problems. In both Fig. 1A and 1B the minimum voltage V_B at which ionization will occur in the air space extending from the edge of one electrode plate to the edge of the opposite plate is $V_B = K_B D$ where D is the spacing between plates and K_B is the dielectric strength of air, which is nearly constant for well-rounded plates spaced fairly close together.

The load voltage V_L required to accomplish the desired heating (at any one frequency) is $V_L = (P/\omega\, C_L \cos\theta)^{1/2}$ where P is the average power required by heating cycle plus losses, ω is $2\pi \times$ frequency of operation, C_L is capacitance represented by the load itself, and $\cos\theta$ is the power factor of the load.

In Fig. 1A, V_L is equal to the plate-to-plate voltage V_P because there is no airgap. In Fig. 1B it is V_P is somewhat higher than V_L, due to the series air-gap capacitor C_G of thickness G, the same area as C_L, but having a dielectric constant of only unity.

Neglecting the effect of the resistive component of the load R_L the plate-to-plate voltage must be at least $V_P = V_L\ (C_L/C_P)$ where $C_P = C_L\, C_G\ /\ (C_L + C_G)$, the equivalent capacitance of the load capacitor and air-gap capacitor in series.

Because air has a dielectric constant of unity, and the lowest dielectric constant commonly encountered for film materials is about four, it is apparent that, if G is made equal iof F (and it often must be ten or more times as large) the plate-to-plate capacitance C_P is no more than $C_L/5$.

The required plate-to-plate voltage V_P has thus been increased, by the presence of the air gap for $G = F$ to 5 V_L, or five times the plate-to-plate voltage required with no air gap. This illustrates the fundamental difficulty introduced by air gaps. In the above example, the minimum breakdown voltage with air gap is only twice the minimum without air-gap, because $F = G$.

Of course, when the dielectric constant of the load is nearly that of air, or when the spacing is very small compared to the film thickness, the effect of an air gap may be small. Figure 1C is a plot of V_P/V_L vs G/F for different values of K, the dielectric constant of the load.

The above analysis holds for any load in which the power factor is low enough so that the resistive component of the load may be neglected. The difficulty increases if the power factor is high, because the ratio V_P/V_L becomes even larger.

Some advantage is obtained because the air gap reduces the heat losses to the electrode plates, and thus reduces the required load voltage. This advantage does not, in general, compensate for the rise in V_P, except for very small air gaps.

The basic limitation inherent in the parallel-plate method arises from attempting to heat the material through its thin dimension. Most of the difficulties outlined above would disappear if it were possible to cause large r-f currents to flow through one of the long dimensions of the film.

There are two methods of achieving longitudinal currents: (1) by direct connection to the edges of the film, and (2) by stray-field configurations. Figure 1D shows that the aspect ratio of the capacitor formed by the direct-connection method is extremely high, thus causing very low efficiency; electrical and thermal radiation losses and fringing are high, and the apparent power factor of the load is many times lower than the actual power factor of the load material. The only applications in which a high aspect ratio is acceptable are those in which both power factor and dielectric constant of the load material are very high, as in the case of thin films of water-borne adhesives, although even then aspect ratios greater than 100 are to be avoided.

Stray-Field Heating

The stray-field method of causing longitudinal currents to flow is generally superior to the parallel-plate method. A number of practical configurations are shown in Fig. 2. The field intensity due to any of these electrodes is nonuniform across the length of the film, which requires that, if the film does not normally move continuously past or through the electrodes, it (or the electrode structure) must be moved

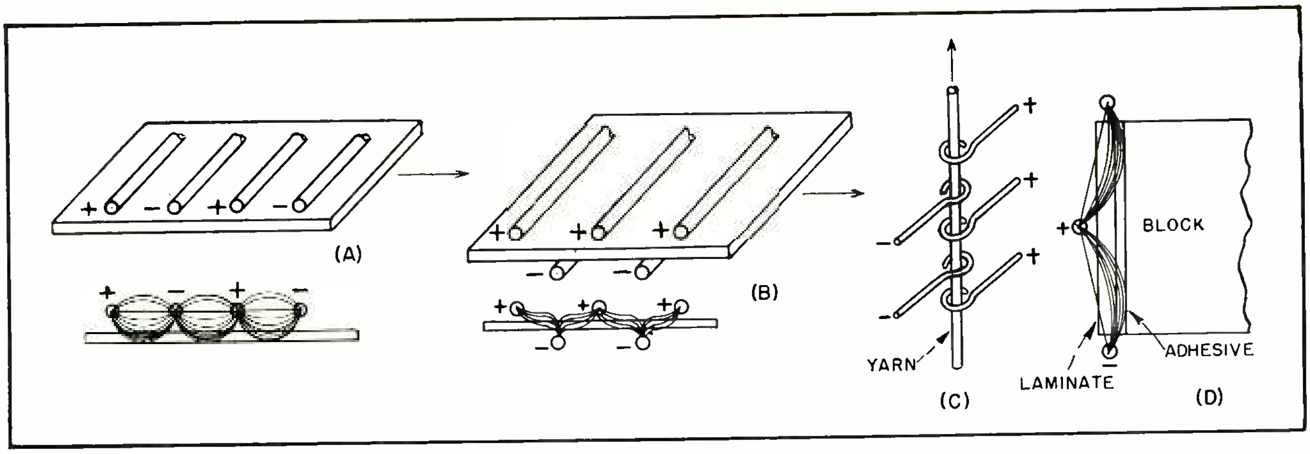


FIG. 2—Arranging electrodes of opposite polarity adjacent to each other along the film (A) or on opposite sides of it (B) minimizes the effect of air gap. The technique can be applied in various ways (C) and (D) depending on requirements

by a suitable oscillating or continuous conveyor system. However, at least 80 percent of the thin-film loads encountered in h-f heating are incorporated in continuous-production processes which not only require very little mechanical revision for the use of the electrodes of Fig. 2 but also provide the motive power for the film.

Electrodes of the type illustrated have none of the disadvantages outlined previously. Furthermore: (1) the capacitance represented by the electrodes (with the load in place) is relatively small, (2) the air-gap between electrodes is relatively large, and the electrodes themselves are generally cylindrical or of a similar shape which discourages arcing, (3) exact alignment of the electrodes is unnecessary because the relative motion between the film and the electrodes tends to cancel misalignment errors, (4) little or no heat loss occurs because the electrodes may be designed with small mass, and, even when in direct contact with the film, present a very small area of contact, with a consequently small conduction loss, (5) the field intensities required to perform a given job of heating are generally lower than those required by parallel-plate electrodes, (6) by means of relatively simple coupling networks it is possible to feed long sections of these electrodes with h-f power without difficulty due to standing waves, (7) because voltage requirements are not as restrictive, and because arcs are discouraged by this type of electrode, most work can be done below 30 mc, which simplifies the power generation problem, (8) the transmission of power to and the establishment of voltage across these electrodes may be accomplished by ordinary methods, and (9) the circulating currents required by loads of this type are not excessive, and conventional generators will readily handle them.

The disadvantages of maintaining an air gap have not been eliminated by selecting this different method of introducing r-f currents into the load. But selecting this type of electrode permits a wider margin of safety between required plate-to-plate voltage and the minimum breakdown voltage of the structure.

All of the electrodes illustrated in Fig. 2 are practical. Selection of the proper one for a given problem is dictated by such factors as: (1) whether or not the electrodes may touch the load, (2) the type of mechanical structure permitted by the process to which h-f heating is being added, and (3) the power factor, dielectric strength, and mechanical characteristics of the film to be heated.

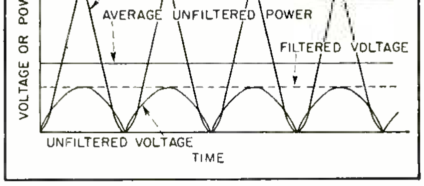


FIG. 3—Arcing at the applicator electrodes limits the peak voltage that can be applied. By filtering the power supply the effective rate of heating can be about doubled

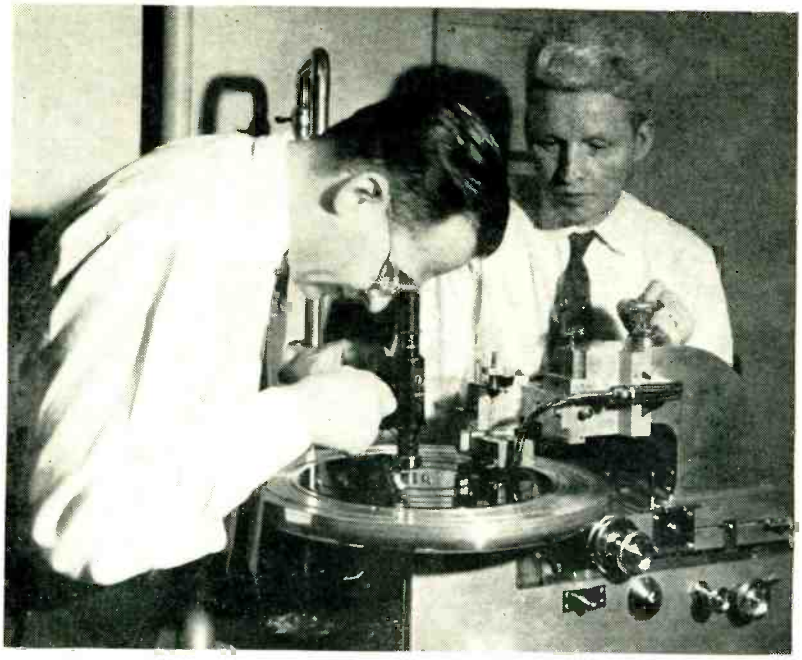
Because of the shape of the electrodes, they tend to radiate considerably, and must be shielded. Tunnel shields which fit around the electrodes snugly and extend some distance beyond them are quite effective. Radiation losses under shielded conditions are negligible. It is important that all surfaces of the electrode structure, particularly the ends of the electrode bars, be well rounded and polished. It is best to use large diameter rods with half-sphered ends.

Design engineers will find that there is an optimum ratio of spacing of the electrodes to their diameters for any given configuration and load. This ratio is often affected by the number of electrode pairs used in an array. Arrangements which permit the electrodes to acquire a coating of any foreign substance, such as adhesive drippings or bits of plastic film should be avoided. Such particles encourage arcs.

Filtered Power Supply

In dielectric heating applications where the power to the load is limited by the arcing voltage dictated by the electrode shape, the maximum average power transmittable to the load may be increased up to 100 percent by filtering the plate supply to the oscillator tubes, if it is not already a pure d-c. That this is so may be seen from Fig. 3.

The author is indebted to John F. Dreyer, Jr., consulting engineer, and Ernst Massey, who devised the arrangement of Fig. 2B, for their cooperation and collaboration in various phases of this development.



Peter C. Goldmark of CBS microscopically examines a new long-playing disk while Rene' Snepvangers looks on

William S. Bachman (standing) discusses one phase of the manufacturing process

Transcription Recordings

New 33-1/3 rpm recording system, cuts up to 300 grooves per inch, achieves low noise with Vinylite and pre-emphasis, Result: a six-record album on a single 12-inch pressing

A NEW APPROACH to satisfy the public demand for long-playing recordings has been jointly announced by Columbia Records Inc., a CBS subsidiary, and the Philco Corporation.

The new recording system, developed by Peter C. Goldmark, René Snepvangers, and William S. Bachman of Columbia, achieves a six-fold increase in recording time per disk by combining 33⅓ rpm transcription-standard turntable speed with an extremely fine pitch of approximately 260 grooves per inch. The decrease in turntable speed from the home standard of 78 rpm introduces a time factor of 2.35, while the larger number of grooves, compared with 85 to 100 per inch typical of conventional home records, provides an additional factor of about 2.6 times. The net result is that as much as 50 minutes of recording time can be accommodated on the two sides of a 12-inch disk, compared with 8 minutes on the older type. The records are known as LP, for long playing.

This is not the first time that 33⅓ rpm disks have been produced for the home market, but it is the first in which a system has been primarily engineered for this market. Earlier attempts failed because the groove pitch could not be made fine enough to secure a substantial increase in recording time, and the noise and distortion were high. Also, home-type turntables of earlier days tended to have excessive wow when operated at 33⅓ rpm. These problems were attacked by Peter Goldmark, well known for color-television developments, and his associates. The Philco Corporation undertook the design of a record reproducer which would meet the stiff requirements of low-speed service and still be marketable at a reasonable domestic consumer price.

Philco has also designed a two-speed turntable with a separate arm for the LP records.

Keys to the success of the new system are the use of Vinylite plastic for the pressings, the development of a new, efficient, light-weight reproducing arm and cartridge and mechanical refinements in the turntable driving mechanism. A pre-emphasis characteristic designed especially for the system, resembling closely the NAB standard transcription curve, was introduced to achieve high signal-to-noise performance. Also, many unconventional techniques have been adopted, including a degree of over-cutting which would not be acceptable in making conventional recordings.

Design Details

The grooves are about 0.003 inch in width, roughly one third the size

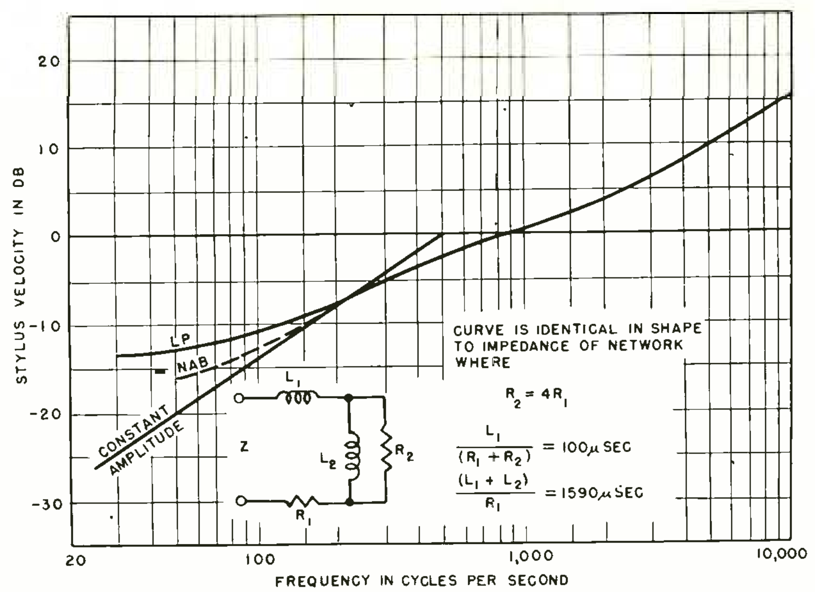


FIG. 1—Characteristics of new long-playing (LP) record, NAB transcription standard, and one having constant amplitude

for the Home

of the standard record groove. Consequently, it is not possible to record at as high a level, by about 9 db as if the cut were held proportional to the groove width. Actually, the level recorded is about 4 db below the usual reference. The 4-db loss in level would not be acceptable if the record material were of the shelac type, but the low-noise properties of Vinylite together with the lightweight pickup permit a highly acceptable noise level to be achieved while maintaining a dynamic range in the order of 45 db. The consequent smaller excursion of the reproducing needle reduces the cartridge output by 4 db, but an efficient crystal has been developed which provides 0.7-volt output at reference level. Accordingly, no high-gain preamplifier is needed in the reproducing system.

The groove shape has an included angle of about 90 deg, and the tip radius is under 0.0002 inch. Accordingly, it is not possible to reproduce the new pressings with a standard 0.003-inch stylus. The cartridge perfected by Philco engineers, uses a balanced Rochelle-salt crystal and a groove pressure of only 6 grams (one-fifth ounce). It employs a semipermanent metal stylus lapped to a tip of 0.001 inch radius. The light pressure and small radius permits the stylus to follow the fine groove with tracking distortion lower than conventional practice. The stylus may be replaced without replacing the cartridge, if desired. To keep distortion at a low level, the diameter of the innermost groove has a minimum value of 5¾ inches, which is almost two inches greater than that of conventional commercial domestic 78-rpm pressings.

The practice of pre-emphasis has been standardized in the new records, using the characteristic shown in Fig. 1. Above 200 cps, the curve is identical with the standard NAB transcription characteristic, reaching 16 db pre-emphasis at 10,000 cps, relative to the 900-cps value. Below 200 cps the characteristic is higher than the NAB, being about 7 db above constant amplitude at 50 cps. The similarity of LP and NAB curves makes it possible to use the LP recordings on standard broadcasting transcription tables with no change in equalizing, although simple RC circuits suffice for equalizing in any event.

Turntable Requirements

The wow problem assumes a serious aspect at 33⅓ rpm, since the speed ratio (1 in 2.35 relative to 78 rpm) requires that variations in turntable speed be reduced by the same amount. The turntables thus far used are of the rim-driven type. Care has been taken in centering the inner edge of the table, and in balancing the motor. Use of a high-grade rubber rim on the idler wheel is mandatory. Moreover, the edge of the rubber rim must be mechanically ground to assure near perfect circularity. In the Philco turntable, the idler wheel is withdrawn from the motor shaft when the table is not turning, to prevent developing a flat in the rubber. The design of the table is such that no appreciable wow was discernible.

Releases and Results

The early releases of the new records consist of rerecordings from existing masters in the Columbia files. Fortunately, in recent years these masters have been made on lacquer, rather than wax, so they may be dubbed without damage directly to the 33⅓ master. More than usual care is required, however, to exclude dust and other foreign matter at every stage in the production of master, mother, and pressings, and the difficulty of securing freedom from blemishes for a 25 minute period (one side) is considerably greater than for 4 minutes. Before release, pressings are checked for technical excellence by engineers on the Columbia staff, a revolutionary procedure in the recording business.

The results, as judged by critical listeners, both technical and nontechnical, are excellent. In frequency range, dynamic range and distortion, the LP records outdistance shellac pressings and, with the possible exception of noise surpass 78-rpm Vinylite pressings.—D.G.F.

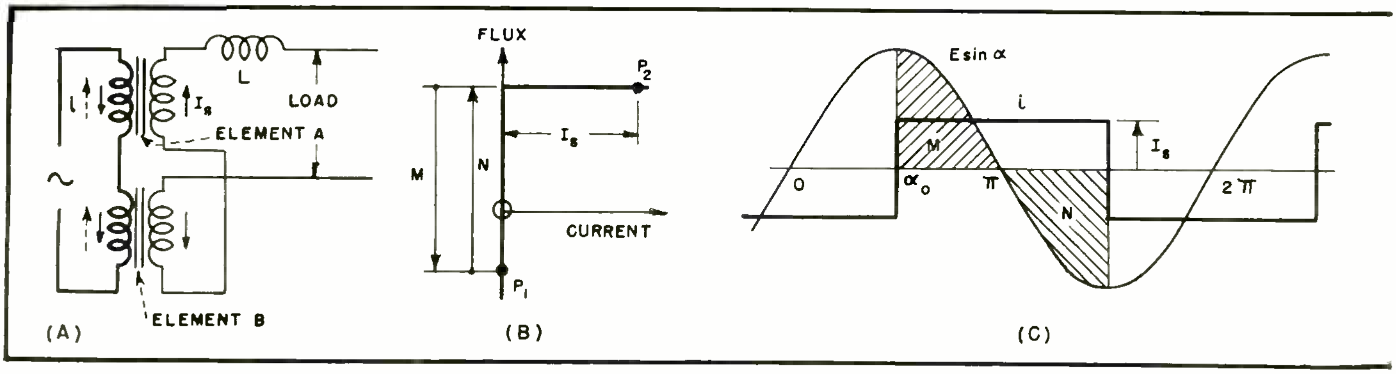


FIG. 2—Simple transductor connection (A) can be analyzed using portion of idealized magnetization curve (B). Voltage-time curves show action during operating cycle with zero

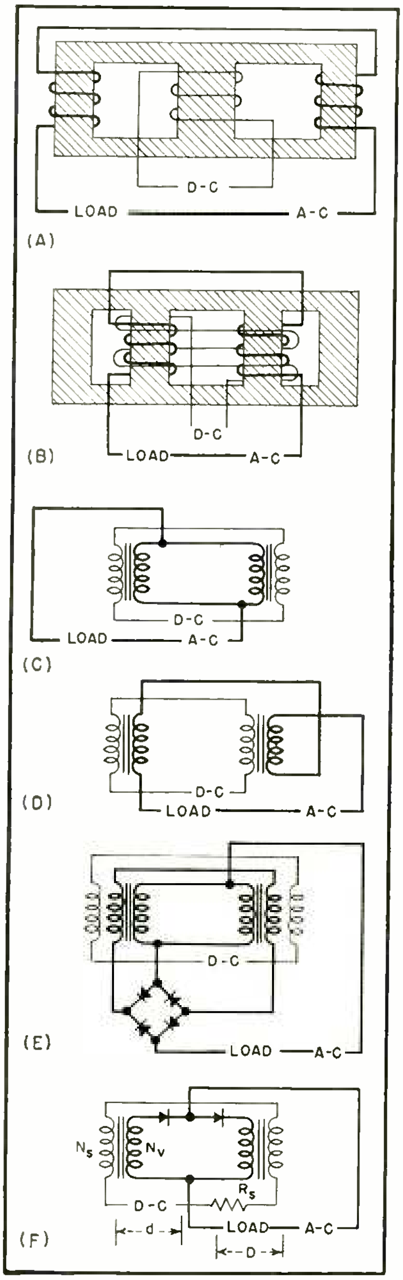


FIG. 1—Windings can be on one core (A) and (B), or on separate cores (C) to (F)

Transductor

By SVEN-ERIC HEDSTROEM and LENNART F. BORG

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ASEA Vasteras
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If a low alternating voltage is applied to a coil wound on an iron core the coil acts as an inductance the value of which is determined by the permeability of iron.

If the operating position on the curve is displaced by applying direct current through a separate winding the incremental permeability then acting diminishes as the position approaches saturation. In this way it is possible to vary the inductance between wide limits.

Because comparatively small direct control current is required the losses incurred in regulating large power are small. Thus a large power amplification is obtained.

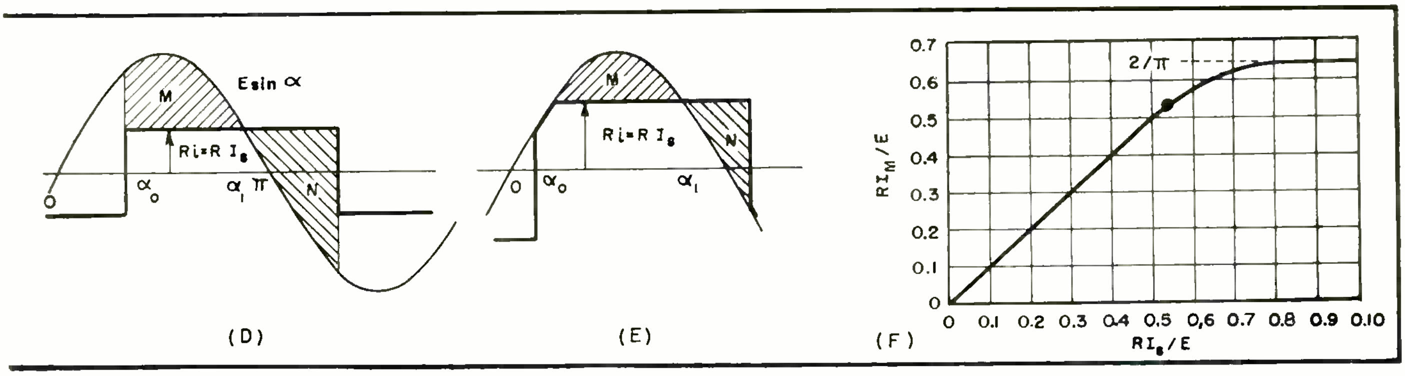
In practice, efficient operation of a direct-current presaturated reactor necessitates employing wide variations of flux. Under such conditions it is inappropriate to base investigations on incremental permeability. Work carried out by Boyajian,[1] Kramer[2] and Lamm[3] has paved the way for an appreciation of the mode of operation and that indicates the basis for calculation and design. On this basis Lamm[4] and others have investigated different couplings and dynamic properties. Instead of studying variations of permeability, variations of flux are investigated and an idealized magnetizing curve having constant slope and abrupt complete saturation is used.

To obtain an indication of flux variations, consider Eq. 1 where ϕ represents the flux in a coil, N the number of turns, and e_l the induced voltage. From Eq. 1 we can write Eq. 2

$$e_l = N d\phi/dt \quad (1)$$

$$\int e_l dt = \phi_2 - \phi_1 \quad (2)$$

which shows that a variation in the flux corresponds to an area (voltage times time) on the voltage-time oscillogram. Using this principle, properties and operation of the d-c presaturated reactor can be analyzed. In this way the mode of operation is found to be different from what is generally termed a reactor, justifying another name.



resistance in a-c circuit (C), with moderate load resistance (D) and with high load resistance (E). In the latter case the control range reaches a limit as shown by the graph (F)

Fundamentals

Magnetic amplifiers are analyzed on the basis of voltage oscillograms, which facilitates interpreting laboratory measurements. Results of the analysis show the effect of load impedance on mode of operation and of supply frequency and inductance on speed of response

These controlled reactors are therefore called transductors.

To avoid the voltage that would be induced in the d-c control winding from the a-c power winding if the two windings were arranged on a single core, a symmetrical arrangement has to be used. Three or four-legged cores could be used. However, the three legged core shown in Fig. 1A has the drawback that its leakage flux impairs the transductor properties. On the other hand the four legged core of Fig. 1B is expensive to manufacture. A simpler arrangement is shown in Fig. 1C in which two separate cores are used. The induced voltages in the d-c windings of the connection shown in Fig. 1D do not counteract each other, but the connection has other advantages and interesting properties. Naturally the windings may be arranged in many ways. Especially, the need for d-c excitation can be minimized if the alternating current is rectified and used to excite the transductor by additional windings as shown in Fig. 1E. This is called a self-excited arrangement. Oscillograms of currents in the a-c and self-excitation windings of Fig. 1E show that the resultant ampere turns every moment are the same as would be obtained by means of only one winding connected in series with a rectifying element. The arrangement thus deduced is shown in Fig. 1F and is called simplified self excitation. By using this connection, winding space is saved in the same way as in an autotransformer. Simplified self-excitation connections can be varied in numerous ways.[5] Single and multiple phase connections are used; the three-phase connections have been treated by Lamm.[4,6]

Mode of Operation

The mode of operation of the connection shown in Fig. 2A can be explained simply if certain assumptions are made: (1) the magnitude of the control circuit current I_s is

UTILITY OF TRANSDUCTORS

Transductors can be self-excited and made to operate as trigger circuits. Thus they can be employed as relays; their opening and closing values are set by applying counter-biasing ampere turns.

Like the electronic amplifier, the transductor can also be made to oscillate. Low-frequency oscillations can be obtained readily.

Electronic amplifiers possess speed that is difficult to obtain with transductors. On the other hand, transductors provide stable low-frequency a-c and d-c amplification with a minimum of equipment. Where loads inherently have long time constants, as in many regulators, inertia of the transductor is negligible.

Transductors require current, whereas electron tubes require voltage for control. A combination of the two may provide excellent solutions of difficult problems. For instance, the transductor may supply voltage for controlling tubes, or tubes may supply current for controlling transductors effectively despite the induced voltages in control windings—

THE AUTHORS

constant and independent of time, represented in the diagram by a large series inductance, (2) the magnetizing curve possesses the ideal shape, (3) the resistance of the a-c circuit may be neglected, and (4) the number of turns on the a-c and d-c windings are the same.

The control current I_s gives element A the initial flux position P_2 shown on Fig. 2B and gives element B a corresponding position on the negative side. Fig. 2C shows the time variations of the characteristic magnitudes. The impressed alternating voltage $E\sin\alpha$ must be fully balanced in the circuit by variations in the flux in the two transductor elements. However, a change in flux is only possible when the number of ampere turns of one or both elements is zero, which means that an alternating current of the same magnitude but directed against the control current must pass continuously. Owing to the counter connection of the control windings on the two elements, this is not possible unless the alternating current commutates between positive and negative values in zero time, the values being of the same magnitude as the control current. No other current combinations are possible. Thus this transductor has a typical current-transformer characteristic, the linear relations between alternating and direct currents being independent of the magnitude of the alternating voltage. The phase of the a-c is determined by the requirement that the voltage across the transductor element cannot include any d-c component. In reference to Fig. 2C this means that the voltage-time areas M and N must be equal, making the control angle α_0 equal to 90 degrees.

It must further be observed that an alternating voltage at twice the supply frequency appears across the d-c terminals. The reactor L prevents this voltage from passing a superimposed current that would altogether change the mode of operation of the transductor.

When there is resistance R as load in the a-c circuit of the transductor, it might be expected that the current-transformer characteristic would be impaired. However, this is not the case, as shown in Fig. 2D. Also in this case the transductor element can only absorb voltage when the alternating and direct currents are of equal magnitude, and, as the resistive voltage drop is assumed to be insufficient to balance the supply voltage, the latter voltage will be split between the resistance and the element (area M) in the time interval α_0 to α_1, as indicated in the figure.

The lowest point P_1 on the magnetizing curve is reached at α_1 and a change in the current still cannot take place because, for it to do so, the magnetic state of the element from P_1 up to the saturation point would have to change by an amount requiring a voltage-time area just as large as that previously required to bring it down from the saturation point to P_1. Thus commutation will take place first when the area M becomes equal to N. When α_0 at an increased resistance drop reaches such a low value that RI_s becomes equal to $E\sin\alpha_0$ i deviates from the rectangular shape as shown in Fig. 2E and Ri coincides for a time with the sine wave. The current-transformer characteristics are thereby jeopardized and,

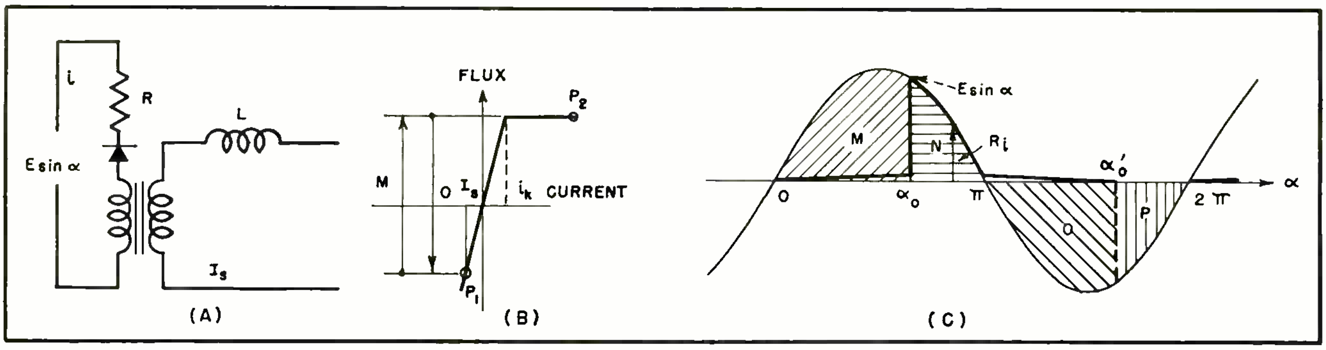


FIG. 3—Operation of a single element of a transductor with an ideal core

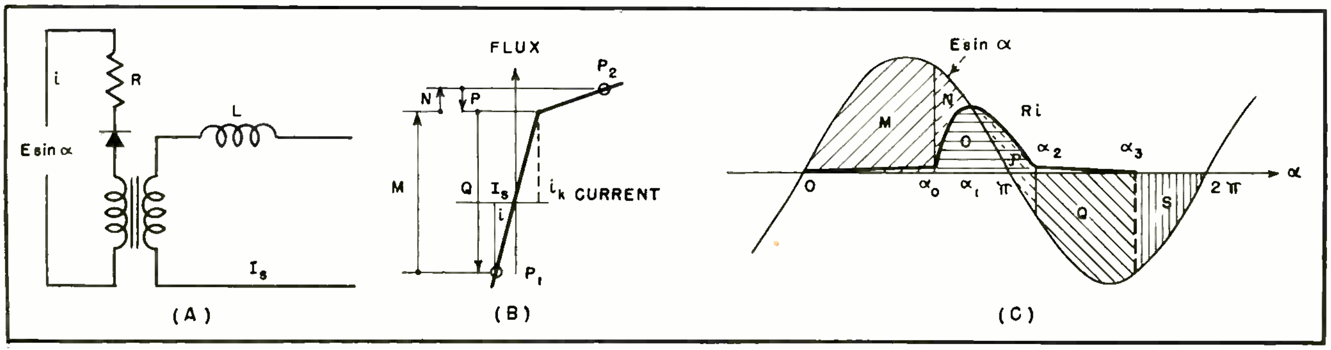


FIG. 4—Analysis similar to that of Fig. 3 but for imperfect core material

Dry-Cleaning

By **JOSEPH ALBIN**
New York, N. Y.

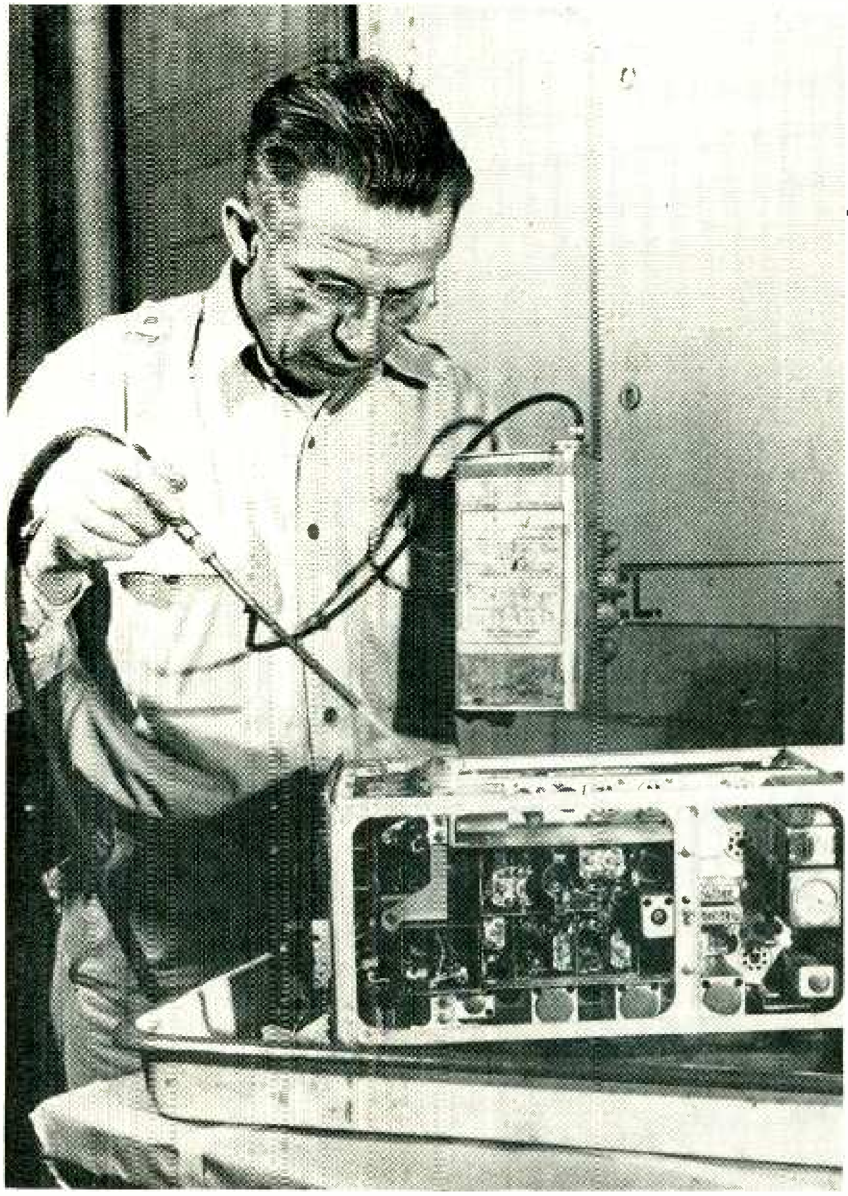


FIG. 1—In well-ventilated working areas, a source of compressed air, gun, tray, Venturi fitting and a solvent can be used for dry cleaning of chassis

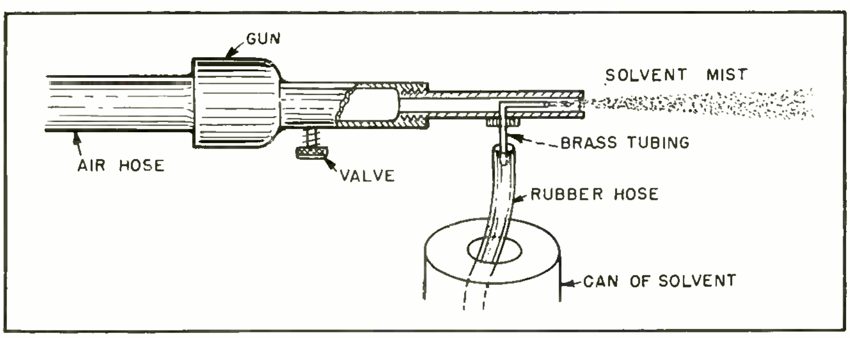


FIG. 2—Construction of simple fitting for air gun to provide fine spray of solvent under pressure

SOLVENT-SPRAY cleaning is one of the maintenance operations undergone by all aircraft and ground radio equipment that is sent to the American Airlines radio overhaul base at La Guardia Field, New York. Overhaul is scheduled after 90 days (average of 900 hours) of operation even though the equipment is operating perfectly. The types of electronic gear cleaned by the spray method include h-f and vhf communication units, adf receivers and indicators, marker, range, glide path and localizer receivers.

A member of the maintenance crew is shown in Fig. 1 going over the chassis of a ground transmitter in one of the hangars. He uses an improvised spray gun constructed as shown in principle in Fig. 2 and connected to a compressed-air line. Solvent contained in the can feeds to the nozzle of the air gun and is sprayed as a fine mist. Because of the pressure, hard to reach places such as capacitor plates and tube sockets are quickly cleaned.

The chassis is supported on blocks in a tray which serves to catch the dirty solvent. As this operation is done in an open space within the hangar, ventilation does not become a problem. To air-dry the equipment after cleaning, it is only necessary to lift the rubber hose out of the solvent can.

The nozzle for the air gun operates on the Venturi principle and consists of a section of metal tubing through which the solvent is aspirated by the air blast. A connection for a rubber hose for insertion in the liquid solvent is made on the side of the tubing a few inches from

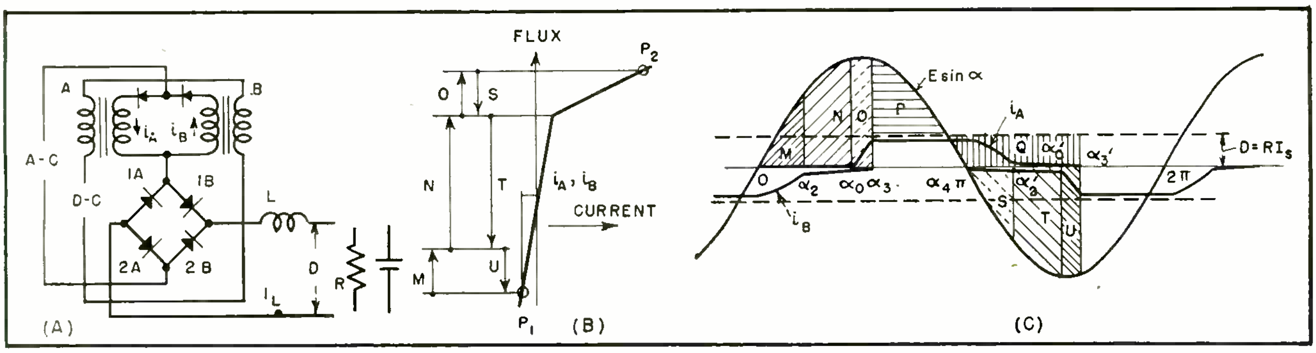


FIG. 5—Analysis like that of two-element transductor shows commutation of current from one element to the other

According to Fig. 5C the relation between the voltage areas is

$$N = T \text{ and } O = U = S = M \quad (4)$$

Furthermore, because the reactor voltage cannot contain a direct component

$$P = Q \quad (5)$$

By comparing the voltage areas between, for instance α_3 and α_3', the magnitude of the direct voltage D can be determined

$$D(\alpha_3' - \alpha_3) = D\,\pi = \int_{\alpha_3}^{\pi} E \sin \alpha \, d\alpha - P + Q \quad (6)$$

but from Eq. 5 and the relation

$$(1/\pi) \int_{\alpha_0}^{\pi} E \sin \alpha \, d\alpha = E_M - E_T$$

where E_M represents the mean value of the alternating voltage and E_T the mean value of the transductor voltage, Eq. 6 becomes

$$D = E_M - E_T \quad (7)$$

Thus the relation is of the first power, and not of the second as might be expected.

Dynamic Response

The preceding analysis has shown that the static conditions in a transductor are determined by the control current, which in effect governs the average flux. The average flux is also the deciding factor in determining how the transductor will momentarily follow the control current until the latter attains a new stationary value. However, the manner in which the control current behaves to a voltage impulse in the control circuit depends on the actual amplification and frequency. Different connections behave differently.

The scope of this article prohibits analyzing all connections, so the following discussion will be limited to the circuit of Fig. 1F. It is assumed that a voltage impulse Δd is impressed on the control winding, which, under steady-state conditions, would cause an alteration ΔI_S in the control current. At the same time the lowest value of flux would be changed from ϕ_1 to ϕ_2, both values being below saturation. The problem is to find the manner in which the load voltage D changes with time ($\Delta D = D_1 - D_2$).

The average load voltage during a half cycle corresponds to the difference between the supply and the transductor voltages so that

$$D_1 = E - 2 N_V f (\phi_0 - \phi_1) \quad (8A)$$

$$D_2 = E - 2 N_V f (\phi_0 - \phi_2) \quad (8B)$$

f representing the supply frequency, N_V the number of turns on the a-c winding. Hence

$$\Delta D = D_1 - D_2 = 2 N_V f (\phi_2 - \phi_1) \quad (8C)$$

but the control current must change the average flux from ϕ_{1M} to ϕ_{2M} so

$$\phi_{1M} = (\phi_0 - \phi_1)/2 \quad (9A)$$

$$\phi_{2M} = (\phi_0 - \phi_2)/2 \quad (9B)$$

$$\Delta\phi_M = \phi_{1M} - \phi_{2M} = (\phi_2 - \phi_1)/2 \quad (9C)$$

If the fictitious inductance of one control winding is L_S and the number of control turns is N_S then

$$L_S = \frac{N_S \Delta\phi_M}{I_S} = N_S \frac{\phi_2 - \phi_1}{2 \Delta I_S} \quad (10)$$

and the time constant of the complete transductor is

$$\tau = \frac{2 L_S}{R_S} = N_S \frac{\phi_2 - \phi_1}{R_S / I_S} = \frac{N_S \Delta D \, (\phi_2 - \phi_1)}{2 N_V f \, (\phi_2 - \phi_1)} \cdot \frac{1}{R_S \Delta I_S} \quad (11)$$

but because $R_S \Delta I_S = \Delta d$ Eq. 11 simplifies to[8]

$$\tau = (\Delta D / \Delta d)(N_S / N_V)(1/2f) \quad (12)$$

which gives the time constant for the rise in load voltage in response to a voltage step in the control circuit. Thus, if the amplification remains constant, the time constant can be reduced either by increasing the frequency of the supply voltage or by selecting a magnetic-core material possessing properties that allows N_S to be reduced. The three properties, power amplification, power sensitivity, and time constant, of a self-excited transductor depend on each other in such a way that one of them can be improved only at the expense of the other two. The rapidity of the transductor is limited by the fact that the control current cannot exert any influence on the transductor during the interval when any of the elements carry the main current; that is, between α_0 and π.

The development of the transductor techniques of which this article is a brief review has been carried forward especially by A. U. Lamm and U. H. Krabbe and by many collaborators. The authors are indebted to ASEA for permission to publish this article.

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(8) U. H. Krabbe, The Transductor Amplifier, Dissertation Copenhagen (to appear), also The Transductor, Principle and Application, *ASEA Jour*, 20, p 119, 1947.

is set by means of the control current I_s giving an initial position P_1, which represents the lowest possible value of flux because the alternating current will be prevented by the rectifier from passing through the transductor in such a direction as to force the flux still lower. In relation to the rectifier, the alternating voltage will be negative immediately before the point $\alpha = 0$. At that time no current i can pass, but after the voltage has changed sign at $\alpha = 0$ it can pass in the forward direction of the rectifier, producing not only a voltage drop in load R but also a change in flux in the transductor element.

It is now of great importance to assume that the voltage drop in R is small as long as $i < I_s + i_K$ and consequently may be neglected. The entire voltage-time area between the zero axis and the sine wave can therefore produce change in the flux as long as the magnetizing curve permits. The knee of the curve is reached at α_0 and further area beyond that of M of the same polarity cannot be absorbed by the transductor element. Instead, the entire voltage is transferred to the load, the current through R momentarily assuming a value at which the voltage balance; $Ri = E\sin\alpha_0$ and area N is swept out. When the voltage changes sign at $\alpha = \pi$ and the diminishing current passes the knee at the same time, the element can again absorb voltage (area O). At α_0' the current becomes zero and the remaining voltage-time area P acts across the rectifier until α becomes equal to 2π, whereafter the cycle is repeated. Because the voltage across the transductor element cannot contain a d-c component the areas M and O are equal and consequently areas N and P are equal.

Effect of Magnetizing Curve

Even if magnetizing curves of modern magnetic materials can be made to approach more nearly that of Fig. 3B[7] it is of practical value to be able to predict the properties of a transductor whose magnetizing curve departs from the ideal. How this is done, in comparison to the technique described in connection with Fig. 3, is shown in Fig. 4.

At α_0 the current cannot assume a value that impresses the whole voltage across the load because a change in the flux continues to take place within the saturation range. Thus the voltage is divided between the load and the transductor element (areas N and O). At α_1 however, the voltage across the element becomes zero, which means that the maximum point P_2 of the flux has been reached and that the current has reached its maximum value. Because the negative area P depends upon the current from P_2 falling off, the current will thereafter be maintained at a value exceeding that required by the alternating voltage. The relations between the areas (and as shown in Fig. 4B) are $M = Q$ and $N = P$, so that $O = S$.

Within the range α_0 to α_2 the current may be expressed as

$$i = (E/R)\,[\cos\phi \sin(\alpha - \phi) - \sin(\alpha_0 - \phi)\exp - \cot\phi\,(\alpha - \alpha_0)] \quad (3)$$

where $\phi = \text{arc}\tan X/R$, X being the reactance, which is represented at the prevailing frequency by the slope of the magnetizing curve within the saturation range.

Multielement Transductors

The transductor connection just described, containing only one element, operates satisfactorily but in practice units comprising several elements are usually employed. There are two reasons for using at least two units: d-c excitation of the transformer feeding the transductor is avoided, and smoothing of the control current can be omitted because the voltages induced in the elements counteract each other in pairs.

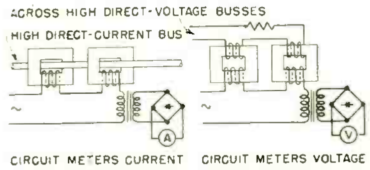
The mode of operation and method of designing transductors comprising several elements can be predicted in the same manner as described above for one element. To show how this is done consider the connection of Fig. 5A, which is a widely used circuit in which the load is taken out as smoothed d-c. The magnetizing curve and oscillogram are also shown in the figure. The rectified current I_L is assumed to be smoothed to the extent that it is entirely relieved of pulsations. Within certain intervals the a-c will then be lower than the d-c and can pass through the rectifier without having to flow through the load. This mode of operation is termed current-peak rectification and is analogous to voltage-peak rectification by means of a rectifying element and a capacitor.

If the resistance of the transductor elements is assumed to be zero, the rectifying elements will never be subjected to reverse voltage. Consequently a change in flux in one of the magnetic elements produces an equal but opposite change in the other one; the rectifiers determining the direction of the current. Figures 5B and 5C show the behavior of the A element. A magnetic displacement in this element produces an equally large but opposite displacement in the other one. After α has become zero the entire alternating voltage is impressed across the A element. A very small excitation current i_A passes through the rectifier that is carrying load current without causing any voltage drop. The knee of the magnetizing curve is reached at α_0 and i_A rises more rapidly thereafter but still under the control of the magnetizing curve and the voltage areas M, N and O. At α_3 the current i_A becomes equal to I_L and flows in branches 1A and 2A of the rectifier and to the load. The reactor then prevents any further increase in i_A for a certain interval. Because no change in flux in the transductor can take place, the entire alternating voltage appears as a constant voltage D across the load and a voltage across the reactor corresponding to area P. Even after α_4 when $E\sin\alpha$ becomes smaller than D, i_A retains its value because there is no voltage available that might produce a change in flux tending to lower the current. After $\alpha = \pi$ such a voltage becomes available as indicated by area S and i_A decreases. From α_1, D is maintained by the reactor voltage (area Q) which has changed sign due to the tendency of the current to decrease. At α_3' current i_A regains the value corresponding to the lowest point on the magnetizing curve and the A element becomes inactive for the remaining half of the cycle. Because the connection is symmetrical, current in the B element begins to rise to rise at α_0' but does not affect the behavior of the A element.

TRANSDUCTOR APPLICATIONS

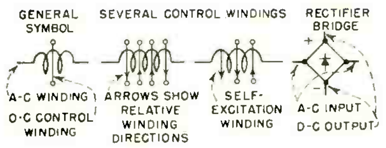
Transductors, like transformers are basic components that can be applied in numerous ways.

One type transductor possesses characteristics of a current transformer. It can be used to measure heavy direct currents or high direct voltages as shown in the accompanying illustration. Measuring

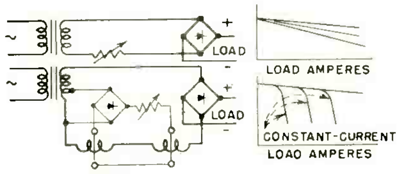


transductors can be built from ordinary transformer laminations and have an accuracy sufficient for service supervision (± 2 percent). By employing special laminations, higher accuracy can be obtained. In addition to the feature of complete isolation between the main circuit and the metering circuit, the measuring transductor has the advantages that the quantity operating the indicating instrument is a-c and therefore can be transformed to any desired value; measurement of summation and differential quantities can be made simply because the quantity to be measured appears as ampere turns, current is measured directly and not translated into voltage as in using a shunt (particularly important with remote measurements), and the power consumption is exceedingly low.

Voltage and current regulation is the most important application of transductors. For simplicity in drawing diagrams of circuits using transductors, rectifier bridges and the several windings of the transductor elements are shown in abbreviated form.

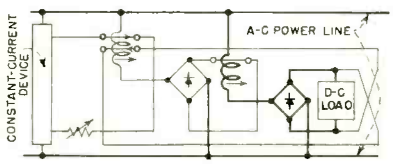


A metallic rectifier can be controlled by a simple series resistance giving the characteristics shown below, or a series transductor can be used. In the latter case power required for regulation is small and the output current is more



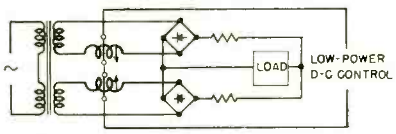
perfectly determined by transductor control current. Until limited by voltage, the current is independent of load resistance. Such circuits are extensively used in battery chargers for trucks and other cases where constant current is required. (For clarity the control portion of the circuit is drawn in lighter lines than the power portions.)

In charging batteries where the voltage must be kept constant, as in broadcast stations and telephone exchanges, a slightly more complex circuit is used. A self-excited transductor provides the regulation. This transductor is, in turn, controlled by a smaller unit the output voltage of which is determined by the total number of ampere turns of its excitation windings. A constant current supplied to one control winding in the same direction as the self excitation sets the regulated value. Another control winding fed



in opposition to the first carries the sensing current that is proportional to the load voltage. Because two transductors are used, the regulation is high. A rectifier of this type which can operate on both constant current and constant voltage is called an avostat. Avostat-regulated rectifiers can be built for all outputs for which metallic rectifiers can be used.

When very little power is available from a quantity to be measured, the high amplification of self-excited transductors can be used. The accompanying circuit shows a push-pull connection giving an output voltage the polarity and magnitude of which are determined by the control



current. Power amplifications as high as a hundred million may be obtained from similar connections. If gain is sacrificed for stability, such transductor circuits are suitable for amplifying currents from photocells and thermocouples—

THE AUTHORS

as shown in Fig. 2F, the relation between the currents follows a straight line only up to a certain point, whereafter it is deflected and asymptotically approaches a limiting value corresponding to the full alternating voltage being balanced by the resistance drop.

Transductor as Amplifier

For a transductor (Fig. 2A) with a resistive load in series with the a-c winding, amplification takes place because the a-c winding requires an input corresponding to only half the copper losses, whereas the load may rise to a value corresponding to the entire transformer output of the transductor. The method, described previously, of decreasing the need for d-c ampere turns by rectifying the a-c and feeding it back by means of a separate winding, or by inserting rectifying elements in series with the a-c windings, is analogous to the feedback used in electronic amplifiers whereby amplification is increased at the expense of linearity. The connection providing simplified self excitation (Fig. 1F) has advantages over that of Fig. 1E and is also easier to analyze. Therefore this connection will be treated in detail.

A transductor element and a rectifying element connected in series between two current-dividing points constitutes a common feature of all simplified self-excitation couplings. The connection, the assumed shape of the magnetizing curve and the mode of operation as represented by the oscillogram are shown in Fig. 3. A certain d-c bias

Electronic Equipment

Rapid removal of soot, dirt and grime is accomplished with pressurized air and a solvent. Used at an airline radio overhaul base, the method can be adapted to maintenance of other electronic equipment

the end. Pressure control is obtained by means of the valve on the air gun.

With a nozzle orifice diameter of 0.125 inch, and air pressure of 40 pounds, the discharge of free air amounts to 12.4 cubic feet per minute. At 90 pounds pressure, the volume is slightly less than double this figure. For an orifice diameter of 0.25 inch, the volume is roughly quadrupled.

An installation suitable for factory applications is shown in Fig. 3. A large container of solvent is attached to the side of the booth and replenished as required. The solvent fluid reaches the nozzle through one of the flexible hoses; the other is for compressed air. Pressure is regulated and monitored by a valve and gage mounted in front of the booth. The cylindrical section contains a filter unit to remove moisture and scale. If driven out by high air pressure, the scale is likely to abrade or otherwise damage the radio equipment.

The booth is similar in all respects to the type used in spray painting, and is vented in the upper rear portion. Used solvent flows down a drain into a receptacle located below the booth.

In cleaning the radio unit shown, the air pressure is between 30 and 40 pounds. To dry, the operator turns a valve which shuts off the flow of solvent into the nozzle. In the overhaul shop, each man cleans the particular piece of equipment he is assigned to service.

A few changes are necessary when cleaning parts having more tenacious deposits of dirt, hence requiring higher air pressure, sometimes as high as 110 pounds. An extra long nozzle is used as well as protective gloves for the operator. Higher pressures can be safely applied to motors and heavy equipment.

Dry-cleaning solvents are of comparatively low inflammability and are nonexplosive. They follow in general the specification for Stoddard solvent, a standard fraction of petroleum, having a flash point between 100 and 105 F. At this temperature sufficient vapor is given off to flash momentarily on the application of a small flame.

In the Airlines laboratory, the chief characteristic checked in solvents is a minimum flash point of 110 F, determined by the Cleveland open-cup test. This is slightly higher than Stoddard solvent. Clarity and dryness are important factors. These flash points may be compared with that of ordinary gasoline at room temperature.

For regular production schedules, solvent-spray cleaning is best done for general comfort and health in a hood or booth that is vented to the outside atmosphere by means of a blower. Where the booth is lacking, the spraying should be carried out in an open and well-ventilated area. Ordinary fire extinguishers, such as those containing carbon tetrachloride, are precautionary equipment. A settling tank can be used for reclaiming a high percentage of the solvent.

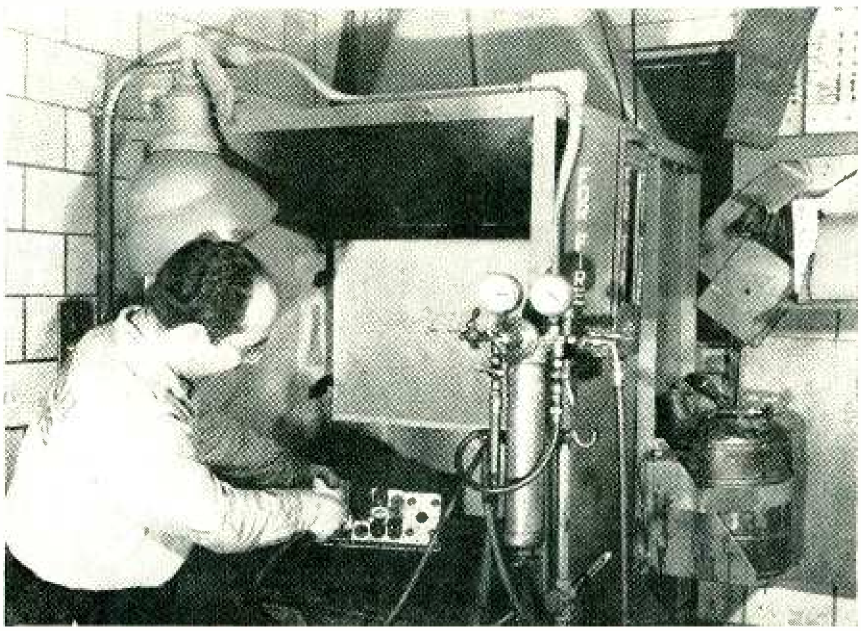


FIG. 3—Solvent spray booth for permanent installation in a factory, shop or laboratory. Fumes are vented to the outside air and additional equipment provided for control of air pressure, filtering and safety

SUPERREGENERATIVE

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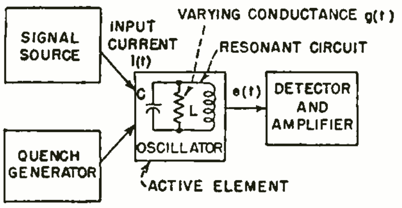

$$e'' + P(t)e' + [\omega_0^2 + P'(t)]\,e = i'(t)/C \quad (1)$$

where $P(t) = g(t)/C$ and $\omega_0^2 = 1/LC$

$$e'' + P(t)e' + \left[\omega_0^2 + \frac{P'(t)}{2} + \frac{P''(t)}{4}\right]e = 0 \quad (2)$$

satisfied by $e = \exp - 0.5 \times \int P dt \pm j\omega_0 t$

$$E(t) = (1/j\omega_0 C) \times \int_{-\infty}^{\infty} F(t,\tau)\, i'(\tau)\, e^{-i\omega_0 \tau} d\tau \quad (3)$$

which for $i(t) = I\cos\omega_s t$, becomes

$$E(t) = (I/2C) \times \int_{-\infty}^{\infty} F(t,\tau)\, e^{i(\omega_s - \omega_0)\tau} d\tau \quad (4)$$

$$F(t,\tau) = \begin{cases} 0 \text{ for } \tau > t \\ \exp - 0.5\int_{\tau}^{t} P(t)dt \text{ for } \tau < t \end{cases} \quad (5)$$

FIG. 1—Chief element of superregenerative detector is resonant circuit with varying damping; the equations describe it

An investigation into the operating mechanism of the superregenerative detector, has used physical reasoning and results of measurements.

The specific object of the investigation was to develop a theory that would identify the factors controlling selectivity, optimum quenching, signal-noise ratio, and account for the difficulty of reproducing a given response from one design to another. Because most superregenerative detectors combine in one tube at least four distinct functions, it is not surprising that the behavior of the circuit is complex.

A superregenerative detector, the elements of which are shown in Fig. 1, ordinarily consists of an oscillator having a resonant circuit tuned to the frequency of the desired signal. This circuit is fed from an r-f stage, converter, or antenna, which can be considered a generator of current $i(t)$. The oscillator is caused to operate intermittently by means of a quenching signal supplied from an auxiliary oscillator or from low-frequency oscillation of the same tube. This quenching action can be represented by a varying conductance $g(t)$. The combination of resonant circuit and varying conductance constitute the active element. In addition there are the auxiliary elements, an oscillation detector and an audio or video amplifier. An automatic regeneration control feedback from beyond the oscillation detector to the active element may also be included.

The circuit performs four fundamental operations in sequence: (1) Quenching erases the effect of the previous cycle of operation, clearing the circuit for reception of new impressions; this is done by cutting off the oscillating tube or by damping the circuit. The varying conductance is positive during quenching. (2) Reception takes place when the incoming wave sets up a signal in the circuit as the quenching is withdrawn. (3) Amplification begins when the quenching is sufficiently withdrawn (conductance made negative) so that oscillations will grow in the circuit. This action continues until the overload level is reached or the circuit is again quenched. (4) Detection, usually in the form of a change in oscillator grid or plate current and sometimes using a separate crystal or vacuum diode or a change in quenching rate, produces an output that varies according to the rapidity with which full amplitude of oscillation is reached, and depends on the principle that the stronger the incoming signal the sooner the oscillation will reach full strength, usually several volts. At the end of this operation the varying conductance may fall to zero and the oscillations cease to grow, but nevertheless the requisite energy is delivered to the detector and amplifier.

Of the four operations, least is generally understood of the reception action. It is not obvious at what instant and in what manner the forced oscillation of the circuit produced by the incoming signal changes to free oscillation of the resonant circuit. To determine this and other circuit actions, an approximate solution of the differential equation of a tuned circuit with varying damping was made. Another rigorous approach, based on the superposition integral, has verified the results and indicated the trivial nature of the error in the approximate solution.

Reception and Amplification

To obtain a detailed picture of the behavior of the active element during reception and amplification of an incoming signal consider that a current $i(t) = I \exp j\omega_s t$ is continuously applied. At negative time (during the quenching operation) the varying conductance $g(t)$ has a large positive value; it varies in some manner through zero at $t = 0$ to a generally negative value for positive values of t. The problem is to find the level of oscillation during the amplification operation.

The problem involves the solution of a linear second order differential equation with the coefficient of the first derivative varying with time. This is Eq. 1 (Fig. 1); the primes indicate differentiation with respect to time. The instantaneous voltage on the resonant circuit is $e(t)$; incoming signal is $i(t)$.

The rigorous solution of Eq. 1 is difficult to obtain and use because, to be mathematically complete, it

DETECTION THEORY

Operation of the superregenerative detector is developed, leading to the concept of a time aperture function. Bandwidth, signal-noise ratio, and other circuit properties are shown to depend on this function, whose values in turn depend on the quenching waveform

must include the effect of the resistance on the resonant frequency and all of the phenomena that hold for large values of $P(t)$, the damping factor, including the transition between oscillating and nonoscillating states. For present purposes such a solution is unnecessary because, in the practical case $P(t) \ll \omega_0^2$ and, for quench frequencies low compared to the resonant frequency $P'(t) \ll \omega_0^2$.

Under these conditions a very similar second order equation (with its right hand member zero), Eq. 2, can be used for comparison. The first two coefficients of Eq. 2 are identical with those of Eq. 1 and the third is negligibly different; hence, over a limited time, the solutions of the two equations cannot be very different in nature. In fact in the practical case of a high-frequency superregenerative detector the third coefficients of the two equations differ by less than the error in measuring ω_0. For the purpose of this analysis the solution of the comparison equation Eq. 2 differs negligibly from the correct solution of the reduced or homogenous form of the circuit equation.

Knowing the two functions e_1 and e_2 that satisfy the reduced equation, the complete solution of the equation with right hand member can be found by the method of variation of parameters (Lester R. Ford, "Differential Equations", McGraw-Hill Book Co., New York, 1933, p 75.) The solutions are Eq. 3, 4 and 5.

Equations 3, 4 and 5 embody a complete solution to the problem. The function $F(t,\tau)$ is called the time aperture function and, as will be shown, is of basic importance in describing superregenerative detection. Equation 3 states that the voltage envelope amplitude across the resonant circuit at a particular instant of observation, t, depends on an integral of the product of the time aperture function and the input signal, the integration being performed over the preceding time, τ, so that each time element of input signal contributes to the output with a relative importance determined by the value of the time aperture function. Usually the time aperture function has one very large peak, at the moment when the damping passes through zero, and falls rapidly to small values on either side of this moment. Therefore the incoming signal at the moment of zero damping has the greatest effect on the output. This behavior gives rise to the sensitive period of the detector.

Equation 4 expresses the output due to a carrier that remains substantially constant in frequency and amplitude during one quench cycle. The integral is of the same form as the Fourier analysis integral that gives the frequency spectrum of a pulse. As a consequence the time aperture function is related to the selectivity curve of the superregenerative detector in the same way that the waveform of the envelope of a pulsed carrier is related to its spectrum. Thus, for example, a narrow time aperture function causes a broad band receiver and a broad function causes a narrow acceptance band.

The time aperture function is given by Eq. 5 provided the variation of damping with time is known; that is, when $P(t)$ is known. In geometrical terms, if a function of time is drawn having everywhere a slope of $0.5P(t)$ and intersecting the time axis at time t of observation of the resonant circuit voltage, the curve for time prior to t is the natural logarithm of the time aperture function. This process is illustrated in Fig. 2.

Suppose that a sine wave is used for quenching, and that it cuts off the oscillator tube for a large part of the cycle; this sort of operation is usual in some of the older separately quenched superregenerative detectors. Then $P(t)$, the exponent gand $F(t,\tau)$ are shown in Fig. 2B.

By sketching the form of $F(t,\tau)$ for various values of t it is discovered that the area under $F(t,\tau)$ increases rapidly with increasing t, showing that $E(t)$ is growing rapidly with time during the amplification phase. It is also found that the peak of $F(t,\tau)$ as a function of τ occurs at the instant that

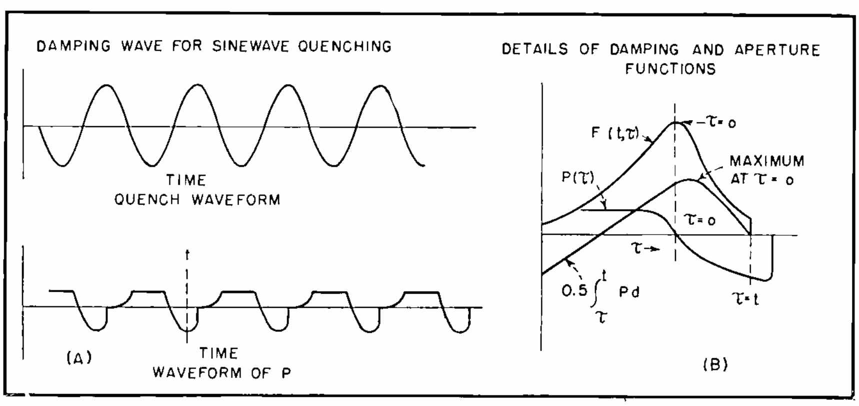

FIG. 2—Variation with time of the damping and aperture functions depends on the form of the quenching wave

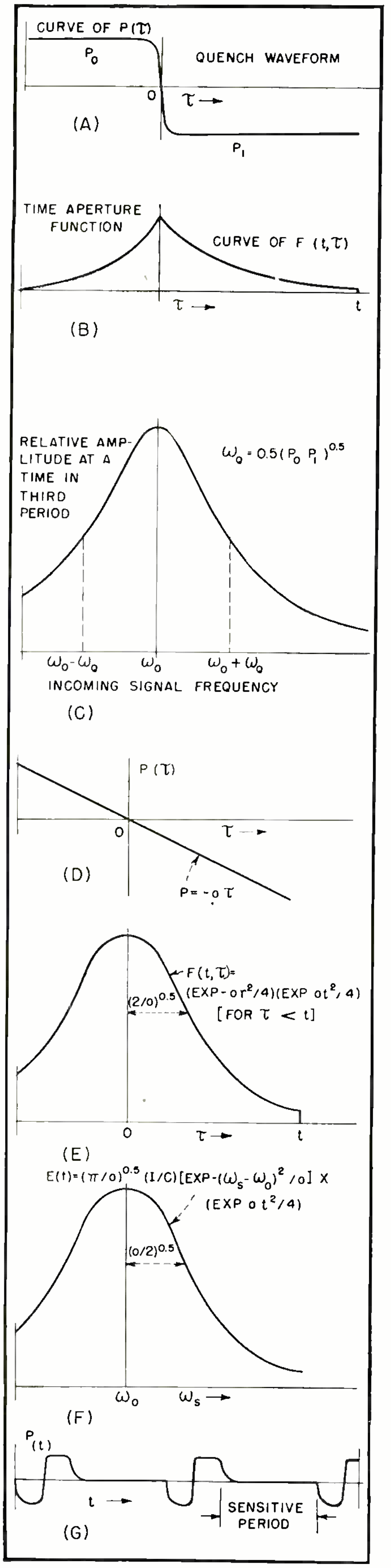

FIG. 3—Knowing the time variation of the damping, the aperture function and pass band can be determined. Optimum quenching waveform is given at (G)

$P(t)$ passes through zero.

The theory developed in the foregoing analysis can be applied exactly in a few interesting cases. Suppose that a square quenching wave is used such that $P(t)$ is positive and equal to P_0 prior to $\tau = 0$ and that it is negative and equal to $-P_1$ thereafter. The quench waveform and time aperture function for this case are shown in Fig. 3A and B. The relative amplitudes of the signal in the amplification phase are also shown (Fig. 3C); this later curve is effectively the selectivity curve of the detector.

For a sensitive, narrow-band detector with a square quenching wave, $-P_1$ should be made as small as is consistent with the chosen quench frequency. For thorough quenching in a short interval P_0 must be large.

Another practical case is that of linearly changing $P(t)$. The commonly used sine wave quenching wave causes $P(t)$ to change from positive to negative nearly linearly. The bandwidth and time aperture function $F(t,\tau)$ depend on the rate of change of $P(t)$. If $P(t)$ has been changing linearly in a negative direction since $t = -\infty$ and at $t = 0$ passes through zero, the voltage $E(t)$ at time t due to an input $I \cos \omega_s t$ can be found as outlined at Fig. 3D through 3F. For this special case both the time aperture and the frequency response have the shape of a probability function.

Requirements for Optimum Quenching

The almost proverbial poor signal-noise ratio of superregenerative detectors is mostly due to the short effective duration of the time aperture function. In most cases the time aperture function has an effective duration, measured between points of half-peak sensitivity, much less than a tenth of the total quench period. Statistical theory indicates that the signal-noise ratio should vary directly as the square root of the ratio of the effective duration of the time aperture to the total quench cycle duration.

The narrowest band and greatest sensitivity as well as the best signal-noise ratio appear to be obtainable when $P(t)$ has a large positive value during the quenching period (first operation), which is made as short as is consistent with thorough quenching, followed by a value of zero during the entire reception period (second function), which is made as long as possible. The amplification (third function) and detection (fourth function) periods should be as short as is practical. To achieve this result, $P(t)$ should become quite negative so as to amplify quickly the voltage existing at the end of the reception period to a usable level. The required waveform is shown in Fig. 3G.

Certain additional precautions must also be observed in designing superregenerative detectors. The quenching must be complete, otherwise remnants of oscillation persist from the preceding cycle, spoiling the sensitivity of the receiver. Ringing or spurious modes of resonance associated with r-f chokes, quenching circuit coils, or other components can interfere with the quenching, retaining a remnent signal to compete with the new incoming one. Typical symptoms of this difficulty appear when a sharply resonant circuit such as a wavemeter is momentarily held close to the active element. Another effect, usually serious only in low-frequency superregenerative detectors, is shock excitation of the active element by the quenching wave. This action reduces the sensitivity; it is eliminated by restricting the frequency content of the quench.

A simple way of testing for the presence of any of these difficulties is to examine the shape of the selectivity curve with a weak incoming signal. The selectivity curve should be smooth and single peaked. Any of the above difficulties will cause peaks separated by an interval equal to the quench frequency.

Although superregenerative detectors may take a bewildering number of special forms depending upon application, the theory developed above has been found to explain the behavior of all forms investigated during the past five years in this laboratory. In each case the development centered around obtaining the prescribed aperture function. Once this had been accomplished the selectivity and signal-noise ratio measured on the detector agreed substantially with the calculations.

SUPERREGENERATOR DESIGN

Gain and selectivity of superregenerative receivers can be predicted by the principles that are developed. Circuit operation and the effects on operating characteristics of changing various components are explained. Effects of specific quenching waveshapes are discussed

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A SUPERREGENERATOR consists of a resonant circuit and an oscillator or regenerator tube, as shown in Fig. 1A. The resonator has a positive damping G_+ consisting of the inherent and coupled losses of the tuned circuit. The resonator is also periodically supplied with an effective negative conductance ($G_- - G_+$) by regenerator tube, which is switched on and off by a quenching voltage to produce this effect.

Much prewar information on this circuit is vague, particularly that concerning gain and selectivity. Extensive war-time application of superregeneration in IFF equipment required a thorough investigation. Late in 1942, H. A. Wheeler developed the basic concepts that lead to a clarification of the characteristics of this device. A summary of this theory is given and it is shown how it can be used as a guide in designing superregenerative receivers.

