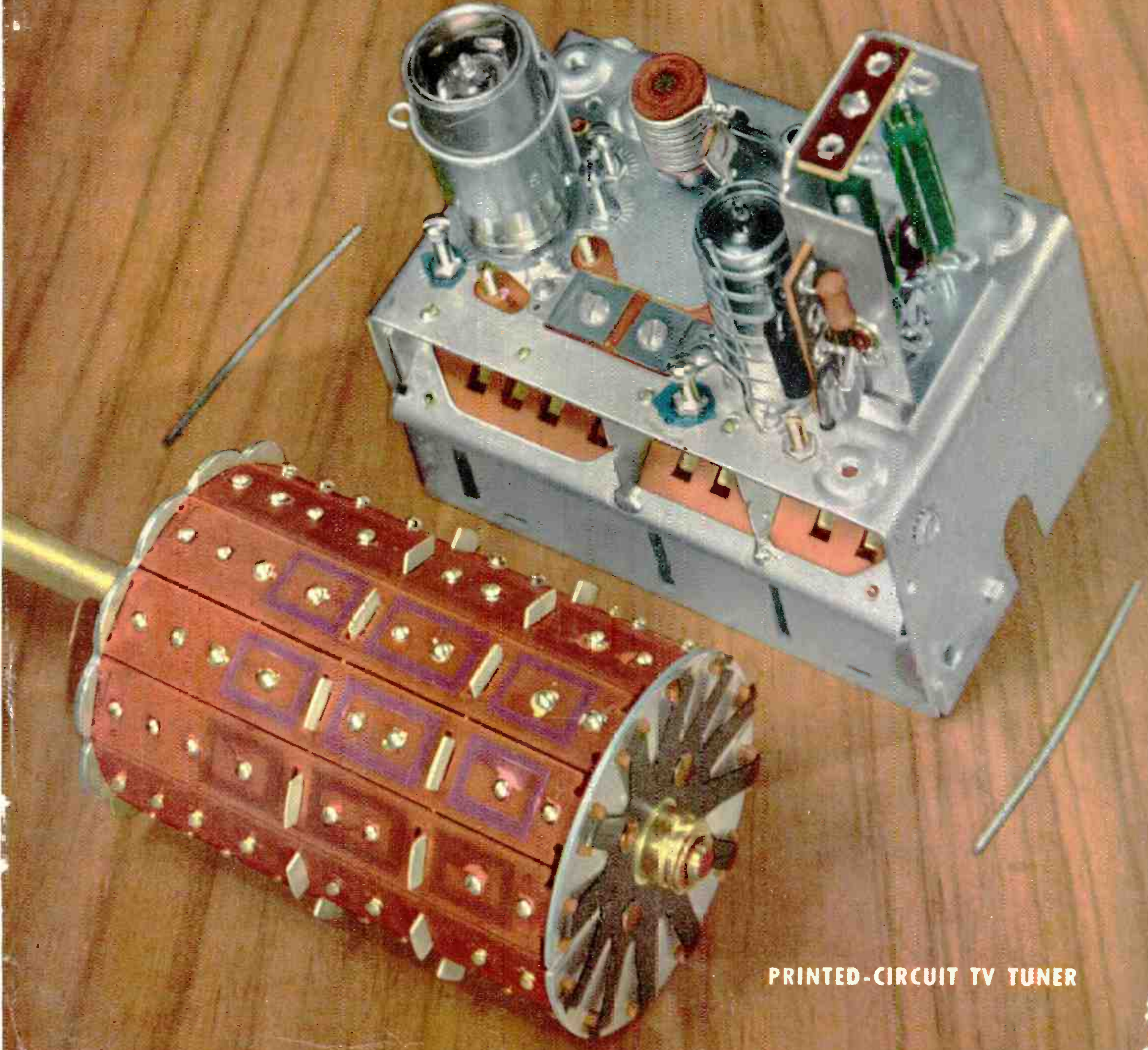
JULY · 1950

electronics

A McGRAW-HILL PUBLICATION



PRINTED-CIRCUIT TV TUNER

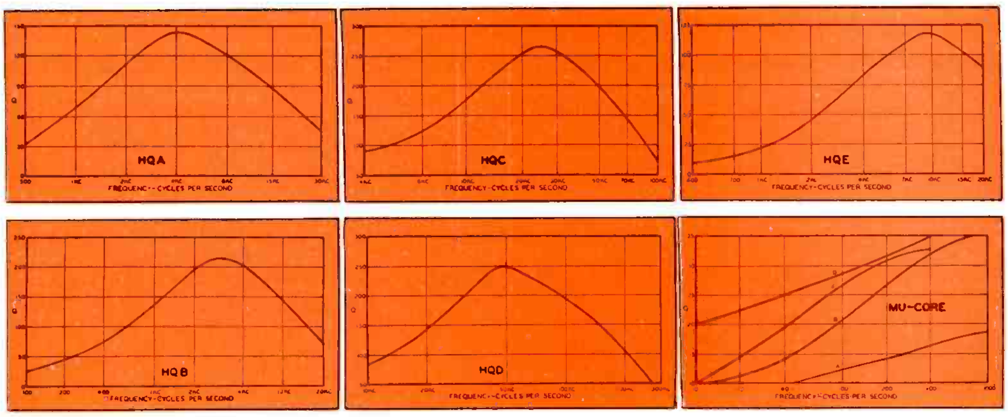
PERMALLOY DUST TOROIDS FOR MAXIMUM STABILITY...

The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles... HQB coils, Q over 200 at 4,000 cycles... HQC coils, Q over 200 at 30 KC... HQD coils, Q over 200 at 60 KC... HQE (miniature) coils, Q over 120 at 10 KC. The toroid dust core provides very low hum pickup... excellent stability with voltage change... negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance. Hermetically sealed.

HQA, HQC, HQD CASE
1 13/16" Dia. x 1 3/16" High

HQB CASE
1 5/8" x 2 5/8" x 2 1/2" High

HQE CASE
1/2" x 1 5/16" x 1 3/16" High

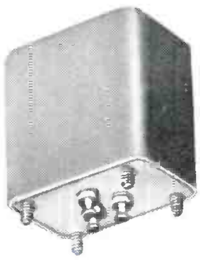


Type No.	Inductance Value		Net Price
HQA-1	5	mhy.	$7.00
HQA-2	12.5	mhy.	7.00
HQA-3	20	mhy.	7.50
HQA-4	30	mhy.	7.50
HQA-5	50	mhy.	8.00
HQA-6	80	mhy.	8.00
HQA-7	125	mhy.	9.00
HQA-8	200	mhy.	9.00
HQA-9	300	mhy.	10.00
HQA-10	.5	hy.	10.00
HQA-11	.75	hy.	10.00
HQA-12	1.25	hy.	11.00
HQA-13	2.	hy.	11.00
HQA-14	3.	hy.	13.00
HQA-15	5.	hy.	14.00

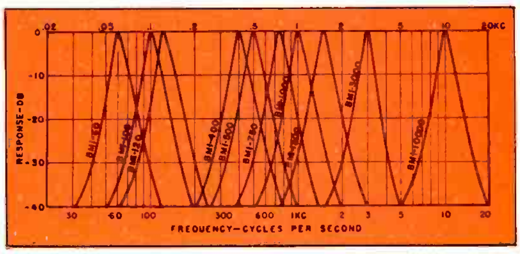
Type No.	Inductance Value		Net Price
HQA-16	7.5	hy.	$15.00
HQA-17	10.	hy.	16.00
HQA-18	15.	hy.	17.00
HQB-1	10	mhy.	16.00
HQB-2	30	mhy.	16.00
HQB-3	70	mhy.	16.00
HQB-4	120	mhy.	17.00
HQB-5	.5	hy.	17.00
HQB-6	1.	hy.	18.00
HQB-7	2.	hy.	19.00
HQB-8	3.5	hy.	20.00
HQB-9	7.5	hy.	21.00
HQB-10	12.	hy.	22.00
HQB-11	18.	hy.	23.00
HQB-12	25.	hy.	24.00

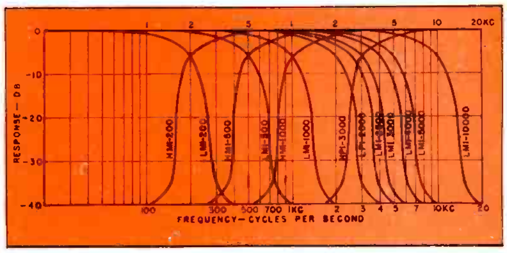
Type No.	Inductance Value		Net Price
HQC-1	1	mhy.	$13.00
HQC-2	2.5	mhy.	13.00
HQC-3	5	mhy.	13.00
HQC-4	10	mhy.	13.00
HQC-5	20	mhy.	13.00
HQD-1	.4	mhy.	15.00
HQD-2	1	mhy.	15.00
HQD-3	2.5	mhy.	15.00
HQD-4	5	mhy.	15.00
HQD-5	15	mhy.	15.00
HQE-1	5	mhy.	6.00
HQE-2	10	mhy.	6.00
HQE-3	50	mhy.	7.00
HQE-4	100	mhy.	7.50
HQE-5	200	mhy.	8.00

UTC INTERSTAGE AND LINE FILTERS



FILTER CASE M
1 3/16" x 1 11/16"
1 5/8" - 2 1/2" High





These U.T.C. stock units take care of most common filter applications. The interstage filters, BMI (band pass), HMI (high pass), and LMI (low pass), have a nominal impedance at 10,000 ohms. The line filters, BML (band pass), HML (high pass), and LML (low pass), are intended for use in 500/600 ohm circuits. All units are shielded for low pickup (150 mv/gauss) and are hermetically sealed.

STOCK FREQUENCIES

(Number after letters is frequency)
Net Price $25.00

BMI-60	BMI-1500	LMI-200	BML-400
BMI-100	BMI-3000	LMI-500	BML-1000
BMI-120	BMI-10000	LMI-1000	HML-200
BMI-400	HMI-200	LMI-2000	HML-500
BMI-500	HMI-500	LMI-3000	LML-1000
BMI-750	HMI-1000	LMI-5000	LML-2500
BMI-1000	HMI-3000	LMI-10000	LML-4000
			LML-12000

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JULY • 1950

PRINTED CIRCUIT TV TUNER .... Cover
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WHY TELEVISION RECEIVERS FAIL IN SERVICE 66
Field experience reveals 15 major reasons for service calls, many preventable at design and production stages

ENGINEERING TRENDS IN SPOT WELDER CONTROLS, by Stuart C. Rockafellow 70
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TELEVISION ANTENNA DIPLEXERS, by W. H. Sayer and J. M. De Bell, Jr. 74
Antenna-matching device permits feeding two or three different carriers to one transmitting antenna

TESTING TURNTABLES FOR WOW, RUMBLE AND SPEED, by R. O. Maze 78
Equipment requires only a standard record for direct indication of record-player characteristics

HIGH-FREQUENCY OPERATION OF TRANSISTORS, by C. B. Brown 81
Describes 23-megacycle amplifier with gain of 8

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Phototube amplifier rejects 120-cps signals caused by room illumination

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THE DIOTRON, AN AID TO RMS INSTRUMENTATION, by R. D. Campbell 93
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KILOMEGACYCLE BUZZER TEST OSCILLATOR, by G. L. Davies, C. B. Pear, Jr., P. E. P. White 96
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CASTING RESIN TECHNIQUES, by Jack Bayha 100
Instructions for preparing, mixing, applying and curing NBS resin for potted electronic units

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Suppresses a total of 247 degrees of radiation and employs four phase monitors

GEIGER COUNTER FOR LECTURES, by Ronald L. Ives 105
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SYNC SEPARATOR CIRCUIT ANALYSIS, by W. Heiser 108
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ESTIMATING VHF FIELD INTENSITY (Reference Sheet), by E. A. Slusser 112
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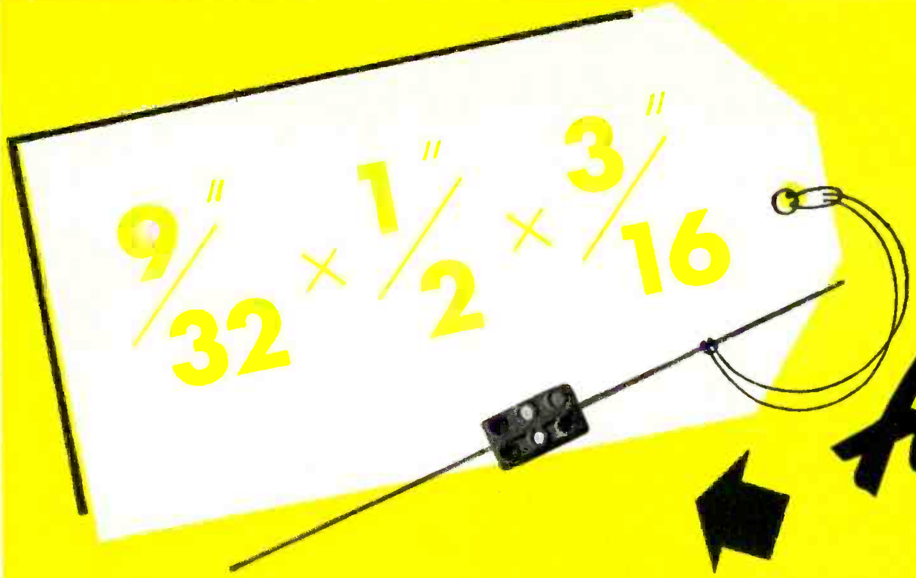
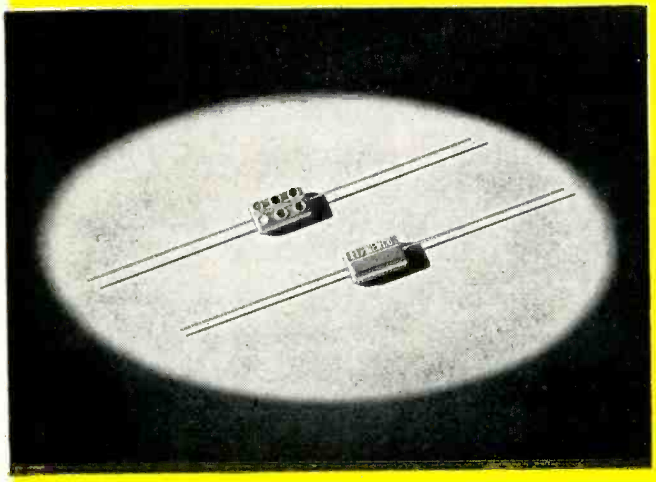


ACTUAL SIZE

EL-MENCO CAPACITOR - CM-15

Miniature



CM 15 MINIATURE CAPACITOR

Actual Size 9/32" x ½" x 3/16"
For Television, Radio and other Electronic Applications
2 — 420 mmf. cap. at 500v DCw
2 — 525 mmf. cap. at 300v DCw
Temp. Co-efficient ±50 parts per million per degree C for most capacity values.
6-dot color coded.

This small-sized, high-capacity fixed mica condenser meets and beats strict Army-Navy standards. Like all El-Menco capacitors, the CM-15 must pass severe tests before leaving the factory. It is tested for dielectric strength at *double* working voltage; for insulation resistance and capacity value. You can always depend on the tiny CM-15 to give positive product performance under the most critical climate and operating conditions.

MANUFACTURERS WHO MAINTAIN REPUTATIONS for high-quality electrical equipment, demand and get high-quality El-Menco capacitors.

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CAPACITORS

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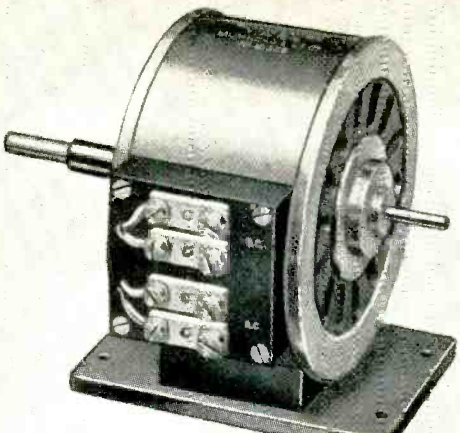
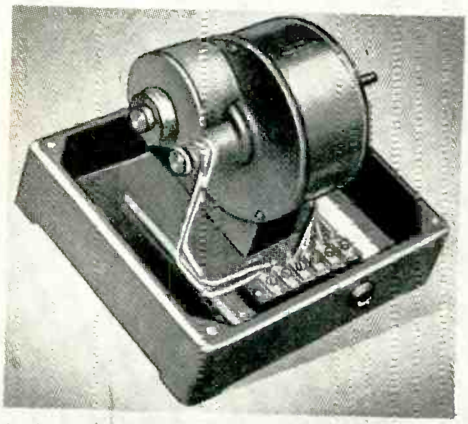
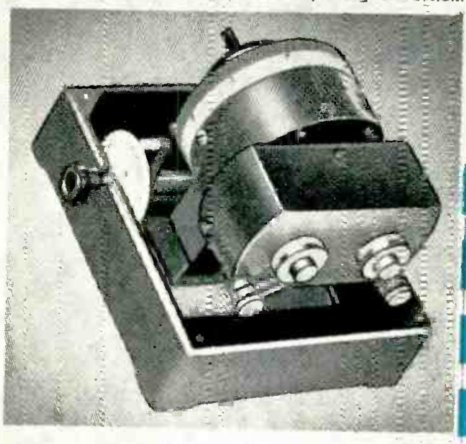


Designed for use at frequencies from 50 c/s - 2000 c/s, Phonic Motors of this type form the nucleus around which are built the timing devices illustrated on this page.



The Timing Device Type D-199-A provides an impulse of 1/10 second duration once every second, when the motor is supplied with power at a frequency of 1000 c/s.

The Timing Device Type D-193-A provides an impulse of 1/10 second duration 61 times per minute and, in addition, an impulse of ½ second duration once per minute. A worm and wheel adjustment allows phasing correction.



Phonic Motors and Timing Devices

In many branches of scientific work the need arises for a motor capable of a very high standard of constancy of speed. The frequency of the mains electricity supply is not normally controlled to better than one or two per cent., so that a mains-operated synchronous motor may be inadequate, and centrifugal governors, as used on gramophone motors, may not provide a sufficiently precise control. In such cases a phonic motor driven by an alternating current supply of high frequency stability may be employed. It is not perhaps generally realized that in their modern form such motors may be used to give quite a large torque, and are able to maintain synchronism despite the sudden imposition of relatively large inertia loads. Under steady-state conditions, "hunting" is almost entirely eliminated, and the constancy of rotational speed is almost entirely dependent on the frequency stability of the alternating current supply.

A precision quartz crystal controlled frequency of 100 kc/s may attain a frequency stability of the order of one part in 10^8. This frequency is then divided electronically to 1,000 c/s by means of regenerative dividers or locked multivibrators. In order to facilitate comparisons with time signals, or to use the frequency standard as a clock, it is necessary to derive a still lower frequency—preferably one cycle per second. Electronic division in the range 1,000 to 1 cycle per second, with high phase stability, is difficult, and the simplest and most reliable method is to drive a phonic motor from the 1,000 c/s source, and to fit mechanical contacts to suitably geared driven shafts. An added advantage is that by employing further gearing, more widely spaced signals may be obtained. Thus signals spaced at intervals of one sidereal second, or any other specified interval, may be obtained from an oscillator with a fundamental frequency of 100 kilocycles per mean time second. By means of a simple mechanical device, controlled changes in phase of the timing of the contacts are also possible.

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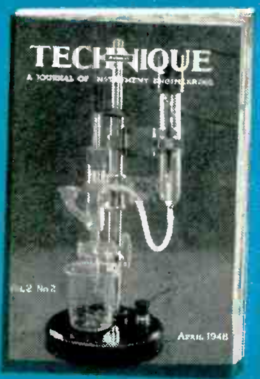

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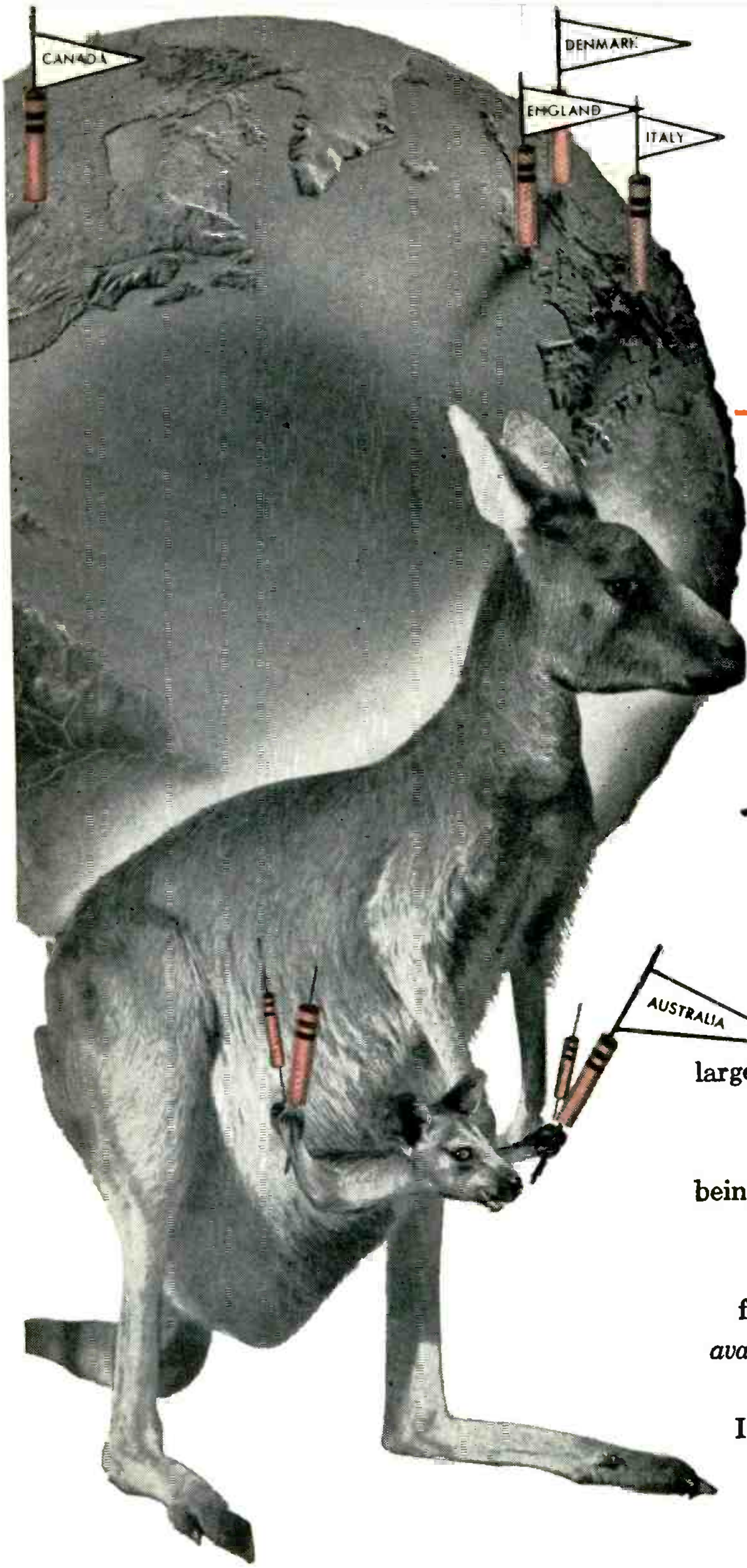
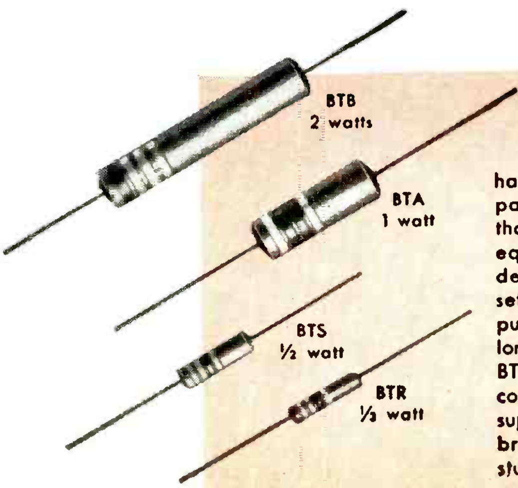


Logistics

for resistors too!