The Superregenerator

In the circuit described above, transient oscillations, excited by a signal in the tank (Fig. 1B), build up exponentially during the period of negative conductance. When the

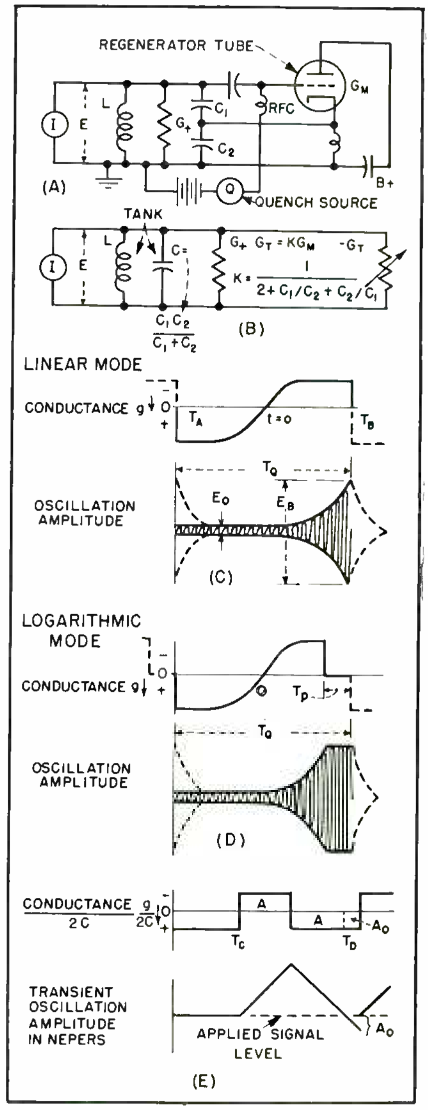


FIG. 1—Superregenerative circuit (A) and equivalent circuit (B) and relation of oscillation amplitude to waveshape of conductance (C), (D) and (E) under various conditions

INDEPENDENT INVESTIGATIONS

This and the preceding article present similar material. One might ask why the duplication. There are two reasons:

(1) Simultaneous investigations of the superregenerative circuit were made, each deserving recognition through publication.

(2) Use of this circuit has been hampered by lack of an adequate explanation of its operation. The subject might still be considered controversial had independent investigators not come to similar conclusions. It is important to progress that there be duplication of effort so the investigators will constantly be checking each other's results.

Now that some agreement has been reached on theory and design factors, numerous applications of the superregenerative method for obtaining stable and extremely high amplification will be found.

quench voltage turns off the regenerator tube, a period of positive conductance results during which the oscillations are quenched. In most applications it is desirable for the transient oscillations of one quench cycle to almost completely die out so that the transient of the next quench cycle is started mainly by the applied signal.

In the linear mode of operation (Fig. 1C) the regenerator tube is turned off and oscillations are quenched before they reach saturation. The oscillations at the end of the negative conductance period, which are generally fed to a peak detector, are linearly related to the applied signal amplitude.

In the logarithmic mode of operation (Fig. 1D) the regenerator tube stays on until the oscillations reach saturation. The duration of saturation varies with the amplitude of the applied signal, giving, for separately quenched operation, a saturation pulse width that is approximately a logarithmic function of signal amplitude. For self-quenched operation a quench rate that is approximately a logarithmic function of signal amplitude results.[1] Detection of a-m in the logarithmic mode may be obtained by using a separate averaging detector or by using the variations in the regenerator tube electrode currents. The transient oscillation energy of a logarithmic-mode superregenerator has also been used to feed an f-m detector.[2] For studies of gain and selectivity it is convenient to ignore the detection action, and to consider the superregenerator as merely a carrier-frequency amplifier.

Calculating Gain

Action of the superregenerator as an amplifier can be described by considering the tank with its inherent and coupled positive conductance as being shunted by a periodically varying negative conductance, representing the regenerator tube. A general shape of conductance-time variation is shown for the two operating modes in Fig. 1C and D.

For calculating gain and selectivity, it is convenient to consider that a cycle of quench operation starts at T_A when the oscillations of the previous cycle are being damped out and the input current I begins to establish a normal signal in the tank, and that the cycle ends at T_B when the oscillations have again built up to maximum amplitude.

The superregenerative transient oscillation resulting from a short r-f pulse at $t = 0$ (when $g = 0$) has an amplitude at time T_B of

$$E_B = E_0 \exp\left(-\frac{1}{2c}\int_0^{T_B} g dt\right) \qquad (1)$$

where E_0 is the amplitude at $t = 0$ and E_B is the amplitude at T_B. It is convenient to express the ratio of the superregenerative transient amplitude to the applied signal amplitude as a gain A in nepers (one neper equals approximately 8.7 db) so that

$$A = \ln\frac{E_B}{E_0} = -\frac{1}{2C}\int_0^{T_B} g dt \qquad (2)$$

Thus, $1/2C$ times the area under the negative conductance-time curve between $t = 0$ and $t = T_B$ represents the gain in nepers to a short r-f pulse applied at $t = 0$ and measured at $t = T_B$.

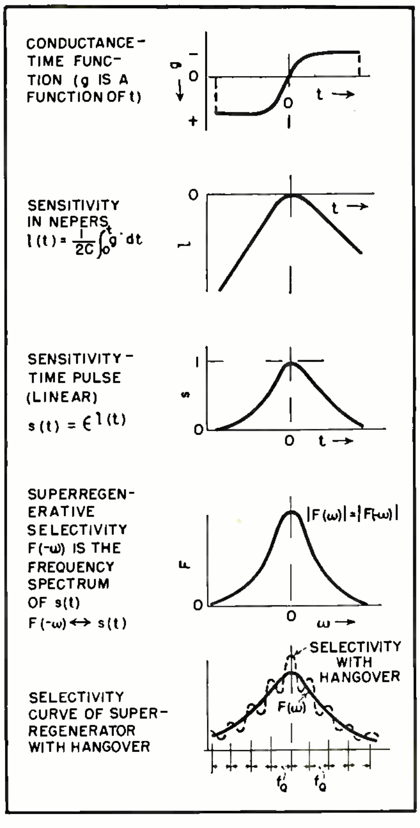


FIG. 2—Steps in the development of selectivity from waveform of conductance, as described in text, and, at bottom, effect of hangover on selectivity

For the linear mode the total superregenerative gain is given by integrating the total negative conductance area. For the logarithmic mode the effective superregenerative gain is obtained by integrating the negative conductance area up to the time of saturation. This is illustrated in Fig. 1D where T_P is the period of the constant amplitude (saturation) oscillations of the logarithmic mode of operation.

The superregenerative gain just described is not the total gain for a continuous carrier at the frequency of the resonator. Some further gain results because the r-f signal is present during the entire quench cycle. This produces a regenerative gain R which is generally considerably less than the superregenerative gain.

Sensitivity Limitations

The manner of decay of the oscillations during positive conductance is similar to the transient build-up during negative conductance, and the same equations hold for the transient amplitude in the positive conductance area. With repetitive quench, as shown in Fig. 1E, the net transient amplitude at T_D due to the energy remaining in the tank from the previous transient of oscillation initiated in the tank at T_C is given approximately by $1/2C$ times the net area under the conductance-time curve between T_C and T_D. *Thus, for the transient hangover to be less than the applied signal, the net area over a complete quench cycle must be positive.* This excess damping, shown as A_0 in Fig. 1E, should be at least 3 to 5 nepers for most applications.

Sensitivity of a superregenerative receiver is determined by the minimum usable signal level. For the logarithmic mode, sufficient superregenerative gain is obtained to amplify thermal noise to saturate the regenerator tube. In this case the sensitivity is limited by the signal-noise ratio or by the signal level necessary to overcome hangover.

In a linear mode superregenerator, sensitivity may be limited by insufficient gain, as well as by signal-noise ratio or hangover. This is particularly true in applications using a very high quench rate, low-transconductance regenerator tubes, or high-capacitance resonators.

If a short r-f pulse is applied to a superregenerator, highest gain is realized if the pulse is applied when the conductance passes through zero going from positive to negative. If applied later, there is less remaining negative conductance area and thus less gain. If applied earlier, the oscillations decay again, giving less gain. Thus, the superregenerator can be considered to have a sensitivity which varies during the quench cycle, having a maximum at the time when $g = 0$ and is going from plus to minus.

Variation of sensitivity in nepers with time can be found directly from the conductance-time function, and from this a linear sensitivity-time pulse can be calculated, as in Fig. 2. The magnitude of the superregenerative selectivity curve has the same shape as the frequency spectrum of this sensitivity-time pulse. The corresponding frequency spectrum can be found by Fourier analysis or by Campbell and Foster's tables.[3] The four steps, ignoring effects of hangover and assuming high gain, in finding the bandwidth of a superregenerator with a known variation of conductance with time, are shown in Fig. 2; at the bottom of the figure the response in the presence of hangover is shown.

Design Data

To illustrate how these steps might be applied, consider the design of a superregenerator that is quenched as in Fig. 1A. From an assumed quench waveshape and a knowledge of the variation in transconductance with grid bias (as obtained from published tube data), the variation of transconductance with time can be found. By applying the equations of Fig. 1B, the variation of G_T can be found. This is subtracted from an assumed (or known) value of G_+ for the resonator, giving the net conductance-time function needed for applying the steps of Fig. 2. The sensitivity function $l(t)$ in nepers can be obtained by integrating (graphically, if necessary) the conductance-time function and multiplying by $1/2C$. The linear sensitivity-time pulse $s(t)$ is obtained by $\exp l(t)$, where $l(t)$ is conveniently taken to be zero at $t = 0$. The superregenerative selectivity shape is found from the frequency spectrum of $s(t)$. If $s(t)$ is not found in Fourier transform tables, an approximate answer may be obtained by graphical Fourier analysis.

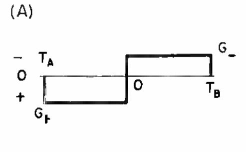
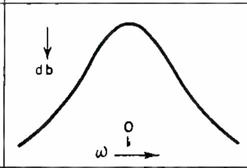
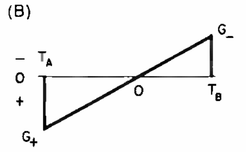
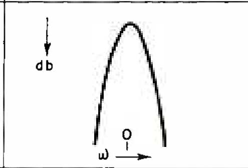
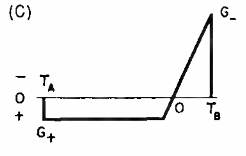
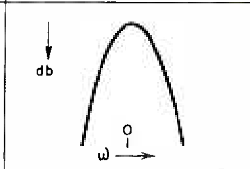
CONDUCTANCE VS TIME	SELECTIVITY	A	R	F (ω)
(A) 		$\frac{G_- T_B}{2C}$	$1 + \frac{G_+}{G_-}$	$\frac{1}{\left(1+j\omega\frac{2C}{G_+}\right)\left(1-j\omega\frac{2C}{G_-}\right)}$
(B) 		$\frac{G_- T_B}{4C}$	$G_+\sqrt{\frac{\pi}{C\left\|\frac{dG}{dt}\right\|}}$	$\epsilon^{-\omega^2 C/\left\|\frac{dG}{dt}\right\|}$
(C) 		$\frac{G_- T_B}{4C}$	$G_+\sqrt{\frac{\pi}{C\left\|\frac{dG}{dt}\right\|}}$	$\epsilon^{-\omega^2 C/\left\|\frac{dG}{dt}\right\|}$

FIG. 3—Conductance waveform controls selectivity, as these specific examples show

If it is desired to calculate the selectivity of an existing superregenerator, it may be convenient to find the plate-current waveform of the regenerator tube (by inserting a small resistor in the plate circuit and observing the quench-frequency voltage waveform across it on an oscilloscope). Then the selectivity can be calculated as before.

Equations for Gain and Selectivity

The variation in superregenerative sensitivity with time means that the effect of the current supplied to the resonator varies with time. This is exactly equivalent to a variation in input current amplitude with time. It can be shown that the magnitude of the superregenerative selectivity response characteristic is equivalent to that of an unvaried and undamped resonator to which an a-m signal is applied. The spectrum of that a-m signal is continuous because each cycle of quench is independent of the others, if hangover is negligible. The selectivity characteristic of the superregenerator is exactly equivalent to the frequency spectrum of the amplitude modulated signal, or of the sensitivity pulse.

The sensitivity pulse is defined as

$$s(t) = \exp\left(\frac{1}{2C}\int_0^t g\,dt\right) \tag{3}$$

where this relation holds for $T_A \leq t \leq T_B$, and $s(t) = 0$ outside of these limits.

The gain of the superregenerator, H, is defined as the ratio of the voltage existing at the peak of a superregenerative cycle to the voltage which would be developed across the tank at resonance if the conductance had remained at the value G_+. That is

$$H = E_B/(I/G_+) \tag{4}$$

It can then be shown (for example, by conservation of energy or by superposition of the effects of a series of impulses) that

$$H = \exp(A)\frac{G_+}{2C}\times \int_{T_A}^{T_B}\exp\left(\frac{1}{2C}\int_0^t g\,dt + j\omega t\right)dt \tag{5}$$

If hangover is ignored and the superregenerative gain is large, Eq. 5 reduces to

$$H = \exp(A)\frac{G_+}{2C}\int_{-\infty}^{+\infty} s(t)\exp(j\omega t)\,dt \tag{6}$$

Equation 6, which ignores end effects, indicates that the selectivity of a superregenerator can be found from the inverse Fourier transform of the sensitivity-time pulse. The factor, $\exp A$, in Eq. 6 is the superregenerative transient gain where

$$A = -\frac{1}{2C}\int_0^{T_B} g\,dt \tag{7}$$

The remaining factor, evaluated at resonance, defines the added gain that is obtained by regeneration. The regenerative gain ratio is

$$R = \frac{G_+}{2C} \int_{-\infty}^{+\infty} s(t)dt \qquad (8)$$

As before, these steps have ignored effects of hangover and assume that the superregenerative gain is large.

Effects of hangover can be computed from the net attenuation, A_0, and phase shift per cycle, exp $(-A_0 - j\,\omega\,T_Q)$. The resulting selectivity is

$$S = F(\omega)/[1 - \exp(-A_0 - j\omega T_Q)] \qquad (9)$$

where $F\ (\omega)$ is the selectivity ignoring hangover. The curve at the bottom of Fig. 2, showing hangover, is plotted to a linear scale; the peaks are very nearly separated by $F_Q = 1/T_Q$ and the troughs are halfway between.

Effects of Special Waveshapes

Figure 3 gives examples of three conductance-time curves with their corresponding selectivities as calculated by the foregoing method, as well as the equations for superregenerative gain A, regenerative gain R and selectivity $F(\omega)$, ignoring hangover and end effects.

In the case of symmetrical squarewave quench (Fig. 3A), a selectivity equal to that of two cascaded, isolated single-tuned circuits (one having conductance G_+, the other G_-) is obtained. When $|G_-| = G_+$ the equivalent phase characteristic of the selectivity has no phase distortion. This distortionless phase characteristic is produced by all conductance-time functions which have skew symmetry about $g = 0$ (Fig. 3A and 3B). When gain A is large, departure from exact skew symmetry in regions remote from $g = 0$ can be neglected.

The triangular conductance waveform of Fig. 3B produces a selectivity having the form of a probability curve. (A probability curve plotted to a db scale forms a parabola.)

The conductance waveshape of Fig. 3C is similar to that found in the usual self-quenched superregenerator, particularly those using grid quench and having the grid leak returned to a positive bias. This waveform produces a selectivity following a probability curve, but considerably wider than that of Fig. 3B. The reason for this is that, for the same quench frequency and gain, the shape of Fig. 3C has a greater rate of change of conductance with time, giving a narrower sensitivity-time pulse and thus a wider frequency spectrum.

When a converting superregenerator is used, such as the Fre-Modyne circuit, an unusual result is obtained. The conversion efficiency varies during the quench cycle so that the r-f sensitivity-time pulse is the product of the i-f sensitivity-time pulse and the conversion efficiency pulse. This generally results in an r-f sensitivity-time pulse that is slightly narrower than the i-f pulse, and thus gives a slightly wider r-f bandwidth than i-f bandwidth.

In the foregoing discussion it has been assumed that the resonant frequency of the superregenerative tank circuit does not vary during the quench cycle. This gives symmetrical selectivity curves. If the superregenerative tank frequency varies appreciably during the period when the sensitivity-time pulse has significant amplitude, then a result much like a combination of simultaneous a-m and f-m is obtained, which can produce unsymmetrical selectivity curves.

Practical Considerations

It can be shown that the shape of the selectivity curve near the nose of the curve is determined mainly by the shape of the conductance-time curve near the time when $g = 0$. If the conductance waveshape is approximately a straight line in the vicinity of $g = 0$, then the selectivity curve is a probability curve to approximately as many db of attenuation as are represented by the superregenerative gain obtained during the linearly sloping part of the conductance wave form. This leads to the useful approximation that *the total bandwidth at one neper (8.7 db) from the peak is*[4]

$$f_W = (1/\pi)\ [(1/c)\,|dG/dt|]^{1/2} \qquad (10)$$

where dG/dt is the slope of the conductance-time curve at $g = 0$.

In a separately quenched superregenerator, Eq. 10 shows that, in general, if the quench voltage amplitude is increased, the selectivity curve will become wider. Also, if the quench voltage frequency is reduced, keeping the same waveshape, that the selectivity curve will become narrower. However, if the quench amplitude is increased, or the frequency decreases, the available superregenerative gain will be increased, producing more total gain for a linear mode operation or producing an earlier saturation in logarithmic mode. *Thus for a given quench waveshape, and for a specified superregenerative gain, the narrowest selectivity is obtained by using the lowest possible quench frequency.* However the minimum quench frequency should be at least equal to twice the maximum modulation frequency of the received signal.

The question frequently arises of how to measure the selectivity of an existing superregenerator. Conventional methods may be applied in certain cases, but are generally inadequate. With certain types of superregenerators the problem is like measuring the selectivity of a conventional receiver having a very flat avc that cannot be disconnected. The following method is suggested as being applicable to substantially all forms of superregenerators normally used.

The audio output noise of the receiver, without an applied signal, is measured by an output meter (rms type preferred). A signal is applied at resonance and adjusted in level until the noise is suppressed by some convenient amount such as 10 or 20 db. Then the signal is detuned and readjusted in level until the noise is suppressed by the same amount. The difference between the two levels is the attenuation or selectivity at the detuned frequency. By this method of constant noise suppression, the complete selectivity curve may be measured (assuming an adequate signal generator) to as much as 80 to 100 db of attenuation.

References

(1) F. W. Frink, The Basic Principles of Superregenerative Reception, *Proc. IRE*, p 76, Jan. 1938. This paper gives a more complete description of the various modes of operation.

(2) H. P. Kalmus, Superregeneration—Its Possibilities and Limitations, *Proc. IRE*, Oct. 1944.

(3) Bell Telephone System Monogram B-584, Fourier Integrals for Practical Applications.

(4) MacFarlane and Whitehead, The Superregenerative Receiver in the Linear Mode, *Jour. IEE*, Part III A, No. 1, 1946.

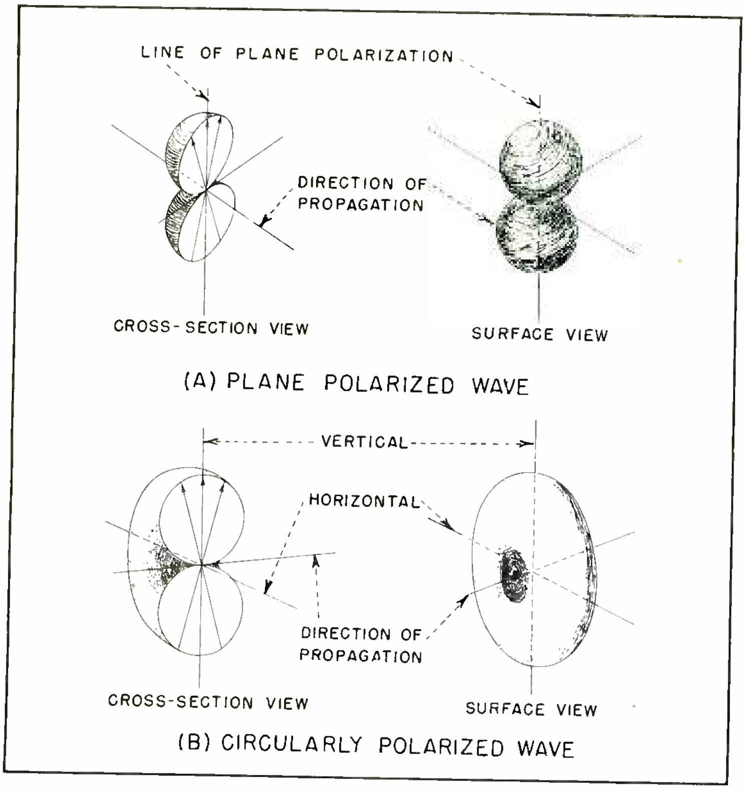
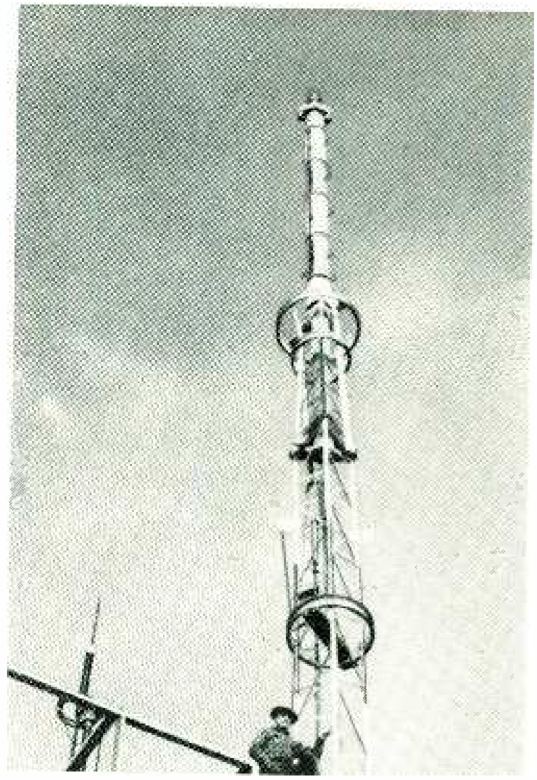


FIG. 1—Reception patterns of half-wave dipole in plane and circularly polarized fields



Circularly polarized antenna in use by radio station WHKX

Circular Polarization in F-M Broadcasting

Experimental field intensity measurements substantiate theoretical advantages to be gained over plane polarization. The high-gain omnidirectional broadcast transmitting antenna described allows most convenient location of home receivers

By **CARL E. SMITH**
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More than two years ago the United Broadcasting Company initiated an experimental program to investigate the use of circular polarization for f-m.

The early experimental work was carried on with a prototype circular-polarization antenna consisting of a vertical half-wave dipole and a horizontal loop, mounted on the same vertical axis. A report covering this work was furnished to the Federal Communications Commission in October 1946.[1, 2] Within 30 days the Commission had amended the Standards of Good Engineering Practice to permit the addition of a vertical component having the same magnitude as the horizontal component and thus making it possible to supply the service area with a diversely polarized signal from a circularly polarized f-m broadcasting antenna by radiating twice the power of either component operating alone.[3]

During the past year field measurements have been made on W8XUB and WHKX in Cleveland to determine quantitatively the im-

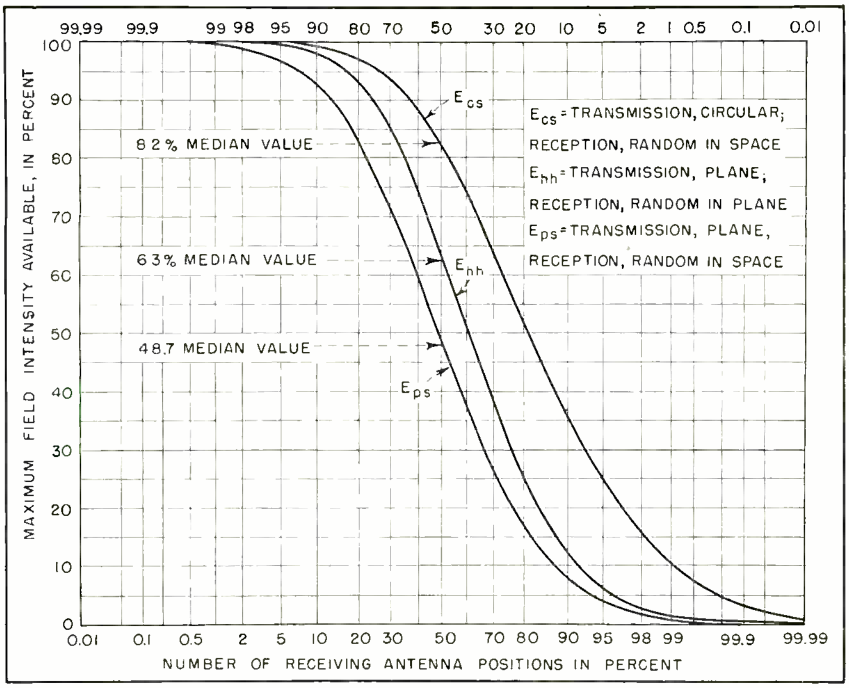

FIG. 2—Distribution of field intensity with receiving antennas in random placements

provement of circular polarization over plane polarization, and a research program has been carried on by the Ohio State University Research Foundation in Columbus to develop a high-gain circularly polarized broadcasting antenna.

Theoretical Advantages

One of the principal advantages of circular polarization over plane polarization is that space is more completely filled with a diversely polarized signal. Figure 1 shows that in a plane-polarized field a simple receiving antenna can be placed in only one position for maximum signal pickup and in a whole plane of positions for zero signal pickup, while in a circularly polarized field a simple receiving antenna can be placed in a whole plane of positions for maximum signal pickup and in only one position for zero signal pickup.

It should be emphasized that although the radiated power can be doubled in going from plane to circular polarization the more important consideration is that the polarization changes from a single line or linear dimension to a surface or two-dimension phenomenon. The radiated power from many f-m stations using plane or horizontal polarization is limited to an equivalent 20-kw, 500-foot antenna in accordance with FCC allocation standards. All of these stations have the privilege of improving their service to the public by employing circular polarization and radiating up to an equivalent 40-kw, 500 foot antenna.

If reception patterns are investigated on a theoretical statistical basis by placing a half-wave receiving antenna at random the curves of Fig. 2 result. For a circularly polarized field with receiving antennas placed at random in space the median value is 82 percent. In a plane-polarized field with receiving antennas placed at random in the plane of polarization the median value is 63 percent. If the receiving antennas are placed at random in space when the field is plane polarized the median value is 48.7 percent.

If ratios between the curves of Fig. 2 are expressed in decibels of improvement the two theoretical curves of Fig. 3 result. The median improvement of circular polarization over plane polarization for antennas placed at random in space is 4.6 decibels, while the improvement of circular polarization over plane polarization when the receiving antennas are placed in the plane of polarization is 2.3 decibels. It should be observed that the improvement to 50 percent of the sets will be much more than this value, as indicated by the sharp upward

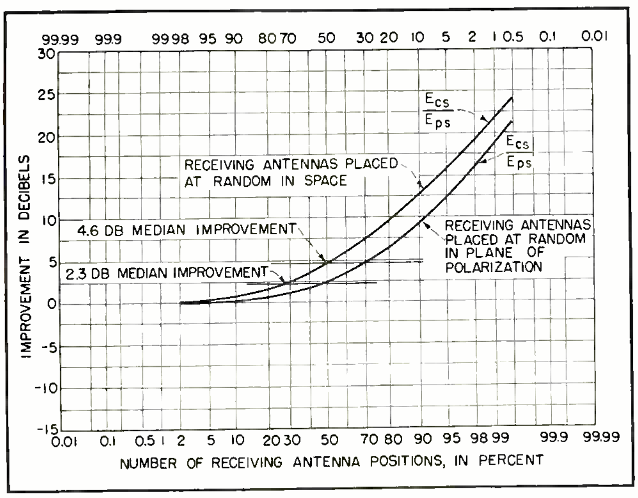

FIG. 3—Theoretical improvement of circular polarization over plane polarization

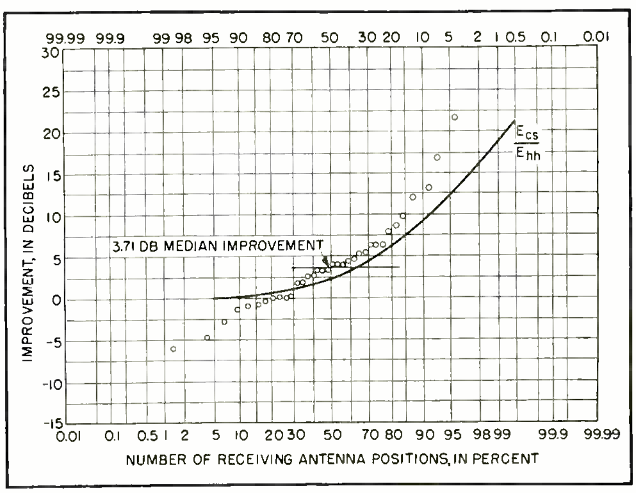

FIG. 4—Improvement of circular over horizontal polarization when receiving antennas are horizontal

curvature toward the right end of these curves.

Field Measurements

To determine quantitatively the improvement of circular polarization over plane polarization as it affects the average home receiver it was assumed that the f-m receiving antenna built into the home receiver must be served. Therefore, 372 carefully controlled field-intensity measurements were made in 36 typical homes throughout the service area of W8XUB.

Measurements in the home were made with a half-wave dipole placed six inches in front and with the center of the dipole level with the top of the home receiver. In other words, an effort was made to reflect into the results the effect of the position of the home receiver as selected by the housewife.

With the test half-wave dipole horizontal, the transmitting antenna was caused to radiate, first horizontal polarization and then circular polarization of equal maximum field intensities. The ratio of these measurements made in 36 homes shows in Fig. 4 that the median improvement is 3.71 decibels. The theoretical curve was also drawn in this figure for comparison purposes. It will be noted that the field measurements data is in fair agreement with the theoretical curve. It is believed that cancellations and reinforcements due to reflections from metalic plumbing and wiring in and around the home cause the measured points to fall below the theoretical curve toward the left end and rise above the theoretical curve toward the right end.

If the receiving antenna is placed at random in space it should be possible to check the theoretical curve of Fig. 3. To accomplish this, measurements of circular polarization transmission with vertical receiving antennas were compared to both vertical and horizontal-polarized transmission with the same vertical receiving antennas. Then a similar set of ratio measurements were made with horizontal receiving antennas. Figure 5 presents 72 such ratio measurements with a median improvement of 4.87 decibels. This is in good agreement with the theoretical median improvement of 4.6 decibels. Again cancellations and reinforcements are believed to be the reason for the statistical data to fall below the theoretical curve at the left and rise above the theoretical curve at the right.

Another case of interest is the improvement that can be expected when the receiving antennas are vertical. A practical application is whip antennas on automobiles and power-cord antennas such as are commonly used on table-model receivers. The 21 statistical measurements for this condition are presented in Fig. 6, which shows a median improvement of 9.25 decibels. The improvement for three points was too great to plot; however, their effect is reflected by shifting the other points to the left.

Summarizing the results indicated by the above field measurements, it is more profitable for a broadcaster to divide the available power between the horizontal and vertical components and employ circular polarization even for serving only horizontal receiving antennas placed in the home. However, such division of total power is not necessary under the Standards of Good Engineering Practice for f-m broadcast stations. Under these standards the broadcaster can expect to more than double the power (3.71 db) in horizontal receiving antennas and increase the power more than eight times (9.25 db) in vertical receiving antennas within the service area.

Antenna Development

The program at the Ohio State Research Foundation embodied basic research on two methods of producing circular polarization. The first employed excitation of a single element geometrically shaped, such as spiral slots or helical antennas, to produce the desired polarization. The second group consisted of horizontal and vertical radiating elements, each fed with the proper proportion of energy to produce equal-magnitude fields and with the proper time-phase difference to produce circular polarization.[4]

In developing the antenna the

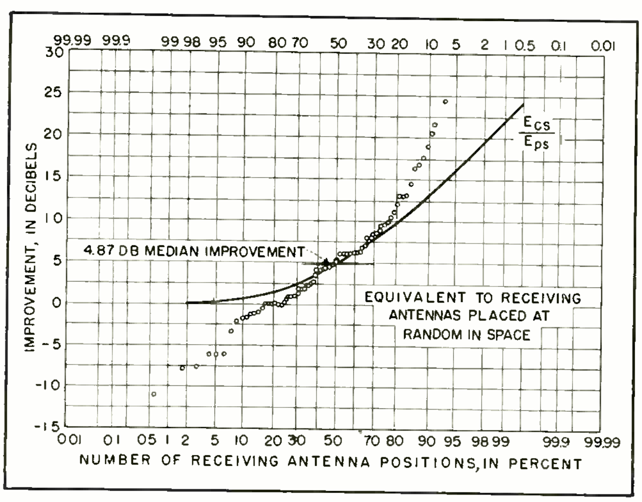

FIG. 5—Improvement of circular over plane polarization with randomly placed receiving antennas

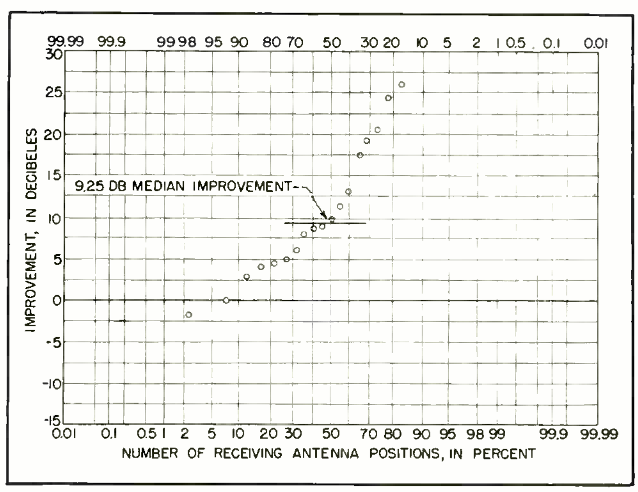

FIG. 6—Improvement of circular polarization over horizontal with vertical receiving antennas

problem was attacked theoretically and experimentally by means of model technique.[5] The theoretical work was devoted to slots in cylinders[6] since it appeared early in the development that this type of antenna would probably be used as the radiating element to produce the horizontal polarized component of the circularly polarized antenna.

To produce circular polarization in the horizontal plane it should be remembered that both the horizontal and vertical radiating elements must have a uniform pattern in magnitude and phase. It has been shown[6] that two diametrically opposed axial or longitudinal slots in a cylinder will satisfy the requirement for the horizontal component, as the magnitude was essentially uniform and the phase shift was less than three degrees through the f-m broadcast band for cylinders whose diameters were 16 inches. By making the cylinder a half-wavelength long and feeding the slots at the center, the desired horizontal component can be produced. The vertical component can be obtained by feeding the half-wavelength cylinders as full-wavelength vertical dipoles. The 90-degree time-phase requirement was satisfied by using a phase control as shown in Fig. 7, which also shows the basic elements and how they were developed and combined to produce the circularly polarized experimental antenna as used by station WHKX, and illustrated on the cover of ELECTRONICS for April 1948.

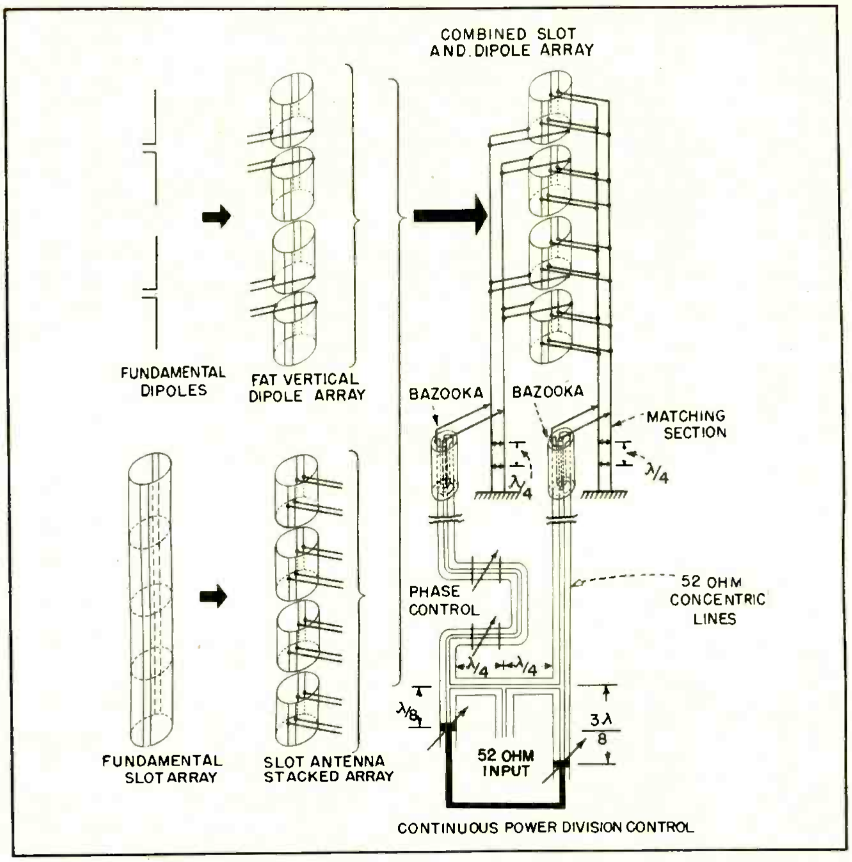

FIG. 7—Development of the circular-polarized antenna from dipoles and a slot array

Experimental data on the slots showed them to have vertical patterns which were similar to the vertical fat dipole and indicated that the units or full-wavelengths bays could be stacked suitably for high gain. Vertical patterns at 100 mc for both elements are shown for half-wave cylinders 16 inches in diameter, in Fig. 8. The horizontal-plane patterns for the two elements are quite uniform, as shown in Fig. 9. With this basic information a model for a circularly polarized antenna was constructed and tested. Pattern tests proved the antenna to be circularly polarized in the horizontal plane and that the units could be stacked for high

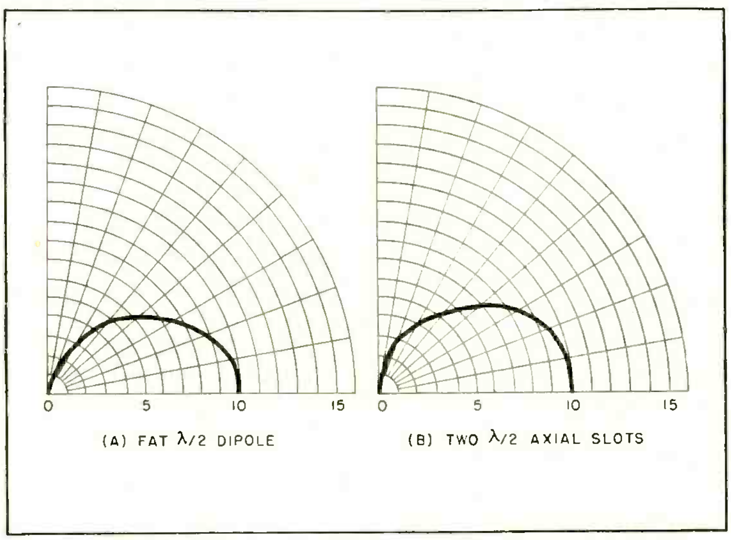

FIG. 8—Vertical field patterns for both vertical and horizontal-polarized elements at 100 mc, using 16-in. diameter cylinder

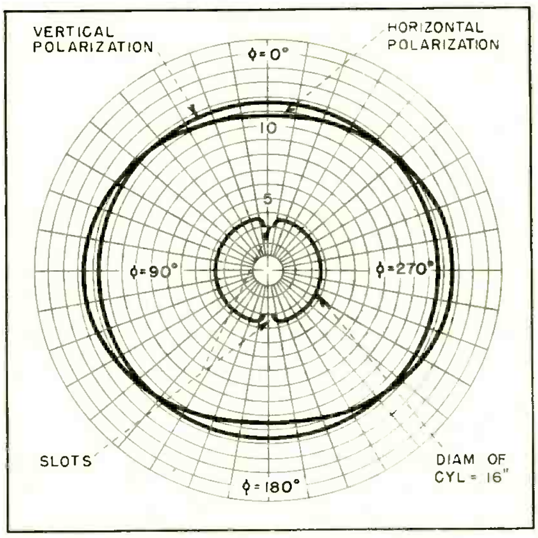

FIG. 9—Vertical and horizontal-polarization components of horizontal-plane pattern at 100 mc

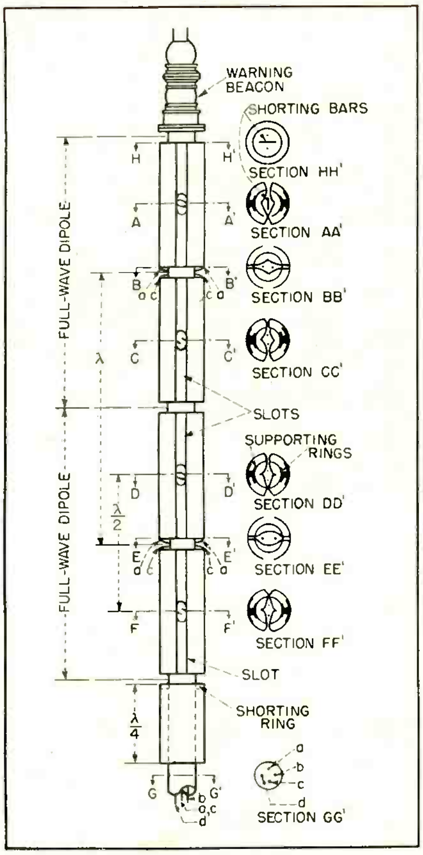

FIG. 10—Construction and feed details

gain. As a result of these studies the full-scale antenna was fabricated and installed for experimental operation.

The Antenna

One unit, or bay, of the antenna consists of two half-wavelength cylindrical sections with two diametrically opposed axial (longitudinal) slots cut in each section as shown in Fig. 10. For the vertical radiating element, the two cylindrical sections are fed at the center of a vertical full-wavelength fat dipole. Since the units are one wavelength long, the feeding problem is simple when the units are stacked in a vertical collinear array, to obtain a high-gain vertical pattern. The horizontally polarized component is obtained by feeding the axial slots, cut in each section of the cylinder, in phase with equal amplitudes of current so the circular pattern in the horizontal plane is obtained.

Feeding the antenna can be accomplished with a multiwire balanced transmission line as shown in Fig. 7 and 10, or a coaxial-line feed system can be employed throughout. The full-scale model employs a balanced four-wire line. The copper-clad steel conductors are stretched from the top to the bottom of the supporting mast and on the inside of it. One pair of conductors is used to feed the vertical radiating elements and the other pair the horizontal radiating elements. The correct phase relationship for the two slots in each cylinder is obtained by properly crossing the connectors from the transmission lines to the slots as shown in Fig. 10. Since the feed points from one cylinder to the next cylinder are a half wavelength apart, altering the crossed connectors keeps the units in phase so they can be stacked. The feed points for the dipoles are one wavelength apart and can thus be fed in phase to produce a simple collinear array of stacked elements.

Each section of the galvanized-iron cylinder shell is fastened to a standard 10-inch steel mast with metal castings to support the shell to the mast. This is possible because the support point is at zero potential, being an odd quarter-wavelength away from the vertical-polarization feed points and equidistant between the horizontal feed points. This keeps the entire antenna free of insulators. A quarter-wavelength skirt is placed at the bottom of the antenna to minimize currents on the supporting structure. Bazookas are used to transform from balanced to unbalanced transmission lines as shown in Fig. 7.

With independent phase and power control it is easy to adjust for true circular polarization. The condition of polarization is determined at WHKX by a half-wave sampling dipole mounted level with the center of the circular-polarization antenna on a wooden pole at a distance of about 100 feet. This dipole can be rotated by a rope control to any position in a plane at right angles to the direction of propagation. The r-f meter at the center of the dipole can be observed by using a telescope mounted in the transmitter building.

The gain of the antenna is a function of the number of units or bays and may be determined by the conventional method used in computing the gain of collinear arrays.

Commercial Antennas

For commercial antennas it may be more desirable to use a concentric transmission line harness-type of feed throughout. By first resonating and then controlling the resistance magnitude at the various antenna-element feed points the standing waves on the feeder lines can be reduced to a minimum. The commercial broadcast antennas can be fabricated in this fashion. All openings in the cylinders will be covered with plastic to minimize effects from weather conditions. It will then be practical to bulk heat the antenna structure if icing is expected to be severe enough to require it. A ladder can be mounted on the cylinders without affecting the radiation pattern, thus making it easy to service the flasher beacon at the top of the antenna.

Acknowledgments

The authors wish to acknowledge the following assistance: H. K. Carpenter, executive vice president of United Broadcasting Co. for his sympathetic interest; George Sinclair of the University of Toronto for his invaluable contributions in the circular-polarization antenna development program; Robert Jacques, Research Supervisor of the Ohio State University Research Foundation Antenna Laboratory for his cooperation; A. O. Austin and Robert Indorf for directing the fabrication and construction of the full-scale developmental antenna.

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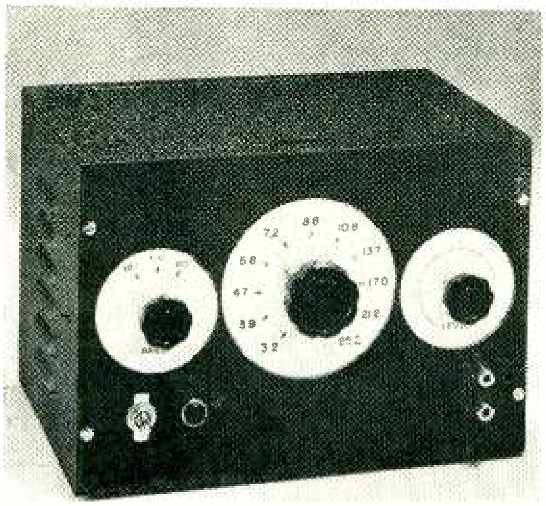
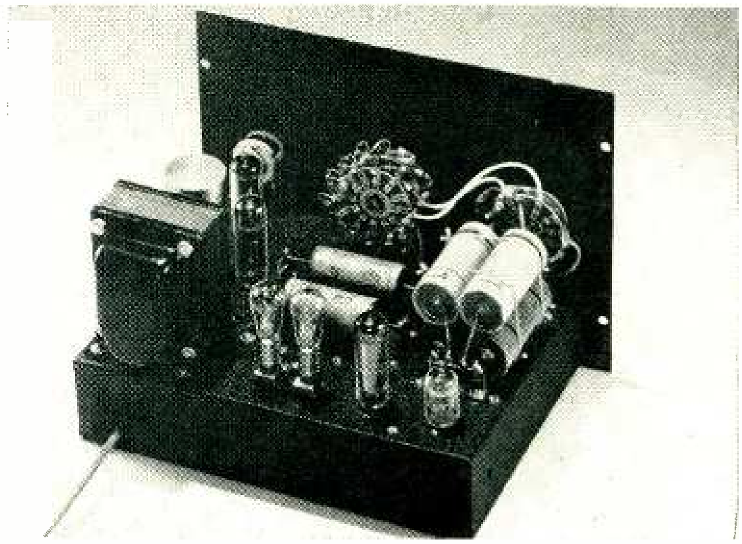


The low frequency oscillator showing range switch, step frequency selector, and level (gain) control



Top chassis view of the oscillator and conventional power supply. The two 6-watt lamps are in the feedback circuit

Low-Frequency

Stable oscillations from 0.3 to 252 cps are obtained in three ranges. The ganged variable-resistance tuning elements give small stepped increments of frequency. Lamps are used for nonlinear negative feedback

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OSCILLATORS in the frequency region below 20 cps have numerous laboratory uses, particularly in the study of vibration problems and in the design and testing of amplifiers which use a large amount of negative feedback.

The two major obstacles to be overcome in designing a satisfactory low-frequency oscillator are the large sizes of the components and the time required for transients to disappear. Because of the low impedance and low Q of inductors in this region, the frequency-controlling elements are almost always resistances and capacitances; and with the comparatively low resistances of wire-wound resistors and potentiometers it is difficult to hold capacitors to a reasonable size. In oscillators with only vacuum tube nonlinearity controlling the amplitude, circuit changes in adjusting the frequency and selecting the range of frequencies cause transients lasting as long as 15 cycles, which is 30 seconds at 0.5 cps, making additional amplitude stabilization desirable.[1]

Beat-frequency oscillators, with the fixed frequency at 1,000 cps, have operated satisfactorily in the low-frequency regions. Time, however, is required to be certain that the zero-beat error is negligible; and a good quality filter is required to eliminate the unwanted modulation components from the desired signal.

The circuit diagram shown in Fig. 1 is fundamentally that of a resistance-capacitance oscillator with nonlinear feedback for stabilizing the amplitude.[2] The frequency-controlling network is of the series R-C, parallel R-C type, and was chosen because only two variable elements are required. Resistance changes are used to control the frequency over a range of 10 to 1, and the decades are selected by varying the associated capacitance. Resistors R_1 and R_2 are the variable parameters, and C_1 through C_6 are the fixed. They give an overall range from 0.32 cps to 252 cps. Negative feedback is controlled by R_3, R_4 and R_5, with R_4 and R_5 the nonlinear resistors. Tube V_1 is a voltage amplifier, and V_2 drives the frequency-controlling and negative-feedback networks.

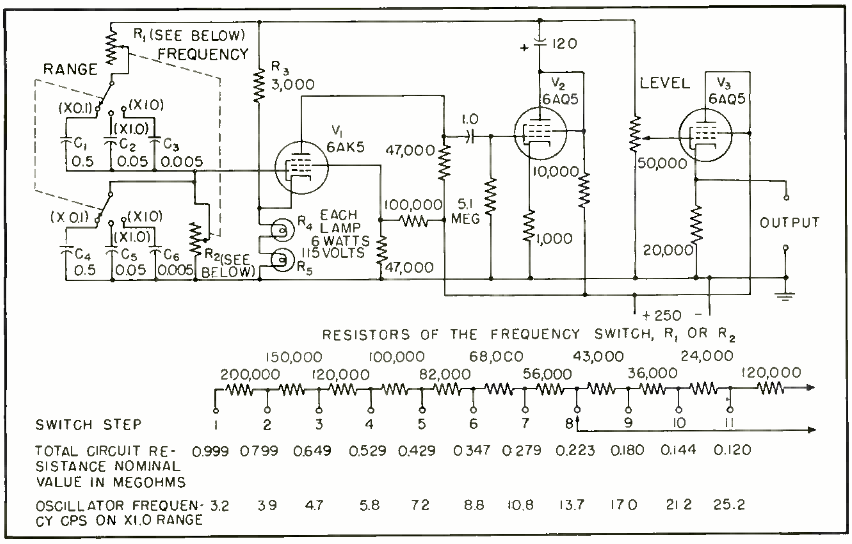

FIG. 1—Circuit diagram of the low-frequency oscillator. The stepped variable frequency control detail indicated

Oscillator

Cathode-follower V_3 isolates the output. The power supply is conventional.

In the circuit of Fig. 1, $f = 1/2\pi RC$, where f is the frequency of oscillation; R is the resistance of R_1 or R_2, assuming them equal; and C is the capacitance of the associated capacitors, assuming they also are equal. Resistors R_1 and R_2 are controlled by a two-section, eleven-point frequency selector switch. At each range setting, if a factor of 10 in frequency is desired for a complete sweep of the frequency switch, along with a proportional increase in frequency with each step of the switch, then the ratio of increase is $10^{1/11}$, or approximately 1.23 per step. This relation, in turn, means a division of the previous value of R_1 or R_2 by 1.23 for each increasing step of the frequency switch. One megohm was a convenient value for the maximum of R_1 and R_2. Using this, the incremental resistances were computed, and the nearest RMA-value resistor was selected. One half-watt resistor was used for each incremental resistance; these mount conveniently on the frequency switch, and result in a neat and compact control. The switch and resistor combination gives a stable, variable resistor with high resistance, so that only a 0.5 μf capacitance is required for the 0.3 cps to 2.5 cps range. The schematic diagram of R_1 and R_2 is shown at the bottom of Fig. 1.

Capacitors C_2 and C_3, C_5 and C_6 were selected and trimmed to fit the decade relationship with C_1 and C_4, respectively. The capacitors C_1 and C_4 were chosen within 5 percent of each other.

Thermal Elements

The choice of the thermal characteristics of the nonlinear resistors in the feedback circuit is a compromise between two requirements. It is desirable that the thermal time constant be as short as possible, so that transients caused by changing the frequency or the range will be as short as possible. Yet there should be no appreciable change in resistance during a cycle of oscillation at the lowest frequency, or waveform distortion will result. Two 115-volt 6-watt candelabra-base lamps connected in series were found experimentally to give acceptable waveform at 0.5 cps, damp transients quickly, and have satisfactory electrical characteristics.

The chief limitation of the oscillator is that the frequency cannot be varied continuously. In most work encountered, the steps have been adequately close. Additional increments, however, can be obtained by using a selector switch with more steps, using ranges of 3 and 30 in addition to 1, 10, and 100, or by connecting auxiliary decade capacitors across the frequency-controlling capacitors.

As noted previously, the lower frequency limit of oscillation is determined by the thermal elements in the feedback circuit. The upper limit, with R_1 and R_2 maxima of 1 megohm, is reached when the tube, switch, and wiring capacitances become appreciable compared with those of the oscillating circuit. A convenient limit for the present oscillator is 252 cps.

Accuracy

The finished oscillator has been calibrated carefully, and the range capacitors adjusted so that the error in frequency is less than 2 percent of any given setting. The use of tubular paper capacitors and composition resistors in the frequency-controlling network, however, means that errors as great as 4 to 6 percent can be expected. This error can be reduced by the use of more stable elements; or a spot calibration can be made whenever a critical situation is encountered.

The low-frequency oscillator has given good service for several months, and seems to be a generally satisfactory instrument. Through the techniques of a switch-controlled variable high resistance and nonlinear negative feedback, a simple, stable, easy-to-use oscillator has been built in a frequency region once noted for its difficulties.

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Digital Computer Switching Circuits

Basic operational requirements of digital computers and fundamentals of the means for obtaining them are set forth. For the most part familiar switching circuits can be used but they must meet the special requirements of positive action that are described here

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AUTOMATICALLY-SEQUENCED digital computers are machines that have no intelligence, yet carry out, without intervention, lengthy routines of mathematical calculation. An understanding of general design considerations requires a survey of the procedures followed by a human computer using desk calculator.

A human computer does more than arithmetic; he not only carries out the elementary processes of addition, subtraction, multiplication, and division, but he also decides what numbers to add, multiply, etc., and what to do with his results. These results of his arithmetic are only stepping stones to his final goal, just as the numbers upon which he performs his arithmetic were previous stepping stones. Some problems require millions of arithmetic operations to arrive at a relatively small set of numbers representing the final answer.

If we reduce the human computer to an automaton having only the ability to read, write, and do arithmetic, we need to give him a very detailed set of working instructions. These instructions include original numerical data from which he works, and an explicit program of operations to be performed. He must be told, for example, to read numbers in two specified places, add them, and write the result in a specified place. He must then be told where to find his next instruction, unless all instructions are serially listed and no variations in their order are to be made. Explicit instructions as to where to write partial results and when and where to refer back to them for further use comprise a sort of automatic memory. The sheets of paper, numbered for identification, form a storage for numbers; his whole program is stored on paper before he starts to work.

Even the power of decision can be mechanized. If a human computer is supposed to compute one intermediate result to a specified degree of accuracy by a method of successive approximations, he must continue until further steps make insignificant changes. He is therefore instructed to keep repeating the procedure until a tentative answer, taken to ten places, equals the previous tentative answer, and then to proceed with the main program.

We see that our automaton must be given instructions, or orders, incorporating the following information: (1) where to find operands; that is, the two numbers to be combined by addition, multiplication, subtraction, or division, (2) which arithmetic operation to perform, (3) where to write the result, either in a specified place for future reference or on his final answer sheet, and (4) where to find his next set of similar instructions.

An electronic computer operates on a similar routine. Machines being designed and built will perform this cycle of operations in a millisecond or less, working with numbers having ten decimal places. Such speed means that these machines will make it practical to solve problems requiring so many millions of arithmetic operations as not to be considered at present. Directing such a machine is a major administrative problem. As Dr. von Neumann of the Institute for Advanced Study expressed it, "Programming a problem for such a machine is equivalent to writing a detailed set of instructions for twenty automatons with desk calculators sufficient to keep them busy for two years, working a forty-hour week." These automatons have no ability to think for themselves!

Leaving the mathematical and administrative problems to others, we can proceed to the basic electronic problems. We must first have (A) an electronic alphabet for writing numbers and orders, (B) a medium on which to write, (C) means of writing and reading, and (D) means for interpreting the written word. These words may be numerical, as 3721499825, or coded orders, as A0173Q75B6. When a number-word (number) is read, it must be translated into what the machine recognizes as numerical form. An order-word (order) must be interpreted by being converted to a set of voltages, to operate switches.

Reading a word consists in part of transmitting it to the organ which is to interpret and be affected by it. Thus numbers are transmitted from storage to arithmetic unit, or vice versa, and orders are sent from storage to the central control organ, or dispatcher. In ad-

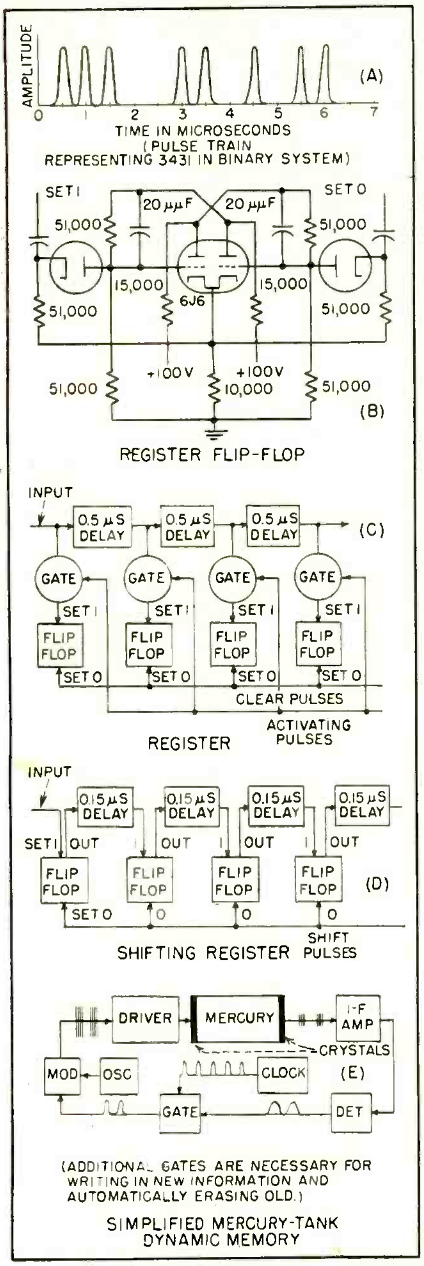


FIG. 1—Pulses are stored statically in flip-flops, dynamically in delay lines

dition, both kinds of words are transmitted to storage from the input as needed, and final answers or desired partial results are transmitted to the machine output.

An order must not only tell the central control which numbers to dispatch to the arithmetic unit from storage, but must also tell central control which arithmetic operation is to be performed and where the result is to be sent.

In addition to the central control organ, there must be various local control stations. The arithmetic unit itself, for example, is primarily a traffic unit such that the arrival of two numbers causes the transmission of a third number. Whether this third number is the sum, difference, product, or quotient of the other two depends upon the dispatching system of the arithmetic unit. Separate arithmetic units can be built for the four cases, but it is also feasible to make a universal arithmetic unit which will perform any one of the four processes upon request of the central control. Hence the central control must not only dispatch number-words and orders, but must also interpret orders and actuate circuit changes.

Transmission and Representation

A NUMBER, say 43712, can be read and transmitted in two fundamentally different ways. If one transmission channel is used for each column, we can simultaneously transmit a 2 along the first channel, a 1 along the next, 7 along the next, etc. This simultaneous transmission of the digits of each position along their appropriate channels is a PARALLEL operation. Its characteristic feature is that it distinguishes between digits by a spatial relation, transmitting all digits at the same time.

Conversely, we could transmit all digits over a common channel, at successive times, in the order 2, 1, 7, 3, 4. The separate digits would be distinguished by their time of arrival on a common line. This is a SERIAL process, digits being distinguished by a temporal relation.

If ten pulses, made recognizable from each other by modulation, are available, any number can be transmitted either serially, over one line, or in parallel, over many lines, from one organ to another. We will consider only serial operation because it is more illustrative of traffic (switching) dispatching problems, as well as because it is the system employed in the machines that will first be constructed.

ORDERS to various parts of the machine must also be capable of transmission, hence they can be expressed conveniently as numbers in some arbitrary code. Thus numbers and orders are represented in the same way, being strings of digits. We know which is which when we put them into the machine, so that if our programmer dispatches only orders to central points and numbers to arithmetic points, it will not matter that the machine by itself cannot distinguish orders from numbers. In fact, this is a convenience, because by considering an order as a number we can modify an order by operating on it with the arithmetic unit.

REPRESENTING the ten digits by pulses of different amplitude would reduce machine reliability, making results depend upon tube constants and supply voltages. It is better to have only two amplitudes to distinguish. If these two amplitudes represent digits 0 and 1, we must find a way of representing numbers in terms of these two digits. In decimal notation, the number 352 means

$$2 \times 10^0 + 5 \times 10^1 + 3 \times 10^2 = 2 + 50 + 300$$

Each successive digit position to the left represents the coefficient of the next higher power of 10. We therefore need digits only to 9; a coefficient of 10 in any place is equivalent to a coefficient of unity in the next place. If we drop the use of 10 as our base, and use 2 instead, we write a number such as 37 in the following binary manner, 100101, meaning

$$1 \times 2^0 + 0 \times 2^1 + 1 \times 2^2 + 0 \times 2^3 + 0 \times 2^4 + 1 \times 2^5 = 1 + 4 + 32 = 37$$

We pay for the simplicity of having only two different digits by needing approximately three times as many columns to write a number in the binary system as in the decimal system.

To represent 0 and 1 and the corresponding pulse trains, we choose a basic pulse repetition rate of 2 mc, and synchronize all parts of the machine so that successive pulses (representing 0 or 1) occur at these half-microsecond intervals. If all trains of pulses are locked to this reprate (repetition rate), we can use the presence of a pulse to represent 1, and the absence of a pulse to represent 0. Thus the six-microsecond pulse train shown graphically in Fig. 1A represents the binary word 110101100111 (read from right to left) which has the (decimal) value 3431. Voltage and tube parameters need only be held within the tolerance range to keep the pulses within their amplitude range of reliable operation.

Now that we have a scheme for representing numbers as pulse trains, we are ready to analyze problems of storing numbers.

STORAGE — Typical machines operate with numbers of ten significant figures in the decimal system, so will require roughly 35 binary places. A 35 binary place number at 2-mc reprate will be represented by a pulse train having a duration of 17.5 microseconds. It is impractical to put information into a machine or to print results at such a rate, over 50,000 words per second. We need a speed changer, or device for storing the many words being written into it at one speed, and capable of being read at some other speed, either faster or slower. One scheme is magnetic recording of the pulse trains on either wire or tape. Magnetic pulses cannot be packed more closely than about 200 per inch if they are not to overlap and become incapable of resolution. The reprate of reading and writing magnetically for a given packing is proportional to the speed at which the wire is transported. Hence we can magnetically record pulse trains leisurely and run them into the machine rapidly or conversely, can record fast signals on a fast wire, and later read the wire at a speed which an electric typewriter can reliably be expected to follow.

Inside the machine we need two types of memory, one that stores a train of pulses statically and another that stores the high reprate trains of pulses.

STATIC REGISTER — The first of these, the static register, is needed, among other places, in the arithmetic unit, to set up central voltages in accordance with the 0's and 1's of a number. Basically a static register is a flip-flop such as that of Fig. 1B which has two stable states. High and low plate voltages can be taken to represent the storage of a 1 or a 0.

In a practical flip-flop, grid capacitors are used to speed transition from one state to the other. Minimum transition time depends upon mutual conductance of the tubes. A more rapid flip-flop than the one shown can be made by using such tubes as the 6AK5, connected either as pentodes or triodes. Provision is also made for setting the flip-flop in either state by applying a negative pulse to the appropriate tube. The diodes are isolation buffers to disconnect the pulse sources when pulses are not being applied. This not only reduces loading on the transfer pulse from one tube to the other, but also prevents this pulse from being transmitted to other flip-flops via the input circuit.

Tying the two input leads together provides a binary counter. The plate-grid coupling capacitances provide enough memory (time lag) for the flip-flop to remember in which state it was prior to the application of a pulse applied to both tubes. As a result, an input pulse changes the state of the flip-flop and provides a scale-of-two, or binary counter. Cascaded binary counters have many applications. For binary counter purposes, the grid input arrangements can be omitted and a positive pulse applied to the common cathode lead.

By using 35 flip-flops, one for each binary column, we can statically store a 35 place binary number. Writing a number into a register consists of setting its flip-flops in accordance with the succession of 0's and 1's in the binary number. Reading the register consists of causing it to generate the pulse train corresponding to its array of 0's and 1's.

FEEDING REGISTER — There are

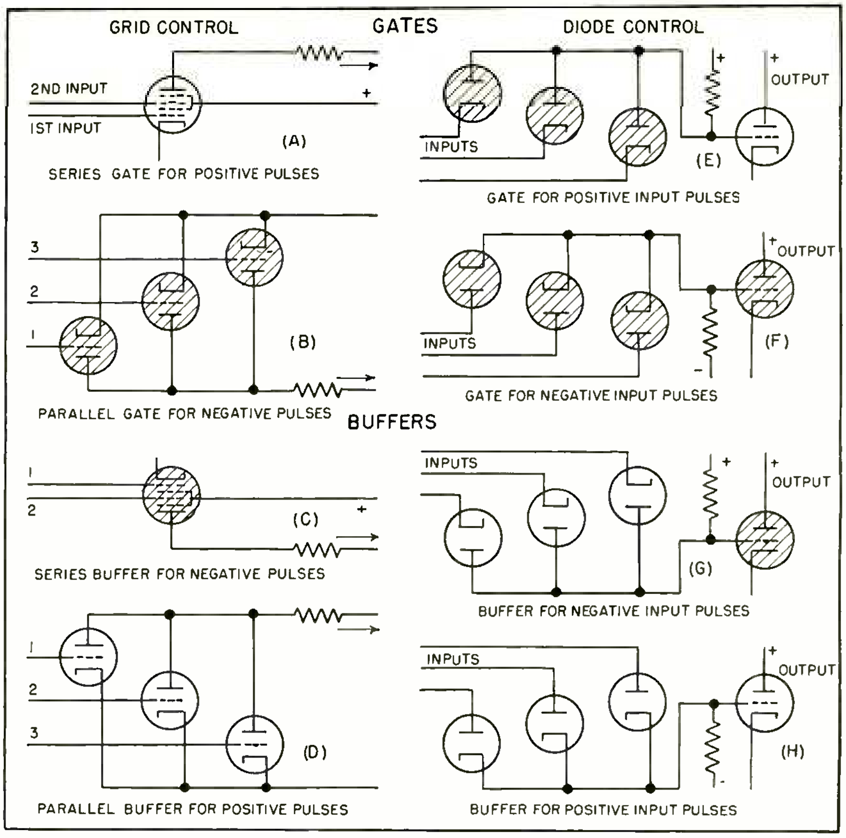


FIG. 2—Gates and buffers constitute the operating elements of the arithmetic units. Germanium diodes may be used for compactness

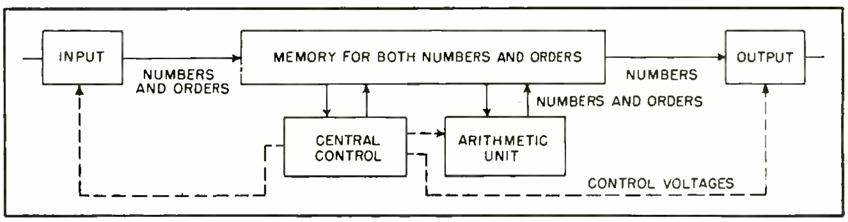


FIG. 3—Basic functional components of digital computer, and their interrelation

two ways of converting a serial train of pulses into the parallel form for storage in the static register. The pulses can either be fed into the register from the end or set up in parallel alongside it.

The latter scheme is indicated in Fig. 1C; the train of pulses is fed into a delay line of 0.5 μs sections, so that just as the last pulse appears at the input the previous pulses appear at the various junctions. The delay line thus momentarily converts the serial pattern of voltage peaks versus time into a spatial pattern of voltage versus position; voltage appears at the junctions corresponding to the positions of the binary 1's in the number represented, no voltage appears at the positions corresponding to 0's. When this space pattern is obtained, all the gates are opened by an activating pulse, and the 1's are entered into the register via the set 1 input leads. The register can be cleared by applying a pulse to the set 0 inputs.

If the plate outputs of the flip-flops are connected to successive junctions of a duplicate delay line, clearing the register (by simultaneously setting all flip-flops to 0) will introduce pulses into the line at the 1 positions; these pulses will come out of the delay line as the desired train.

The other scheme for sending a train into a static register is somewhat similar to the operation of some desk computing machines that have only 10 keys, 0 through 9. Pushing 3 enters 0003 on the dials, then pushing 5 shifts the 3 along as the 5 is entered, showing 0035, etc. This sequential to parallel conversion can be accomplished by the shifting register of Fig. 1D.

The set 0 lines are all connected to a shift pulse bus. A shift pulse then clears all flip-flops, and any registering 1 generate output pulses. These pulses arrive at the set 1 leads of the next flip-flops, transferring the 1's one place to the right. Clearing a flip-flop registering 0 generates no pulse, so leaves the next flip-flop cleared to 0. Hence every time a shift pulse is sent in, the contents of the register shift to the right. If the shift pulses come at a 2-mc reprate, evenly interspersed between the 2-mc signal pulses sent into the left-hand flip-flop, every time the register is shifted it will find the next digit of the train in the left-hand flip-flop and 35 shifts will result in a static storage of the 35 pulses in the train. We now stop the shifting and have the number stored.

Reading the register (regenerating the train of pulses) is simple. The output of the right-hand flip-flop is connected to a transmission bus and 35 shifts are made, sending the successive 1's and 0's onto the line, and leaving the register cleared to all 0's, assuming that no signal is coming in from the left.

The static registers described above require two tubes per binary digit, or 70 tubes per word stored, so are uneconomical for the main storage. (A general purpose computer needs storage facilities for at least 1,000 words). However the static register is useful in the arithmetic unit for intermediate storage between two organs with different speeds, such as internal parts of the machine and the magnetic wire. One word at a time can be written at any speed, and then read at any other, permitting synchronizing input data pulses with the 2-mc clock, which would be impossible to do by trying to run the wire at an exact speed.

The other internal high-speed memory, or scratch paper, of the machine can either hold pulse trains as a static array, or remember them dynamically; that is, in the form of pulse trains available for retransmission on demand. Only the latter choice will be discussed here.

DYNAMIC MEMORY—The simplest way of achieving dynamic memory is to feed pulses into a delay line whose output is connected back to the input to keep the pulses circulating. An amplifier and pulse regenerator are needed at the delay line output to compensate losses. Distorted pulses from the line are used to control a gate feeding fresh pulses from the master pulser, or clock, back into the line. Such a gating combination in the recirculation system is referred to as a pulse reshaper.

The losses of an electric delay line are too great. Each word to be stored requires 17.5 μs of line to hold it; this implies a total of 17.5 milliseconds of electrical delay line, whether in one or several segments. To transmit the individual 0.2 μs pulses without excessive distortion requires a bandwidth of 10 mc. Even with the optimistic figure of 6 db per μs attenuation in lines having this bandwidth, attenuation would be 105,000 db, requiring 7,000 tubes such as the 6AK5 having a gain of 15 db per stage. This is excessive.

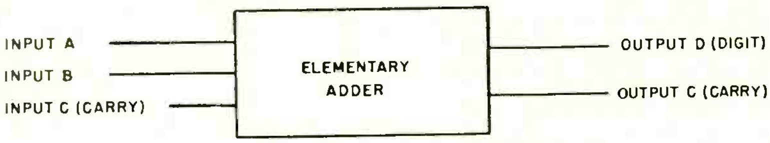
A practical way to simplify dynamic storage is to store pulses acoustically rather than electrically. We can convert the 0.2 μs pulses into 0.2 μs packets of h-f using a carrier frequency of 20 or 30 mc. These h-f pulses can then be used to drive a quartz crystal which in turn generates waves in a mercury column. A receiving crystal at the far end senses these waves giving a signal that is amplified and rectified to regenerate the pulses. Attenuation in mercury is approximately 0.06 db per μs at a carrier frequency of 30 mc, or one percent of that for the electrical line. The pair of crystal transducers used with the line introduces a loss of about 50 db.

If one long delay line is used, coupling losses would be negligible, but a single delay line of 17.5 milliseconds would require on the average a waiting time of 9 milliseconds before the desired word would be available. This is too long. A practical compromise between equipment and speed is to subdivide the memory into lines, or tanks, of 20 word capacity, each having a delay of 350 μs. Thus 50 lines are needed, involving 50 pairs of transducers having 2,500 db attenuation. Adding the attenuation of 1,050 db in the mercury, we have a total of 3,550 db attenuation (to be compared with the 105,000 db of electrical lines) and requiring only about 250 amplifier tubes. A typical recirculating tank circuit is shown in Fig. 1E.

We now have conceptually a source of input signals, a receiver for output signals, an arithmetic unit, static registers and dynamic memory tanks. Signals must be dispatched from one to another of

Table I—Operation of an Elementary Adder

Terminals of Elementary Adder



List of Binary Input-Output Combinations

In A	0	0	0	0	1	1	1	1
In B	0	0	1	1	0	0	1	1
In C	0	1	0	1	0	1	0	1
Out D	0	1	1	0	1	0	0	1
Out C	0	0	0	1	0	1	1	1

Rules of Arithmetic

Binary operations	Logical concepts
(1) A single input 1 generates a 1 and no carry	(1) (A AND B) or (A AND C,) or (B AND C) generates a carry
(2) Two input 1's generate a carry but no output	(2) A or B or C generates an output digit unless one of the above AND combinations occurs, which operates a gate to prevent the transmission of the digit
(3) Three input 1's generate both and output and a carry	(3) A AND B AND C generates both digit and carry

Functions of Elementary Adder

Transmit a digit if A OR B OR C and not A AND B, A AND C, nor B AND C, or if A AND B AND C
Generate a carry if A AND B, A AND C, or B AND C

these organs. In general, any organ may be called upon to send signals to any other. The simplest way of doing this is to connect all tank inputs to a common point through switches (electronic gates) and to connect the arithmetic unit output to this point. Then opening the proper gate will allow the signal to proceed to the chosen tank, and to no other. Conversely, if several sources are to be capable of sending to several receivers, all sources can be connected in parallel to a common transmission bus, and the receivers connected to this bus through gates. Then by opening a receiver gate, and instructing the proper source to transmit, the desired result should follow. In practice, this would not work, for with many sources in parallel, each source would be loaded by the parallel combination of the output impedances of all the others. We need, between each source and the common bus, a buffer which allows only one way traffic, so that a signal can come from a source through the buffer to the bus, but the other sources cannot load the bus. The use of a buffer between an oscillator and a modulated r-f amplifier is well known. In our case of passing pulses of only one polarity, we do not need a triode or pentode buffer, but can use a diode. This diode is normally biased with back voltage so that it presents a high impedance to the common bus. A pulse on the bus increases the back voltage on the diodes and is protected. A pulse from a source, however, reverses the polarity on that one diode and goes through with small loss. The advantage of such buffers is that germanium diodes can be used, greatly reducing shunt capacitance.

With gates and buffers we can perform circuit switching, or spatial selection for traffic control. If we stored our 1,000 words in 1,000 one-word tanks, there would be an exorbitant number of switches with their attendant losses and control problems. We could compromise on 50 tanks holding 20 words each. We can choose any one of these 50 tanks by spatial switching and any one of the 20 words in a tank by temporal selection. The temporal selection requires no switches aside from the timing gate.

The timing circuit can be operated by dividing the master clock rate. The 2-mc reprate drives a counter which counts up to 35 and then throws a flip-flop, giving an output which is on for 35 pulses, or one word time, and off for the next. By feeding these rectangular waves of word duration into a scale-of-20 counter, we can devise a circuit which will give an output (to control a gate) for the duration of any desired one of the twenty words.

Arithmetic Circuits

To understand how to combine gates and buffers to make a circuit that will do arithmetic, it is convenient to interpret gates and buffers in terms of their logical behavior.

A GATE is essentially a device having two inputs and one output. Either input can be considered as the signal, and the other as the control. Obtaining output from a gate is dependent upon stimulating both inputs; that is, it requires stimulation of one input AND the other input. Logically the gate detects the AND concept, one thing AND another.

BUFFERS, on the other hand, that feed two or more signals to a common point give an output signal if any one of the sources is excited; that is, if one OR another input of the row of buffers is stimulated. Hence two buffers connecting two inputs to one output constitute the logical concept of OR, one signal OR another.

Typical gate and buffer circuits using tubes are shown in Fig. 2. The series gate of Fig. 2A has both grids normally biased beyond cutoff; both must be driven above cutoff to produce an output. The parallel gate of Fig. 2B has all tubes normally conducting. If the load resistor is large compared to the conducting resistance of a single tube, the common plate voltage will remain low unless all tubes are cut off by signals.

The series and parallel buffers of Fig. 2C and 2D represent inverse operating conditions on the corresponding gate circuits. The normal-abnormal conduction states are interchanged, and the circuits are stimulated by pulses of sign opposite to those required by the corresponding gates. A signal on any input produces a change in the output.

The diode circuits of Fig. 2 are all parallel circuits. Gates, requiring the AND or multiple coincidence, have all their diodes normally conducting, while buffers have all their diodes normally nonconducting. Diodes are generally of the germanium type.

Adder Is Basic Element

To add two digits, the basic operation of arithmetic, we need two inputs and one output. If the sum of the two digits is greater than 9 in the decimal system, or greater than 1 in the binary system, a carry will be produced to add in the next digit position. Hence we need three inputs, one for each digit in the given position, plus one for the possible carry from the previous position. We also need two outputs, one for the output digit, and one for the carry. Thus each digit position requires a device as shown in Table I. Operating characteristics of this elementary adder can be deduced from the laws of arithmetic. The desired outputs for the eight possible input combinations of 0 and 1 on the three inputs are listed in the table.

There are two types of adders: parallel and serial.

A PARALLEL ADDER is made of 35 elementary adders, one for each digit position. Various digits are set up in a static register, as previously discussed, and the steady register output voltages representing 0's and 1's activate static elementary adders. The carry output lead of each place can be permanently connected to the carry input lead of the next, requiring one type of elementary adder to satisfy the rules of arithmetic. Alternatively the sum and carry digits can be formed statically in each place, and the carrier transmitted to their neighboring adders an instant later. Part of the difference in the circuitry is involved with the fact that a carry may generate a carry, as in adding 7774 to 2226. Propagation of the carry down the line can be handled in various ways.

THE SERIAL ADDER uses a single complicated elementary adder for successive digit places in sequence. Pulse trains are not set up in static form, but are fed in dynamically, the two numbers arriving simultaneously. If an output 1 pulse is generated, it is transmitted immediately as one digit of the sum. If a carry pulse is generated, it is delayed 0.5 μs and returned to the carry input, arriving there coincident with the input digits of the next place.

An elementary adder can be made of gates and buffers. Rules of arithmetic shown by the list of input digit combinations are stated in Table I. The preventing operation in case (2) implies a negative gate, or logical AND NOT, which is easy to devise from diodes by using several bias levels. With this terminology, the functions of an elementary adder can be described logically as at the bottom of the table. The complicated combinations of AND and OR are straightforward logically and electronically, but lead to a practical circuit employing (in one design) nine pentodes and 36 diodes! Some of these elements are incorporated to reshape pulses, and several diodes are used as limiters and d-c level restorers.

Any adder can be considered as a problem in traffic control where the signals (numbers) that are put in control the transmission of pulses throughout the adder. This local control is one step more complicated than the central control, or traffic dispatch between organs. In the central control problem, control voltages set up the paths to be taken by signal pulses. In the local control, pulse paths, and times (clock beats) at which pulses occur are set by the signals themselves, so that there is no longer a clear-cut distinction between signal and control pulses.

MULTIPLICATION is a more complex problem. Ordinary longhand multiplication consists essentially of adding the multiplicand (574) as many times as the right-hand digit of the multiplier (31) shifting columns, adding on the multiplicand as many times as the next digit, etc., as in the example:

```
  574          574
   31           31
 ----    =    ----
  574          574
 1722         574
 ----         574
17794         574
             -----
             17794
```

Because in the binary system, only 1's and 0's occur, we have for the partial products either the multiplicand itself, or zero.

```
Decimal              Binary
  23                  10111
   5                    101
  ---       =       -------
  115                 10111
                     00000
                    10111
                    -------
                    1110011
```

This allows us to use a shifting register (previously described) together with a basic adder, to perform multiplication. We do or do not add in the multiplicand according to whether the right-hand digit of the multiplier is 1 or 0, shift the number in the register, and repeat. Thus a basic arithmetic unit consisting of registers, which can be shifted when desired, gates and buffers, can either add or multiply according to whether it gets a simple signal to add, or whether it gets also a signal to shift and repeat. Other modifications permit subtraction and division. Which operation is to be performed is controlled by signals from central control, usually quasi-static voltages to keep certain gates open until the operation is completed.

Before examining means for converting pulse trains representing arbitrarily coded orders into gate control voltages, let us glance at the overall organization of the computer.

The input portion of the machine sends all its words, both numbers and orders, to the high speed memory storage. From storage, orders go to the central control, logically through a decoder, but this decoder is the main part of the central control and so is not usually considered separately. Central control must dispatch operating instructions to all machine units, including the input, for it must tell the input when there is room in the memory for more data and orders to continue the problem. The general scheme is shown in Fig. 3. The only feature of the diagram that is unnecessary is the transmission of orders (not control voltages) to and from the arithmetic unit. This is a useful way of pyramiding the hierarchy of control to achieve versatility of operation. Because orders themselves are coded to appear as numbers, orders can be modified by performing arithmetic upon them. This feature simplifies programming the mathematical problem in terms of dispatching orders, but need not concern the electronic circuit designer.

We have mentioned that orders are coded in numerical form. Suppose for example that eight different orders are desired; that is, eight different lines are to be energized. Any eight things can be represented in code form by the binary numbers 0 to 7; that is, 000, 001, 010, 011, 100, 101, 110, 111. These are the eight combinations of three places, each having either of two values. Electrically, we can have three wires, each of which may have voltage applied. If orders are pulse trains they can be converted to the static three wire combination by setting up a static register of three flip-flops. We then have three wires, any one or more of which may be hot, representing eight different possibilities, and we wish to excite any one of eight leads in accordance with these choices. In general, we have N wires of two possible states each (hot or cold) giving 2^N combinations, and wish to excite only one of 2^N outputs. In practice, instead of using N wires from N flip-flops, having some hot and some cold, it is better to bring two wires from each flip-flop, one from each side. We then have N pairs of wires, each of which has only one side hot. All input pairs are thus excited one way or the other, avoiding complications of zero-voltage input signals.

The simplest case of a decoder is where $N = 2$, so that there are two input pairs and four output leads. The circuit of Fig. 4A shows this case. The horizontal and vertical lines are connected through diodes, so that the diodes in any column form a gate, or AND circuit. If upper and lower lines of the top pair are excited positively, output from the left-hand lead is excited, and so on for the four possible combinations of input.

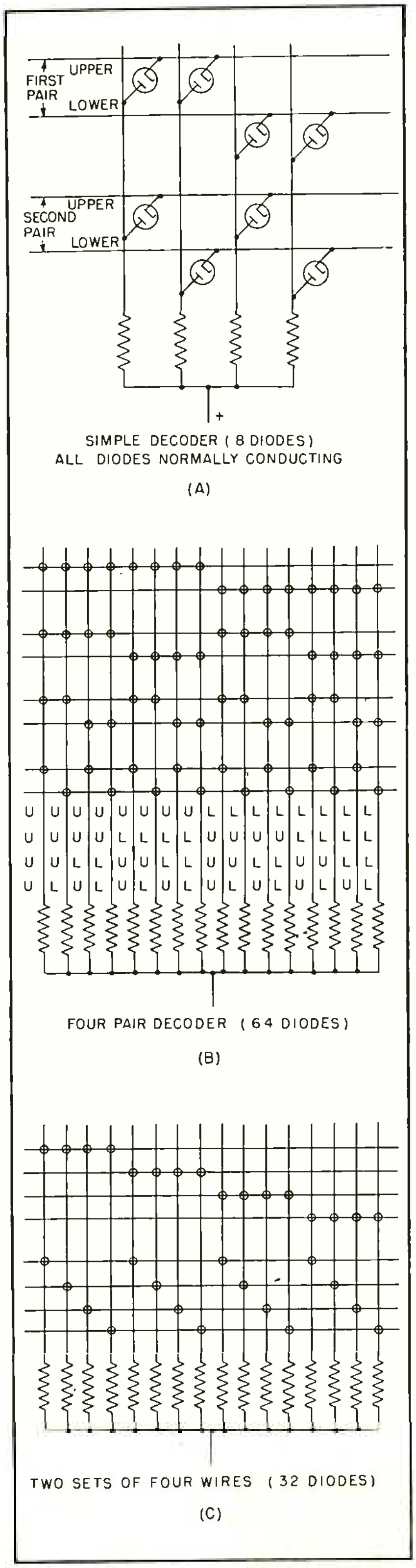


FIG. 4—Switching circuits use unidirectional conductance of diodes

For larger decoders, it will be convenient to indicate the presence of a diode connection between two lines by a circle at the crossover. There are no direct connections. Figure 4B shows a simple decoder for four input pairs, yielding 16 possible output excitations. Combinations of upper and lower pair excitations that result in excitation of each of the 16 lines are indicated on the figure.

This direct check of the possible combinations can be called a one-stage decoder. Fewer diodes are required if we decode in two stages, namely, by mixing two pairs as in Fig. 4A to get one line out of four, and doing the same with the other two pairs to get one line out of another set of four. We then have two sets of four lines each, in which only one line of each set is excited. These two sets can be fed into the circuit of Fig. 4C. Thus in using Fig. 4B, each output line requires a quadruple coincidence for excitation, and 64 diodes are needed. By using two circuits of Fig. 4A and one of Fig. 4C, making successive simple coincidences, we need $8 + 8 + 32 = 48$ decoders, or a saving of 25 percent.

Multistage decoding exhibits even greater savings as N increases. For $N = 8$, allowing selection of any one of 256 memory tanks by virtue of the $2^8 = 256$ different gates that may be opened by an 8-pulse signal, a three-stage decoding requires only 608 diodes as against 2,048 for single-stage decoding.

Traffic Handling Systems

Having seen how a coded order can be converted to the selection of a gate opening voltage, it is of interest to consider briefly the general traffic handling plan. The mathematician prepares his instructions to the machine in terms of numerical data, coded orders to select which basic operation the arithmetic unit is to perform, for sequencing the machine or for expressing the routine to be followed. In general two kinds of words are put into the machine memory: numbers and orders.

Assume that the memory is capable of storing 1,000 words and, for

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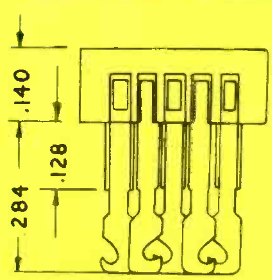

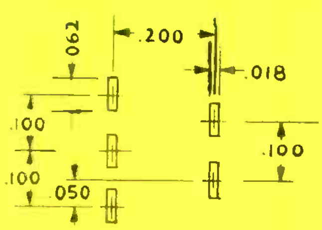

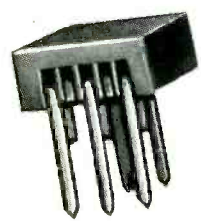

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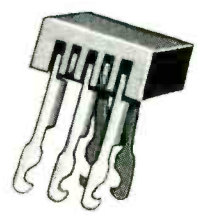

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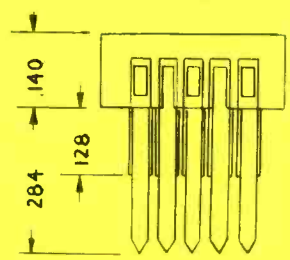

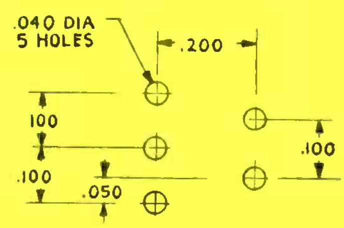

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simplicity, that the two kinds of words are of equal duration, or number of pulse positions. These 1,000 words occupy definite positions in two dimensional space-time. Hence we can consider their positions as pigeonholes numbered from 1 to 1,000 and call for transmission of a word to or from any pigeonhole. The simplest way of entering the input data is to take the first thousand words from a magnetic wire and store them sequentially in the thousand cells. This can be done by using a counter to measure off a word, and cause unity to be added to the address to which the next word is to be sent.

High speed reading of the memory can also be done sequentially by giving the address 1 as the instruction for the cell to be read and by having a built in arrangement for automatically adding unity to the address of the cell to be read. It will then automatically read cell 2 as soon as it has finished with cell 1 and is ready to read again.

A procedure that may be more flexible for repeating subsequences and setting up branch operations (choice of next order depending upon present results) and also more convenient in practical programming is the four address code. In this system each order is composed of four addresses (or memory cell locations): the address of the first operand (number to be arithmetically operated upon), the address of the second operand, the code for the operation to be performed, and the address of the next order to be read after completion of the present instructions. This system is more efficient if memory reference is slow compared to other operations; that is, if waiting time for a word to be reached in the sequential reading of a dynamic memory is relatively large because it allows the essentially simultaneous look-up of both operands.

A variation of the four address system is the use of a fifth address in the words on the input wire, to designate the cell into which that word is to be stored. The fifth address is automatically deleted as the word is entered into the machine.

In electronic digital computers, the tubes, for example, are called upon to develop a pulse of usable level, or not called upon at all. Variations between tubes, aging, or tolerances of resistors do not affect accuracy, until they become so extreme that the signal falls out of usable range. A ten to twenty per cent variation of signal strength has no effort on a series of pulses. Ideally a computing machine works perfectly or not at all. Actually, as tubes deteriorate, there is a threshold at which operation may be erratic. By setting a limit checking circuit for a safe level margin, this otherwise possible operation can be put in the class with complete breakdown.

Errors can occur due to noise generating a false pulse at an allowed pulse time when the word transmitted has a zero in that position. This noise pulse may be indistinguishable from a proper pulse. Occurrence of errors due to such random causes can be guarded against by one of several checking schemes.

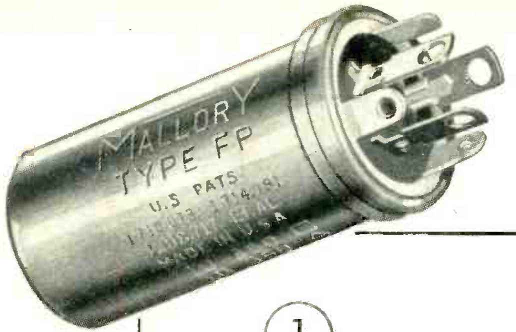
One of the most elaborate checking schemes that has been proposed is to check the arithmetic and the transmission. The arithmetic can be checked in a fashion similar to the ancient system of casting out 9's, where each number is expressed as its excess over a multiple of 9; that is, it has a value of 0—8. This is done by adding sideways. The 9's excess of a sum of numbers is equal to the sum of their individual excesses, (expressed as an excess if larger than 9). The 9's excess of the product of two numbers equals the (excess of the) product of their excesses. A simple auxiliary addition or multiplication on the excesses has often been used for checking arithmetic. For example, multiplying 371 by 24 gives 8904. The 9's excess of 371 is found by adding the digits $3 + 7 + 1 = 11$, $1 + 1 = 2$. Similarly, the 9's excess of 24 is 6. The product of these two excesses is 12, having itself an excess of 3, which agrees with the excess of 8904, $8 + 4 = 12$, $1 + 2 = 3$. A corresponding procedure of casting out $(2^N - 1)$ can be set up for binary computation, and a small auxiliary arithmetic unit operated simultaneously with the main unit.

This type of checking lends itself to verifying correct transmission of a number. The excess count of a number can be stored with it in the memory for performing the parallel arithmetic check. It can be used as a transmission check by taking the excess count of a number received by the arithmetic unit and comparing it with the received check count. Very peculiar transmission errors are required to make the new count of an incorrectly transmitted number agree with either its original count or an incorrectly transmitted count. This type of checking is based on arithmetic.

Checking the address selection exercised by central control can be done by storing with each word its address. When the word and accompanying address is read, the read address is checked against the called-for address. This checks both the spatial and temporal phases of word selection in the machine.

Electronic design of machines is fast progressing to the point where they will be more perfect than the mathematics set up for them. I refer to such varied factors as round-off error, inevitably introduced by working to a fixed number of significant figures. If a machine performs 1,000 arithmetic operations a second for days on end, what relationship does the final answer have to the original hypotheses? Some mathematical research is being done on this point. A more vital question is the design of mathematics suited for machines. Many procedures use machines for replacing human computers, using numerical computational schemes developed for the human brain. Characteristics of an electronic machine are different from those of a human brain, and it is reasonable to suppose that computational procedures can be devised which, although unsuited for hand computing, are well adapted to machine routines. Such procedures have been developed for a few special problems.

The writer thanks the Raytheon Manufacturing Company and the Eckert-Mauchly Computer Corporation for supplying some of the circuit details shown in the figures.



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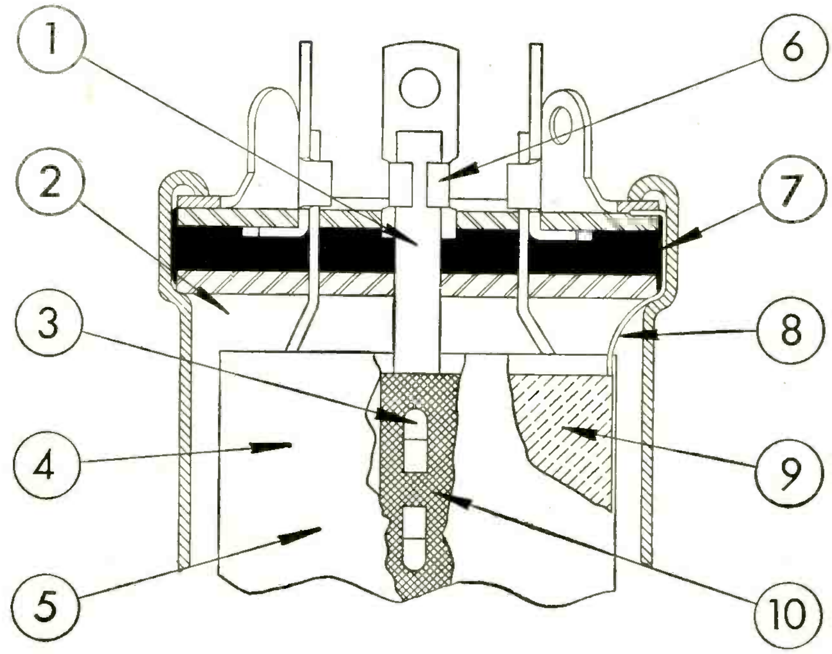

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TUBES AT WORK

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Edited by VIN ZELUFF

Mobile Television Receivers

TELEVISION receivers mounted on three jeeps operated by an automobile club made it possible for several additional thousands of people to see the telecasts of the national political conventions from station WCAU-TV, Philadelphia.

The receivers were mounted so that they faced the sidewalk when the jeep was parked on the right-hand side of the street. Thus each jeep could be parked along the highway enabling spectators to watch the television picture from the sidewalk without producing a traffic hazard.

Table model television sets were used, standard Philco model 1001 receivers with 10-inch direct-view screens. As the picture shows, each television set was mounted on a special rack at the right rear of each jeep, and a 12-foot aluminum antenna was also mounted on the side of each jeep. The antenna comes in 6-foot sections, and two sections were used.

For driving along highways with bridges or low-hanging trees, the top mast section and dipole were detached and strapped to the top of the jeep. A single half-wave dipole without a reflector was fastened to the top mast section. This was connected to the receiver by a 70-ohm coaxial line to minimize ignition interference from passing automobiles.

Philco ten-inch table model television receiver mounted on a jeep for the convenience of roadside viewers

Such an installation is useful for observing television reception in various locations. Measurements of field strength may be taken by checking agc voltage and multipath may be observed by watching the picture. The jeeps had standard JAN ignition suppression and in the absence of bad standing waves it was possible to obtain a steady picture when the jeep was traveling at 30 mph.

Power for each set was supplied by three 120-ampere-hour storage batteries in the back of each jeep. One battery supplied heater voltage at 14.4 amperes to all tubes. For the purpose, the 5V4 damper tube was replaced by a 6W4.

The other two batteries supplied two Mallory VP-555 Vibrapacks whose total output was 340 volts d-c at 140 ma. Cold-cathode 0Z4 rectifiers were used and filament power was applied at least 30 seconds before the Vibrapacks were energized.

Initially planned by the staff of WCAU-TV, the idea was executed by Philco engineers under the direction of Joseph Fisher, project engineer, Research Division, Philco Corporation. One engineer from Philco Service accompanied each jeep, with the regular uniformed drivers of the Keystone Automobile Club. The jeeps are normally used for emergency calls and are equipped with mobile radiotelephone, and now have mobile television.

Taxi Tele

Taxicab operation of a television receiver is reported by G. W. Fyler of Motorola. The receiver used was a Motorola VT-71 in which the 12 and 25-volt tubes were changed to 6-volt tubes of similar characteristics. A Mallory Vibrapack was added for plate supply. This was mounted away from the receiver to prevent hum components in the picture. Filters designed for the television frequencies to be used were also added.

Modifications to the receiver included series-connected VR tubes for plate supply regulation and adjusting the time constant of the agc circuit to about 0.01 second. This permitted fast circuit action in standing waves but not so fast as to lose too many low-frequency components, including the vertical sync

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pulse. Adequate heater voltage was found important to stabilize sync action.

To cover both the high and the low channels, an all-band antenna was shortened and modified at the center as a compromise between good performance at the proper length and ease of mobility of the vehicle.

Ignition suppressors and special generator filtering were found desirable but no special shielding was added to the receiver circuits. It was found to be important to have low set and car noise during minimum signals in the standing wave pattern.

The high-channel signals seemed to have more standing waves and ghosts. In severe standing waves the agc was able to follow signals on the low channels better because the standing waves occur about three times as far apart. Video and audio signals seemed to have different standing wave patterns.

Signals from the high-band channels were stable in open flat country but tend to have somewhat deeper shadows behind hills as expected. Standing waves were found to be greatest near large metal structures such as a bridge but were often perfectly stable under the bridge. Strangely, slight ghosts appeared in a few areas in flat open country without overhead wires or other objects that cause reflection.

Industrial Tube Tester

THE EFFICIENCY of gas or mercury-filled industrial tubes such as thyratrons and phanotrons is tested by the circuit shown in Fig. 1.

In most cases, gas or mercury vapor tubes are used as high-current, low-voltage devices. For that reason, this General Electric tube tester is designed to test the ability of the tube with high current passing through it. The passage of current may readily be seen by noting the familiar blue glow.

Tube efficiency can be determined by measuring the voltage drop from anode to cathode when rated peak anode current is passed. With the TT-1 tube tester, the rated peak, anode current is carried by the tube under test for a half-cycle shot once per second, thus preventing the cathode of the tube from warming up due to the passage of current. The lowering of the voltage drop due to passage of current can easily be checked by allowing the tube to conduct during short portions of each cycle for a few minutes and noting the change in the dial setting required to light the indicating neon tube. This is the reason for making the test reading on the first five conducting cycle positions. A voltage drop of 25 volts is usually considered the maximum limit for good tubes at rated peak anode current.

An anode-to-cathode voltage of 110 volts is placed across the tube for one-half cycle of a 60-cycle source by means of a contactor which is opened and closed by an electronic circuit when the test button is pushed. Various peak currents may be put through a tube by changing the load resistor to various selector settings. When current passes the tube under test, a voltage drop appears across the tube which lights the indicating neon light if the voltage drop exceeds the rated value. The zero calibration is set for a series of tests to compensate for the slight change in the tube characteristics in the electronic calibrating circuit.

In testing ability of the tube to pass current, other defects of the tube are automatically tested. If a tube is leaky or gassy, has an open filament or low emission, it will immediately show up as having poor ability by a high voltage drop.

Mercury vapor pressure inside of tubes nearly doubles for every 10 C rise in temperature. Too low a mercury pressure causes a high-voltage drop from anode to cathode and therefore speeds up the positive ions in the region between the anode and cathode, resulting in bombardment of the delicate cathode coating. A higher mercury pressure lowers the tube's voltage drop but also lowers the ability of the tube to withstand inverse voltage. For these reasons, mercury tubes have a minimum and maximum temperature limit, usually from 40 to 80 C.

Temperature is measured at the point where condensation takes place, usually at the bottom of the tube. A test of the ability of the tube as given by the TT-1 tube tester is made at the lower temperature limit so that tests will be under the highest voltage-drop condition. However, in low ambient temperatures a longer period than the cathode heating time is required in order to get the condensed mercury temperature of the tube to this lower temperature limit.

For this reason, and also because it is necessary for the mercury to be properly distributed (all condensed in the bottom of the tube), a heating time longer than the normal cathode heating time is called for in the instructions for use of this tester. A condensed mercury temperature of 40 C is usually taken as the temperature for measuring the ability of the cathode.

Gas-filled tubes differ from mercury-filled tubes in that the gas pressure does not vary excessively in normal temperature conditions of

(Continued on p 136)

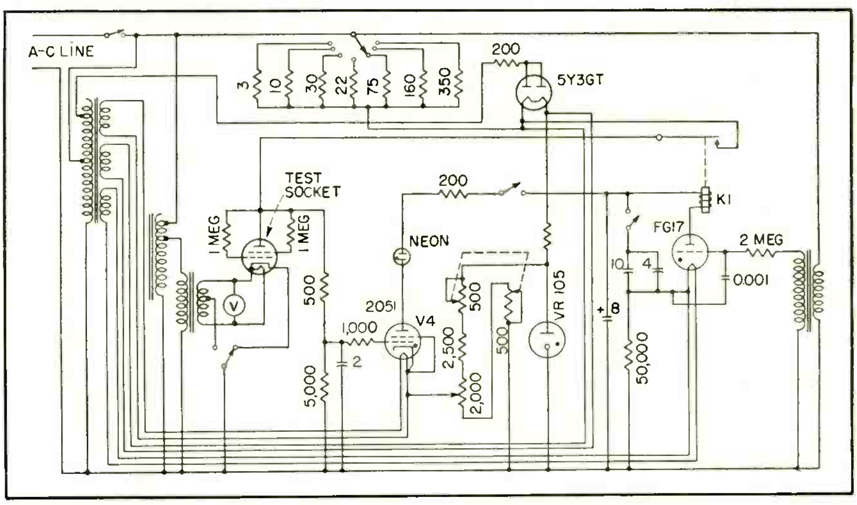
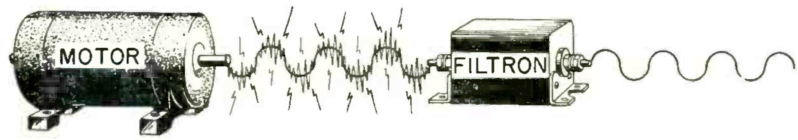


FIG. 1—Complete circuit of tube tester for phanotrons and thyratrons

FILTRONS

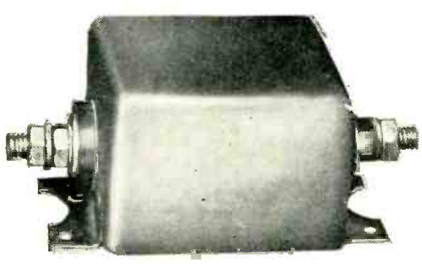
Stop
CONDUCTED AND RADIATED INTERFERENCE
at the source

STOP RADIO INTERFERENCE



2.5 amp Filtron for 50 V. D.C. operation size $1\frac{3}{4}'' \times 1\frac{1}{4}'' \times \frac{7}{8}''$

Shielded Spherical-Seat Terminal Filtron—designed for continuous high attenuation from 150 kc to well above 200 mc



100 amp Aircraft Filtron size $3\frac{1}{2}'' \times 3\frac{1}{2}'' \times 2\frac{1}{2}''$

THOUSANDS of FILTRONS—radio interference filters—are standard equipment on the majority of the current production of Aircraft. Thousands of others are in use in vital equipment where radio interference must be suppressed.

Filtron's experienced Engineers, recognized authorities in the noise-suppression field, are available to measure the RF interference caused by your product, and to specify a standard Filtron or design the proper filter so that Army, Navy, Air Force or FCC interference specifications are met.

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All measurements are made in our new modern specially-designed shielded Radio Noise Suppression Laboratory, which is equipped with the most modern and approved radio frequency measuring instruments.

"Filtron," the largest exclusive manufacturer of Radio Noise Filters, offers you both the services of their Engineers and facilities to make your product "Noise Free."

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INCORPORATED
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BAYSIDE, NEW YORK CITY, N. Y.

LARGEST EXCLUSIVE MANUFACTURER OF RADIO NOISE FILTERS

THE ELECTRON ART

Edited by FRANK ROCKETT

Detection of Microwaves

ABSORPTION OF MICROWAVES by gases has been studied to determine such physical constants as molecular dipole moments.[1] In these investigations thermal and acoustic effects have also been observed.[2] Using the expansion produced in gases by their absorption of microwave energy it has been possible to detect as little as 10 milliwatts with relatively simple apparatus. The absorption phenomena can also be used, at low gas pressure, to stabilize the frequency of microwave oscillators as effectively as oscillators of lower frequency are stabilized by quartz crystals.[3]

Microwave Wattmeter

Figure 1 shows a wattmeter. The resonant gas-tight metal cavity is filled with a highly absorbing gas such as ammonia or one of the Freons. The cavity communicates with the U-tube in which is a light liquid that does not react with the gas. When a transmitter generating 10 watts is coupled to the resonator the liquid is deflected about 12 inches in a second; equally rapid response is obtained when the power is cut off.

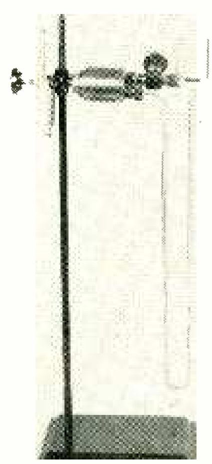


FIG. 1—Wattmeter utilizes expansion of gases produced when they absorb microwaves

This type of wattmeter can be used with 1.25-cm and 3.2-cm transmitters delivering either continuous or pulsed power. The action is a consequence of the conversion by resonant molecular absorption of the microwave energy, followed by collisions of the excited molecules thereby converting their internal energy into an increased gas pressure.

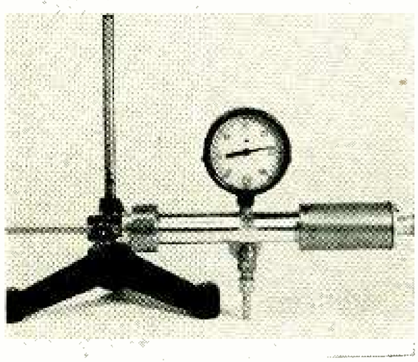


FIG. 2—Gas-filled cavity is acoustically resonant to modulation, electrically resonant to carrier frequency

Resonant Absorber

The conversion of microwave energy into gas pressure can be used directly as a detector of modulated microwaves. If a balloon, filled with an absorbing gas, is placed in the throat of a horn excited by a microwave transmitter, the modulation will be heard for some distance as the gas in the balloon expands and contracts in proportion to the instantaneous energy of the wave. Such an arrangement constitutes a true *wireless* receiver.

The technique can be used in a sensitive detector having square-law response. A gas-filled cavity is arranged that is acoustically resonant at the modulation frequency and electromagnetically resonant at the carrier frequency, as shown in Fig. 2. A study of the optimum wave configurations for excitation of the cavity indicated that the microwave energy should be confined to only half of the cavity. A cutoff guide can be inserted at the midsection to confine the electromagnetic waves without disturbing the acoustic waves. A Rochelle-salt crystal is coupled to the aluminum disc that seals the end of the cavity. A conventional audio amplifier and vacuum-tube voltmeter complete the experimental equipment. It is sufficiently sensitive to detect 10 milliwatts of modulated uhf.

The same technique could be used by a football coach to communicate with a quarterback. The coach would use a highly directional voice-modulated microwave transmitter. The quarterback would have a helmet equipped with a gas-filled ear piece.

(1) W. D. Hershberger, The Absorption of Microwaves by Gases, *Jour. Appl. Phys.*, p 495, June 1946; p 814, Oct. 1946.
(2) W. D. Hershberger, E. T. Bush, and G. W. Leck, Thermal and Acoustic Effects Attending Absorption of Microwaves by Gases, *RCA Review*, p 422, Sept. 1946, on which the foregoing article is based.
(3) W. D. Hershberger and L. E. Norton, Frequency Stabilization with Microwave Spectral Lines, *RCA Review*, p 38, March 1948.

Plotting Electron Paths

By PAUL J. SELGIN
Ordnance Development Division
National Bureau of Standards
Washington, D. C.

TRAJECTORY OF AN ELECTRON is frequently determined graphically. The method described here uses a universal set of curves developed on the assumption that the electron trajectory between equipotentials is an arc of a parabola. The curves are used in conjunction with a map of the electric field in which the electron moves, and requires knowledge of the initial position and velocity of the electron in that field.

Development of Method

While the greatest difficulty in most engineering problems lies in

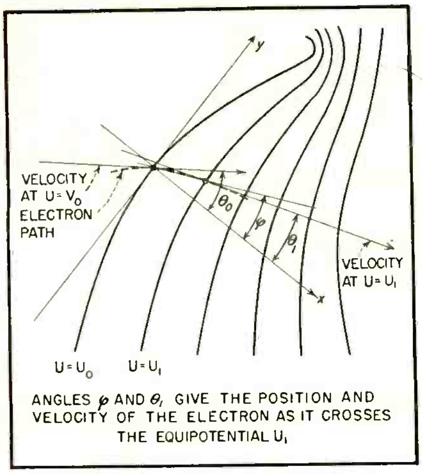


FIG. 1—Notation for general problem

reducing the problem to a mathematical statement, in the study of electron paths the equations of motion, though readily obtained, are difficult to solve. In most design problems the electron does not reach relativistic velocities, so that its mass can be considered constant. Usually there is negligible magnetic field, and, for beams of low density, the region is also free of electrostatic charges. Although this latter assumption will introduce an error, the error is slight and can be taken into account geometrically.[1] These simplifications lead to the equation of motion

$$(d/dt)\ \mathbf{V} = (e/m)\text{grad}\ U \tag{1}$$

where $\mathbf{V}$ is a vector representing the electron's velocity, U is a vector representing field potential, whose value in a charge-free region can be obtained by calculation or by an experimental technique such as the electrolytic tank[2]; m represents the mass, and e the charge of an electron. Because the values are expressed in MKS units, there are no numerical constants.

Equation 1 cannot readily be integrated because of the difficulty of expressing U in analytical form for usual configurations. On the other hand, because U is usually available in the form of equipotential contours, the partial derivatives of $\mathbf{V}$ along Cartesian coordinates X, Y, and Z can be determined, and can be considered constant within a small region of the field.

The basis of this graphical method is to assume that the potential gradient is constant between equipotentials, and to compute the trajectory through this region. Then another short span is similarly treated, and so on. To make it practicable to repeat the process, a simple graphical method is developed.

Universal Curves

To systematize the construction, an analytical expression for the motion of an electron is obtained and a universal plot is made from which individual problems can be solved by projection.

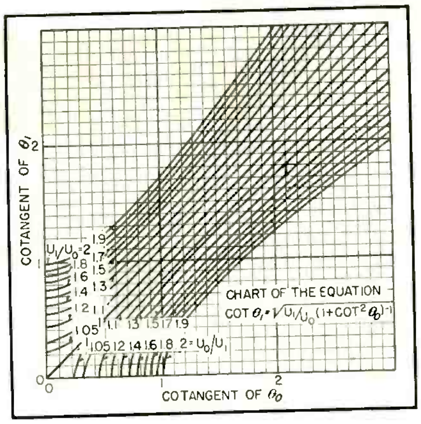


FIG. 2—Chart of universal equation

Due to the initial assumptions, Eq. 1 becomes

$$A_X = (e/m)\ (U_1 - U_0)/X_1 \qquad A_Y = 0 \tag{2}$$

having taken the X axis perpendicular to the equipotential contour U_0 at the point where the electron intersects it (the origin for this particular phase of the solution), A_X is the acceleration in the X direction, U_0 is the potential contour at which the velocity of the electron is given, and U_1 is the contour at which it is to be found; X_1 is the distance between contours (Fig. 1).

With the above orientation of coordinates, there is no acceleration in the Y direction. For fields of usual symmetry, there will be no acceleration in the Z direction, and it will be assumed that there is no initial component of velocity in the Z direction. Integrating Eq. 2 gives

$$V_X = V_{X0} + \frac{e}{m}\,\frac{U_1 - U_0}{X_1}\,t \qquad V_Y = V_{Y0} \tag{3}$$

in which V_{X0} and V_{Y0} are the given initial components of velocity. Integrating Eq. 3 gives the coordinates of position of the electron

$$X_1 = V_{X0}\,t + \frac{1}{2}\,\frac{e}{m}\,\frac{U_1 - U_0}{X_1}\,t^2 \qquad Y_1 = V_{y0}\,t \tag{4}$$

At time t_1 the electron crosses contour U_1 at position X_1, Y_1. From the above equations it is seen that, under the assumed conditions, the trajectory between contours is a segment of a parabola.

Because the time of flight is usually not of interest, it need not be found. The magnitude of the final velocity can be determined from

$$V^2 = 2\ (e/m)\ U \tag{5}$$

in which U is the total potential difference through which the electron has fallen. From the geometry of the problem as shown in Fig. 1

$$\begin{aligned} Y_1 &= V_{Y0}\,t \\ (Y_1/X_1) &= \tan\phi \\ (V_{Y1}/V_{X1}) &= \tan\theta_1 \\ (V_{Y0}/V_{X0}) &= \tan\theta_0 \end{aligned} \tag{6}$$

where ϕ determines the point where the electron intersects U_1, θ_1 indicates the path of intersection, and θ_0 is the angle of intersection of U_0. Using these relations, the pairs of parametric equations (Eq. 4) can be reduced to

$$\begin{aligned} \cot\phi &= 0.5\ (\cot\theta_0 + \cot\theta_1) \\ \cot\theta_1 &= \pm\left\{(U_0/U_1)\ (1 + \cot^2\theta_0) - 1\right\}^{1/2} \end{aligned} \tag{7}$$

Only the second of these relations need be considered, and only the positive sign need be chosen for it. The negative value would apply if the electron described the entire parabola, cutting the equipotentials.

Although the position of the electron at equipotential U_1 could be obtained from Eq. 4 or 7, and the process repeated at the next contour, the trajectory can be obtained more conveniently by constructing a universal family of curves from the second of Eq. 7. The curves are hyperbolas symmetrical about the axes, but not with common foci. Mutually reciprocal values of U_1/U_0 are associated with curves symmetrical about the $x = y$ line. The chart is thus as shown in Fig. 2, but only one half of it need be constructed for actual use.

Graphical Construction

To plot the path of an electron, a sheet on which the universal curves are plotted is placed on a map of the potential field as shown in Fig. 3. The lower edge of the chart is

(continued on p 162)

mended load impedance is 5 megohms.

Two-Speed Changer

MAGNAVOX CO., Fort Wayne 4, Indiana. A new two-speed record changer that makes it possible to play the new long-playing records at 33.3 rpm will also play conventional discs at 78 rpm. Pickup weight is 5 grams.

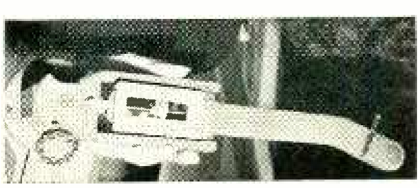
F-M Monitor

DOOLITTLE RADIO, INC., 7421 S. Loomis Blvd., Chicago 36, Ill. The FD-12 f-m frequency and modulation monitor handles up to four frequencies anywhere between 25 mc and 170 mc and has an accuracy of

0.0015 percent. A 500-ohm output is provided for audio monitoring. Power consumption is 80 watts.

Tone Arm

GENERAL ELECTRIC CO., Syracuse, N. Y. A new tone arm equipped with a variable reluctance cartridge for playback of 10 and 12-inch rec-



ords has a 1-ounce stylus pressure. Designated No. UPA-002, the unit is a companion to the professional transcription arm (illustrated) type FA-21-A with stylus pressure adjustable by means of a calibrated scale.

Alignment Generator

PHILCO CORP., Philadelphia, Pa., introduces a portable visual alignment generator, model 7008, for

television and f-m receivers, and for research and engineering work in frequencies from 3.2 to 250 mc. Price is $395.

Two-Jaw Clip

MUELLER ELECTRIC CO., 1583 East 31st St., Cleveland 14, Ohio. The new no. 22 clip has jaws at both ends. Either jaw or both may be opened by properly applied pressure. The clip is two inches long and has a screw connection. Free samples are available.

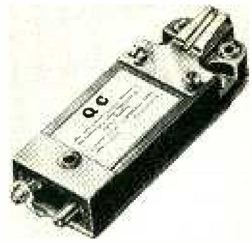
Lab Counter Set

EL-TRONICS, INC., Philadelphia, Pa. Model LS64 laboratory counter set is a complete instrument for use with Geiger counter tubes in measuring radiation intensities.

The unit has a built-in recording clock and uses the Higginbotham scaling circuit.

Ceramic Pickup

ASTATIC CORP., Conneaut, Ohio. Model QC pickup cartridge with



ceramic element has great physical ruggedness. It has a frequency range of 50 to 10,000 cycles and needle pressure of one ounce.

New Converters

RADIO CORP. OF AMERICA, Harrison, N. J. Types 6BA7 and 12BA7 high-gain pentagrid converters are identical except for heater ratings. They have a conversion transconductance of 90 micromhos with 250 volts on the plate. The short inter-

nal leads are so designed for service in f-m broadcasting. A brochure is available.

UHF Signal Generator

BOONTON RADIO CORP., Boonton, N. J. Type 218 signal generator is a portable signal source for receiver measurements in the band from 400 to 1,000 megacycles. Maximum power output is 1 milliwatt

(Continued on p 182)

RAYTHEON RELIABILITY WITH A CAPITAL "R"

is required of the Raytheon Tube

in this
WHEELCO
FLAME-OTROL
COMBUSTION
SAFEGUARD

Says the chief engineer of Wheelco Instruments Company, "We use this special Raytheon tube to be sure of uniform characteristics, long life and greater stability throughout its operating life."

The Wheelco Flame-Otrol guards life and property against the danger of explosion of any gas or oil fired furnace or industrial *heating* equipment. It does it ingeniously and positively by utilizing the electrical conductivity of *a gas flame or spectral response of an oil flame translating resistivity change or response of sensing element,* due to flame failure, through the use of a single Raytheon CK-5608 Tube, into change of current sufficient to operate a relay which acts to close the fuel valves. Action, being electronic, is instantaneous and sure.

Write for Detailed Information on RAYTHEON Special Purpose and Subminiature Tubes

Wheelco uses a RAYTHEON CK-5608 Tube because of its *reliability* and *stability*—the result of:

1. Proven design and precise manufacturing control, backed by the experience of 25 years of continuous production involving $125,000,000.00 worth of special purpose tubes.

2. Unsurpassed engineering knowledge and ability in the development and manufacture of tubes especially to meet long life, industrial application.

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RAYTHEON
Excellence in Electronics

NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, tubes, testing apparatus and products closely allied to the electronics field. A review of catalogs, handbooks, technical bulletins and other manufacturers' literature

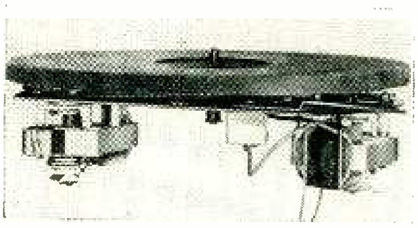
500-Mc Tube

RAYTHEON MFG. Co., Newton, Mass. Type CK5703 (formerly CK608CX) has a mutual conductance of 5,000 micromhos and amplification fac-

tor of 25. It has a 3-watt plate dissipation and can be made to produce about a watt of output power at 500 megacycles.

Old-New Record Turntable

ALLIANCE MFG. Co., Alliance, Ohio. A new dual-speed turntable operating at either 33.3 or 78 rpm is a



modification of the model 80, containing two motors instead of one. Only one motor is used at a time.

Oscillosynchroscope

BROWNING LABORATORIES, INC., 742 Main St., Winchester, Mass. Model OL-15B Oscillosynchroscope includes a vertical amplifier bandwidth of 6 mc, recurrent sweeps of 5 to 500,000 per second and driven sweep rates of 0.25 microseconds per inch to 200 microseconds per

inch. The instrument is self-contained and uses a 5-in. cathode ray tube.

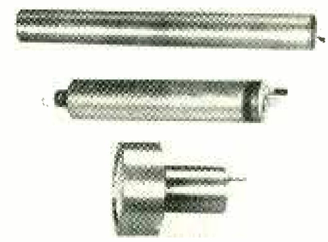
Ultrasonic Thickness Gage

PHOTOCON RESEARCH PRODUCTS, 1062 North Allen Ave., Pasadena 7, Calif. The Metroscope measures wall thickness of metal, plastic, and glass parts from one surface and will also detect flaws or imperfec-

tions in these materials. Using ultrasonic frequencies, the device operates on the basis of thickness vibrations, and gives a cathode-ray presentation of its findings.

Geiger Tubes

NUCLEAR DEVELOPMENT LAB., Box 7601, Kansas City, Missouri. Thin-



window, thin-wall, and all-metal cosmic ray counters illustrated are completely described in Bulletin 10.

Diversity Reception

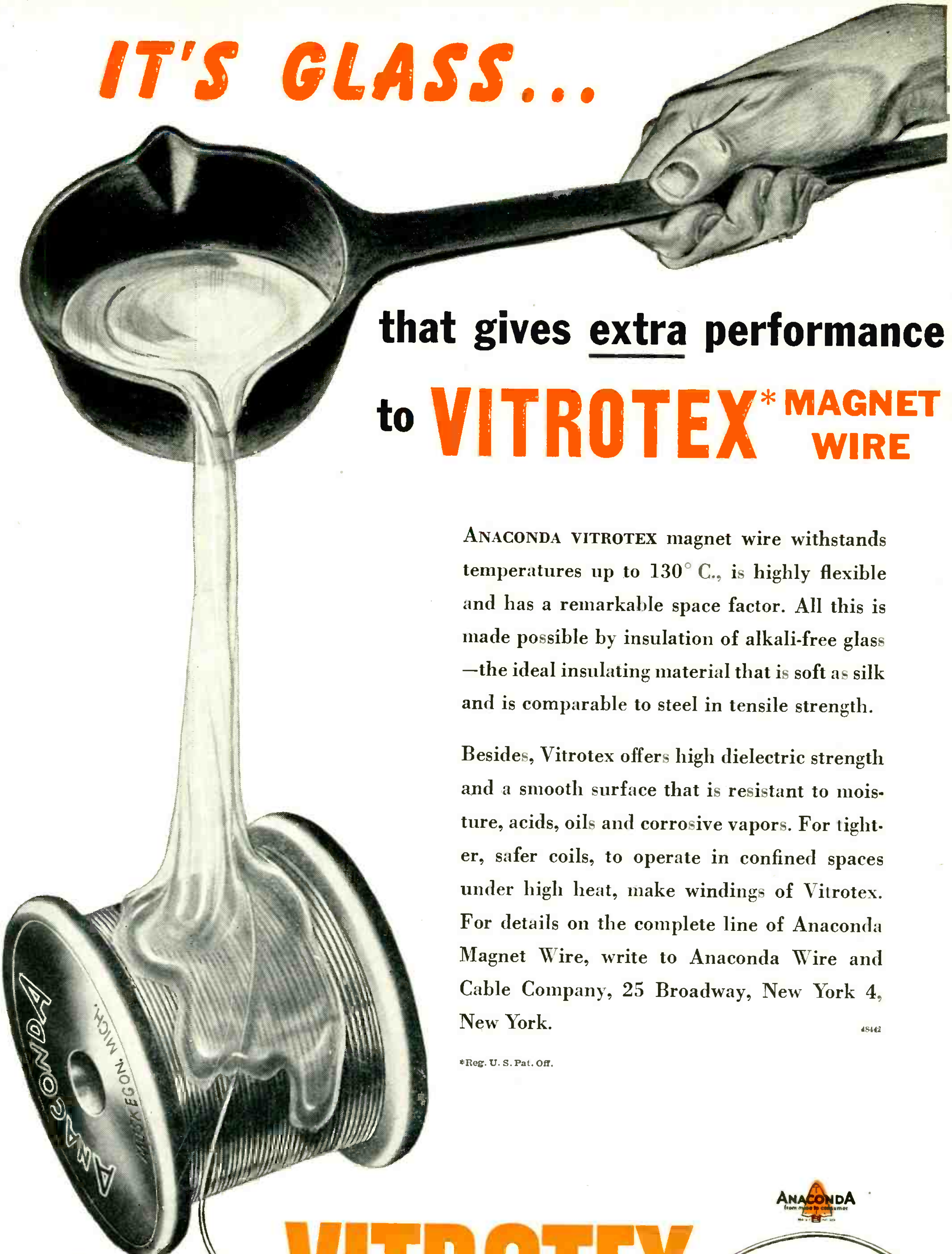
DECIMETER, INC., 1428 Market St., Denver 2, Colorado. The DM-430 Diverse Adaptor selects the better

of two antennas for receiving the desired signal on as little as 0.05 volt of avc. It operates on 200 to 300 volts at 15 ma and filament supply of 6.3 volts a-c at 1.5 amperes.

Ceramic Microphones

ASTATIC CORP., Conneaut, Ohio. Two new microphones using ceramic elements are now available. Chief feature of the unit illustrated is its independence of high ambient temperatures. Its response is essentially flat from 30 to 10,000 cycles. Output level is minus 62 db. Recom-

IT'S GLASS...



that gives extra performance to VITROTEX* MAGNET WIRE

ANACONDA VITROTEX magnet wire withstands temperatures up to 130° C., is highly flexible and has a remarkable space factor. All this is made possible by insulation of alkali-free glass—the ideal insulating material that is soft as silk and is comparable to steel in tensile strength.

Besides, Vitrotex offers high dielectric strength and a smooth surface that is resistant to moisture, acids, oils and corrosive vapors. For tighter, safer coils, to operate in confined spaces under high heat, make windings of Vitrotex. For details on the complete line of Anaconda Magnet Wire, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York. 48442

*Reg. U. S. Pat. Off.

ANACONDA

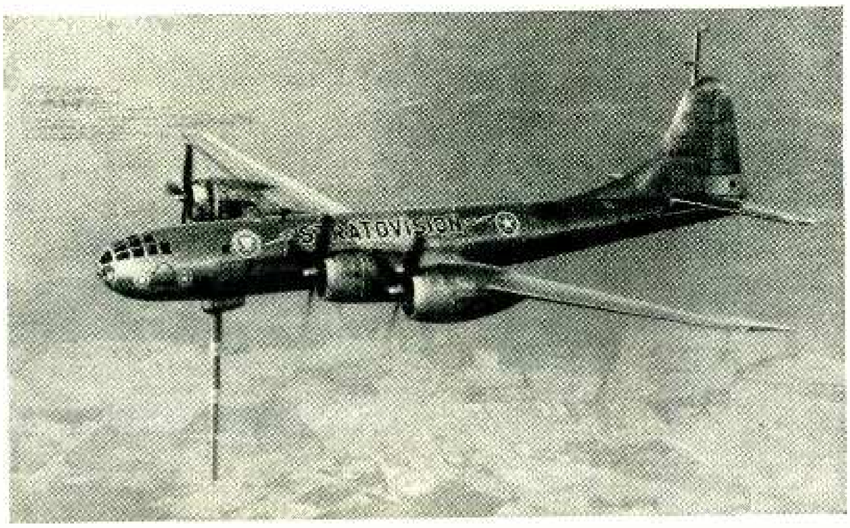
Anaconda VITROTEX THE GLASS INSULATED MAGNET WIRE

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Rural industrial radio; URSI-IRE meeting; tv reallocation; Army tests transistors; utilities radio group; IRE-RMA Fall meeting

Stratovision Demonstration



Stratovision's flying television station over outskirts of Pittsburgh

RURAL AND SMALL town television coverage is now in the offing by means of Stratovision, whereas service in such areas could not otherwise be expected for years. A recent experiment in which some 40 reporters were flown to Zanesville, Ohio, was not too successful due to weather conditions, but a solution for the problem has been promised.

The principal purpose of the recent experiment conducted by Westinghouse and Glenn H. Martin Co. was to show the FCC why the sponsor should get channel 8 in Pittsburgh for regular ground service and Stratovision and why no other channel 8 station should be permitted within 200 miles of the city.

Immediate plans called for making KDKA-TV the conventional ground station operating several hours daily. It would then go off the air and would relay its programs by microwave to the plane, which would spray the channel 8 signal over a 200 to 250 mile radius.

Electronic equipment aboard the plane consists of a 5-kw video transmitter, the size of an ice-box; a 1-kw audio transmitter, intended to be placed in the same rack with the video; a transmitting mast 25 feet long, with 2 bays, lowering from the bomb-bay; and a receiving mast 8 feet long projecting from the tail fin.

The system when perfected would use four planes at each station. Two would alternate in the air, four hours at a time, while two were being serviced on the ground.

Highlights of RMA Convention

ANTICIPATED MILITARY requirements of a billion dollars annually for radio and electronics equipment recently prompted the RMA board of directors, led by president Max F. Balcom, to appoint an eight-man industry mobilization policy committe. The committee, appointed at the RMA's 24th annual convention in Chicago, consists of Fred R. Lack of Western Electric Co. as chairman, Paul V. Galvin of Motorola Inc., vice-chairman, Frank M. Folsom of RCA Victor, Harry A. Ehle of International Resistance Co., George R. Haase of Operadio Mfg. Co., H. L. Hoffman of Hoffman Radio Corp., W. A. MacDonald of Hazeltine Electronics Corp., and R. C. Sprague of Sprague Electric Co.

Objectives of the committee are to persuade government officials to establish a four-man committee to centralize and coordinate procurement of equipment and components, and to seek means of expediting production of military equipment through spreading work among all segments of the radio industry.

Other accomplishments of the convention were the reelection of Max F. Balcom as president of RMA for his second term, election of three new division chairmen and three new directors, re-election of 12 directors and two division chairmen, and the admission of 13 manufacturers as new members.

New division chairmen are: Set Division—George M. Gardner, president of Wells-Gardner & Co., Chicago; RMA Parts Division—A. D. Plamondon, Jr., president of the Indiana Steel Products Co., of Chicago; Transmitter Division—T. A. Smith of RCA Victor Division, Camden, N. J.; Tube Division—R. E. Carlson of Newark, N. J.; Amplifier & Sound Equipment Division—Fred D. Wilson of Operadio Manufacturing Co., St. Charles, Ill.

New directors are: Allen B. DuMont, president of Allen B. DuMont Laboratories, Inc., Passaic, N. J.; John W. Craig general manager of the Crosley Division of Avco Manufacturing Corp., Cincinnati, Ohio; and Herbert W. Clough, vice-president of Belden Manufacturing Co., Chicago.

The twelve directors who were reelected are: Benjamin Abrams, Max F. Balcom, W. J. Barkley, H. C. Bonfig, G. Richard Fryling, Samuel Insull, Jr., J. J. Kahn, F. R. Lack, W. A. MacDonald, A. D. Plamondon, Jr., Allen Shoup and G. W. Thompson. Retiring directors are past president R. C. Cosgrove, Lloyd A. Hammarlund and Monte Cohen.

Leslie F. Muter of Chicago was relected RMA treasurer for his fourteenth year, Dr. W. R. G. Baker of Syracuse, New York, was reelected director of the RMA Engineering Department. Bond Geddes was reelected executive vice-president.

Following are the 13 new members elected: Aircraft-Marine Products, Inc., Harrisburg, Pa.; Barnes Metal Products Company, Chicago 23, Ill.; David Bogen Co., Inc., New York 12, N. Y.; Consolidated Television Corp., New York 1, N. Y.; Drake Manufacturing Company, Chicago 22, Ill.; Electronic Tube Corporation, Philadelphia 18, Pa.; General Precision Equipment Corp., New York 7, N. Y.; Perfection Electric Co., Chicago 5, Ill.; Radio Specialty Mfg. Co., Portland 14, Ore.; Shure Brothers, Incorporated, Chicago 10, Ill.; Rowe Industries, Toledo 9, Ohio; Wirt Company, Philadelphia 44, Pa.; W. M. C. Inc., Chicago 47, Ill.

Following action by the RMA Set Division and upon recommendation of retiring chairman Paul Galvin,

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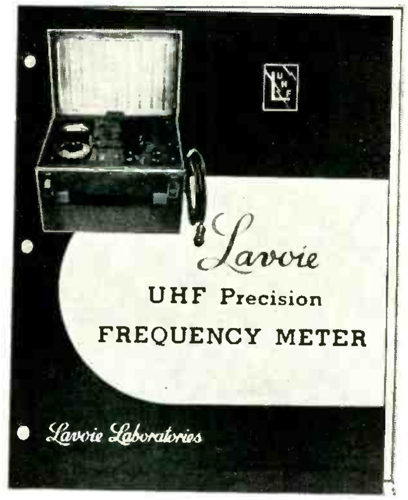
UHF PRECISION INSTRUMENTS

PROVIDES harmonic output voltages in 10 or 40 mc series with crystal-controlled accuracy.

SELECTS 10 or 40 megacycles series by means of front panel switch.

USED FOR calibration of receivers, wavemeters, or (with Beat Detector built into instrument) for calibration of oscillators and signal generators. May also be used in conjunction with a low-frequency communications-type receiver to determine UHF oscillator drift. A mixer unit is available for this application.



Completely portable Accuracy 0.1% Models available from 100 to 2000 megacycles with 2 to 1 frequency coverage on each model.

RECOMMENDED FOR:

- Production testing
- Measurement of oscillator drift
- Independent alignment of transmitters and receivers
- Precise measurements of frequencies

FULL DETAILS ON REQUEST

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RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

Fred R. Lack, vice-president of Western Electric, addressing membership luncheon at annual convention of RMA in Chicago

the board of directors voted to continue the policy not to sponsor or endorse any public or trade shows of television or radio receivers. The board also adopted a resolution asking the FCC to retain the present numbers of the twelve television channels for the avoidance of confusion.

Finally, associate director Virgil Graham reported that the Rochester Fall Meetings in the future will be under the sponsorship and direction of the RMA Engineering Department in cooperation with the IRE, instead of the Rochester Fall Meeting Committee which originated these annual engineering conferences.

MEETINGS

AUG. 20-29: All-Electrical Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

AUG. 24-27: AIEE Pacific General Meeting, Spokane, Wash.

AUG. 30-SEPT. 17: 114th national meeting, American Chemical Society. Eastern session, Washington, D. C., Aug. 30-Sept. 3; midwest session, St. Louis, Mo., Sept. 6-10; western session, Portland, Ore., Sept. 13-17.

SEPT. 4-6: ARRL Convention, Milwaukee Auditorium, Milwaukee.

SEPT. 6-11: International television meeting, with exhibition Sept. 2 to 15, Swiss Federal Institute of Technology, Zurich. Address inquiries to Secretariat, International Television Meeting, Gloriastrasse 41, Zurich 6, Switzerland.

SEPT. 13-17: Third Instrument Conference and Exhibit, Convention Hall, Philadelphia, Pa.

SEPT. 20-23: Annual meeting, Associated Police Communication Officers, Inc., Rice Hotel, Houston.

SEPT. 27-OCT. 1: Third National Plastics Exposition, Grand Central Palace, New York City.

SEPT. 29-OCT. 2: Pacific Electronic Exhibition and IRE west coast Annual Convention, Biltmore Hotel, Los Angeles, Calif.

OCT. 5-7: AIEE Middle-Eastern District Meeting, Washington, D. C.

OCT. 7-9: Second joint meeting, URSI and IRE, National Bureau of Standards, Washington, D. C.

OCT. 11-12: PM Association Second Annual Convention, Sheraton Hotel, Chicago.

OCT. 12-16: Fifth National Chemical Exposition, Coliseum, Chicago, Ill.

OCT. 23-29: Annual convention, American Society for Metals, Benjamin Franklin Hotel, Philadelphia.

OCT. 25-28: Annual Fall meeting of the Institute of Metals, Division, American Institute of Mining and Metallurgical Engineers, Hotel Adelphia, Philadelphia.

OCT. 25-29: National Metal Exposition, Commercial Museum and Convention Halls, Philadelphia.

OCT. 25-29: Annual Convention, American Welding Society, Bellevue-Stratford Hotel, Philadelphia.

OCT. 25-29: 64th semiannual convention, Society of Motion Picture Engineers, Hotel Statler, Washington, D. C.

OCT. 27-28: Annual Convention, Society for Non-Destructive Testing, Hotel Adelphia, Philadelphia.

NOV. 4-6: National Electronics Conference, Edgewater Beach Hotel, Chicago.

NOV. 8-10: Twentieth Rochester Fall Meeting of members of IRE and RMA Engineering Dept., Sheraton Hotel, Rochester, N. Y.

NOV. 29-DEC. 1: Conference on electronic instrumentation in nucleonics and medicine, sponsored by IRE and AIEE, Engineering Societies Building, New York City.

NOV. 29-DEC. 4: 18th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

Instrumentation Conference

A THREE-DAY conference on electronic instrumentation in medicine and nucleonics, jointly sponsored by the AIEE and IRE, is scheduled to be held in New York City, Nov. 29 to Dec. 1, 1948. Arrangements are to have the area of common interest fall on the second day of the meeting. On the first day, devoted to electronic aids to medicine, such items as biological amplifiers and recording devices (c-r oscillograph, electrocardiograph and electroencephalograph) will be covered. The second and third days will cover nucleonic instrumentation, including subjects of interest in medicine and physics. The second of these three days will be devoted to matters of interest to medical personnel, including stable isotope measurement.

Further information on the conference and registration may be obtained by writing to C. C. Wilson, AIEE Headquarters, 33 W. 39th St., New York 18, N. Y.

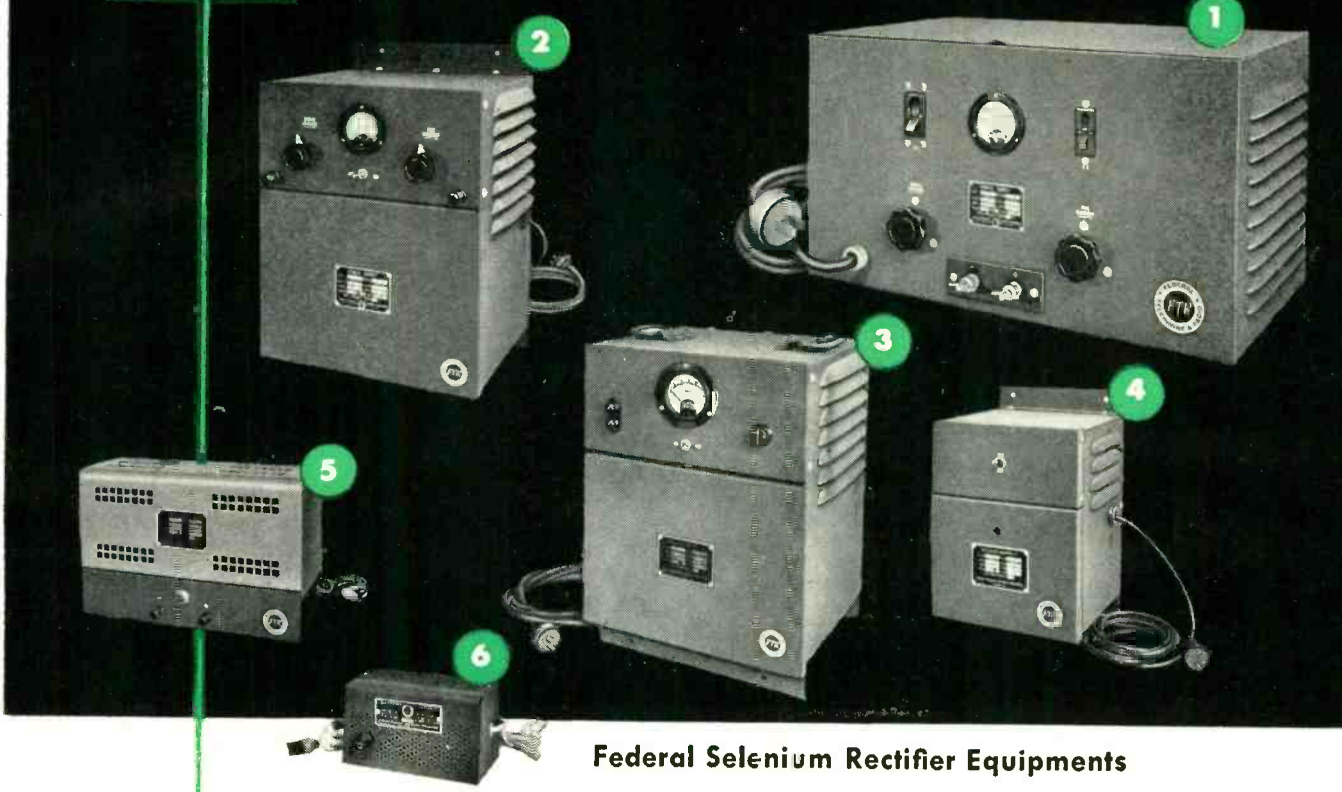
Soviet Television

INDICATIVE of the status of television in the USSR is the fact that one electrical appliance store in Moscow now has on sale to the general public the Moskvich T-1 television receiver. It is a 20-tube set with combination f-m radio reception but only an adapter for record-playing.

However, reconstruction work is being carried out at the Moscow Tele-Center television broadcasting station, which is still using 343-line pictures, for changeover to 625-line pictures. Image clarity at the Leningrad center has been increased to 441-line pictures compared with the prewar 240-line images. Regular

(Continued on p 212)

SIX SOLUTIONS TO YOUR D-C POWER PROBLEMS



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HERE'S FEDERAL'S line of standard D-C Power Supplies which offer you a convenient, economical and always *dependable* source of direct current for a wide range of industrial and laboratory applications.

These attractively styled, compact and efficient units are completely self contained—ready to connect to your a-c power supply—ready to supply d-c power wherever and whenever you want it. Because they are powered by Federal's long-life Selenium Rectifiers, their service life is practically unlimited—with no expendable parts which require frequent replacement. These equipments are conservatively rated, using the new heavy-duty stacks which assure a wide margin of safety to withstand momentary heavy overloads.

For complete information on these new d-c power supplies, write to Federal today —Dept. E313.

Available for *IMMEDIATE DELIVERY*

1	FTR 3300-DS	D-C Output—2-32 volts, 50 amperes A-C Input—115 volts, 1-phase, 60 cycles
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3	FTR 3128-BS	D-C Output—22-30 volts, 10 amperes (filtered and regulated) A-C Input—115 volts, 1-phase, 60 cycles
4	FTR 3341-AS	D-C Output—28 volts, 5 amperes A-C Input—115 volts, 1-phase, 50/60 cycles
5	FTR 3246-BS	D-C Output—6 volts, 10 amperes (filtered) A-C Input—115 volts, 1-phase, 60 cycles
6	FTR 1342-AS	D-C Output—6 volts, 4 amperes (3 cells 6-3 amperes) A-C Input—115 volts, 1-phase, 50/60 cycles

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Export Distributors:—International Standard Electric Corp. 67 Broad St., N. Y.

TUBES AT WORK

(continued from p 122)

10 to 80 C. For this reason, less heating time is required in testing gas-filled tubes.

In general testing, a few points should be reviewed before a tube has definitely been considered bad:

Heater voltage at the heater terminals of the tube must be at the rated value. Any poor connection on one of the heater terminals will cause a lowering of voltage at the terminal with a resulting lowering of cathode temperature and an increasing voltage drop from anode to cathode during conduction.

The anode, cathode, and grid leads of thyratrons must make good contact with the caps of the tester to insure proper current conduction.

Sensitive Transducer

A DEVICE for electrically measuring mechanical motions or displacements that places no friction load on the transmitting device and exerts little or no reaction force on the transmitting device, is the Atcotran. It has a linear electrical response when actuated by a linear mechanical motion and operates from 60-cycle current.

Essentially the Atcotran is a differential transformer with a linear response. It consists of three coils as shown in Fig. 1. These are wound on a single spool, with a free-moving armature of magnetic material mounted inside the spool.

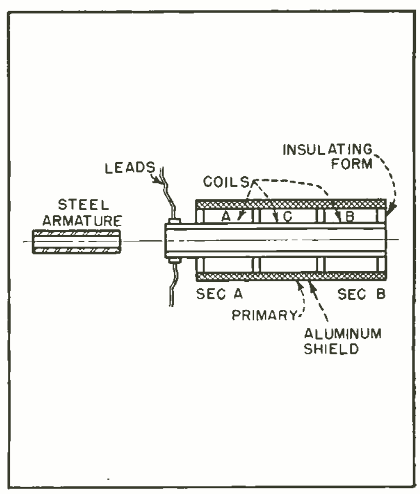

FIG. 1—Cross-section of coil assembly

Alternating current is supplied to the center or primary coil C and the magnetic flux generated by this coil is distributed by the armature so

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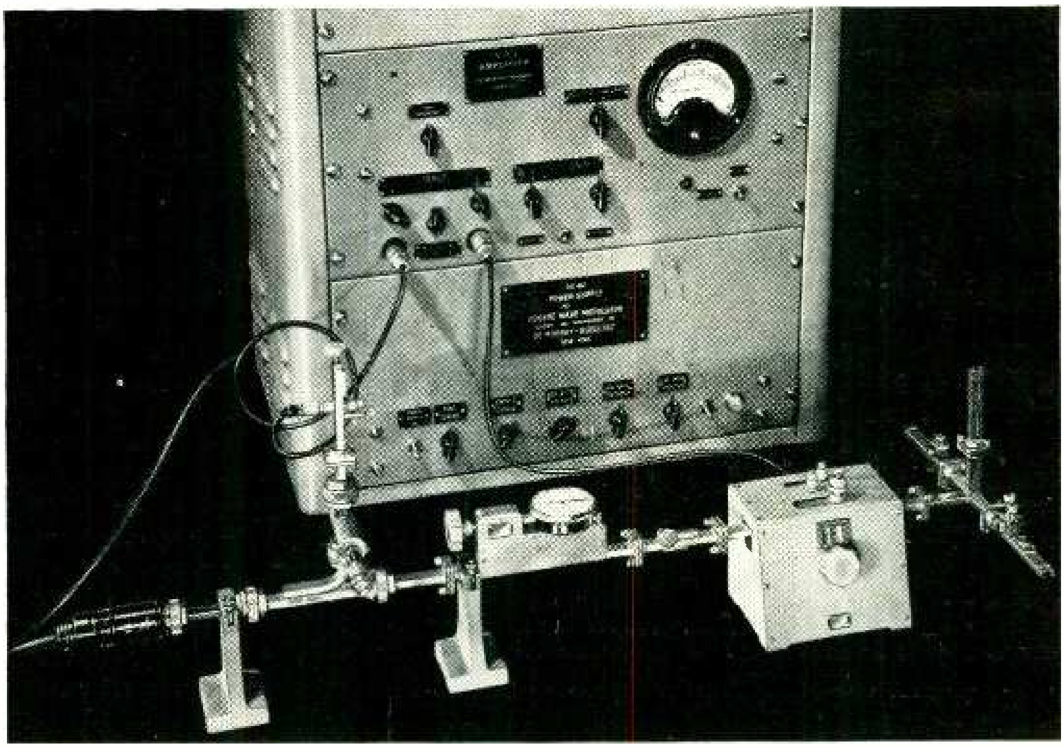
STANDARD TEST EQUIPMENT
For Precision Broad Band Microwave Measurements



A typical, K Band, bench test set-up with power supply and amplifier

The complete line of De Mornay-Budd standard test equipment covers the frequency range from 4,000 mcs to 50,000 mcs. It provides all R. F. waveguide units necessary for broad band precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

To eliminate guesswork, each item of this De Mornay-Budd test equipment is individually tested and, where necessary, calibrated, and each piece is tagged with its electrical characteristics. All test equipment is supplied with inner and outer surfaces gold plated unless otherwise specified.