For *adequate* supplies of resistors in an ever-widening market, depend on IRC *logistics*. Already the largest manufacturer of resistors in the world, IRC has increased its output tremendously to meet your requirements. And in addition, IRC capacity is now being supplemented by licensees in Canada and Denmark—while English, Australian and Italian licensees provide resistors for other world markets formerly supplied from the United States. IRC *availability* extends even to your urgent, small-order requirements for standard resistors. Through our Industrial Service Plan, your IRC Distributor can supply these promptly from full stocks of the most popular types and sizes.



Stock-piling of advanced BT's

has been proved practical by IRC's study of resistor-use patterns. A recently completed three-year profile shows that 80% of the BT resistors used in TV and radio equipment include only 30 values. This holds true despite design changes and shifts in the industry's emphasis on sets. And these facts prove that you can now simplify purchasing, stocking and expediting practices by placing long-term orders covering your basic, recurring needs for BT's. Engineered to meet JAN-R-11 specifications for fixed composition resistors, IRC BT's have established their superiority in all important characteristics. Bulletin B-1 brings you full details of IRC BT's, and a copy of our study is yours for the asking.

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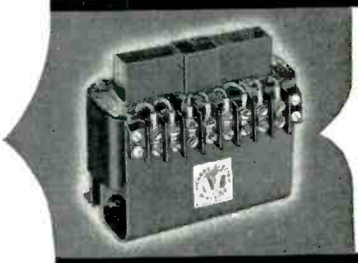
...designed to give you better control—at lower cost

Whatever your specific control operation needs in power . . . performance . . . and economy . . . you'll find a Vickers Standard Magnetic Amplifier that is tailored to give your control requirements these benefits:

- **NO MAINTENANCE**
- **HIGH PERFORMANCE**
- **RUGGED CONSTRUCTION**
  No Moving Parts
- **NO WARM-UP TIME**
- **A-C OR D-C CONTROL**
  A-C or D-C Output
- **RESPONDS TO SUM OR DIFFERENCE OF SEVERAL SIGNALS**
- **ALLOWS ELECTRICAL ISOLATION BETWEEN CIRCUITS**

HIGH PERFORMANCE

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



HIGH GAIN

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

HIGH POWER

For 60 cps power sources — 20 styles — maximum output powers from 65 watts to 3660 watts.

TYPICAL APPLICATIONS

Servo Mechanisms • Line-to-line Voltage Regulators • Hydraulic Transmission Controls • A-C and D-C Generator Voltage Regulators • Speed and Frequency Regulators • Lamp and Furnace Controls
Temperature Regulators
Time Delay Devices

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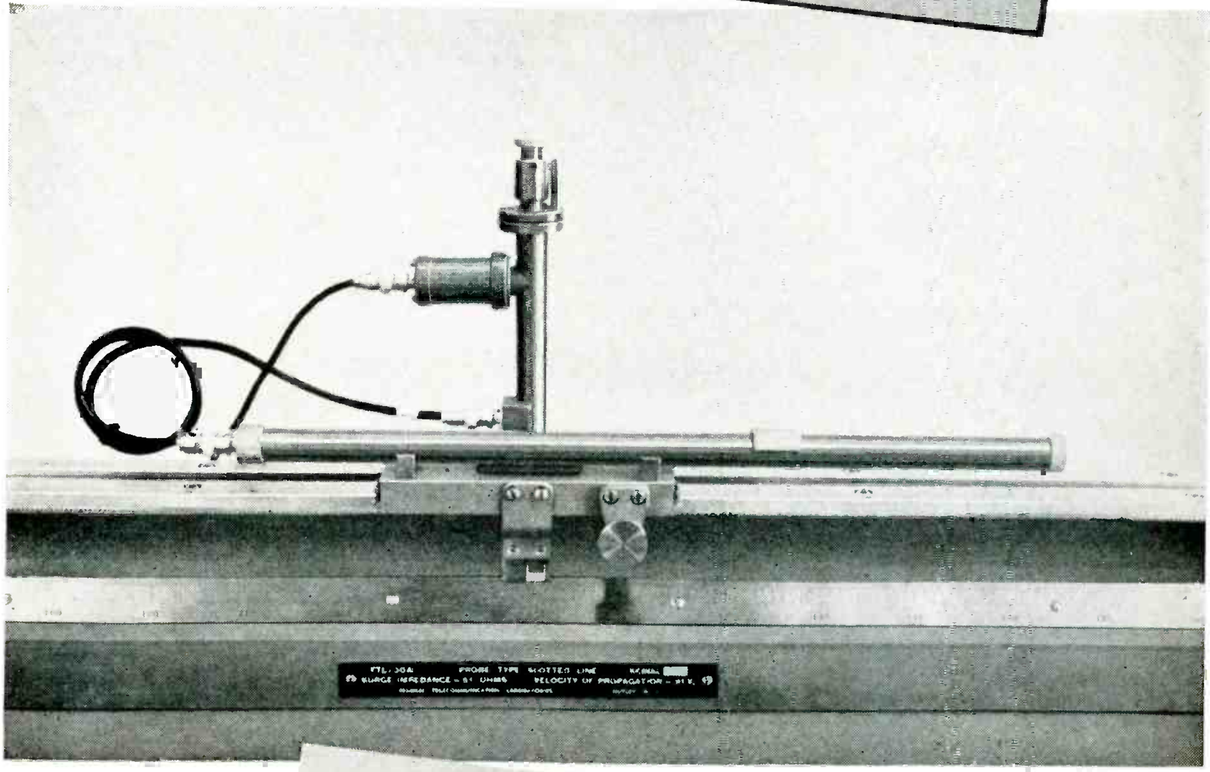
1000 to 2000 Mc range covered with slightly reduced accuracy.



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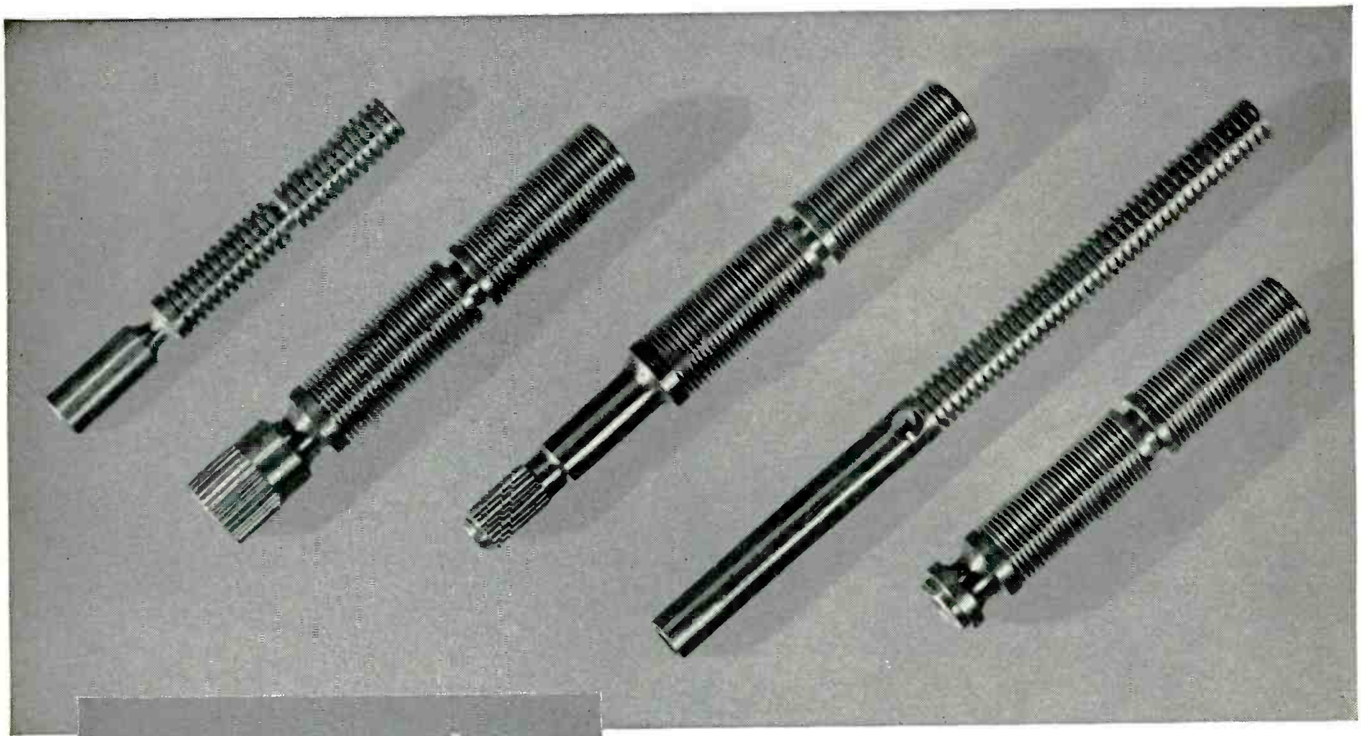

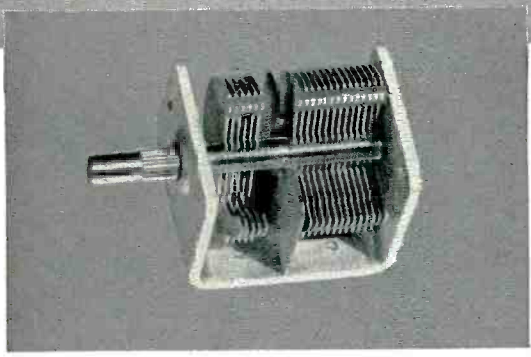

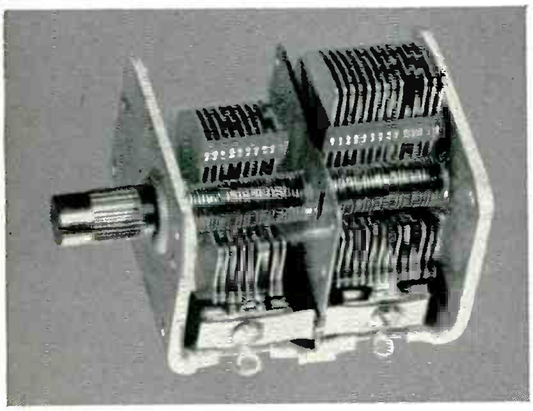

Above, Model CS, smallest condenser, air space .009". Below, Model B, largest, air space .013". Rotor shafts, shown in top illustration, are Revere Free-Cutting Brass, plates aluminum. Made by The American Steel Package Co., Defiance, Ohio, an important supplier to the electronics industry.

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

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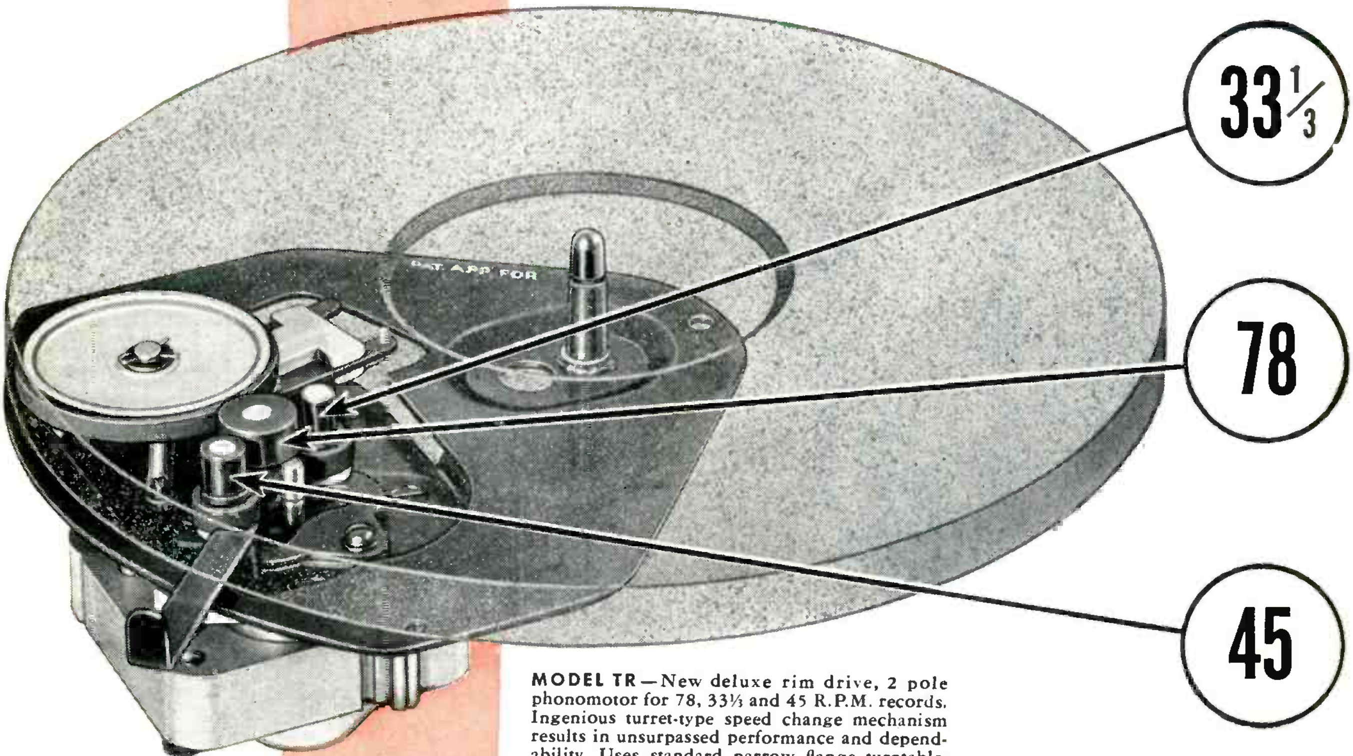


MODEL TR—New deluxe rim drive, 2 pole phonomotor for 78, 33⅓ and 45 R.P.M. records. Ingenious turret-type speed change mechanism results in unsurpassed performance and dependability. Uses standard narrow flange turntable.

General Industries' *New* Deluxe

3-SPEED PHONOMOTOR

Now . . . in answer to the tremendous demand for a manual version of the popular GI turret model 3-speed record changer motor, General Industries presents the *new* Model TR. Truly the last word in compact 3-speed phonomotors, the Model TR is designed for use in the finest phonographs and radio-combinations.

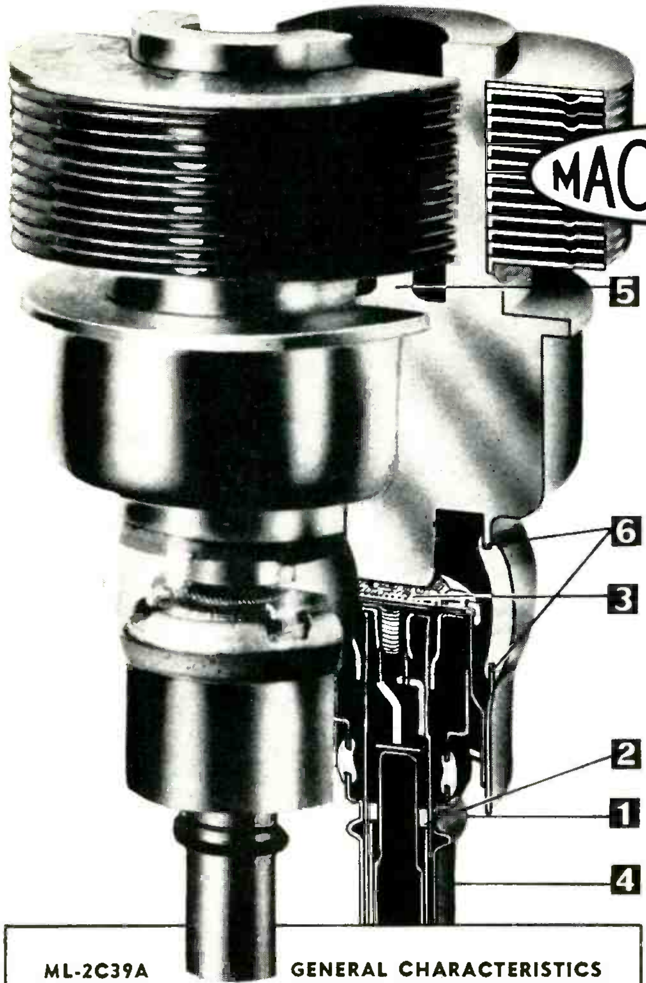
In addition to the Model TR, General Industries will continue to offer the ever-popular Model TS, 3-speed neoprene belt-driven model for both manual and record-changer use.

Today, as always, General Industries leads the field with the *only* complete line of phonomotors for every record-playing requirement. Write, wire or phone for the latest General Industries catalog containing specifications and description of the full GI *Smooth Power* lineup.

The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO

The New ML-2C39A*...



Proving once again that

MACHLETT ..*makes the Difference*

1. Design of cathode lead for positive adjustment and control of transconductance; limits are 20,000-23,000 μmhos or only 25% of permissible specified range.

2. High temperature ceramic in hot cathode end eliminates danger of gas evolution from glass at high temperatures. Assures better protection under overload conditions.

3. Uniquely processed mesh grid assures greater frequency stability with variation in grid dissipation.

4. Gold over silver plating to maintain optimum surface conductivity even in corrosive atmospheres.

5. Machlett's high vacuum processing for good cathode activation and freedom from gasiness.

6. Stronger glass-metal seals. Less breakage inserting and removing tubes.

* *Conforms with recently issued JAN specifications.*

ML-2C39A GENERAL CHARACTERISTICS

Electrical

Cathode: Coated Unipotential	
Heater Voltage	6.3 volts
Heater Current	1.0 amperes
Amplification Factor (Average)	100
Direct Interelectrode Capacitances (Average)	
Grid Plate	1.95 μμfd.
Grid Cathode	6.50 μμfd.
Plate Cathode	0.035 μμfd.
Transconductance (i_b = 70 ma., E_b = 600 v.) (Average)	23,000 μmhos

Radio Frequency Power Amplifier
Class-C FM Telephony or Telegraphy
(key-down conditions, 1 tube)

Maximum Ratings	
D-C Plate Voltage	1000 max. volts
D-C Cathode Current	125 max. ma.
D-C Grid Voltage	−150 max. volts
Peak Positive R-F Grid Voltage	30 max. volts
Peak Negative R-F Grid Voltage	−400 max. volts
Plate Dissipation	100 max. watts
Grid Dissipation	2 max. watts

ML-381 FOR PULSED APPLICATIONS

Maximum Ratings (Tentative)

e_p, peak	3500 volts
i_p, peak	4.5 amps
i_g, peak	2.0 amps
I_p, ave	30 MA
I_g, ave	15 MA
T, pulse length	5 μ sec.
duty	1%
E_f	5.5 volts ± 5%

In all other respects the ML-381 is electrically and mechanically interchangeable with the 2C39A.

"Look to the Tube Specialist"

Long experience in the development and manufacture of the 2C39A electron tube has given Machlett Laboratories a comprehensive understanding of the operating problems encountered in a wide variety of applications of this tube type.

Distributed by GraybaR

For assistance on your specific problem, write to Machlett Laboratories or contact your local Graybar office.

MACHLETT **OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE**

ADVENTURES IN ELECTRONIC DESIGN

THE BEST CHEFS IN THE WORLD ARE MEN.

Each one of these renowned chefs has his pet dishes for which he is famous. In making up these dishes, from Shish Kabob to Crepes Suzettes, these chefs carefully select each ingredient and carefully blend them in exact proportions to impart the distinct flavor body and texture that make these dishes glamorous good eating. And ceramic capacitors are just like foods that are good eating. For example Centralab has actually experimented with over 20,000 different ceramic compounds and discarded all but 250 of them. With these 250, they've developed a wide variety of formulas or recipes. Each one makes a ceramic capacitor of distinct electrical and physical properties. That's why CRL ceramic capacitors are better — the exact ceramic formula to meet exact electrical and physical needs is individually compounded to meet them. CRL has spent hundreds of thousands of laboratory and manufacturing hours . . . over the past 20 years to perfect its ceramic parts. New experiments with new ingredients are constantly going on. So as each chef has his own secrets of food success — so Centralab engineers develop the perfect ceramic body to solve each of your capacitor problems.

Centralab — DEVELOPMENTS THAT HELP YOU

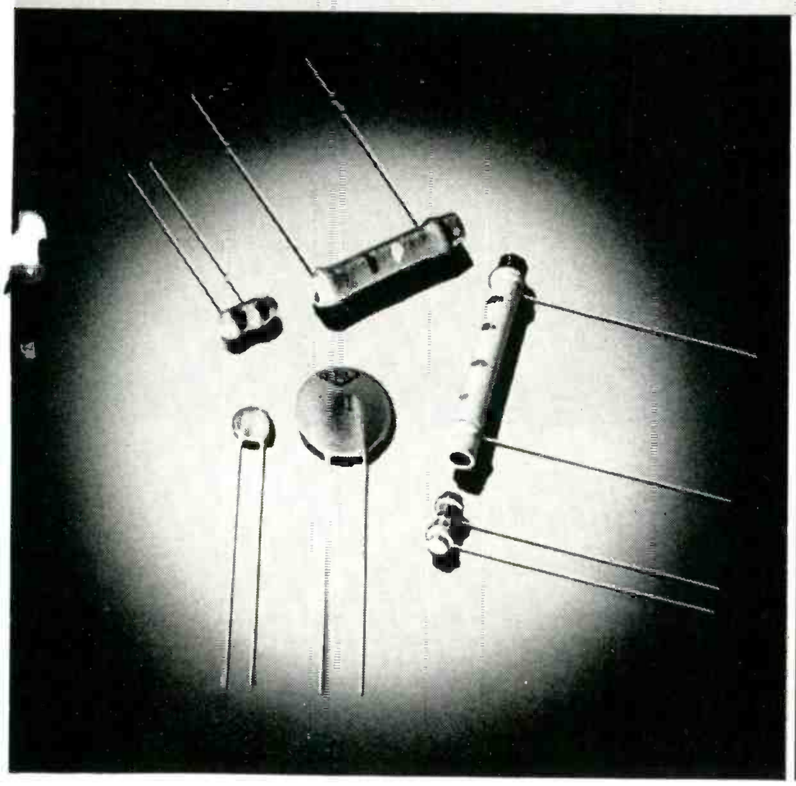
Division of GLOBE-UNION INC., Milwaukee

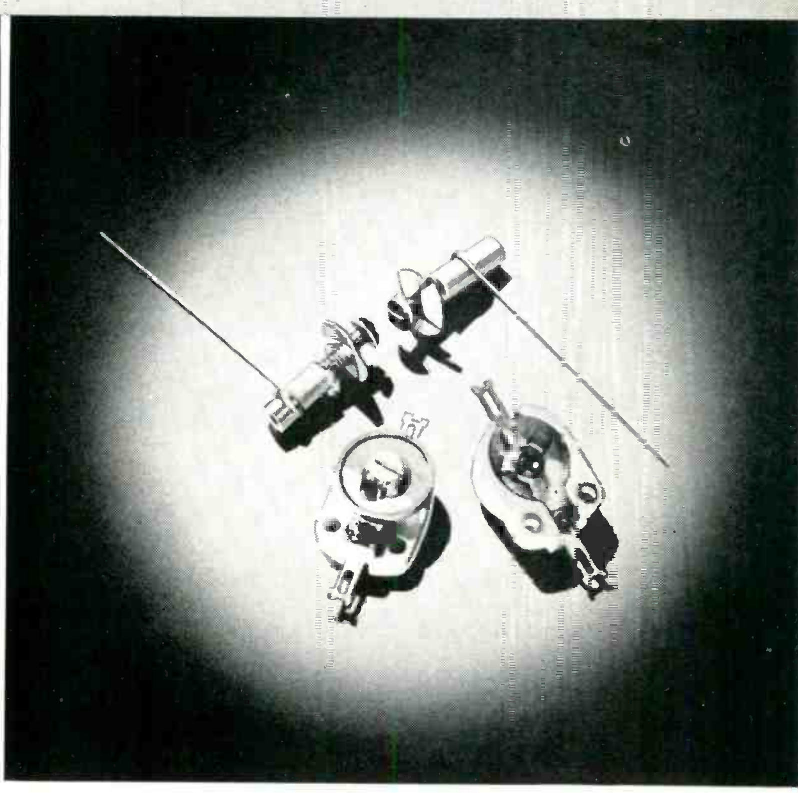
THE SPOTLIGHT'S
The Most Permanent-

RESULTS prove Centralab Hi-Vo-Kaps Best for TV

YES, CRL Ceramic High Voltage Capacitors — the kind that high voltage requirements of TV need (10-20-30 KV; 500 mmf capacity) — have become the accepted standard for the TV industry. This is no accident! For these units were specifically designed for the TV job. Behind them stands more years of engineering know-how—more extensive production know-how than offered by any similar units. If you have high voltage capacitor problems — it will pay you to call in CENTRALAB — to investigate CRL Hi-Vo-Kaps today.