DE MORNAY BUDD

THE MARK OF PRECISION

NOW READY

The new DeMornay-Budd catalogue of Standard Components and Standard Bench Test Equipment is now ready. This catalogue features a 36 page "Introductory Concepts to Microwaves" and "Measurement & Calibration Procedures." This catalogue is available to those requesting copies on company letterhead.

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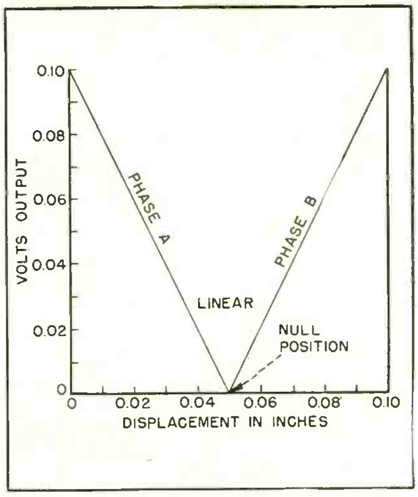


FIG. 2—Output voltage as a function of movement of the armature

that a voltage is induced in secondary coils *A* and *B*.

If the armature is symmetrically located (centered), the induced voltages will be equal but if the armature moves to the left the induced voltage in coil *A* will be greater than that induced in coil *B*. If the armature moves to the right the voltage in coil *B* will be greater than that induced in coil *A*.

In normal operation, coils *A* and *B* are connected in a series bucking relationship so that, when the armature is centered and both coils have equal voltages induced into them, the resulting output will be zero. If the armature moves to the left a voltage of one phase A will predominate, and if the armature moves to the right a voltage of the other phase B will predominate. Phase A will differ from phase B by 180 degrees. These relations are illustrated in Fig. 2.

If the unit were connected as il-

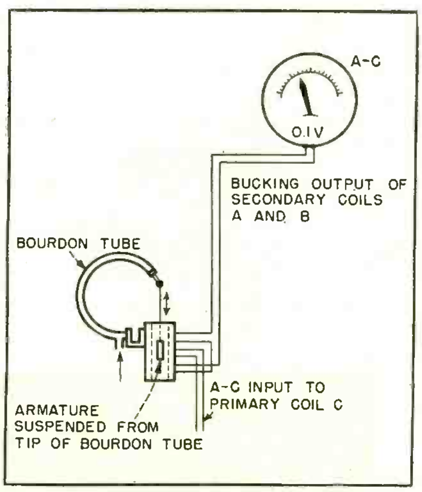
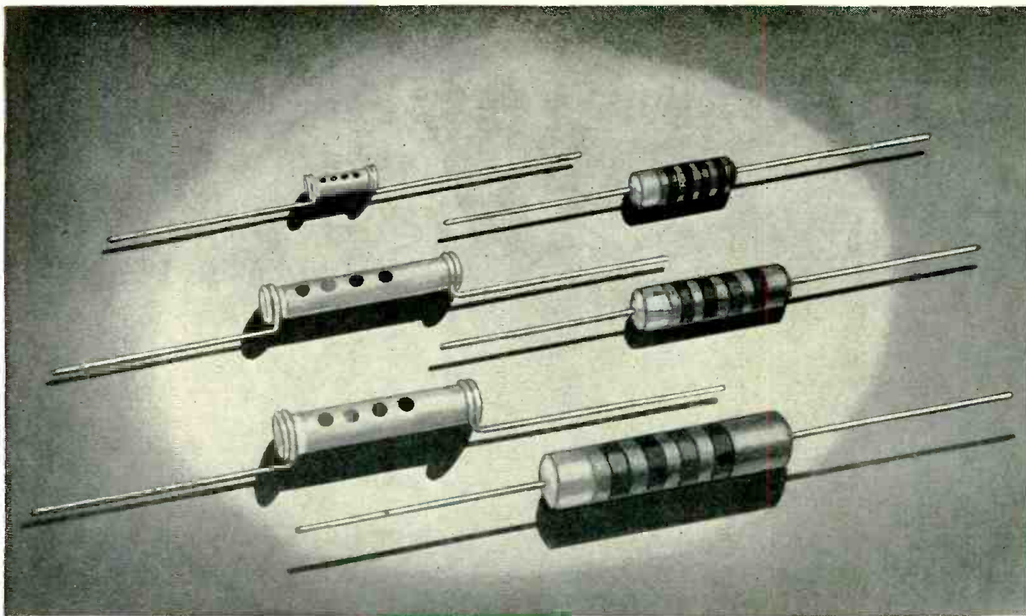
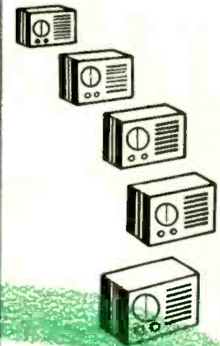
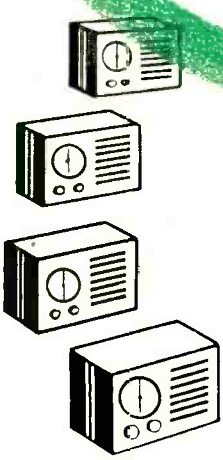


FIG. 3—Application of the pick-up unit to a Bourdon tube for pressure measurements





Speed up assembly in your plant— use ERIE "GP" Ceramicons



ERIE "GP" Ceramicons are small and compact, even in high capacities. Tubular in shape, they require less space than rectangular condensers. They can be wired into position more easily and quickly where space conditions are close, and thus are basically easier to handle in any type of installation.

The wide range of adaptability of ERIE "GP" Ceramicons simplifies the inventory problem, reduces "out-of-stock" bottlenecks, and saves confusion generally.

The enormous popularity of "GP" Ceramicons is the result of a combination of their superb performance and economical cost. Their inherently simple construction results in higher resonant frequencies that are so important in by-passing applications for FM and Television.

ERIE "GP" Ceramicons are made in insulated styles in popular capacity values up to 5,000 MMF, and in non-insulated styles up to 10,000 MMF. If you haven't switched to "GP" Ceramicons for by-pass and coupling applications, write for full details.

Electronics Division

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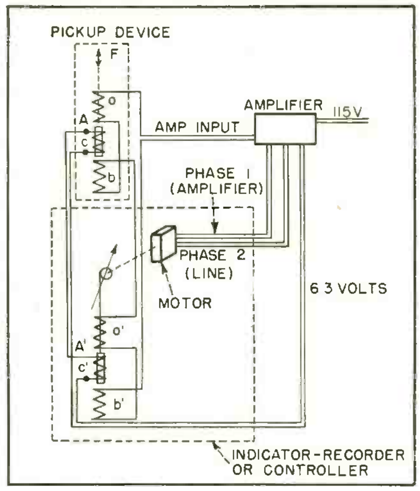

FIG. 4—Two Atcotrans in a balance circuit for remote indication or control

lustrated in Fig. 3, and if the portion of the curve in Fig. 2 between 0.05 and 0.1 inch were used, the a-c meter pointer would go from zero to full scale for a Bourdon tube deflection of 0.05 inch. The meter could readily be calibrated in terms of pressure as applied to the Bourdon tube.

A null-balance circuit is shown in Fig. 4.

When both Atcotran armatures are in their proper position the outputs of Atcotrans *A* and *A′* will be equal and opposite in phase and the resultant input to the amplifier will be zero. No voltage will be applied to the amplifier phase of the motor and it will be dominant.

When the pickup device raises the armature of Atcotran *A*, phase A will predominate and the input to the amplifier and subsequent input to the motor will be in the proper phase relationship with the line voltage to run the motor and raise the armature of *A′* Atcotran a like amount and balance the system.

If the pickup device lowers the armature of Atcotran *A*, phase B will predominate and the motor will run in the opposite direction until the system is again rebalanced. In this way the motor will continually cause the armature of Atcotran *A′* to follow the movements of the pickup, and any pointer or pen coupled to the motor shaft will indicate or record a motion exactly proportional to the motion of the pickup, which in the case of a Bourdon tube is in turn proportional to the pressure applied to it. Such an arrangement will result in a remote pres-

THE new alarm-lock works easily enough when you know the right buttons to push. Push the wrong ones, and you bring the cops on the run. Like so many other signaling devices, the alarm-lock is operated by a Telechron synchronous electric motor.

In this lock, the motor is the low-cost Telechron H-3. This is the popular model for range and radio timers, sequence timing, signaling, control and recording devices. Many millions of these versatile motors are giving long, economical service in many different types of timing mechanisms.

These dependable, self-starting motors give your product the extra sales appeal of famous Telechron accuracy. Operating in perfect synchronism with the frequency, *they have to be right* . . . can't run fast or slow. Sealed-in lubrication and precision building assure long, trouble-free life.

Telechron motors are produced by the largest maker of synchronous electric timing motors for over 25 years, and are Underwriters Laboratories approved. If you have a special timing, control or recording problem, why not consult Telechron's application engineers? There's no obligation, of course. Address Motor Advisory Service, Dept. M, Telechron Inc., Ashland, Massachusetts. A General Electric Affiliate.

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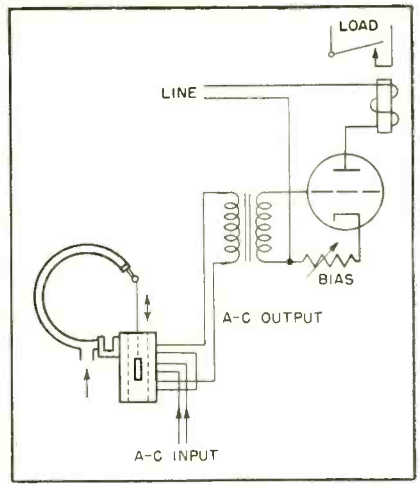


FIG. 5—Electronic phase and voltage-sensitive relay

sure transmission system of unusual stability and accuracy.

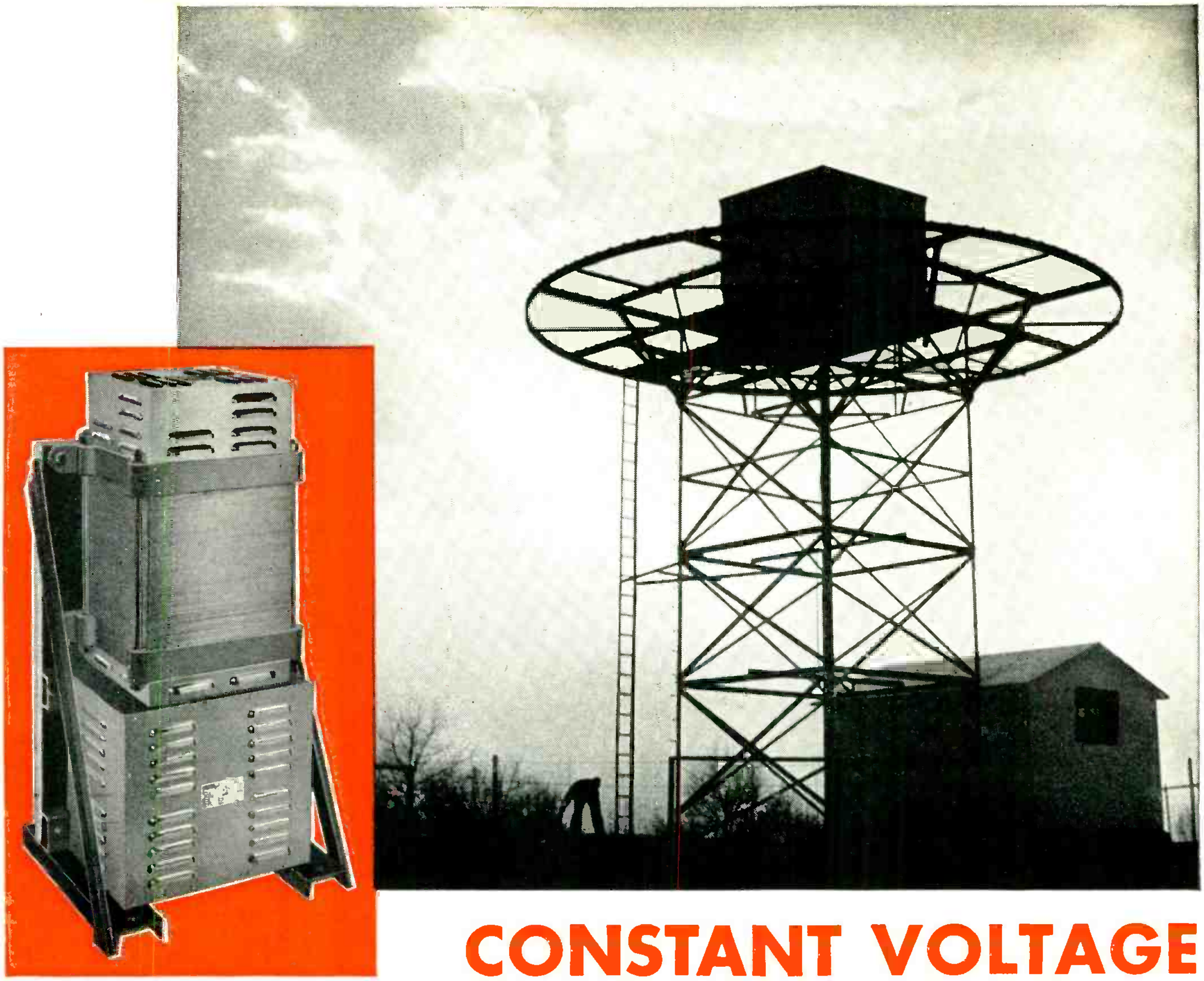
Another arrangement is shown in Fig. 5. The electronically operated relay will pull in and either close or open a load circuit, when a small a-c voltage is applied to its input terminals. The magnitude of this voltage required to operate the relay is determined by the bias control. When the Atcotran armature is in a phase A relationship the relay will not be actuated, but if its armature moves through the null or zero output position (see Fig. 2) to a phase B position, the relay will pull in and actuate a load circuit. Such an arrangement would give off and on control of pressure or could be used as an alarm.

If two electronic relays were used—one connected to pull in on A phase and one on B phase and the bias controls were properly adjusted we would get three-position (High—Neutral—Low) control.

Since the Atcotran made by Automatic Temperature Control Co., is a voltage-producing device a number of these units may be connected in series to give an electrical output which is either the sum, difference or average of a plurality of variables.

Video Interference

AS MEMOED to designers and manufacturers of television receivers by I. J. Kaar, chairman of RMA Committee on Television Receivers, there is a serious problem of radio interference that may be caused by



CONSTANT VOLTAGE

puts the "safety" in safety controls

Without CONSTANT VOLTAGE protection, this self-sustaining link in the chain of relay points that chart the nation's airways, could not successfully perform its safety function.

It is remotely located, at times almost inaccessible to service personnel and solely dependent on local power service. Were it not for a SOLA Constant Voltage Transformer, its delicately engineered electronic and radio equipment would be constantly at the mercy of periodic and unpredictable surges or low voltage levels.

Throughout the entire cross-country system SOLA Constant Voltage Transformers maintain operating voltages at a constant, predetermined level and the nation's air-men fly their courses with confidence.

If you are building electrically energized equipment to operate at precise voltage levels, remember this: *it is more economical to include Constant Voltage protection in your design than to install it later as a remedial measure.*

Revised Bulletin DCV-192 available on request. Write for your copy.

31 standard types of SOLA Constant Voltage Transformers available in capacities ranging from 10VA to 15 KVA.

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

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

Since the range from 10 kilocycles to 4,500 kilocycles is coincident with those frequencies used in radio communication and radio broadcast, it is to be expected that wiring and components in the television receiver which carry video currents may possibly radiate or produce induction fields of sufficient strength to cause interference to other services employing radio frequencies.

Interference in the broadcast band is of particular importance because receivers for this band may be located in an adjacent room in an adjoining apartment in the same building so that possibly only a few feet may separate the broadcast and the television receivers. The video interference usually sounds quite mushy and makes itself evident as a noisy background of variable intensity riding along with the broadcast program. The intensity may be so severe in some cases as almost to obliterate completely weak broadcast signals. In addition to the mush there may be birdies or tweets caused by more or less steady frequency components in the video signal beating with the carrier.

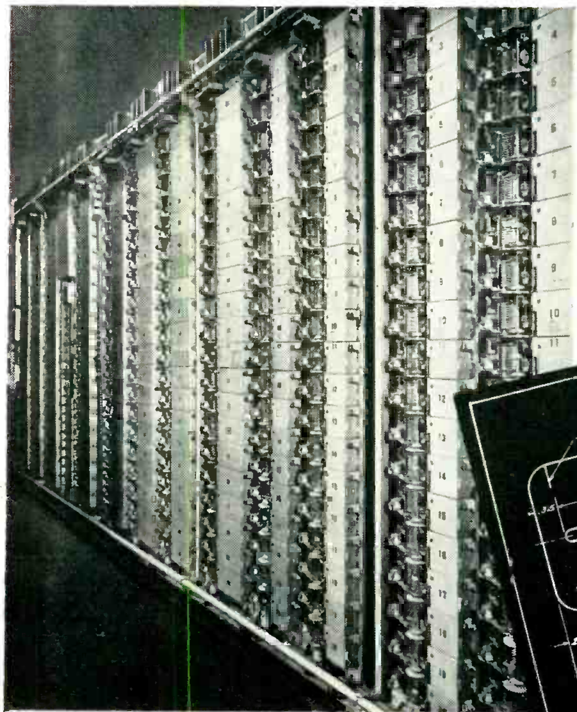
Intercarrier Audio

A third type of interference may be found at 4,500 kilo-cycles, in a band used at airports and for some fixed and mobile services. This frequency is found in video circuits as a result of detection of the television sound carrier by the television picture second detector since the difference between the picture and sound carriers is 4,500 kilocycles. This 4,500-kilocycle signal will be frequency modulated by the television sound signal and may be readily identified and received by using slope detection in a standard a-m receiver.

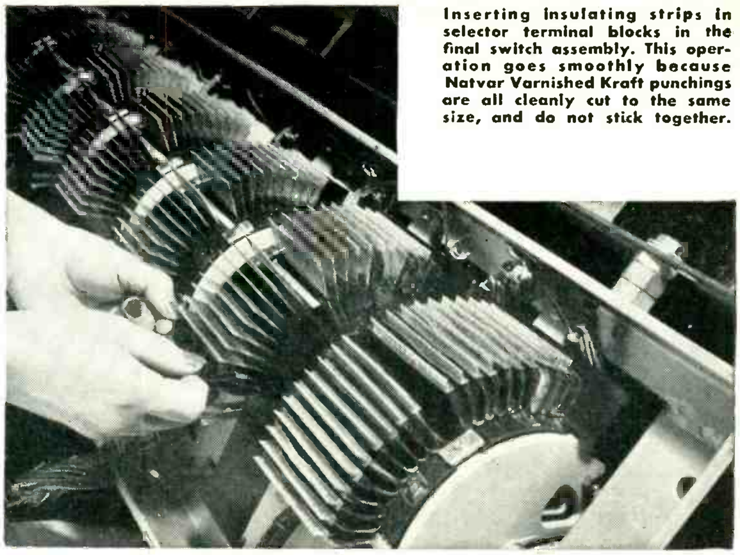
In one instance the 4,500-kilocycle signal interfered with airport operations at an airport located over a mile from the offending receiver. An examination of the receiver revealed that the installation was a custom-built one wherein the video frequency conductor from the last video amplifier to the cathode-ray tube was over ten feet in length and unshielded.

In general, video interference can

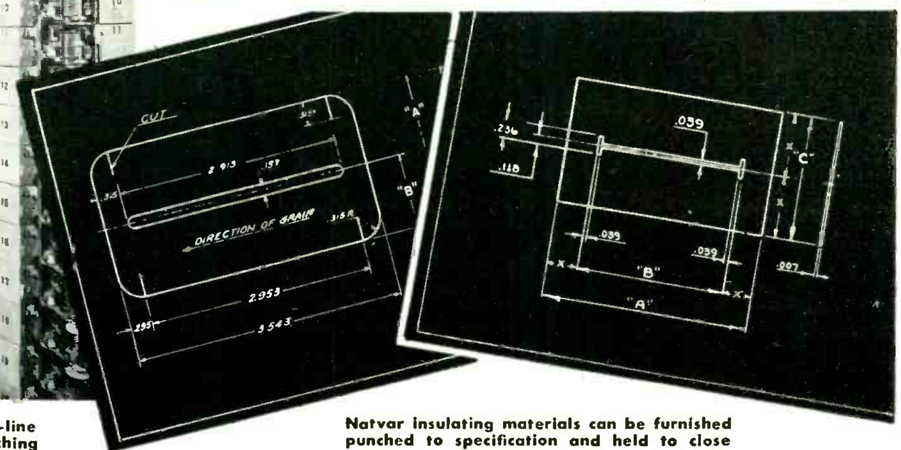
Compact... Dependable



Selector Switch Frames—a part of the 15,000—line installation of Federal Rotary Telephone Switching Equipment at the Rochester Telephone Corporation, Rochester, N. Y.



Inserting insulating strips in selector terminal blocks in the final switch assembly. This operation goes smoothly because Natvar Varnished Kraft punchings are all cleanly cut to the same size, and do not stick together.



Natvar insulating materials can be furnished punched to specification and held to close tolerances, in the finish best suited to the operation.

The 7A-2 Rotary System is modern high speed automatic telephone equipment, built by Federal Telephone and Radio Corporation, Clifton, N. J., an I. T. & T. associate. It must be both compact and dependable. This calls for minimum clearances without sacrifice of reliability of performance or ease of maintenance.

In the words of one of their engineers:

> "To produce a system which fulfills the many complex circuit requirements of today, which is at the same time sound and robust mechanically, requires the closest cooperation between circuit and mechanical designers."

Natvar Varnished Kraft insulators are an example of this cooperation. Here an electrical insulating material has been used to provide both electrical and mechanical protection to the selector terminal blocks and to the ribbon cable which multiples the terminal banks.

If your requirements call for insulating materials with good physical and electrical performance characteristics, in bulk or cut to your own specifications, it will pay you to use Natvar. Get in touch with your Natvar distributor, or with us direct.

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- Varnished cambric—straight cut and bias
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be reduced by using short connecting wires shielded by running them in fairly close proximity to conductors at r-f ground potential. A brute-force method would be to enclose the whole receiver in a cabinet having a screen shield built completely covering its inner surface. Screening cannot be put over the face of the picture tube, so some radiation occurs through the face of this tube. In an experimental receiver the residual interference was further reduced by employing a picture tube having a special conductive but translucent coating applied to its face and grounding the coating to the chassis.

Scanning Circuits

Scanning systems develop pulse-type and sawtooth-type waves having fairly steep decay characteristics (short-time decay). An analysis of the frequency spectrum reveals the presence of fairly strong harmonics of the line (horizontal) and field (vertical) frequencies. The harmonics of the field frequency, being harmonics of 60 cycles per second, are ordinarily not bothersome at radio frequencies because the amplitude usually falls off inversely with the order of the harmonic.

This is not true in the case of the horizontal frequency because the fundamental is 15,750 cycles per second, and is therefore itself a radio frequency. Harmonics of sufficient amplitude to cause interference to broadcast service have been observed. This type of interference makes itself evident in the form of birdies or tweets caused by the harmonics beating with the broadcast station carriers.

This type of interference is quite annoying and does not change in intensity with picture content, but may change in intensity if the size and linearity controls are adjusted or if a person walks up to a television receiver and changes the radiated field intensity by an antenna effect. A satisfactory cure for this type of interference has been found by the employment of grounded shielding. The components requiring shielding usually are the sweep yoke, the high-voltage rectifier system for the picture tube second anode if the h-v supply is

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8 Important New Speakers

12″ and 15″ electro dynamic and permanent magnet type speakers specially designed for use in deluxe radio-phonographs, electronic organs, sound film projectors, coin operated phonographs, public address systems, etc

Model	Type	Max. Field Copper	Magnet Size	Diameter
12E3017	Electro Dynamic	3 lbs.	—	12″
12E1037	Magneto Dynamic	—	1.00 lb.	12″
12E1537	Magneto Dynamic	—	1.47 lbs.	12″
12E2237	Magneto Dynamic	—	2.15 lbs.	12″
15E3017	Electro Dynamic	3 lbs.	—	15″
15E1037	Magneto Dynamic	—	1.00 lb.	15″
15E1537	Magneto Dynamic	—	1.47 lbs.	15″
15E2237	Magneto Dynamic	—	2.15 lbs.	15″

The 12″ size will handle 15 watts maximum speech music audio power and the 15″ size, 18 watts.

THE MAGNAVOX COMPANY specializes in quality speakers for every type installation. Over 100 different models are produced in the modern new Magnavox speaker factory at Paducah, Kentucky.

The nation's most efficient loud speaker plant, plus all the research and experience amassed in thirty-three years of service to the radio industry, enables Magnavox to meet your specifications exactly. Write for complete new speaker catalog today.

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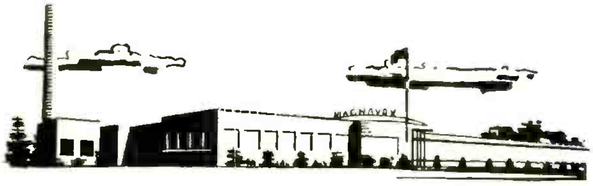
Magnavox is the oldest and largest producer of quality loud speakers!



The Magnavox Company of Kentucky, at Paducah

Magnavox

has served the radio industry for over 33 years

derived by the "kick" across the horizontal output transformer, the horizontal sweep amplifier tube and horizontal sweep-damping tube, if employed.

Visual Examination of Crystal Modes

USE of the Megasweep, a sweeping oscillator with output between 50-kc and 500-mc (ELECTRONICS, Aug. 1947, p 112), makes possible the visual observation of crystal modes.

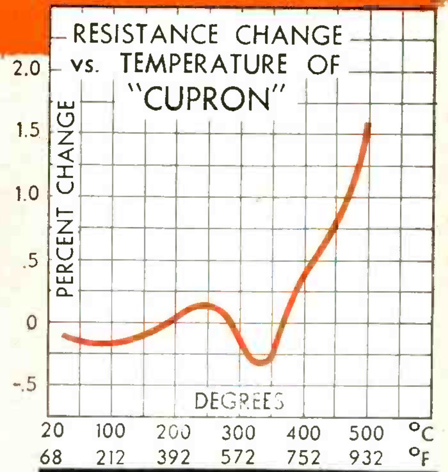
The sawtooth sweep voltage of the sweeping oscillator is applied to the horizontal plates of an oscilloscope, providing a horizontal deflection which is proportional to frequency. The frequency-modulated output signal of the sweeping oscillator is applied across a quartz crystal; and the voltage across the crystal, after rectification and filtering, is passed on to the vertical deflecting plates of the oscilloscope. With the sweeping oscillator adjusted for maximum sweep, the oscilloscope pattern will show those crystal modes lying within the sweep width.

The maximum sweep of the instrument is usually about 30 mc, but it can, with some loss of linearity, be brought up to about 70 mc. As the sweeping frequency passes through the crystal frequency or one of its odd harmonics, the crystal impedance and the rectified voltage across it become minimum. Since this absorption occurs periodically at the sweep rate, a stationary pattern is seen on the oscilloscope with pips corresponding to the series resonant modes of the crystal.

As the center frequency of the sweep is shifted, higher modes can be seen to appear on the pattern. With the sweeping oscillator adjusted for narrow sweep, the pattern of an individual "pip" occupies a large area on the oscilloscope and can be studied in detail.

In a typical test using a 10-mc fundamental crystal, the modes were traced up to the 11th, a frequency of 110-mc. The size of the pips was noticeably different, the variation being due either to different mode strengths or amplitude

Photomicrographics are only part of the story...



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FOR METER AND INSTRUMENT SHUNTS. LOW TEMPERATURE COEFFICIENT. LOW THERMAL EMF AGAINST COPPER.

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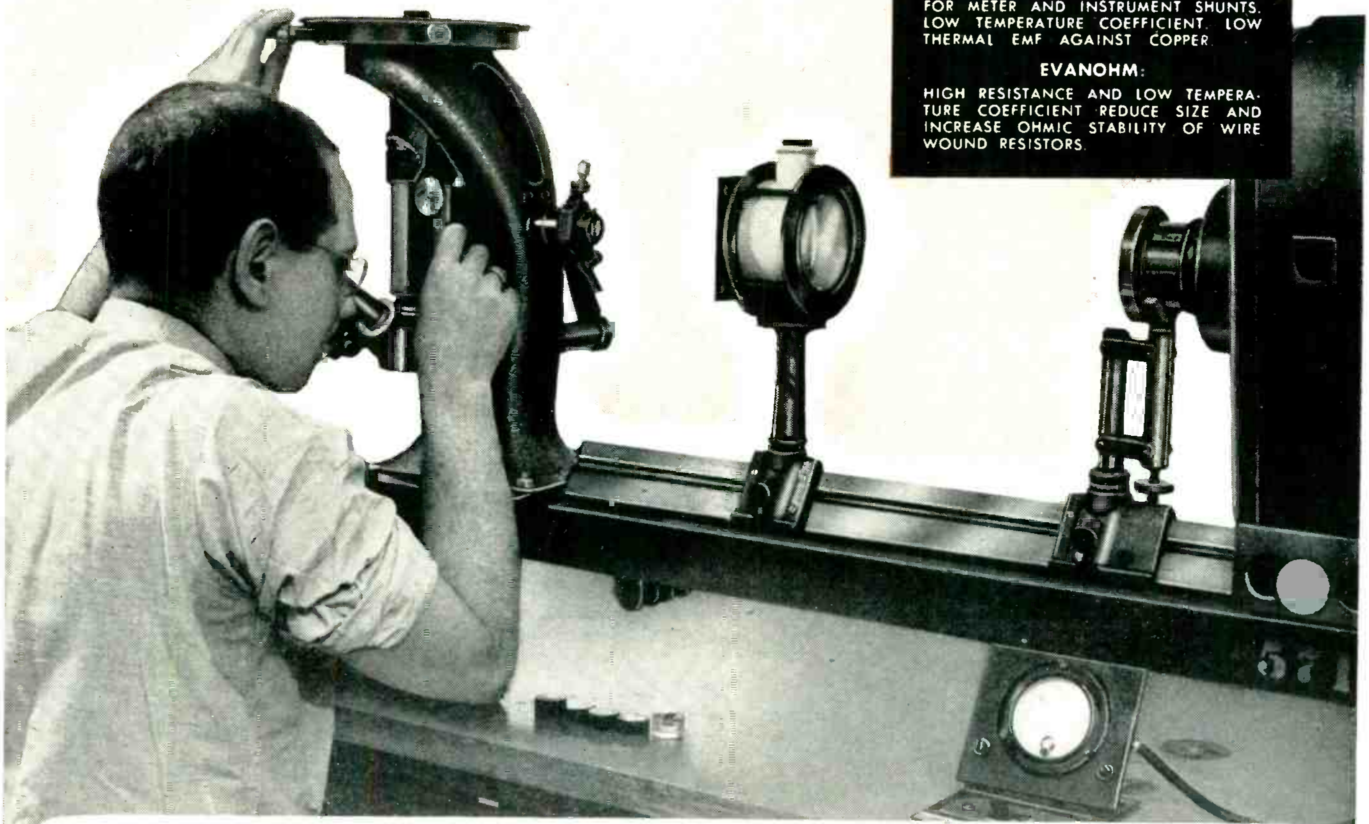

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150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY

modulation in the output. Using the wavemeter incorporated in the instrument, the frequencies of the modes were measured and found to be 20-mc apart.

Acoustic Well Sounder

DETERMINATION of the fluid level in the annular space between the casing and the tubing of an oil well is being done with an acoustic method.

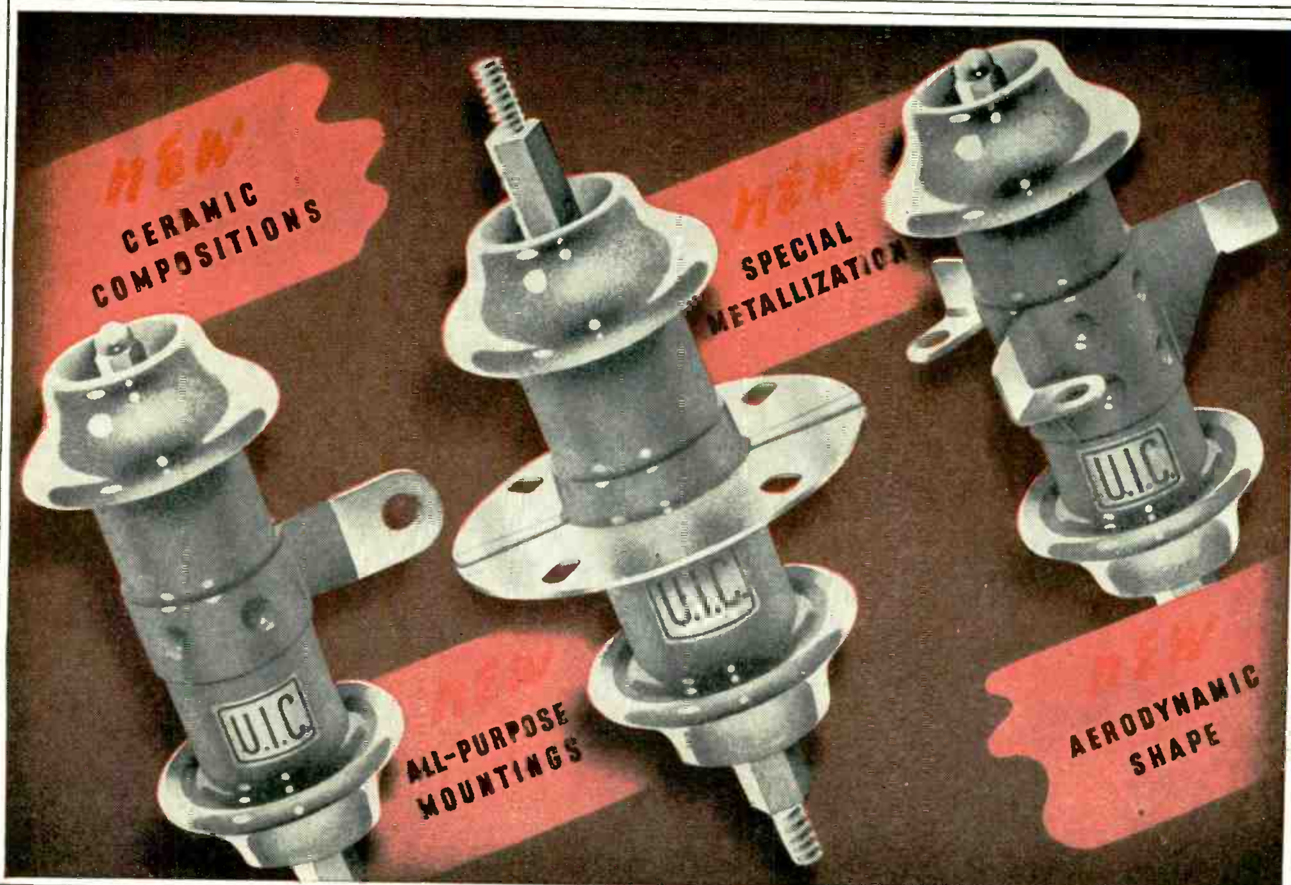
A small pressure-tight chamber attached to a casing outlet at the surface of the ground contains a microphone and a mechanism for firing a blank cartridge. The sound of the explosion travels down the annulus between the tubing and the casing; the sound is partially reflected at all obstructions such as tubing collars and tubing catcher, and is finally reflected almost totally at the top of the column of oil which usually extends some distance above the pump.

The sound of the initial explosion, and also all of the reflected pulses are transformed into an electric current by the microphone within the chamber attached to the well-head. This current is amplified and recorded on a moving strip of paper by means of two pen-and-ink recording galvanometers operating simultaneously.

The reflection from the top of the fluid appears on the record as a large disturbance superimposed on a succession of small kicks which result from the weak reflections at the tubing collars. Thus the top of

Well attachment ready for firing. Sound traveling down is partially reflected by obstructions and surface of oil

revolutionary new designs U.I.C CERAMIC Hi-Load* CAPACITORS



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for R. F. Heaters and Transmitters

U.I.C of England, pioneer manufacturers of ceramic transmitter capacitors, now introduce a range of capacitors which embody the accumulated experience of many years. They are acclaimed for their outstanding electrical performance and rugged construction by leading British and European manufacturers of R.F. Heaters and Transmitters who have used U.I.C Ceramic capacitors at the rate of 1,000,000 KVA in 1947 alone. Further details furnished on request. All orders and enquiries to :—

Examples from a wide range of Types

Type	HL52031	HLT2021	HLT2021	HLC2011	HLC2014★
Capacitance	125pF	300pF	600pF	800pF	1000pF
Max. R.F. Load	70KVA	50KVA	45KVA	25KVA	40KVA
Peak Voltage	7.5KV	7.5KV	7.5KV	7.5KV	7.5KV
Max. R. F. Current	30 Amps.	30 Amps.	30 Amps.	30 Amps.	30 Amps.
Body Dimensions	$1\frac{3}{4}'' \times 3\frac{1}{2}''$	$1\frac{3}{4}'' \times 3\frac{1}{2}''$	$1\frac{5}{8}'' \times 3\frac{1}{2}''$	$1\frac{3}{4}'' \times 3\frac{1}{2}''$	$1\frac{5}{8}'' \times 3\frac{1}{2}''$

★ Lead-through type, all other examples tag type.

U.I.C UNITED INSULATOR CO. LTD

Unsurpassed In Ceramics

TOLWORTH . SURBITON . SURREY . ENGLAND — CABLES: CALANEL . SURBITON . SURREY the fluid is located with reference to the natural scale of tubing collars. The interpretation of the record requires only the counting of the number of tubing joints exposed above the fluid.

As employed in the Keystone Sonolog, the two simultaneous recording channels are adjusted permanently for best response to different events, which makes it possible to dispense with critical adjustments, and semiskilled personnel obtain satisfactory results.

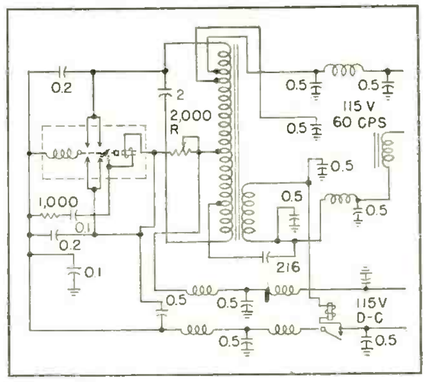
The instrument is designed for portable operation and consists of three components, the well-attachment, the amplifier-recorder and a power converter operating from a six-volt storage battery. The log is available immediately without any intermediate processing since pen and ink are used.

Power Converters for Television

OPERATION of television receivers from a d-c power line can be accomplished by using the vibrator-type converter whose circuit is shown in the diagram. It incorporates a frequency control (potentiometer R) which permits adjusting the vibrator to a frequency of 60 cycles to prevent distortion of the picture.

Although most cities are supplied exclusively with a-c power lines, there is still a significant number that contain d-c districts. New York City, for example, has 316,000 d-c meters, Boston has 58,000, and Chicago has 26,000. And television stations are now operating in all three cities.

The circuit shown is that of one



Adding potentiometer R to a vibrator power supply permits frequency adjustment

SUPERIOR ELECTRIC COMPANY
PROTECTS THEIR AUTOMATIC VOLTAGE REGULATORS WITH
HEINEMANN
MAGNETIC CIRCUIT BREAKERS

In a Bulletin advertising the high quality equipment shown at the left, the manufacturer states that since the first STABILINE Voltage Regulator, Type EM was built, many improvements have been added, among them "a fast-trip magnetic type circuit breaker to perform two functions. It eliminates the task of replacing fuses when the current is overloaded, and also acts as an ON-OFF switch." This emphasizes the convenience of the HEINEMANN CIRCUIT BREAKER.

POSITIVE *Yet* FLEXIBLE *Protection*

In the above equipment the Circuit Breaker is installed in the brush lead of the Powerstat variable voltage transformer. When the load exceeds the current rating of each individual transformer, the Circuit Breaker opens, thus eliminating any chance of injury to any part of the equipment.

These breakers are *instantaneous* on short circuit, but a magnetic-hydraulic time delay mechanism allows passage of slight, temporary overload. If this overload continues beyond the time-delay limit, the breaker trips. Magnetic blowout provides high and fast interrupting capacity.

Your equipment can be equally well protected by the installation of

HEINEMANN MAGNETIC CIRCUIT BREAKERS

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converter made by Electronic Laboratories. It is filtered to less than one microvolt throughout the f-m and television bands, and powers a receiver rated up to 230 watts. A second model supplies up to 475 watts. These ratings are applicable to equipment having a high power factor, from 80 to 100 percent, such as is normally found on transformer-operated devices.

Baseline for Visual Alignment Systems

BY ELLIOTT A. HENRY
Globe Products Corp.
Bridgeport, Conn.

ACTIVITY in the television field has stimulated interest in sweep-frequency generators and visual alignment systems. The time saving and ease of adjustment inherent in visual systems outweigh the initial cost of equipment and the difficulty in making accurate gain measurements. Precise gain measurements, as well as a more accurate picture of the gain-frequency characteristic of the amplifier or net work, may be obtained if a reference of zero voltage (baseline) is provided on the cro screen.

The baseline may be obtained by blanking the return sweep within the sweep generator or by blanking the input of the vertical amplifier of the cro. As the majority of sweep generators do not incorporate internal blanking, and as physical or electrical considerations present conversion problems, the latter method is to be preferred.

While electrical blanking, obtained by keying one of the cro amplifier stages, might be used, it will not produce satisfactory results as the d-c component of the rectified

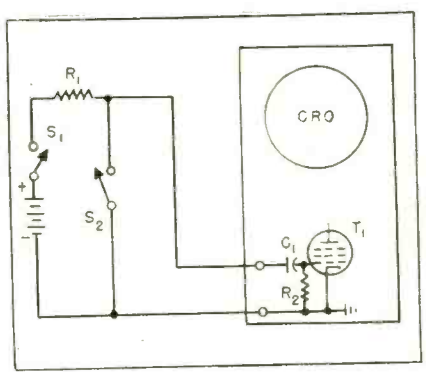

FIG. 1—Simplified circuit using battery to charge capacitor

outstanding advantage offered in Highest Quality Potentiometer

GIBBS MICROPOT GUARANTEES

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"Integral Molding" . . . Exclusive Gibbs Engineering Development . . . Forever Locks Coiled Resistance Element and Terminals into One Integral Unit with Housing . . . Assures Unequalled and Permanent Operational Accuracy.

. . . and only the

MICROPOT

has it!

The coiled resistance element is threaded on the molded core

Resistance element and terminals are one integral part of housing

OTHER IMPORTANT FEATURES OF GIBBS TEN-TURN MICROPOT

Write Today!
For engineering specifications and complete detail folder. Submit any problems to our engineering staff for recommendations. Units for immediate shipment. —1,000 to 30,000 ohm range. Special resistance values made to order.

- Resistance output is directly proportional to shaft rotation through a full 3,600 degrees within ±0.1%: this linearity is carried right to the counter clockwise stop. In the Gibbs MICROPOT such results are obtained by precision manufacturing and methods.
- Precision ground, stainless steel, double thread, lead screw guides the rotating contact, *guarantees* smooth action, low uniform torque and accurate settings—*permanently*.
- Rotor assembly, supported on two bearings, assures long life and low torque.
- Ends of resistance element *soldered* to terminals *before molding*.
- Anti backlash spring in contact guide—assures you positive setting and resetting.
- The 43½″ length of resistance element gives you a finer resolution.

DEPT. 34 ***GIBBS Division***

THE GEORGE W. BORG CORPORATION

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wave will be lost in coupling to the cro and a d-c component, equal to the plate voltage difference of the keyed stage, will be added and appear on the cro screen. Since it is necessary, to produce an accurate picture of the gain-frequency characteristic of the network under test, to transfer the d-c component of the rectified wave to the cro screen and since this is readily accomplished by periodically restoring the cro vertical amplifier to its zero operating condition, mechanical blanking was chosen.

Basic Operation

For an explanation of the transfer of the d-c component, reference is made to Fig. 1. With switch 2 open, when switch 1 is closed, with the battery polarity as shown, C_1 charges through R_1 and R_2. The direction of current flow makes the grid of T_1 go positive and the cro spot to move upward. When C_1 becomes fully charged, current ceases to flow and the grid returns to its static value. The spot returns to its former position and nothing further happens as long as conditions remain unchanged.

Now if switch S_2 is momentarily depressed, C_1 will be discharged through R_2 while the battery will be protected by R_1. The direction of current flow is now such as to make the grid of T_1 go negative and the cro spot to move downward. Therefore if S_2 is made to operate rapidly and to have equal off and on time, the pattern obtained will be a series of square waves, the magnitude of which will be an absolute proportionality to the battery voltage as C_1 has had a charge alternating between zero and full battery voltage.

By substituting the load of the linear diode detector for the battery, adjusting switch S_2 on-time to 180 degrees of the modulation cycle, and providing a means of phasing the start of S_2 on-time, either the up or down sweep may be blanked and the baseline, equivalent to zero voltage, obtained.

Resistor R_1 should have a value at least four times greater than the diode load resistor to prevent the discharge of the diode capacitor during switch S_2 on-time. Switch S_2 must be capable of very fast action and have very low contact resistance. A relay with the mercury-

for HIGH Resistances

SPECIFICATIONS

RANGE: 2,000 ohms to 50,000 megohms in five overlapping ranges; zero to 100 volts, d-c as a vacuum-tube voltmeter.

ACCURACY: within ±5% of indicated value from 30,000 ohms to 3 megohms; within ±8% from 3 to 3,000 megohms when the central decade of scale is used. Voltage measurement accuracy is ±2% of full scale.

SCALE: standard direct-reading ohmmeter calibration is used; scale is illuminated.

VOLTAGE ON UNKNOWN: does not exceed 106 volts and varies with meter indication.

INPUT RESISTANCE: for voltage measurements input resistance in megohms is indicated by selector switch. On the "infinity" position, resistance is greater than 20,000 megohms.

TEMPERATURE-HUMIDITY EFFECTS: over normal room temperature and humidity ranges, accuracy is substantially independent of either.

DIMENSIONS: 10 x 8 x 5½ inches.

WEIGHT: 8½ pounds, net.

THIS NEW MEGOHMMETER is very similar to the usual ohmmeter except that a vacuum-tube voltmeter is used as the indicating device. It is a-c operated and direct-reading in five overlapping ranges from 2,000 ohms to 50,000 megohms. The a-c power supply is regulated to make readings of the instrument independent of supply voltage variations.

This megohmmeter is very useful for moderately high resistance measurements such as leakage resistance of cables and insulating samples, locating defective insulation in electrical machinery, and particularly for the determination of moisture content of wood, paper and other products. By means of a panel switch it is convertible to use as a d-c vacuum-tube voltmeter for measurements up to 100 volts, d-c.

The Type 1861-A Megohmmeter is convenient to use, accurate and stable.

TYPE 1861-A MEGOHMMETER $130.00

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

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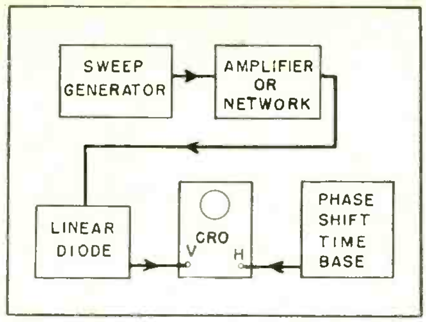

FIG. 2—Conventional circuit for single image alignment

wetted type contacts is recommended to provide the clean baseline and fast action required.

Single Image Alignment

A common arrangement for single image alignment is shown in block form in Fig. 2. Here the sweep generator uses sinusoidal modulation and a sinusoidal time base is used to produce a linear frequency-time pattern. With the modulation and time base voltages in phase, a single image will be seen, assuming no distortion, with the up and down sweeps coinciding at all points. With this arrangement only the a-c component of the rectified wave is viewed and no knowledge of the actual instantaneous voltage is obtained.

The practice of using a sweep-width very wide in comparison to the pass-band of the network under test to obtain two points of assumed zero voltage (F_{max} and F_{min}), may lead to a false picture of the gain-frequency trace. A more accurate picture of the steady-state characteristic of the network under test is obtained by using a narrow sweep-width and the baseline for accurate gain measurements.

Figure 3 shows the blanking unit in block form connected to the common arrangement of Fig. 2. The

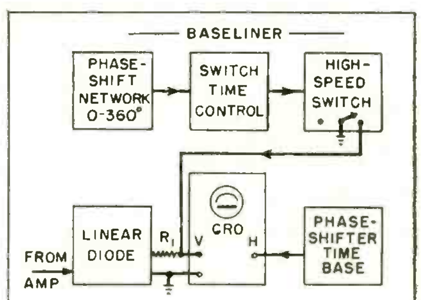

FIG. 3—Addition of the Baseliner provides zero reference trace

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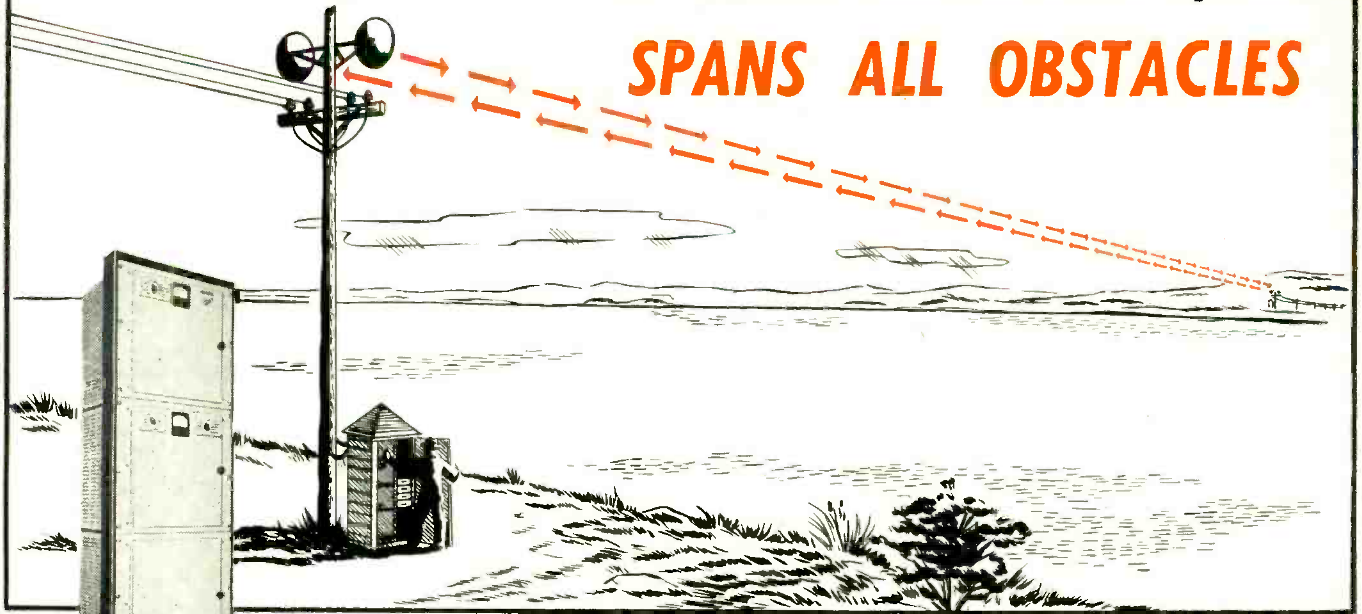

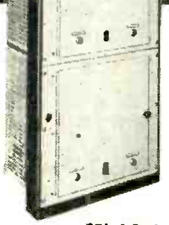

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Radio Link

FTR 9-H-1 Short-Haul Carrier.

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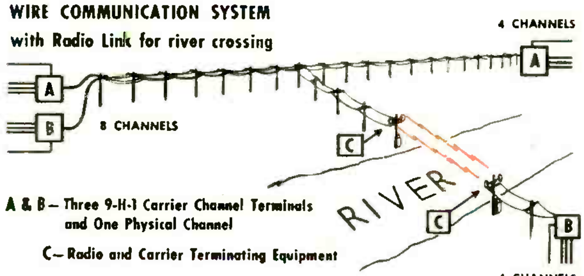
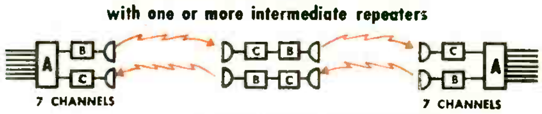
WIRE COMMUNICATION SYSTEM
with Radio Link for river crossing



A & B – Three 9-H-1 Carrier Channel Terminals and One Physical Channel

C – Radio and Carrier Terminating Equipment

TYPICAL 7 CHANNEL
RADIO COMMUNICATION SYSTEM
with one or more intermediate repeaters



A – Six 9-H-1 Carrier Channel Terminals and One Physical Channel

B – FTL 13-A Radio Link Transmitter

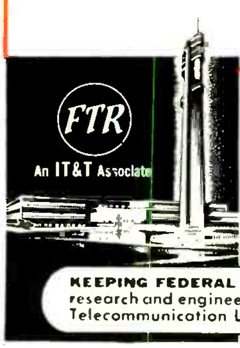
C – FTL 13-A Radio Link Receiver

offer you new flexibility and economy for multi-channel wire or radio systems

Federal's new UHF broad band radio link, for multi-channel telephone and telegraph service, can be used as a complete communication system—or as an intermediate link in cable or open wire systems. It is especially designed to provide economical communication over mountainous, swampy, or soft terrain where pole lines are costly or impractical—and for spanning wide rivers, lakes, bays or inlets.

The FTL-13A radio link equipment has a total usable communication bandwidth from 200 to 60,000 cycles. It operates in the 890 to 960 Mc UHF band, offering the economy of low transmitter power and highly efficient directive antennas.

Write Federal today for complete information on this new type of communication system. Dept. H-113.



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phase-shift network in the Baseliner is adjusted to make the switch ON time start with either F_{max} or F_{min}. The switch time control is used to adjust the switch ON time to exactly 180 degrees.

With single-image alignment, the procedure is the same as where no blanking is used. With double-image alignment, the blanking is not used until alignment is complete. After alignment is complete the blanking is used and one image disappears, being replaced by the baseline. Absolute gain measurements may then be made.

External input connections allow the use of any switch rate from one to sixty cycles. As the switch contacts are single-pole double-throw, the unit may also be used as a high speed mechanical switch (up to 60 cps) to replace an electronic switch. It is most advantageous where one or more of the signals to be switched has a d-c component that it is desired to preserve.

REFERENCE

(1) Frantz, The Transmission of a Frequency Modulated Wave Through A Network, *Proc. IRE*, Mar. 1946.

PHOTOMETER incorporating a magnetic amplifier has an indicating instrument requiring 5 milliamperes for full-scale deflection instead of a few microamperes as is usually required. The instrument, made by Electro Methods Ltd. (London, England) is thus quite rugged. The photosensitive element can be either a barrier layer or a photoemissive type capable of delivering 0.1 microwatt at 3.5 microamperes to the magnetic amplifier. The indicating instrument requires about 250 microwatts for full-scale deflection, and thus the amplifier provides a power gain of 2,500; it is linear within ±2 percent of full-scale output over its operating range. A 5-percent change in the 50-cps power supply voltage produces only a 1-percent change in output current. Adjustments on the meter enable the zero and sensitivity to be set to standards; the meter is intended for comparison measurements and is calibrated in percent.

FOR *FM* AND *Television*

PHILCO VISUAL ALIGNMENT GENERATOR

PHILCO 7008. The only instrument of its kind, combining all functions for complete, accurate visual alignments on Television and FM receivers. Includes 5 different signal generators and their associated controls; a complete oscilloscope with centering, gain, focus, intensity, phasing and blanking controls, and power supplies. Separate RF probe permits measurements of sensitive circuits without disturbance. Removable crosshatch screen for special ultra-short 3″ cathode-ray tube. Compartment for storage of all cables, including RF probe.

PHILCO MAKES TEST EQUIPMENT HISTORY

In creating precision instruments for radio measurements, in compact, portable, inexpensive form . . . Philco engineers have repeatedly achieved results considered impossible by experts. Especially so, in the new Philco 7008 Visual Alignment Generator for FM and Television . . . which combines in one economical instrument functions that can be approached only by a cumbersome, costly collection of conventional devices. The 7008 *alone* performs complete, accurate visual alignments . . . saves the test engineer's time . . . makes the job easier. In every unit of today's Philco Test Equipment line you will find equally important advantages.

WRITE FOR TECHNICAL LITERATURE TO: PHILCO CORP., PHILADELPHIA 34, PA.

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THE ELECTRON ART

(continued from p 126)

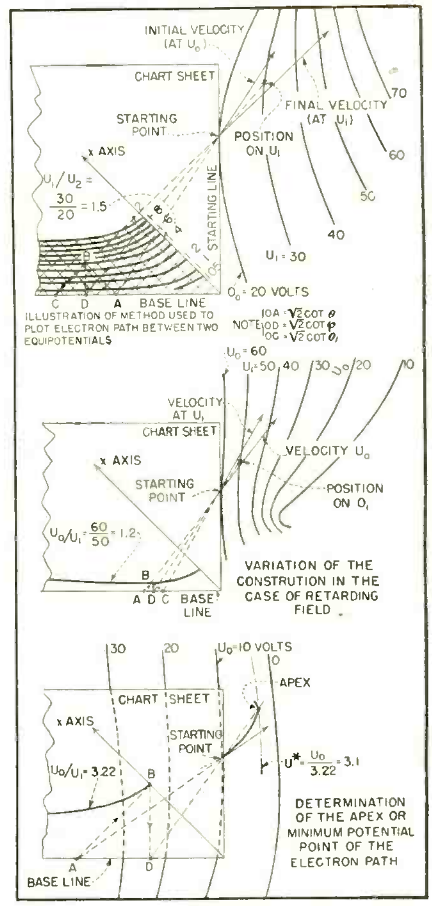
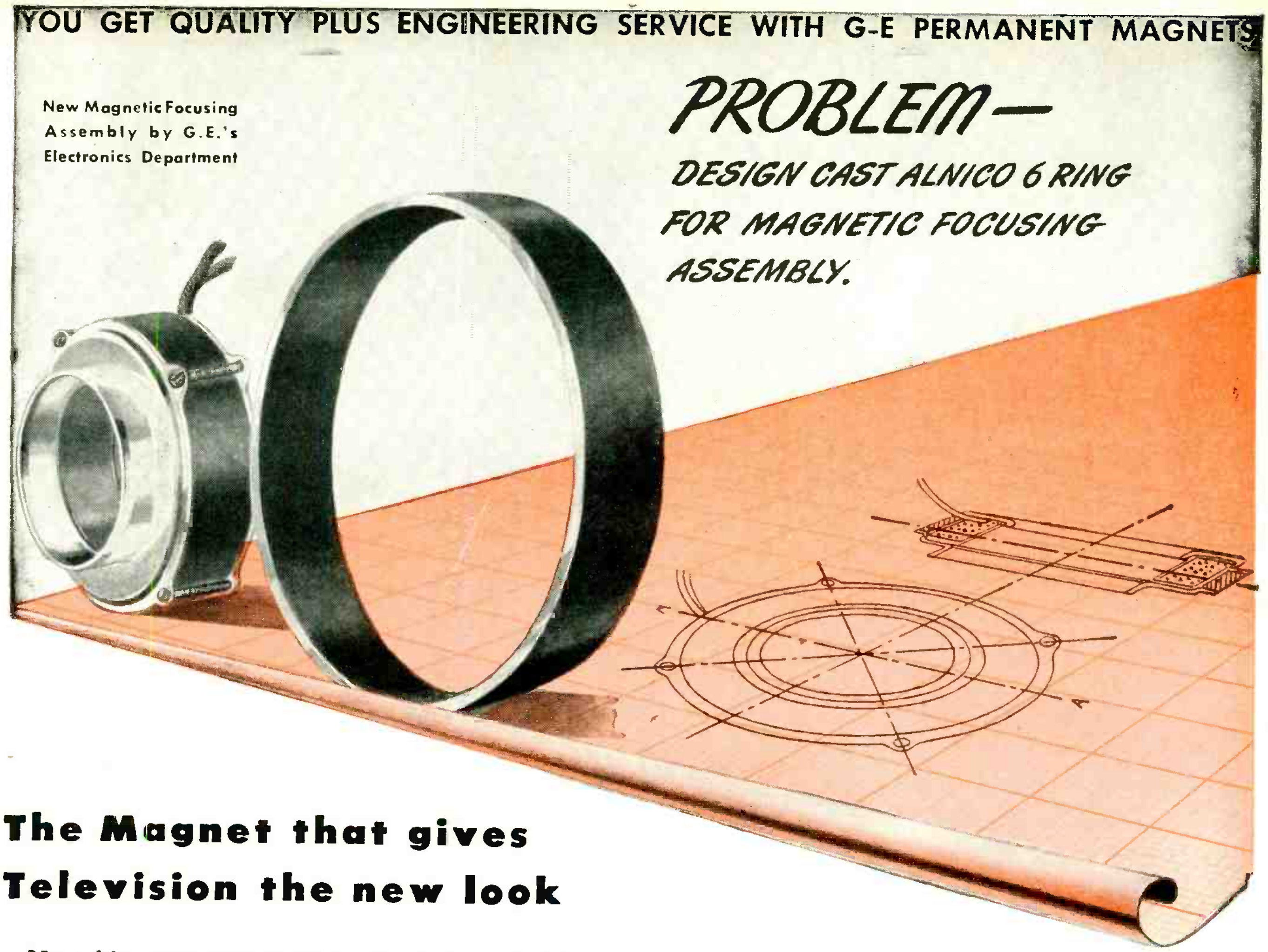


FIG. 3—Chart is used with field map

the $x = y$ line, termed the base line. The coordinates of the chart (parallels of the X and Y axes) cut the base line at 45 deg.

The right-hand edge of the chart is normal to the base line and contains the origin of the chart; this edge is termed the starting line. In operation, the starting line is placed tangent to the equipotential where the electron starts at a point distant $2\frac{1}{2}$ from the origin, marked the starting point; the unit of distance is that used in plotting the chart.

A straight line is projected through the starting point along the direction of the initial velocity, intersecting the base line at point A. The ratio U_1/U_0 or U_0/U_1 whichever is greater is computed. If the field is accelerating ($U_1 > U_0$), the coordinate line from A is followed upward and to the left to the intersection with the corresponding U_1/U_0 line at B, then back to the base line at point C. A straight line is projected from C to the starting point. This line indicates the new direction of the electron as it

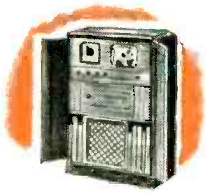


The Magnet that gives Television the new look

Now it's permanent magnets for better television reception. The permanent magnet shown above keeps electrons on the beam . . . eliminates blurring of the television picture. Once the set has been focused further adjustments are unnecessary. And, the use of a G-E permanent magnet results in greater efficiency since no heat is generated by the Cast Alnico ring magnet.

An outstanding feature of this ring magnet is the very thin wall section developed by G-E process engineers. Heretofore this was possible only with sintered magnets. Better permanent magnets as well as new applications are constantly being developed by G-E engineers.

Perhaps you can improve the efficiency of your product with G-E permanent magnets. General Electric will be glad to work with you to improve your product. Greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. All are produced under rigid quality control methods. This assures you of receiving magnets of the highest uniform quality for your application.



Clear, sharp television reception with the new G-E Magnetic Focusing Assembly.

The magnetic field set up by the assembly focuses the electron beam on the television screen. The combined effect of the G-E Cast Alnico 6 permanent magnet and a small coil produces this magnetic field axial with the tube neck. The ring magnet supplies the bulk of the magnetic flux while the coil acts as a vernier adjustment. The punched pole pieces collect the magnetic flux and direct it into a uniform radial pattern.

Outstanding advantages of this new assembly are increased efficiency and compactness. Defocusing due to line voltage fluctuation and warm-up drift is eliminated.

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CD48-V8

crosses the equipotential U_1. A line drawn on the field map parallel to this line will record this direction.

The point where the electron crosses U_1 is found by locating the midpoint of AC, point D (which can be done by dropping a perpendicular from B to the base line). The straight line projected from D through the starting point to U_1 locates the intersection of U_1 by the electron. The construction is then repeated extending the path to another equipotential U_2, and so on.

If the field is retarding the only difference in the construction is that point B is above and to the right of A, and C is to the right of A instead of to the left. As the electron progresses through a retarding field, there comes a point where the construction cannot be carried out because the electron will not reach the next equipotential, indicated by the fact that the line drawn upward and to the right from A will not intersect the required U_0/U_1 curve. In this case the line is brought to a point on the X axis. The value of U_0 is divided by U_0/U_1 at this point to obtain the minimum potential that the electron will reach.

The equipotential so found contains the apex of the electron trajectory. The point of tangency to this contour is obtained by dropping the normal from the intersection of the X axis to D and drawing a straight line from D to the limiting equipotential through the starting point.

From its apex, the electron curves back to the starting contour U_0. The position and direction of the electron at U_0 is found by inverting

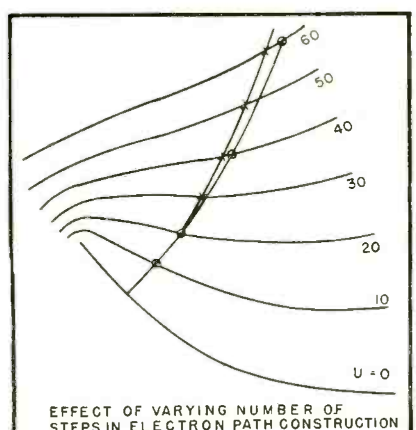

FIG. 4—More steps give higher accuracy

the construction whereby the electron was followed initially from U_0 to the apex. For this purpose the position of the chart on the field map must also be inverted because the electron is now passing through equipotentials in the opposite direction. In general, more points are needed near the apex than in other regions to retain the accuracy.

Figure 4 shows an electron path plotted by this method. Two paths have been plotted with different numbers of points to show the change in accuracy. For most purposes the construction with fewer steps will be adequate. If electrons enter the field at an initial emission velocity U_E volts, all contours on the map should be increased by U_E. The direction of emission velocity can be arbitrarily assigned.

Several other graphical methods have been described for plotting electron paths. The simplest and most widely used constructs the path in a succession of arcs of circles.[3] Modifications of this method to overcome the disadvantage on large radii of curvature have been applied to the electron lens[4] and to the cyclotron.[5] Another parabolic method has been described elsewhere.[2] Under the last reference the reader will find a wide survey of other methods.

(1) I. Langmuir and K. Blodgett, Currents limited by space charge between coaxial cylinders, *Physical Review*, p 374, 22, 1923; also p 49, 24, 1924.
(2) V. K. Zworykin and G. A. Morton, "Television", p 73, John Wiley, New York.
(3) H. Salinger, Tracing electron paths in electric fields, ELECTRONICS, p 50, Oct. 1937.
(4) K. Spangenberg and L. M. Field, Some simplified methods for determining the optical characteristics of electron lenses, *Proc. IRE*, p 138, March 1942.
(5) W. E. Parkins and E. C. Crittenden, A graphical method for determining particle trajectories, *Journal of Applied Physics*, p 447, June 1946.

Electronic Circuit has Logarithmic Response

By A. W. NOLLE
Department of Physics
University of Texas
Austin, Texas

INSTRUMENTS for measurements in communications and acoustics are most useful if their indicating meters have uniform decibel scales; that is, if they are logarithmic instruments. Such instruments are more versatile if the voltages that they develop are logarithmically re-

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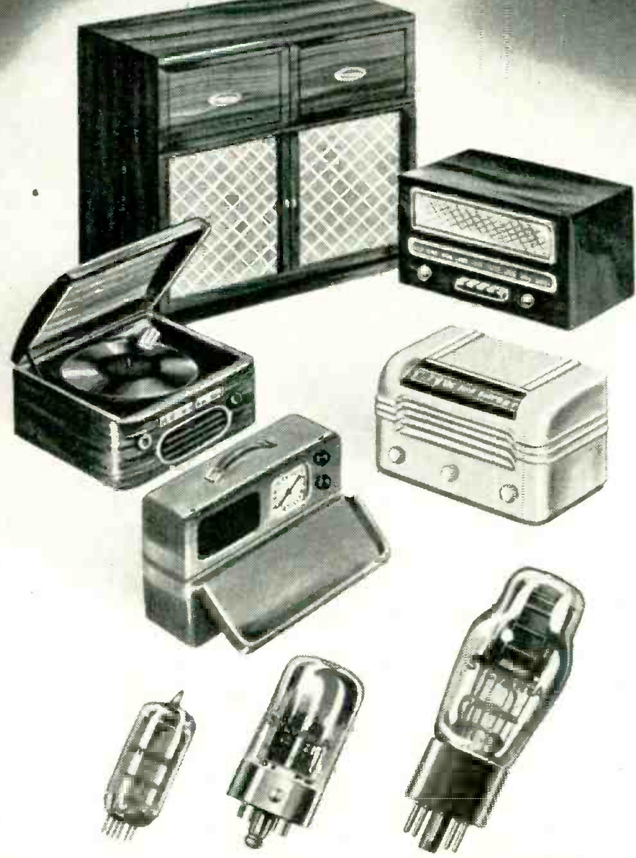

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In the leading makes of home radios—from portable models to console combinations—you'll find Sylvania tubes helping to assure fine reception and lasting service. The quality of Sylvania tubes has made them famous throughout the world.

For information on Sylvania tubes, see Sylvania Distributors, or write Radio Tube Division, Emporium, Pa.

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ZENITH LONG DISTANCE RADIO

lated to their inputs, instead of the uniform decibel scale being obtained by modification of the meter movement. The output voltages can then be applied to recording instruments or to oscilloscopes, thus extending the forms in which the logarithmic presentations can be made.

Conventional circuits for this application use nonlinear components such as pentode amplifiers,[1] grid-cathode rectification in triodes,[2] and copper-oxide rectifiers.[3] The circuit described herein uses the exponential characteristics with time of a resistance-capacitance circuit, thus obtaining logarithmic response from an inherent property of the circuit rather than from an approximate characteristic. The exponential response to square-wave exicitation of R-C and R-L-C circuits is familiar and need not be reviewed here.

Basis of Operation

The exponentially decreasing output voltage E_R of, for example, an R-C circuit is $E_R = E_o \exp -t/RC$ where E_0 is the initially applied voltage. the time T_K required for the output to decay to an arbitrary value E_K is $T_K = RC(\ln E_o - \ln E_K)$. This equation is the basis for the

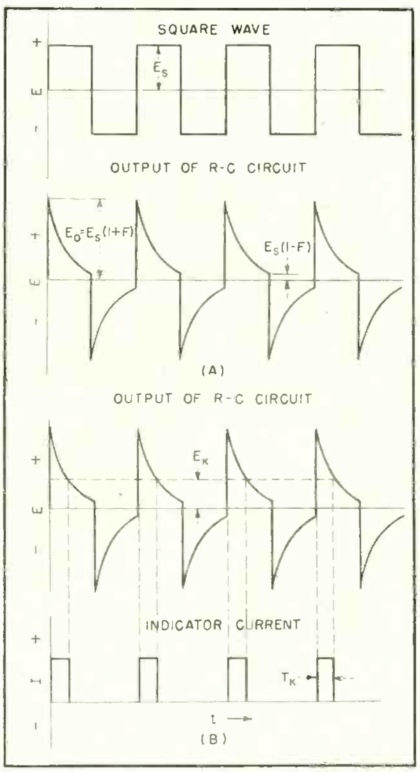

FIG. 1—(A) Response to a repetitive square wave, and (B) sampling action

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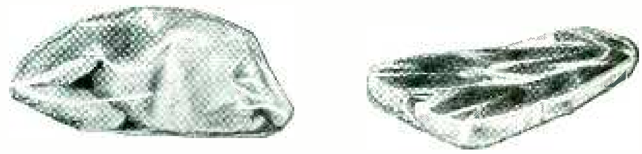

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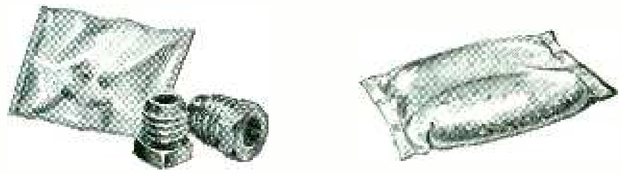
(Water absorption, 24 hrs., 0.01%)



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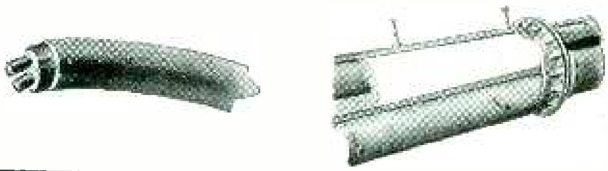
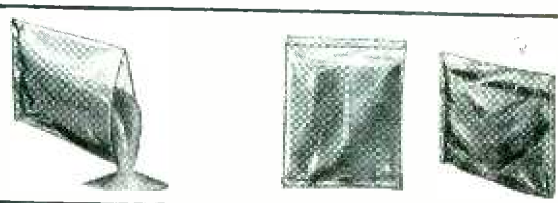
(Dielectric constant of 2.3 at frequencies of 10^3 and 10^6)



CHEMICALLY-RESISTANT
(Not affected by acids, alcohols)



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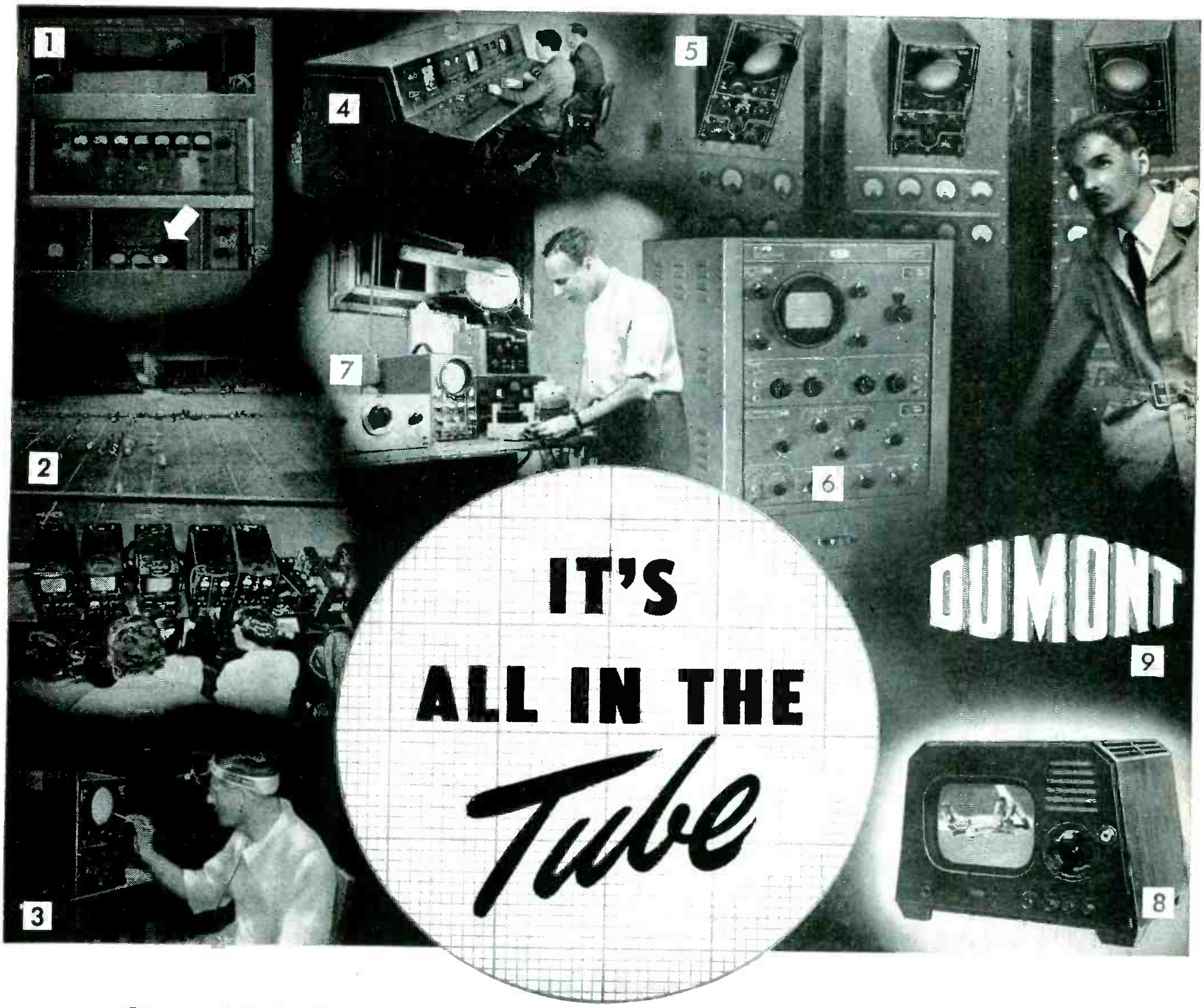
logarithmic circuit. If either the applied voltage or the arbitrary smaller voltage is made a constant of the apparatus, the partial decay time T_K becomes a linear function of the logarithm of the other voltage. In practice it is simpler to fix E_K and to use E_o as the variable to whose logarithm the instrument responds. The instrument is then designed so that a measurement is made of the time interval for the voltage under test to decay to a standard value. This one measurement is sufficient to give the logarithm of the amplitude of the voltage.

Practical Circuit Design

Because most voltages that are to be measured vary with time and because continuous indications are usually desired, it is necessary to repeat the process continuously. When this is done, a succession of time measurements is delivered to the final indicating device in such electrical form that an averaged indication of its logarithmic level is always presented.

The repetitive action can be produced simply by applying a square wave whose amplitude is proportional to that of the input signal to an R-C or R-L circuit. The output from an R-C circuit is shown in Fig. 1A in relation to an applied square wave of amplitude E_S. Because the capacitor does not charge completely each half cycle, the peak output voltage is $E_o = E_S(1 + F)$ where $F = \tanh(T/4RC)$, T being the period of the applied square wave. At the end of each half cycle the voltage has decayed to $E_S(1 - F)$. In practice the logarithmic response circuit must be designed so that F is nearly equal to unity if differences of the order of 20 db are to be registered. Thus the peak output voltage of the R-C circuit is essentially equal to the peak-to-peak amplitude of the square wave.

The time required for the output voltage of the R-C circuit to decay to the fixed value E_K is T_K. Measurement of T_K will give the correct indication of the logarithmic amplitude of the square wave provided that the peak voltage $E_S(1 + F)$ is (1) greater than the reference voltage E_K but (2) small enough that



By way of illustration . . . 1. Du Mont transmitter unit utilizing Du Mont cathode-ray tubes as indicators. 2. Du Mont television field equipment for picking up remote programs. 3. Scientific research in medicine, aided by Du Mont oscillography. 4. Du Mont Television Transmitting Control Console utilizing Du Mont cathode-ray tubes. 5. Du Mont Type 208-B oscillographs used in nuclear research. 6. Du Mont Type 280 oscillograph for precision measurements of television waveforms utilizing the Type 5RP-A high-voltage tube. 7 Typical scene in most radio repair shops, where servicemen make their diagnosis with a Du Mont Type 274 oscillograph. 8. Du Mont Chatham table set with a 12-inch Du Mont picture tube for clear, bright, truly superlative pictures. **9. The symbol of quality cathode-ray tubes—always your best buy**

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Literature on request

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

the interval T_K is less than half a cycle.

Figure 1B shows a method for obtaining a signal indicative of T_K. An indicator circuit is so arranged that current of constant amplitude flows through an indicating instrument, such as a d-c meter, as long as the output of the R-C circuit is greater than E_K. The output of the indicator circuit is thus a pulse train modulated in width in proportion to the logarithm of the amplitude of the initial square wave. The average value of this pulse train produces the proper steady deflection of the indicating instrument. If the calibration of the instrument is to remain fixed, it is essential that the period of the square wave be constant.

There are several other practical considerations: The square-wave generator feeding the R-C circuit must have a constant internal resistance. Full-wave operation can be obtained if the indicating circuit operates on both halves of the square wave, responding to E_K, then to $-E_K$. The meter deflection per db can readily be controlled by varying the resistance of the R-C circuit. The absolute level of the meter scale can be controlled by the amplification of the input signal and by the magnitude of the bucking current through the meter, which should be large enough that, in the absence of signal input, the indicating element will be off scale so as to avoid ambiguity.

A Specific Circuit

Figure 2 shows the diagram of a specific circuit which has a logarithmic range of more than 20 db. This circuit is designed for measuring alternating voltages and therefore is provided with an a-c amplifier stage and a balanced voltage-doubler rectifier. This rectifier converts the signal into direct voltages at A and B that are positive and negative respectively by equal amounts as compared to the average potential at D.

A limiting amplifier, excited by the high voltage from the power transformer, develops a square wave at D whose peak-to-peak amplitude closely equals the voltage difference between A and B because of the action of the limiting diodes. A variable bias current is obtained

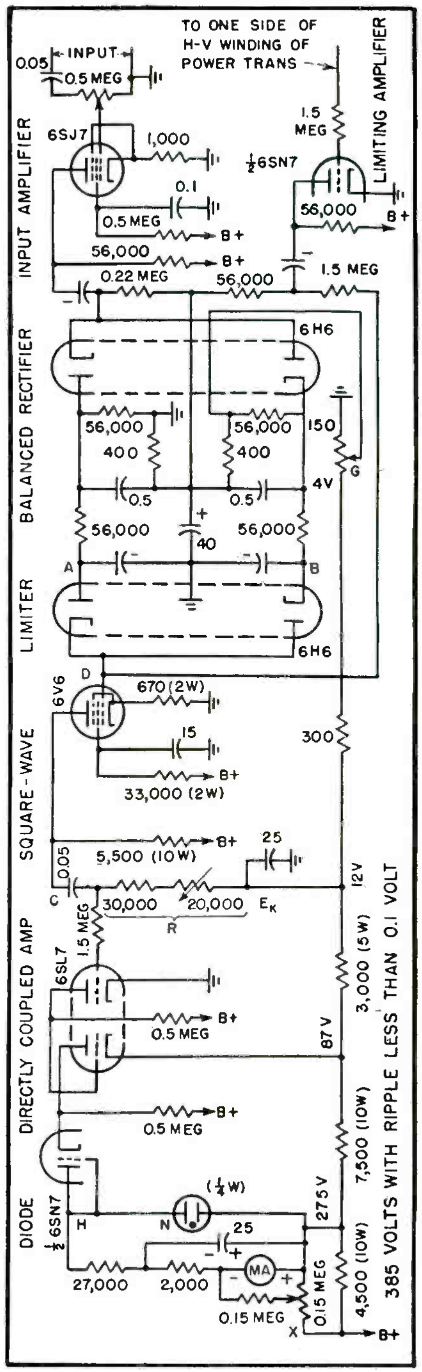

FIG. 2—Circuit diagram of instrument having full-scale response of 20 db

from G to assure that both the rectifying and the limiting diodes operate only within their linear regions. This bias is desirable to avoid operation of the diodes in their low-current regions where there is considerable variation of plate resistance, thus improving the linearity of the circuit at low levels. The rectifier-limiter circuit is adjusted so that changes of input level produce very little variation of direct voltage level at D.

The portion of the circuit de-

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Designed to transform 118 VAC to high voltage—low current DC for use in radiation counters, oscilloscopes, dust precipitators, projection television sets, spectographic analysers, photoflash equipment, etc. Hi Volt Power Supplies are self-contained in hermetically sealed steel containers.

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Cat. No.	VDC	Dimensions	Your Cost
PS-1	2400	3 3/16x3¾x5½"	$11.14
PS-2	2400	3 3/16x3¾x5½"	15.14
PS-5	5000	4 9/16x3¾x6½"	38.22
PS-10	10000	4 9/16x3¾x8"	58.80
PS-30	30000	7x7x7"	147.00

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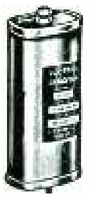

PHOTO FLASH

Cat. No.	Watt Sec.	Pk. Chg V.	Dimensions	Your Cost
AOCOE22C3	7.6	2250	4x2x1¼"	$2.92
AOCOE3M2	9	3000	4x2x1¼"	3.00
AOCOE4M1.5	12	4000	4x2x1¼"	3.20
AOCOE55C1	15.1	5500	4x2x1¼"	3.60
AOCE4M12	100	4000	4½x4 9/16x3¾	27.17
AOCE4M24	200	4000	8x4 9/16x3¾"	38.81

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By the use of synthetic plastic film dielectrics, PLASTICONS can be made smaller, lighter, more efficient and more economical than older types of capacitors made with paper and mica insulation. Plasticon films are chemically purer and more uniform. Plasticon capacitors have a longer life and can operate under more severe conditions.

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Taking advantage of the wide variety of plastic film dielectric characteristics, Plasticons are engineered to meet many special applications. We can furnish capacitors for 200°C· for pulse network duty; close tolerances; ultra high resistance. Send us your specifications.

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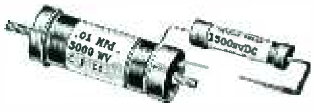
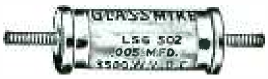


Type ASG are Plasticon A dielectric-silicone fluid impregnated capacitor elements in hermetically sealed glass tubes. Temperature range — 60° C to + 125° C. The smallest and lightest high voltage capacitors made. Type ASG are ideal for DC and low frequency AC applications

Cat. No.	Cap. Mfd.	Volts D.C.	Dimensions	Your Cost
ASG 1	.01	600	19/32x1 3/16"	$ .88
ASG 2	.02	600	19/32x1 3/16"	.94
ASG 3	.05	600	19/32x1 9/16"	1.03
ASG 4	.1	600	¾x1¾"	1.15
ASG 5	.25	600	29/32x2¼"	1.32
ASG 6	.5	600	1⅜x2¼"	1.53
ASG 7	.005	1,000	19/32x1 3/16"	.88
ASG 8	.01	1,000	19/32x1 3/16"	.94
ASG 9	.02	1,000	19/32x1 9/16"	1.00
ASG 10	.05	1,000	¾x1¾"	1.09
ASG 11	.1	1,000	¾x2¼"	1.26
ASG 12	.25	1,000	29/32x2¾"	1.47
ASG 13	.002	2,000	19/32x1 3/16"	1.12
ASG 14	.005	2,000	19/32x1 3/16"	1.21
ASG 15	.01	2,000	19/32x1 3/16"	1.32
ASG 16	.02	2,000	19/32x1 9/16"	1.47
ASG 17	.05	2,000	¾x1¾"	1.66
ASG 18	.1	2,000	29/32x2¼"	1.88
ASG 19	.25	2,000	1⅜x2¾"	2.18
ASG 20	.001	3,000	19/32x1 3/16"	3.03
ASG 21	.002	3,000	19/32x1 3/16"	3.09
ASG 22	.005	3,000	19/32x1 3/16"	3.18
ASG 23	.01	3,000	19/32x1 9/16"	3.28
ASG 24	.02	3,000	¾x1¾"	3.44
ASG 25	.05	3,000	29/32x2¼"	3.62
ASG 26	.1	3,000	1⅜x2¾"	3.92
ASG 27	.001	5,000	19/32x1 3/16"	3.82
ASG 28	.002	5,000	19/32x1 3/16"	3.94
ASG 29	.005	5,000	19/32x1 9/16"	4.09
ASG 30	.01	5,000	¾x1¾"	4.26
ASG 31	.02	5,000	¾x2¼"	4.50
ASG 32	.05	5,000	1⅜x2¾"	4.79
ASG 33	.1	5,000	1⅜x3½"	5.35
ASG 34	.001	7,500	19/32x1 9/16"	4.12
ASG 35	.002	7,500	19/32x1 9/16"	4.26
ASG 36	.005	7,500	¾x1¾"	4.44
ASG 37	.01	7,500	¾x2¼"	4.79
ASG 38	.02	7,500	29/32x2¾"	5.44
ASG 39	.05	7,500	1⅜x2¾"	6.76
ASG 40	.0005	10,000	19/32x1 9/16"	4.29
ASG 41	.001	10,000	19/32x1 9/16"	4.41
ASG 42	.002	10,000	19/32x1 9/16"	4.59
ASG 43	.005	10,000	¾x1¾"	5.29
ASG 44	.01	10,000	29/32x2¼"	6.17
ASG 45	.02	10,000	1⅜x2¾"	7.35
ASG 46	.03	10,000	1⅜x3½"	8.82
ASG 60	.06	10,000	1⅜x3½"	10.29
ASG 47	.0005	15,000	29/32x2¾"	8.53
ASG 48	.001	15,000	29/32x2¾"	8.70
ASG 49	.002	15,000	1⅜x2¾"	9.12
ASG 50	.0005	20,000	1⅜x3½"	11.47
ASG 51	.001	20,000	1⅜x3½"	12.07
ASG 52	.0005	30,000	1⅛x3½"	13.24

RF GLASSMIKES



Plasticon L film-silicone fluid impregnant in Glassmike style case. Type LSG has Q of 2500 to 5000. Rated at 3500 WV—7500 V Test. Lower losses, more easily mounted, smaller and more economical than mica capacitors.

Cat. No.	Cap. Mfd.	Dimensions OD Length	Your Cost
LSG500	.00005	19/32x1 3/16"	$.88
LSG101	.0001	19/32x1 3/16"	.88
LSG251	.00025	19/32x1 3/16"	.88
LSG501	.0005	19/32x1 3/16"	.88
LSG102	.001	19/32x1 9/16"	1.00
LSG202	.002	¾x1 9/16"	1.44
LSG502	.005	¾x1¾"	2.06
LSG602	.006	29/32x1 9/16"	2.20
LSG103	.01	29/32x1¾"	2.49

INDUSTRIAL and TRANSMITTING

Plasticon A element; mineral oil impregnated in sturdy lead coated steel containers. Smaller, lighter and more economical than paper capacitors. Temperature range — 40°C to + 105°C. Type AOC-rectangular; Type AOCO-flattened oval. Type ASC and ASCO (not listed) have Plasticon A element, silicone impregnated. Same dimensions as corresponding AO types. Temperature range — 60° C to + 125° C; greater capacitance stability. Prices on application.

DC RECTANGULARS

Cat. No.	Cap. Mfd.	Volts DC	Dimensions	Your Cost
AOC6C1	1.0	600	2⅛ 1¾ 1"	$2.19
AOC6C2	2.0	600	2⅝ 1¾ 1"	2.65
AOC6C4	4.0	600	3½ 2½ 1 3/16"	3.30
AOC6C8	8.0	600	4 3¾ 1¼"	4.98
AOC6C10	10.0	600	4⅝ 3¾ 1¼"	5.60
AOC1M1	1.0	1,000	2⅜ 1¾ 1"	2.37
AOC1M2	2.0	1,000	4 1¾ 1"	2.59
AOC1M4	4.0	1,000	4 2½ 1 3/16"	3.86
AOC1M8	8.0	1,000	4⅝ 3¾ 1¼"	5.43
AOC1M10	10.0	1,000	4⅝ 3¾ 1¼"	6.27
AOC2MO5	0.5	2,000	2⅜ 1¾ 1"	2.87
AOC2M1	1.0	2,000	3⅛ 1¾ 1"	3.47
AOC2M2	2.0	2,000	3½ 2½ 1 3/16"	4.02
AOC2M4	4.0	2,000	3½ 3¾ 1¼"	5.43
AOC3M1	1.0	3,000	4 2½ 1 3/16"	7.12
AOC3M2	2.0	3,000	4 3¾ 1¼"	9.05
AOC3M4	4.0	3,000	4⅝ 3¾ 2¼"	12.52
AOC4M1	1.0	4,000	4 3¾ 1¼"	16.17
AOC4M2	2.0	4,000	4 3¾ 1¾"	19.40
AOC4M4	4.0	4,000	4 3¾ 4 9/16"	29.66
AOC5M1	1.0	5,000	4 3¼ 1¾"	19.40
AOC5M2	2.0	5,000	3½ 3¾ 4 9/16"	24.70
AOC75C1	1.0	7,500	3½ 3¾ 4 9/16"	29.11
AOC10M1	1.0	10,000	4 3¾ 4 9/16"	51.74

DC OVALS

Cat. No.	Cap Mfd.	Volts D.C.	Dimensions	Your Cost
AOCO6C2	2.0	600	2⅛ 2 1¼"	$2.59
AOCO6C4	4.0	600	4 2 1¼"	3.11
AOCO1M1	1.0	1,000	2¾ 2 1¼"	2.26
AOCO1M2	2.0	1,000	3½ 2 1¼"	3.04
AOCO3MO1	0.1	3,000	2⅛ 2 1¼"	4.46
AOCO5MO1	0.1	5,000	2¾ 2 1¼"	8.28
AOCO5MO25	0.25	5,000	3½ 2 1¼"	9.05
AOCO5MO5	0.5	5,000	4⅝ 2 1¼"	10.88
AOCO8MOO5	0.05	8,000	2¼ 2 1¼"	8.93
AOCO8MO1	0.1	8,000	3½ 2 1¼"	9.83
AOCO10MOO5	0.05	10,000	3½ 2 1¼"	11.32

LABORATORY CAPACITORS

Type LAG (Glassmike style) and Type LAC (Rectangular can) have the lowest dielectric absorption of any capacitor made. Residual charge is .01 — .02%. Dissipation factor at 1 MC is .0002 to .0003. Capacitance and Q is constant from DC to 100 KC. Resistance averages one million megohms per microfarad. Standard capacitance tolerance is ± 5%. Type LA units are used for timing and integrating circuits.

Cat. No.	Cap. Mfd.	Dimensions	Your Cost
LAG101	.0001	19/32x1 3/16"	$1.76
LAG201	.0002	19/32x1 3/16"	1.76
LAG501	.0005	19/32x1 3/16"	1.76
LAG102	.001	19/32x1 3/16"	1.76
LAG202	.002	19/32x1 3/16"	2.06
LAG502	.005	¾x1¾"	2.88
LAG103	.01	¾x1¾"	3.94
LAG203	.02	¾x2¼"	5.12
LAG503	.05	29/32x2¼"	6.17
LAC104	.1	2¼x1¾x1"	9.23
LAC204	.2	2¼x2½x1 3/16"	9.82
LAC504	.5	4x2½x1 3/16"	12.35
LAC105	1.	4x3¾x1¼"	18.87
LAC205	2.	4x3¾x2¼"	30.16
LAC505	5.	6x3¾x4 9/16"	57.98

The above condensed version of the Plasticon Line will appear in the new catalogs of leading electronic distributors. Plasticons are manufactured by Condenser Products Company, Chicago 22, Illinois

scribed thus far generates a constant-frequency (60 cps) square wave whose amplitude is proportional to that of the input signal. This square wave is amplified and applied to the R-C circuit. The effective resistance of this circuit includes the generator impedance contributed by the amplifier stage. Resistance R is adjustable so that the desired scale factor can be obtained on the indicating instrument. The circuit is terminated on a low-impedance bleeder that provides the reference E_K. The values shown produce a 20-db scale on a 1-ma meter; a 30-db scale can be obtained by reducing the 30,000-ohm fixed resistor to 15,000 ohms and adjusting E_K to about 5 volts.

The output of the R-C circuit feeds a two-stage directly coupled amplifier. In the absence of signal the reference voltage E_K at the grid of the first stage acts to cut off the second stage. The plate of the second stage is then at a higher potential than the indicating instrument circuit at H and no current passes the diode. When signal is present, the second stage of the d-c amplifier conducts whenever the output of the R-C circuit is less than its average value by at least E_K. During these intervals, constant current passes through the meter M. Neon bulb N regulates this constant current. Control X determines the magnitude of reverse meter current employed to place the zero off scale; it may be used as a fine adjustment to set the end of the scale to correspond to a specified input voltage.

Response of the Meter

The frequency response of the instrument and its absolute sensitivity within gross limits are determined by the input amplifier, which is conventional. The full-scale indication of the instrument as shown in the circuit diagram corresponds to an input of about 3 rms volts.

With the instrument adjusted for a 30-db scale, it is accurate within 0.1 db over the top 20 db. If the linearity control is properly adjusted, this accuracy can be extended over the full-scale range. Thus, while it is possible to secure substantially ideal performance over a 30-db range, this result is only obtained by careful correction of the rectifier and limiter diodes. Therefore the circuit is shown for a 20-db scale for which critical adjustments are unnecessary. The sensitivity of the instrument to line voltage changes is 0.07 db per volt, which represents a uniform scale drift.

Design Limitations

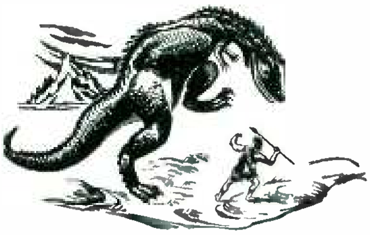
The serious source of error is the rectifier-limiter circuit. The portion of the meter following the rectifier-limiter circuit of Fig. 2 is accurate within ±0.2 db over a 30-db range.

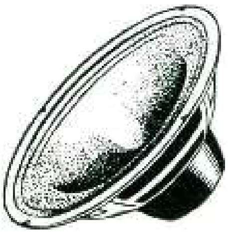
If it were required to redesign the meter for a 30-db range, an input stage having a larger output capability than the 6SJ7 would be necessary so that the rectifiers and limiters could be operated farther into their linear ranges. If this were done, the square wave would have to be attenuated before going to the grid of the 6V6 power stage.

The maximum useful range of the logarithmic circuit, which begins after the limiter diodes, is determined by the finite on-off sensitivity of the d-c amplifier. This sensitivity is of the order of 0.1 volt, and must be small compared to E_K in order that sharply defined pulses be produced. Thus there is a lower limit to E_K of about 3 volts. If the working range of the circuit is to be as much as 40 db, the peak-to-peak undistorted output of the square-wave amplifier must be greater than 3 volts by the 40 db plus a safety margin of about 3 db, or 400 volts peak-to-peak. Because of this requirement, a reasonably portable instrument is limited to about 30 db full scale.

The R-C filters between the rectifiers and the limiters are important to prevent slow periodic variations of the instrument indication at certain input frequencies. When the input frequency is nearly a multiple of the 60-cps square wave, ripple in the rectifier output is sampled in stroboscopic fashion in the limiting process. Thus a 10-percent ripple component in the rectifier output could produce a cyclic 1-db variation in the instrument indication.

These R-C filters are the chief factors in limiting the speed of response of the instrument; the values for them shown in Fig. 2 are commensurate with the mechanical





performance of usual milliammeters. If more rapid response were desired for operation of a high-speed recorder or for presentation of the results on an oscilloscope, it would be necessary to redesign the instrument for operation at a higher square-wave frequency. This change, although increasing the circuit complexity, would produce a faster response by providing more rapid sampling and by permitting reduction of the time constants of the R-C filters.

Acknowledgements

The author is pleased to acknowledge the cooperation of the Ordnance Research Laboratory of the Pennsylvania State College, with whose facilities a preliminary test of the principle of the logarithmic circuit described above was made, and of the Electrodyne Company of Boston, to whom development rights have been assigned.

(1) S. Ballantine, ELECTRONICS, p 472, 1931, and *Jour. Acous. Soc. Am*, p 10, 5, 1933; also F. V. Hunt, *RSI*, p 672, 4, 1933; W. Holle and E. Lubcke, *Hochfrequenztechn. u. Elektroakustik*, p 41, **48**, 1936; M. Nuovo, *Ricerca Scientifica*, p 522, 2, 1937.

(2) M. Lambrey, *Comptes Rendus*, p 1023, **201**, 1934, and also M. Nuovo, *Alta Frequenza*, p 206, **8**, 1939.

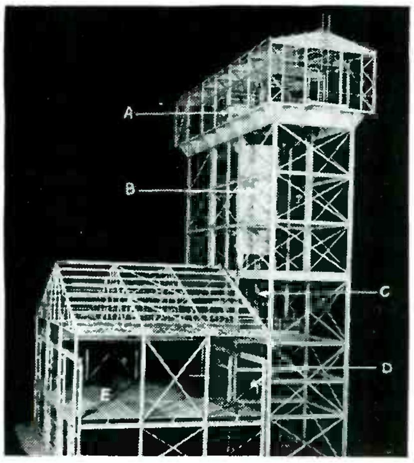
(3) H. G. Thilo, *Zeits. f. Techn. Physik.*, p 558, **17**, No. 12, 1936.

SURVEY OF NEW TECHNIQUES

PROPAGATION MEASUREMENTS conducted at the National Bureau of Standards under the direction of K. A. Norton indicate that atmospheric ducts may increase the range beyond line of sight of f-m broadcasting stations operating in the 88 to 108 mc band. The effect is most pronounced in the early morning and reaches a maximum during the summer months. (Ed. Note: Listeners have begun reporting reception of distant f-m stations now that the summer is here.) The increased transmission is caused by changes in refractive index in the region from 10,000 to 20,000 feet of air strata of different temperatures and hence different densities. The measurements also indicate that increased transmitter antenna height is more effective in increasing range than increased power. For rural areas, receivers that definitely limit with signals of five microvolts per meter will not be affected by natural noise, except possibly strong local lightning. For the most part fading at great distances is caused by multipath effects.

THICKNESS of cigarette paper can be controlled to within 0.2 micron (0.2×10^{-12} meter) by a beat-frequency capacitance meter. The method, being applied in French factories manufacturing paper having a thickness of about 0.001 millimeter, is based on developments described by J. Coulon in his doctor's thesis at the Faculte des Sciences de l'Uinversite de Toulouse, France. The thesis reports methods of stabilizing the frequency of crystal oscillators.

LINEAR electrostatic accelerator, designed to yield positive ions with energies up to 12 mev, will be built at the University of California Los Alamos Scientific Lab. Although other types of accelerators capable of higher energies are operating or under construction, there is need in nuclear technology for precise measurements within the range for which this new machine is designed; beam energies will be controllable to a precision of one-tenth of a percent (orbital accelerators are accurate to only about two percent). The flexibility of the energy controls will permit experimenters to select particles and target materials to produce monoenergetic neu-



Housing for accelerator accommodates 150-ton crane (A) to lift pressurized generator (B) so that vital parts can be adjusted, stack of annular steel plates and insulators (C) inside which beam is formed and accelerated toward deflecting magnet (D) that directs beam into target room (E) where nuclear reactions will be produced

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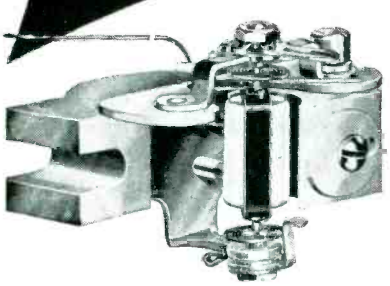

BALANCE WEIGHTS of helical type phosphor bronze, formed in a manner which eliminates slipping or shifting, are used to balance the moving element. All ranges AC and DC available in 2½", 3½", 4½" rectangular or round case styles and are guaranteed for one year against defects in workmanship or materials. Refer inquiries to Dept. F98.

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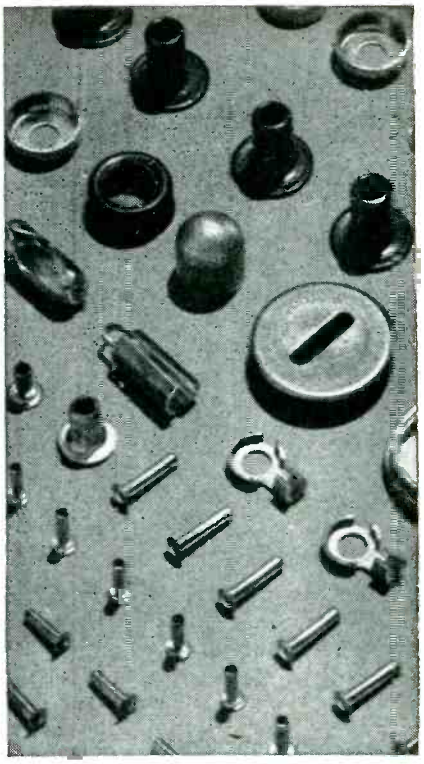

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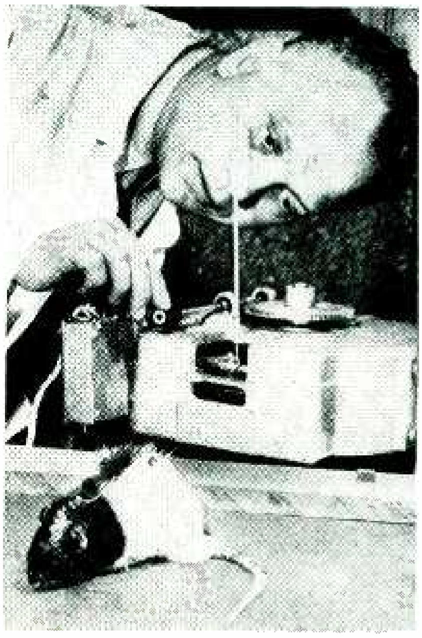
tron beams of any energy from 0.03 to 30 mev. The accelerator is basically a pressurized version, as developed by R. C. Herb of the University of Wisconsin, of the Van de Graaf generator. The building in which it will be housed is to be located at the base of a cliff, which will give lateral bracing to the tower and serve as a radiation shield for the control room and general laboratory that will be located atop the nearby mesa.

LABORATORY RATS carrying miniature radio receivers are being used at the University of California, Los Angeles, by Dr. J. A. Gengerelli. The object is to study learning and retention traits of the rats. The rats are enclosed in mazes through which they can run freely. By means of a radio transmitter tuned to the frequencies of the rats' receivers, electrical impulses can be



Dr. Gengerelli adjusts transmitter that sends impulses to tiny crystal rectifier placed under skin covering rat's skull. Note antenna wire projecting above rat

delivered to their brains. In this way traits that might be influenced by electrical shock can be studied without the hindrance of long wires connected to the rats.

A GROUP of cemeteries in Chicago will use a 160-mc Motorola central station and a radio dispatcher to help in the maintenance of extensive grounds and the smooth handling of funeral processions.

NEW PRODUCTS

(continued from p 130)

into a 50-ohm load. The attenuator is calibrated in c-w or peak pulse power or voltage into a 50-ohm load. Pulse rate is 40 to 4,000 cycles. Details of performance are available.

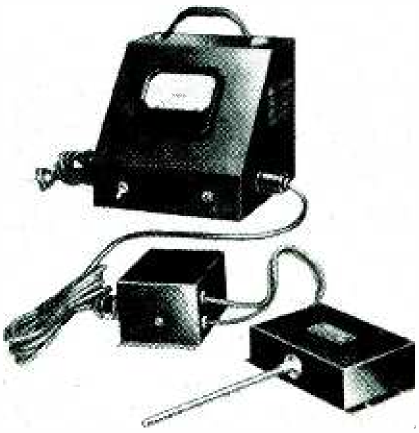
Dual-Channel Recorder

AMPLIFIER CORP. OF AMERICA, 398-7 Broadway, New York 13, N. Y. Model 910-B Twin-Trax magnetic tape recorder gives four continuous hours of recording and playback at 7½ inches per second. Two sound tracks are recorded on a single tape,

one in one direction and the other in the reverse. Frequency response is essentially flat from 40 to 10,000 cps.

Vacuum Indicator

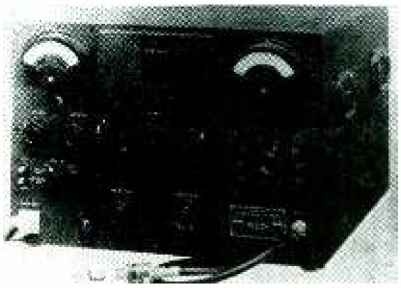
GEORGE E. FREDERICKS CO., Bethayres, Pa. The Televac Model I vacuum indicating meter has a scale calibrated directly in the range from 1 to 1,000 microns. A voltage stabilizer mounted within the portable meter case eliminates errors



due to line voltage fluctuations. Readings are obtained merely by the operation of an on-off toggle switch, no previous current adjustments or calibration being required.

Signal Generator

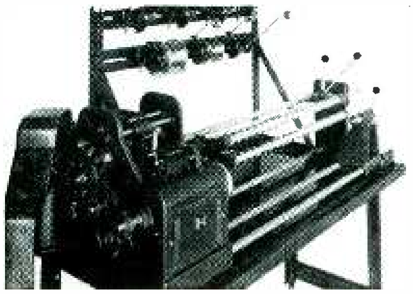
THE ROLLIN CO., 2070 N. Fair Oaks Ave., Pasadena 3, Calif. Model 30 power-type standard signal generator has 6 watts nominal r-f output and 50-ohm impedance with a 160-db range of attenuation and c-w, a-m or pulse operation. It can be



tuned from 40 to 400 mc and has a spiral dial scale equivalent to 4 feet in length.

Coil-Winding Machine

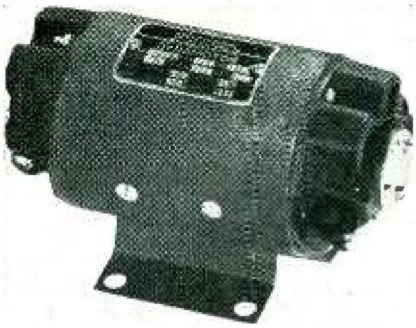
ASSOCIATED PRODUCTION CO., 2655 W. 19th St., Chicago 8, Ill., announces new improvements in a



coil-winding machine that permits almost micrometer adjustment of guide roller travel through positive electric limit switches. The machine winds coils of all types in 16 gage to 42 gage wire. Maximum arbor space is 36 inches.

Mobile Dynamotor

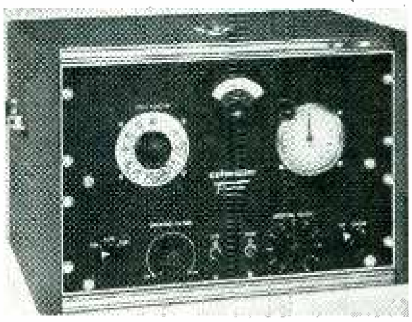
GOTHARD MFG. CO., 2110 Clear Lake Ave., Springfield, Ill. Model GP-26 dynamotor was designed chiefly for mobile transmitters but is suited to



many marine and aircraft applications. It is available in a range of capacities, with power output ranging up to 80 watts continuous and 150 watts intermittent duty. The unit weighs 8¼ pounds.

Scaling Unit

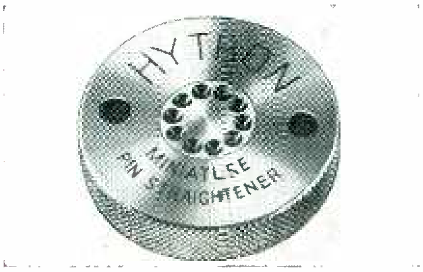
TRACERLAB INC., 55 Oliver St., Boston 10, Mass., is now manufacturing the SC-1A Autoscaler with a high voltage supply continuously variable from 500 to 2,200 volts. A time delay circuit is included. Scaling circuit and precision timer are



actuated by a pushbutton. Overall resolving time of the input amplifier and scaling circuit is about 5 microseconds. Pulse height sensitivity is approximately 250 millivolts.

Pin Straightener

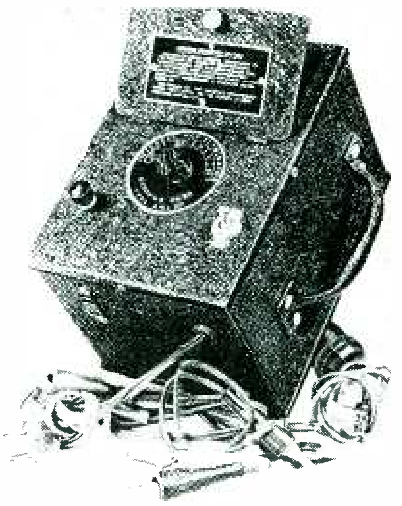
HYTRON RADIO & ELECTRONICS CORP., Salem, Mass. A new miniature 9-pin straightener is now



available. It is built of aluminum and stainless steel. Designed primarily for radio servicemen, it should find utility in any laboratory.

Filter Selector

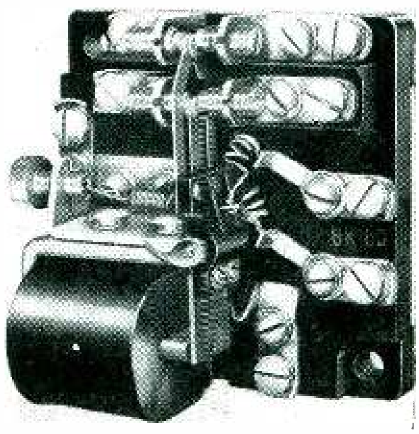
AEROVOX CORP., New Bedford, Mass. Choice of proper interference filter is simplified by the analyzer that can be varied to simulate all types of stock filters manufactured by the company.



Knob setting designations are calibrated in terms of these types. Optimum arrangement can then be made after it is determined by means of the analyzer.

Sensitive Relay

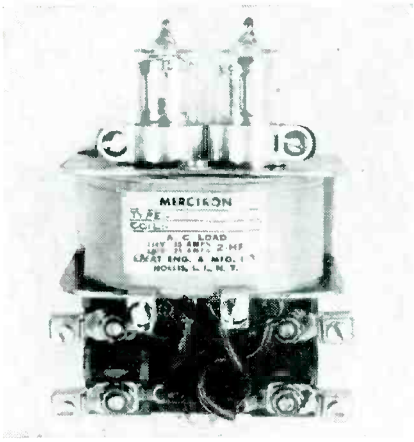
ALLIED CONTROL CO., INC., Dept. S, 2 East End Ave., New York 23, N. Y. Type BK relay, designed for high sensitivity, has a d-c coil rating up to 32 volts at 24 milliwatts and an a-c coil rating of 220 volts



at 0.240 volt-ampere. Contact rating is 1 amp at 48 v d-c. It is supplied in single or double pole, normally open or normally closed contact arrangements, also double throw.

Two-Pole Relay

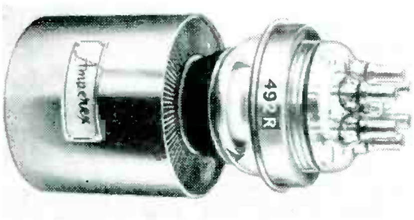
EBERT ENGINEERING AND MFG. CO., 185–09 Jamaica Ave., Hollis 7, L. I., N. Y., announces a 2-pole normally-open or normally-closed mercury relay for loads up to 25 amps breaking both sides of the line, also



motor loads up to 3 h-p at 230 volts a-c. Overall dimensions are 5 in. long, 3 in. wide and 2 in. high.

High-Frequency Triodes

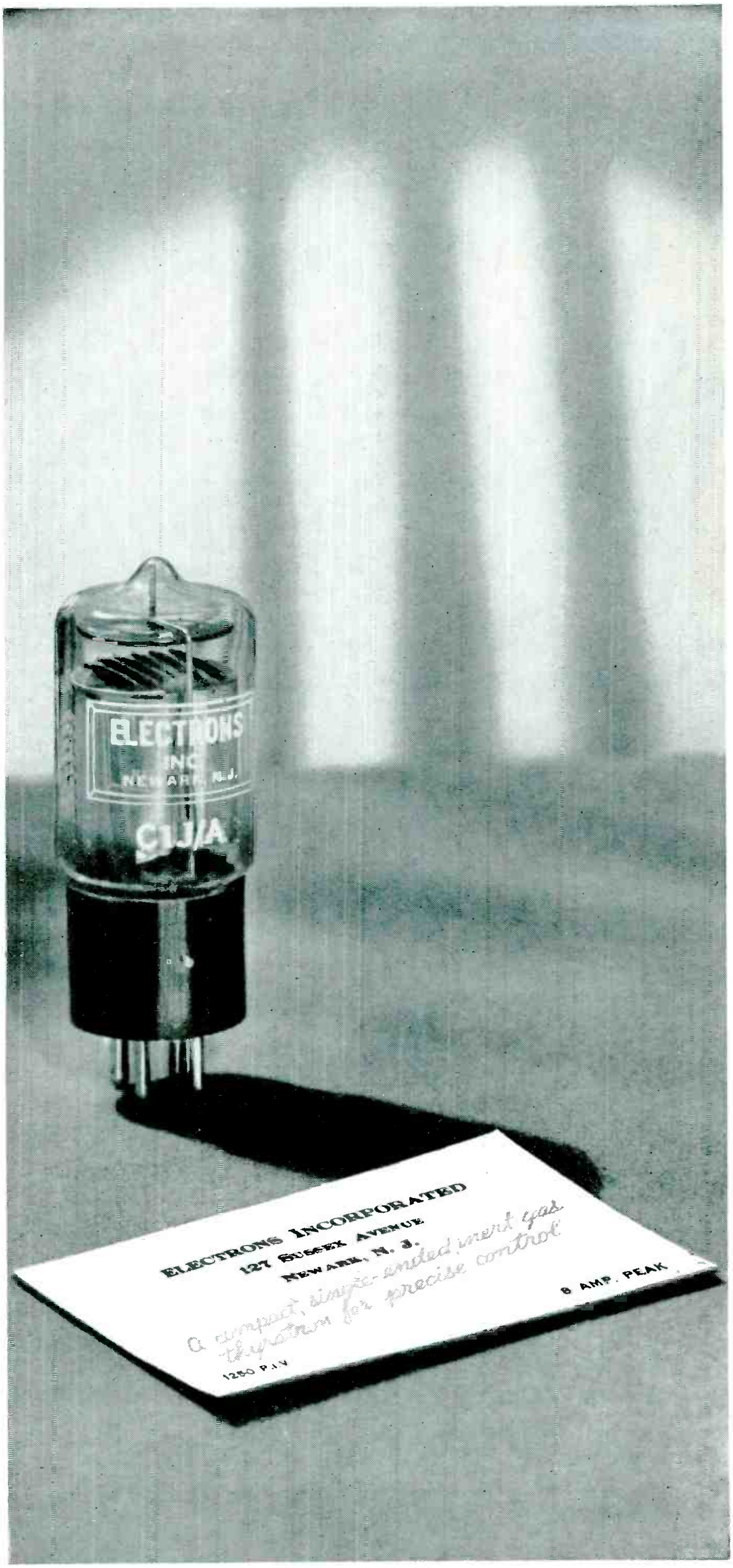
AMPEREX ELECTRONIC CORP., 79 Washington St., Brooklyn, N. Y., announce the 492 and 492-R h-f water-cooled and air-cooled triode amplifier and oscillator tubes having a 5-kw plate dissipation. The grid of each is mounted to a ring seal by an unperforated section of



copper cone which forms a shield between filament and anode, and makes the tube suitable for grounded- grid h-f circuits.

Intrusion Alarm

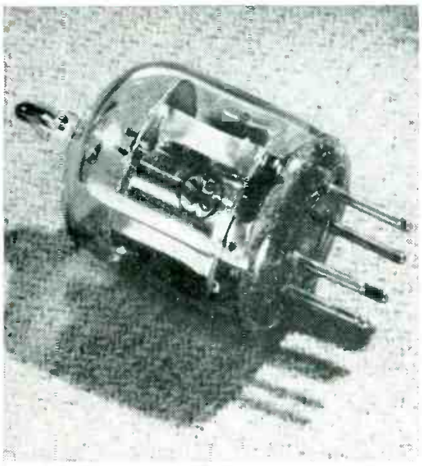
EL-TRONICS, INC., 2647 North Howard St., Philadelphia 33, Pa. Model



HS-5 alarm detects intrusion by change in antenna capacitance upon approach of a person. It also detects fire by means of a heat detector that operates at about 160 F. Slow capacitance changes owing to changing meteorological conditions will not affect the device.

Midget Thyratron

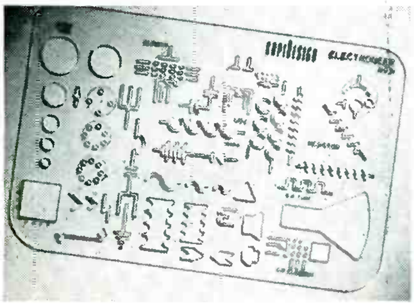
GENERAL ELECTRIC CO., Schenectady, N. Y. Type GL-5663 midget thyratron designed to maintain low



control grid and shield grid currents is inert-gas filled. Peak forward and inverse voltage ratings are 500 volts. Average anode current is 20 ma.

Symbol Tracer

RAPIDESIGN, INC., P. O. Box 592, Glendale, Calif., announces the new



No. 31 Electroneer template for design and drafting personnel in the industrial electronic, television, radio, and electrical engineering fields. A cellulose nitrate sheet of 0.04-inch thickness, it measures 4¼ x 6½ inches.

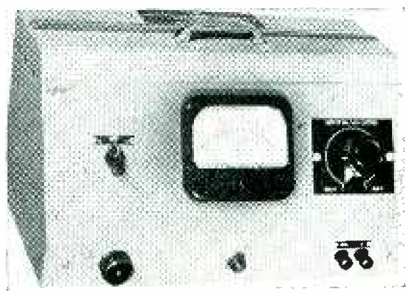
High-Gain T-V Antennas

THE WORKSHOP ASSOCIATES, INC., 66 Needham St., Newton Highlands 61, Mass., has developed eight different high-gain antenna arrays for television and f-m. Each is mounted

on a single mast and designed for reception of all channels operating in a particular area. Elements are constructed of half-inch aluminum tubing. More arrays can be added to the installation as additional stations go on the air.

Low-Current Power Supply

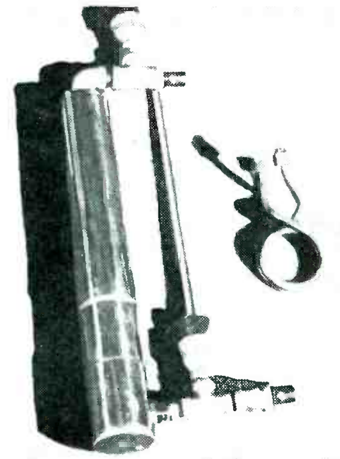
BETA ELECTRONICS CO., 1762 Third Ave., New York 29, N. Y. Model 251 regulated low-current power supply is used for currents below 10 milliamperes at voltages up to 500 volts d-c. Output voltage is continuously variable, up to 500, either positive or negative with



respect to ground; and it will change less than 0.5 percent at any setting for line voltage variations from 95 to 135 volts.

Calorimeters

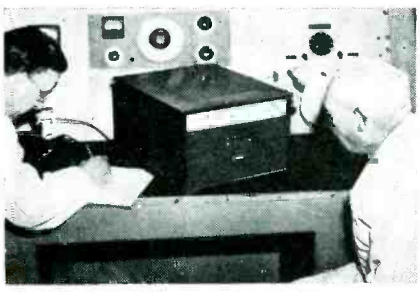
R. A. WHITEMAN, 630 N. Wisner Ave., Park Ridge, Ill. The types IHC-20 (illustrated) and IHC-50 calorimeters measure and check the power output of induction heating units. They permit measurements



from low values to 20 kw and 50 kw respectively. Each is available in either magnetic or nonmagnetic steel.

Light-Beam Wattmeter

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has developed a new portable light-beam wattmeter giving readings in the low wattage, low power factor ranges for frequencies

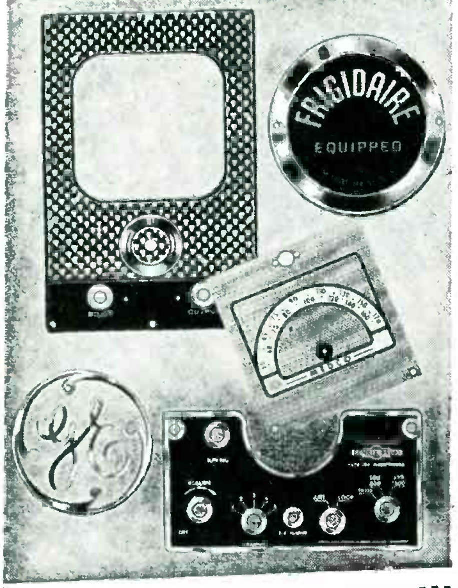


of 25 to 3,000 cycles. It can be used as an instrument calibrator and in laboratory production testing.

Actuator

PHILLIPS CONTROL CORP., 612 N. Michigan Ave., Chicago 11, Ill. The 51A actuator features a frame of

Quality you can see!



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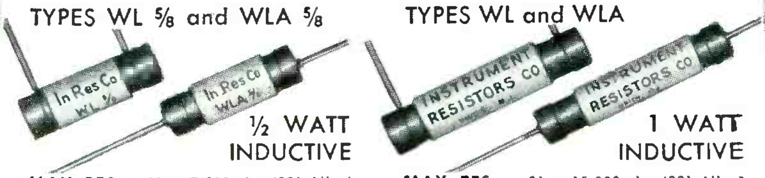

TYPES WL 5/8 and WLA 5/8	TYPES WL and WLA
1/2 WATT INDUCTIVE	1 WATT INDUCTIVE
MAX. RES: .01 to 7,500 ohm (331 Alloy) .01 to 4,000 ohm (Nichrome) .01 to 1,250 ohm (Manganin)	**MAX. RES:** .01 to 15,000 ohm (331 Alloy) .01 to 8,000 ohm (Nichrome) .01 to 2,500 ohm (Manganin)
BODY SIZE: 5/8" lg. by 3/16" diam.	**BODY SIZE:** 1" lg. by 3/16" diam.
TOLERANCE: STANDARD 1%	**TOLERANCE:** STANDARD 1%

Can be supplied non - inductive with one-half indicated maximum resistance.

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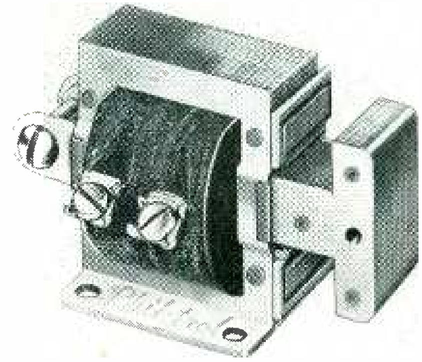
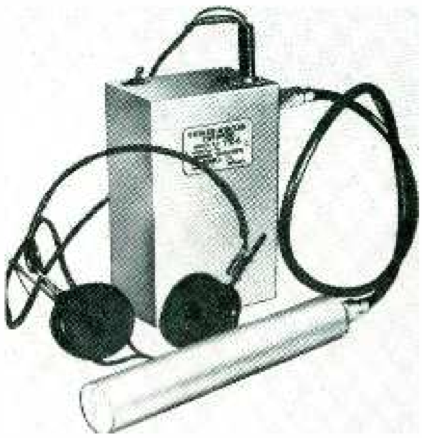


bonded silicon steel laminations and a T-shaped laminated plunger adaptable for both push and pull operations. It is available for continuous duty on 115 volts, 60 cycles, with a maximum stroke of one inch. Approximate pull is 2 pounds at ¾ inch, 4.2 pounds at ¼-inch stroke.

Geiger Counter

OMAHA SCIENTIFIC SUPPLY CORP., 3623 Lake St., Omaha 4, Nebraska. The 3½-pound TX-6 Geiger counter consists of a probe, amplifier, and headphones. Gamma rays from uranium ore produce clicks in the



phones. The instrument is sensitive enough to detect radiation in a radium dial watch.

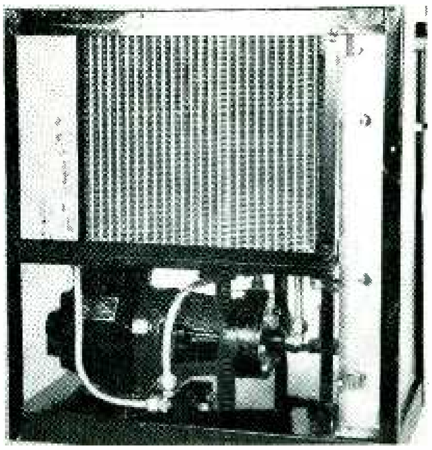
Photorelays

PHOTOBELL CO., 116 Nassau St., New York 7, N. Y. Type ES-1 electric eye relay operates from 115 volts 60 cycles, and comprises a photoelectric tube, amplifier, relay and sensitivity adjustment all mounted on a 2½ x 5-inch steel chassis. Type ES-2 is similar but includes a light projector built into

the chassis base. Response time is about 0.05 second, permitting use as a counting machine at speeds up to 600 counts per minute.

Heat-Transfer Unit

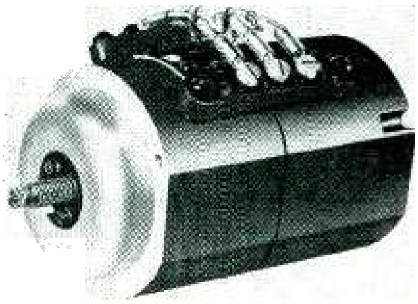
EASTERN INDUSTRIES, INC., 296 Elm St., New Haven 6, Conn. Model No. 5-H.T.U. is a new heavy duty heat-transfer unit for cooling the magnetron power tube in an induction-

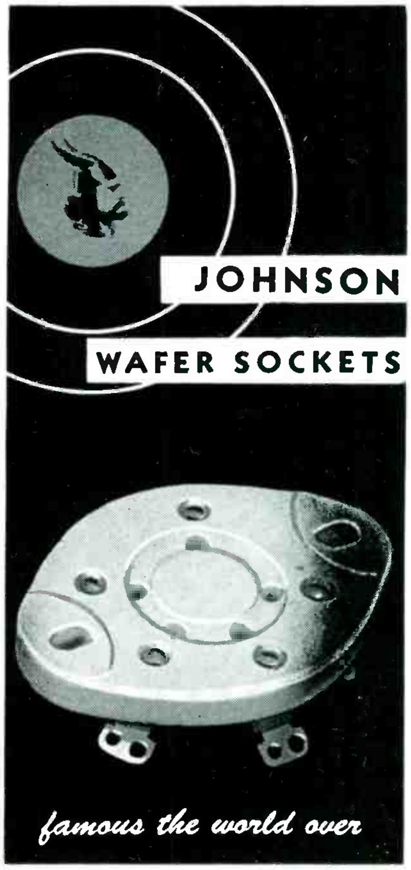


heated oven. The unit will dissipate 3,000 watts within a temperature rise of 40 F above ambient.

Engine Synchronizer

SQUARE D CO., KOLLSMAN INSTRUMENT DIVISION, 80-08 45th Ave., Elmhurst, N. Y. A new 28-ounce synchronous differential contains two synchronous motors and a mechanical differential. Used in synchronizing engines, it serves as an





Exacting users prefer JOHNSON wafer sockets because they are insulated with grade L4 steatite or better, top and sides are glazed, the underside is impregnated against moisture. Contacts are brass with steel springs, cadmium plated and are mounted against phenolic washers in molded recesses to prevent movement. Rivets are countersunk and mounting holes bossed to permit sub-panel mounting. Locating grooves facilitate tube insertion.

Illustrated above is the 122-225, a 5 pin socket which can be used with such tubes as the 807.

Additional Types

122-224, 4 pin, for tubes such as the 812 or T40

122-226, 6 pin, for tubes such as the T21

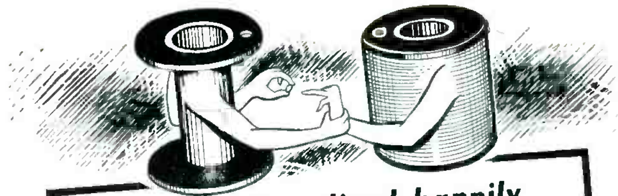
122-227, 7 pin medium, for tubes such as the RK34

122-217, 7 pin small, for tubes such as the 6A7

122-228, octal, for tubes such as the 6L6 and 815

Also available are Giant wafer sockets for transmitting tubes, of 5 or 7 pin bases, sockets incorporating a base shield, and Super Jumbo 4 pin base sockets.

JOHNSON
a famous name in Radio
E. F. JOHNSON CO. WASECA, MINN.



"—And they lived happily ever after."

Your coil windings are perfectly mated for long and useful life when the bases are

PRECISION BOBBINS

Precision provides the *strength*, the *insulation*, the *dependability* by the most thorough specialized engineering, exactly to your specifications.

Spiral winding of the tube—heavy heat-treated compression—swaged tube ends securely locked—impregnation of the complete assembly are factors of Precision's exceptional service. Lightest of all coil bases. Permit larger gauge, or more wire of same gauge in winding area.

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ROUND · SQUARE · RECTANGULAR --- *any coil shape*

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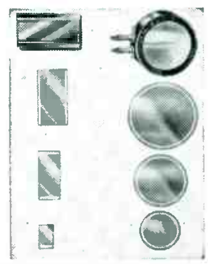
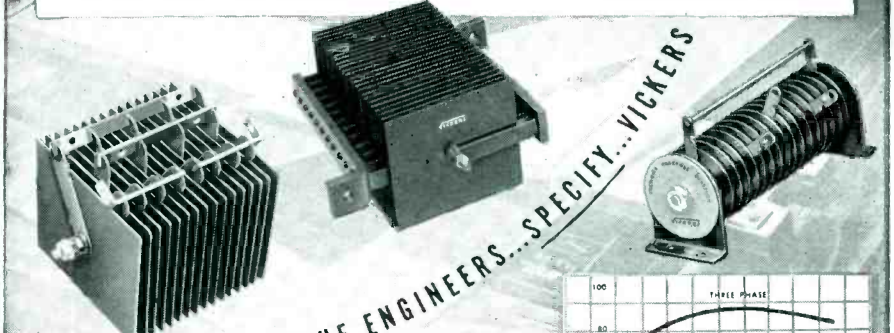
LINKING FUNCTION TO DESIGN

Engineers and Designers who insist on dependable components have adapted Vickers Selenium Rectifiers into their circuits. They are specifying Vickers products, and are submitting their rectifier problems to us. Our greatly expanded plant facilities, plus the recognized dependability of Vickers products, make it possible for us to offer the most complete line of Selenium Rectifiers and self-generating Photoelectric Cells.



PHOTOELECTRIC CELLS



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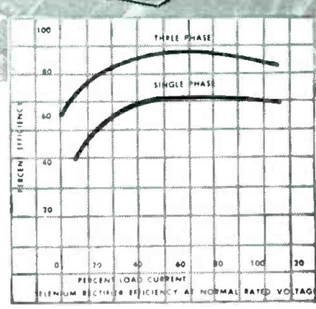


3-1

VICKERS ELECTRIC DIVISION
VICKERS INC.

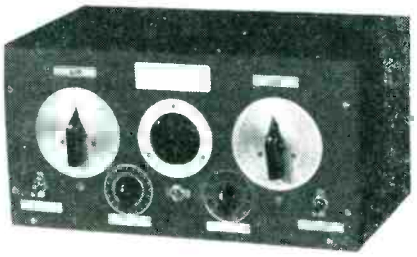
2160 EAST IMPERIAL HIGHWAY • EL SEGUNDO, CALIF.

EXPORT: Frazar & Hansen, Ltd., 301 Clay St., San Francisco 11, Calif.
CANADA: Powertronic Equipment Ltd., 494 King St., E. Toronto 2, Canada

intermediary regulating device of engine control equipment. It may also be used as a torque-producing half-speed synchroscope. The unit operates from a three-phase source over a frequency range of 15 to 60 cycles with an input voltage of 0.007 times the frequency in cycles per minute.

Control Tester

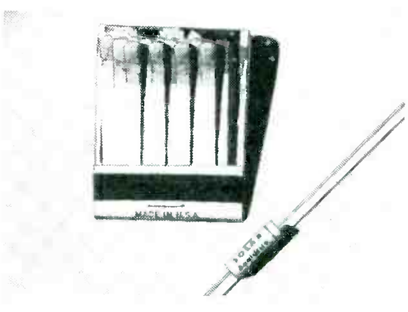
FLIGHT RESEARCH ENGINEERING CORP., P.O. Box 1-F, Richmond 1, Va. The Servo Analyzer is used as an aid in developing and testing servos and automatic control systems employing 400 cycle error measuring devices such as Selsyns



or E type pickoffs. Frequency response and transfer function may be obtained over an input range of from 1 to 60 cps.

Miniature Capacitors

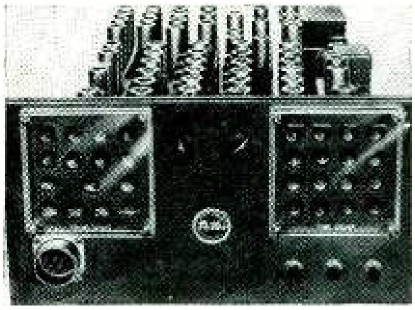
SOLAR MFG. CORP., 1445 Hudson Blvd., North Bergen, N. J. Type TST capacitors are 3/16 inch in diameter and 3/8 inch long, sealed



against humidity effects. Details are given in a new catalog bulletin.

High-Speed Counters

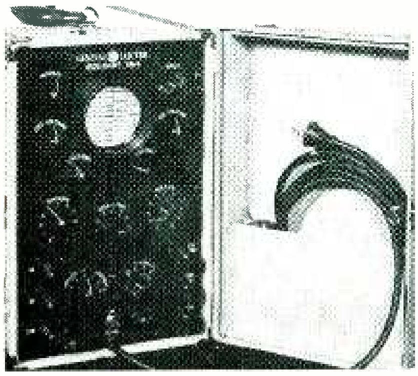
POTTER INSTRUMENT CO., INC., 136–56 Roosevelt Ave., Flushing, N. Y., has developed a new system for measuring frequencies from 0 to 1.6 mc with accuracies



of one part in ten million or greater. Basic units of the system are two high-speed electronic counters, a crystal oscillator and an electronic switch. The instrument shown, a Doppler frequency chronograph, measures unknown frequencies of 50 to 200 kc using the new system.

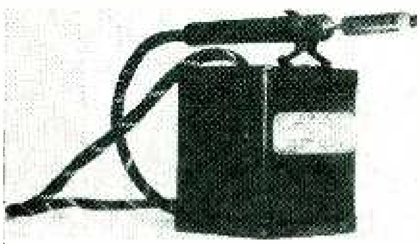
Industrial Scope

GENERAL ELECTRIC CO., Syracuse, N. Y. Industrial oscilloscope type YNA-4 is intended primarily for servicing such equipments as resistance welders, motor control circuits, and photoelectric circuits. A three-inch tube is employed with pushpull d-c amplifiers. Horizontal sweeps range from 10 cps to 20 kc.



Low-Voltage Soldering Iron

JET THERMAL DEVICE CO., 2873-86th St., Brooklyn, New York. The Slim Jim soldering iron can be used on automobile storage battery or socket



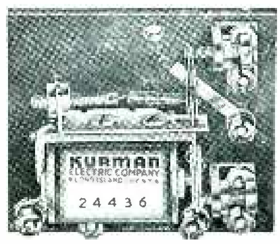
power. It is designed for heavy duty but weighs only $3\frac{1}{2}$ ounces including tip and cord. The unit will operate on a-c or d-c.

New Contact Metal

FANSTEEL METALLURGICAL CORP., North Chicago, Ill. Fasaloy 99 is a new contact metal with surface resistance substantially that of fine silver but which will successfully break resistance load circuits 25 percent higher than those that can be broken by fine silver contacts. Write for Fansteel Technical Data Bulletin 7.104.

Sensitive Relay

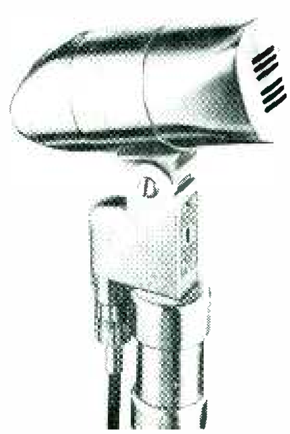
KURMAN ELECTRIC CO., INC., 35–18 37th St., Long Island City 1, N. Y. The type 24 split-armature relay can be adjusted to operate at 0.005



watt from 0.01 to 115 volts d-c or a-c. Several contact combinations are available.

High-Fidelity Mikes

ELECTRO-VOICE, INC., Buchanan, Mich. Models 650 and 645 high-fidelity, high-output dynamic broadcast microphones are designed for both f-m and a-m. Each is equipped with a newly developed shock mount and a switch which permits instant



selection of either 50 or 250 ohms impedance balanced to ground. Further information is available in a recent bulletin.

Fractional Motor

BACH ELECTRICAL CORP., Bridgeport, Conn., announces a new fractional 110-volt 60-cycle a-c motor. It is Fiberglas insulated and has

cast-aluminum rotors. Further information is available from the company.

Control Panel

EWART AND KOCH, 15 Brattle St., Cambridge 38, Mass. The switch and receptacle unit illustrated is equipped with eight feet of rubber

cord with fused plug. A neon pilot lamp shows when the unit is plugged in.

Plane Radio

RADIO CORP. OF AMERICA, Camden, N. J. A new compact, plane-radio transceiver is now available. The One-Sixteen weighs only nine pounds and fits into the instrument panel. A single selector switch tunes in any broadcast program on the standard band or any frequency from 200 to 400 kc. A special

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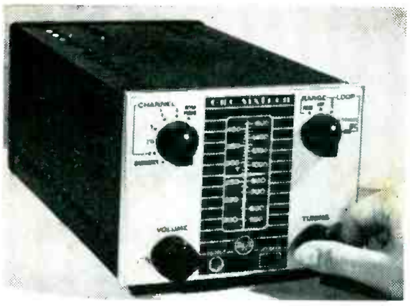
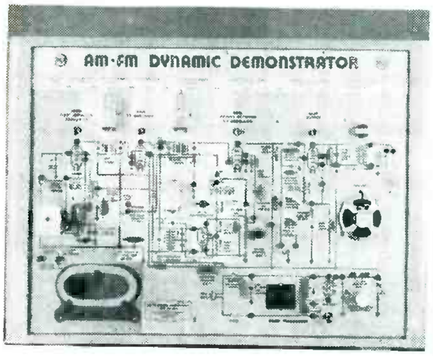


marker indicates standard tower frequency of 278 kc.

Radio Instruction

RADIO CORP. OF AMERICA, Camden, N. J. The Dynamic Demonstrator is an f-m and a-m six-tube radio receiver with its circuits and components laid out on a panel 45 × 33 inches for purposes of study. It is designed to simplify the teaching of radio theory, operation and



maintenance. The unit will operate on a-m from a signal generator as well as an antenna. The f-m i-f will operate from a sweep generator.

Audio Units

FAIRCHILD CAMERA & INSTRUMENT CORP., 88–06 Van Wyck Blvd., Jamaica 1, N. Y. Audio units from microphone preamplifier to rack frame are available in numerous combinations that are flexible to the current needs of the amplifier system. Basic component is Unit 620 power amplifier with a frequency response from 20 to 20,000 cycles.

Appliance Tester

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. Model 900B volt-ampere wattmeter is designed for testing all a-c appliances from clocks to 220-volt electric ranges. The unit incorporates a current

transformer for additional ranges of 5,000 and 10,000 watts, and 65 and 130 amperes.

Literature

Fabrics Bulletin. The Duplan Corp., Industrial Division, 512 Seventh Ave., New York, N. Y. Many technical facts for a large number of standard weaves of Fiberglas and Nylon fabrics are given in a recent bulletin. A wide range of industrial applications is illustrated and described, together with details of their properties.

Connector Catalog. Cannon Electric Development Co., Humboldt St. and Ave. 33, Los Angeles 31, Calif. The C-47 edition of Cannon Plugs contains 32 pages in 3 colors, covering the thirteen major type series of multi-contact electric connectors. Prices are given on all except the AN, K, and DPD series.

Motor Catalogs. Gleason-Avery Inc., Auburn, N. Y. Two new catalog sheets have been recently released. The first deals with both synchronous and nonsynchronous instrument and timing motors. The second covers the series 500 gear motors. Both are well illustrated and give complete specifications.

Automatic Computing System. Eckert-Mauchly Computer Corp., Broad and Spring Garden Sts., Philadelphia 23, Pa. An 8-page

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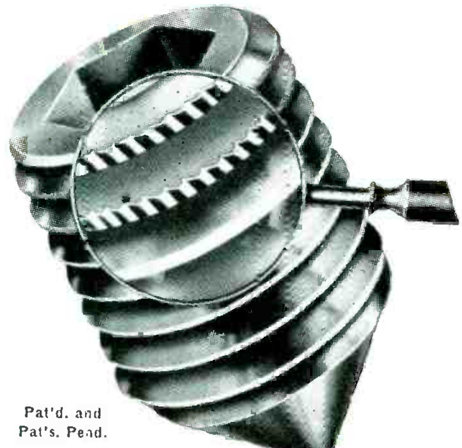

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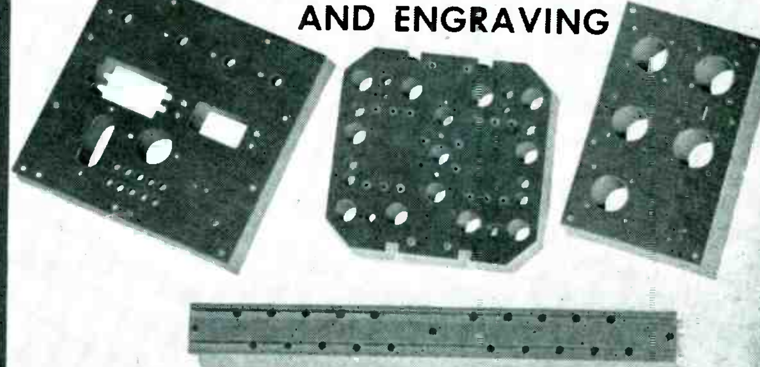

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booklet shows the chief features of the Univac (Universal Automatic Computer), which is the central component of an electronic system by which many types of information can be processed with speed and economy. Operation includes the use of a newly developed magnetic tape recording system.

Microwave Test Equipment. Polytechnic Research and Development Co., Inc., 66 Court St., Brooklyn 2, N. Y. New sheets are now available for the company's catalog of test equipment. Included are waveguide terminations, variable flap attenuators, slide screw tuners, and directional couplers.

All-Channel Antenna. The Workshop Associates, Inc., 66 Needham St., Newton Highlands 61, Mass. A catalog sheet and assembly instructions are available for the new indoor television and f-m antenna that is constructed of corrugated board covered with aluminum foil. The antenna is designed to be mounted in an attic.

Transmitting Tubes. Sylvania Electric Products, Inc., Emporium, Pa. Characteristics on more than a score of types with rated plate dissipation ranging from 20 to 175 watts are given in a six-page bulletin.

Motor Control. J. B. Lewis & Co., 3324 Main St., Hartford 5, Conn. Bulletin 105 points out the features of a new wide range, adjustable speed, motor control employing two electronic tubes.

A-M and F-M Tuner. Browning Laboratories, Inc., Winchester, Mass., has issued catalog sheet 8415 describing the characteristics of an a-m and f-m tuning unit with f-m sensitivity of 10 microvolts for 30 db noise reduction. Curves of its performance are also available.

Crystal Pickup. Electro-Voice, Inc., Buchanan, Mich. The Series 12 Torque Drive crystal pickup cartridge was developed to provide light weight coupling of crystal to record groove. Fourteen outstand-

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ing features are treated in bulletin 141.

Standards Index. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. The recently issued 240-page index to ASTM standards as of December 1947 will be furnished without charge on written request. Items are listed under appropriate key words according to particular subjects.

Electronic Glassware. T. C. Wheaton Co., Millville, N. J. A complete line of electronic glassware, particularly glass-to-steel hermetic terminals in various shapes and sizes, is covered in a recent bulletin.

Industrial and Laboratory Devices. Airmec Laboratories Ltd., 19 Charterhouse St., London, E. C. 1, England. Descriptive leaflets are available on the d-c ionization voltage tester type 732, the d-c oscilloscope type 723, and the electro-mechanical counter type 737.

Oscillography Equipment. Allen B. DuMont Laboratories, Inc., 1000 Main Ave., Clifton, N. J., has issued an informative pamphlet covering c-r tubes, oscillographs, allied equipment, and accessories. It may be obtained by request on business letterhead.