ON CERAMICS
Type Capacitors



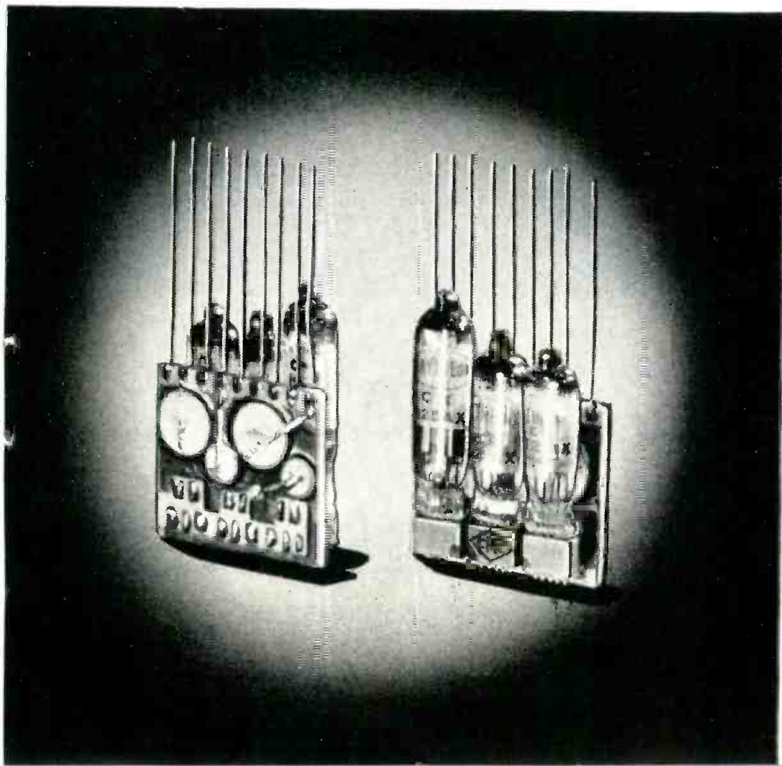


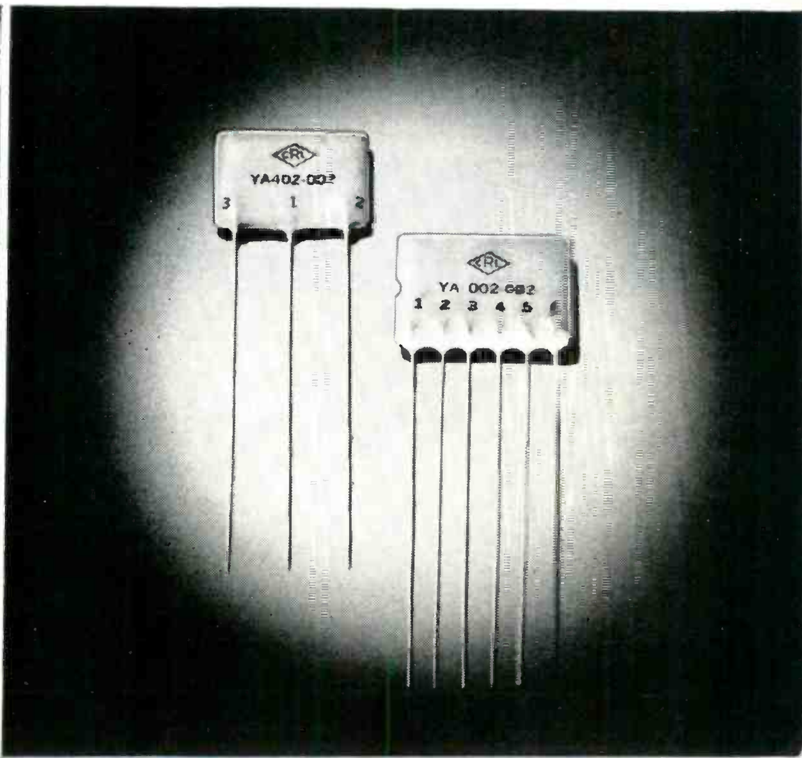
Centralab offers the widest line of ceramic capacitors in the entire industry — By-pass, Coupling, Temperature Compensating — tubulars, discs, plates. *Remember* — it's ceramics for longest life under high humidity and high temperature conditions.

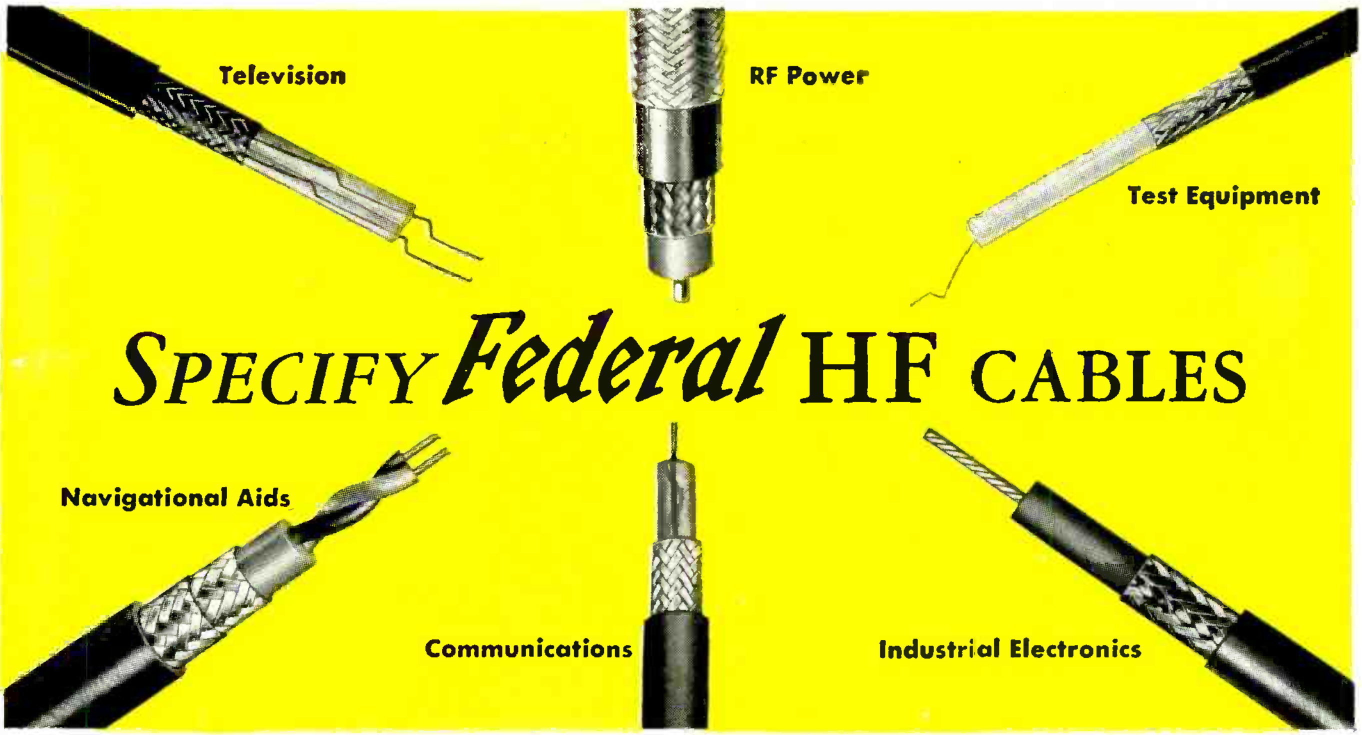
Top — tubular trimmers especially designed for TV tuners. Bottom — ceramic trimmer-capacitors — with unusually stable characteristics. Stability due to *optically ground* uniformly flat surfaces. Rotor and stator plates of metallic silver — fired to ceramic rotor and stator bodies.

Printed Electronic Circuits — the pinnacle of their development — Centralab Ampec. . . . 3 full audio stages of a speech amplifier — all components complete in one miniature unit — 1¼" x 1⅛" x .340" over tube sockets.

Looking for savings? *At left* — Vertical Integrator — widely used in TV vertical integrator circuits — vastly reduces assembly costs. *At right* — a CRL Pentode Couplate — easily replaces screen, grid and plate resistors; screen by-pass, plate r.f. by-pass and coupling capacitors.







to get the cable that is *Precisely Right* for your application

IT PAYS TO SPECIFY FEDERAL...

- **America's most complete selection of solid dielectric cable types.**
- **Quality and performance proved by years of outstanding operation.**
- **Competitively priced . . . prompt delivery—most types available for shipment from stock.**

There is no need to compromise when you specify Federal cable. Federal is your assurance of obtaining precisely the cable you require—whether it is one of the scores of Army-Navy approved types or one of the exclusive Federal-developed special purpose cables.

Nor is there any compromise with quality and dependability when you insist on Federal. Millions of feet of Federal cable, serving in countless applications, are continuing proof of Federal's superiority.

Does Your New Design Require Unusual Cable Characteristics?

These three types are typical of the special purpose cables developed by Federal to meet specific requirements and manufactured exclusively by Federal:

Federal No.	TYPE	Characteristic Impedance — Ohms	Capacitance mmf/foot
KT-107	Shielded, balanced, twisted pair (Twinax)	72	22
K-109	Ultra-low-capacitance coaxial cable	160	8.3
K-113	Low impedance coaxial cable	34	39

For data on other Federal special types, as well as specifications on Federal's complete line of JAN-Approved cables, write today for your free copy of Federal's Cable Data Booklet. Address Department D-313.

Federal Telephone and Radio Corporation

FEDERAL TELEPHONE & RADIO — FTR — an IT&T associate

SELENIUM and INTELIN DIVISION, 100 Kingsland Road, Clifton, New Jersey
***In Canada:* Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.**
***Export Distributors:* International Standard Electric Corp., 67 Broad St., N. Y.**

MIRAGLAS TUBINGS and SLEEVINGS

NOW COST NO MORE THAN COTTON TUBINGS AND SLEEVINGS

. . . and PROVIDE PREMIUM PROTECTION . . . at NO EXTRA COST

MIRAGLAS TUBINGS and SLEEVINGS, woven of fiberglas yarn, provide the ultimate protection against overloading, extreme high or low temperatures, moisture, corrosive acids, fumes, vapors, oils, general dust and dirt . . . they won't rot, have high tensile and dielectric strength and great flexibility . . . and they cost no more than cotton sleevings and tubings.

MIRAGLAS VARNISHED TUBINGS are made in 4 grades:

STANDARD *for maximum flexibility and high temperature applications where dielectric strength is not a factor*

DOUBLE SATURATED *is similar to Standard but with a dielectric rating up to 1500 volts*

TRIPLE STRENGTH *is especially flexible, resists rough handling and has a dielectric rating to 2500 volts*

IMPREGNATED *is the superior grade, has a dielectric rating beyond 7000 volts, is high gloss, non-hydroscopic, and unequalled for long life under most severe conditions*

MIRAGLAS BRAIDED SLEEVINGS, **of continuous filament fiberglas yarn, are available untreated or impregnated to prevent ends from fraying, in two average wall thicknesses: .008" and .006" with inside diameters from 1/16" to 1/2" in 1/16" increments (there is no 7/16" I.D. sleeving).**

Take note of the name MIRAGLAS . . . it stands for the ultimate in fiberglas electrical insulations . . . TAPES, TUBINGS, SLEEVINGS, CORDS, CLOTHS, ETC. Write today for details and characteristics.

MITCHELL-RAND INSULATION CO. Inc.

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

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

I-T-E's

NEW ADJUSTABLE

SHUNT PM-EM FOCUS COIL

Gives You Proper Focus Under a Wider Range of Conditions

With the I-T-E Adjustable Shunt PM-EM Focus Coil you can adjust PM strength over a wide range, compensating for most tube and set variations. This feature virtually eliminates assembly line rejects caused by out-of-tolerance PM strength. Flexibility of the adjustable shunt makes it possible for you to use one focus coil design to focus several types and sizes of tubes.

Design features greatly reduce magnetic interference with ion magnet on new short neck tubes. Among the many other advantages of I-T-E Adjustable Shunt PM-EM Focus Coils is their low operating temperature — gained through lower focus current requirements. I-T-E Adjustable Shunt PM-EM Focus Coils retain proper focusing over a wide range of line voltage variations.

I-T-E makes Adjustable Shunt PM-EM Focus Coils for use with 10″, 12″, 14″, 16″ and 19″ picture tubes. They are available in a variety of standard or special mountings, and any special mounting can be furnished upon request. Information needed to manufacture: Type of tube; second anode voltage; focusing current desired; special considerations for mountings and leads.

I-T-E's design engineers will be glad to work with you on your applications or requirements — consult them without obligation. For complete information of I-T-E Adjustable Shunt PM-EM Focus Coils — or any other I-T-E wire-wound products — write, wire, or call, specifying your needs.

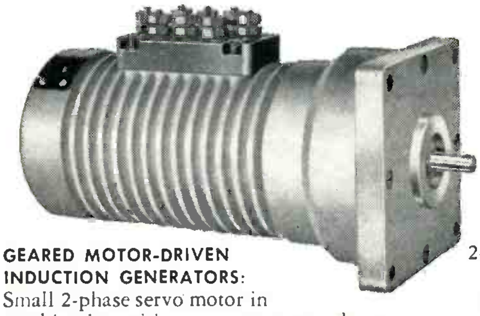
FOCUS COILS

RESISTOR DIVISION, I-T-E CIRCUIT BREAKER COMPANY

19th & Hamilton Streets, Philadelphia 30, Pa.

I-T-E Wire-Wound Products: FOCUS COILS • DEFLECTION YOKES • RESISTORS

extreme precision, instant response in remote indication and control

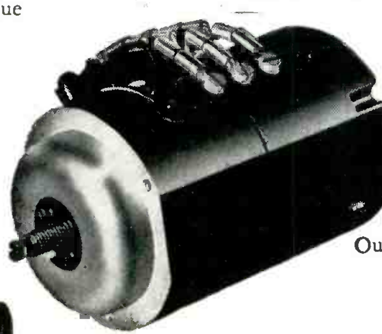


GEARED MOTOR-DRIVEN INDUCTION GENERATORS: Small 2-phase servo motor in combination with a compact gear-reducer and a low residual induction generator. Motor has high torque/inertia ratio and develops maximum torque at stall. Gear-reducer permits a maximum torque output of 25 oz. in. and is available in ratios from 5:1 to 75,000:1.

CIRCUTROL UNITS: rotary electro-magnetic devices for use as control components in electronic circuits and related equipment. Single and polyphase rotor and stator windings are available in several frame sizes. Deviation from sine accuracy of resolver shown is ±0.3% of maximum output.

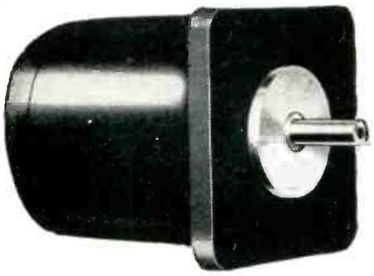
INDUCTION MOTORS: miniature 2-phase motors of the squirrel cage type. Designed specifically to provide fast response to applied control signals and maximum torque at zero r.p.m. Unit shown weighs 6.1 oz. and has stalled torque of 2.5 oz. in.

SYNCHRONOUS MOTORS: for instrumentation and other applications where variable loads must be kept in exact synchronism with a constant or variable frequency source. Synchronous power output up to 1/100 H.P.



SYNCHRONOUS DIFFERENTIAL UNITS: electro-mechanical error detectors with mechanical output for use in position or speed control servo systems. These torque-producing half-speed synchroscopes are composed of two variable frequency synchronous motors and a smoothly operating system of differential gearing.

Output: Speed $= \frac{N_1 - N_2}{2}$: Torque up to 1.0 oz. in.



TELETORQUE UNITS: precision synchros for transmitting angular movements to remote points. Accurate within ±1°. May be actuated by mechanisms that produce only 4 gm. cm. (.056 oz. in.) of torque.

ADDITIONAL SPECIAL PURPOSE AC UNITS BY KOLLSMAN

With the recent addition of new units to Kollsman's already widely diversified line, the electronics engineer will find the solution to an even greater variety of instrumentation and control problems. These lightweight, compact units offer the high degree of accuracy and positive action essential in dealing with exact quantities. They are the product of Kollsman's long experience in precision instrumentation and aircraft control — and of considerable work done in this field by Kollsman for special naval and military application. Most units are available at various voltages and frequencies. For complete information, address: Kollsman Instrument Division, Square D Company, 80-64 45th Avenue, Elmhurst, N. Y.

KOLLSMAN INSTRUMENT DIVISION

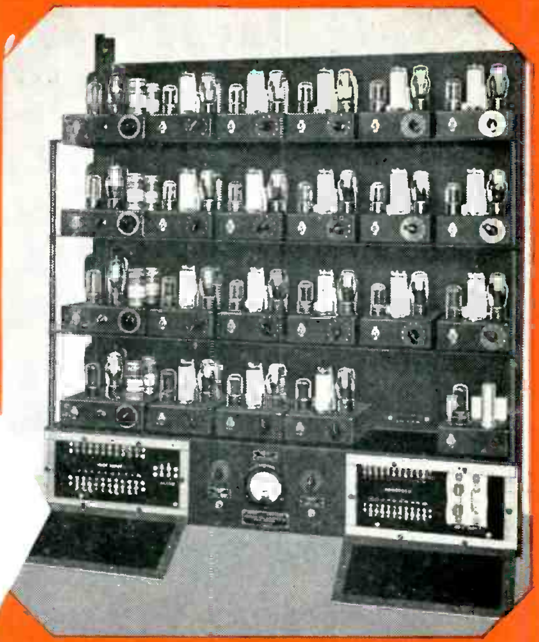
SQUARE D COMPANY

ELMHURST, NEW YORK — GLENDALE, CALIFORNIA

NEW

DRIVER-HARRIS ELECTRONIC TESTING

Obsoletes Previous Methods of Testing Enameled Wire Insulation



This revolutionary Dielectric Continuity Tester at Driver-Harris checks the quality of coating on 19 strands of wire simultaneously—as the wire leaves enameling furnaces. Tap switches on the test units are calibrated in impulses per minute required to operate an alarm. With the speed of the wire known, and also the maximum number of faults per 100 feet permitted by specification, each test unit is readily set to operate in conformance with the terms of the test imposed.

In order to guarantee the quality of a spool of enameled wire, every inch of the wire should be checked for dielectric faults, not just a few feet. In general practice, however, only a short sample of wire is examined. This is passed through a mercury cup held at a fixed potential, and shorts through the insulation are indicated on a voltmeter. If faults do not exceed a specified maximum for a given length of wire, insulation throughout the entire spool is assumed to be satisfactory.

This inefficient, compromise method has two important disadvantages: (1) the small portion of wire tested may not truly represent the condition of insulation throughout the spool; (2) insulation failures are not discovered until long after the enameling process is completed.

By checking insulation *continuously*, as wire leaves the enameling furnaces—the only 100% dependable way—Driver-Harris' new test equipment obsoletes such ineffectual and wasteful procedure.

So long as specifications are met, the new Driver-Harris electronic tester permits the enameling process to continue uninterrupted. When the *rate* at which faults occur approaches the maximum number of faults permitted by specifications, the test mechanism sounds an alarm and a record is made on a moving chart.

In this way, enamel coating is not only tested for continuity throughout the entire length of spooled wire, but sub-standard enameling is detected—and can be corrected—as soon as it occurs.

Thus makers of wire-wound resistors—particularly in finer sized wire, where shorts are more likely to occur—are enabled to eliminate time-waste and material-waste in their production, and obtain superior, more dependable products.

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

Driver-Harris Company

HARRISON, NEW JERSEY

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

Manufactured and sold in Canada by

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

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

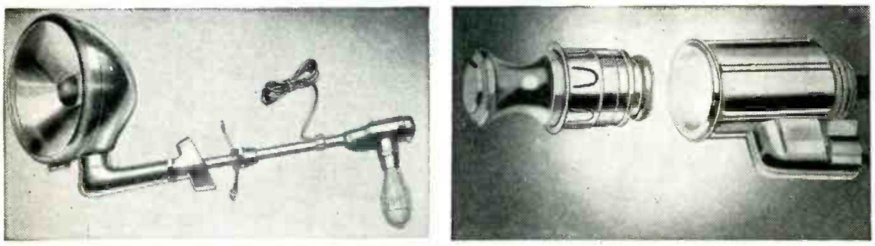
*T. M. Reg. U. S. Pat. Off.

COPPER ALLOY BULLETIN

PRODUCT IMPROVEMENT EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*



Brass is used for the reflector and housing of the Perfection Telebeam Spotlight. Both brass and silicon bronze serve best for the vital parts of the Vis-O-Lite illuminated cigarette lighter. Courtesy Casco Products Corp., Bridgeport, Conn.

Brass for Automotive and Electrical Accessories

Reduction of cost without sacrificing quality is uppermost in the minds of design and production engineers. The merits and demerits of available metals and alloys for fabricating long run items, such as automotive and electrical accessories, should be carefully weighed.

More Easily Fabricated

Brass, from long experience, takes the first choice because of its ease of workability and many other advantages. It can readily be stamped, formed, drawn, spun, swaged, drilled, threaded, soldered, welded, polished, plated.

For electrical applications the high conductivity of the brasses is advantageous where the parts are designed to carry current.

Aside from the fact that it can stand deep draws and can be made into intricate shapes, its low coefficient of friction with steel means remarkably long tool life. Its initial cost is partially offset by its high scrap value as compared with other materials.

Another important property that should not be overlooked is its excellent corrosion resistance to moisture and weathering.

Since automotive accessories are exposed to the rain, sleet, snow, dampness, and extremes of heat and cold, a non-rusting metal is desirable in the manufacture of high quality products. Although modern chromium plating gives an attractive finish to most metals, time soon reveals the weakness of an inferior metal since chromium plate may be porous and does not give complete protection from the elements. Chromium plated brass over an under coat of nickel plate retains its beauty for many years, requiring only an occasional removal of surface grime with a damp cloth.

Some savings can often be obtained in reducing the cost of polishing previous to plating. Because of its intrinsic hardness or resistance to abrasion and wear, brass takes on a polished finish quickly with the minimum of effort. However, in some cases, the polishing time can be reduced by obtaining metal of the proper grain structure. Informing the mill as to the operations and finish required will enable it to supply metal with the structure which will produce the greatest economy.

Importance of Annealing

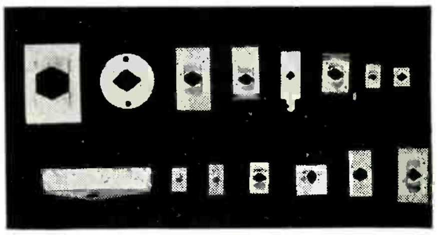
At the same time, fabricators should realize that the original microstructure of the metal as it comes from the mill changes with the subsequent annealing operations which it may receive during fabrication. In other words, the fabricator should control the grain structure of the metal during his own annealing just as carefully as the mill performs this important operation. As frequently mentioned, a coarse grain structure results in a rough surface which requires considerable cutting down to produce the necessary high polished effect. A fine grain structure, on the other hand, produces a smoother surface which requires less polishing and color buffing.

Phosphor Bronze for Speed Nuts

The old adage, "a chain is only as strong as its weakest link," probably caused engineers at Tinnerman Products, Inc., Cleveland, Ohio, to select Phosphor Bronze for their speed nuts.

These small but vital spring parts must withstand constant tension and vibration. In the assembly of a mechanism, the metal in the nut must take a sizable deflection without setting, or the function of the nut would be nullified.

Phosphor Bronze Grade C, about 92% copper, 8% tin, and 0.1% phosphorus, 8 B&S numbers hard, has a tensile strength of about 112,000 psi. The Grade A alloy contains about 95% copper, 5% tin and 0.15% phosphorus and has a tensile strength of about 103,000 psi when rolled the same temper.