Laboratory Catalog. Fisher Scientific Co., 717 Forbes St., Pittsburgh, Pa. and Eimer & Amend, 635 Greenwich St., New York 14, N. Y. A 40-page profusely illustrated book pictures 268 laboratory innovations and describes more than 300 equipment items that have been developed to aid laboratory work.

Chemical Products. General Electric Co., 1 Plastics Ave., Pittsfield, Mass. An 18-page illustrated booklet CDP-576 describes briefly a wide range of chemical products such as plastics, resins and insulating materials, metallurgical products and compounds. A technical bulletin is available on each product described.

Tube Data. Radio Corp. of America, Harrison, N. J. A four-page technical bulletin gives complete data on the 6BA7 and 12BA7 pentagrid converters which are in-

tended especially for use in f-m broadcast service.

Motors Guide. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. A 12-page loose-leaf perforated booklet offers a quick reference to data on a variety of general purpose motors. It is well illustrated and gives specifications and applications.

Snap Switches. The Acro Electric Co., 1305 Superior Ave., Cleveland 14, Ohio. A recent catalog describes, complete with mechanical drawings and operating characteristics, many types of snap-action switches with the patented rolling spring construction.

Silicone Products. General Electric Co., Pittsfield, Mass. A 30-page illustrated bulletin CDR-57 describes in detail the new silicone resins, oils, greases, water repellents, and rubber together with their many industrial uses. Charts and tables are included for handy reference.

Isotope Apparatus. Tracerlab Inc., 55 Oliver St., Boston 10, Mass. A 40-page booklet shows a variety of scalers, counters, timers, sample changers, and radiation survey meters. Chief features, uses, and specifications for each are given. Also included are descriptions of radioassay accessories.

Annual NBS Report. Department of Commerce, U. S. Government Printing Office, Washington, D.C. The 1947 report of the National Bureau of Standards involves five types of activities: research and development; test, calibration and standard samples; commodity standards and codes and specifications; advisory services; and co-operative activities. A complete table of contents is given.

Resistance Measurement. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. The 12-page bulletin 24–25 contains photographs, wiring diagrams and charts showing various aspects of low-resistance testing and its application. It features the Ducter ohmmeter which measures resistance down to 0.000001 ohm.

Radio Heater. Rediffusion Ltd., Broomhill Road, Wandsworth, London, S. W. 18, England. A re-

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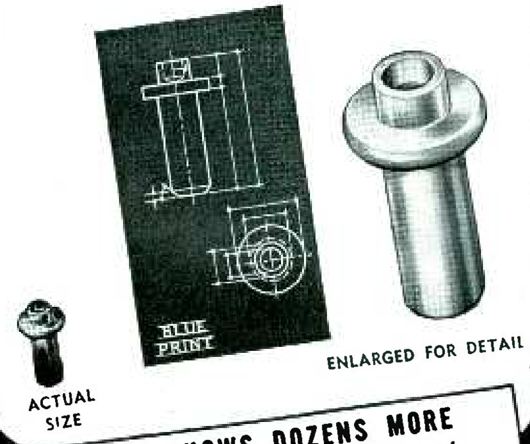

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cent leaflet pictures and technically describes the model RH. 24 Redifon industrial radio heater with an output of over 350 watts. The unit is specifically designed for dielectric heating applications and features a single oscillator valve of the latest repairable silica-envelope type.

Paper Tubulars. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Descriptive bulletin NB116 covers the Grey Tiger paper tubulars which are Vikane impregnated and feature outstanding performance over a temperature range of -55 C to $+100$ C. These capacitors are primarily designed for use in automobile radios and other high-temperature applications.

Recording Catalog. Gorrell & Gorrell, Haworth, N. J. Bulletin G-100 is a condensed catalog briefly outlining features, functions and general construction of several types of instruments for timing, control, and graphic recording. Complete details and typical applications are given in individual bulletins.

Microphones. Electro-Voice, Inc., Buchanan, Mich. Bulletin 103 illustrates and describes in four pages many models of microphones, stands and accessories now available.

Internal Defect Locator. Sperry Products, Inc., 1505 Willow Ave., Hoboken, N. J. Operation and application of the new portable, lightweight type SR05 supersonic reflectoscope is described in bulletin 3001. This nondestructive testing instrument is used for locating internal defects in metals and other materials.

Precision Equipment. R.T.S. Electronics Ltd., King St., Exeter, England. The model EA11 single-channel cro, model EA20 resistance-capacitance bridge and EA36 signal tracer are fully treated in a 12-page, board-covered booklet.

Fractional H-P Motors. Alliance Mfg. Co., Alliance, Ohio. Various types and sizes of electric motors rated from less than 1/400th h-p to 1/20th h-p are described and illustrated in a four-page folder. Applications are given.

(continued from p 134)

programs are currently being broadcast in Leningrad twice a week, and are expected to be increased to four times a week soon. The Leningrad center also plans to have in operation by autumn a portable television transmitter.

During the past two years The Moscow Radio Club organized two cycles of 15 lectures each dealing with the principles of television and how to build a television receiver. Under the aegis of the club's television section 400 amateurs made their own television receivers and are now viewing regular programs broadcast by the Moscow Tele-Center.

Rural Industrial Radio

A SPECIAL INDUSTRIAL radio service was recently proposed by the FCC to make radio-communication available to persons engaged in commercial or industrial operations which are predominantly rural in nature. Under this category would be included farming, ranching, irrigation, mining and construction activities.

Also covered by the proposed special service would be those engaged in commercial and industrial operations involving hazard to life and property where use of radio would decrease such hazards, those engaged in operations reacting directly upon public welfare or safety, and maintenance and repair services directly involving public health or well-being.

URSI-IRE Meeting

A SECOND joint meeting of the American Section, International Scientific Radio Union, and the Institute of Radio Engineers will be held in Washington on Thursday, Friday, and Saturday, October 7, 8, and 9, 1948.

The program will, as usual, be devoted to the more fundamental and scientific aspects of radio and electronics. The program of titles and abstracts will be available in booklet form for distribution before the meeting. Anyone wishing to submit papers for presentation at this meeting should send in title and a 100-word abstract before

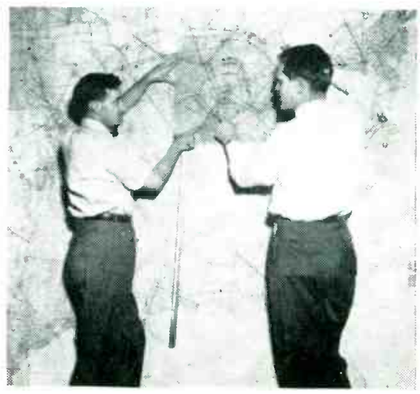
August 20 to Dr. Newbern Smith, Secretary, American Section, URSI, National Bureau of Standards, Washington 25, D. C.

San Francisco Audio Society

ON JUNE 22 in San Francisco's NBC Building the first organizing meeting for formation of a San Francisco Section of the Audio Engineering Society was held. About thirty audio specialists attended and established by acclamation a temporary chairman, I. R. Ganic of Audiophone, Oakland, Calif. There was also a talk and demonstration of the Ampex tape recorder by Myron Stolaroff.

Television Reallocation

HEARINGS WERE HELD in Washington, D. C. recently at which the FCC proposed a nation-wide reallocation of the twelve television channels. A 10 x 16ft. map of the U. S., on which interference conditions are graphically portrayed, was prepared by Allen B. DuMont Laboratories, Inc., for the occasion.



Dr. Thomas T. Goldsmith (right), head of DuMont research division and an assistant, Robert Wakeman, with map of U. S. showing FCC's proposed allocation

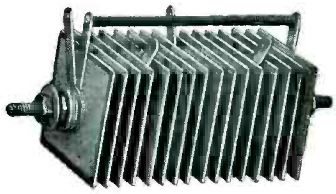
The DuMont proposal includes first the correcting of some serious spacings in the proposed FCC allocation plan and secondly the addition of a few further channels beyond the present twelve.

Channel Numbers to Stay

WAYNE COY, chairman of the FCC, recently announced that the Commission is not considering a renum-

BRADLEY RECTIFIERS

HIGH VOLTAGE SELENIUM RECTIFIERS



Bradley selenium power rectifiers are rugged and compact. Square plates afford maximum of rating to space factor. Conservatively rated up to thousands of amperes. Shown: SE11W20F, full-wave bridge, rated at 110 volts A.C., 5 amperes D.C.

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Our engineers will select or develop rectifiers or photo cells to meet your needs exactly. Write for BRADLEY LINE showing basic models.

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LABORATORIES, INC.
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Tektronix Type 511 Oscilloscope

Versatility...Plus

The Tektronix Type 511 is a portable wide band oscilloscope providing facilities formerly available only in very expensive, cumbersome instruments.

SWEEP CHARACTERISTICS

Continuously variable .1 second to 1 microsecond (10 cm. deflection).
Direct reading sweep speed dial.
Choice of triggered, recurrent or single sweeps at all speeds.
Triggers on sine waves to 10 mc. or pulses over .05 microsecond.
Any 20% of sweep may be expanded 5 times.
DC coupled PP amplifier for external sweep input.

VERTICAL DEFLECTION SYSTEM

Amplifier Bandwidth 10 mc., 1 stage; 8 mc., 2 stages.
Rise Time .04 microsec., 1 stage; .05 microsec., 2 stages.
Maximum Sensitivity .27 V/cm. (Peak to Peak).
Input Impedance Direct 1 meg., 40 mmf.; Probe 10 meg., 11 mmf.

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Calibrating voltage 0-1, 0-10, 0-100 volts, 60 cycles.
CRT 5CP1A, 5CP7A or 5CP11A operating at 3 kv.
Direct connection to all plates from side panel.
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FOR RADIO AND TELEVISION RECEIVERS

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bering of the present 12 television channels. In a letter to the executive vice-president of the RMA he stated that neither the report and order deleting Channel No. 1, nor the proposed rule revising the allocation of television channels contemplates changing the numbering of the remaining 12 television channels.

Army Tests Transistors

A RECENT Bell Laboratories development, the transistor (see p 68, this issue), gives promise of having great military value for communications equipment. Exhaustive tests are being undertaken by the Signal Corps to gather complete data on the device's characteristics and its reaction to shock, vibration and extremes of climate.

The transistor, a new crystal triode, is important to the army because, having no filament, it requires no heating current to amplify voltages. In portable communications equipment, such as the walkie-talkie and the handy-talkie, a large part of the weight and bulk consists of batteries for heating tube filaments. Transistors would greatly reduce the ground soldier's load.

Signal Corps engineers caution that there is little conclusive data on the new crystal triode's performance. They believe it will be useful where low power is involved but expect to continue to rely on the vacuum tube for high-power equipment.

Utilities Radio Committee

AT A RECENT meeting attended by twenty-two power utilities representatives from all over the country, the National Committee for Utilities Radio was organized in Chicago. It will be a successor committee to the group formerly known as Committee 4 of Panel 13, RTPB.

The first item of business which the new organization undertook was the formulation of comments to be forwarded to the FCC on their new proposal for the reallocation of frequencies in the various bands and on the proposed new rules under which the licensees represented by this committee are to operate. Empha-

sis was placed on the importance of communications in this service, its emergency nature, and the public safety features involved.

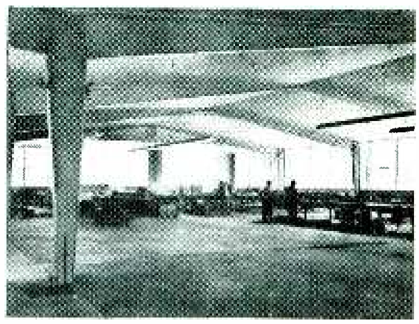
Rochester Fall Meeting

THE MEETING OF members of the IRE and RMA Engineering Department scheduled for November 8, 9 and 10 at the Sheraton Hotel, Rochester, New York, will mark the 20th anniversary of the Rochester Fall Meeting. Officers of the committee in charge, in addition to Virgil Graham of Sylvania, chairman, include Howard A. Brown, vice-chairman and H. J. Klumb, treasurer, both with Rochester Gas and Electric Corp., and O. L. Angevine of the Rochester Engineering Society, secretary.

BUSINESS NEWS

RAYMOND ROSEN ENGINEERING PRODUCTS, INC. is a recently formed subsidiary of Raymond Rosen & Co. for handling specialized phases of sound, communication and electronic engineering and development work.

HEWLETT-PACKARD CO., Palo Alto, Calif., manufacturers of precision electronic measuring instruments,



Interior of new Hewlett-Packard plant

has completed construction of new plant facilities totalling 20,000 sq. ft.

RCA INSTITUTES has opened new quarters with expanded facilities at 350 W. Fourth St., New York City. The new building has space for more than 20 classrooms, offices and laboratories.

MULLARD ELECTRONIC PRODUCTS LTD., London, now has the right to

Now Available . . .

DIAMOND NEEDLES

for Manufacturers of

- ★ RADIO PHONOGRAPH COMB.
- ★ PICKUPS
- ★ RADIO PHONOGRAPH TELEVISION COMB.
- ★ TRANSCRIPTIONS

Our research and development now permit us to offer manufacturers genuine diamond needles hitherto unobtainable.

Radius and angle are positive gem finish, insuring gem contact in record groove, and assuring a minimum of record wear.

These diamond needles are obtainable in any radius and angle desired, including one-thousandths radius for the new micro-groove records.

Our diamond needles may be inserted in any spring or similar assembly with a minimum of mass.

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Office: 403 Statler Building
Boston 16, Mass.

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When you use these tough, lightweight and inexpensive parts, you build their many advantages *into your own product*. Fabricated to order, BAER FIBRE washers, special shapes, terminal boards, and other parts are accurately and uniformly produced to specification in any quantity. Selection of grades by physical and electrical qualities, permits application to a wide range of operating conditions and requirements. Investigate now!

LITERATURE ON REQUEST

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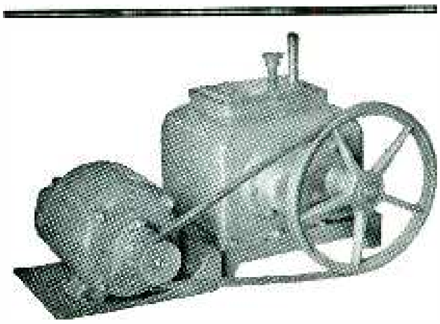

BAACH-INTERNATIONAL COMPOUND HIGH VACUUM PUMP

This high vacuum pump is widely known and used extensively in the manufacture of electric lamps, radio tubes, fluorescent lamps, for laboratory work and for many industrial applications where high vacuum, plus rapid exhausting are essential requirements in processes of manufacturing.

In free air capacities ranging from 1 cubic foot to 50 cubic feet per minute.

Readings on all sizes guaranteed 0.50 microns or better.

Operates quietly. Prompt deliveries

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Manufacturers of Baach-International Hot Cut Flare machine.

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DIRECT READING WATTMETER MONITORS SWR

MicroMatch

Model MM252
Model MM272

New Direct Reading Wattmeter—MicroMatch models MM252 and MM272—can be used in laboratory or field to monitor continuously RF power or standing wave ratio at levels up to 500 watts, and may be used to measure momentary power levels up to 1000 watts. Price, either model $60.00

Micro-Match models available for operation at 500 KC to 250 MCS, and power levels of 2 to 50,000 watts.

SPECIFICATIONS

Frequency Range 3 to 162 Megacycles
Transmission line impedance 52 (MM252) or 72 (MM272) ohms
Wattmeter Scales 0 to 10, 100 and 1000 watts
Range of Power measurement 1/10 to 1000 watts
Power range for SWR measurement 2-1000 watts
Reflection Coefficient less than ½ db.
Power loss through instrument less than 3/10 db.
Connectors Amphenol type 82-84; also available 83-1R

Write for complete details on these and other MicroMatch SWR and RF power monitors.

M. C. JONES ELECTRONICS COMPANY

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Distributed outside continental U.S.A. by RCA International Division Radio Corporation of America.

manufacture all Hallicrafters communication designs.

RADIO SONIC CORP., formerly Tuck Electronic Corp., has moved its research laboratory and factory to 186 Union Ave., New Rochelle, N. Y.

AMERICAN BROADCASTING COMPANY recently installed an RCA 80-ft antenna for WJZ-TV atop the Hotel Pierre, New York City.

GENERAL ELECTRIC CO., Syracuse, N. Y., designed and installed a 2½-watt f-m transmitter for Syracuse University. Preliminary FCC approval of such noncommercial, low-cost f-m broadcasting has been given.

HOWARD W. SAMS & CO., INC., Indianapolis, Ind., publishers of the Photofact Folders, began in set No. 38 a presentation of television principles for radio service technicians. The entire series will be included in consecutive sets.

THE PERMANENTE METALS CORP. will reactivate its plant at Permanente, Calif., to handle the facilities of an entire German aluminum foil mill purchased from the Foreign Liquidation Commission.

FIELDEN ELECTRONICS INC., of Huntington Station, N. Y., was recently incorporated and is closely associated with Fielden (Electronics) Ltd., of Manchester, England, manufacturers of the Drimeter, a device for giving continuous indication of moisture content for the textile industry.

PERSONNEL

M. J. KELLY, executive vice-president of Bell Telephone Laboratories, has been named chairman of the newly constituted Committee on Navigation which will work closely with the Air Navigation Development Board.

FRIEDA B. HENNOCK recently became the FCC's first woman commissioner.

CLARENCE A. LOVELL was co-recipient of the 1948 Potts Medal of the Franklin Institute for combined

contributions to the theoretical and practical design of the electrical gun director.

DAVID B. PARKINSON was co-recipient with Dr. C. A. Lovell of the 1948 Potts Medal of the Franklin Institute.

JAN A. RAJCHMAN, with RCA since 1936 and chiefly responsible for the development of the electron multiplier, recently received the 1948 Levy Medal of The Franklin Institute in recognition of a paper entitled "The Electron Mechanics of Induction Acceleration", jointly authored with W. H. Cherry.

J. A. Rajchman

W. H. Cherry

WILLIAM H. CHERRY, co-author of the above-mentioned paper, was the co-recipient of the Levy Medal. He has been engaged in research for RCA since 1941 and is at present working in the RCA television group.

WILLIAM BALDERSTON, formerly executive vice-president, has been elected president of Philco Corporation. Between 1944 and 1946 he directed the company's reconversion to civilian production.

PAUL H. WENDEL, formerly associate editor of *Radio News* and business manager of *Radio Maintenance*, has joined the Photofact staff of Howard W. Sams & Co., Inc., Indianapolis, Ind.

DAN DROMMERHAUSEN, senior engineer with Hoffman Radio Corp., Los Angeles, has become manager of the service department.

STUART BALLANTINE (deceased) was recently awarded posthumously the Armstrong Medal for outstanding contributions to the art. One of his many works was development, on a purely mathematical basis, of

the theory of the vertical antenna and its low-angle radiation.

DONALD K. DE NEUF is chief engineer of the Rural Radio Network's sixth f-m station, WVBN, at Turin, N. Y. Like the other five (WFNF, WVFC, WVCV, WVBT, and WVCN), it is operating on a radio relay network basis. WGHF in New York City is an affiliate.

EVERETT S. LEE, chief engineer of G-E's General Engineering and Consulting Laboratory at Schenectady, has been elected president of the AIEE for 1948-49.

ALBERT J. FRIEDMAN, formerly associated with the Federal Telephone and Radio Corp. of Nutley, N. J. and the Island Electronics Co. of Freeport, N. Y., has been appointed chief antenna development engineer at J. F. D. Mfg. Co., Inc., Brooklyn, N. Y.

PAUL THOMPSON has been named chief electronic engineer of the Turner Company, Cedar Rapids, Iowa, manufacturers of microphones and electronic equipment.


P. Thompson


L. L. Helterline, Jr.

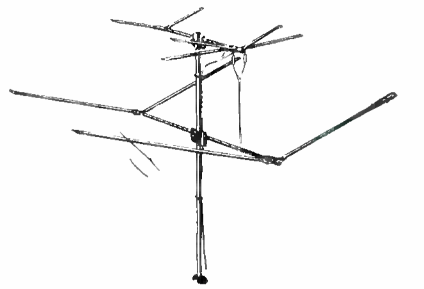
LEO L. HELTERLINE, JR. has been promoted from chief engineer to general manager of Sorensen and Co., Inc., Stamford, Conn. He was formerly associated with General Motors and Sylvania Electric Products Co.

WILLIAM A. BROWNE, former engineering buyer for radar development at Sylvania's Electronics Division, was recently appointed merchandising supervisor for the Radio Division of Sylvania Electric Products, Inc.

R. L. CAMPBELL has established a consulting television engineering laboratory in Boston, Mass.

PREMAX

Lo-Hi Television Antenna



COVERS ALL CHANNELS

- SIMPLER
- EASIER TO ERECT
- LOWER COST

A radically new Television Antenna providing two separate arrays, each consisting of dipole and reflector, to insure maximum pickup for all 12 channels. Both arrays are fully adjustable in both horizontal and vertical planes. Simple design, quickly and easily assembled. A low-cost, satisfactory Antenna that gets results.

Get complete details from your radio jobber or write direct.

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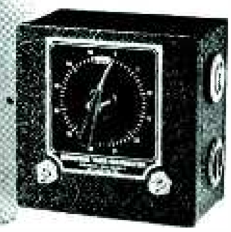
Accurate Timing Saves Money . . . Material . . . Manpower

Cut your production costs, increase your output by controlling process cycles with versatile, efficient electric synchronous motor timers. Use them in your own operations; specify Industrial Timers for your products. You get longer service and unquestioned accuracy with Industrial Timer equipment.



Two widely used Industrial Timers!

Time Delay Series—May be incorporated in assembly as a unit. Meter type mount allows flush panel installation. Automatic re-set, adjustable timing cycle up to 5 minutes. Small size. Both screw and solder type terminal connection. Available in various voltages and frequencies. Used on conveyors, molding presses, in diathermy and vacuum tube operation.

Automatic Re-Set Timer—P Series—Controls time of exposure to light, heat, electric current or agitation. Instant push-button operation—automatic re-set. Can be operated by remote control positions. Available in maximum time cycles from 15 seconds to minutes.

We manufacture more than 400 types of electric time controls for specific jobs. Write us your requirements.

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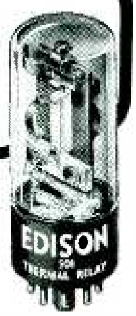
111 EDISON PLACE • *"KNOWN THE WORLD OVER"* NEWARK, N. J.

Edison Model 501 Thermal Relay *PROTECTS* Electronic Tube Cathodes



Delays application of plate voltage. Timing varies with line voltage, as does cathode heating time.

Sealed-in-Glass

Hermetic sealing excludes dust and corrosion. Arc-quenching atmosphere minimizes contact pitting or transfer. Contacts actuated silently and positively by an electric heater. Insensitive to transients or momentary power interruptions. Operates in any position. A simple, inexpensive relay for continuous operation.

GENERAL SPECIFICATIONS

Delay: 5 sec. to 8 min. Preset as required.	**Ambient Range:** —60° C to +60° C
Contacts: SPST, normally open or closed.	**Size:** 1¼" dia.; 3½" high, seated.
Contact Rating: 6 amps. at 250 volts AC/DC	**Weight:** 0.08 lb. to 0.14 lb.
Heater: 5 watts. 115 volts max. AC/DC	**Mounting:** Std. Octal or 4-prong tube base.

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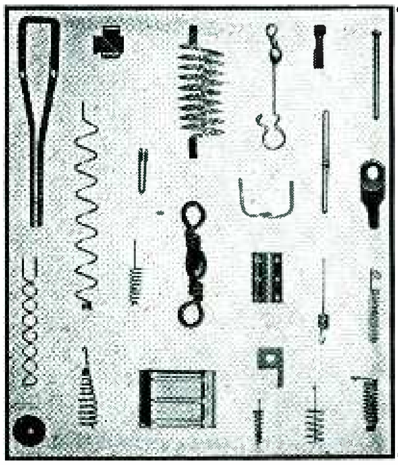
THOMAS A. EDISON, Incorporated



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Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to ⅛-inch. Any length up to 12 feet.

LUXON fishing tackle accessories.

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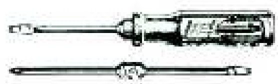
TWO SCREWDRIVERS IN ONE—Phillips blade on one end, standard on the other. Quickly reversible in the quality XCELITE handle **Regular size, just $1.60; Stubby, $1.30. Extra blades, Regular, only $.90; Stubby, $.65.** ASK YOUR DEALER for this bargain in better screw driving!

"ANOTHER XCELITE FIRST"



XCELITE
"Combination-Detachable"
Screwdriver

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Quality Tools **PREFERRED BY EXPERTS**

*FIRST TO USE PLASTIC FOR SCREWDRIVER HANDLES

NEW BOOKS

Vibration and Sound

BY PHILIP M. MORSE, *Director, Brookhaven National Laboratory. McGraw-Hill Book Co., Inc., New York, N. Y.* 1948, *Second Edition*, 468 *pages*, $5.50.

THIS IS a revision of the original book brought out in 1936. The author has continued the objective of the first edition, namely, a thorough treatment of the theory of vibration and sound for students in physics and communication engineering. In attaining these aims the author has provided an adequate and complete treatment of the mathematical foundations of conventional sound theory which forms the basis for the solution of the specific problems. Accordingly, the first part of the book is concerned with a complete mathematical treatment, with most of the detailed steps included. In the latter portion of the book, the treatment is not as complete and therefore, requires some effort to fill in the intermediate steps.

The subject matter is confined for the most part to types of vibrations that can be handled mathematically. It is not, however, a book on mathematics with sound as an excuse. Mathematics is used as a tool. Sufficient explanation is given for the most part to keep the physical concepts and significance of the formulas clear.

The use of diagrams to illustrate modes of vibrations of strings, bars, membranes, and plates is one of the outstanding and useful features of the book. In the case of membranes and plates, the figures are presented in perspective to show the shapes for the lower modes of vibration. Illustrations of this kind are useful because they give at a glance information which cannot be readily gleaned from the mathematics.

Some of the subjects not usually considered in detail in books on sound are as follows: the perturbation theory of strings with variable density, effect of motion of the end supports of a string, vibration of membranes and plates, radiation resistance of radiators of various shapes, scattering of sound from obstacles, and room acoustics.

The transient response of vibrating systems is one of the important

characteristics which depicts the performance of a vibrating system. It is fortunate that one of the additions in the revision is the application of the operational calculus and the Laplace transform to the study of transients.

The treatment of room acoustics is outstanding. The following subjects are considered: room resonance, the characteristic frequencies or modes, rooms of various shapes, steady-state response and boundary coefficients.

The book includes a useful set of tables of trigonometric, hyperbolic, Bessel and Legendre functions and absorption coefficients, and plates or graphs of hyperbolic tangent transformation, standing-wave-ratio vs acoustic impedance, and absorption coefficient vs acoustic impedance. The glossary of symbols used in the book is very useful.

The bibliography on contemporary books is not complete or up to date. For example, there are at least six new and pertinent books which have been published since the old edition was issued which are not listed.

A large collection of problems of a practical nature, at the end of each chapter, gives the student a working knowledge of problems in vibrating systems and sound.

The book is a valuable addition to the literature in acoustics, particularly to the serious student and investigator.—HARRY F. OLSON, *RCA Laboratories.*

Microwave Magnetrons

Volume 6 of the MIT Radiation Laboratory Series, EDITED BY GEORGE B. COLLINS. *McGraw-Hill Book Company, New York*, 1947, 769 *pages*, $9.00.

THE BOOK opens with an introduction which is evidently intended, in a concise manner, to acquaint the reader with the fundamentals of the field of microwave magnetrons. This takes the reader through subject matter which is in the main repeated in greater detail in the five main parts of the book. Though the introduction is well written, the extent to which it touches upon material to follow renders its value in the book somewhat questionable. Beyond the introduction the de-

tailed treatment of the subject matter is presented in five main parts.

In the four chapters of Part 1, a quite complete analysis is made of resonant systems as developed for cavity magnetrons. The last of these chapters deals with the problem of coupling the load to the tube cavity.

The four chapters comprising Part 2 present an analysis of the operation of microwave magnetrons to the extent that this was developed during the wartime activity. In this part, one is impressed by the need of additional research in this field, and the apparent complexity of an analytic treatment of the problem. The chapter entitled, "The Space Charge as a Circuit Element", is particularly interesting and instructive. This is followed with a discussion of transient behavior which necessarily deals to a considerable extent with mode selection. The concluding chapter of this part deals with noise in the magnetron.

Part 3 consists of four chapters on design which generously present various devices for arriving at quantities needed to make up a tube design. Interesting block diagrams are provided to set forth interrelations among design parameters. The laws are given of scaling a known tube design to arrive at values for a new tube. For application of these laws, performance charts of a number of existing types of tubes are included. This is followed by appropriate data for r-f portions of the tube, the cathode, and the magnetic structure.

Part 4 deals with mechanical and electronic tuning, and frequency stabilization. Part 5 contains practical information relating to tube construction. It is gratifying that the book is rounded out with this section, which is of great importance to anyone setting out to build magnetrons. After a chapter on measurements and test equipment, there is a closing chapter of data on typical magnetrons.

Upon studying this book, one is impressed with its uniqueness, scope, and general excellence. For a worker in the field of microwave magnetrons it is unquestionably an essential.—H. W. ANDERSON, *Electronics Laboratory, General Electric Co., Syracuse, N. Y.*

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.

More Hartley Law

DEAR SIRS:

IN REPLY to the letter of Mr. L. A. Zadeh in your May issue, it is, of course, true that Hartley, in his original paper, fully realized that the capacity of a channel to carry information per unit time was proportional to the product of the bandwidth of the channel and the logarithm of the number of quantum levels. It is also true, as Hartley pointed out, that the capacity of the system is limited by the distortion (random and nonrandom) introduced by the transmission circuit. It is not, however true, in the absence of distortion of the random variety, that the capacity of a channel to carry information per unit time is limited, as was shown in the original Hartley article. It is in the recognition of this last point, which eluded Hartley in his otherwise striking analysis, that the new theories represent a revision of the Hartley law.

In his 1928 paper Hartley showed that the capacity of a channel to transmit information was limited by a quantity which he called intersymbol interference; namely, interference produced by the fact that any filter with finite cut-off frequency contains energy storage elements. Energy stored in these elements results in the appearance of signals at the output of the filter long after the input signal has become zero. The spurious output signals, according to Hartley, become mixed with subsequent signals. According to this viewpoint, one must wait until the intersymbol interference has decayed to a suitable value before measuring the amplitude of any new incoming signals.

It has now been shown, by all the workers in the field mentioned in

Mr. Zadeh's letter, that this intersymbol interference need not exist. In other words, in the absence of random noise or harmonic distortion, and, in fact, sometimes even in the presence of the latter, information may be transmitted at an arbitrarily high rate over a system of any bandwidth desired. Systems have been constructed, on paper at least, capable of performing this operation. The statements, to the effect that the "new" law, indicated the possibility of transmitting speech on a bandwith of only a few hundred cycles, are therefore completely correct and do not involve a method of frequency compression similar to that described by D. Gabor in the November issue of the *Journal of IEE* (London). These schemes having to do with the "new" law concern themselves purely with the elimination of the intersymbol interference found by Hartley to be the major factor limiting the rate of transmission of information in communication systems as we know them today.

Since this intersymbol interference may readily be eliminated from any communication system, it is necessary to probe further into the problems of the transmission of information to discover what does limit the rate at which information may be transmitted. We must then go to the terms which from Hartley's viewpoint were second order, namely noise and distortion. It is in this recognition of the nonexistence of the Hartley limit and the probing into the second order effects that the revised theories hold their utility. It is perfectly correct that the equations involved in the "new" law can readily be obtained directly from Hartley's law by a process such as that given by Mr. Zadeh in his letter after one recognizes the unessential nature of the Hartley limit. This process, however, glosses over certain of the effects of wide-band modulation which should be included in any derivation of an adequate law for the rate of transmission of information and have been so included by all of the later workers in the field.

It should also be pointed out that in the derivation of the "new" law, no tacit assumption that the bandwidth of the transmission channel is at least as large as that of the message need be made, and, in fact no such tacit assumption has been made by those whose theories have received recent attention. Such a restriction may be placed, if desired, and if this is done, a special form of the law will be obtained. This restriction is neither desired nor necessary in any general statement of theory. It is to be hoped that a complete statement of the derivation of the revised Hartley law may be published within a reasonable time so that this whole matter may be cleared up.

W. G. TULLER
Melpar, Inc.
Alexandria, Virginia

Acronyms

DEAR SIRS:

WE READ the article "Surveying with Pulsed-Light Radar" in the July issue with a great deal of interest.

How about using the acronyms "infrar", "lidar" and "ultrar" for infrared, light-wave and ultraviolet-type pulsed radars?

TED POWELL
Engineering Dept.
Amplifier Corp. of America
New York, N. Y.

Radiosonde Measurements

DEAR SIRS:

IN CONNECTION with my article "Radiosonde Potential Gradient Measurements" (p 184 Jan. 1948) I wish to point out that the article is based on a portion of my M.SC. Honours thesis. The work described was done at the Physics Department, Aukland University College, New Zealand, under the supervision and following the suggestions of Dr. K. Kreielsheimer and Prof. P. W. Burbidge. Doubtless as a consequence of the (present) address from which I corresponded with your staff, the published affiliation is misleading.

R. E. BELIN
Wellington, New Zealand

NOTE: On April 8, 1948, Mr. Belin wrote pointing out the misleading impression created by the affiliation published under his byline. Publication of the above letter has been delayed during correspondence with Mr. Belin and Dr. Kreielsheimer. Public announcement of radiosonde potential gradient measurements was first made jointly by Dr. Kreielsheimer and Mr. Belin (*Nature*, p

227 Feb. 23, 1946). Dr. Kreielsheimer who appears to be the originator of the modifications to the original Bureau of Standards radio meteorograph has previously described the methods before the Science Congress (Wellington, N. Z., 22 May 1947, in a paper to be published in the *Trans. Royal Soc. N.Z.*).—THE EDITORS.

Light Meter

DEAR SIRS:

IN THE article, Light Meter for Electric Flash Lamps, that appeared in the June 1948 issue, there is an error in the drawing on page 78. The negative lead of the 45-volt battery should connect to the lower side of capacitor C instead of one side of the filament.

HAROLD E. EDGERTON
Massachusetts Institute of Technology
Cambridge, Massachusetts

Square-Wave Response

DEAR SIRS:

IN THE reference sheet "Square-Wave Response" (ELECTRONICS, p 130, Aug. 1947) a waveform is shown identifying the voltages used in the equations on which the nomograph is based. The formula seems to apply to a pulse, but could be made applicable to a square wave if voltages were measured with reference to a mean-value axis.

W. F. THOMSON
Wembley, England

DEAR MR. THOMSON:

I AM sorry that an errata has not been made stating that E is the peak value at the beginning of the cycle (not the peak-to-peak value) and that e is the peak value t seconds later. With these definitions, the nomograph is applicable to rectangular waves of any duty cycle. The waveform certainly should have been more representative. You may also have noticed that R in the circuit diagram should have been R_G and that an additional defining relation: $R = R_G + R_L$ where R_L is the load resistor of the first plate, should have been added.

I am grateful to you for bringing these errors to our attention. The printer was unable to send the nomograph with the waveform, circuit diagram, and equations to me for approval before publication.

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V70D	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR92	.75
VR105	.75
VR150	.98
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
WL619	49.50
Z225	1.95
0A2	1.69
0A3/VR75	.98
0A4G	1.06
0B2	2.05
0B3/VR90	.75
0C3/VR105	.75
0D3/VR150	.75
OY4	.88
0Z4	.88
0Z4G	.88
01A	.50
1A3	.72
1A4	1.28
1A4P	1.28
1A5GT	.88
1A6	1.06
1A7GT	.72
1AB5	1.06
1B3GT	1.56
1B4	1.28
1B5/25S	1.06
1B7GT	1.06
1C5GT	.72
1C6	1.06
1C7G	1.06
1C8	.88
1D5G	1.28
1D5GP	1.28
1D7G	1.06
1D8GT	1.28
1E5GT	1.56
1E7GT	1.56
1F4	.88
1F5G	.88
1F6	1.28
1F7G	1.28
1G4GT	.88
1G6GT	.88
1H4G	.72
1H5GT	.60
1H6G	1.06
1H6GT	1.06
1J6GT	1.06
1L4	.72
1LA4	1.06
1LA6	1.06
1LB4	1.06
1LC5	1.06
1LC6	1.06
1LD5	1.06
1LE3	1.06
1LG5	1.06
1LH4	1.06
1LN5	1.06
1N5GT	.72
1P5GT	.88
1Q5GT	.88
1R4	.88
1R5	.72
1S4	.88
1S5	.66
1T4	.72
1T5GT	.88
1U4	.72
1U5	.66
1V	.72
1V5	.88
1W5	.88
2A3	1.06
2A4G	1.28
2A5	.72
2A6	.88
2A7	2.20
2B7	.88
2E5	.88
2V3G	1.10
2X2A	.69
3A4	.72
3A5	1.29

Type	Price
3A8GT	1.92
3B7	1.06
3C6/XXB	1.28
3D6	.89
3E6	1.06
3LF4	1.06
3Q4	.72
3Q5GT	.88
3S4	.72
3V4	.72
5AZ4	.42
5R4GY	1.03
5T4	1.28
5U4G	.53
5V4G	.88
5W4	.88
5W4GT	.60
5X4G	.60
5Y3G	.50
5Y3GT	.38
5Y4G	.50
5Z3	.60
5Z4	.88
6A3	1.06
6A6	.88
6A7	.72
6A8	.72
6A8G	.72
6A8GT	.72
6AB5/6N5	.88
6AB7/1853	1.06
6AC5GT	1.06
6AC7/1852	1.06
6AD7G	1.06
6AG5	.96
6AG7	1.06
6AH6	1.42
6AJ5	.99
6AK5	.99
6AK6	.88
6AL5	.72
6AL7GT	1.06
6AQ6	.66
6AQ7GT	.88
6AR5	.66
6AT6	.54
6AU6	.72
6AV6	.54
6B4G	1.06
6B5	1.56
6B6G	.72
6B7	1.06
6B8	1.06
6B8G	1.06
6BA6	.66
6BE6	.66
6BG6G	1.92
6BH6	.93
6BJ6	.72
6C4	.60
6C5	.60
6C5GT	.60
6C6	.72
6C8G	1.06
6D6	.60
6D8G	1.06
6E5	.72
6F5	.60
6F5GT	.60
6F6	.72
6F6G	.60
6F6GT	.60
6F7	1.06
6F8G	1.06
6G6G	.88
6H6	.60
6H6GT	.60
6J5	.54
6J5GT	.54
6J6	1.06
6J7	.72
6J7G	.72
6J7GT	.72
6J8G	1.06
6K5GT	.88
6K6GT	.54
6K7	.60
6K7G	.60
6K7GT	.60
6K8	.88
6K8G	1.06
6K8GT	.88
6L5G	.88
6L6	1.28
6L6G	1.06
6L6GA	1.06
6L7	.88
6L7G	1.06
6N6G	1.28
6N7	.88
6N7GT	.88
6P5GT	.88
6Q6G/6T7G	1.06
6Q7	.72
6Q7G	.60
6Q7GT	.60
6R7	.88
6R7GT	.88
6S7	.88
6S7G	.88
6S8GT	.96
6SA7	.60
6SA7GT	.60
6SB7Y	.88

Type	Price
6SC7	.72
6SD7GT	.96
6SF5	.60
6SF5GT	.72
6SF7	.72
6SG7	.72
6SH7	.72
6SJ7	.60
6SJ7GT	.60
6SK7	.60
6SK7GT	.60
6SL7GT	.88
6SN7GT	.80
6SQ7	.54
6SQ7GT	.54
6SR7	.60
6SR7GT	.60
6SS7	.66
6ST7	.88
6SV7	.88
6U5/6G5	.72
6U6GT	.72
6U7G	.60
6V6	1.06
6V6GT	.72
6W7G	.88
6X4	.54
6X5	.88
6X5GT	.54
6Y6G	.88
6Z7G	1.28
6ZY5G	.72
7A4/XXL	.72
7A5	.72
7A6	.72
7A7	.72
7A8	.72
7AD7	1.06
7AF7	.72
7AG7	.88
7AH7	.88
7B4	.72
7B5	.72
7B6	.72
7B7	.72
7B8	.72
7C4/1203A	1.06
7C5	.72
7C6	.72
7C7	.72
7E5/1201	1.06
7E6	.72
7E7	.88
7F7	.88
7F8	1.06
7G7/1232	1.06
7A7	.80
7J7	1.06
7K7	1.06
7L7	.88
7N7	.88
7Q7	.72
7R7	.88
7S7	1.06
7V7	1.06
7W7	1.06
7X7/XXFM	1.06
7Y4	.72
7Z4	.72
10	1.56
12A6	.89
12A6GT	1.06
12A7	1.06
12A8GT	.72
12AH7GT	.88
12AL5	.72
12AT6	.54
12AT7	1.06
12AU6	.72
12AU7	.88
12AW6	.96
12BA6	.66
12BE6	.66
12C8	.89
12F5GT	.60
12H6	.60
12J5GT	.54
12J7G	.72
12J7GT	.72
12K7G	.72
12K7GT	.60
12K8	.88
12K8GT	.88
12Q7GT	.60
12SA7	.60
12SA7GT	.60
12SC7	.72
12SF5	.60
12SF5GT	.60
12SF7	.72
12SF7GT	.88
12SG7	.72
12SH7	.72
12SJ7	.60
12SJ7GT	.60
12SK7	.60
12SK7GT	.60
12SL7GT	.88
12SN7GT	.80
12SQ7	.54
12SQ7GT	.54
12SR7	.72
12SR7GT	.72
12X3	.98

Type	Price
12Z3	.88
14A4	1.06
14A5	1.56
14A7/12B7	.88
14AF7/XXD	.88
14B6	.88
14B7	.88
14B8	.88
14C5	.88
14C7	.88
14E6	.72
14E7	.88
14F7	.88
14F8	1.06
14H7	.88
14J7	1.06
14N7	1.06
14Q7	.88
14R7	.88
14S7	1.06
14W7	1.06
14X7	1.06
14X4	.88
19	1.06
19T8	1.06
20	1.56
22	1.28
24A	.72
25A6	1.06
25A6G	1.06
25AC5GT	1.06
25C6G	1.06
25L6	1.06
25L6GT	.60
25Y5	1.06
25Z5	.54
25Z6	.72
25Z6GT	.54
26	.60
27	.54
28D7	.98
30	.72
31	.88
32	1.06
32L7GT	1.28
33	1.06
34	1.06
35/51	.72
35A5	.72
35B5	.72
35L6GT	.60
35W4	.46
35Y4	.72
35Z3	.72
35Z4GT	.50
35Z5GT	.46
35Z6G	.88
36	.88
37	.60
38	.72
39/44	.59
41	.60
42	.60
43	.60
45	.60
45Z5GT	.60
46	.88
47	.88
49	.88
50	1.56
50A5	.88
50B5	.72
50C6G	1.06
50L6GT	.60
50X6	.88
50Y6GT	.60
53	.88
55	.72
56	.60
57	.72
58	.72
59	1.06
70L7GT	1.42
71A	.72
75	.60
76	.60
77	.60
78	.60
79	.88
80	.42
81	1.28
82	.88
83	.88
83V	1.06
84/6Z4	.60
85	.72
89	.72
99V	1.28
99X	1.28
117L7GT	1.42
117M7GT	1.42
117N7GT	1.42
117P7GT	1.42
117Z3	.54
117Z4GT	1.06
117Z6GT	.88
FM-1000	1.28
1273	.88
9001	.89
9002	.69
9003	.49
9004	.49
9005	.98
9006	.49

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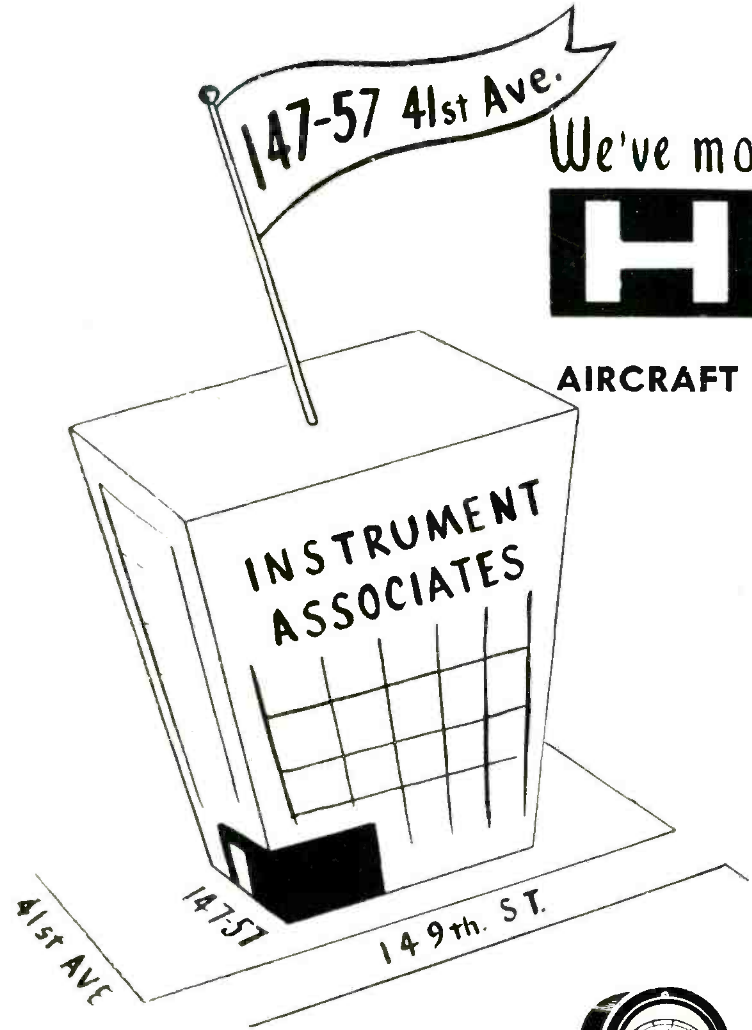

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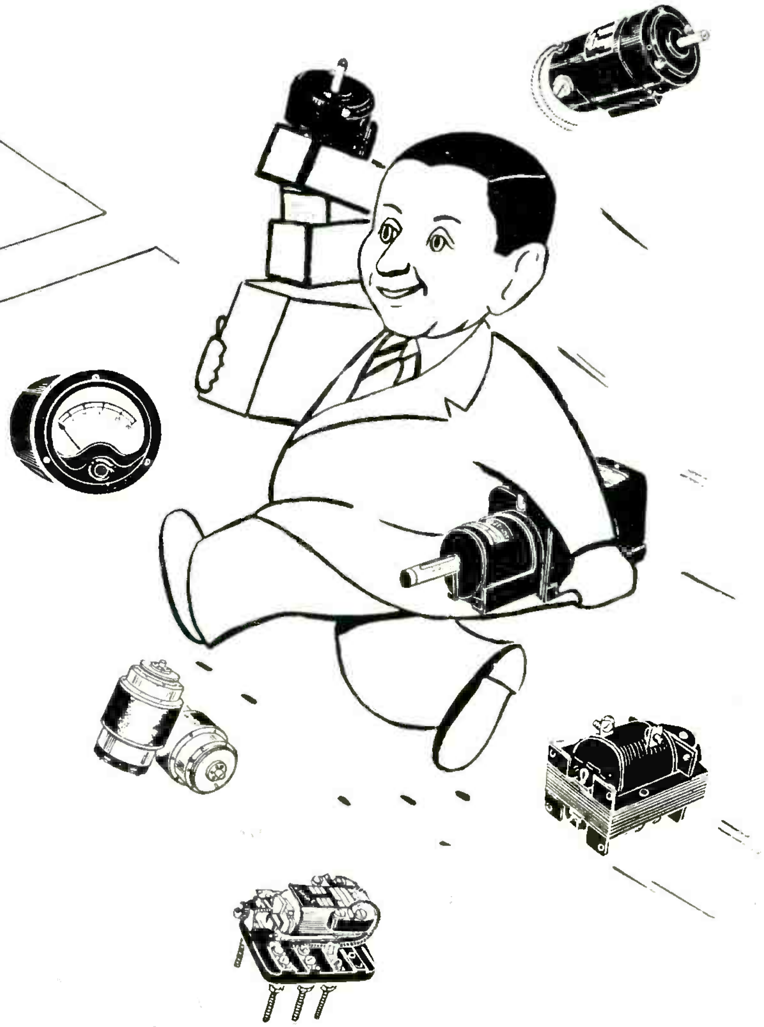

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83-1AP—Angle Plug	39¢	83-1T-T Connector	1.39
10H/528	39¢	10H/701	39¢

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2500-0-2500 V @ 500 MA
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2000-0-200 V @ 500 MA
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1—Smoothing choke
1—Filament Xformer
2—2 Mfd.—3000 v. Condenser
2—872 A Tubes
2—Plate Caps for 872A
2—Sockets for 872A
All parts New! Reduced to **$79.50**

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PRIMARY 440/220 VOLTS
SECONDARY 230/115 VOLTS
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Full Wave Bridge Type

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up to 18v AC	up to 12v DC	½ Amp.	$0.98
up to 18v AC	up to 12v DC	1 Amp.	1.95
up to 18v AC	up to 12v DC	3 Amp.	3.45
up to 18v AC	up to 12v DC	5 Amp.	4.45
up to 18v AC	up to 12v DC	10 Amp.	7.45
up to 18v AC	up to 12v DC	15 Amp.	9.95
up to 36v AC	up to 28v DC	1 Amp.	3.45
up to 36v AC	up to 28v DC	5 Amp.	7.45
up to 36v AC	up to 28v DC	10 Amp.	12.45
up to 36v AC	up to 28v DC	15 Amp.	18.95
up to 115v AC	up to 100v DC	.25 Amp.	2.95
up to 115v AC	up to 100v DC	.6 Amp.	6.95
up to 115v AC	up to 100v DC	5 Amp.	19.95
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NATIONALLY ADVERTISED BRANDS
All Ratings, D. C.

2x.1mfd.	600v	$0.35	1mfd.	2000v	$0.95
.25mfd.	600v	.35	3mfd.	2000v	2.75
.5mfd.	600v	.35	4mfd.	2000v	3.75
1mfd.	600v	.35	15mfd.	2000v	4.95
2mfd.	600v	.35	2mfd.	2500v	2.49
4mfd.	600v	.60	.1mfd.	2500v	1.25
8mfd.	600v	1.10	.25mfd.	2500v	1.45
10mfd.	600v	1.15	.5mfd.	2500v	1.75
3x.1mfd.	1000v	.45	.05mfd.	3000v	1.95
.25mfd	1000v	.45	.1mfd.	3000v	2.25
1mfd.	1000v	.60	.25mfd.	3000v	2.65
2mfd.	1000v	.70	.5mfd.	3000v	2.85
4mfd.	1000v	.90	1mfd.	3000v	3.50
8mfd.	1000v	1.95	12mfd.	3000v	6.95
10mfd.	1000v	2.10	2mfd.	4000v	5.95
15mfd.	1000v	2.25	1mfd.	5000v	4.95
20mfd.	1000v	2.95	.1mfd.	7000v	2.95
24mfd.	1500v	6.95	3mfd.	4000v	6.95
.1mfd.	1750v	.89	2mfd.	3000v	3.45
.1mfd.	2000v	.95	2x.1mfd.	7000v	3.25
.25mfd.	2000v	1.05	.02mfd.	12000v	9.95
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2x3500 mfd.—25 WVDC	3.45
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1000 mfd.—15 WVDC	.99
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100 mfd.—50 WVDC	.49
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Frequency Range—100-156 Mc
Four band—Auto tune—Crystal Controlled, Complete With 2-1625, 2-832, 1-815 and 4 Crystals
Ant-Rec. relay switching
Brand New **$79.50**

MOBILE or BOAT
12 Volt INVERTER
ATR—Model R5A
Input 12V DC—Output 110V. 60 Cyc.
125 W. Int.—100 W. Cont.
Special! Brand New Reduced to **$16.95**

115 V. D.C. INVERTER
Input 115 V D.C.
Output 115 V. 60 Cyc.
250 W. Continuous
Slightly Shelf-worn But GOOD! Reduced to **$19.95**

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Complete with 14 tubes—418 to 456 Mc.—28 V. Dynamotor
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3" Shield	$1.49
5" Shield	1.98
12" Shield	5.98

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HI-VOLTAGE INSULATION

3710v @ 10 ma.; 2x2½v @ 3A	$9.95
2500v @ 15 ma	6.50
2500v @ 4 ma.; 2½v @ 2A. 6.3v @ 1 amp.	7.95
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335-0-335v @ 60 ma.; 5v @ 3A; 6.3v @ 2A; 0-13-17-21-23v @ 70 ma.—PRI. 110/220	4.95
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12 hy @ 150 ma	2.25	10 hy @ 200 ma	1.98
12 hy @ 100 ma	1.39	10/20 @ 85 ma	1.59
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.1 hy @ 5 amps	6.95	3 hy @ 50 ma	.29
4 hy @ 600 ma	5.95	30 hy Dual @ 20 ma.	1.49
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1B56	8.00
1N21	.59
1N23	.59
1P22	11.50
1P24	2.00
1S21	1.95
2AP1	2.95
2B22	5.35
2C21	.98
2C22	.39
2C26A	.75
2C34	.59
2C40	1.98
2C43	7.50
2C44	1.75
2C46	7.50
2D21	1.69
2D29	1.39
2E22	1.50
2E24	4.37
2E25	3.95
2E26	3.29
2E30	2.25
2J21A	14.95
2J22	24.95
2J26	14.95
2J31	24.95
2J32	24.95
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2J39	34.95
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2J42	34.95
2J49	34.95
2J51	34.95
2JB51	4.95
2J53	25.00
2J54	25.00
2K25	24.95
2K28	24.95
3AP1	2.95
3B22	4.95
3B23	4.95
3B24	1.95
3B25	.98
3B26	5.95
3BP1	2.95
3C21	5.95
3C22	39.95
3C23	4.95
3C24	.69
3C30	1.50
3CP1	3.00
3BP1	3.95
3EP1	3.95
3D21A	3.00
3E29	4.95
3GP1	4.95
4-65A	14.50
4-125A	27.50
4-250A	37.50
4A1	1.98
4AP10	6.95
4B24	4.95
4C35	19.95
4E27	8.95
4J28	34.95
4J29	34.95
5AP1	4.95
5AP4	5.95
5BP1	1.95
5BP4	4.95
5CP1	3.95
5CP7	13.95
5D21	29.95
5FP7	3.95
5GP1	9.95
5JP1	11.95
5J29	29.50
5J30	29.50
5LP1	11.95
5TP4	20.00
6AF6G	.88
6C21	24.95
6D4	1.95
6J4	3.95
6Q5G	1.25
7BP7	4.95
7EP4	17.95
7GP4	19.40
9GP7	15.00
9JP1	3.95
9LP2	3.95
3A4	.72
3A8GT	1.92
3C6	1.28
3L4F	1.06
6A5G	1.56
6A5G	1.56
6AF8	.88
9LP7	4.95
9MP7	14.95
10BP4	34.95
10CP4A	42.20
10FP4	54.50
10HP4	49.50
10Y	.69
10 spec.	.69
12DP7	14.95
12GP7	14.95
12JP4	60.00
15AP4	125.00
15E	1.50
15R	1.50
20AP4	270.00
23D4	.49
45 spec.	.49
75TL	3.95
100TH	12.95
100TS	3.00
102F	4.00
114A	.69
114B	1.25
120	5.95
121A	2.65
203B	10.95
203R	5.95
204A	49.95
205B	4.50
211	.98
215A	3.00
217C	7.50
221A	2.95
222A	120.00
227A	3.95
241B	90.00
242C	5.95
249C	3.49
250R	7.95
250TH	19.50
250TL	19.50
252A	4.95
259A	4.95
274A	1.25
274B	1.25
301A	4.95
304TH	7.95
304TL	1.98
305A	12.95
307A	6.25
310	4.95
311A	1.98
316A	.89
322A	120.00
327A	4.95
331A	4.95
350/A/B	2.95
353A	4.95
368AS	9.95
371A	2.95
371B	2.95
388A	7.95
393A	7.95
394A	4.50
417A	24.95
434A	3.95
446A	1.95
450TH	24.95
503	195.00
527	12.90
531	49.55
575A	14.95
632A	9.95
701A	4.95
702A	3.95
703A	4.95
704A	1.98
705A	2.95
706BY	24.95
706CY	24.95
707A/B	24.95
708A	7.95
709A	9.95
713A	1.65
714AY	14.95
715A/B	19.95
715C	29.50
717A	1.65
720CY	34.95
721A/B	4.35
723AB	5.95
724A/B	4.95
725A	24.95
726A	23.50
800	2.25
801A	.98
802	2.95
803	8.95
804	9.95
6SD7GT	.82
7AF7	.82
7AF7	.82
14Y4	.88
14X4	1.06
14W7	1.06
9001	.89
805	4.95
806	17.50
807	1.25
808	2.95
809	2.50
810	7.95
811	2.25
812	2.95
812H	6.90
813	7.95
814	4.95
815	2.50
816	1.19
822	11.95
826	.79
827R	99.50
828	6.95
829/A/B	7.95
829B/3E29	4.95
830B	5.25
832/A	3.95
833A	39.50
836	1.15
837	2.50
838	3.95
841	.69
843	.69
845	4.95
845W	5.95
851	98.00
852	14.95
860	3.00
861	49.95
864	.69
865	.98
866A	.89
868	1.95
869B	75.00
872A	2.50
874	2.49
876	.98
878	2.49
879	.89
884	.98
889	.98
891	110.00
892R	200.00
902P1	7.95
905	11.95
920	2.95
923	.98
931A	4.95
950	1.06
953B	4.95
954	.75
955	.75
956	.75
957	.75
958A	.75
959	.75
991	.69
1000 spec.	24.95
1000T	75.00
1611	.99
1613	.75
1614	1.75
1616	1.39
1619	.75
1621	1.98
1622	1.75
1624	1.75
1625	.49
1626	.49
1627	7.95
1629	.69
1630	7.50
1636	5.95
1638	.98
1641	.79
1642	.98
1654	1.98
1665	.98
1851	1.25
1852	1.06
1853	1.06
1963	.95
2050	.98
2051	.98
2140	20.00
5514	4.95
5516	5.95
5562	10.00
7192	.39
8005	4.95
8011	2.95
8012	4.95
8013	2.95
8016	1.89
8020	3.95
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C5B	12.95
C6A	9.95
C6J	12.95
6EQ72	1.95
CK1005	.39
CK1006	.69
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F123A	12.95
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GL146	11.00
GL605	250.00
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HY24	1.50
HY69	2.49
HY75	1.25
HY114B	1.25
HY115	1.25
HY31Z	5.50
HY615	1.25
HYE1148	.48
HY1251Z	5.50
HY1269	5.50
KC4	105.00
KU676	22.00
ML100	105.00
ML101	150.00
ML502	300.00
MR4	90.00
QK59	39.50
QK60	39.50
QK61	39.50
QK62	39.50
REL21	4.25
RK12	1.95
RK21	3.95
RK22	4.95
RK25	2.95
RK33	.98
RK34	.59
RK59	3.95
RK60	.79
RK69	49.50
RK72	1.95
RK73	3.95
RX120	10.00
T20	1.95
TZ40	2.95
UX6653	3.95
V700	6.95
VR75	.98
VR78	.75
VR90	.75
VR91	1.49
VR92	.75
VR105	.75
VR150	.98
VT127A	3.00
VU111	1.19
WL460	14.95
WL468	14.95
WL532A	4.95
WL562	150.00
WL616	105.00
WL619	49.50
Z225	1.95
OY4	.99
OZ4	.99
OZ4G	.99
1A3	.81
1A4P	1.54
1A5GT	.67
1A6	1.20
1A7GT	.81
1B3/8016	1.89
1B4P	1.54
1B5/25S	1.20
1C5GT	.81
1C6	1.20
1C7G	1.20
1D5GP	1.54
1D7G	1.20
1D8GT	1.54
1E5GP	1.62
1E7G	1.54
1F4	.99
1F5G	.99
1F6	1.54
1F7G	1.54
1G4GT	.99
1G5G	.99
1G6GT	.99
1H4G	.81
1H5GT	.67
1H6G	1.20
1J5G	1.20
1J6G	1.20
1J6GT	1.20
1L4	.81
1LA4	1.20
1LA6	1.20
1LB4	1.20
1LC5	1.20
1LC6	1.20
1LD5	1.20
1LE3	1.20
1LH4	1.20
1LN5	1.20
1N5GT	.81
9003	.49
1P5GT	.99
1Q5GT	.99
1R4/1294	1.20
1R5	.81
1S4	.99
1S5	.99
1T4	.81
1T5GT	.99
1U4	.81
1U5	.99
1V	.81
2A3	1.20
2A4G	1.54
2A5	.81
2A6	.99
2A7	.99
2B7	.99
2E5	.99
3B7/1291	1.54
3D6/1299	1.54
3LF4	1.20
3Q4	.81
3Q5GT	.99
3S4	.81
3V4	.81
5T4	1.54
5U4G	.62
5V4G	.99
5W4	.99
5W4GT	.62
5X4G	.67
5Y3GT	.39
5Y4G	.57
5Y4GT	.57
5Z3	.67
5Z4	.99
6A3	1.20
6A4/LA	1.20
6A6	.99
6A7	.81
6A8	.81
6A8G	.81
6A8GT	.81
6AB5/6N5	.99
6AB7/1853	1.20
6AC5GT	.99
6AC7/1852	1.20
6AD7G	1.20
6AF6G	.99
6AG5	1.20
6AG7	1.20
6AH6	1.62
6AK6	.99
6AL5	.81
6AQ5	.81
6AQ6	.81
6AT6	.67
6AU6	.81
6AV6	.67
6B4G	1.20
6B5	1.62
6B6G	.81
6B7	1.20
6B8	1.20
6B8G	1.20
6BA6	.81
6BD6	.81
6BE6	.81
6BF6	.67
6BG6G	1.89
6BH6	.81
6BJ6	.81
6C4	.67
6C5	.67
6C5GT	.67
6C6	.81
6C8G	1.20
6D6	.67
6D8G	1.20
6F5	.81
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6F5GT	.67
6F6	.81
6F6G	.67
6F6GT	.67
6F7	1.20
6F8G	1.20
6G6G	.99
6H6	.67
6H6GT	.67
6J5	.62
6J5GT	.62
6J6	1.20
6J7	.81
6J7G	.81
6J7GT	.81
6J8G	1.20
6K5GT	.99
6K6GT	.62
6K7	.67
6K7G	.67
6K7GT	.67
6K8	.99
6K8G	1.20
6K8GT	.99
6L5G	.99
6L6	1.54
6L6G	1.20
9004	.49
6L7	.99
6L7G	1.20
6N7	.99
6N7GT	.99
6P5GT	.99
6Q7	.81
6Q7G	.81
6Q7GT	.67
6R7	.99
6R7GT	.81
6S7	.99
6S7G	1.20
6S8GT	.99
6SA7	.67
6SA7GT	.67
6SB7Y	.99
6SC7	.81
6SC7GT	.81
6SF5	.67
6SF5GT	.81
6SF7	.81
6SG7	.81
6SH7	.81
6SH7GT	.81
6SJ7	.67
6SJ7GT	.67
6SK7	.67
6SK7GT	.67
6SL7GT	.99
6SN7GT	.99
6SQ7	.62
6SQ7GT	.67
6SR7	.67
6SR7GT	.81
6SS7	.81
6ST7	.99
6SZ7	.81
6T7G	1.20
6U5/6G5	.81
6U6GT	.81
6U7G	.67
6V6	1.20
6V6GT	.81
6W7G	.99
6X4	.67
6X5	.99
6X5GT	.62
6Y6G	.99
6Z7G	1.54
6ZY5G	.81
7A4/XXL	.81
7A5	.81
7A6	.81
7A7	.81
7A8	.81
7B4	.81
7B5	.81
7B6	.81
7B7	.81
7B8	.81
7C5	.81
7C6	.81
7C7	.81
7E6	.81
7E7	.99
7F7	.99
7F8	1.20
7G7/1232	1.20
7H7	.99
7J7	1.20
7L7	.99
7N7	.99
7Q7	.81
7R7	.99
7S7	1.20
7V7	1.20
7W7	1.20
7Y4	.81
7X7/XXFM	1.20
7Z4	.81
10	1.62
12A7	1.20
12A8GT	.81
12AH7GT	.99
12AL5	.81
12AT6	.67
12AU6	.81
12AU7	.99
12AV6	.67
12AW6	1.20
12AX7	.99
12BA6	.81
12BD6	.81
12BE6	.81
12C8	1.20
12F5GT	.67
12H6	.67
12J5GT	.62
12J7GT	.81
12K7G	.81
12K7GT	.67
12K8	.99
12K8GT	.81
12Q7GT	.67
12SA7	.67
12SA7GT	.81
12SC7	.81
12SF5	.67
9005	.98
12SF5GT	.67
12SF7	.81
12SG7	.81
12SH7	.81
12SJ7	.67
12SJ7GT	.67
12SK7	.67
12SK7GT	.67
12SL7GT	.99
12SN7GT	.99
12SQ7	.62
12SQ7GT	.67
12SR7	.81
12SR7GT	.81
12Z3	.99
14A4	1.20
14A5	1.62
14A7/12B7	.99
14AF7/XXD	.99
14B6	.99
14B8	.99
14C7	.99
14E6	.81
14F7	.99
14H7	1.20
14J7	1.20
14N7	1.20
14Q7	.99
14R7	.99
15	1.20
19	1.20
24A	.81
25A6	1.20
25L6	1.20
25L6GT	.67
25Z5	.62
25Z6	.81
25Z6GT	.62
26	.67
27	.62
30	.81
31	.99
32	1.20
32L7GT	1.54
33	1.20
34	1.20
35/51	.81
35A5	.81
35B5	.81
35L6GT	.67
35W4	.52
35Y4	.99
35Z3	.81
35Z4GT	.57
35Z5GT	.52
36	.99
37	.67
38	.81
39/44	.99
41	.67
42	.67
43	.67
45	.67
45Z3	.67
45Z5GT	.67
46	.99
47	.99
49	.99
50	1.62
50A5	.99
50B5	.81
50L6GT	.67
50Y6GT	.67
53	.99
55	.81
56	.67
57	.81
58	.81
59	1.20
70L7GT	1.62
71A	.81
75	.67
76	.67
77	.67
78	.67
79	.99
80	.47
81	1.54
82	.99
83	.99
83V	1.20
84/6Z4	.67
85	.81
89	.81
117L7/M7GT	1.62
117N7GT	1.62
117P7GT	1.62
117Z3	.81
117Z6GT	.99
6AJ5	.99
6AK5	.99
IAB5	1.06
RK75	6.25
RK65	24.95
2x2	.69
2v3G	1.10
6J4	3.95
6AL7	1.06
9006	.49

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RADIO HAM SHACK Inc.

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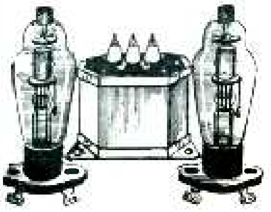
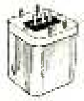


KIT 866A's & XFORMER INPUT 115VAC/50-60cy OUTPUT 2.5VCT/10Amps 10KVinsltn Sockets Ceramic SPECIAL $5.95 KIT 872A XFORMER Insltd 2.5KV SOCKETS & TUBES SPECIAL $12.95



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UTC 854 cys, 1024 cys, 1250 cys ea $1.95 3 for $4.50
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ANTENNA VARIABLE 1KW MATCHING NETWORK 1001A tunes 1500to7000KC useable to 28mc's; loose coil turns can be recemented; METAL CABINET RACK WITH INSULATORS & RF METER Complete With Manuel. NEW $9.95
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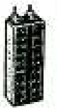

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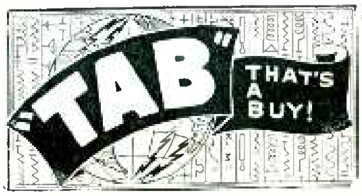
15Hy/400ma or 20Hy 1300ma/12KV ins 7.95
8Hy/150ma NEW U&C Crckd Bklte T'bd 2for 2.25
8Hy/100ma $1.10 12Hy/275ma 3.29
8Hy/125ma HV insl.69; 31Hy/100ma 1.29
CHARTS, CIRCULAR & STRIP Humidity & Temperature for L&N, FOXBORO, BRISTOL, BROWN & TAYLOR RECORDERS, Write for List
VOLTAGE REGULATOR NEW RAYTHEON 95-130V/60cy;Outpt115V/60Watt 10.95
198to242Vinpt/50-60cy;Outpt220V/500 Watts/0.5% Regulation Rack Mtg. Moisture proofed 36.00

SOLA CONSTANT VOLTAGE REGULATOR PRI 95to190V 50-60cycs Outpt 125or220V 2KW/17.4 Amps Cont Duty USN LN* $149.50 NEW $175.00 Gvt Cost $369



"TAB" STANDARD & JAN TUBES

0A4G	$1.00	6SG7	$.71	956	$)49
0Z4	.85	6SH7	.72	957	.49
1B24	2.95	6SJ7	.58	958A	.45
1B27	2.95	6SJ7GT	.58	991	.35
1E7G	.98	6SK7	.58	1613	.69
1L4	.70	6SL7	.87	1614	1.50
1LC6	1.00	6SN7	.75	1616	1.87
1LH4	1.00	6SN7GT	.75	1619	.25
1LN5	1.00	6SQ7	.54	1622	1.49
1P5G	.79	6SS7	.71	1624	.70
1P24	2.95	6V6GT	.71	1625	.39
1R4/1294	1.00	6U7G	.58	1626	.45
2AP1A	2.85	6X4	.53	1629	.58
2C26	.39	6X5	.53	1635	1.90
2C34/RK34	.49	6Y6G	.88	1641	.75
2C40/446	.73	6Z4/84	.74	2050	.88
2D21	.20	7BP7/1813	2.90	2051	.48
2E22	1.45	9JP1	3.95	7193	.38
2J21/725	12.49	10Y	.59	8005	3.25
2J26	14.95	12A6	.34	8012	3.95
2J30	14.50	12AH7	.87	8013A	4.95
2J31	14.50	12AR7	.95	8020	4.95
2J32	16.95	12DP7	14.75	9001	.49
2J33	14.50	12GP7	14.75	9002	.59
2J34	18.95	12SA7	.58	9003	.49
2J49	35.00	12SH7	.71	9004	.49
2J55	24.95	12SK7	.58	9006	.45
2J61A	39.95	12SQ7	.58	C6J	4.95
2K25	9.95	12X3	.90	CE206	3.95
2K29	6.95	15E	1.45	CE215	5.95
2V3G	.98	25Z5	.53	CK1005	.30
2X2	.49	35L6	.58	F127A	12.00
3A4	.70	35Z5	.45	FG104	14.95
3B7/1291	.95	37	.78	FG105	11.95
3B24	.95	50L6	.58	FG166	49.00
3BP1	1.49	80	.52	434/7C29	7.90
3BP1A	2.95	83V	.88	HK24/3C24	.59
3C23	4.95	205B/VT2	.98	RX215	9.95
3E29/829B	3.90	211	.79	T200	12.00
3FP7	2.98	215	2.95	VR90	.74
3HP12	2.95	250TH	19.49	VR92	.45
3S4	.55	250TL	18.00	VR105	.74
4J47	35.00	304TH	9.95	VR150	.74
5AP1	2.75	304TL	1.98	WL468	9.95
5BP1	1.45	307A/ARX95		WL530	49.50
5BP4	3.95		3.75	WL531	9.95
5CP1	2.95	388	1.49	WL619	20.00
5D21	19.00	393	5.95	UX6653	2.95
5FP7	3.95	450TH	29.95	TUNGAR*	
5HP1	3.95	450TL	29.95	20X672*	2.95
5T4	11.25	527/1000S	65.00	199698*	2.95
5U4G	.53	631P1/SN4	3.75	289881*	$2.50
5V4	.87	703A	4.95	MAZDA PL**	
5W4	.87	707B/2K28	9.95	49**Box	.60
5Y3	.38	710A/8011	2.90	64**Box	.07
5Z4	.88	717A	.69	S6/T4**	
6AB7	.98	722/287A	9.95	Box	1.40
6AC7	.72	723AB	4.95	100W/	
6AG5	.88	726A	6.95	20V**@	.39
6AG7	1.05	802	1.95	313/	
6AJ5	.98	803	7.95	28V** @	.10
6AK5	.69	804	6.70	323/100**	
6AL5	1.05	805	3.74	qty	10.00
6B4G	1.04	807	1.24	AVIATION	
6B8G	.98	808	1.95	LGTS	
6C4	.39	810	5.75	4522/250W	1.49
6C5	.51	811	1.95	4560/600W	3.50
6C6	.71	813	5.95	NEON BULBS	
6C8G	.98	814	2.98	NE2/100	4.50
6D4	.59	815	2.25	NE16 &	
6D6	.59	816	1.15	991 @	.25
6E5	.71	826	.79	NE51 &	
6F6/1613	.69	829B	3.95	NE20/	
6F8	1.04	832A	2.75	100 @	6.00
6G5/6U5	.95	836	1.10	SOCKETS	
6G6	.86	837	2.25	2X2HV	.30
6H6GorM	.54	WL632A	12.95	705/715	.69
6J4	5.25	845	4.50	803/304T	.90
6J5	.49	860	2.49	807	.24
6J6	.65	861	19.95	813	.69
6J7	.70	864	.67	829/832	.25
6K5Gt	.86	865	1.00	866	.24
6K6Gt	.49	868	1.00	872/211	.49
6K7	.59	GL872A	2.49	Acorn 6 for	1.00
6K8	.86	884	.89	Diehptal	.69
6L6G	1.04	918/CE1C	1.20	Maginal	.69
6L7	.87	922	1.40		
6N7	.87	923	.49	TUBES GTD	
6S7	.87	931A	3.49	except open Fil.	
6SA7	.54	954	.45	&breakage	
6SC7	.71	955	.45		

HEL 36 Acorn type 6J4 1.98

XTALDIODES&THERMISTORS NEW
1N34 $1.08@ 10for $9.85, 50for 45.00
1N21 or 1N23 ea49c; 3for 1.00
1N21A, 22, 23A, 25 @$1, 12for 10.00
1N23B, 1N26 @$2, 10for 17.50
D168391 Compensator @$2, 3for 5.00
D170396 HF pwr meas @90c 3for 2.50

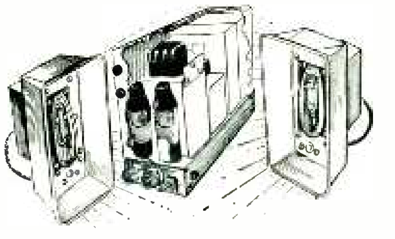
BOX KITE NYLON 2.95
BALLOON 4'&H'Gas 4.95
GLYPTAL CEMENT JAR .35
DIRECTION INDICATOR & DRIVE BENDIX & GE Remote 360deg 4.95
COLLINS ART13 Speech Amplifier 4.50

RECTIFIERS BRIDGE

In	Out	Amps	Price
18V	14	1.35	2.49
18V	14	3.5	3.49
18V	14	5	4.85
36V	28	3.5	3.49
36V		5	4.85
210V	190	40ma 69c ea	

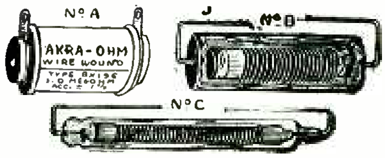
FOR OTHER SIZES WRITE

"TAB" MONEY BACK GUARANTEE. $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES & 25% DEPOSIT. WORTH 2-7230



PHOTOFLASH and 2 lamps

PHOTOFLASH KIT AIRCORPS 1503 NEW. Contains Power Supply, RECTIFIERS & CONDENSERS 50 mfd, TRANSFORMERS & Relay, 2 STROBOLAMPS 12 million lumens light outpt, 15 to 30000 flashes & Reflctrs, for COLOR & BW film. READY for use on 12VDC. In addition, KIT INCLUDES INSTRUCTIONS & PARTS to convert to 115VAC.
SPECIAL "TAB" BUY $59.95
1503 SET plus six 2V (12V) S Batys $69.95
PHOTOFLASH 1503 & BATY PACK for 115VAC/12VDC operation READY to WORK $119.
PHOTOFLASH LAMPS & REFL. $10.95, 2for $21.00
Flash Condensers 8mfd/660VAC/3000Vint $3.95
15mfd/2000Vint $4.50; 16mfd/3000Vint $7.95
25mfd/2000Vint $7.95; 4X8mfd/3000Vint $11.95
16mm/PAN/50 Film Gun GSAP Camera 3 for $1; 54 for $8.98
16mm/PAN Film Gun Camera 3 for $1; 10 for $1.98



PRECISION RESISTORS for METERS BRIDGES, AMPLIFIERS, RADAR, TELEVISION and TELEPHONE equip. STANDARD MFGS. SPECIALISTS IN PRECISION RESISTORS. Write Qty.

From .116 to 95000 ohms each 30¢, TEN for $2.50

100000	150000	240000	353500	575000
110000	155000	245000	380000	600000
115000	169360	250000	400000	620000
120000	180600	265000	402000	621000
125000	185000	268000	422000	654000
130000	201000	275000	458000	750000
135000	220000	294000	478000	761300
140000	225000	307500	500000	800000
141000	229000	314000	520000	900000
145000	235500	330000	521000	930000
147000	238000	333500	570000	950000

ABOVE SIZES EACH 40¢ ....TEN for $3.50

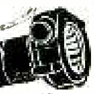
1 Meg	1.8 Meg	3.5 Meg	4.23 Meg	10 Meg
1.2	2	3.673	4.5	11.5
1.5	2.855	3.9	5	12.83
1.579	3	4	9.05	20

ABOVE SIZES EACH 75¢ ....TEN for $6.50

VACUUM Precision Hivolt Resistors (C) 0.12,0.25, 0.6,0.75,0.83,0.99megohms 1,1.5,2,3,3.75megohms, accy 0.5% SPECIAL $1.00@ ....TEN for $7.50
MEGMAX 10or12Meg/10KV/9W $1.35@ 10 for $10.00
MVZSIRC/30Meg/25KV/20Watt $1.98@ 6 for 10.00
MFB105IRC/1Meg./.5%acy/JANR29 $1.98@ 6 for 10.00

WRITE "TAB" for ALL SIZES PRECISION RESISTORS

BLOWERS



75CFM/28VACDC (C Cut) $2.75
SAME&TRANSF/115VAC ... 4.25
100CFM/28VACD ... 4.95
SAME&TRANSF/115VAC ... 6.45
125CFM/115VAC ... 8.95
250CFM/28VACDC & TRANSFORMER 115 VAC, Continuous Svce NEW 10.95
VARIAC 200B/0-130V/175 Watt NEW 10.95
VARIAC 200C/0-130V/860 Watt 16.95
VARIAC 100R/0-230, or 270, 115 or 230 Vinpt Rated 9 Amps/2KW NEW 39.95
DYNAMOTOR PE94p/oSCR522 NEW includes filter, Starting Relay & Voltage Regltr, input 24 & 28V. Outpt 300V/260ma, 150V/10ma. 14.5V/5A Cased Air Corps 10.95
VIBRAPACK 6VDC/outpt 425V/110ma 10.95
VIB PE157p/oSCR593&BATy &CHGR 8.95
VIB 12VDC/190V/85ma Mallory 3.49
VIB PP18/AR/14Vin/outpt28V/1.75Amps 6.95
DYN DM4/12&24Vin/220/100ma/140/200ma 6.95
DYN DA3Ap/oPE94p/oSCR522 7.95
DYN 28Vin/540V/250ma/out Used LN* 2.49
DYN 12&24Vin/275V/110ma/P'magnet 2.98
DYN 12&24in/500/50ma;or275/110ma/6Vin 4.50
NAVY LINE FILTERS 10Amp/130VACDC/filters 0.1 to 1000mcs/USN ea $1.29. 30Amp/250VACDC 0.15 to 1000mcs/USN ea $4.50. NEW Suppresses & FILTERS NOISE or RF for RCVRS,XMTTRS, Tools OILBURNERS, Refrig, MCH-TOOLS, SIGNS, G cost $39 A "TAB" SPECIAL 4.50

GE 100 Amp. line filter has 245 MFD Condensers, 50V, Works on 110V AC-DC. Gtd. TAB Special 1.98

"TAB" • Dept. 9E, Six Church Street, New York 6, N. Y., U. S. A. • "TAB"
THAT'S A BUY • • • CORNER CHURCH & LIBERTY STS., ROOM 200 • • • THAT'S A BUY

PORTABLE A.C. AMMETERS

Surplus New WESTON MODEL 528

DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost .... ONLY $12.50

PORTABLE A. C. VOLTMETERS

(See illustration of Ammeters)
SURPLUS NEW WESTON
MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box .... ONLY $9.50
Combination Offer: 528 Voltmeter—528 Ammeter
BOTH For $21.00

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

BC-1161-A RADIO RECEIVER

150 to 210 Megacycles. Operates off 115 volt 60 cycle Power supply. Inductance tuning for R.F., Antenna, detector and oscillator. With a few modifications this unit makes an ideal F.M. Receiver. Each set complete with circuit diagram and the 14 following tubes: 1—6SN7 Cathode Follower; 1—6H6 second Detector; 2—6SH7 1st and 2nd R.F. Amp.; 1—6SH7 Video Amp.; 3—6AC7/1852 1st, 2nd, 3rd IF Amp.; 2—6AB7/1853 4th, 5th IF Amp.; 1—9006 Mod.; 1—6J5 Osc.; 1—5U4G Rect.; 1—6E5 Tuning Indicator.
Complete in a metal cabinet 10" high 16½" wide and 15" deep.

NET fob, N. Y. $34.50

BC-1160-A TRANSMITTER

157 to 187 Megacycles. Operates off 117 Volt 60 cycle. Contains 115 volt, 1525 R.P.M. Blower, General Radio 200 B 1.5 Amp. Variac 10 tubes, 0-5 Kilovolt 3½" meter transformers, relays, circuit breakers too numerous to advertise. Complete in metal cabinet 17⅜" x 18½" x 18", with circuit diagram.

@ $29.50

A. C. VOLTMETERS

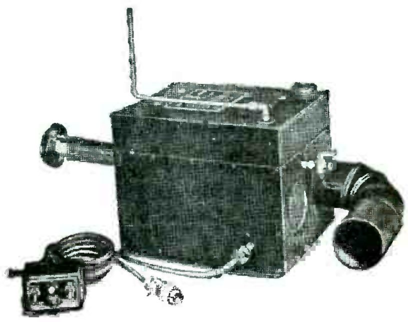
0-15 WH NA-35 3½" rd fl bake case (100 MA) $3.95
0-150 WH NA-35 3½" rd fl bake case (10 MA) $5.50
0-150 Triplett 331-JP 3½" rd fl bake case .. $4.50

A.C. AMMETERS

30 Triplett 331-J.P. 3½" Rd fl bake case $4.00
50 GE AO-22 3½" fl bake case $4.50
60 & 120 Burlington 32XC with ext current transformer $7.50
75 Triplett 31-JPC 3½" rd fl bake case $3.50

MOTOROLA MODEL GN-3-24

Gasoline Heater



An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volts 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.

Approximately 12" long x 9⅛" high x 9½" wide. Complete with technical manual and parts list.

@ $22.50 F.O.B. N. Y.

SPECIAL METERS

Frequency Meter—Dual Range—covers frequency ranges from 48 to 52 cycles and 58—62 cycles—J.B.T. 30-F—Dual element, Vibrating Reed type—115 V—3½", rd fl metal case $5.95
Voltage Polarity Phase Rotation Tester—Triplett 337 AVP—Checks 115, 220 and 440 line voltage—locates open circuits, blown fuses, damaged wiring, etc. Indicates whether A.C. or D.C. and polarity of D.C.—Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.—Consists of a 3" square meter and a small polarized vane movement in a small handy sized case—Complete with 36" leads with test prods $8.50
Signal Strength ("S") Meter—Simpson 25, 3½", rd fl bake case. Use this on the plate circuit of your receiver to show the relative strength of incoming signals. Sc calibrated—6 to 100 DB above 1 microvolt, 5 MA Zero right mvt with translucent sc. for internal sc illumination from rear of meter. Comp. with socket, lamp and leads. For further details refer to pages 164-165 & Fig. 730 B of Radio Amateur's Handbook $4.50

SPECIAL METERS

DECIBEL METER—10 to plus 6, WH RC-35 3" sq case, 6 MW 500 ohms zero DB=1.7 volts. $5.95
HOUR METER Totals to 99,999.9 hrs & repeats WH NH-35, 3½ rd fl case. Operates on 230 volt 60 cycle $8.50
D.C. MILLIAMMETER Weston 271 fan type, 1-0-1 MA & 60-0-60 M.V. mvt. Scale cal 600-0-600 RPM $12.50

D. C. MICROAMMETERS

0-200 Superior, 500 ohms resistance 4" x 4½" flush case. Knife edge pointer Sc. cal. 0-200 Meg and 20,000 ohms Insulation Tester $7.50
0-400 Triumph 4" Rect fl bake case 500 Resist sc cal 3/15/60 V MA $5.50
0-500 G.E. DO-41 3½" rd fl bake case sc cal 0-20 KV $4.50
0-500 DeJur No. 210 2½" rd fl bake case ... $3.00

CARBON PILE D.C. VOLTAGE REGULATOR

20 Amps max. 110 load volt max. 140 line volts max. Safety Car Heating & Lighting Co. #29540 Type S700 E 16" x 16⅜" x 10" @ $65.00

AIR CIRCUIT BREAKERS

125 Amp. 500 Volt A.C. G.E. Type AF-1 3 pole #6275122XG-22. Approximately 8¼" x 5¾" x 15½" with 4½" studs @ $35.00
225 Amp. 500 Volt A.C. G.E. Type AF1 3 pole #6275122XG-26. Approx. 8¼" x 5¾" x 15½" with 4½" studs @ $35.00

SWITCHBOARD TYPE CURRENT TRANSFORMER

Westinghouse Type KN Style 1294677 Ratio 500:5, 1000 voltmax, 60 cycle dry type, 15 V.A. with automatic short circuiting device. @ $18.00

PORTABLE CHRONOMETRIC TACHOMETER

To measure speeds from 0 to 20,000 R.P.M. with scale calibrations in 10 R.P.M. divisions. Divide scale reading by 2 when using the peripheral wweel and you can read surface speeds up to 10,000 F.P.M.

3 2" open face dial provides unequaled readability. Each division on large dial indicates 10 R.P.M. & each division on small dial indicates 1000 R.P.M. Readings are similar to those made on kilowatt hour meters. Results of tests remain on dial until next test taken.

Complete with 2 tips, peripheral wheel, & operating instructions—No stop watch or other timing mechanisms required. Made by Jaeger Watch Co. model 43 A-6. Complete in velvet lined case 5" x 3½" x 1½". List price $75.00.
Surplus—New—Guaranteed $24.50 f.o.b. N. Y.

MULTIPLE RANGE, CONTINUOUS INDICATING PORTABLE TACHOMETER

Three ranges in R.P.M. & three ranges in F.P.M. 300-1200. 1000-4000. 3000-12.0000 R.P.M.
Large 4" dial shows INSTANTANEOUSLY & CONTINUOUSLY the speed or change in speed of any revolving shaft or surface.
Complete with 4 tips, peripheral wheel, extension rod and operating instructions. No stop watch or other timing mechanisms required.
Made by Jones Motorola, Stamford, Conn. Comes complete in velvet lined case 7⅛" x 4" x 5". List price $75.00.
Surplus—New—Guaranteed $24.50 f.o.b. N. Y.

TACHOMETER GENERATOR

Three phase

64, 65 & 89 volts at 1000 RPM 1 M.A., A.C.; G.E. Type CM 5 Model 2CM5AEA @ $9.50

AIRCRAFT TYPE D.C. MOTOR

28 volts, reversible. Shaft ¼" dia x 1⅛" long, 3¾" overall length x 1¾" dia. Bendix Radio E 11500-1. 700 Available. 75¢ each. Minimum order 50 pieces.

METER RECTIFIER

Full Wave Weston part number D89367. For use with model 301 meters. Terminals marked A.C., plus and minus @ .... $1.50 (Ten for $12.50)

STRIP HEATERS

50 Watt, 115 Volt, 250 Ohms, G.E. Catalog No. 2A301, 1½" x ½" x 6". Minimum order 10 pieces at 60¢ each. Discounts for quantity.

MICROSWITCH

Single Pole. Normally closed 10 Amp 125 Volt Minimum order 10 pieces at 30¢ each. Discounts for quantity.

THERMAL CIRCUIT BREAKER

120 Volt. 15 Amp. A.C. Double pole. Single throw. Curve D. By Heineman Circuit Breaker Co Catalog No. 0322.

REVERSE CURRENT RELAY

12-15 Volt 200 Amps. For Generator Current Control on vehicles, boats and aircraft equipment, etc. Leece Neville #23509. Each $2.50

All items are Surplus—New—Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit. Orders accepted from rated concerns, public institutions, etc., on open account.
The above is only a partial listing of the many items we have in stock. Send for free circular.
MANUFACTURERS. EXPORTERS, DEALERS—we invite your inquiries.

MARITIME SWITCHBOARD

336 Canal Street Worth 4-8217 New York 13, N. Y.

We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, laboratory standards, etc.

OVER 50,000 METERS IN STOCK

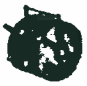
We also have in stock various surplus components, tubes, code keying and recording units, code training sets, tachometers, analyzers, tube testers, converters, precision resistors, current transformers, transmitters, receivers, condensers, and other electronic units, parts and accessories.

STEPDOWN TRANSFORMERS

Input: 115V.-60 cycles.
Output: 20 V., at 10 amps.
Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier applications, etc.

Brand New $2.45

SELENIUM RECTIFIER



Bridge Type
Input: 36 V. AC
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

APPROACH INDICATORS

Type 1D-24/ARN-9

Brand New $3.95

ALTIMETERS

Type AN/APN-1 Complete, brand new in original cartons with instruction books

$49.50

KOLLSMAN COMPASSES

Type B-16 Brand new and complete with spare pilot lamp

$9.75

SOLAR ELIMOSTATS

Line filters, 20 amps. capacity. 115 V. AC, 600 V. DC.

Brand New $3.95

INSTRUMENT LAMPS

Mazda #323

$10.00 per Hundred

SOLA VOLTAGE REGULATORS

Cat. No. 30807—Pri. 95-125 V. 60 Cy. Output 115 V. 2.18 amps. VA. 250.

$39.50

RADAR EQUIPMENT

All Brand New Material!

ANTENNA ASSEMBLIES

SO-1 (66AGE) $125.00
SO-3 (NMT-2062) $120.00
SO-8 (66AGD) $120.00
TDY (NMT-2062) . . . . $ 95.00

SPARE PARTS

Complete Set SO-3 Tender Spares **$2500.00**

10 CM Flatwise Bend 90° Bronze Elbow **$20.00**

Complete spare parts in stock for Type SO-1 Radar

ALSO

SO-Radar Repeater Adapters CBM-50AFO, PPI units, SO-11 Modulators, Remote Indicators, SO Receiver Transmitter Units, Antenna Unit Controls, etc.

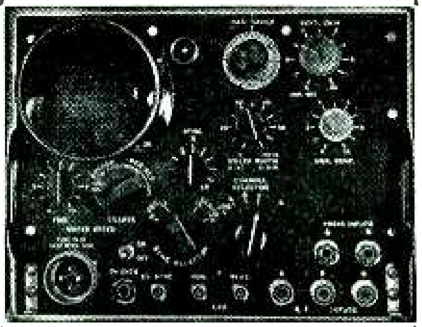
Large Stock. All Brand New Material!

RADAR TUBES IN STOCK

Types—4C35, 2J62, 3B24, 3C45, 7BP7

PAN-OSCILLO-RECEIVER

Ideal for laboratory, television and general service work.



Model AN/APA 10

Performs work of four units

1. **PANORAMIC ADAPTOR:** For use with any receiver with I.F. frequency of 405-505 kcs., 4.75 to 5.75 mcs., and 29-31 mcs.
2. **OSCILLOSCOPE:** Visually checks received signals, monitors transmitter output, percentage modulation, carrier wave-shape, etc.
3. **SYNCHROSCOPE:** External inputs provide synchroscope action.
4. **RECEIVER:** Three inputs provide facilities for use with convertors to cover wide range of frequencies to 10,000 mcs.

FEATURES:

- 3" scope tube
- 21 tubes
- Variable sweep 35-40,000 cy
- Transformer built in for 110 V. 60 cycle operation.
- 2 I.F. stages—double conversion.
- 2 Video stages in push pull to vertical plates.
- Pentode output audio monitor.
- Multi-Vibrator horizontal sweep (radar type).
- Horizontal sweep amplifiers P.P. to horizontal plates

Surplus equipment tested and guaranteed in perfect operating condition. We have sold hundreds of these units to leading schools, laboratories, amateur operators all over the world.

$129.50

(Mail $3.50 for 80 page Technical manual and instruction book)

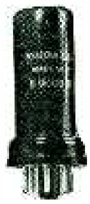
SOUND POWERED CHEST SETS

No batteries required

Ideal for television installers, or any antenna measurement work. Leaves hands free to make adjustments. Set consists of microphone and headset as illustrated.

Brand New **Per Set $19.50**

W. E. TYPE D-168479 MERCURY CONTACT RELAY



For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and constant operating characteristics under adverse atmospheric conditions. Hermetically-sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure.

1000 hours life at 60 operations per second. Two coils of 700 ohms, and 3300 ohms. Operating current, coils, series aiding—6.6 mils. Release current, coils series aiding—5.2 mils. Four page Technical Data on request.

Brand New in Original Cartons **$4.75**

MOTOR GENERATORS

Brand new. Built by Allis-Chalmers to rigid specifications of the U. S. Navy

K.V.A. output 1.250 R.P.M. 3600
K.W. output 1. Cont. Duty Ph. Single
P.F. 80 Cycles 60
Volts input 115 D.C. Volts output 120 A.C.
Amps. input 14 Amps. output 10.4
Length 26"; width 12⅞"; height 13".

Compound accumulative A.C. and D.C. fields. Centrifugal starter. Splashproof covered. Frequency adjustable to load, plus or minus five cycles.

PRICE $125.00

Identical Machine, but 230 volts D. C. Input, $125.00

Set of Replacement Spare Parts for Either Machine $29.50

DYNAMOTORS—500 Watts Navy Type CAJO-211444

Input: 105-130 Volts D.C., 6 amps. Output 13 or 26 Volts D.C. (26 V. at 20 amps. in series or 13 V. at 40 amps. in parallel). Designed for radio use, fully R.F. filtered, complete with separate Square D line switch box.

BRAND NEW $59.50

SYNCHROS

(Selsyns, Autosyns, etc.)

Navy Ordnance types: 5B, 5G, 5F, 5CT, 5DG, 5SG, 5SDG, etc.

Army Ordnance types: 2J5FBI, 2J5SI, 2J1F3, CAL 18300, C78414, C78863, C78411, etc.

Also

Pioneer Precision Autosyns AY101D, brand new in original containers.

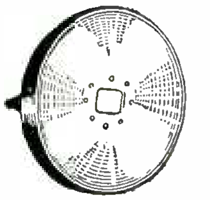
G. E. AMPLIDYNES

Type 5AM21JJ7, NEW $49.50
Type 5AM45DB20, NEW $69.50

G. E. SERVO AMPLIFIERS

Type 2CVICI, New $19.50

PARABOLOIDS



Ideal for microwave experimental work.
Spun Magnesium dishes
Reinforced Perimeter
17½" Diameter x 4" Deep
Two sets mounting brackets on rear.
Open center hole 1½" x 1⅝"

Per Pair, Brand New . . $8.75

TRANSMITTING EQUIPMENT

B C-325 B Transmitter. Freq. range 1.5 to 18 mcs. Output 400 watts C. W. or 50 watts phone. 110 V. 60 cycle, 1 ph. Complete with tubes. Used, but in good operating condition **$295.00**

MD1/FRC Modulators. Part of T-4/FRC and T-5/FRC. Complete in enclosed metal racks. Each unit consists of a dual modulator channel, each of 300 watts audio output (2-810's in push-pull). Complete from microphone input jack to modulation transformer output terminals for connection to Class "G" final amplifier R.F. stage. Brand new **$275.00**

SA-2/FRC Switch Panels **$10.00**

All prices quoted subject to change. 20% deposit on C.O.D.'s fob. Tuckahoe, N. Y. About 20 miles N. of N.Y.C.

ELECTRONICRAFT INC.

All merchandise guaranteed. Immediate delivery, subject to prior sale.

5 WAVERLY PLACE **PHONE—TUCKAHOE 3-0044** **TUCKAHOE 7, NEW YORK**

SEARCHLIGHT SECTION

VOLTAGE REGULATOR

Mfg. Raytheon: Navy CRP-301407: Pri: 92-138 v, 15 amps. 57 to 63 cy. 1 phase. Sec: 115 v, 7.15 amp. .82 KVA. .96 PF. Contains the following components:

REGULATOR TRANSFORMER: Ratheon UX-9545. Pri: 92-138 v, 60 cy, 1 PH. Sec: 200/580 v, 5.5/5.26 amps, 4000 v rms test.

FILTER REACTOR: .156 hy, 5 amps, 4000 v test. Raytheon UX 9547.

TRANSFORMER: Pri: 186 v, 5 amps; Sec: 115 v, 7.2 amps. Size: 12" x 20" x 29". Net Wt. approx. 250 Lbs.

Entire unit is enclosed in grey metal cabinet with mounting facilities. New, as shown........$99.50

VOLTAGE REG. "Transtat". Amertran Type "RH" 2 Kva Load. Input: 90/130 v 50/60 cy. Output 115v $40.00

TRANSTAT VOLTAGE REG. 11.5 KVA, 0-115 vac. 60 cy. 100 amps $75.00

ITE Circuit Breaker. 115 amps, 600v........$15.00

STEP DOWN TRANSFORMER: Pri: 440/220/110 volts a.c. 60 cycles, 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7"........$40.00

PLATE TRANSFORMER. Pri: 117 v. 60 cy. Sec. 17,000 v. 3/4" 144 ma. with choke. Oil immersed. Size 26" x 29" x 13". Ameritran $65.00

Fil. Transformer: Pri: 220 v. a.c., 60 cy. .05KVA. Sec. 5 v.c.t., 34,000 v. test $24.50

Fil. Trans. UX-6899. Pri: 115 V. 60 cy. Sec: Two 5V. 5.5 Amp Wdgs. 29KV Test $24.50

Plate Transformer: Pri: 115/230 v.a.c., 50-60 cy. Sec: 21,000 v, 100 ma. $145.00

440 Cy. TRANSFORMERS

HV PLATE XFMR: Pri: 115 v, 400 cy. Sec: 13.5 KV, 3.5 ma. GE #52J652 ....$11.50

D-163253: Pri: 115 v, 400 cy. Sec: 2.5 v, 5 amp, 5200 v, 2 ma. $7.95

PLATE XFMR: Pri: 115 v. 400 cy. Sec: 9800 v or 8600 v @ 32 ma dc........$12.50

#12033, Plate Xfmr: Pri: 115 v. 800 cy. Sec: 4500 vct. 250 ma. $4.50

KS 9445. Pwr. Xfmr. Pri: 115 v. 400-2400 cy. Sec: 592 vct. 120 ma. 6.3v. 8 amp; 5v. 2 amp........$3.50

PLATE XFMR. Pri: 115 v, 400-2400 cy. Sec: 4500 v. 6 ma $6.50

#7143. Pri: 115 v, 400 cy. Sec: 6.3 v, 7 amp, 8.3 v, 8.8 amp; 6.3 v, 1.3 amp. $2.50

KS 9584. Pri: 115 v, 400 cy. Sec: 5000 v, 290 ma. 5 v. 10 amp. $15.00

PLATE XFMR: Pri: 115 v, 380-2800 cps. Sec: 2200 v, 350 va $3.95

PLATE XFMR: Pri: 115 v, 400 cy. Sec: 1150-0-1150 v. 40 ma $1.75

INVERTERS

PE 206-A. Input: 28 VDC @ 38 amp. Output: 80 volts @ 500 volt-amps. 800 cycles. Leland. New, complete with enclosed relay, filter, instruction book....$12.50

PE 218: Input: 25-28 VDC @ 92 amps. Output: 115 volts @ 1500 volt-amps. 380-500 cycles. Poor physical but good running condition $15.00

LABORATORY ACCESSORIES

Coax Cable

RG 18/U, 52 ohm imp. armored........$ .51/ft.
RG 24/U, twin coax, 125 ohm imp. armored..$ .50/ft.
RG 28/U. 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV........$ .50/ft.
RG 35/U, 70 ohm imp, armored........$ .50/ft.

Coax Connectors

831R	$.35	UG 21/U	$.85
831SP	$.35	UG 86/U	$.95
831AP	$.35	UG 254/U	$.75
831HP	$.15	UG 255/U	$.85

Homedell male to type "N" male adapter........$1.25

THERMISTORS ($.95 ea.)	VARISTORS $.95 ea.
D-167332 (Bead)	D-167176
D-170396 (Bead)	D-170225
D-168392 (Button)	D-168687
D-166228 (Button)	D-171121
D-167018 (Tube)	D-171631

RT ANGLE Sperry fittings........$1.00

THERMISTOR MOUNT: Broad Band "S" thru "X", with type "N" input........$8.00

SPERRY KLYSTRON TUNER Mod. 12........$2.00

SINE POTENTIOMETERS, GE-#251 X 96 or W.E. #KS 15138 L01........$3.50

PH-SHIFTING CAP., 180 deg. W.E. #D-150734 $2.50

KLYSTRON SOCKETS for 723 A.B. and similar types. 2 for $1.00

LINE INSERTION ATTENUATOR, type OAX-1. 20 Db atenuation, with 3-contact plug and socket (amphenol 16S-5) $2.25

"PPI" ROTATING YOKE TYPE, complete with all necessary osciliator circuits. CR tube 5FP7, complete with tubes. Used with SO radar.......... $100.00

RT39/APG-15. Transmitter-receiver. 2200-2700 mc APX. Complete with 2C43 lighthouse plumbing. TR, 30 mc, I.F., all enclosed in compact pressurized housing. New, less tubes........$100.00

CP 14 APS-15A COMPUTER. Compiles slant range-ground range against altitude........$15.50

CURSOR DIAL ASSEMBLY for 7" CR tube. Azimuth calibrated to 360 deg. Roller bearing mechanism. $12.50

MAGNETRONS

TUBE	FRQ. RANGE	PK. PWR. OUT.	PRICE
2J31	2820-2860 mc.	265 KW.	$15.00
2J22A	9345-9405 mc.	50 KW.	$25.00
2J22	3267-3333 mc.	265 KW.	$15.00
2J26	2992-3019 mc.	275 KW.	$15.00
2J27	2965-2992 mc.	275 KW.	$15.00
2J32	2780-2820 mc.	285 KW.	$15.00
2J38 Pkg.	3249-3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267-3333 mc.	8.7 KW.	$25.00
2J55 Pkg.	9345-9405 mc.	50 KW.	$25.00
3J31	24,000 mc.	50 KW.	$17.00
714AY			$15.00
4J20BY	2800 mc.	1000 KW.	$50.00
730A			$25.00

KLYSTRONS: 723A/B $7.75 707B W/CAVITY $20.00

MAGNETS

For 2J21, 725-A, 2J22, 2J26, 2J27, 2J31, 2J32, and 3J31 ....Each $8.00
4850 Gauss, 5/8" bet. pole faces, 3/4" pole diam... $8.00
1500 Gauss, 1 1/2" bet. pole faces, 1 5/8" pole diam. $8.00
1000 Gauss, electromagnet, adjustable 2 3/8" to 3" bet. pole faces, 2 1/2" pole diam. $12.00

TUNABLE PKG'D "CW" MAGNETRONS

QK59 2675-2900 Mcs.	QK61 2975-3200 Mcs.
QK60 2800-3025 Mcs.	QK62 3150-3375 Mcs.
New—$45 each	New—$55 each

VACUUM TUBES

01-A	$.45	532	$2.
1A3	$.70	559	$4.
2C21	$.69	562	$90.
2C22	$.69	615	$.89
2J21-A	$25.	703-A	$7.
2J22	$15.	704-A	$.75
2J26	$15.	705-A	‡$2.85
2J27	$15.	707-B	$20.
2J31	$25.	714-AY	$15.
2J32	$15.	715-B	$12.
2J38	$25.	720CY	$25.
2J39	$25.	721-A	$3.60
2J55	$25.	723-A/B	$7.75
3J31	$25.	724B	$1.75
2X2/879	$.69	724-D	$2.50
3A4	$.65	725-A	$25.
3BP1	$2.25	726-A	$9.50
3C24	$.60	800	$2.25
3C30	$.70	801-A	$1.10
3D6	$.79	804	$9.95
3CP1 S1	$3.50	811	$1.95
3D21-A	$1.50	814	$5.95
3DP1	$2.25	815	$2.50
3EP1	$2.95	836	$1.15
3FP7	$1.20	837	$1.95
3GP1	$3.50	843	$.59
3Q5	$.79	860	$15.
5BP1	$1.20	861	$40.
5BP4	$4.95	874	$1.95
5CP1	$3.75	876	$4.95
5FP7	$1.35	889R	$78.50
5JP2	$8.	1005	$.35
5J30	$39.50	1613	$.95
6AC7	$1.	1619	$.21
6AK5	$.69	1624	$.85
6G	$2.	1629	$.35
6SC7	$.70	8012	$3.95
6SL7	$1.	9004	$.47
7C4	$1.	9006	$.47
7E5	$1.	CEQ 72	$1.95
7F6	$.72	EF 50	$.79
10Y	$.60	E-1148	$.75
12A6	$.35	F-127	$20.
12K8Y	$.65	FC 258A	$165.
12SF7	$.49	FC 271	$40.
12SR7	$.72	GL 562	$75.
15R	$1.40	GL 623	$75.
28D7	$.75	GL 697	$75.
30 (Spec.)	$.70	ML 100	$60.
35L6	$.69	QK 59	$45.
35Z5	$.66	QK 60	$45.
45 (Spec.)	$.59	QK 61	$55.
50L6	$.79	QK 62	$55.
39/44	$.49	RCA 932*	$.65
35/51	$.72	VR 91	$1.
227A	$4.95	VR 130	$1.25
225	$8.80	VR 135	$1.25
250R	$7.95	VR 137	$1.25
268-A	$20.	VR 150-30	$.75
355-A	$19.50	VU 120	$1.
530	$90.	VU 134	$1.
531	$45.	WN 150	$3.
		WT 260	$5.

SPECIALS

SEL. RECTIFIER: Input: 115 vac. 60 cy. Out: 115 vdc, 1.66 amps. Full Wave Bridge, F. T. & R. #DE11 ....$9.95

SEL. RECTIFIER: Input: 30 vac. 60 cy. Out: 24 vdc. .5 amp. Full wave bridge, GE #SC10........$1.50

POWER SWITCH. 4 pos. 60 amps, 600 vac. Arrow H&H $4.25

ROTARY SPARK GAP. 24 vdc motor, 4 spark gap electrodes, p/o Xmtr BC 1081-TG........$5.50

PRECISION CONDENSER: W.E. #D-166602, 16 mfd @ 400 vdc. temp comp 50 to 85 deg C........$7.50

PRECISION CONDENSER: W.E. D-161270. 1 mfd @ 200 vdc. temp comp —40 to plus 65 deg. C......$5.00

PRECISION RESISTOR: W.E. D-171221, matched pair, 6,330 meg. $2.50

QBG-1, ECHO RANGING DRIVER-RECEIVER. underwater sound signal transmission and reception unit with range of 200 to 600 yds. and freq. range of 16 to 27 kc. New, with battery box in leather chest, less projector $85.00

MICRO WAVE GENERATORS

AN/APS-15A "X" Band compl RF head and modulator, incl 725-A magnetron and magnet, two 723A/B klystrons (local osc & beacon), 1B24 TR, revr-ampl, duplexer, HV supply, blower, pulse xfmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV Pk Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl pkg, new........$210.00

APS-15B. Complete pkg. as above, less modulator $150.00

"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A 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

Modulator-motor-alternator unit for above.....$ 75.00

Receiver - rectifier power unit for above........$ 25.00

Rotating antenna with parabolic reflector for above. New $75.00

MICROWAVE PLUMBING

10 CENTIMETER

"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output........$3.00

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated........$45.00

10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1 1/2" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. New and complete $135.00

721-A TR CAVITY WITH TUBE. Complete with tuning plungers $5.50

10 CM. McNALLY CAVITY Type SG........$3.50

WAVEGUIDE SECTION. MC 445A. rt. angle bend. 5 1/4 ft. OA. 8" slotted section $21.00

10 CM OSC. PICKUP LOOP, with male Homedell output $2.00

TS115/APS-2F 10 CM ANTENNA in lucite ball, with type "N" fitting........$4.50

OAJ NAVY TYPE CYT66ADL, ANTENNA in lucite ball, with Sperry fitting........$4.50

10 CM. FEEDBACK DIPOLE antenna, in lucite ball, for use with parabola........$8.00

7/8" RIGID COAX—3/8" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00

SHORT RIGHT ANGLE bend, with pressurizing nipple $2.00

30 FT. FLEXIBLE SECTION, 7/8 rigid to 7/8 rigid $7.50

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

7/8" COAX. ROTARY JOINT........$8.00

RT. ANGLE BEND 15" L. OA........$2.00

FLEXIBLE SECTION, 15" L. Male to female....$4.25

7/8" RIGID COAX, bead supported........$1.20/ft.

MAGNETRON COUPLING to 7/8" rigid coax 3/8" IC line, less "M" nut, with TR pickup loop, gold plated $7.50

3 CM. PLUMBING

(STD. 1" x 1/2" GUIDE UNLESS OTHERWISE SPECIFIED)

WAVEGUIDE, 1" x 1/2" I.D. per ft........$1.50

"X" BAND WAVEGUIDE, 1 1/4" x 5/8" OD, 1/16" wall, aluminum ....per ft. $ .75

TR CAVITY for 724-A TR tube, transmission or absorption types $3.50

724-A TR tube (41-TR-1) $2.50

WAVEGUIDE SECTION. CG 251/APS-15A, 26" long choke to cover, with 180 deg. bend of 2 1/2" rad. at one end $4.00

ROTARY JOINT with slotted section and type "N" output pickup $8.50

WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2 1/2" radius, 90 deg. bend........$4.50

STABILIZER CAVITY feeding waveguide section, with filtered output and attenuating slugs........$20.00

SLUG, TUNER/ATTENUATOR, W.E. guide, gold plated $3.75

TR/ATR DUPLEXER section with iris flange....$4.00

RIGHT ANGLE ELBOW, 5 1/2" choke to cover, 2 1/4" radius E or H plane $5.00

TWIST, 5" 90 deg., choke to cover........$5.00

WAVEGUIDE SECTIONS 2 1/2" long, silver plated, with choke flange $4.50

WAVEGUIDE, 90 deg. bend E plane, 18" long....$4.00

ROTARY JOINT, choke to choke $6.00

ROTARY JOINT, choke to choke, with deeck mounting $6.00

S-CURVE WAVEGUIDE, 8" long cover to choke..$2.50

DUPLEXER SECTION for 1B24........$10.00

CIRCULAR CHOKE FLANGES, solid brass...... .55

"T" SECTION (TR-ATR) choke to choke, supplied with circ. or sq. flanges $3.50

DIRECTIONAL COUPLER CG 124 APS-15A on 16" section cover to cover 15 deg., bend........$5.00

FEEDBACK DIPOLE with 90 deg. twist, 7 1/2"...$3.50

2K25/723AB, X band local oscillator mount with (1) choke coupling to beacon reference cavity; (2) choke coupling to TR and receiver; (3) Iris coupling with AFC attenuator to antenna waveguide; (4) Radar AFC crystal mount; (5) Receiver crystal mount; (6) Attenuating slugs. Mfg. DeMornay. Budd $22.50
TR/ATR Duplexer section for above........$4.00

2 1/2" FLEXIBLE SECTION, cover to cover........$4.00

SHORT ARM "T" section, with additional choke output on vertical section $4.00

1.25 CENTIMETER

WAVE GUIDE Section 1" cover to cover........$2.00

T SECTION choke to cover $4.50

MITRED ELBOW cover to cover........$3.00

MITRED ELBOW and "S" sections choke to cover $3.50

FLEXIBLE SECTION 1" long choke to choke.....$3.00

K-BAND ROTARY JOINT $45.00

ALL MERCHANDISE GUARANTEED. MAIL ORDERS PROMPTLY FILLED. ALL PRICES, F.O.B. NEW YORK CITY. SEND MONEY ORDER OR CHECK. SHIPPING CHARGES SENT C.O.D. RATED CONCERNS SEND P.O.

131-E Liberty St. New York, N. Y.

COMMUNICATIONS EQUIPMENT CO.

Cable "Comsupo" Ph. Digby 9-4124

SURPLUS ELECTRONIC MATERIAL

IMMEDIATE SHIPMENT BELOW IS A PARTIAL LISTING FROM OUR CATALOG

TUBES! GUARANTEED!

TYPE	PRICE	TYPE	PRICE
1LA6	$1.65	851	$49.50
1L4	.65	860	2.75
1V	.65	864	.65
2X2/879	.65	866A	.75
3A4	.45	872A	1.65
5R4GY	.95	954	.45
6AC7	.95	957	.45
6AG7	.95	968	.25
6C4	.55	1613	.85
6F8	.95	1616	.95
6G6G	.85	1625	.45
6H6GT	.55	1626	.45
6L6	1.10	1629	.18
6SA7	.65	1632	.18
6SD7	.45	1641/RK60	.65
6SQ7	.65	1644	1.25
6SJ7	.65	1294/1R4	.65
6Y6	.75	3D6/1299	.65
6X5	.65	388A	3.95
7B7	.65	394A	2.95
7C7	.95	9002	.35
7F8	.95	9003	.25
7N7	.85	9006	.35
7Y4	.75	8013	2.95
12A6	.18	RK60/1641	.65
12K8	.95	RK72	.75
12Q7	.55	RK73	.45
12SL7	.65	1B24	1.95
12SN7	.65	2C46	3.95
30 SPECIAL (VT67)	.45	3B25	.75
32	.65	3B27/836A	.95
25Y5	.85	3C23	2.95
25Z6	.75	4B27	2.95
35L6	.65	4C33	2.95
38	.65	4D32	9.50
45 SPECIAL (VT53)	.35	14E6	.55
56	.55	23D4	.45
210	.65	28D7	.45
250	.65	HY114B	.45
350B	4.95	5CP1	3.95
801	.95	2J1005	.35
807	.95	Amperite Voltage Regulator 13-4	.25
814	4.95	Hytron Ballast 100-79	.25
826/2J	.95	JFD Ballast 60R30	.25
841	.65	E1148	.95
843	.65	VR78	.45

STANDARD BRAND PRECISION RESISTORS

Types WW3, WW4, and WW5

Following sizes are in 1% and 2% tolerance Price $.35

1 meg	66,000	1500
.8 "	54,500	1400
.75 "	46,000	1200
.7 "	40,000	1000
.6 "	33,000	750
.268 "	13,300	235
.22 "	12,000	130
125,000	11,000	125
120,000	7,500	110
109,000	4,500	55
100,000	4,300	22
95,000	4,000	20
92,000	2,500	14
84,000	2,230	12
82,000	2,200	10
80,000	1,700	6

Following sizes are 5% or better tolerance, Price $.15

110,000	70	40
22,000	50	35
		30

The following sizes 1% or better. Price $.10

41,808	105.8	4.4
14,460	53.96	4.35
4,285	53.32	4.3
1,123	33.22	3.94
988	23.29	3.5
414.3	13.52	1.563
366.6	13.333	.29
220.4	10.2	.268
147.5	5.1	.25

COAXIAL CABLE

TYPE	IMPEDANCE	PRICE
RG 6/U	76 Ohms	$.07½/ft.
RG 38/U	55 Ohms	.07½/ft.
RG 59/U	73 Ohms	.05½/ft.
RG 62/U	93 Ohms	.07½/ft.
RG 77/U	48 Ohms	.07½/ft

RELAYS

RCA Vacuum Relay. Relay contacts will break 3000 volts and carry 10 amperes Solenoid resistance 200 ohms, 24 volts DC—Excellent as R.F. antenna relay .... **Price $ .95**

Struthers Dunn S.P.D.T. Relay 36 Volt coil—20 ma. Contacts 2 amps at 115 V.A.C... **Price $ .95**

Relay—D.P.D.T. Heavy contacts Coil 6 volts D. C. 18 ohms .... **Price $ .95**

Leach type 1154 D.P.S.T. Heavy contacts Coil 50 Volts 50/60 cycles .... **Price $1.25**

Struthers Dunn #61RXX104 D.P.S.T. Coil 12 Volts D.C. Contacts 25 amperes at 12 Volts D.C. **Price $ .95**

Allied Control #D0X8 4 Make 4 Break. Heavy Contacts Coil 18 turns #10 enamelled wire. **Price $ .75**

Relay S.P.S.T. WE Co. #D163781 unit encased in vacuum tube shell with octal base. 2 pins term for coil, two for switch, 2500 ohms 10 V.D.C. Operating current 4.3 ma. release current 2.5 ma. cont. rating 1 amp. Switching speed up to 200 cycles .... **Price $1.95**

Allied Control #BOY-X5 Coil 6 Volts D. C. Contacts D.P.D.T. plus SPST N.C. Heavy contacts **Price $ .95**

Aircraft-type Starter Relay Leach type #7220-3-24 Coil 24 Volts D.C. Res. 132 Ohms. Very Heavy Contacts .... **Price $ .75**

Isolantite Relay D.P.D.T. Heavy Contacts Coil 100 ohms, 12 Volts D.C. .... **Price $ .75**

Weston Mod. 705 Relay—meter type. Requires only 7½ microamperes (plus or minus) to close contacts. Coil resistance approximately 50 ohms. Solenoid reset coil—400 ohms at 18 volts D.C. Limited quantity .... **Price $3.95**

Telephone Type Relay—W.E. #D166578. Dual contacts, DPDT plus D.P.S.T.-N.O. plus D.P.S.T.-N.C. Coil 200 ohms, 12 volts D.C. **Price $1.25**

TIME DELAY RELAYS

Thermal vacuum type
S. P. S. T. 100 ohm coil
24 Volts AC/DC
90 second delay .... Price $ .95

Cramer Time Delay Relay—#44SP3 N.L. Motor 115 Volts—60 cycles—Two Pole Switch 115 Volts at 10 amps—One circuit closes at 4 seconds, other circuit closes at 40 seconds. **Price only $4.95**

4000-6000 VOLT LOW CURRENT DC SUPPLY

These units have been designed for use with television, cathode ray, electron multiplier and other types of equipment requiring high voltage with low current. Brand new completely wired and tested. Ready to operate from 115 volt power line. D.C. output is filtered.

Price Complete $12.50

2000-3000 Volt D.C. Supply similar to above, but with lower output voltage. Ready to operate from 115 Volt power line. **Price Complete $7.95**

HIGH FIDELITY INPUT TRANSFORMERS

Ferranti #4794 Balanced winding, shielded type. Description—Turns ratio step-up 2/1 primary inductance 133 Henrys ± 1 DB 60-9000 cycles. Can be used to match any single or push-pull plates to any single or push-pull grids—overall dimensions 2¼" x 3" x 2½"......... **Price $1.75**

AMERTRAN TRANSTAT VOLTAGE REGULATORS

Model #29144
Fixed Winding 115 Volts—60 cycles
Commutator range 75-120 Volts
Maximum output .25 KVA
Housed in shielded case 5" x 6" x 6"
Price $6.95

Type RH
Fixed Winding 115 Volts—400 cycles
Commutator ranges 75-120 Volts
Load—.72 KVA
Housed in Shielded case 5½" x 6" x 6½"
Price $1.95

RADIO NOISE FILTERS

These line noise filters are available in large quantities and priced for quick sale.

Mallory NF 12-6EG—Housed in a bathtub type container and rated at 7 amps, 50 volts D.C. Solder lug terminals .... **Price $ .35**

Mallory NF7-3A—Housed in silver-plated rectangular case 3¾"x1⅞"x2½" with male and female amphenol AN3108 plugs .... **Price $ .95**

Mallory NF7-4—Housed in rectangular case 3"x1½"x7½". Internal screw terminals. Rated at 12 amperes—35 V.D.C. .... **Price $ .95**

Mallory NF2-2—Housed in square case 3¾"x2½" high—Rated at 50 amperes 35 volts... **Price $ .95**

General Electric Noise Filter—Housed in square case 4¼" by 3" high. Rated at 200 amperes at 50 volts .... **Price $ .95**

Mallory NF2-1—100 amps, 35 volts—Housed in shielded container 3¾" square x 2½" high screw terminals .... **Price $ .95**

Solar Elim-O-Stat—Type EA105—50 amps at 50 Volts—$ .95. Type EA109—50 amps at 35 volts. Both units are housed in container similar to Mallory NF2 .... **Price $ .95**

Bendix—model 3937—Generator Filter—50 amps, 120 Volts D.C.—Housed in shielded containers 4"x3¾"x8" .... **Price $1.25**

Line Noise Filter—Unshielded and mounted on a bracket Suitable for use on regular power lines—Consists of two .01 molded condensers and 140 turn solenoid choke coil....... **Price only $ .10**

Last Minute Specials

These are in limited quantity and subject to prior sale.

JONES PLUGS & SOCKETS

"500 series"

These units are designed for 5000 volts and 25 amperes per contact. Plugs are all furnished with removal caps.

	Type
Plug P 508-CE	8 contacts
Plug P 510-CE	10 contacts
Plug P 512-CE	12 contacts
Sockets S 510	10 contacts

Price each above $1.45

Small type-18 Terminals
Plug #222815 .... Price $ .25
Sockets #222816 .... Price $ .25

28 Volt Transformer

Pri. 115 Volts 60cycle
Sec. 28V. C.T. 5A.
28V. C.T. 5A.
28V. C.T. 5A.
28V. C.T. 5A.
Price $12.95

Write for Descriptive Catalog Listing a Large Variety of Electronic Components

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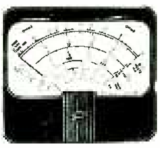
Finest of surplus at a fraction of cost

PEAK ELECTRONICS CO.

Industrials Schools - Labs

50 MICRO AMP METER



This is the exact meter utilized in the General Electric model YMW—1A Lab-Type Unimeter

- 50 Microamp Movement ± 2%
- 2500 Ohms Resistance ± 2%
- Knife Edge pointer
- Uncrowded Multi-Range Scale
- 4 x 4½" Black Bakelite Case
- 50 Microamp scale available at 25c additional
- A Peak scoop at only $9.75 ea.

METER SPECIALS

1½" GE 0-1 MA Basic $3.95
2" GE 0-30 amps. D.C. 2.95
2" GE 0-1 amp RF (internal thermo) 2.95
2" GE 0-5 ma (amp scale) 1.95
2" GE 0-1.2 ma (0-100 scale) 2.49
2" GE 0-1 ma (volt scale) 2.95
2" Gruen 0-3V DC (1000 ohms per volt) 2.45
2" Weston 150-0-150 Microamps 3.49
3" Westinghouse 0-75 amp AC 4.95
3" Weston -10 to 4 DB 5.45
3" Westinghouse 0.50 amps AC 4.95
3" Triplett 0-75 amps AC 3.95
3" WE 0-80 MA DC 2.95
3" GE 200-0-200 volts DC 2.95
3" McClintock 0-1 ma 3.95
3" Westinghouse 0-2 ma DC 3.95
3" Westinghouse 0-20 ma DC 3.95
3" GE 0-15 ma DC (square) 3.95
3" Westinghouse 0-150V AC 3.95
3" Westinghouse 0-150 volts AC Rectifier type (Linear) 5.95
3" WE 0-50 microamps 9.95
3" GE running time, 110 v. 60 cy 7.95

15 MEG 1% ACCURACY

Precision Resistors

Non inductive, 1 Watt, Hermetically sealed in glass .39c each; 10 for $3.50.

W. W. POWER RHEOSTATS

25 Ohm 25 Watt .... .39
300 Ohm 50 Watt .... .69
50 Ohm 50 Watt .... .69
1500 Ohm 50 Watt .... .69
Dual 200 Ohm 50 Watt .... .89

H. V. VARIABLES

Steatite Insulation

150 MMF .5 Spacing $17.50
250 MMF .5 Spacing 19.50
75 MMF .3 Spacing 9.50
250 per section .051 .... 3.95
250 per section .1 .... 5.95

MIDGET VARIABLE BARGAINS

Hammerlund MC 250S 250 mmf .... $ .60
Hammerlund MC 320S 320 mmf .... .79
Hammerlund APC 100 100 mmf .... .39
Bud MC 913 35 mmf. D.S. 1.25
Hammerlund HF 15 15 mmf .... .39
National TMS 150 mmf .... .79

HIGH VOLTAGE MICAS

C.D. .001 600 W.V. Type 9 .... $ .19
C.D. .01 600 W.V. Type 9 .... .29
C.D. .027 600 W.V. Type 9 .... .49
C.D. .0005 5000 W.V. .... .79
C.D. .002 2500 W.V. 5000 V.T. type 9 .... .49
C.D. .002 3500 W.V. 7500 V.T. type 9 .... .69
Micomold .005 2500 W.V. type 4 .... .69
R.C.A. .02 2000 V. D.C. 1.75
Sangamo (F2L) .015 2000V D.C. 1.50
C.D. (6H) .0013 5000V. D.C. 1.00
C.D. (6H) .005 5000V. D.C. 2.50
R.C.A. .0002 2500 W.V. 5000 V.T. .... .30

VARIABLE CERAMICON TRIMMERS

1.5 to 7 MMF—.24
5 to 20 MMF—.24
4 to 30 MMF—.24
7 to 45 MMF—.24
10 to 110 MMF—.39

DAVEN AUDIO FREQUENCY METER MODEL 837E

Direct readings from 0-30 KC in 4 separate ranges on 6" Weston Model 271 Fan Meter. Built-in voltage regulated power supply operates from 115 volts 60 cycles, has high input impedance. With pick-up can be used to determine frequency in vibration tester. With suitable mixer can check deviation of R.F. carrier from standard. Mounts of 8¾"x19" rack panel. Complete with tubes. Slightly used but perfect. Only $59.50

"A POWERFUL BABY"

This plate transformer built to rigid Signal Corps spec. input 118 volts, 25 to 60 cycles. Has 2 separate 118 volt primaries and can be used on 110 or 220 volts. Secondary 800 volts center tapped at 775 mills. Exceptional regulation even when loaded to 900 mills! Fully cased—4 mtg holes, 37 lbs. net wt. 6½ x 6½ x 7⅛. Peak value at 7.95. 10 for $70.00

"BRUTE FORCE"

This fully encased choke 6 Henry at 550 mills. 28 ohms dc resistance. Built to rigid Signal Corps specs. Net weight 16 lbs. 5½ x 4¼ x 5⅜. A great buy at $4.95 each. 10 for $40.00.

FILAMENT TRANSFORMER

Two separate 118 volt, 25 to 60 cycle primaries. Can be used on 110 or 220 volts. Secondary 5 volts at 15 amps. Built to Signal Corps specs. Fully encased. 5 x 4¼ x 5⅜. Net wt. 10 lbs. $3.75 each. 10 for $30.00.

VERSATILE POWER

These transformers have many uses—filament, isolation, stepdown, bias, etc.
All have 2 separate primaries for 110/220 volt 25-60 cycle operation. Primaries. Can be used in series or parallel.
3 Choices of Secondaries:
Type 504—115 volts 500 mills and 6.3 volts 5 amps.
Type 505—115 volts 900 mills and 6.3 volts 2 amps.
Type 502—0.70-75 volts at 2.5 amps. (35-37 v. in series)
Fully encased—4 mtg. holes. 5⅛ x 4¼ x 5⅛.
Your cost any type .... $1.95 each
10 for $17.00

STEPDOWN TRANSFORMER

220/110 volts. 100 watts. Fully encased. 5⅛ x 4¼ x 5⅛. 110V. 60 cycle .... $2.49 each

AMERTRAN 3 KV PLATE

6000/2500 Volts C.T. at 1 Amp Pri 110/220 Volts 60 Cycles. 10 x 10 x 8. Wt. 120 lbs. $67.50

AMERTRAN PLATE 3000 VOLTS

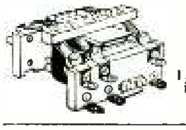
C.T. at 1 Amp. Pri 110/20 V 60 Cycles. 8x8½x7 Wt. 80 lbs. $32.50

SOLA CONSTANT VOLTAGE TRANSFORMER

Pri. 95-130 Volts. Sec 115 Volts. 335 VA. 2.9 Amps $29.95

U. H. F. COAX. CONNECTORS

UG12U—831R—831J—UG21U—831AP—831SP
.39 ea.



T.P.D.T. ANTENNA RELAY

110 V. 60 cycle coil Steatite insulation. Only $1.95 each

ELECTROLYTIC CONDENSERS

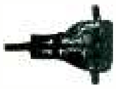
25 Mfd. 25 V.D.C. Tubular 25c
50 Mfd. 50 V.D.C. Tubular 29c
8 Mfd. 450 V.D.C. Tubular 37c
12 Mfd. 450 V.D.C. Tubular 44c
1000 Mfd. 25 V.D.C. 95c
20x20 Mfd. 450 V.D.C. $1.05

Tremendous stocks on hand. Please send requests for quotes. Special quantity discounts. Prices f.o.b. N Y. 20% with order less rated, balance C.O.D. Minimum order $3.00.

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"x10". Brand new with tubes plus running spare parts including extra tubes. Great value only $69.95.

SPERTI RF VACUUM SWITCH



9200 volts peak, 8 amps. Used as antenna switch in Collins ART 13. BRAND new $1.75

CHOKE BARGAINS

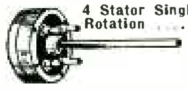
W.E. 4.3 hy 620 42 ohms .... $ 4.95
N.Y.T. 8 henry 160 ma. 140 ohms D.C. 1.39
C.T.C. 1.5 henry 250 ma. 72 ohms .... .60
R.C.A. 50 henry, 680 ma. high voltage 19.50

POWER PLANT (PE 197)

4 cylinder Hercules Gas driven engine. Output 110 volts 60 cycle, voltage regulated, 5KW-6.3KVA at 80% Pwr. Ptr. Single phase, complete with running spare parts, meter panel, battery, tools, remote cables, etc.
Weight 1200 lbs. Export Paacked. Excellent for emergency power. Brand new $575.00

Scope Transformer hermetically sealed 1,800 volts, 4 ma, 6.3 volts, 9 amp. 2½ volts, 2.5 amps., 5 x 3¼ x 3¾ $5.95

4 QUADRANT PHASING CONDENSER

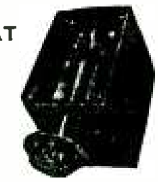


4 Stator Single Rotor. 0-360 Degrees Rotation .... Only 2.95 each

AMERTRAN TRANSTAT

or Stepdown Transformer

110/220 volts 60 cycle input. Output variable plus or minus 10% of 115 volts at 8.5 amps. Also can be connected to give different voltage combinations. Brand new .... only $12.95



AMERTRAN VOLTAGE REGULATOR

130/230 volts 50/60 cycles input. Output variable from 0—260 volts, 1.3 KVA, single phase. Used but good $19.50

OIL CONDENSER

1 mfd 250 vac—.85
5 mfd 150 vac—.49
1 mfd 600 vdc—.29
2 mfd 600 vdc—.39
4 mfd 600 vdc—.59
3/3 mfd 600 vdc—.79
10 mfd 600 vdc—.95
14 mfd 600 vdc—1.35
2 mfd 1000 vdc—.79
4 mfd 1000 vdc—.95
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25
1 mfd 2000 vdc—1.45
2 mfd 4000 vdc—5.50
3 mfd 3000 vdc—3.95
1 mfd 5000 vdc—4.50

.15/.15 mfd 6000 vdc—1.95
.1 mfd 7500 vdc—1.95
.15/.15 mfd 8000 vdc—2.75
4 mfd 8 kv dc—19.95
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.03 mfd 16 kv dc—5.75
.65 mfd 12,500 vdc—12.95
.75/.35 mfd 8/16 kv—12.95
.1 mfd 25 kv dc—17.50
.02 mfd 20 kv dc—7.95

MISCELLANEOUS SPECIALS

2-11 mmf. Butterfly with ball bearings .... $ .59
G.E. S.P.D.T. Relay 10000 ohm coil .... .59
Heineman Circuit Breaker 5 amp. 110 v. A.C. .... .89
G.E. Solenoid W/Microswitches 24 V. D.C. .... .69
Microswitch 10 amps. (interlock) .... .59
C.H. Bat Handle Switch—D.P.S.T. 1½ H.P. .... .95
Veeder Root Counter .... .95
Trim Commercial Phones (High Imp) 4.50
I-196 Signal Gen. 5.95
I-114 Test Set 3.95
WE 6.3v 10 amp 2.95
TS 13 Handset 3.95

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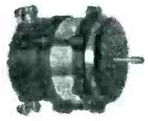


Kollsman 775-01 Selsyn

Ideal for Ham use as transmitter or receiver. 6-12 volts 60 cycles. 26 volts 400 cycles. Stock #SA-57.
Price $3.75

Size 5 Synchro Generator

Similar to Navy Ordance type 5G with shaft detail per Army Ordnance Dwg. C-78414. 115 v. 60 cy. Stock #SA-43.

Servo Motor

Pioneer Type CK-2. 2 phase 400 cycle. Fixed phase 26 V., var. phase. 49 V. max. 1.05 oz/in. stall torque. Stock #SA-97. **Price $4.75 ea. net.**

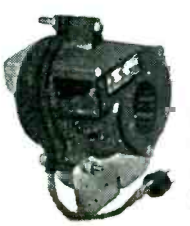
RATE GENERATORS

Elinco PM-2
2.0 v. DC per 100 rpm. Use to 2000 rpm. Stock #SA-53. **Price $7.50 ea.**

ELINCO F-16. 2 Phase AC. 1.3 v AC per 100 rpm. 60 cy. output at 1800 rpm. Stock #SA-193. **Price $12.50 each.**

SPERRY PHASE ADAPTOR — 661102. 115 volts 400 cy. Used for operating 3 phase equipment from single phase source. Stock #SA-194. **Price $6.75 each.**

Delco PM Motor—5068571
Alnico field. 27 v. DC. 10,000 rpm. 1" x 1" x 2" lg. 0.125 diam. shaft. 21/32" lg. Stock #SA-151. **Price $3.75 each.**



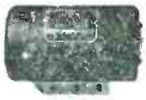
WESTINGHOUSE FL BLOWER

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price $6.75 each.**

SWEEP GENERATOR CAPACITOR

Hi-speed bearings. Split stator. Silver plated coaxial type. 5-10 mmf.

Stock #SA-167. **Price $2.75 each.**



DYNAMOTORS

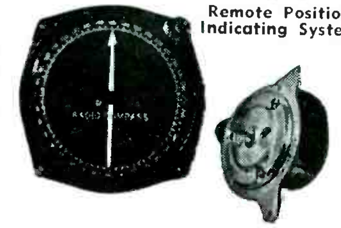
D-101. 27 v. DC in @ 1.5 amps. DC output 285 v. @ .060 amps. Stock #SD-187. **Price $1.50 each. DM-40A.** 14 v. DC in @ 3.4 amps. DC output 172 v. @ .138 amps. Stock #SA-188. **Price $3.25 each.**

MICROWAVE ANTENNA—

AS-217A/APG 15B. 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" diam. 24 V. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs.

Price $9.50 ea.

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

DC MOTORS

Synchron 10 RPM Timing Motor—24 V. Hanson Mfg. Co. Stock #SA-110. **Price $3.75 each.**

G.E. 10 RPM—5BA10FJ12—40 lb/in. 24 V. 1.1. amps. **Reversible.** Stock #SA-17. **Price $8.75 each.**

Westinghouse — 1171391. 27 V 6.5 amps. series. Fan cooled. 3" diam. 4½" lg., ⅛ H.P. Cont. duty. Stock #SA-156. **Price $6.75 ea.**

DC Timing Motor—Hayden ½ rpm. 29 volts. 100 mils. Stock #SA-157. **Price $3.95 ea.**

Constant Speed DC Motor—G.E. 5BA25-MJ24. 24V DC 7100 rpm. RC noise filter. Stock #SA-100. **Price $8.50 ea.**

$250 RPM. Delco 5067127—27 V PM field. 1¼" diam. x 3¼" lg. 42 tooth ⅝" pitch diameter pinion on 0.250" shaft. Stock #SA-108. **Price $2.95 each.**

John Oster. Series wound 27 V. 7,000 rpm. 1/100 H.P. Stock #SD-30. **Price $3.75 ea.**

28 V. DC DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $6.50 each.**

NOTE

All merchandise is new and guaranteed to meet manufacturer's specifications.

SELSYN SPECIAL

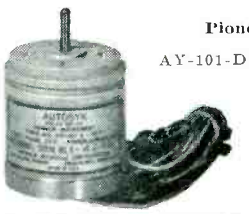
W.E. KS-5950-L2. Size 5. 115 v. 400 cycles. Use on reduced 60 cycles. Stock #SA-182. **Price $4.75 each.**

MAGNESYNS
Pioneer CL-3

6 power Magnesyn. Use as transmitter or receiver. 26 v. 400 cy or 52 v. 800 cy. Stock #SA-6. **Price $3.75 each.**

PRECISION AUTOSYNS

Pioneer Types AY-101-D and AY-131-D



Special Quantity prices.

Phase Shift Capacitor—4 stator single rotor 0-360° phase shift. Stock #SA-114. **Price $4.75 ea.**

400 Cycle Inverters

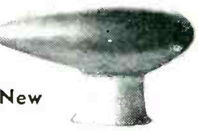
Pioneer—12116-2-A. 12123-1-A.
Holtzer Cabot—MG-149F. MG-149H.
General Electric—5D21NJ3A, 5AS131JJ-11A.
Leland—10563 and PE-218.

INVERTER—Wincharger PU-7/AP—Input 28 v. DC at 160 amperes. Output 115 v., 400 cy. @ 2500 V.A. Voltage and frequency regulated. Cont. duty. Wt. 75 lbs. Stock #SA-164.

800 Cycle Inverter

Navy Type CRV-21AAR. GE. 5AS121LJ2. 27 v. DC input @ 45 amps. 120 v. 800 cy. output @ 750 V.A. P.F. 0.90. Wt. 22.5 lbs. Stock #SA-192. **Price $39.50 each.**

LP-21-LM Compass Loops



New

Original Cartons
Stock #SA-99.
Price $9.50 each

110 RPM MOTOR

G.E. 5BA10J18D. 27 V. @ 0.7 amps. 1 oz/ft torque. 1⅜" diam. x 3½" lg. Operates on AC or DC. Stock #SA-98.

Include 15¢ for P.P. and handling
Price $2.95 ea. net

Write for complete listing, or call ARmory 4-3366

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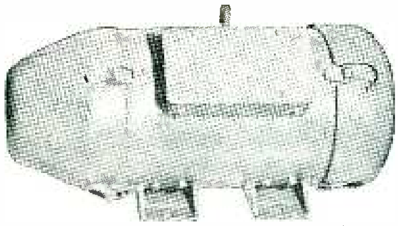
Incorporated
Surplus Division

Open account shipments to rated concerns.
All prices F.O.B. Paterson, N. J.

4 Godwin Ave. Paterson, N. J.

BIG VALUES IN SURPLUS

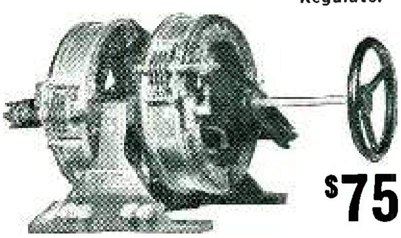


MOTOR GENERATORS

Built by Allis Chalmers to U. S. Navy Specifications

Input: 115 Volts, DC at 14 amperes. 3600 speed, ball bearings. Output: 1.25 KVA; 80% P.F.; 120 Volts, 10.4 Amperes. With resistive control of voltage output and frequency built-in and with Centrifical automatic controller built-in, permitting line-start operation. Fully enclosed. Splashproof. Brand New in Original Factory Cases. **Price $100.** Same machine for 230 Volts, DC operation. **Price $120.** Spare parts kit of brushes, brushholders, ball bearings, field coils, etc. in steel case, **Price $10.**

"TRANSTATS" *Amertran Voltage Regulator*

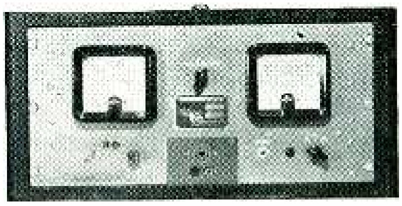


$75

11.5 KVA; 50/60 cy. Commutator Range 0-115 V. Max. Amp. 100. Can be reconnected for 230 volts @ 50 MA.

BRAND NEW

Fitch Radio Crystal Duplicator Model QZ-1000



Calibrates crystal plate of unknown frequency against standard plate of desired frequency. Consists of standard and test oscillators whose outputs are mixed to produce an amplified beat note the frequency of which is shown on meter with ranges of 500. 5000, 50,000 cycles. In sturdy metal cabinet with hinged cover, 9"H x 13"W x 19"L. 4" square activity and frequency meters on front panel. Complete with tubes. Used but in excellent condition.

$22.50

An Outstanding Value

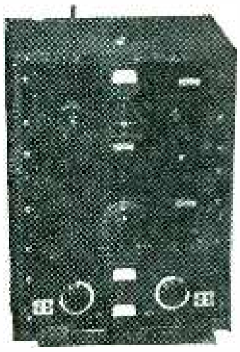
List Price $5500—Our Price $750

THEROMIC INDUCTION HEATER

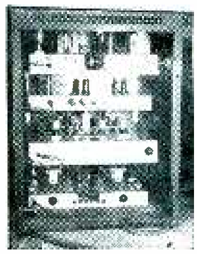
Mfd. by Induction Heating Corp. of N. Y. Model 1070. Used for heat treatment of steel. Input: 220 V. 1 ph., 60 cy. 170 A. Output: 20 KW 375,000 cy. Water cooled. Uses two RCA Type 892 tubes and four Amperex Type 575 A tubes.

Used but looks like new. Complete with tubes **$750**

RCA Crystal Test Equipment



Consisting of 2 Power Supplies #TX-1403A
1 Audio Mixer (TX-1404A)
1 High Frequency Oscillator (TX-1417A)
1 Duplex Oscillator (TX-1418A)



Complete unit in heavy steel cabinet, 20" x 28" x 15". Wrinkle enamel finish. Front panel ⅛" black Bakelite. Doors on top and rear of cabinet for easy accessibility. Connections to each unit made quickly with cords and connectors.

Well Regulated Power Supplies. Supply No. 1 uses:

2—6L6's, 1—6SJ7, VR-75,30, VR 150-30,—for current and voltage regulation. DT Toggle Switch in back of chassis for either "High" or "Low" voltage. Supply No. 2, for low power consumption, uses same tubes except VR 150-30.

Audio Mixer contains 3 tubes—6L7, 6SJ7, 6V6. Standard Fone Jack on panel for local monitoring. Volume control also employed. Other units as designated above are linked with Mixer.

High Frequency Oscillator divided into four ranges: 10-13 MC; 12.5-15.5 MC; 15-18; 17.5-20 MC, each is push button controlled. On front panel is National PW-D micrometer dial which reads 0-500 degrees, controlling a four gang variable condenser.

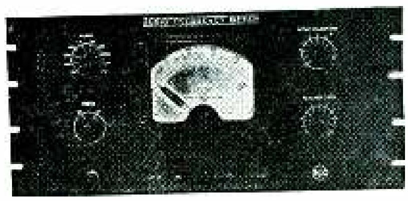
Duplex Oscillator—consists of 2 variable condensers, with coil assembly in conjunction with 1 each 6P5 and 6J5 tubes. On front panel are 2 GE 3" square meters, 0-300 microamperes and 0-30 milliamperes. The two variable condensers are tuned by National Velvet Vernier Dials.

Each unit is separable, can be easily removed—and can be used individually as a separate unit.

USED, BUT EXCELLENT CONDITION—PRICE—$75

RCA Audio Frequency Meter Type 306-A

Can be used to great advantage in industrial applications when the frequency in cycles per second is converted to r.p.m. also used to check frequency of unknown sources of voltage; as a check on calibration of beat frequency oscillators or other generators.



Features

- Direct reading—0 to 50,000 cycles.
- Regulated Power Supply.
- Ten ranges. 6" meter scale.
- Output drives recording meter direct
- Accuracy unaffected by input wave shape.
- Limiting circuit makes reading independent of input voltage over wide range.

Specifications:

Frequency Range .... 0-50,000 cycles in ten ranges
Input Voltage .... 1 to 200 volts rms
Input Impedance ..... 25,000 ohms
Recorder Output ..... 5.0 ma. 1000 ohms max.
Accuracy .... ±2%
Power Supply .... 105-125 volts, 50-60 cycles
Power Consumption .. 70 watts

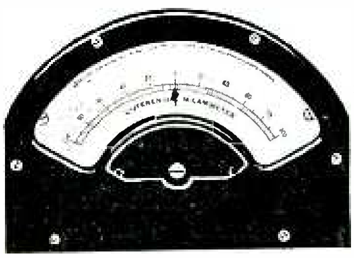
Height 8⅜"; width 19"; depth 13⅝"; weight 41 lbs.

Used but in excellent condition

AN ELECTRO VALUE...$75

MILLIAMMETERS

Weston Model 264 and Jewell Model 52



Designed for use as balance indicators on telephone and telegraph circuits but are equally as well suited for use in the laboratory or anywhere that a vertical scale desk type of meter is desired. Permanent magnet moving coil type. Scale length: 4⅛". Weighs 3½ pounds. 6"x2½"x4 5/32". Range: 150-0-150 M.A., D.C. accuracy within ½ of 1%.

Used But Good Condition OUR BARGAIN OFFER **$2.50**

Heavy Duty TRANSFORMERS

Primary: 55 V. Secondary: 10 V @ 238 Amps., 2.38 KVA. Dimensions: 9½"x7½" x8½".

Two transformers can be put in series to operate on 110 V Input, giving secondary of 20 V, 238 Amps.

BRAND NEW INDIVIDUALLY CASED

$12.50 each

2 units for $22.50

G. E. Distribution Transformers

Spirakor—Oil Filled

3 KVA 50-60 cycles 1 phase
Type HS Form W2F Continuous Duty.
Primary: 3000/5200 Y Volts
Secondary: 115/230 Volts
Dimensions: 23" High x 13" Diameter
Brand New Individually Cased **$36**

All prices F.O.B. Boston. Orders accepted from rated concerns on open accounts. Net 30 days.

Write for 112 Page Catalog on company letterhead

Electro Sales Company

Dept. E-9, 110 Pearl Street, Boston 10, Mass.

SURPLUS BARGAINS!

D. C. AMPS & MILLS

0-1 Ma 2" G.E. DW41 (special scale)	$2.95
0-1 Ma 2" Weston 506	3.75
0-2 Ma 2" Sun 1AP525-5	2.25
0-3 Ma 2" Weston 506 with metal case	2.35
0-5 Ma 2" Dejur S-210	2.25
0-25 Ma 2" G.E. DW41	2.95
0-30 Ma 2" G.E. DW41	2.95
0-35 V. 2" Simpson (metal case)	2.95
0-100 Ma 2" sq. Simpson 127	2.95
0-500 Ma 2" G.E. DW41	3.25
0-1 Ma 3" G.E. DO-41	4.95
0-15 Ma 3" Westhse NX-35 (scale: 15/150/300)	3.35
0-10 A. 3" Simpson #25	4.50
0-300 A. 3" Roller-Smith	4.95
50 MV (fl. bake Type TD (Black or White Scale)	4.95
0-300 A same as above (without shunt)	2.25
0-30 Ma DC G.E. DO-58, 4½"x4" (Black or White Scale)	4.95

All meters are white scale flush bakelite case unless otherwise specified.