Speed Nuts made from Phosphor Bronze. Courtesy Tinnerman Products, Inc., Cleveland, Ohio.

Phosphor Bronze has many industrial applications because of its high corrosion resistance and excellent spring properties retained under repeated flexing. It is used widely for electrical snap switches, diaphragms, current collectors, spring contacts, and parts for electronic equipment.

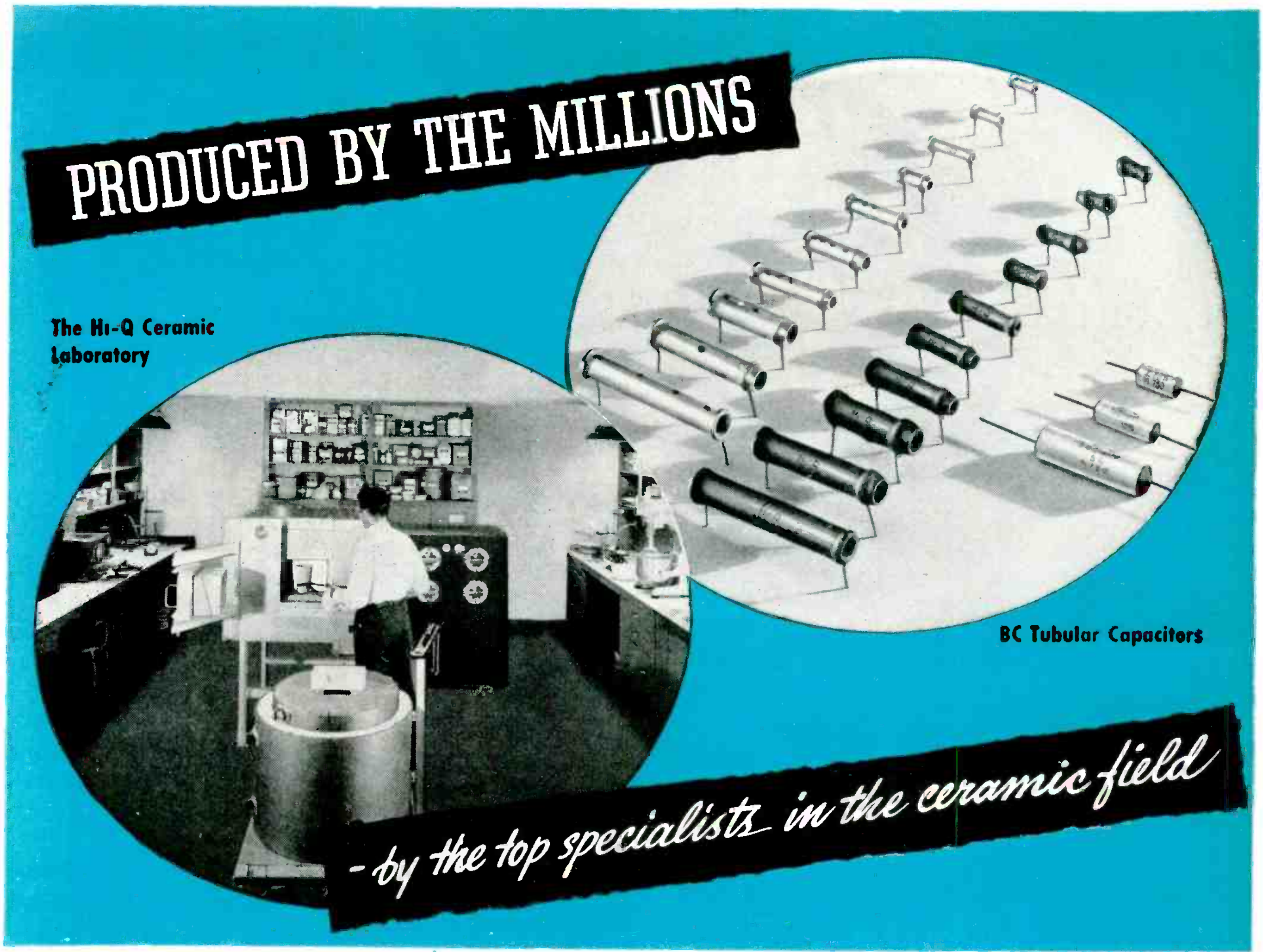
BRASS · BRONZE · COPPER · DURONZE — STRIP · ROD · WIRE · TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA

In Canada:
Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONNECTICUT
Established 1865

"Bridgeport" *District Offices and Warehouses in Principal Cities*



Hi-Q COMPONENTS

Capacitors
Trimmers • Choke Coils
Wire Wound Resistors

BETTER 4 WAYS

- ✓ PRECISION
- ✓ UNIFORMITY
- ✓ DEPENDABILITY
- ✓ MINIATURIZATION

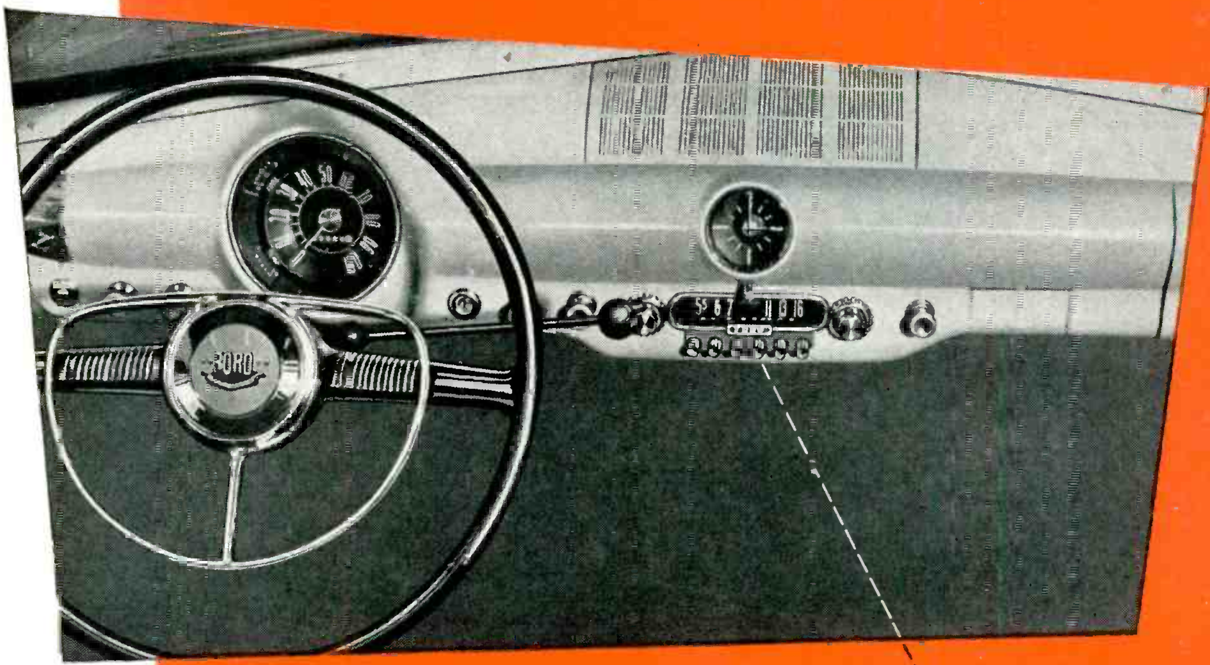
● **Hi-Q** BC Tubular Ceramic Capacitors for by-passing, coupling and filtering are available with any of three types of insulations:—clear non-hydroscopic styrene coating (CN)...Durez impregnated with low loss microcrystalline wax (SI) . . . or a ceramic (steatite) cover tube sealed with a specially developed end seal (CI). The **Hi-Q** trade mark is your assurance that like all **Hi-Q** Components, they rigidly meet specifications and are uniformly dependable in every respect. As leading specialists in the ceramic field, **Hi-Q** has come to be regarded by producers of radio, television, communications and electronic equipment as their best source of technical assistance in developing components to meet the needs of any circuit.

JOBBERS – Address: 740 Belleville Ave., New Bedford, Mass.

Hi-Q *Electrical Reactance Corp.*
FRANKLINVILLE, N. Y.

SALES OFFICES: New York, Philadelphia
Detroit, Chicago, Los Angeles

PLANTS: Franklinville, N. Y., Olean, N. Y.
Jessup, Pa., Myrtle Beach, S. C.



FORD for '50
HYTRON for '50

Thrifty, nifty fifty Ford. On the dash a fine new Ford radio receiver. And again tubes by Hytron. Hytron continues as a major supplier of Ford auto radio tubes. Because Hytron *specializes* in auto radio tubes. Engineered for leaders like Ford, these Hytron tubes are leaders too. 'Nuff said! Buying auto radio tubes? Buy wise . . . like Ford. Buy Hytron!

OLDEST MANUFACTURER OF RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

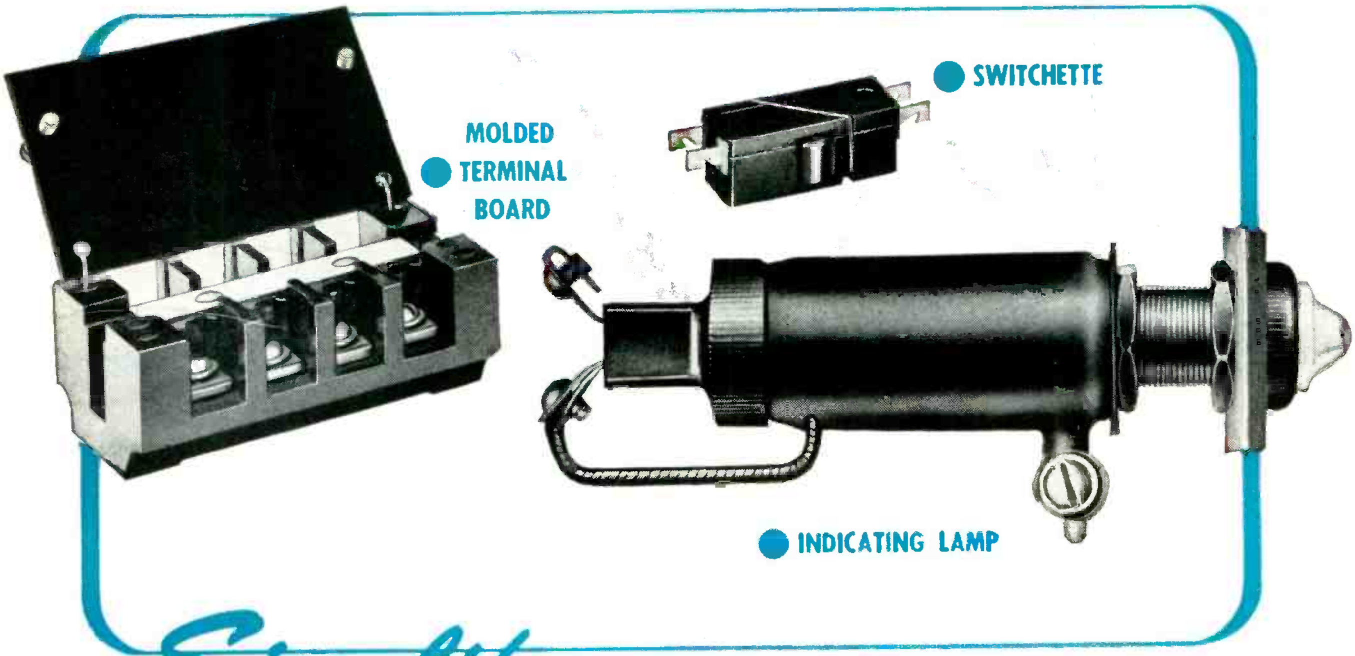
MAIN OFFICE SALEM, MASSACHUSETTS

NEW 4TH EDITION — Hytron Reference Guide for Miniature Electron Tubes. Free from your Hytron jobber; or write us. Original . . . unique. Lists all miniatures to date, regardless of make. Six pages: 132 miniatures — 41 new. 73 basing diagrams. Lists similar larger prototypes. Get your copy today.

FREE — Hytron Tool Catalogue Describes famous Hytron service-shop tools; Soldering Aid, Tube Lifter, 7-Pin and 9-Pin Straighteners, Tube Tapper and Auto Radio Tool. Find out how these Hytron tools can ease your work . . . help you make more money. Write today.

ELECTRONICS

Designers



Simplify YOUR CONTROL CIRCUITS WITH THESE G-E COMPONENTS

● MOLDED TERMINAL BOARDS—Designed to give positive electrical connection without soldering lugs, these sturdy terminal boards are built of molded Textolite® with reinforced pole barriers. Hinged protective covers protect wiring; marking strips are reversible—white on one side, black on the other. Boards are available with 4 to 12 poles; are 2 inches wide, 1¼ inches long. See Bulletin GEA-1497.

● "SWITCHETTES"— Use them in tight places; depend on them for long life. They're available in single- or two-circuit, normally open or normally closed circuits; have momentary or maintaining contacts; are equipped with screw terminals, soldering lugs or quick-connect lugs. They're corrosion-proof, vibration-resistant, and have low r-f noise output. Ratings up to 10 amps at 230 vac. Size: 1¼ x ½ x ½. See Bulletin GEA-4888.

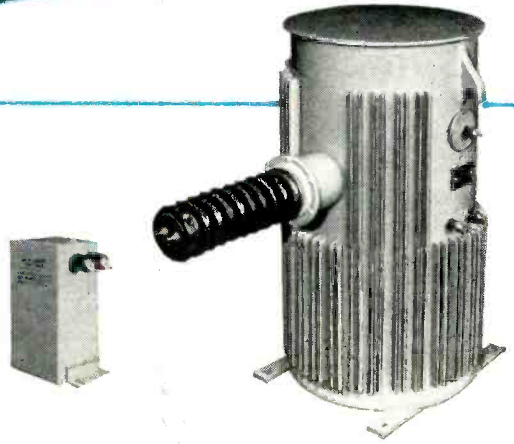
● INDICATING LAMPS—You can see from any angle whether these lamps are off or on. Color caps—made from a special translucent compound—are clear, green, red, yellow, white, or blue. Available for 24, 48, 125, 250, or 660 volts d-c; 125, 220, 440, or 550 volts a-c. Mount on panels up to 2 inches thick. All units include built-in series resistors, to insure long lamp life and eliminate the need for fuses. Size: about 5 inches long. See Bulletin GEA-3643.

GENERAL ELECTRIC

667-6

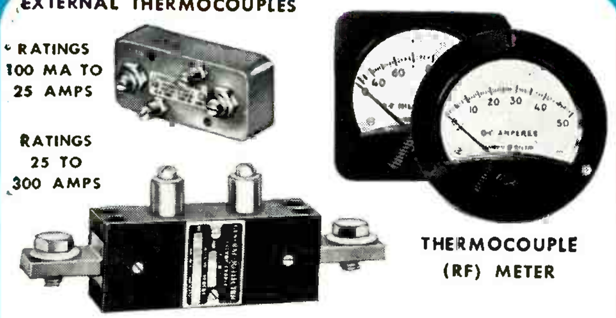
Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



PULSE TRANSFORMERS... MIDGET OR GIANT

A six-inch midget and two-foot giant, both are examples of G.E.'s family of oil-insulated, hermetically sealed pulse transformers. General Electric has built units with peak voltage ratings of from 10 to 100 kv and over, peak power ratings up to 30 megawatts, for pulse durations of from .05 to 20 microseconds and repetition rates up to 10,000 pps. Oil filled units have also been used for lower voltages to minimize internal corona. Typical applications: pulse voltage step-up or step-down, impedance matching, phase reversing, and transmitter plate-current measurement. What is your requirement? Write, giving complete details, to Power Transformer Sales Division, General Electric Co., Pittsfield, Mass.



ACCURATE RF MEASUREMENT

100 MA to 300 AMPS

The new, sturdy, and easy-to-read G-E panel instruments are available for measuring r-f from 100 ma or less to 300 amps. R-f meters are usually supplied with internal thermocouples, but for applications where remote location of thermocouple is required, or for measuring extremely high currents (over 20 amps), external units are available. For complete data on these or other G-E panel instruments for a-c, d-c, or a-f, see Bulletin GEC-368.

New! FOR COMPACT DESIGNS MINIATURE RECTIFIER CELLS

Here's a new series of rectifier cells that can help you fit your circuit into a smaller space. These new "K-type" cells may be used to replace tubes for dual-diode, voltage-doubler, and blocking applications.

The cells are built with a new G-E evaporation process which makes for long life and stable output. Forward resistance and back leakage are low. Standard cells are moisture resistant, special units are hermetically sealed. All have a $\frac{7}{16}$-inch diameter and can be mounted as easily as an ordinary resistor. Circuits: half-wave, center tap, or bridge. Ratings: as high as 40 RMS volts input, 56.5 maximum inverse peak volts at 10 d-c ma. Data in Bulletin GEC-655.

General Electric Company, Section C667-6
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

Indicate for reference only	✓	☐	GEA-1497	Terminal boards
		☐	GEA-3643	Indicating lamps
		☐	GEA-4888	Switchettes
for planning an immediate project	X	☐	GEC-368	Panel instruments
		☐	GEC-655	Rectifier cells

Name..

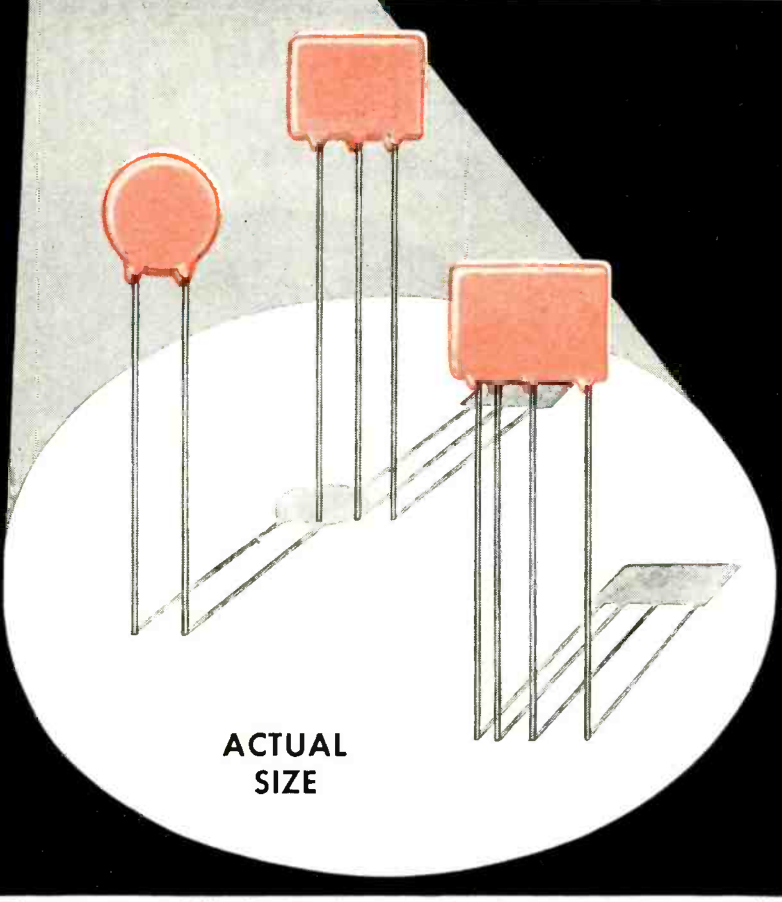
Company..

Address..

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

Erie Disc and Plate Ceramicons®

for By-passing and Coupling Applications



ACTUAL SIZE

STANDARD AVAILABLE CAPACITIES			
ERIE TYPE	**SIZE**	**CAPACITY RANGES**	**MARKING**
831	9/32" Max. Dia.	.0008 MFD	Stamp ℞ 800
801	7/16" Max. Dia.	.001 MFD	Stamp ℞ .001
		.0015	Stamp ℞ .0015
		.002	Stamp ℞ .002
811	19/32" Max. Dia.	.005	Stamp ℞ .005
		.01	Stamp ℞ .01
812	19/32" Max. Dia.	Dual .001	Stamp ℞ 2—.001
		Dual .0015	Stamp ℞ 2—.0015
		Dual .002	Stamp ℞ 2—.002
822	3/4" Max. Dia.	Dual .003	Stamp ℞ 2—.003
		Dual .004	Stamp ℞ 2—.004
883	9/16" x 3/4" Max.	Triple .0015	Stamp ℞ 3—.0015

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA

High capacity in extremely compact size is the distinguishing feature of Erie Disc and Plate Ceramicons. For example, .01 mfd is now available in 19/32" diameter. Illustrations are exact size, and their shape as well as their compactness make them amazingly easy to install in small spaces. They simplify soldering and wiring operations and speed up the assembly line.

Erie Disc and Plate Ceramicons consist of a flat ceramic dielectric with silver plates fired onto the dielectric. Lead wires of 24 gauge tinned copper wire are firmly soldered to the silver electrodes and the unit is given a protective coating of phenolic.

Such simplicity of construction results in low series inductance and unusual efficiency in high frequency by-passing.

For complete information and samples to meet your particular needs, write us today.

SPECIFICATIONS

Voltage: Units are rated at 500 VDC, except Type 811—.01 MFD which is rated at 400 VDC based on life test of 1,000 hours at 800 VDC and at 85° C. Dielectric strength test; 1,500 VDC.

Power Factor: 2.5% max. at 1 K.C. at not more than 5 volts RMS.

Insulation Resistance: 7,500 meg. Ω min.

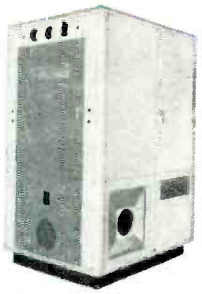
Capacity: Capacity measurements are made at room temperature (25° C) at 1 K.C. and at not more than 5 Volts RMS. Standard tolerance is +100%, −0%. (Blue)

Temperature Characteristics:
The capacity of all units except Type 811—.002 MFD and below shall not decrease more than 50%, nor increase more than 25% from its value at room temperature (25° C), as the temperature is varied from +10° C to +75° C. (Characteristic Gold)

Type 811 units .002 MFD and below shall not decrease more than 20%, nor increase more than 10% from capacitance value at room temperature (25° C), as the temperature is varied from −40° C to +85° C. (Characteristic Silver)


TV Monitor Console


Desk Panel Cabinet Rack

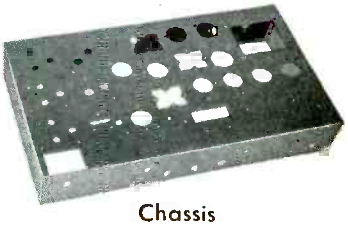

Induction Heater Housing

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

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

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

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


Chassis

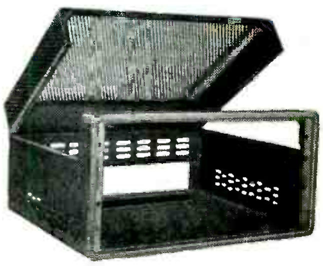

Marine Radio Housing

CABINETS • BOXES • CHASSIS • HOUSINGS • ENCLOSURES

KARP METAL PRODUCTS CO., INC.

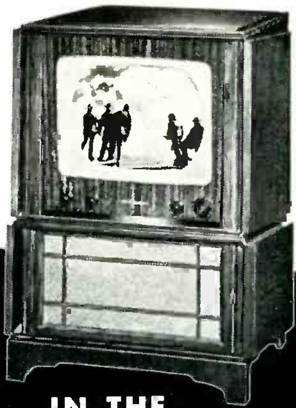
215 63rd STREET, BROOKLYN 20, NEW YORK

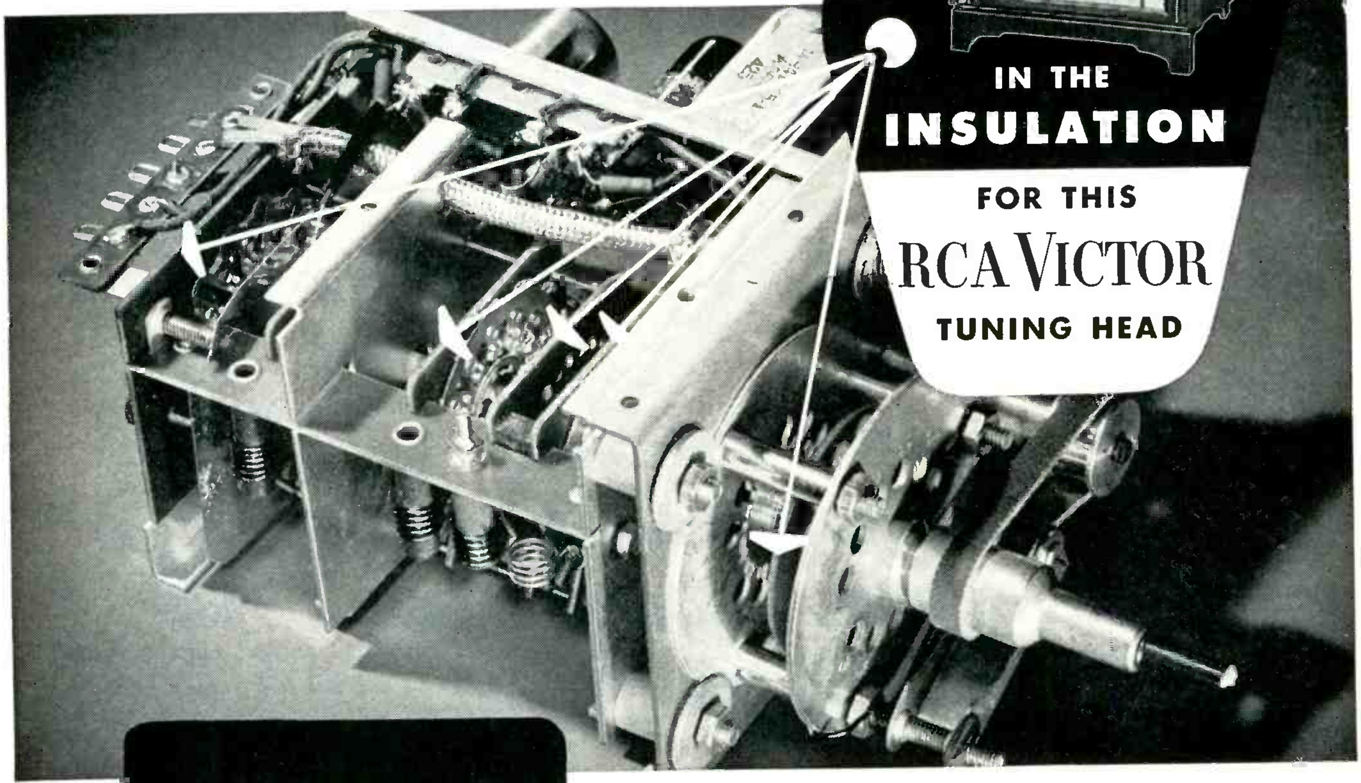
Custom Craftsmen in Sheet Metal


Cabinet

OAK MFG. CO. DEMANDS

UNIFORMITY





IN THE **INSULATION** FOR THIS RCA VICTOR TUNING HEAD

INSUROK DOES THE JOB!

3 POPULAR ELECTRICAL GRADES OF LAMINATED INSUROK

T-725 An outstanding paper-base laminate that can be hot-punched to intricate shapes. Has excellent electrical and physical properties, is stable under moisture and heat, and only slightly affected by sanding.

T-800 Has unmatched electrical properties, yet punches with ease. It has a sensational ability to retain these properties in high humidity.

T-812 A further development in the electrical sheet field with insulation resistance on the order of T-800 and mechanical properties comparable to T-725.

In manufacturing components for this critical tuning head for RCA Victor television receivers, Oak Manufacturing Co. faced a tough insulation problem. The insulation had to be strong, yet produce clean, intricate, punched parts. It had to possess superior electrical properties—unchanged after sanding to close tolerances. And its electrical characteristics had to remain stable through a wide range of temperature and humidity.

INSUROK electrical sheets provide Oak with a unique combination of all of these desired properties. And even more important, from shipment to shipment, Oak engineers can depend on INSUROK's properties remaining uniform.

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

The RICHARDSON COMPANY

FOUNDED IN 1858

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

CLEVELAND • DETROIT • INDIANAPOLIS • LOCKLAND, OHIO • MILWAUKEE
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We know only too well what is modern today in Electronics can be obsolete tomorrow. We can retard obsolescence by designing our products with an eye toward the future and what future applications may demand of our products.

Burnell & Company has shaped its engineering policy with this viewpoint — by striving to keep well ahead — not just abreast of developments in the Hi Q Coil and Filter business.

We search constantly for new design ideas that will permit the reduction of size and weight of Filters that "fly"; new circuits and components that will give our customers "more for their money" — and new production methods that will speed output and guarantee the reliability and life of our products.

Even our price structure has been streamlined to conform with the increasing industry-wide demand for economy, with no sacrifice in our high standard of quality.

We say that modern applications demand Burnell & Company's toroids and toroidal filter products because we are modern in every sense of the word: modern in outlook and technique as well as in price.

Exclusive Manufacturers of Communications Network Components

We particularly invite your inquiries concerning difficult filter applications

Burnell & Company
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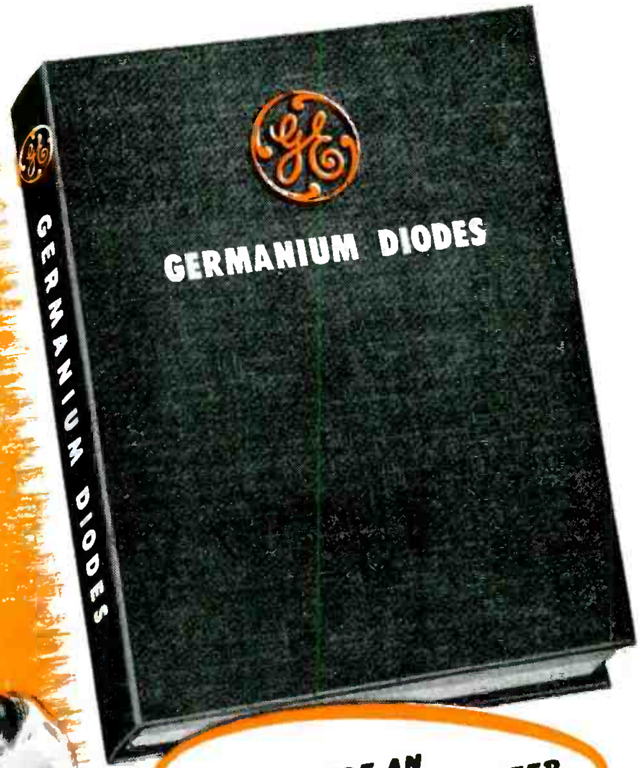
NEW HANDBOOK

ON GENERAL ELECTRIC WELDED GERMANIUM DIODES



"IF YOU'RE AN ELECTRONICS ENGINEER, PAL, YOU NEED THIS BOOK!"

HERE'S the book that digests all the facts you should have on Germanium Diodes. Contains valuable pages of up-to-the-minute information on diodes and their applications in today's widening electronics market!

For designers and engineers who want basic facts on the development, characteristics, advantages and circuitry of diodes, this carefully prepared General Electric manual is a valuable tool. Includes specific data on diode problems, characteristics curves, electrical rating charts, circuit diagrams.

Assembled in loose leaf fashion, the book is tabbed by sections for easy reference. The $1.25 price of this leatherette bound handbook includes supplementary sheets on new diode developments which will be sent to you as they are published. Your copy is waiting. Mail the coupon today!

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GENERAL ELECTRIC

HERE'S WHAT IT TELLS YOU

- Design, manufacture, and specifications of G-E Welded Germanium Diodes
  - General purpose types
  - TV types
  - Quads
  - UHF diodes
- **CHARACTERISTICS CURVES**
  36 curves on resistance, current, voltage, temperature, and efficiency. Also typical distributions.
- **SERVICE NOTES**
  - How to install
  - How to check and inspect
  - Precautions
- **DIODE APPLICATIONS**
  Typical circuit applications and brief descriptions of diode characteristics as used in circuits covering AM & FM receivers, TV receivers, measuring equipment, carrier current, miscellaneous.
- Pertinent articles and public presentations on diode theory and application.

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Please send me ...... copies of the new G-E Germanium Diode Handbook at $1.25 per copy—Postpaid.

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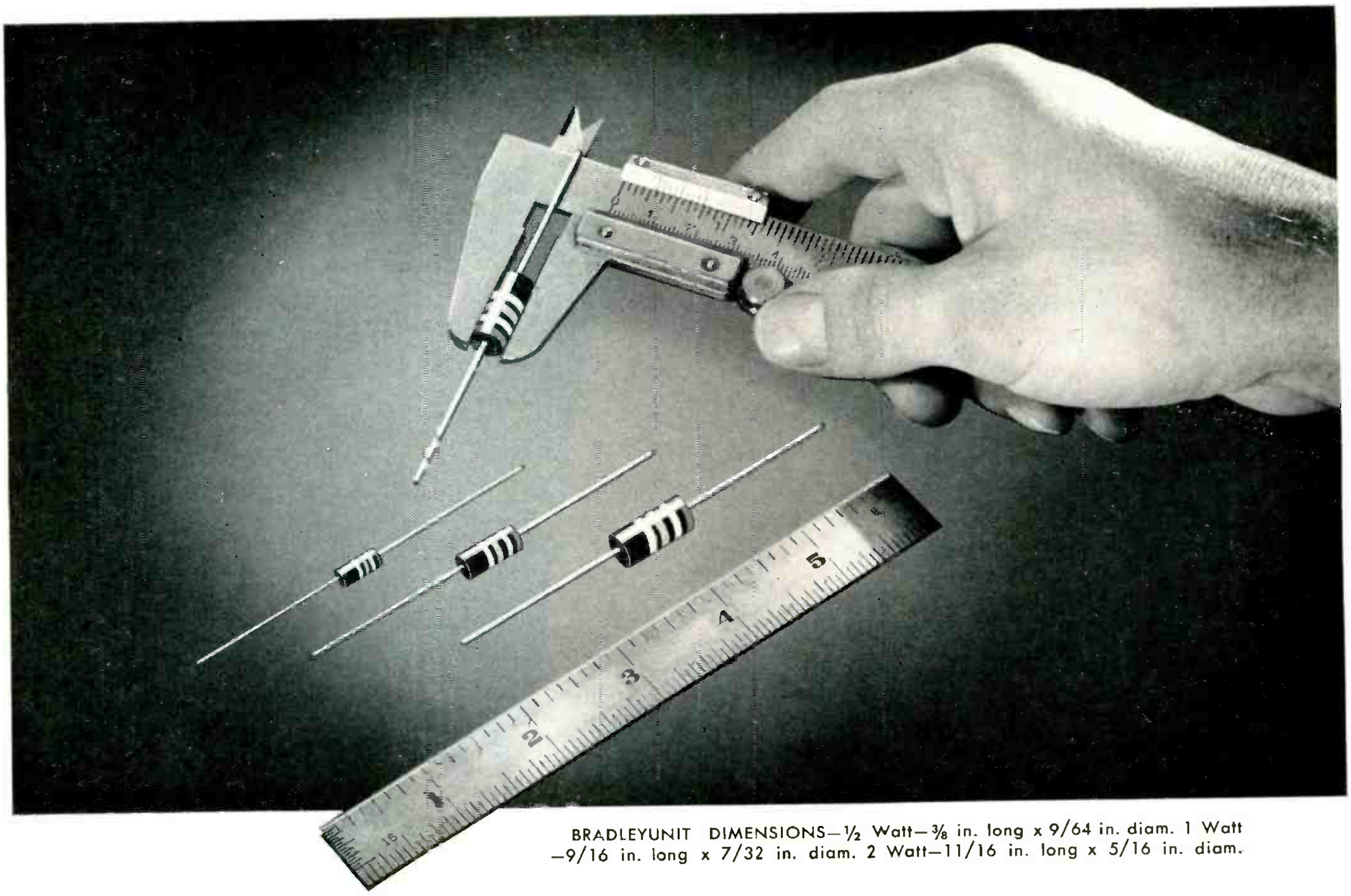

BRADLEYUNIT DIMENSIONS—½ Watt—⅜ in. long x 9/64 in. diam. 1 Watt—9/16 in. long x 7/32 in. diam. 2 Watt—11/16 in. long x 5/16 in. diam.

QUALITY FIXED RESISTORS

for Electronic Circuits

Bradleyunit resistors are small in size . . . but "super" in the performance demanded by electronic engineers. Bradleyunits are rated at 70 C ambient temperature, not 40 C. Thus, they have a much wider safety factor. Furthermore, under continuous full load for 1000 hours, resistance change is less than 5 per cent. And, Bradleyunits require no wax impregnation to pass salt water immersion tests. Another advantage is the differentially tempered leads which prevent sharp bends near the resistor.

Bradleyunits are packed in honeycomb cartons to keep the leads straight and avoid tangling. They are available in ½, 1, and 2 watt ratings in standard R.M.A. values up to 22 megohms.

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

SOLID MOLDED ADJUSTABLE RESISTORS

Available in single, dual, and triple unit constructions with solid molded resistor elements. Any resistance—rotation curve. Rated at 2 watts.

A·B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

"AMERICAN Screw Company?

. . . please call the NEW NUMBER . . . at WILLIMANTIC CONNECTICUT!"

Wire Storage

. . . and get fastest fastener-service from this modern, high-production plant

Save time and "wrong numbers" by changing your records *now* to the address of American's new main plant and home office.

This high-production operation . . . one of the most modern in the screw industry . . . is equipped and staffed to raise American quality and service to new high levels, both in American Phillips Recessed-Head Fasteners, and also slotted products. Whatever it takes to make better screws, American has it at Willimantic!

Photos at the right give you a good picture of American's present position on deliveries. So for either Phillips or slotted, mark your order *American* . . . and shoot it to Willimantic.

AMERICAN SCREW COMPANY

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

Warehouses at:

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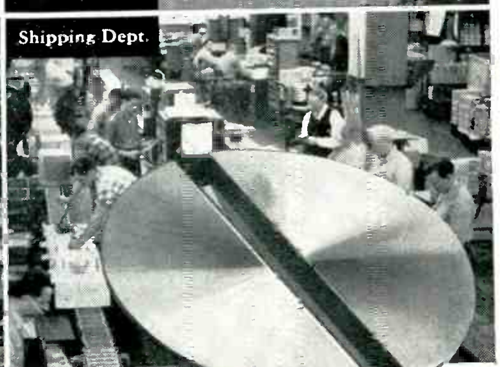
Cut Threading Dept.



Shipping Dept.

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

Phillips

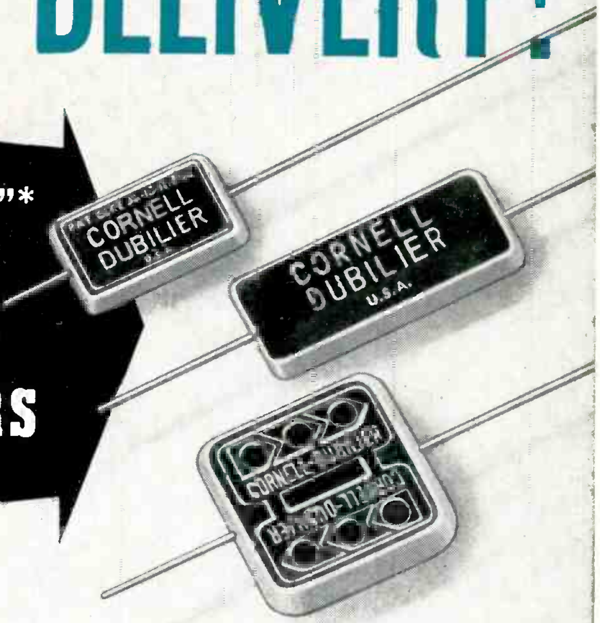
AMERICAN SCREWS

Slotted

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

24 HOUR DELIVERY!

"SILVER MIKE"* MICA CAPACITORS



Now you can get the same dependability that has made C-D's famous in engineering circles the world over, on a twenty-four-hour delivery basis. The demand for "Silver Mike"* Micas through the years has been so great that every expansion program has proved insufficient. But with the completion of our last expansion program we are making available the entire Providence plant exclusively to the production of the famous, reliable C-D line of "Silver Mike"* Micas. Of course, in addition to the new, improved delivery standards, you still get these other features that have made C-D's "Silver Mike"* Micas so popular:

Extra heavy silver coating thoroughly bonded to mica — results in a uniform and low capacity-temperature coefficient (+.002% per degree C.); excellent retrace characteristics; practically no capacity drift with time.

Molded in low-loss red compound — results in an exceptionally high Q (3,000 to 5,000); fixed electrical characteristics.

Wax impregnated — results in a humidity-proof capacitor.

"Silver Mike"* Mica Capacitors are available in 300 and 500 V.D.C., and in capacities from .000001 to .005 mfd. at standard tolerance of ±5%. "Silver Mike"* Micas can also be supplied, on special order, to tolerances of ±3%, ±2% and ±1%.

Your inquiries are invited. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-7-0, South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

FOR A CONSTANT LC PRODUCT . . . FOR DEPENDABLE RESULTS . . . FOR UNRIVALED PERFORMANCE . . . SPECIFY C-D!

Best by Field Test!

40TH ANNIVERSARY CORNELL DUBILIER CAPACITORS 1910 1950

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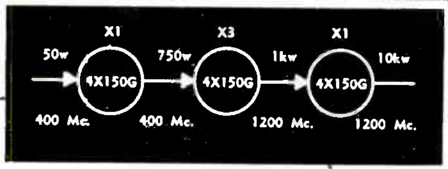
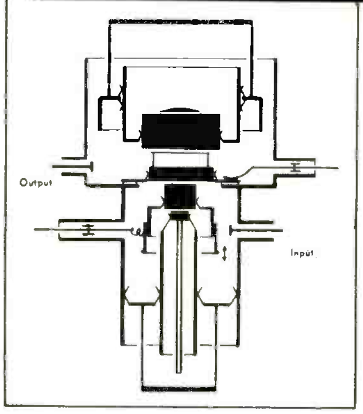




These illustrations show an example of the simplicity made possible by the 4X150G. The cavity is for a broad-band 1200 Mc. power amplifier for a pulse application. The block diagram indicates the tube line-up of the IPA, tripler, and final PA stages. More detailed data on the 4X150G are available. Please make requests on your company letterhead.

The 4X150G has been specifically designed to make feasible relatively high power at UHF. It is excellent as an amplifier, oscillator or frequency multiplier in either pulse or cw service. Good efficiency is obtained over a wide range of plate voltages to over 1500 Mc.

Power-gains of 10 are easily obtainable at 1200 Mc. when pulsed, and peak pulsed outputs of 20 kw per tube are possible without extending the tube beyond its maximum ratings.

At lower frequencies, for instance around 750 Mc., the 4X150G operating as a cw amplifier will provide 100 watts output with but 12½ watts of grid-drive . . . a power-gain of 8, with complete stability.

These examples are only indicative of the tube's potentialities. More comprehensive data are contained in a new data sheet, available upon request.

EITEL-McCULLOUGH, INC.
San Bruno, California

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

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

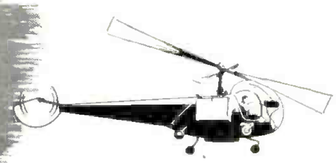
The 4X150G is another Eimac-developed contribution to electronic progress.

258

Announcing the **H-14** SIGNAL GENERATOR

108-118 megacycles

Newest in ARC's Line of Signal Generators



Checks on . . .

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

MICROWAVE TEST SET . . . TYPE H-10

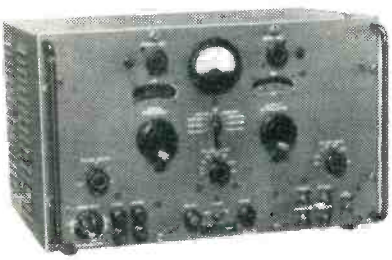
23,500-24,500 MEGACYCLES

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

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

UHF SIGNAL GENERATOR . . . TYPE H-12

900-2100 MEGACYCLES



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

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

Use the H-14 for Testing Omni Receiving Units in Aircraft . . . . . . or on the Bench.

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

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

ARC COMMUNICATION AND NAVIGATION EQUIPMENT

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

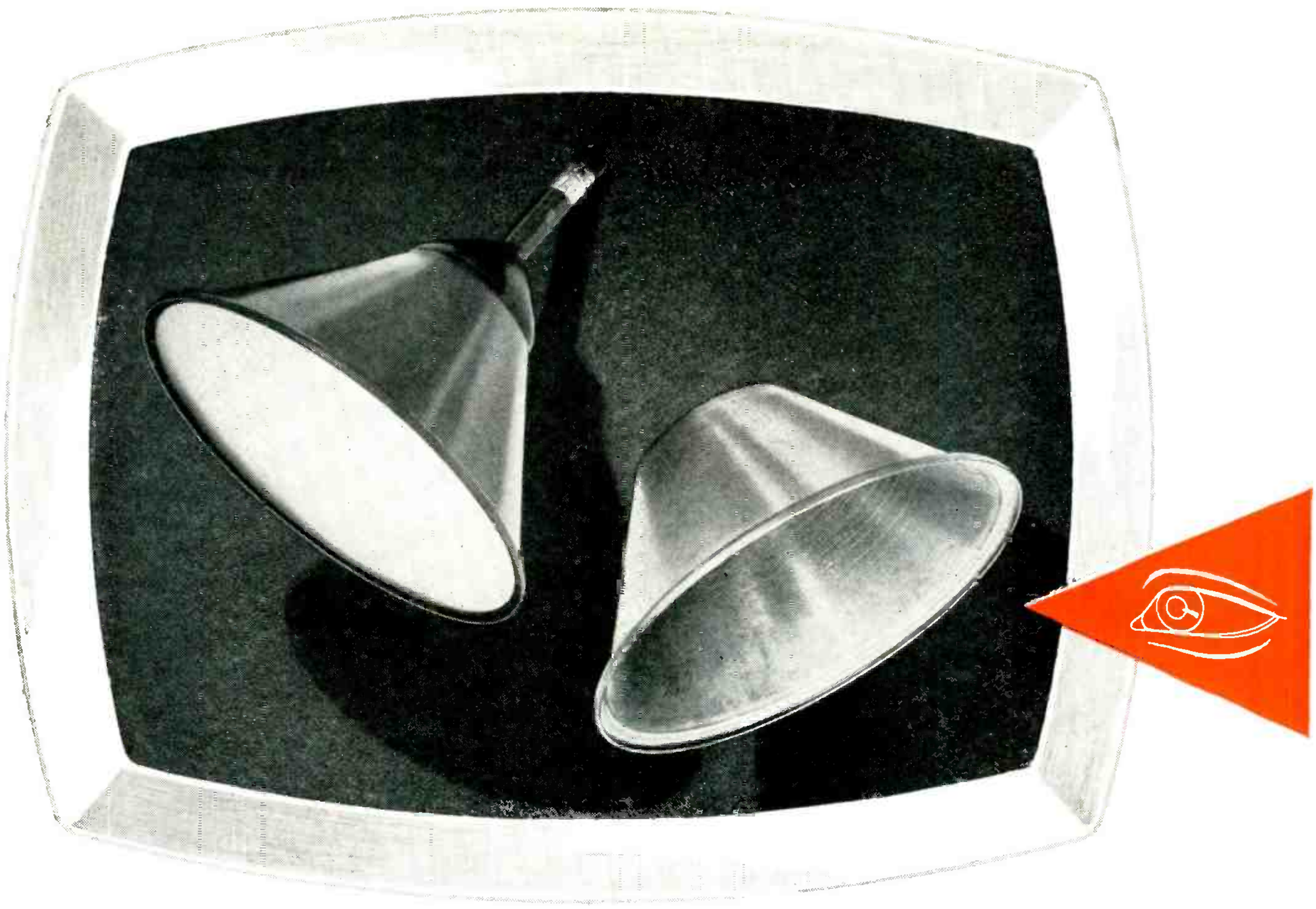
ARC

Aircraft Radio Corporation

Boonton, N. J.

Dependable Electronic Equipment Since 1928

WRITE TODAY *for descriptive bulletins on any of these instruments*



U·S·S Stainless Steel is in the television picture

PICTURE TUBE CONES OF U·S·S 17-TV REDUCE WEIGHT, HELP CUT COSTS

PUBLIC demand for bigger and better television at low price has brought manufacturers face to face with new problems in reducing weight and holding down set cost. And, like so many other industries, television has turned to Stainless Steel to solve this problem.