D. C. VOLTS

0-15 V. 2" Westhse BX-33 (Black scale)	2.75
0-20 V. 2" Weston 506 (1000 Ohms per Volt)	2.95
0-40 V. 2" Weston 506	2.95
0-150 V. 3" G.E. DO-41	4.75
0-150 V. 4" Weston 643 (Black scale—flush—metal)	6.75

AC—VOLT AMMETER SET

Whse RA-37—4" SQ. 0-300 VAC Scale: 300/600 V AC With Potential TFMR $10.00
Whse RA-37—4" SQ. 0-5A AC Scale 75/150 Amps AC With Donut Current TFMR for Double Range 75/150 to 5 .... 10.00
ALL 4 PIECES 17.50

FREQUENCY METER RANGE

350-450 Cycles, Weston 637 Aircraft, 3½" Complete $4.95

A. C. AMPS

0-1.5 A. 2" Weston 507 (RF)	$3.50
0-3 A 3" Westhse NA-35 (scale: 120 A.)	4.50
0-30 A. 3" Triplett (metal)	2.95
0-5 A 4" sq. Triplett 431A (scale: 150/300)	2.95
0-75 A, 4" Weston 642 (Surface Metal Case)	6.75

A. C. VOLTS

0-10 V. 2" G.E. AW-42	$2.95
0-7.5 V 3" SQ Whse RA 35	$3.75
0-150 V. 2" Simpson 155 (metal case)	3.35
0-15 V 2" Weston 517	3.00
0-150 V 3" Triplett 331	4.50

PORTABLE A. C. AMMETER

Weston 528—Double Range 0-3 Amps, 0-15 Amps AC, Complete in leather case with test leads $12.25

RUNNING TIME METER

Industrial Timer Corp. 3½" RD. Total Hours, 4 Cardinal Digits, 1 Decimal Digit, 100-130 V 60 Cycles.
A BUY AT $7.95

SELENIUM RECTIFIERS

NEW . . . FRESH STOCK NOT OVER 6 MONTHS OLD
Full Wave Bridge . . Single Phase . . Resistive/Inductive Load
Conservatively Rated—Continuous Duty

Type	Max. RMS Input	Max. D. C. Output at 35°C	
3B-1	24	18 V @ 3.1 A	$5.03
5B-1	24	18 V @ 5.2 A	6.73
10B-1	24	18 V @ 10 A	8.71
1B-1	24	19 V @ 1.6 A	4.04
16B-1	24	19 V @ 16 A	16.40
24B-1	24	19 V @ 24 A	23.76
1B-2	48	37 V @ 1.2 A	7.21
3B-2	48	37 V @ 3.1 A	9.60
5B-2	48	37 V @ 5.2 A	13.37
10B-2	48	37 V @ 10 A	17.18
16B-2	48	37 V @ 16 A	30.89
24B-2	48	37 V @ 24 A	44.67
5B-6	144	110 V @ 5.2 A	35.70
2B-6	144	112 V @ 2.4 A	21.86
1B-6	144	114 V @ 1.2 A	17.34
2B-7	168	131 V @ 2.4 A	25.51
1B-7	168	133 V @ 1.2 A	19.68
5B-7	168	133 V @ 5.2 A	41.10

RECTIFIER TRANSFORMERS

PRI—105/110/115/120 V.—50/60 Cycles—Open Frame Construction

SEC		
18 V @ 2.5 Amps	4 lbs.	$3.35
18 V @ 5 Amps	5.5 lbs.	5.25
18 V @ 10 Amps	10 lbs.	6.75
18 V @ 25 Amps	25 lbs.	14.95
18 V @ 50 Amps	30 lbs.	24.75
36 V @ 2.5 Amps	7.5 lbs.	5.25
36 V @ 5 Amps	10 lbs.	6.50
36 V @ 10 Amps	20 lbs.	10.95
36 V @ 25 Amps	30 lbs.	22.50

PRI—115 Volts—50/60 Cycles—Open Frame Construction

SEC		
135/145/155/165 V @ .5 Amps	5 lbs.	5.25
135/145/155/165 V @ 1.5 Amps	15 lbs.	7.95
135/145/155/165 V @ 2.5 Amps	25 lbs.	13.50
135/145/155/165 V @ 5 Amps	35 lbs.	24.50

STEPDOWN TRANSFORMER .... SPECIAL OFFER

Made by G.E., Heavy Duty, Considerable Over-Design, Open Frame, Ideal For Rectifier Application, Etc. Size 3½" x 3½" x 4", PRI-115 V, 60 Cycles.

SEC — 15 V @ 12 Amps.... A Buy At.... $3.75
SEC — 10 V @ 18 Amps.... A Buy At.... 3.75

SELENIUM RECTIFIERS GOV'T SURPLUS NEW

APPROXIMATE RATING

No.	Mfr.	Type	In-put Max	Out-put Max	Amps.	Price
10B1CV1	FED.	FWB	18 V	14 V	.5	.98
5D1457	FED.	FWB	18 V	14 V	3.0	.65
13B2ARV2	FED.	FWB	28 V	16 V	10.0	7.85
199S1	B.L.	FWB	36 V	28 V	3.2	5.50
5B2 AV5	FED.	FWB	36 V	28 V	8.0	11.75
4B 3CV2	FED.	FWB	48 V	36 V	.5	2.75
11BA6AM1	FED.	FWB	120 V	100 V	1.6	11.95
1BOB7FF1C	B.L.	FWB	126 V	100 V	.1	2.50
2B7CV1	FED.	FWB	126 V	100 V	.1	2.50
9DO612R	FED.	FWB	150 V	115 V	1.6	14.50

RHEOSTATS

Ohms	Amps	Size-Diam	Price
.87	13	3½"	$2.50
6	2	1½"	1.75
10	9.2	14"	5.95
22	4.5-3.1	6"	6.50
30	1.7-.9	2½"	1.50
32	2.4	3½"	4.95
40	1.12	2"	2.50
50	1.11	2"	2.50
75	3.5	6"	7.50
100	1	3"	2.95
200	.25	1½"	.75
250	2.5-.51	6"	7.50

OHMITE POWER TAP SWITCH

Non-Shorting, Model 312, Cat. #312-10, 25 Amps A.C., 10 taps, without knob, Dimensions: 3¼" Diam. x 3¼" Deep.
Your Price $1.50

CAPACITORS

Cap. Mfd.	Volts D.C.	Height Width Length	Price
10	1000	5-7/8 x 1-3/4 x 3-7/8"	$1.85
4	1000	5-7/8 x 2-3/4 x 1-1/4"	.85
1	1000	3-5/7 x 2 x 1-1/16"	.50
1	500	2" x 1-1/4" x 1-1/16"	.25
.25	1000	1-1/2 x 1" x 3/4"	.25

.001 Mfd.—50 K.V. DC.—5⅛"x7¾"x4" $12.50 Insulators 4" Dia. x 7" High.
.1 Mfd.—25 K.V. DC.—13"x7"x4" $9.85

HEINEMAN CIRCUIT BREAKER

For use with low voltage, D.C., 100 Amps. Dimensions: 3¼"H x 4"D x 1" W $1.75

RECTIFIER TUBES

6 Amp. (Tungar Type) for battery chargers, rectifiers.
Your Cost $1.50
Minimum Order .... 10 Tubes

15 Amp, 115 V AC, Curve 3, CAT.AM 2511-15 .... $1.75
35 Amp, 120 V AC, Curve 2, CAT.AM 1510R-35 .... $1.75
1.5 Amp, 117.5 V AC, Instant Trip $1.75

STRUTHERS-DUNN RELAYS

D.P.S.T., Normally open, 115V, 60 Cycle, A.C. coil, 30 Amp contacts, fibre base with 4 holes for mounting. Dimensions, 4½" L x 3" W x 2¾" H.
A Real Buy At $2.50

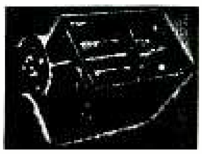
HEAVY DUTY STEPDOWN TRANSFORMERS

Input: 115 V. (with 8 taps in primary).
Output: from 16 to 10.5 V. (in 8 steps).
Capacity: 1.25 KVA—Sec. Amps: 100.
Size: 13"x10"x5". Approx. Weight: 30 Lbs.
Open Frame Construction.
Your Cost **$12.50**
10 for **$100.00**

POWER TRANSFORMER

Pri.—440/220 V 60 Cy Sec—125/115/105 V Rating .8 KVA RCA Open construction. Bracket mounted, pri & sec terminal boards. Overall dimensions: 5¾"H x 7½"W x 8"D. Mounting dimensions: 6⅞"x5⅞".
Price **$12.50**

TRANSTATS—3 K. V. A.



Type RH Input: 115 V. 10%. Output: 115 V. Max. Amps: 26 A. Made as a line voltage corrector 10% of input voltage, or can be connected to give plus 20% or minus 20% of input. Can also be reconnected to be used as an isolated type stepdown with variable secondary. Input: 115 V. Output: 0-30 Volts at 30 Amps. No Knob.
***A Real Buy at* $18.00**
(same type but .25 KVA. Input: 103-126 V. Output: 115 V.-2.17 A.) **Price $6.50**

ALL PRICES INDICATED ARE FOB, OUR WAREHOUSE, NEW YORK, N. Y.

Shipments Transportation Charges Collect Will Be Made Via Railway Express Unless Sufficient Postage Is Included, Or Other Instructions Issued. We Will Refund Excess Postage In Stamps.

POWERTRON Electrical Equipment Co.
117 LAFAYETTE STREET *Phone:* **WOrth 4-8610** **NEW YORK 13, N. Y.**

RELIANCE SPECIALS

OIL FILLED CAPACITORS

.1 mfd	12,000 V. DC	$4.95	10 mfd	2,000 V. DC	4.25
.2 mfd	10,000 V. DC	4.25	8 mfd	2,000 V. DC	3.70
.1 mfd	7,500 V. DC	1.95	2 mfd	2,000 V. DC	2.65
.1-.1 mfd	7,000 V. DC	2.45	4 mfd	1,000 V. DC	1.00
.1 mfd	7,000 V. DC	1.95	3 mfd	1,000 V. DC	.80
.1 mfd	6,000 V. DC	1.65	1 mfd	800 V. DC	.40
.03-.03 mfd	6,000 V. DC	1.65	10 mfd	600 V. DC	1.35
.01-.03 mfd	6,000 V. DC	1.60	4 mfd	600 V. DC	.69
.01 mfd	6,000 V. DC	1.45	1 mfd	600 V. DC	.35
.1 mfd	3,000 V. DC	.90	6-2 mfd	450 V. DC	.55
.2 mfd	750 V. AC	.90			
	(2,200 V. DC)	.49			

ORDER Your Coaxial Cable NOW at these never again PRICES!

RG 8/U—NEW-UNUSED 52 OHM

Very low DB loss

500-2500 feet ....$40.00 per M
3,000-5,000 feet .... 35.00 per M
5,500-10,000 feet .... 30.00 per M
10,500-20,000 feet .... 27.50 per M
over 20,000 feet........................ 25.00 per M

No charge for reels.

TRANSFORMERS & CHOKES

Current	HV	6.3V	5V	Case	Price
250 ma	800 V. CT	8A	3A	4"x4 3/4"x6" high	$4.50
70 ma	650 V. CT	2A	3A	3"x2 1/4"x4" high	2.35
400 ma	12 Henry	90 ohm		4 1/2"x5" 3/8"x4 1/4"	3.85
110 ma	9 Henry			3" Dia.x4" High	1.20

COAXIAL FITTINGS

Hood 10¢ — Socket 40¢ SO 239 83-1R — Plug 40¢ PL-259 83-1SP — Angle Adaptor 40¢ M-359 83-1AP

PL259A, 831SPN, 83-1J, UG21U, UG22U, CUF 49190 (83-1SP with small hole for RG59U Coaxial Fittings) UG85U Baby "N" plug, UG27U. 40¢ each

UG87U Baby "N" Socket, Gold Plated with Hood Attached ....50¢ each

UG28U—"N" type Tee ....$1.00 ea.

GENERAL RADIO FREQUENCY METER

100 Kc—5200 Kc (30 Mc on harmonics)

Reg. price $695.00

Reliance net only $295.00

UNIVERSAL JOINT

ALUMINUM

1⅛" long x ½" O.D. ¼" ID

35¢

ALLEN SET SCREWS

2-56x1/16	6-32x1/8	1/4-20x1/2
4-40x1/8	8-32x1/8	1/2-16x3/8
4-40x3/16	8-32x3/16	

All sizes ....$1.50 per C
Wrenches (2-56 out of stock)........................2¢ each
Allen Socket Head Screws, stainless steel, 10-32 size 3/8", 1/2", 1 1/8"........................$3 per c

FILAMENT TRANSFORMER

WESTINGHOUSE #6D4298

Tested at 34,000 volts

Pri. 115 V.A.C., Sec. 5V @ 6.5 Amp.

ONLY $8.50

POSTAGE STAMP MICAS

MMF	56MMF	200MMF	630*MMF	.002MFD
8.2	60	220	650	.0022
10	68	300	680	.0027*
20*	70	360	800	.003*
22	82*	390*	820*	.0033*
25*	90*	400	.001MFD	.0039*
33*	110*	470	.0012	.0047
39	120*	500*	.0013*	.0068*
47	150	510	.0015	.0082
50	185*	525*	.0016	.01

*Silver Mica

Price schedule

5MMF to .001MFD	—5¢ Silver Mica	10¢
.0012MFD to .0027MFD	—7¢ Silver Mica	20¢
.0029MFD to .0068MFD	—12¢ Silver Mica	50¢
.0082MFD	—16¢ .01MFD	18¢

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5E	3/16"	1/2"	5/32"	25¢
ND 34	5/32"	5/8"	3/16"	30¢
ND 38	5/16"	1 3/64"	9/32"	45¢
Timken	1/2"	1 3/8"	7/16"	85¢
ND5202C13M	1/2"	1 3/8"	1 3/8" (dual)	1.25
ND 88503	43/64"	1 37/64"	21/32"	1.00
MRC 206SFE	1 3/8"	2 7/16"	5/8"	1.25
Fafnir 545	2 1/6"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

	ID	OD	
B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X1/4" wide	3/16"	11/32"	25¢

STAINLESS STEEL SHAFT 3/16" dia. x 12" 15¢

FEDERAL TEL. STEPPING RELAY — UA12486, 6 pole, 11 position, 24V.D.C. Coil $3.95

DELAY NETWORKS. 1400 ohm, in small cans (look like I.F.) made up with ceramicans and R.F. chokes. Ideal for making pulse generators, etc.

T113—approx. 1.2 micro second delay..............85¢
T114—approx. 2.2 micro second delay..............85¢
T115—similar to T114 with tap brought out........85¢

METER — 10-0-10 MA. D.C. (60-0-60 Amp. D.C. Scale), 2" $2.45

BC 1072 A IFF X'MITTER in MAPLE CHEST

150 to 200 Mcs
115 V., 60 Cyc

POWER SUPPLY gives: 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 V.A.C. Also contains: 11 tubes (6J5, 826, 6SN7, 5U4G, etc.). 5 KV meter, Blower, Condensers and many other useful parts too numerous to list. Used. Shipping Wt. 245 lbs.

Only $22.50

SELSYNS

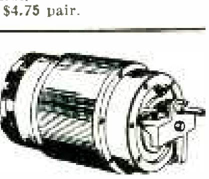
ONLY $7.25 pair

#C78248

115 V., 60 Cyc., 3¼" dia. x 4½" body. Used in Pairs for Remote Control.
Also 50 V., 50 Cyc. $4.75 pair.

SELSYN DIFFERENTIAL #C78249

ONLY $2.25 ea.



115 V., 60 Cyc.

Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Also 50 V., 50 Cyc. $1.50 ea.

PRECISION RESISTORS

1% or better

Any Order For
100 pieces ....10% Off
1000 pieces ....20% Off

¼ WATT—30c

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—30c

.250	2.04	97.8	300	4,451
.334	2.25	125	400	5,000
.502	11.1	180	723.1	5,900
.557	13.15	210		6,500
.627	46	235	2,500	7,000
.76	52	260	2,850	7,500
1.01	55.1	270	3,427	8,000
1.53	75	298.3	4,000	8,500

PULSE TRANSFORMERS

#352-7250 (±3db 100 cy to 175 kc).........$1.25
D166638 (Permalloy) 1.25
9280 UTAH 1.50
KS9800 (Permalloy) 2.00

HARDWARE ASSORTMENT (mostly brass) —screws, nuts, washers, solder lugs, etc. 3 lbs. $1.00

SLIP RING ASSEMBLY—5 silver plated rings on molded bakelite rotor. Stator holds 2 silver carbon brushes for each ring. Rotor 3⅞" O.D., fits 1¾" shaft. Complete with brushes $2.95

BRASS BINDING POST screw down with 8-32 mounting screw, per hundred....$2.50

HANDLES—Brass 5/16" round stock, 1¾" long, 1½" high, black, tapped 8-32 10 for 70¢

GEAR REDUCTION BOX—Aluminum housing, 16½ :1 ratio, 5¼" x 2¾" x 6" plus couplings & base $5.00

½ WATT—35c

10,000	15,000	17,000	25,000	100,000
14,825	15,750	20,000	37,000	150,000

1 WATT—30c

1.01	3.39	10.1	270	5,000
2.58	5.05	10.9	1,250	7,000
5	5.21	100	3,300	9,000

1 WATT—35c

18,000	30,000	55,000	70,000	75,000
20,000	50,000			

1 WATT—45c

100,000	128,000	180,000	470,000	600,000
120,000	130,000	250,000	522,000	700,000
125,000	160,000	320,000	525,000	

1 Megohm, 1W, 1%, 75¢: 5%, 45¢

RELIANCE *Merchandizing Company*

All Orders f.o.b. PHILA., Pa.

Arch St. Cor. Croskey, Philadelphia 3, Pa.

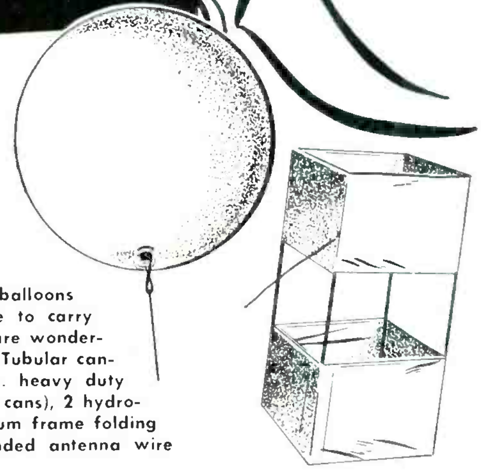
Telephone RIttenhouse 6-4927

MINIMUM $3 ORDER

WELLS
Radio-Electronic Components of *Guaranteed* Quality

10 METER MOBILE ANTENNA

This 8 ft., 3 section mobile antenna is by far the best whip we've seen. The elements are copperplated, spring steel tubing, painted O.D. for protection against the weather. A 4" ceramic insulator reduces losses to a minimum. Long service under extreme vibration conditions is assured by the special molded rubber spring mounting. Positive co-ax connector at base. Mobile Antenna complete—only $5.75 each.



BALLOONS AND KITES

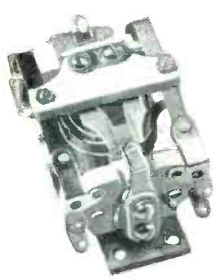
These Army emergency balloons and box kites were made to carry long wire antennas. They are wonderful for field and DX work. Tubular canvas bag containing 2 4-ft. heavy duty balloons (packed in sealed cans), 2 hydrogen generators, an aluminum frame folding box kite, 300 ft. of stranded antenna wire —only $9.95.

MICRO-SWITCHES AND SWITCHETTES

Our Micro-Switch and Switchette stock is one of the nation's largest. Listing 104A contains popular types at extremely attractive prices.

CO-AX CONNECTORS

Standard and British Type Co-axial Connectors in stock. Send for Listing 100A.



RELAYS

We have over a million relays in our warehouse. Huge quantities of hundreds of types make Wells the foremost source of equipment of this kind. Every relay is brand new and has been inspected, rated, individually boxed, and priced far below the market. Tell us your requirements or write for our Relay Catalog.

WALKIE TALKIES

A self-contained portable 10 and 6 meter transmitter-receiver. Wells Walkie-Talkies are shipped ready to operate complete with new batteries, telescoping antenna and handset. Rebuilt by the Government. Price only $45.00. Parts, batteries and accessories for Walkie-Talkies and Handie Talkies available from stock. Write for listing No. 20.

WELLS TREMENDOUS STOCK INCLUDES A WIDE SELECTION OF THE FOLLOWING COMPONENTS:

- Transmitting Tubes
- Mica Condensers
- Transmitting Condensers
- Wire & Cable
- Transformers & Chokes
- Terminal Strips
- Wire Wound Resistors
- Volume Controls
- Rheostats
- Dry Disc Rectifiers
- Tube Sockets
- Selector Switches

Manufacturers and Jobbers Write for Latest Complete Electronic Catalog

AMATEURS:
See us in Milwaukee at the ARRL Convention.
Write for Amateur Catalog H400C

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. S-L; CHICAGO 10, ILL.

RADIOMEN'S HEADQUARTERS — WORLD WIDE MAIL ORDER SERVICE ! !

BUFFALO RADIO SUPPLY, ONE OF AMERICA'S LARGEST ELECTRONIC DISTRIBUTORS, IS IN A POSITION TO SUPPLY MOST OF THE REQUIREMENTS OF FOREIGN PURCHASERS, DIRECTLY FROM ITS GIGANTIC STOCKS OR THOSE OF ITS AFFILIATES. EXPORT INQUIRIES ARE SOLICITED BOTH FROM EXPORT HOUSES AND FROM FOREIGN GOVT. PURCHASING COMMISSIONS HERE AND ABROAD. EXPENSE CAN BE REDUCED AND REQUIREMENTS FILLED WITH A MINIMUM OF DELAY BY CONTACTING BUFFALO RADIO SUPPLY INITIALLY.

SOS EMERGENCY TRANSMITTER SOS

This is the famous Gibson Girl Transmitter that saved so many lives during the war. It is used as a distress call transmitter on boats and airplanes. The Gibson Girl is the easiest transmitter in the world to operate. No instruction or experience necessary. No external power supply required for operation. It is merely necessary to turn the crank on the top of the transmitter and power is generated and the distress signal is automatically sent out on the international distress frequency. Brand New Gibson Girl transmitter complete with tubes....................$9.95

Antenna Kit for Gibson Girl transmitter. This kit was designed to improve the effectiveness of the Gibson Girl Transmitter by increasing the range several times. The kit includes 300 feet of special antenna wire, two balloons for raising the antenna in calm weather, two hydrogen generators to inflate the balloons, a special box kite for antenna erection in windy weather, and a searchlight, powered by the crank operated generator in the transmitter. Complete kit $9.95

BUFRAD CAR RADIO ANTENNAS

All of our car radio antennas are made of triple plated Admiralty Brass Tubing, complete with low loss shielded antenna leads and high quality fittings.

SIDE COWL—BR-1, 3 sections extend to 66". Your price—single units—**$1.50**; in lots of 12—**$1.35 ea.**

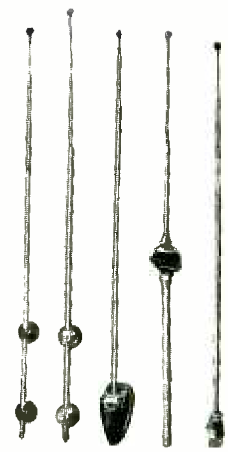
SKYSCRAPER—BR-2 has 4 heavy duty sections that extend 98". This super-aerial must be seen to be fully appreciated. Your price—single units—**$2.45**; in lots of 12—**$2.25 ea.**

TILT ANGLE—BR-3, may be adjusted to all body contours, 3 sections extend to 66". Single unit price—**$1.50**; 12 lot price—**$1.25 ea.**

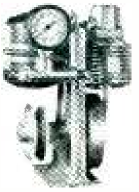
VERSATILE—BR-4, single hole fender or top cowl mounting may be adjusted to conform with all body contours, 4 sections extend to 56". Single unit price—**$2.90**; 12 lot price—**$2.75 ea.**

THE MONARCH—BR-5, single hole top cowl mounting, 3 sections extend to 56". Single unit price—**$1.90**; 12 lot price—**$1.75 ea.**

AFTER SEEING OUR ANTENNAS AND COMPARING, YOU WILL NEVER BUY ANY OTHER MAKE!



COMPRESSED AIR INSTANTLY, Anywhere!!



Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball-bearing on connecting rod and oil impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. **PATENTED** unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than one minute. Comes complete with 100 lb. gauge, although finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides, annealing or brazing with natural gas, inflating tires, etc. Price $14.50 postage prepaid anywhere in the U. S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose available for only $7.75 with pint container, also prepaid. 25% required on all C.O.D. orders. Send for free catalogs of radio parts and surplus items.

AUTO-TRANSFORMERS—Steps up 110v, or steps down 220v to 110v—$1.95.
FIL. TRANSF.: 6.3v, 20 Amps.—$1.98; Universal Output Trans. 8 Watt—89c; 18 Watt—$1.29; 30 Watt—$1.69. **AUDIO TRANSFORMERS:** S. Plate to S. Grid, 3:1—79c; S. Plate to P.P. Grids—79c; Heavy Duty Class AB or B. P.P. inputs $1.49; Midget Output for AC-DC sets—69c; **MIKE TRANSFORMER** for T-17 Shure microphone, similar to UTC ouncer type—$2.00. Stancor SB or DB mike to line or grid—$1.95.
POWER TRANSFORMERS Half-shell type, 110V, 60 cy. Centertapped HV winding. Specify either 2.5 or 6.3V filament when ordering.

For 4-5 tube sets—650V, 40MA, 5V & 2.5 or 6.3V	$1.49
For 5-6 tube sets—650V, 45MA, 5V & 2.5 or 6.3V	1.75
For 6-7 tube sets—675V, 50MA, 5V & 2.5 or 6.3V	1.90
For 7-8 tube sets—700V, 70MA, 5V & 6.3 or two 2.5V	2.35
For 7-8 tube sets—700V, 70MA, 5V & 6.3 (25 Cycle)	3.60
For 8-9 tube sets—700V, 90MA, 5V-3A, 2.5V-3.5A, 2.5-10.5A	2.85
For 9-11 tube sets—700V, 5V & 6.3V-4A......	2.85
For 9-15 tube sets—600V, 150MA, 5V & 6.3V.	2.95

BENDIX SCR 522—Very high Frequency Voice Transmitter-Receiver—100 to 156 MC. This job was good enough for the Joint Command to make it standard equipment in everything that flew, even though each set cost the Gov't $2500.00. Crystal Controlled and Amplitude Modulated—HIGH TRANSMITTER OUTPUT and 3 Microvolt Receiver Sensitivity gave good communication up to 180 miles at high altitudes. Receiver has ten tubes and transmitter has seven tubes, including two 832's. Furnished complete with 17 tubes, remote control unit, 4 crystals, and the special wide band VHF antenna that was designed for this set. These sets have been removed from unused aircraft and are guaranteed to be in perfect condition. We include free parts and diagrams for the conversion to "continuously variable frequency coverage" in the receiver.
The SCR 522 complete with 24 volt dynamotor sells for only **$37.95**. The SCR 522 is also available with a brand new 12 volt dynamotor for only **$42.95**.

STEATITE VARIABLE CONDENSERS

Ideal for high-frequency applications in receivers and low power transmitter stages.

STANDARD ¼" DIA. SHAFTS	SCREW DRIVER ADJUSTMENT
10 mmf $.35—10 for $2.90—100 for $23.00	
15 mmf $.35—10 for $2.90—100 for $23.00	$.20—10 for $1.80—100 for $16.00
25 mmf $.35—10 for $2.90—100 for $23.00	$.20—10 for $1.80—100 for $16.00
35 mmf $.40—10 for $3.40—100 for $28.00	
50 mmf $.45—10 for $3.70—100 for $30.00	$.20—10 for $1.80—100 for $16.00
75 mmf $.50—10 for $4.40—100 for $38.00	$.25—10 for $2.30—100 for $20.00
100 mmf $.55—10 for $4.50—100 for $39.00	$.25—10 for $2.30—100 for $20.00
140 mmf $.80—10 for $7.40—100 for $64.00	$.30—10 for $2.70—100 for $25.00
160 mmf $1.00—10 for $8.50—100 for $70.00	
140—140 mmf $1.60—10 for $12.50—100 for $100.00	$.40—10 for $3.60—100 for $32.00

Butterfly condensers, rotor has two ball bearings and a ¾" shaft.

15 mmf. per section $.50—10 for $4.50—100 for $40.00
30 mmf. per section $.60—10 for $5.50—100 for $50.00
50 mmf. per section $.70—10 for $6.50—100 for $60.00

Manufacturers and distributors write for prices on larger quantities.

WE HAVE OVER 250,000 VARIABLE CONDENSERS IN STOCK.

FILTER CHOKES: 200, 300, 400, 500 ohm light duty—**59c**; 200 or 300 ohm heavy duty—**99c**; 250 ma 35 ohm, made for U.S. Navy, fully shielded—**$1.95**; 75 ohm 125 ma—**25c**; or 25 for **$4.25**; "Meissner type" tapped filter chokes—**25c**; Choke-condenser combination, ideal to replace any size speaker field when installing PM speaker—**79c.**
LINE FILTERS—110V—each unit contains two 2 mfd. oil filled condensers and a 15 amp. iron core choke. This filter has innumerable uses such as oil burner line filter, etc. A ten dollar value for **98c.**
SELENIUM RECTIFIERS—Dry disc types 1½", 1". 1.2 Amp. maximum, suitable for converting DC relays to AC, for supplying filament source in portable radios, converting DC meters to AC applications, and also may be used in low current chargers—**90c.**
30 MC IF TRANSFORMERS, double slug tuned—**25c.**
30 MC VIDEO AMPLIFIER PLATE COILS—Slug tuned—**25c.**

RT-1579 consists of a three stage, cascade 6SJ7's and 6F6 output stage high gain, high fidelity amplifier with 60 cycle, 110V power supply on the same 13¼x 14½ chassis, which is protected by a substantial steel cover over tubes and parts. Made by Western Electric with typical quality components such as a husky power transformer and oil condensers, this unit is obviously intended to give years of trouble-free service with no more need for repairs than a telephone. Disconnecting one wire each, from the special input and output filters, will result in as high a fidelity amplifier as can be obtained. Your cost with tubes, diagram and parts list included—**$14.95.**

RT-1655 — 11 tube crystal controlled superhet receiver for 24-28V DC operation. Beautiful chassis and cabinet. Uses latest tube types including 7 miniature 6AJ5's. Tubes and schematic supplied. Only a few available at......................**$14.95**

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. 9-E BUFFALO 3, N. Y.

TELEVISION CAMERA EQUIPMENT

Available for immediate delivery.
DUMONT Type 5027-A IMAGE ORTHICON PICKUP HEADS, with type 5047-A ELECTRONIC VIEW FINDERS, complete with all tubes,—including 2P23 Image Orthicons.

Factory Reconditioned—Perfect Condition f.o.b. N.Y.C. Subject to prior sale.

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THE NATIONAL INSTRUMENT COMPANY
FAR ROCKAWAY, NEW YORK

Special Values

D. C. MICROAMMETERS

0-100 ua. 4" sq. G.E. DO 58.........	$12.00
same with "Volt-Ohm-M.A." scale..	12.00
0-100 ua. 2½" Gruen	4.00
0-100 ua. 4½" round Weston 643..	12.00
0-200 ua. 4½" round Weston 643..	10.00

R. F. MILLIAMMETERS

0-100 Ma. 3½" Weston 425	$ 9.00
0-120 Ma. 2½" Weston 507	7.00
0-10 Ma. 4½" Weston (vacuum)...	22.00

SHUNTS

150 or 240 Amps-50 Mv-aircraft type $1.00

PRECISION ELECTRICAL INSTRUMENT CO.
146 Grand Street New York 13, N. Y.

SO-7 RADAR SETS

10-cm Band, 275,000 watts peak pulse watts. Operate on 110v 60 cps AC, 3 KW

Unused, $1,950.00
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GULF COAST ELECTRONICS
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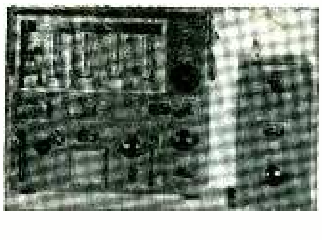
RADIOMEN'S HEADQUARTERS — WORLD WIDE MAIL ORDER SERVICE ! !



GENERAL ELECTRIC 150 WATT TRANSMITTER

Cost the Government $1800.00 • Cost to You—BRAND NEW—$67.50

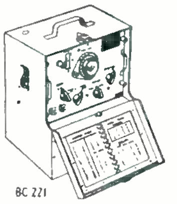
This is the famous transmitter used in U.S. Army bombers and ground stations, during the war. Its design and construction have been proved in service, under all kinds of conditions, all over the world. The entire frequency range is covered by means of plug-tuning units which are included. Each tuning has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits—all designed to operate at top efficiency within its particular frequency range. Transmitter and accessories are finished in black crackle, and the milliammeter, voltmeter, and RF ammeter are mounted on the front panel. Here are the specifications: FREQUENCY RANGE: 200 to 500 KC and 1500 to 12,500 KC. (Will operate on 10 and 20 meter band with slight modification for which diagrams are furnished). OSCILLATOR: Self-excited, thermo compensated, and hand calibrated. POWER AMPLIFIER: Neutralized class "C" stage, using 211 tube and equipped with antenna coupling circuit which matches practically any length antenna. MODULATOR: Class "B"—uses two 211 tubes. POWER SUPPLY: Supplied complete with dynamotor which furnishes 1000V at 350 MA, from either 12 or 24 volts. Complete instructions are furnished to operate set from 110V AC. SIZE 21½x23x9¼". Total shipping wgt. 300 lbs., complete with all tubes, dynamotor power supply, seven tuning units, antenna tuning unit and the essential plugs. NOTE: Price increases to $100.00 effective Oct. 1, 1948

GENERAL ELECTRIC RT-1248 15-TUBE TRANSMITTER-RECEIVER

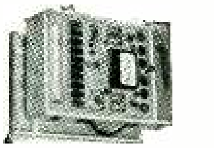
TERRIFIC POWER—(20 watts) on any two instantly selected, easily pre-adjusted frequencies from 435 to 500 Mc. Transmitter uses 5 tubes including Western Electric 316 A as final. Receiver uses 10 tubes including 955's, as first detector and oscillator, and 3—7H7's as IF's with 4 slug-tuned 40 Mc. IF transformers, plus a 7H7, 7E6's and 7F7's. In addition unit contains 8 relays designed to operate any sort of external equipment when actuated by a received signal from a similar set elsewhere. Originally designed for 12 volt operation, power supply is not included, as it is a cinch for any experimenter to connect this unit for 110 AC, using any supply capable of 400 DC at 135 MA. The ideal unit for use in mobile or stationary service in the Citizen's Radio Telephone Band where no license is necessary. Instructions and diagrams supplied for running the RT-1248 transmitter on either code or voice in AM or FM transmission or reception, for use as a mobile public address system, on 80 to 110 Mc, as an FM broadcast receiver, as a Facsimilie transmitter or receiver, as an Amateur Television transmitter or receiver for remote control relay hookups, for Geiger-Mueller counter applications. It sells for only **$29.95** or two for **$53.90**. If desired for marine or mobile use the dynamotor which will work on either 12 or 24V DC and supply all power for the set is only $15.00 additional.

BRAND NEW
BC-221 FREQUENCY METERS

with calibrating Crystal and calibration charts. A precision frequency standard that is useful for innumerable applications for laboratory technician, service man, amateur, and experimenter at the give away price of only **$75.00.**



BC 221



1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER

with new 9 pin socket to handle all future tube developments **$49.95**

No possibility of good tubes reading "Bad" or bad tubes reading "Good" as on dynamic conductance testers or other ordinary emission testers Attractive panel and case equal to any on the market in appearance... Large 4½" meter... Calibrated micromho scale as well as a Bad-Good scale ... Front panel fuse ... Individual sockets for all tube base types—voltages from .75 volts to 117 volts and complete switching flexibility allow all present and future tubes to be tested regardless of location of elements on tube base ... Indicates gas content and detects shorts or opens on each individual section of all loctal, octal and miniature tubes including cold cathode, magic eye and voltage regulator tubes as well as all ballast resistors. Name of the nationally knreading "Good" as on dynamic conductance testers or other

Model "C"—Sloping front counter case **$49.95**
Model "P"—Handsome hand-rubbed portable case **54.95**
Built-in roll chart with either of above **$5.00** extra.

RT1711 Brand New 12 Tube, 110 Volt Receiver-Indicator-Oscilloscope complete with all tubes and power supply. Has telescoping hood over scope tubes, which is equipped with a detachable calibrated screen. Has centering and amplitude controls and two video inputs. A natural for television **$39.95**

SELENIUM RECTIFIERS. All types are rated at 130 V.A.C. **Do not assort to make quantity.**

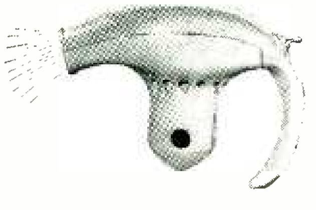
75 MA	**.70**	**10 for 6.50**	**50 for $31.00**
100 MA	**.75**	**10 for 7.00**	**50 for 32.50**
150 MA	**.80**	**10 for 7.50**	**50 for 35.00**
200 MA	**1.05**	**10 for 10.00**	**50 for 47.50**
250 MA	**1.25**	**10 for 12.00**	**50 for 57.50**

TERRIFIC VALUE— PORTABLE ELECTRIC DRILL

(Sold at less than established factory price so we cannot mention brand name.)

Only **$19.95** equipped with ¼" Jacobs Geared Chuck and Key.
Not an intermittent duty drill, but a full size rugged tool.
Most convenient type switch, natural grip handle, and balance like a six-shooter.
Precision cut gears—turbine type cooling blower—extra long brushes.
No stalling under heaviest pressure because of powerful 110 Volt AC-DC motor and multiple ball thrust bearing.
Other bearings self-aligning lifetime-lubricating Chrysler Oilite type.
Made for toughest year-in and year-out service in Plant or on construction jobs.
Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use.
25% deposit on C.O.D.'s. Full refund if returned prepaid within five days.

HEAT GUN



Streamlined pistol grip heat gun in vivid red housing, that delivers a powerful 20 Cubic Ft. per minute blast of hot air at 160 Fahrenheit. Ordinary blowers have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that produces a hurricane of either hot or cold air. Perfect for blowing out dirt or dust from radio chassis, drying out ignition systems, warming up carburetors, quick-drying paint, thawing out radiators or water pipes, etc. Warning:—Keep this away from your wife, or she will be using it to dry her hair because it will do it in half the time of her ordinary hair dryer, to say nothing of her using it to dry stockings or clothing, or defrost the refrigerator instantly. Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

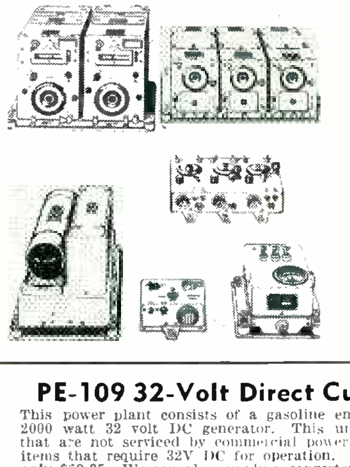
CONDENSERS—PAPER TUBULAR 600 WV—.001, .002, .005—**8c**; .01, .05—**9c**; .1—**10c**; .25—**23c**; .05—**35c**; **ELECTROLYTICS:** 8mfd 200v—**20c**; 10mfd 35v—**20c**; 30mfd 150v—**23c**; 20/20mfd 150v—**35c**; 30/20 150v—**46c**; 50mfd 150v—**43c**; 8mfd 475v—**34c**; 16mfd 350v—**65c**; **OIL CONDENSERS:** 4mfd 600v **49c**; 2mfd 600v—**29c**; 3X.1mfd 600v—**29c.**

SPEAKERS These PM speakers are the finest that are available. All have heavy oversize Alnico V magnets.

3½"		$1.15	6 for $6.60
4"		$1.15	6 for $6.60
5"		$1.10	10 for $9.50
6"		$1.50	6 for $8.70
7" (Car Radio Size)		$4.50	6 for $21.50
8"	10 oz.	$3.95	6 for $20.50
8"	21 oz.	$4.95	6 for $26.50
10"	21 oz.	$5.50	6 for $30.00
12"	21 oz.	$7.95	6 for $42.00

$5.95 Takes Both BIG BARGAINS

1. **ALUMINUM GEAR BOX** 18x8x7 that contains two powerful electric motors and two matched gear trains, 62 gears in all varying in size from ½ to 4 inches in diameter. This unit is readily converted to rotate a beam antenna or any other similar use.......... $3.00
2. **SENSATIONAL FASCINATING, AMAZING SELSYNS.** Brand new selsyns made by G. E. Co. Two or more connected together work perfectly on 110 VAC. Any rotation of the shaft of one selsyn and all others connected to it will rotate exactly as many degrees in the same direction, following unerringly as if the units were connected together by shafting instead of wires. This is true whether you twist the shaft of the master unit a fraction of a revolution or many revolutions. Useful for indicating the direction of weather vanes, rotating directional antennas, or controlling innumerable operations from a distance. Complete with diagram and instructions. Per matched pair $4.95



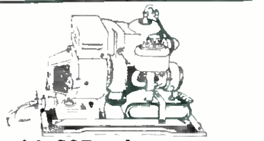
SCR-274N COMMAND SET

The greatest radio equipment value in history

A mountain of valuable equipment that includes 3 receivers that use plug-in coils, and consequently can be changed to any frequencies desired without conversion. Also included are two Tuning Control Boxes; 1 Antenna Coupling Box; four 28V. Dynamotors (easily converted to 110V. operation); two 40-Watt Transmitters including crystals, and Preamplifier and Modulator. 29 tubes supplied in all. Only a limited quantity available, so get your order in fast. Removed from unused aircraft and in guaranteed electrical condition. A super value at $34.95, including crank type tuning knobs for receivers.

PE-109 32-Volt Direct Current Power Plant

This power plant consists of a gasoline engine that is direct coupled to a 2000 watt 32 volt DC generator. This unit is ideal for use in locations that are not serviced by commercial power or to run many of the surplus items that require 32V DC for operation. **The price of this power plant is only $58.95.** We can also supply a converter that will supply 110 V AC from the above unit or from any 16-32 V DC source for $12.95.



Cable Address: BUFRAD

Minimum order $3.00—All prices subject to change—25% deposit with COD orders.

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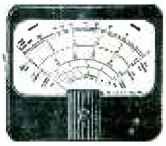
A LEEDS LEADER



- 50 microamp movement ± 2%
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This is the exact meter utilized in the G.E. YMW-IA Lab Type Unimeter
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Just Arrived

115 Volt AC 60 cycles. Transmitters only. Can be used to turn small beam antenna or as indicators only 3½" Diameter x 5½" High. Shipping Weight 10 lbs. Per Pair. Special Per Pair **$5.95**

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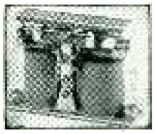

Dual coil with armature pivoted between coils. All contacts normally open. Operates 220-250 Volts, 8000 Ohms each coil, contacts S.P.D.T. Controls rated 2 amps. at 110 VAC. Ideally suited for balanced or bridge type circuits where limited current or power is available. Will withstand 12 G Vibration up to 60 cycles at 35,000 feet altitude. Special low price .... **95¢**

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100,000 ohm, precision made, G.R. type, 25 watt, 8" diameter. Brand New **$1.95**

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Variable Transformer for precise Voltage Control. Excellent mechanical construction, design, and durability.

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Ferris: 18B Signal Generator; 33A, 34A Crystal Calibrators.

Boonton: 120A V.H.F. Circuit Checker; 140A Wide Range BFO; 155A FM Signal Generator.

Hewlett-Packard: P-6255B Interpolation Oscillator 510-1000 & 1280-2520 CPS.

L & N: 4223 Precision Resistor; 7655 Portable indicators and Standard Cell.

Millen: P4E Synchroscopes.

Western Electric: RA 90A High Voltage Power Supplies; SID 353384 VT Regulated Power Supplies; TS/5AP Range Calibrator (Sweep Marker Generator); 15154, D 152213 Modulator Oil Units; TS9/APQ-5 Range Calibrator Modulator; 157A Output Transformers; Breakdown Testers, 500 volt.

Weston: Model 1; 0-300 M.A.; 0-500 Volt D.C. Model 45; 0-75 Volt; 0-300 Volt; 0-1500 Volt; 0-150 M.A.; 0-300 M.A. D.C.; 785 Industrial Analyzer.

Dumont: 213 Modulation Monitor.

G.E.: LU Radar Test Equipment.

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#3—6.3 Volts—0.6A
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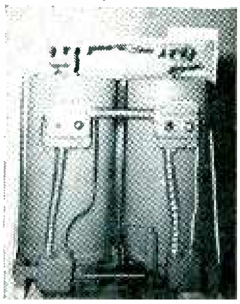

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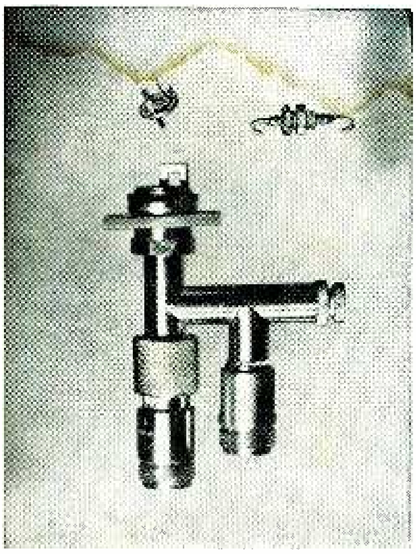

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TYPE N CONNECTORS, UG-10, 12, 21, 22, 24, 25, 27, 30, 58, 59, 83, 86, 190, 201, 245, and UHF connectors SO 239, PL 259 83 1AP, UG 266, complete with center contacts, immediate delivery.

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B1–1X5	1.5 AMP.	2.95
B1–3	3 AMP.	3.49
B1–5	5 AMP.	5.95
B1–7X5	7.5 AMP.	7.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–25	25 AMP.	20.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95

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B3–250	250 MA.	1.95
B3–600	600 MA.	3.25

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Type#	Current	Price
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B4–3X5	3.5 AMP.	15.95
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B6–250	250 MA.	2.95
B6–400	400 MA.	4.95
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B6–3X5	3.5 AMP.	21.95
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B2–3	3 AMP.	6.95
B2–5	5 AMP.	9.95
B2–6	6 AMP.	10.95
B2–7X5	7.5 AMP.	13.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
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Type#	Current	Price
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C1–30	30 AMP.	17.95
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C1–120	120 AMP.	46.95

* Select Proper Capacitor From List Shown Below, to Obtain Higher D.C. Voltages Than Indicated

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For Types B1 through B6, and Type C1 .....$ .35 per set
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For Types 3B .... 1.20 per set

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CF-13	6000 MFD	10VDC	$2.49
CF-14	3000 MFD	12VDC	1.69
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CF-2	2000 MFD	15VDC	1.69
CF-3	1000 MFD	25VDC	1.69
CF-4	2X3500 MFD	25VDC	3.45
CF-18	10000 MFD	25VDC	4.95
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-16	2000 MFD	50VDC	3.25
CF-17	50 MFD	150VDC	.59
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	200VDC	3.25
CF-11	100 MFD	350VDC	2.25
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All Primaries 115VAC 50/60 Cycles

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XF15–12	15	12	3.95
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TXF36–5	36	5	4.95
TXF36–10	36	10	7.95
TXF36–15	36	15	11.95
TXF36–20	36	20	17.95

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Type#		Amps.	Price
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HY3	.03 Hy	3	2.95
HY5	.02 Hy	5	3.25
HY8X5	.02 Hy	8.5	7.95
HY10	.02 Hy	10	9.95
HY12	.125Hy	12	12.95
HY15	.015Hy	15	13.95

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		Lots of 10	Lots of 100
100 MFD	50 VDC	$2.20	$19.00
50 MFD	150 VDC	2.00	18.50
8–8–20 MFD 350	150 VDC	4.70	43.00
*20–20 MFD 400	250 VDC	4.50	38.00
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15 MFD	450 VDC	2.50	20.00
15–15 MFD	450 VDC	3.00	22.00
40 MFD	450 VDC	4.20	36.00

* 4 prong plug-in type.

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With instruction and maintenance manual.

Specially priced

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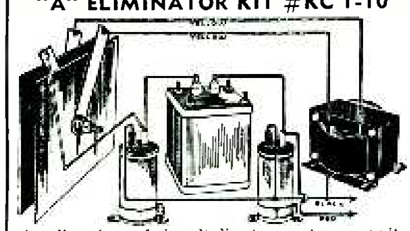
"A" ELIMINATOR KIT #KC 1-10



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Basic movement—approximately 12.5 ma. Shunt readily replaced permitting conversion to lower range scale.

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5FP7	.88	FG-235A	42.50	1625	.19		
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also—Model SL1, 10cm; Model APS/3 and APS/4, 3 cm; APR/4—TN/54 Tuning Units.

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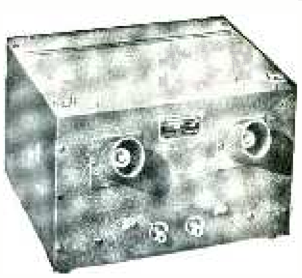

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This instrument was developed by the Boonton Radio Corp. to permit checking at VHF: Capacitance, Inductance and complete Resonant Circuits. Ideal for Television and FM Tuners, Quality control, etc. Four Frequency Ranges. Available for immediate delivery.

Catalog price is $320.00—Our price is $150.00 f.o.b. N.Y.C. Reconditioned, in good operating condition, subject to prior sale.

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FAR ROCKAWAY, N. Y.

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Transmitter-Receiver RT7/APN-1 Complete with 14 tubes—415 to 460 mc. MT-14/Arn-1 shock mount included—Navy inspected.

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Photograph 3 times actual size
Glass bulb 1/8"x3/8"
Soldering iron removes lamp from base
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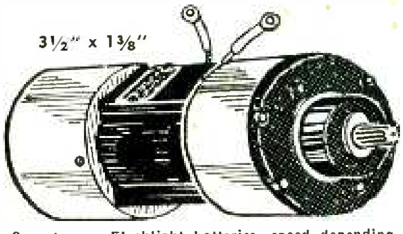
Used for illuminating Meters, Compass Dials, and Airplane Instruments.
Great for Models, Doll Houses, Miniature Trains, etc.

Dozen...... **$1.50** Post Paid

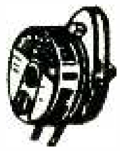
Also have G.E. 328 6v. .2A and 322

3½" x 1⅜"



Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc., 250 RPM. FEW MORE AT............ **$5.00**

12 Volt, 100 Watt Soldering Iron..... **$1.30**



HAYDON SYNCHRONOUS MOTOR

to operate switches, etc., can be had either 1 Rev. per hour or 1 Rev. per minute at this

SPECIAL PRICE **$3.85**

Many other speeds available at $4.95

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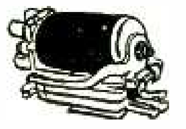


CLARE RELAYS

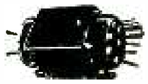
No. R30 3500 ohm 6MA SPDT 3a cont...89¢ ea.
No. R13 200 ohms 24v SPST N.O. ...49¢ ea.
No. R58 150 ohm 12v DPDT & SPST Norm clsd 3a cont.....49¢ ea.

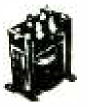
ALLIED RELAYS

No. R06 230 ohms 24v SPDT Dble Br 20A cont. ....49¢ ea.
No. 66 150 ohms 12v DPST N. O. ....59¢ ea.
G.M. Relay No. R16 240 ohms 24v 4PDT 10A. cont ....98¢ ea.
No. R31 40 ohms 12v SPST N. O. ....39¢ ea.

TRANSFORMERS & CHOKES

Pwr Trans: 1500v C.T. at 150ma. 6.3v 2.5a. 6.3v 1.6a. 5v 3a. 115v 50-60c pri G.E. .... **$4.89 ea.**





Fil Trans: 6.3v 8a. 115v 50 - 60c pri G.E.
$1.95 ea.

3 hy 5ma 325 ohms 1 9/16" d x 1¼" h 25¢ ea.

20hy 15ma 975 ohms G.E. Herm Sealed 2¼"x 1⅞"x2¼"
29¢ ea.

400 CY INVERTER 1500 VA 115V. SINGLE PHASE. INPUT 24V D-C MFR. LELAND ELECTRIC **$27.50**

G.E. JY 17 Current Transformers. 50 to 5A, 240 volts, 60c circuits.... **$7.50 ea.**

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Prices F.O.B. Our Plant

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500 Mfd 50V dry Electrolytice....... .95
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10 Mfd 600V Oil........ .95
2 Mfd 2500V Oil........ 2.40
2 Mfd 3000 Oil........ 2.75
.25/.25 6000V D.C. or .125 Mfd—12000V D.C. Oil........ 3.75
1.0 Mfd 25 KV........ 36.00
.001/25,000V Mica........ 25.00
50 MMF 32 KV Tubular vacuum........ 4.95

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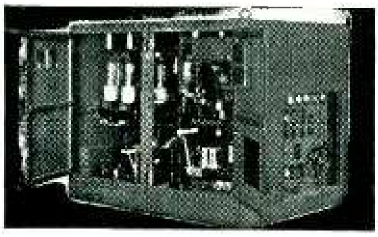
RC-117—Westinghouse Time Delay Current Relay, Type SC-M .2 to 1 amp A.C. or D.C. .8 amp continuous rating. Rating 20-40% drop out ratio $12.95. Net Wt. 3 lbs. Dim. 3" W x 5" D x 5⅜" H.



NEW RA38 POWER SUPPLY

115V., 60 cyc. input adjustable output 0-15,000V. A.C. or D.C. @ 500 Mils. Complete with set of New Tubes and remote control. Shipping weight 2100 lbs. **$250.00**

METERS

M-140 AB Weston Model 476-3" A.C. Ammeter, 3 Amps. full scale, Calibrated 0-120 Amps., flush mounting with 40/1 current trans..$8.50
Net wt. 3 pounds

M-143 A.B. Weston Kilovoltmeter-3". Model 301, 20 KV. @ 1000 ohms per volt, flush type calibrated for steel panel mountings with 20 meg. 20 KV Weston resistor complete with clips and standoff insulators............$18.00
Net wt. 4 pounds.

Multimeter, supreme model 543-s..$12.95
R. F. ammeter Weston 425-0-3 amps.$5.95

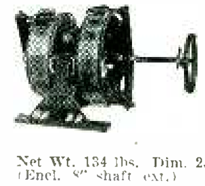
TRANSTATS

- 115 V. 50/60 cycle input 103-126 V. output @ 2.17 amps........ $9.95
- 115/230 V. 50/60 cycle input 0-260 V. output @ 2½ amps........ $21.50
- GR Variac, 115 volts 50/60 cycle input 0-135 V output @ 5 amps cased.$14.50
- 115 V. 50/60 cycle input, 0-135 V. output @ 10 amps........ $24.50

THERMOSTAT SWITCH. Fenwall —50°+400° F. 110-220 V. 2500 watt contacts, adjustable, $1.60

KV Meter Multiplier resistor 1 meg. 1/10% noninductive Wire Wound........ $1.25

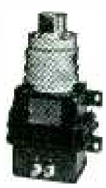
TRANSFORMERS



T-103—Voltage regulator Transtat, American Transformer Co. Spec. 29145 Max KVA output 11.5 50/60 cyc. 0-115 V. 100 amps. or 230 V. 50 amps. **$75.00**

Net Wt. 134 lbs. Dim. 25" W x 16" D x 17½" H (Encl. 8" shaft ext.)

T-102—Filament Transformer, American Transformer Co. Spec. 29106, Type WS .050 KVA, 50/60 cyc. Single phase, 35 KVA test, 12 KV D.C. operating. Primary 115 V, secondary 5 V., 10 amps with integral standoff insulator and socket for 250T, 371, 872, 5563, etc. rectifier tubes **$12.50**



Net Wt. 15¾ lbs. Dim. 6½" W x 6" D x 12" H.O.A.

PE-95G GASOLINE GENERATORS

10 KW, 100% P. F. 120/240 V. 60 cycle, single phase. Remote start, new, export packed with spares, tools. Gross wt. 2128 Cubic 70 $850.00

ONAN GASOLINE GENERATOR—Type CDO

73004-A (for TBW Radio Equipment) 120 V. 800 cycle, single phase @ 9.8 amps. and 14 V. DC @ 20 amps. New in watertight metal case. $140.00

WESTINGHOUSE—Type "AB" De-ion circuit breakers

Thermal trip—without enclosure 3 pole—50 amp frame size
Style 545-389 D 15 amp rating...... 9.50 ea.
Style 545-391 D 25 amp rating...... 9.50 ea.
Style 545-393 D 50 amp rating...... 9.50 ea.

HEATERS

H-149—Chromolox strip heaters, 300 W., 115 V. (¼x1½x12") $1.00

All merchandise in "as new" condition. Add approximately 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 detailed information on any of the above items and for special quantity discounts.

1527 E. Seventh Street **EPCO** Los Angeles 21, California

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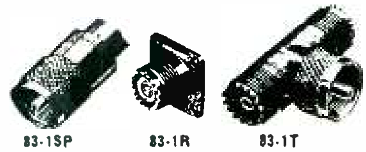
OFFERS

"UHF" COAXIAL CABLE CONNECTORS

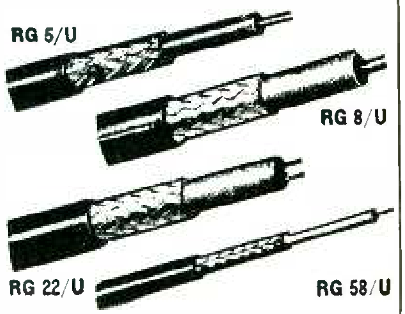


83 SERIES

No.	An. No.	Description	Price
83-1SP	(PL259)	Plug.......ea.	22¢
83-1SPN	(PL259A)	Plug.......ea.	22¢
83-168	(UG176U)	Reducing adapter for RG 29, 55 and 58U. Use with 83-1SP or 83-1SPN.......ea.	12¢
83-1R	(S0239)	Receptacle.......ea.	28¢
83-1AP	(M359)	Angle Plug adapter..ea.	22¢
83-1T	(M358)	Connector.......ea.	98¢
83-22R	(UG103U)	Receptacle.......ea.	35¢
83-22SP	(UG102U)	Plug.......ea.	35¢

Minimum Quantity — 100 of a type

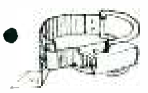
COAXIAL CABLES



RG5U......	per 1000 ft..........	$ 45.00
RG8U......	per 1000 ft..........	$ 40.00
RG11U......	per 1000 ft..........	$100.00
RG12U......	per 1000 ft..........	$175.00
RG22U......	per 1000 ft..........	$125.00
RG29U......	per 1000 ft..........	$ 37.50
RG58U......	per 1000 ft..........	$ 59.00
RG59U......	per 1000 ft..........	$ 45.00
RG62U......	per 1000 ft..........	$ 45.00

Prices based on minimum quantity of 500' of a type.

BIRTCHER TUBE CLAMPS



926 A....19¢ ea.	926 B5 ..19¢ ea.
926 A2 ..19¢ ea.	926 B33..19¢ ea.
926 B....19¢ ea.	926 C....19¢ ea.
926 B1 ..19¢ ea.	929 1....29¢ ea.

TYPE F2L MICA CAPACITORS
CM 70 TYPE

.024 MFD 1500 U. Pk. Wkg..ea. 75¢
.033 MFD 1500 U. Pk. Wkg..ea. 75¢
.056 MFD 1500 U. Pk. Wkg..ea. 75¢
.0001 MFD 5000 U. Pk. Wkg..ea. 75¢

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91 GOLD STREET, N. Y., N. Y.
TELEPHONE DIGBY 9-4154-5

7,000 NEW STORAGE BATTERIES

PORTABLE TYPE

Plastic and Hard Rubber Containers

waterproof, lead acid type terminals, 6 volts, 15 amp. hrs., 3 cells, 2 volts each, 1½ amps. for 10 hrs., size 4½" width by 4½" length by 5⅝" height, manufactured by Willard and Gould, packed in wood boxes of 9, 12 and 18 each. At $2.00 each, f.o.b. Allentown, subject to prior sale.

Sample orders upon request

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Western Electric transformer 223A per D-163041 torroid type core impedance 600 to 600..........$1.95
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W.E. D-165627 band pass 600 ohm impedance..........$1.95

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.0002 CD 1000 test transmitting type per 100..........$19.50
.02 CD 1000 test transmitting type per 100..........$29.50

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W.E. .0002 402D 300 wvdc per 100....$9.50

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W.E. regulated power supply KS15036, 115 VAC operated, 135 volt, DC output, complete with tubes......$25.00
Varistor 34A per D-162482.......... $1.95
Telephone switchboard cords, 2-conductor tinsel rubber covered 6½' long, both ends lugged..per 100 $4.00
per 1000 $35.00

Write for Quantity prices
No orders less than $5.00 accepted

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THESE ITEMS SURPLUS TO OUR PRESENT NEEDS

4—Scott SLRM—New....		$125.00 ea.
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1—PE-73-CM DM Unit..		2.50 ea.
2—GE—27 v/60v-530w Amplidyne M/G......		2.50 ea.
1—RCA-AVR-20A-Rec....		10.00 ea.
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Record 62½ Minutes on each side of a 16½" MemoDisc.
4 Model AA Dual Rack-Mounted continuous recorders.
3 Model AP Portable Recorders. Complete with Playbacks, Monitors, etc., and a large quantity of MemoDiscs.

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FAR ROCKAWAY NEW YORK

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For manufacturing radio tubes, electronic tubes, cathode-ray tubes, lamps. New and used. Reasonably priced, satisfaction guaranteed.
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67 E. 8th St. New York, N. Y.

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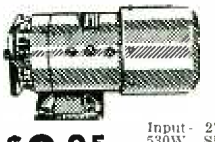
WESTERN ELECTRIC
35 Watt Driver Unit
FULL FREQUENCY RESPONSE
Orig. Gov't Cost $40.00
8 Ohm Voice Coil
Will Handle
Up To 55 Watts

Built to the highest standards of electrical and mechanical tolerances to insure peak efficiency and perfect alignment for greater efficiency. A breakdown proof diaphram of plastic replaces the old metal type. Completely impervious to climatic changes and corrosion.
The most rugged unit ever built, shockproof construction, can be used as Tweeter with your Woofer or as a driver with your own projector outdoors or indoors.

$5.95 Each
In Lots of 10—$49.50



Brand New In Sealed Cartons
GENERAL ELECTRIC
AMPLIDYNE
Manufactured for U.S. Air Forces

$9.95 Input- 27V-DC. Output 60V 530W. Shaft approx. 1"-dia.— ½" air cooled by removable fan. Unit measures 11¾x5½

A WIRE BUY ! ! ! $30.00
No. 18—7 strand Black Plastic Vinelite indoor and outdoor wiring. O.D. ⅛" on 27" reel. 15000 ft.—$270.00 value. Lifetime covering—100 uses.
Send Check or M.O.—No C.O.D.'s

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The finest performing reproducers—barring none

"The Standard by Which Others Are Judged and Valued"

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A RADIO STATION Received the SA-79 AUDAX units and are very well satisfied with them. They are much better than anything we have ever used."

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Meets every requirement

- NO INTER-MODULATION DISTORTION
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What is the life of a "Permanent" needle? Write for Complimentary Pamphlet on this important subject.

AUDAK COMPANY

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"Creators of Fine Electro-acoustical Apparatus since 1915"

DAVEN

FIXED ATTENUATORS

Daven fixed attenuators are precision built, accurately calibrated networks. These units are extensively used in major broadcasting installations, motion picture sound studios and as laboratory standards of attenuation.

Some suggested uses are:

- **LOSS:** Introduction of a fixed known loss.
  - (a) To reduce level
  - (b) To equalize several incoming lines
  - (c) As laboratory standards of attenuation
- **TRANSFORMATION:** To transform or change from one impedance to another without introducing frequency or reflection errors.
- **ISOLATION:** To isolate one part of a line from another.
- **BRIDGING:** To bridge a program line for monitoring purposes.
- **MULTIPLE CIRCUIT:** To combine several inputs into one output, or to divide one input into several outputs.

The following fixed attenuators are our standard type units. Unless specifically stated, any standard impedance or loss is available upon request. Frequency range, unless listed, is from zero to 50 KC for most values. Upon request, this range can be extended.

TYPE T-950

TYPE T-950
"T" Network

TYPE H-950
Balanced "H" Network

Size: 11/16" diameter x 1⅝" long (overall).
Mounting: No. 6 screw through center hole.

Maximum level + 20 DBM

TYPE T-691

TYPE T-691
"T" Network

TYPE H-691
Balanced "H" Network

Size: 1⅜" dia. x 3" long.
Mounting: Octal tube socket.

Maximum level + 20 DBM

TYPE T-154

TYPE T-154
"T" Network

TYPE H-154
Balanced "H" Network

Size: 1-13/16" high x 1½" long x 1⅝" wide (overall)
Mounting: Four 6/32" screws.

Maximum level + 25 DBM

TYPE V-154

TYPE V-154 – "T" OR π NETWORK
Video Attenuator.

FREQUENCY RANGE: 0 to 10 MC. Loss: 0 to 30 DB per unit. Impedances: 50 to 75 ohms. Furnished with BNC type receptacles. Matching plugs or right angle adaptors for RG cable can also be furnished.

TYPE T-153

TYPE T-153
"T" Network

TYPE H-153
Balanced "H" Network

Size: 3⅜" high x 1½" long x 1⅝" wide (overall).
Mounting: Four 6/32" screws.

Maximum level + 30 DBM
(Available up to 20 Watts, upon request)

TYPE RF-155

TYPE RF-155 – "T" OR π NETWORK
Radio Frequency Attenuator.

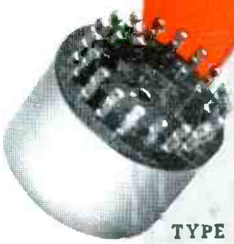
FREQUENCY RANGE: 0 to 200 MC. Loss: 0 to 20 DB per unit. Impedances 50 to 75 ohms. Total of 80 DB available by connecting in series.

MULTIPLE NETWORKS

TYPE 1030

TYPE 1030 – "T" NETWORK
0-40 DB in 1 DB steps.

SIZE: 1⅜" diameter x 1¼" long.
MOUNTING: No. 6 screw through center hole.



TYPE 1130-8

TYPE 1130-8 – "H" NETWORK
1 input, 8 outputs, 18 DB loss.

SIZE: 1¾" diameter x 1⅝" long.
MOUNTING: No. 6 screw through center hole.

Special multiple output networks available in a wide variety of inputs and outputs in Type 1030 or Type 1130.

When ordering kindly supply the following information: Type, Circuit "H" or "T", and DB loss required.

THE DAVEN CO.
191 CENTRAL AVENUE
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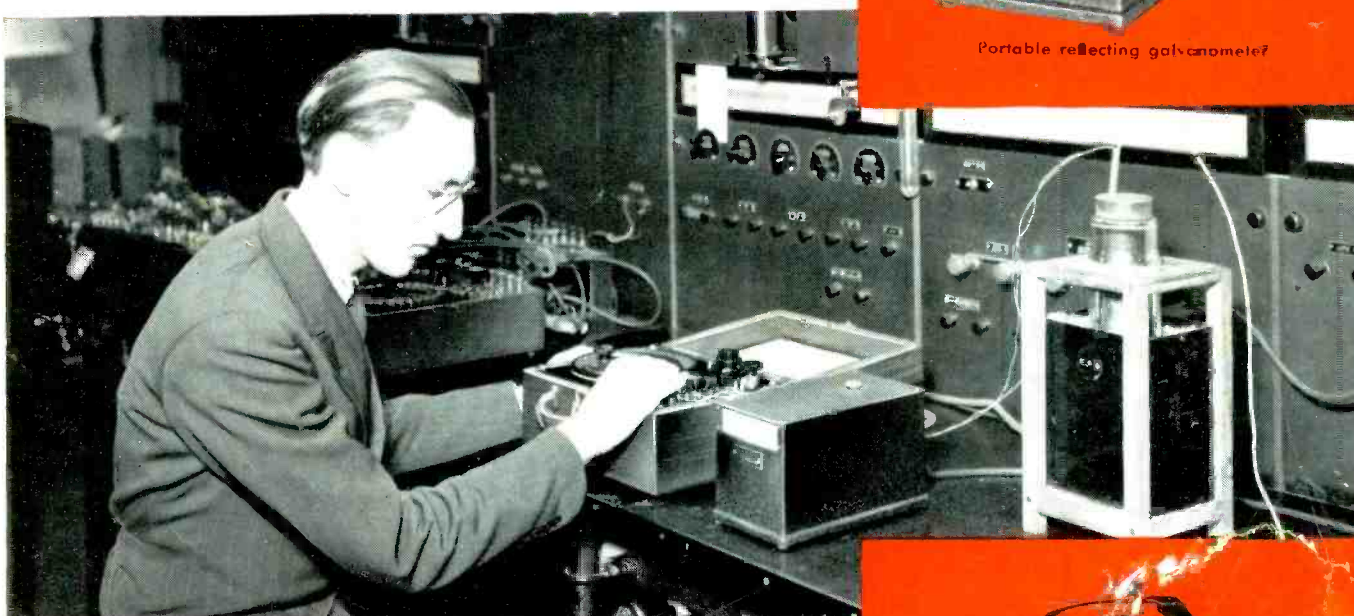
Further information on these units will be supplied on request.

To Measure the Lowest Values of Current and Voltage Accurately

We Recommend These High-sensitivity Instruments

Portable reflecting galvanometer



D-c recording milliammeter (Type CF-2)

THE high sensitivity, excellent responsiveness, sturdiness, and dependability of our complete line of galvanometers make them ideal for use in:

1. Laboratory measurements of temperature, resistance, etc.
2. Production tests of instruments and materials where rapid readings and minimum fatigue to operators are essential.

These galvanometers are portable and are easily connected into a circuit. Seventy-five ranges are available for immediate shipment. With such a large number of ratings you can be sure to find one that has the characteristics required for your particular application.

D-c Inkless Recorder—Its low power consumption makes it particularly well suited for high-sensitivity measurements. This recorder can be obtained as an ammeter, voltmeter (1000 ohms per volt), microammeter, millivoltmeter, milliammeter (for example, 1 ma—16 ohms).

It is accurate within 2 per cent, sturdy, and portable. Its inkless feature means there's no pen to start, no ink to spill, and rapidly fluctuating loads will not cause "painted" charts.

For a-c measurements, the companion Type CF-1 instrument is available as an ammeter and voltmeter.

For further information on the galvanometers, ask for Bulletin GEA-2136; on the recorders, GEA-3187. The nearest G-E office has copies. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

602-23-6200

RCA Type 68-B Beat-Frequency Oscillator. For equalizing the frequency-response of your remote lines ... for checking frequency-response of your station equipment . . . for measuring distortion . . . this laboratory-type oscillator is ideal. Output is substantially constant over entire range, 20-17,000 cycles. Calibration accuracy within 1 cycle below 100 cycles; less than 1% deviation above 100 cycles.

RCA Type 69-B Distortion Meter. With the Type 68-B Oscillator, the 69-B permits rapid determination of distortion, hum in amplifiers, noise, and frequency-response characteristics. Harmonic distortion can be measured at *any* audio frequency—not just at one "check frequency."

RCA Model 89-B Attenuator Panel. Use with the 68-B Oscillator and 69-B Distortion Meter, this attenuator panel will sav much valuable time for your technical staf It permits setting up equipment for measurements with the least effort. Built-in volume indicator, attenuator system, impedance-matching system, jacks. Reads directly input and output levels.

BETTER STATION OPERATION begins with accurate measurements!

RCA Type 311-AB Frequency Monitor. Meets the new rigid requirements of F.C.C. requiring frequency stability within ± 20 cycles. The Crystal Oscillator of the 311-AB is stable to better than 2 parts per million! Double heat-control. Double-range large scale meter is undeflected by modulation.

RCA Model 66-A Modulation Monitor. For rapid checking of percentage modulation. Neon peak flash lamp can be set to any predetermined threshold value. Readings can be made on either positive or negative modulation peaks. Measures also program levels, modulated carrier-shift, and average carrier value during modulation. Equipped with easy-reading meters, the 66-A is simple, accurate, foolproof.

RCA Model 308-A Field Intensity Meter. *Direct Reading.* No calculations. Quick and accurate to use ... light and easy to carry on field-intensity surveys. Covers 120 to 18,000 kc. Reads directly signal-strengths from 20 microvolts per meter to 10 volts per meter. Because it avoids time-wasting calculations for each of the hundreds of individual survey-points, the 308-A quickly pays for itself.

Your station's technical staff can keep your equipment at its peak efficiency only if they have the *facts* from which to work! That's why accurate measuring equipment is about the best investment any station can make. It assures maximum coverage . . . helps get that extra margin of audio quality that pleases advertisers and audiences alike. Make a note now to ask your staff if they have *all* the measuring equipment they really need!

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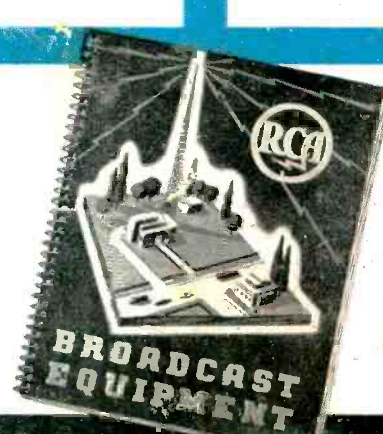

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