A new grade of U·S·S Stainless Steel, known as U·S·S 17-TV, has been developed especially for this television application. Having an appropriate coefficient of expansion, it permits fusing of the faceplate and neck to the metal cone with a strong air-tight seal.

By using U·S·S 17-TV instead of glass for the conical section of the picture tube, you can cut the weight of this key part over one-third. The result is important savings in handling, shipping and packing costs. The tube can be shipped installed in the receiver with little danger of damage in transit.

In addition to its light weight, other inherent advantages of Stainless make important contributions here. Its strength enables the tube to withstand extreme pressures and reduces breakage hazards. Because glass area is held to a minimum, and because of the protection provided by the Stainless Steel cone, hazards of implosion are minimized—in tube manufacture, in installation and in service. The U·S·S 17-TV cone permits the use of a flawless, smooth glass face, thus resulting in cleaner, and sharper pictures.

Whether you manufacture or use cathode ray tubes, investigate the possibilities of U·S·S 17-TV Stainless Steel, developed especially for the television industry. Like all other grades of U·S·S Stainless, it is made to give you the finest possible performance.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
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UNITED STATES STEEL

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HAMILTON STANDARD and FAIRCHILD rely on

BENDIX-SCINTILLA ELECTRICAL CONNECTORS

Unfailing dependability is one of the requirements set by Hamilton Standard and Fairchild in their selection of equipment. The installation of Bendix-Scintilla electrical connectors in vital circuits of Hamilton Standard propellers is, therefore, a tribute to a fine product.

Wherever circuits must be arranged to connect and disconnect with ease and certainty, Bendix-Scintilla is the choice. Remember that whenever there is no compromise with quality, it pays to specify Bendix-Scintilla electrical connectors—the finest money can buy!

CHECK THESE ADVANTAGES

- Moisture-proof
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Lightweight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required
- Approved A-N source

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BENDIX SCINTILLA

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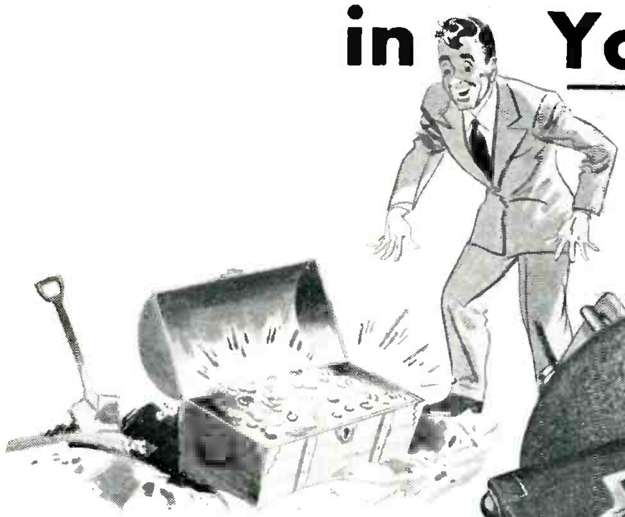
Bendix AVIATION CORPORATION

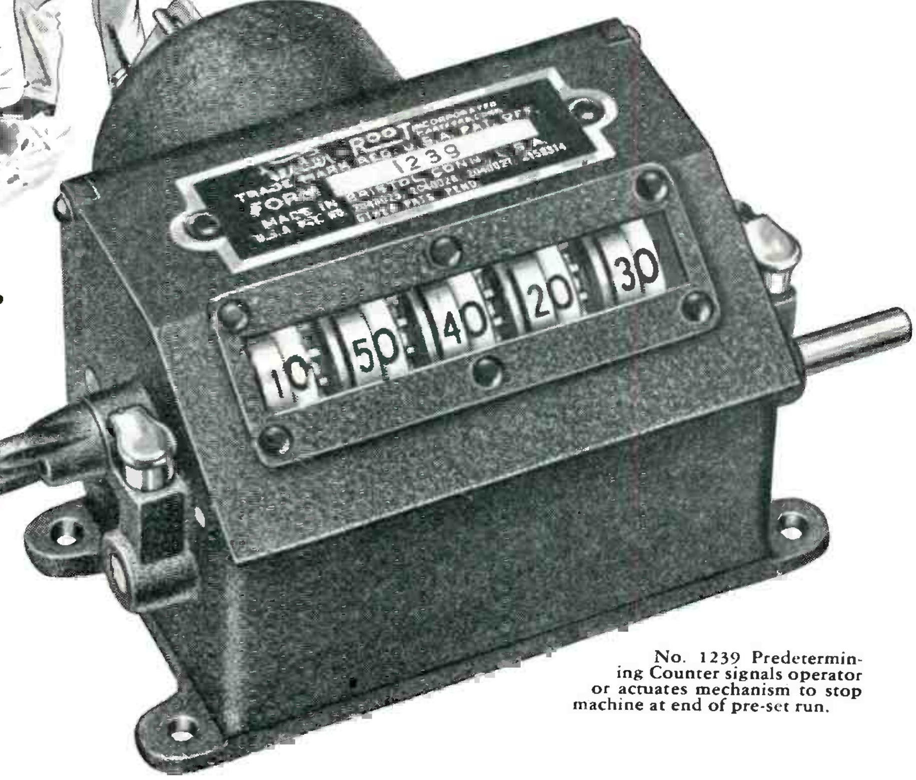
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Buried Treasure

in Your Product?



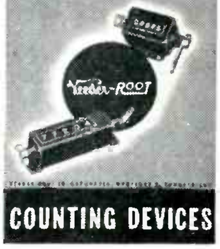
More than likely... if you can dig up New Ways to make it do more for your customers ...by COUNTING



No. 1239 Predetermining Counter signals operator or actuates mechanism to stop machine at end of pre-set run.

Dig deeply into this million-dollar question: "How could *my* product increase its usefulness and sales . . . *by counting?*" And you may well uncover a new and distinctive merchandising appeal that will set your product apart from competition . . . as so many manufacturers have done.

It's as simple as this: If your product is mechanically or electrically operated, then it's definitely worth a search to see if there's hidden sales-treasure buried there. This can be quickly determined by some fast spade-work done by a Veeder-Root engineer, paired off with your design engineer. And the digging can get under way . . . *any time you say.*

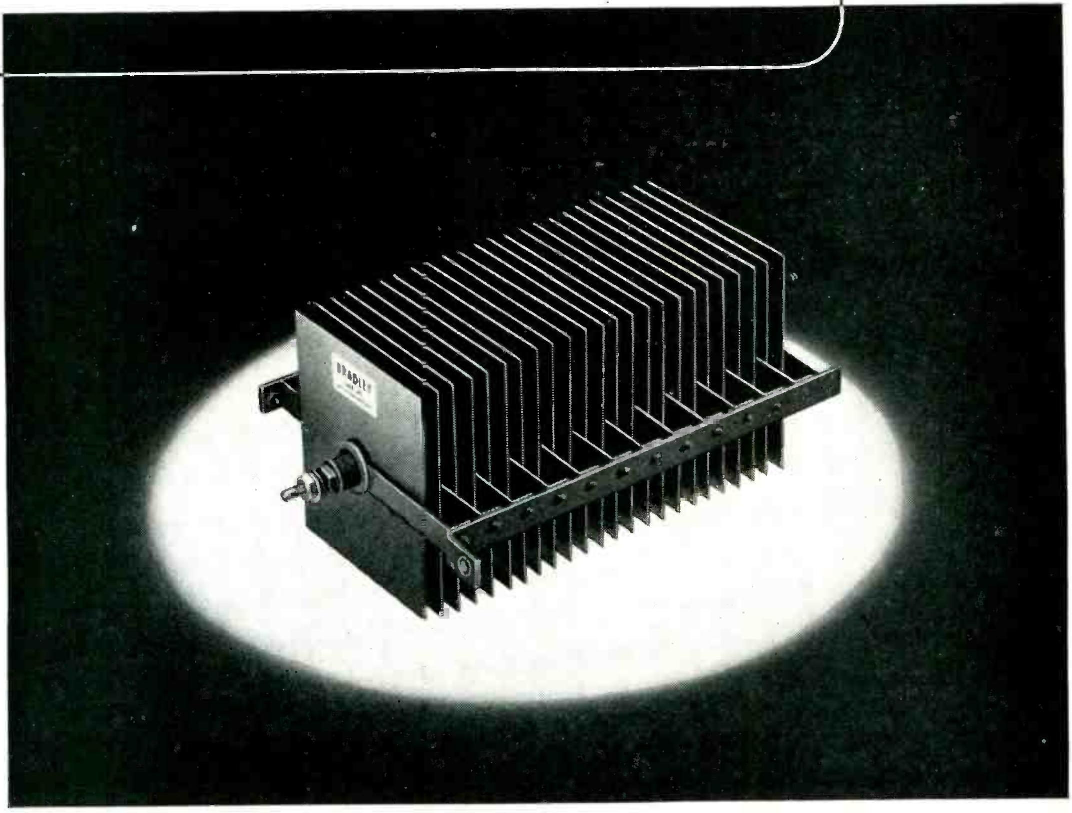


Write for 8-page "Counter Book" which shows all types of V-R electrical, mechanical, and manual counters . . . standard and special.

Veeder-Root COUNTERS

VEEDER-ROOT INC., HARTFORD 2, CONN.
In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3.
In Great Britain: Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.

MEANING OF "VACUUMED" SELENIUM IN BRADLEY RECTIFIERS FOR HIGH POWER USE



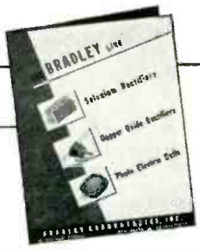
Selenium rectifier performance — aging, stability, and rating-per-space-factor — is based to a large extent upon the quality of selenium used. The purer the selenium, the better the rectifier performs.

Therein lies the importance of the Bradley vacuum process to every user of rectifiers. Through this exclusive process, we remove impurities in the raw selenium and prevent contamination during manufacture. Only Bradley rectifiers have the advantage of this unique type of quality control.

Besides offering maximum rating per space factor and consistent uniformity of rating, Bradley power rectifiers provide an unusual margin of safety against over-loading. One manufacturer reported that he was able to eliminate costly over-voltage protective devices upon installing Bradley power rectifiers.

Bradley rectifiers are available for every power conversion purpose. Our engineers are always available for consultation. Investigate Bradley vacuum-processed rectifiers for your next application.

SELENIUM RECTIFIERS • COPPER OXIDE RECTIFIERS • PHOTOCELLS



Write for your copy of "The Bradley Line," booklet showing many additional rectifier and photocell models.

BRADLEY LABORATORIES, INC.

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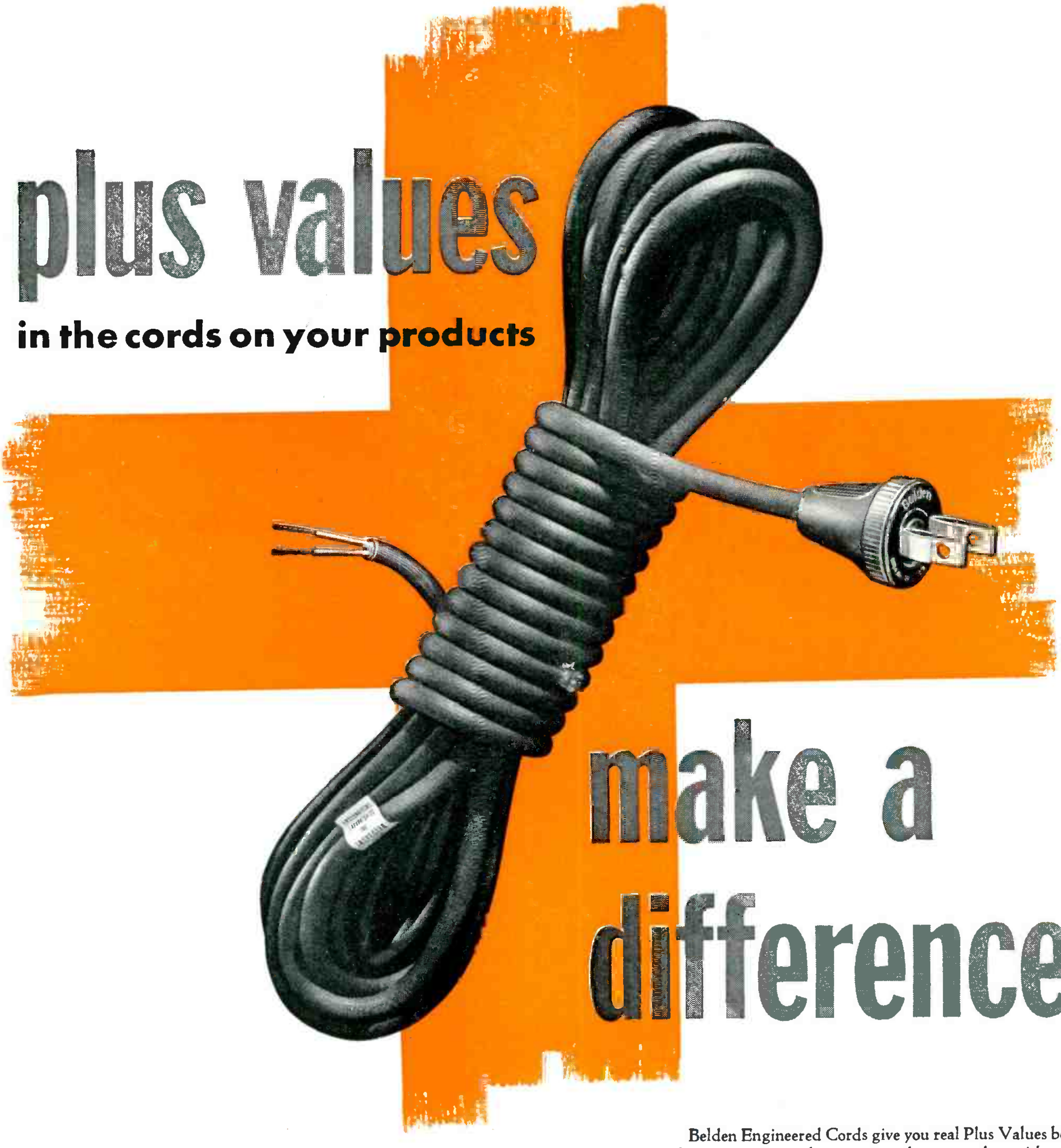
plus values

in the cords on your products



make a difference

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

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

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

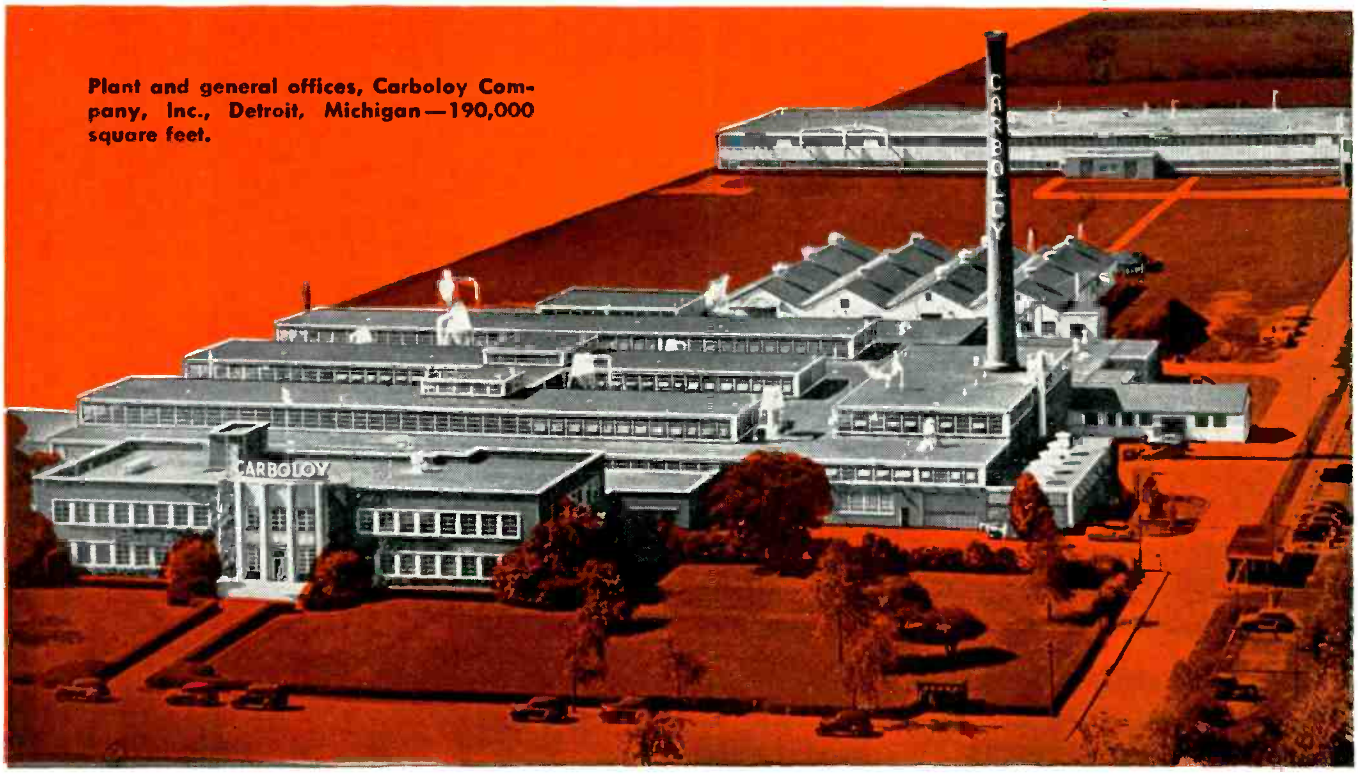
a Belden Cord Means

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

CORDITIS-FREE CORDS BY

Belden

WIREMAKER FOR INDUSTRY



Plant and general offices, Carboloy Company, Inc., Detroit, Michigan—190,000 square feet.

CARBOLOY COMPANY
announces
Special Metals Division to produce G-E ALNICO

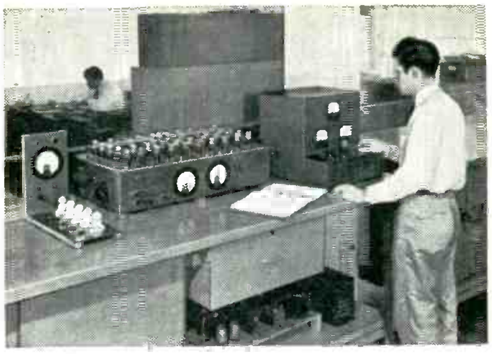
ALL OF Carboloy Company's experience, technical "know-how", and applicable facilities are being made available for mass production of Alnico permanent magnets. The pioneer in the development of cemented carbides, Carboloy Company, welcomes this addition to its line of special metals.

It is anticipated that the streamlining and conversion of necessary facilities will be completed at an early date.

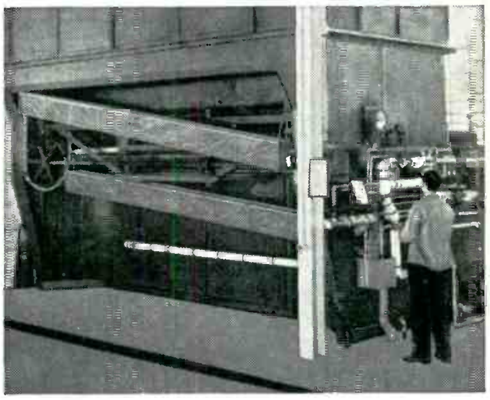
LOOK to CARBOLOY

for the finest in special metals

Trim Assembly Time with the Tube with the Tab

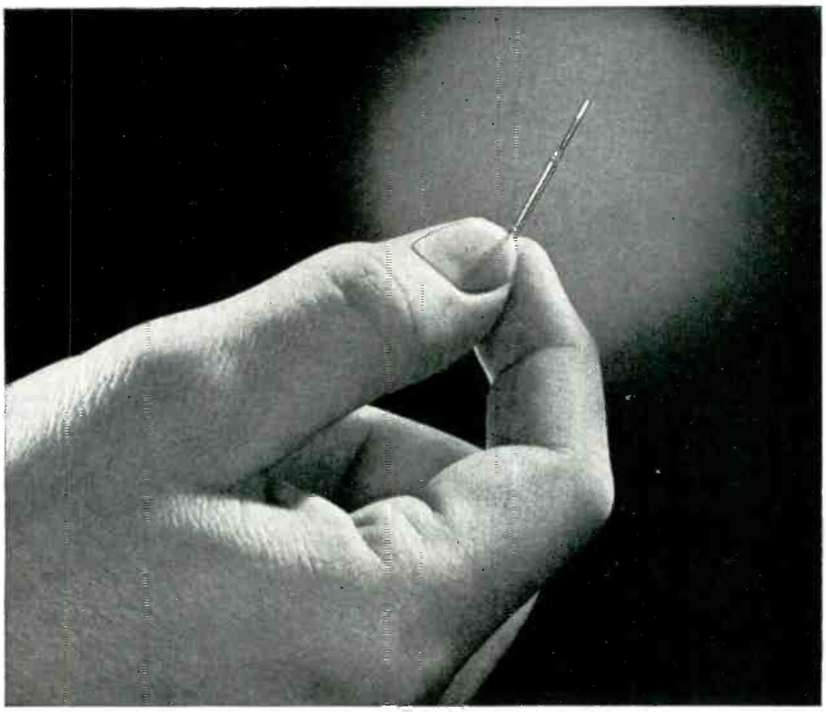


Electronic Engineering — Life test rack and emission test set. Checking Superior assembled standard diodes under simulated customer conditions to determine if material meets minimum requirements.



To guard against contamination by processing lubricants, Superior tubing is thoroughly degreased before each annealing operation.

Part of inspection procedure on Lockseam Nickel Cathodes as they come off the production machine. Each cathode must undergo many rigid tests before being approved.



● Superior's pioneering in tubing technology is constantly at work to bring electronic manufacturers new developments—to help them produce better equipment, faster, at lower costs. Newest of these improvements is the integral tabbed round Lockseam* cathode. It is designed to eliminate a welding operation, cut assembly time, and provide superior performance.

These integral tabbed round Lockseam* cathodes may be valuable to you . . . but whether they are or not one thing is sure. If you use Seamless or Lockseam* cathodes in your product a Superior tube is available to do a Superior job. Our research and engineering facilities are ready at all times to help solve your tubing problems.

For more information about Superior Tubing and its possible place in your operation write to Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

Which Is The Better For Your Product . . .

SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010" to .121" O.D. inclusive, with wall thicknesses of .0015" to .005". Cathodes with larger diameters and heavier walls will be produced to customer specification.

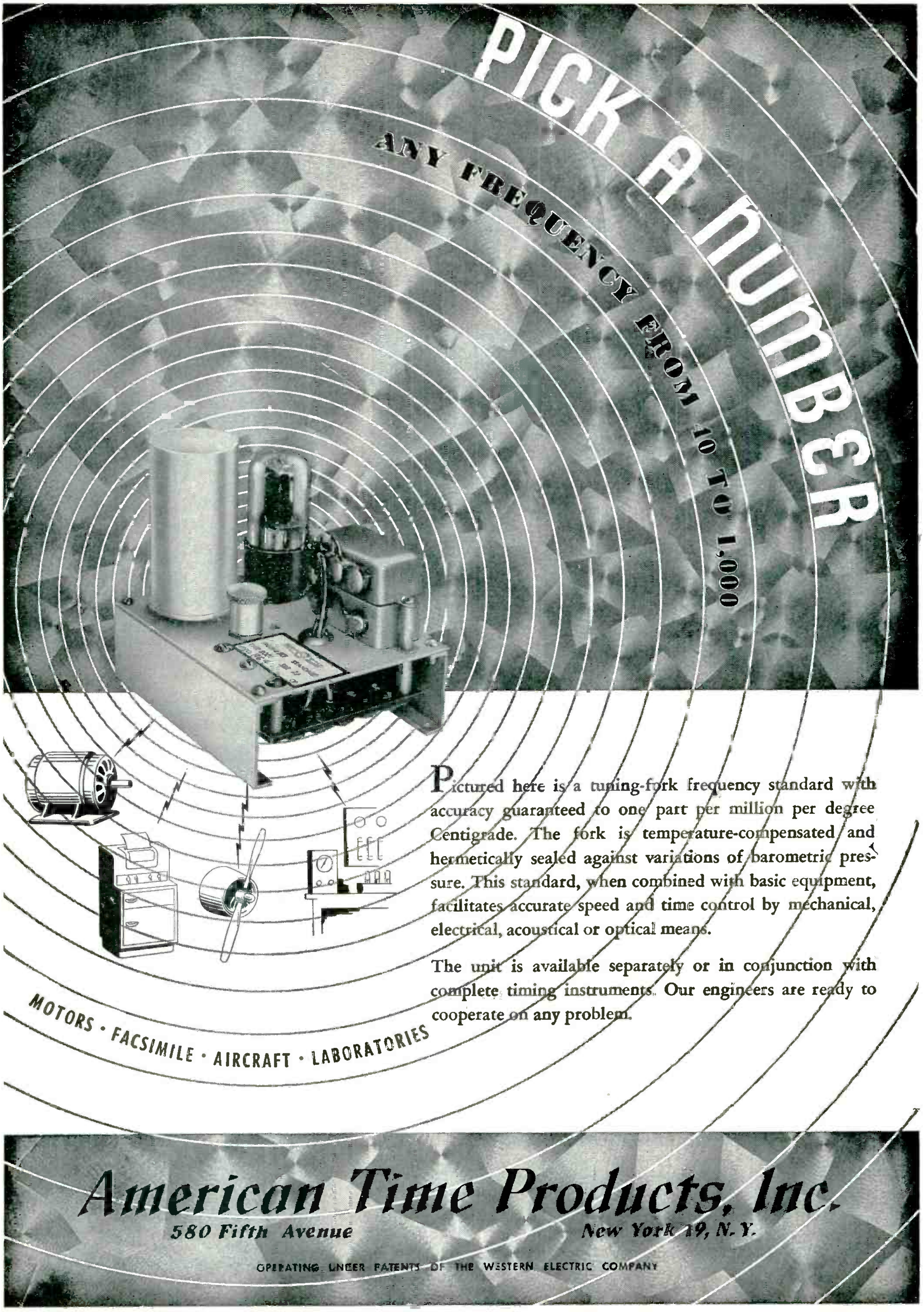
Or LOCKSEAM* . . . ? Produced directly from thin nickel alloy strip stock, .040" to .100" O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

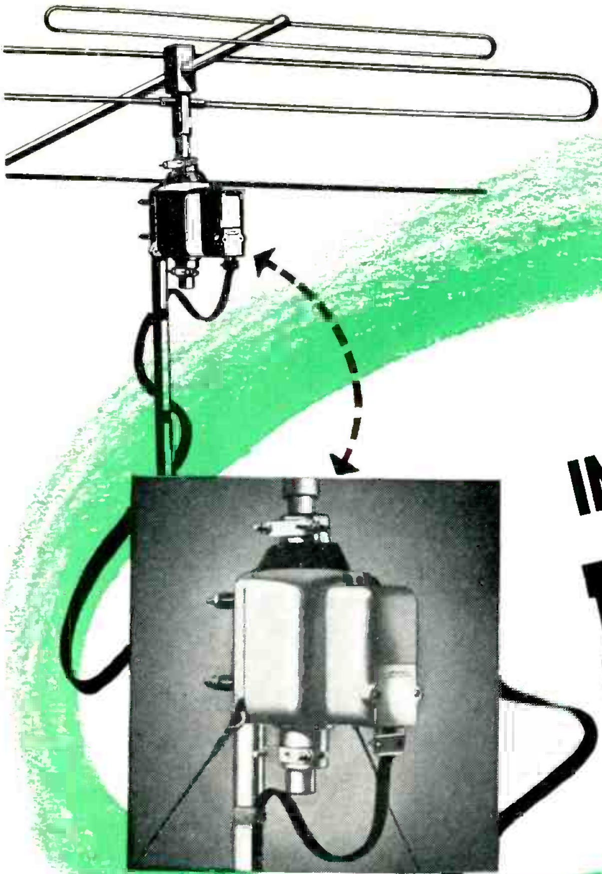
Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to 5/8" O.D.
Certain analyses (.035" max. wall) Up to 1 1/8" O.D.

**Mfd. under U. S. Pats.—SUPERIOR TUBE COMPANY • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey.*


PICK A NUMBER
ANY FREQUENCY FROM 10 TO 1,000
Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.
The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.
MOTORS · FACSIMILE · AIRCRAFT · LABORATORIES
American Time Products, Inc.
580 Fifth Avenue
New York 19, N. Y.
OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY



alliance
TENNA · ROTOR

INSULATED WITH NATVAR 400

AIMS THE ANTENNA IN ALL KINDS OF WEATHER

The ALLIANCE TENNA-ROTOR rotates the antenna at 1 rpm either clockwise or counter-clockwise through 365° with a positive mechanical stop at end of travel. In the Model DIR (illustrated), sensor in rotator unit operates meter in control box to show direction. Reversible motor in rotator unit operates on 24 volts supplied by transformer in control box through a 3-position switch. Motor leads are insulated and protected by Natvar 400 extruded vinyl tubing.

The TENNA-ROTOR, made by Alliance Manufacturing Company, Alliance, Ohio turns a beam antenna to the compass point where interference is least and reception is best.

It is designed and built to operate for years exposed to rain, snow and sleet. For this rugged service, components are carefully tested and selected. Natvar 400 extruded vinyl tubing is used in the rotator unit for motor leads because of its superior resistance to weather.

Natvar 400 also has uniformly superior resistance to oil, and is approved for continuous operating temperatures of 105°C. Prompt deliveries can be made either from a nearby wholesaler's stock or from our own. Full Underwriters report on request.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubings and sleevings
- Varnished identification markers
- Lacquered tubings and sleevings
- Extruded vinyl tubing and tape
- Extruded vinyl identification markers

Ask for Catalog No. 21

THE NATIONAL VARNISHED PRODUCTS *Corporation*

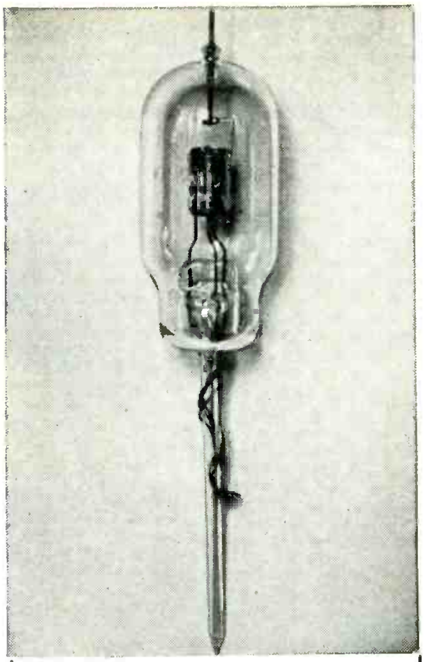
Telephone Rahway 7-8800 — Cable Address NATVAR: Rahway, N. J.

201 RANDOLPH AVENUE ★ WOODBRIDGE, NEW JERSEY

40 years a standard metal

NICKEL

for vacuum-tube applications



A TUBE THAT MEASURES A VACUUM

The VG-2 Ionization Gauge shown above measures the vacuum in a vacuum tube by counting the ions of residual gases. To achieve dependable characteristics, almost all of its metal components are Nickel . . . yet its selling price is under four dollars.

The VG-2 Ionization Gauge is manufactured by Heintz & Kaufman Division, The Robert Dollar Co., Redwood, California.

• • •

A partial list of the companies using the VG-2:

Argus, Inc.
Buhl Optical Company
Carbide & Carbon Chemicals Corp.
Curtis Laboratories, Inc.
Distillation Products, Inc.
Farrand Optical Co., Inc.
Johns-Hopkins University
National Research Corporation
National Technical Laboratories
Raytheon Manufacturing Co.
Technicolor Motion Picture Corp.

More than four decades ago, when Dr. Lee De Forest developed his historic triodes, he made the elements of platinum.

But after the success of his first triodes, Dr. De Forest began a search for a more economical material of which to construct his tube elements . . . one that was inexpensive, workable, stable, with acceptable electronic characteristics.

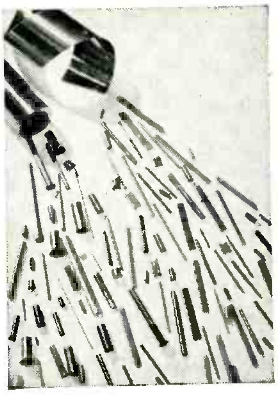
He found his answer in pure Nickel . . . a metal that to this day has never been supplanted as the most practical for critical, high-precision, mass-production electronic tubes.

The qualities that recommended Nickel to De Forest . . . and to succeeding generations of electronics designers and research men . . . are:

1. **High and stable electronic emission.**
2. **Excellent high-temperature characteristics.**
3. **Good de-gassing properties.**
4. **High resistance to corrosion and fatigue.**
5. **Good workability and weldability.**

The value of Nickel in critical tube design can be inferred from the following: An ordinary large transmitting tube may contain virtually no Nickel, a large receiving tube may contain 50% or more Nickel, and a miniature receiving tube may employ Nickel for almost all its parts.

In addition to pure Nickel, many other nickel-bearing metals and high-Nickel alloys are used for special applications in the electronics field. Recent uses include non-magnetic "326" Monel and heat-resistant Inconel for cathode ray and television tube applications.



Nickel is available in a wide variety of mill forms easily adaptable to large-scale, low-cost production of vacuum tube components. Photo of Nickel cathodes courtesy of Superior Tube Company, Norristown, Pa.

• • •

If you would like to know more about the many important uses of these metals, ask for your copy of *"Inco Nickel Alloys for Electronic Uses."*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS
TRADE MARK

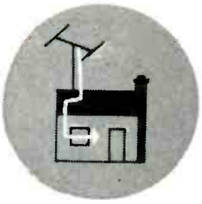
Monel® • "K"® Monel • "R"® Monel • "KR"® Monel • Nickel • "D"® Nickel
"L"® Nickel • Inconel® • Duranickel® • Permanickel® • Inconel "X"®

Announcing

DU PONT "RULAN"*

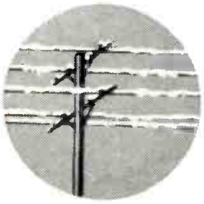
FLAME-RETARDANT PLASTIC for electrical insulation

Here's a new Du Pont material, especially developed for the electrical industry to meet the need for high-quality insulation that will not support combustion. Look at these features—



1. **Dielectric Properties.** "Rulan" flame-retardant plastic has a dielectric constant of 2.7 and high dielectric strength. It has a low power factor (0.002) that is constant over a wide range of frequencies. It is non-tracking. And "Rulan" retains its excellent electrical properties even after immersion in water for long periods at elevated temperatures.

2. **Nonflammable.** In flammability tests for insulation, "Rulan" has proved nonflammable. Further, it won't melt or drip, a big safety improvement.



3. **Mechanical Properties.** "Rulan" has good tensile strength, is tough and flexible. It has excellent low-temperature properties, is useful even below −60°C. (−76°F.). "Rulan" has very low water absorption (only 0.02 per cent by A.S.T.M. test).

for

High-voltage hook-up wire
Neon-sign cable
Signal-control wire
Multi-conductor control cable
Television lead-in wire
Radio feed-back wire
Flame-retardant line wire
High-voltage street-lighting cable
Other high-frequency uses

*Trade-Mark

"Rulan" contains no plasticizer, hence is useful in non-migrating jackets. It can be extruded onto wire at high speeds and can be injection-molded. At present, molded electrical parts and extruded electrical tape are being developed for uses where flammability is a factor. Wire today for more information. Our salesmen and technical staff will be glad to help you. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Plastics Sales Offices: 350 Fifth Avenue, New York 1, N. Y.; 7 S. Dearborn Street, Chicago 3, Ill.; 845 E. 60th Street, Los Angeles 1, Calif.

DU PONT
REG. U. S. PAT. OFF.
PLASTICS
Better things for Better Living
. . . through Chemistry

Before Any Other Consideration

Integrity of Circulation

ABC

OF THE several factors that enter into the use of published media, the distribution of the advertisers' sales messages, as governed by the selection of media, can of itself decide the success or failure of the advertising investment. That is why integrity of circulation is the first consideration with experienced space buyers.

The emblem shown above stands for the FACTS that make it possible for advertisers to select the right media and to know what they get for their money when they invest in publication advertising. It is the emblem of membership in the Audit Bureau of Circulations, a cooperative and nonprofit association of 3300 advertisers, agencies and publishers.

Working together, these buyers and sellers of advertising have established standards for circulation values and a definition for paid circulation, just as there are standards of weight and measure for purchasing agents to use in selecting merchandise and equipment. In other words, A.B.C. is a bureau of standards for the advertising and publishing industry.

A.B.C. maintains a staff of specially trained auditors who make annual audits of the circulations of the publisher members. Information thus obtained is issued in A.B.C. reports for use in buying and selling space. All advertising in printed media should be bought on the basis of facts in these reports.

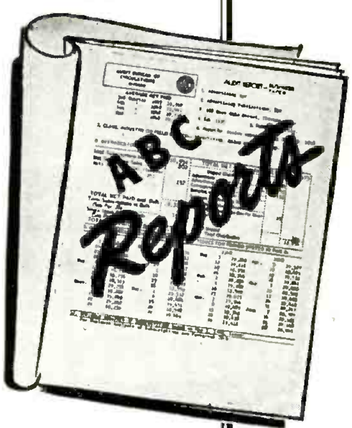
This business paper is a member of the Audit Bureau of Circulations because we want our advertisers to know what they get for their money when they advertise in these pages. Our A.B.C. report gives the facts. Ask for a copy and then study it.

SEND THE RIGHT MESSAGE TO THE RIGHT PEOPLE

Paid subscriptions and renewals, as defined by A.B.C. standards, indicate a reader audience that has responded to a publication's editorial appeal. With the interests of readers thus identified, it becomes possible to reach specialized groups effectively with specialized advertising appeals.

SOME OF THE AUDITED INFORMATION IN A.B.C. BUSINESS PAPER REPORTS

- How much paid circulation.
- How much unpaid circulation.
- Prices paid by subscribers.
- How the circulation was obtained.
- Whether or not premiums were used as circulation inducements.
- Where the circulation goes.
- A breakdown of subscribers by occupation or business.
- How many subscribers renewed.
- How many are in arrears.

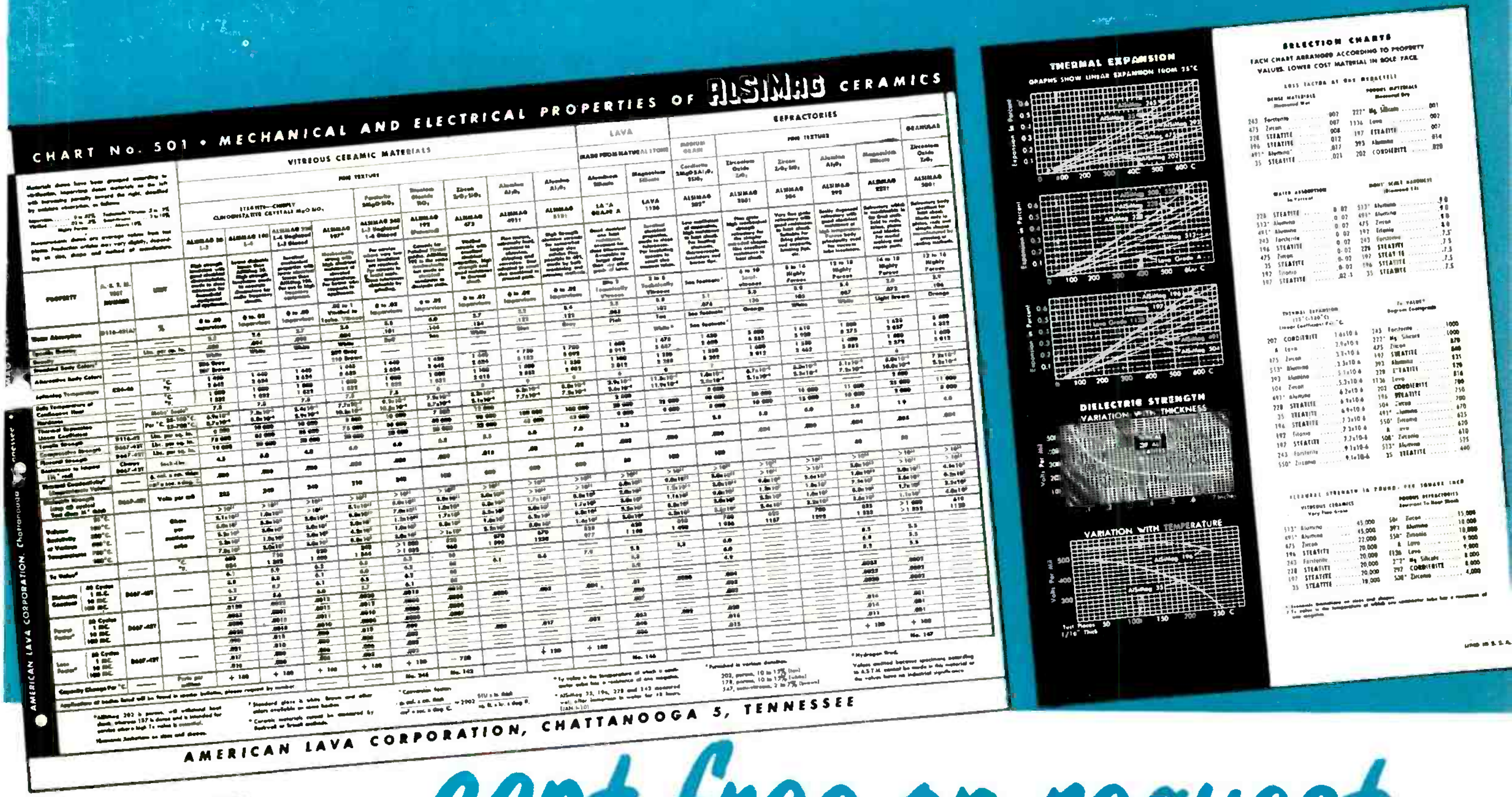


McGRAW-HILL PUBLICATIONS

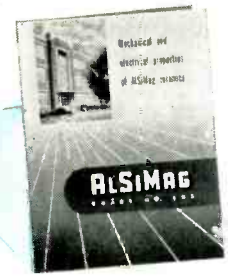
A.B.C. REPORTS — FACTS AS THE BASIC MEASURE OF ADVERTISING VALUE

New Property Chart of ALSIMAG®

TECHNICAL CERAMIC COMPOSITIONS



sent free on request



American Lava Corporation, Chattanooga 5, Tennessee, has issued a new chart giving the mechanical and electrical properties of AlSiMag custom-made technical ceramics.

WHAT ALSIMAG IS

AlSiMag is the trade name of a large family of technical ceramic compositions. These compositions have different physical, electrical, mechanical and chemical characteristics. AlSiMag ceramics are custom-made to specifications.

WHAT THE CHART TELLS

The chart covers seventeen of the more frequently used AlSiMag compositions and is the most complete chart yet issued in this field. A new feature is a selection chart which simplifies and speeds the selection of the most useful composition for the individual requirement. This selection chart indicates lower cost materials in BOLD FACE. This helps the product engineer to design for utmost economy.

Some properties, such as thermal expansion, dielectric strength, in relation to thickness and temperature are presented in graphic form.

ALSIMAG COMPOSITIONS NOT ON CHART

Many special AlSiMag compositions have been developed to meet specific conditions. These are too numerous to chart. If chart indicates general characteristics of value, modifications to suit your special application may be available.

WHO NEEDS THE CHART

Designing engineers, production technicians or purchasing agents will find chart helpful in their search for materials for unusual applications.

HOW TO GET THE CHART

The AlSiMag Property Chart is sent free on request. Request as many copies as you need to cover your organization.

WHERE ALSIMAG IS USED

AlSiMag custom-made technical ceramic parts are extensively used as:

Insulators for the electronic field • Insulators for electric appliances and other electrical applications • Thread Guides for textiles, wires, paper twine, etc. • Extrusion dies for such products as pencil leads, battery carbons, soft wires, explosives, etc. • Gas burner tips • Controlled atmosphere welding tips • Oil burner ignition insulators • Ceramics for hermetic seals • Metal-ceramic combinotions • Air-acid jet nozzle inserts • Polishing heads for delicate final polishing operations • Cores and inserts for precision castings • Strainer cores for metal foundries • Cut-off cores for metal foundries • Refractory pins and plates in small sizes and special shapes • Work holders for electronic heating devices • As a replacement for parts made of plastic, wood or machined metal wherever a wear resistant part is required • In short, wherever electricity, heat, chemical or certain abrasive or friction conditions must be controlled.

49TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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

BUSINESS BRIEFS

By W. W. MacDONALD

Scientific Apparatus needed by American laboratories for research and the development of new products was largely imported prior to 1917. When fighting in Europe cut off the supply our importers started to build their own, and the industry might be said to date from that time in this country.

Now a new condition has arisen. The average scientific apparatus maker comes under the heading of small business, with perhaps 35 employees. There are about 1,700 such concerns. And many of them find themselves squarely up against serious competition from countries in which labor rates are low and exchange very favorable. Certain optical items, for example, dropped off 20 percent in sales in 1949 and so far this year are off 30 percent.

Considered broadly, the situation seems to be this: Foreign trade agreements help our friends and therefore may ultimately help us. On the other hand, reduction in the number of people designing and building scientific apparatus here would reduce our self-sufficiency.

Largest Single Procurement action likely this year by the Army Signal Corps, still open for bids, is for $15-million worth of f-m equipment for vehicular and ground use.

David Sarnoff Says "If final standards are adopted and commercial operation in color is authorized soon, the RCA could and would be in factory production of color television receivers by June of next year. This would amount to a weekly production rate of 200 color receivers. By the end of that year, our color receiver rate of production will have reached over 1,000 per week. Thereafter, we expect production quantities to rise substantially."

Average TV Set contains 800 individual component parts and 15,000 feet of wire. There are 7,500 assembly operations, including 750 soldered joints. Capacitors, according to Aerovox, total 124, broken down as follows:

Ceramic	55
Paper	39
Electrolytic	17
Mica	13

Schwab House, 700-unit New York apartment building, is the biggest master antenna job for television we've heard of so far, RCA doing the work. Anyone know of an installation that tops it?

Milwaukee Journal survey produces the following interesting figures showing television receiver ownership as of January 1950 and families planning to buy sets this year, by income groups:

	Owners	Prospects
Under $2,000	10.0%	11.1%
$2,000 to $2,999	16.0	18.3
$3,000 to $3,999	17.2	17.6
$4,000 to $5,999	23.9	19.9
$6,000 to $7,500	27.9	20.9
$7,500 and up	35.0	17.0

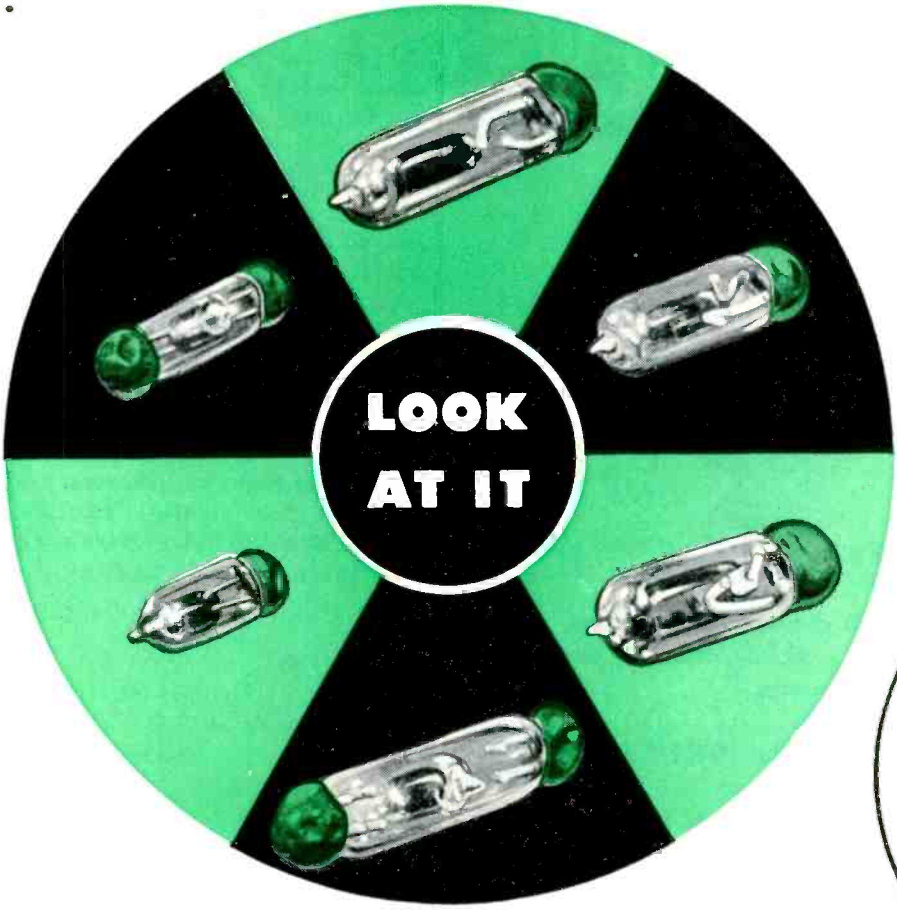
Television Equivalent of radio's tone control is the contrast control. Joe Public likes tone controls adjusted to minimize noise (and high notes) and make music "mellow." He also thinks the best pictures are those that have the most contrast, and any attempt to make him think otherwise is probably futile.

Real Estate Office near this columnist's home has had half-a-dozen miniature houses constituting a model development in its window for several years. Last week antennas and reflectors were placed on the little rooftops.

Such is the influence of television upon the American scene.

Printer's Error, if we hadn't caught it before publication: ". . . . Standing-wave ratio reduced to $1.05 . . . .".

Broadcast Station Revenue increased 10.3 percent in 1949 over 1948, according to an FCC report just released. A total of 2,850 a-m, f-m and tv stations reported a $459,800,000 take. Expenses were up 14.4 percent to



for economy, long life and low maintenance *in action*

and you'll pick the

HONEYWELL
Mercury Switch

Designers, manufacturers and consumers alike have plenty of praise for these "miracle" midgets that do a giant job at a cost that's amazingly low. As the ideal switching medium, they offer the result-producing advantages of safety . . . long service life . . . minimum maintenance . . . and small initial cost.

You'd become dizzy counting the times they tirelessly provide positive on-off action in many varied products . . . but actual operating records show more than 50 million cycles without attention. That's economy and value in use!

Honeywell Mercury Switches are compact . . . easily adaptable to your product . . . operate at low angles . . . are sealed against dust, gas and corrosion. Available in hundreds of types from 1/3 amp to 45 amp, 115 volts a-c non-inductive load.

The complete line is at your command. For detailed discussion of possible product application call in your local Honeywell Engineer . . . he is as near as your phone. Write for Catalog 1343 and latest price schedule for manufacturers.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

FOR • POSITIVE ACTION • LOW ANGULARITY • LONGER LIFE • WIDE SELECTION

Specify MINNEAPOLIS Honeywell MERCURY SWITCHES

$425,000,000 however, so that income before Federal tax was $34,800,000, a decline of 24.5 percent.

Navy Accountant recently okayed a bill for a bale of diapers, but it took some explaining. The soft, lint-free cloth that is kind to Junior is apparently also good for cleaning the inside of certain electron tubes prior to evacuation and sealing.

Receiver Sales by licensees, first quarter 1950, totalled 4,201,891, worth $316,936,375. Here's the way the total broke down:

Type	Units	Dollars
Electric		
Table (under $12.50 billing price)	676,233	$7,022,686
Table (over $12.50 billing price)		
A-M	469,662	8,788,532
A-M/F-M	77,525	2,467,146
F-M (including converters)	2,933	57,168
Consoles		
A-M	1,749	123,702
A-M/F-M	2,743	245,802
Table-Radio-Phonos		
A-M	70,667	2,911,857
A-M/F-M	6,129	225,917
Console-Radio-phonos		
A-M	13,862	1,056,298
A-M/F-M	109,442	12,681,254
Battery		
Portable A-C/D-C	232,197	4,321,080
Table	20,977	355,271
Consoles	6	455
Auto	888,541	22,980,494
Television		
Converters	6	2,618
Radio Table Models	691,834	94,692,577
Radio Consoles		
Direct Viewing	610,864	115,868,045
Projection	6,276	1,531,597
Radio Phonos		
Direct Viewing	139,770	37,109,676
Projection	17	9,885
Phonographs		
Phono only	146,267	2,522,171
With radio attachment	11,551	191,635
Without Cabinets		
A-M	2,121	69,300
A-M/F-M	6,893	210,365
Television	13,638	1,496,080

Magnetic Tape Recorders manufactured by licensees of the Armour Research Foundation totalled 20,000 in 1949.

Figures presented at a recent conference on components again emphasize the importance of electronics in the aircraft field.

L. V. Berkner of Carnegie Institution: "In a patrol bomber costing $1,315,374 the electronic equipment costs $179,899 and includes 45 devices composed of more than 25,000 components."

Charles R. Banks of Aeronautical Radio: "The airlines now have 2,000,000 capacitors, 1,500,000 resistors and 180,000 electron tubes operating in 750 aircraft. . . . The investment is $10,000,000, and maintenance cost is over $3,000,000 annually for materials and labor."

Employment was up 5.6 percent in March as against January among 190 communications equipment manufacturers reporting to the U. S. Department of Labor, and a further rise of 2.6 percent was anticipated by midyear. Television sparked the increase, easily counterbalancing a slight decline in employment among telephone and telegraph equipment makers.

A Bonus of $10,000 is paid by the AEC to anyone who discovers a new uranium deposit and delivers twenty short tons of ore containing 20 percent or more of uranium oxide to the Commission.

Reading Our Own Ads leads us to make the following observations:

Hermetic seals, and hermetically-sealed components, appear to be getting quite a play. Military applications undoubtedly provided the springboard, but aviation and other industrial users are now interested.

Solderless connections, commented upon in this column several times before, seem to be picking up adherents among industrial users. Communications applications still develop slowly.

Life-rating of a particular receiving-type tube is given as 10,000 hours.

A new amateur transmitter is said to be TVI-less in 97 percent of the installations made to date.

We very much like the phrase, used in connection with a test instrument "Industrial Endurance With Research Quality."

Reading time: 1½ hours.

Perils Of Publishing: For six months one of our distant representatives has been dickering with a man for a story. Queried recently from the home office concerning prospects of getting it, our rep replied: "The story in which you are interested seems to have gone a little sour . . . . *The engineer who had promised it shot a guy and is now in the jug.*"

Critical Requirements of Television Prove Remarkable Performance of Mallory FP Capacitors!

There can be no more convincing proof of superiority than the performance records hung up by Mallory FP Capacitors in the demanding field of television service.

In one case, an outstanding television manufacturer kept detailed records of field failures of component parts over a six month period . . . found only six Mallory failures, with nearly 400,000 FP Capacitors in service!

That's service beyond expectations!

That's why so many leading manufacturers insist on Mallory Capacitors that have set the pace in the industry for years. That's why you should specify Mallory, at no premium in price, for any application that demands continuous, trouble-free performance.

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CROSS TALK

► **WORLD TV** . . . This is written in London, where your exhausted servant has just completed a tour of television systems in the USA, France, Holland and Great Britain. The trip was preparatory to the second meeting of the Television Study Group of CCIR. This group, carrying forward the work begun in Zurich last year, is attempting to find a common basis for agreement on international television standards.

Since the meeting is still in progress as deadline approaches, we cannot report the findings in this issue. A full account will be published next month. Meanwhile, some general impressions may be of interest.

Within the space of 15 days, we have seen television on 405, 441, 525, 625 and 819 lines, at 50 and 60 fields per second, on video bandwidths from 2.7 to 10 mc. Our impression, shared by many in the tour, is that the US standard of 525 lines and 60 fields per second with a 4.25-mc video band is the happiest compromise among the systems demonstrated to us.

This is not to say, however, that the American television industry leads the world in all respects. Our British cousins are showing their heels to us in four departments: First, the transient response of British television studio equipment, coaxial cables, radio relays and transmitters is generally superior to ours. It is a matter of personal pride with nearly every British operator to adjust the phase correction of the apparatus until the leading and trailing transients just balance. Admittedly their problem is somewhat simpler than ours, but their attitude toward phase correction is one we should adopt.

Second, the British transmission of movie films, by the flying-spot method of scanning, is wonderful to behold. Despite the fact that they use at least one megacycle less video bandwidth than do the US stations, the images are sharper and crisper and the tonal gradation is definitely superior.

Third, a new camera tube, the cathode-stabilized orthicon, is just coming into use and, for studio use at least, seems to have several distinct advantages over the image orthicon. The most notable of these are an inherently steady black level and a noise level which increases with light. These properties permit gradation correction circuits to be used, and the result is an image of truly photographic quality. Moreover, this tube (the c.p.s. emitron) will produce a respectable image with one footcandle illumination at a lens aperture of f:1.9. American television engineers could use it to great advantage, despite the fact that the tube has a tendency to instability at high light levels. Certainly US television would be the richer if the cathode-stabilized orthicon were available here.

Fourth, the new Birmingham station has a visual power at 35 kilowatts into the antenna. Plans are afoot for future stations of 100 kw with antenna power gain of four times. We could use such power.

In most other respects, the American system leads the parade. European television images display an alarming tendency to flicker at brightness levels far below those demanded by the American public, due to the 50 per second field scanning rate. A Dutch demonstration of a long-persistence (about 10-millisecond) white-light phosphor was impressive in reducing flicker, but the image is subject to color fringing of objects in motion. The visible effect of ignition noise, which produces white spots on the screen due to the use of positive modulation in England, is definitely more annoying than the black spots of the American system. The sound channel of the British stations, transmitted by a-m rather than f-m, is apt to be noisy. The limiters used in some receivers to limit impulse noise have the unfortunate effect of introducing audio distortion.

The concept of standardizing on the line-scanning frequency, with a narrow tolerance, to permit interchange of programs even when the number of fields per second and lines per picture are not the same in different countries, is one of the noteworthy suggestions of the meeting.

► **QUIZ COMING** . . . Our query of several months ago concerning a series of electronic problems for the amusement and edification of readers has drawn a most encouraging response. Accordingly, in future issues we shall publish such problems as come to hand, with answers the following month. We have a few problems on hand, but need more. Look for problems and answers on the Backtalk page.

Why Television Receivers

WITH TODAY'S SPOTLIGHT on television receiver production figures and dollar volume of sales, there is a tendency to overlook the fact that television servicing is also big business. Based on current average prices for sets and yearly service contracts, every dollar paid for a television receiver will within five years be matched by another dollar paid to service organizations. Putting it another way, an estimated $325 million will be paid out in 1950 just to keep television sets running, in contrast with only $300 million of business (at factory prices) done by the entire electronic industry in 1939.

Why does it cost so much to keep tv sets running? To probe into this question, sampling surveys were made of the field experiences of tv manufacturers who have their own service organizations. In addition, independent service organizations who take on service contracts for all makes of sets were queried. This article presents in detail the results of an investigation by the staff of ELECTRONICS.

Breakdown of Calls

Reasons for calling a television serviceman are broken down in Table I for four representative organizations. A quick check shows that only about 30 percent of these reasons are traceable to human nature, to antenna systems and to other nonmanufacturing factors. The remaining 70 percent of the calls deserve detailed technical analysis here because they can be eliminated at least in part at the manufacturing level, with immediate savings in service division overhead and long-term gain in serviceman and consumer goodwill.

Just as in radio sets, a defective tube is by far the most common cause of trouble in a television receiver. In television, however, causes of tube failures are much more often attributable to set design engineers than to tube manufacturers. Tubes are worked close to the upper limits of their ratings in many tv circuits, leaving little margin for normal tolerances of other parts and for effects of ageing. As a result, tube testers are rarely if ever used for checking tubes in tv sets. Substitution of new tubes is the universal practice among service organizations. So critical is circuit design in some cases that it is not unusual to have to try half a dozen new tubes before finding one that works in a particular set.

Picture tube replacement ranks high, considering that it is the most expensive replacement part in a tv set. On a first-year service contract, about half the picture tube failures occur within the first three months, covered in all cases by the standard 90-day warranty of the manufacturer. The trend is toward free replacement by manufacturers during the remainder of the first year as well, usually under a first-year contract whereby the set manufacturer replaces all defective parts for a blanket price of $5 to $20 that is paid by the service organization or dealer.

Reasons for replacement of biggest troublemakers among other tubes are given in Table II. In general, the practice of tv servicemen is to replace a tube if that will make the set work again, even though some other part is the real cause of trouble. Replacement with a selected upper-limit new tube can cure a lot of other troubles in certain circuits, eliminating removal of the chassis to the shop for more expensive replacement of a cheaper under-chassis component.

Other Troubles

Antenna troubles vary greatly from one locality to another, and depend also on the number, location and effective signal strengths of the

Table I—Analysis of Television Receiver Service Calls

Reason for Call	Percent of Total Calls			
	Mfr. Service Organization No. 1	Mfr. Service Organization No. 2	Independent Service Co. No. 1	Independent Service Co. No. 2
Replace picture tube	10%	4%	5%	6%
Replace other tubes	30	21	35	25
Reorient antenna*	8	2	15	10
Repair antenna system*	3	6	2	2
Change antenna or add high-band*	1	2	1	3
Readjust back-of-set controls	2	1	13	12
Correct deficiency in circuit design	1	7	6	2
False calls*	4	15	10	10
Replace paper capacitor	9	1	3	2
Replace resistor	9	1	3	3
Repair or replace tuner	8	15	2	5
Replace other components	4	15	1	6
Repair poorly soldered joint	5	4	1	1
Realign	4	2	1	8
Customer not at home*	2	4	2	5
* Total not fault of set manufacturer	18%	29%	30%	30%

Fail in Service

Three years of field experience by manufacturers and independent service companies reveals 15 major reasons for service calls. Many can be eliminated at design and production stages, often with accompanying savings in manufacturing cost

transmitters in the area. As localities reach their legal quota of stations, antenna calls diminish since the required compromise orientation can be made at the time of installation. New antenna types are proving highly satisfactory in the field and reducing antenna calls.

On the other hand, as more sets enter second and third years of service, antenna repair calls go up. Though the figures in Table I are for the entire three-year period since the war, 1949 sales of well over 2,000,000 tv sets pretty well weight the picture.

Readjustment of back-of-set controls is high in percentage for independents, low for manufacturer service organizations. Stability of circuits used by the particular manufacturers polled may be one reason. Another fact, more pertinent to independents who must know a little about a lot of different sets, is the psychological value of actually doing something to a set even when the picture is found to be of acceptable commercial quality for the particular set involved.

Corrections of circuit design come in batches coinciding with launching of new tv models. Least trouble comes from models using refinements or improvements of the previous year's circuitry, and most trouble when designers choose to toss out the experience of former years and start from scratch.

Where a capacitor goes, so often goes a resistor, hence figures for these two parts run hand in hand across the board. Importance of incoming inspection of components and quality control during assembly shows up in the total of 18 percent for resistor and capacitor replacements by one manufacturer as contrasted to a 2-percent total for the other.

Tuner troubles, particularly tuning switches, rank high with manufacturers, possibly because independents touch these critical units only as a desperate last resort. Men specializing in one make of set and having replacement tuners for them right on the service truck can make a changeover of a complete tuner quickly and at fairly low cost. Independent servicemen obviously cannot carry spare tuners for all sets, nor can they be expected to take apart double and triple-shielded tuners in the home for repairs. Fortunately, prevalence of tuner trouble is going down with improved design in 1949 and 1950 models of most sets.

Electrolytic capacitor troubles run as high as 3 percent for one independent who handles a lot of off-brand and lower-priced sets and also has a large number of second and third-year contracts on the books. The other three sources rated electrolytics as under one percent, however. Flyback transformers receive vitriolic comment in most shops, but troubles with these parts just about vanish when manufacturers change over to ceramic-core units.

An independent serviceman just cannot understand how a joint could

Table II—Tubes Failing Most Often in Television Receivers

Type and Function	Nature of Failure	Remedy
6BG6G and 19BG6G horizontal output	Gassy, resulting in dead tube, due to electrolysis at top connection	Change to new tube, which in some makes now have a leaded glass envelope
	Can't fill screen because near lower limit of sensitivity	Select new tube near upper limit of sensitivity
	Barkhausen interference, producing black line at edge of picture	Try new tube or put magnet around tube
6SN7 sync	Open filament, low gain, intermittent or gassy	Try new tube. If in relaxation oscillator, selection is needed
5U4 and other rectifiers	Open filament, or loss of emission	Install new tube; drive less hard if possible, as these tubes are often operated too close to rated limits
6J6 oscillator	Microphonic	Select nonmicrophonic new tube
12AT7 converter	Failure to oscillate on high channels because of low g_m	Select new tube that will oscillate
5V4 and other damping tubes	Flashover, causing burnout, apparently because of heater sagging	Replace tube
12AU7 video amplifier	Microphonic	Select nonmicrophonic new tube

get out of a factory without being soldered, hence doesn't look for bad joints as a rule. Manufacturer servicemen, on the other hand, are given guided tours through the factory so they can see how easy it is to miss a joint or two, and are specially drilled in hunting for bare joints hence find more of them in the field. Independents may offset an unsoldered high-resistance joint by replacing a tube or adjusting the screwdriver controls to compensate.

Realignment includes shifting the i-f value when two receivers in the same building interfere with each other. Most alignment work is done in the shop.

No matter how definitely an appointment is made for a service call, women still persist in "just stepping next door" at the appointed time, or even forget about it and go off for the day. False calls are high, but there isn't much that can be done about them until servicing is put on a charge-per-call basis. Temporary interference, transmitter troubles, and misrepresentation by salesmen as to merits of built-in antennas are just a few of the reasons for dry runs. In addition, there are times when work must be done to retain goodwill or prevent badwill even though the service organization has no responsibility.

Home vs Shop Repairs

The percentage of sets fixed in homes ranges from 20 percent to 96 percent, depending on the service organization. Top figure is logically that of a manufacturer's service organization, where men receive specialized training and acquire experience on just the one make of set and carry practically all needed repair parts and test equipment for that make right with them in the service truck. For high-caliber independent service organizations handling all makes of sets, an average of 70 percent of calls completed in homes is considered excellent because they cannot possibly carry spare parts for all makes.

Low figure of 20 percent is for independent service organizations that employ low-salary field men who know little more than how to replace tubes and remove the chassis. These firms rely heavily on at-the-shop experts despite obvious costliness of making two comes and goes per service call. Such practices have resulted in bankruptcies of some service organizations, with consequent headaches and loss of good-will for manufacturers of sets left stranded without service.

With an average of 5 to 6 service calls per set per year for all types of organizations and an installation cost running as high as $20 per set, almost any kind of bookkeeping quickly reveals the difficulties of breaking even on service contracts when a high percentage of sets have to be brought into the shop. Firms doing this can of course exist handsomely as long as new service contract money flows in at an accelerating rate, but eventually comes the day of reckoning. As a result of bitter experience along these lines, more and more manufacturers are exhibiting interest in the service organizations to whom their dealers farm out service contracts.

Design Economies

Another topic probed during this survey was the current accent on cost-cutting in tv receiver production. Some of the items and techniques being used or receiving consideration are listed in Table III, with advantages and drawbacks of each. Service organizations contributed equally as much as manufacturers to this tabulation, showing their intense interest in the effects of manufacturing economies on service calls.

Many of the items listed in Table III can give lower manufacturing costs than comparable earlier versions. Most of the changes have little or no effect on the number of service calls or the quality of set performance. A few of the changes actually improve performance and reliability, while still others have adverse effects on performance that in the long run can offset cost savings.

Although attention to individual items one after another can result in appreciable savings, much broader thinking is needed to get maximum benefits. One philosophy of television receiver design has the design engineer starting not with components or even circuits, but with pure logic. The overall receiver is designed first to do a certain commercial and technical job, using a number of separate system components corresponding to the blocks of a block diagram. Possible patterns of interconnection of the blocks are studied, with no concern for details of internal circuitry. Deliberations might follow a line like this:

"From an overall point of view a receiver should have a flat avc with gain to spare. Perhaps, therefore, the avc might stabilize the signal at the final output on the picture tube grid. In so doing it might be arranged to hold the black level to a constant bias. This would not only prevent variation of background but would also make it much easier to pick off sync at that point since the sync would be held by the powerful avc to a constant bias. A single stage of video, d-c coupled, is appropriate in this case. Instead of the usual complicated video contrast control circuit with its long hot leads, the gain control can now be a simple d-c control, arranged to add a variable bias in series with the video signal. The avc counteracts this to force the black level to remain at its proper bias, and in so doing changes the contrast."

Reasoning in this way, the design engineer carefully investigates the consequences of all sorts of interconnections, looking particularly for arrangements that make efficient use of tubes and circuits. Thus, by careful critical thinking he makes sure that the overall economy of the system is excellent and the performance is the best possible for the intended purpose and price range. Last rather than first comes attention to components and production practices such as are tabulated in Table III.

Broad overall reasoning during design stages is difficult and requires great familiarity with television circuitry and all its possible variations. Above all, such designing requires clear thinking without being distracted by the many details involved. Recent experience shows, however, that it is the best approach to the problem of obtaining improved television receiver performance at lower initial cost, with less complexity, and lower service cost.—J.M.

Table III—Examples of TV Receiver Design Changes, with Effects on Cost, Performance and Service

Technique	Effect on Cost	Effect on Performance
Standardize horizontal sweep transformer, focus coils, tuners	Permits ordering or making larger quantities at lower cost	None. Simplifies servicing since fewer replacement parts need be stocked
Use germanium diodes in video detector and sound discriminator	Easier to install and need no sockets	Better picture definition. Improvement in uniformity of production
Omit separate horizontal sync amplifier tube	Eliminates cost of one stage	Reduces sync stability, increasing service calls
Omit automatic brightness control	Simpler wiring	None, but makes set harder to operate
Use direct-coupled video amplifiers	Uses fewer parts; permits omitting d-c restorer	None if properly designed. Makes servicing simpler
Use fewer r-f and i-f stages	Appreciably lower cost	Reduces sensitivity and/or bandwidth
Less shielding of r-f units	A few pennies	None, but set may radiate interfering signal
Use separate narrow-band i-f amplifier for sync signals	Higher, but improves sales appeal	Better performance on extremely low and high signal strengths, by providing more reliable sync signals
Use 40–45 mc i-f value	Slightly lower cost though harder to align	Reduces oscillator radiation; practically eliminates diathermy and industrial interference
Use intercarrier system	Cheaper tubes; cheaper components	Good if properly designed. Easier tuning, practically no head-end contact noise. Drift almost unnoticeable
Omit one or more sound traps	Appreciable saving	Sound patterns on picture, more service calls
Use multipurpose tubes	Lower total cost of tubes, fewer sockets, less labor	None usually, but harder for servicemen to trace circuits
Use low voltage on c-r 2nd anode	Cheaper high-voltage supply	Dimmer picture; possible blooming and blurred highlights
Use larger picture tube	Higher, but greater sales appeal; fewer service calls	Same effect as low 2nd anode voltage
Use punched metal c-r masks	Cheaper than molded rubber	None. Gives impressive designs, more colors
Use rectangular picture tube	Smaller, cheaper cabinet	None. Good sales feature
Anchor picture tube to chassis rather than cabinet so one man can remove and replace chassis	Easier to test and repair sets in factory, shop and home, offsetting cost of bracket needed	Servicemen can work under chassis without damaging tube; eliminates adjusting coils each time chassis is removed
Use Alnico magnet for focusing	Cheaper than equivalent copper	None at first, but harder to readjust later
Use mechanical adjustments of yoke in place of pots	Appreciable saving	Little or none at first, but possible trouble later as components drift off value; harder to adjust
Use hot chassis with universal a-c/d-c power-supply circuits	Simpler and easier to wire	Dangerous to servicemen and to children poking fingers in set
Provide built-in antenna	Increased sales appeal	None in noise-free high signal-strength areas
Move as many controls as possible to back of set and hide others behind hinged, sliding or drop panel	Higher, but increases sales appeal by making customers think set is simpler to operate; improves appearance	More service calls as some people are afraid to touch essential at-rear controls, while others play with at-rear controls
Use lower-wattage resistors	Slight saving	Can impair performance; increases service calls
Use lower voltage ratings for paper capacitors	Slight saving	None at first; leakage may later affect performance, and breakdowns will increase service calls
Use cheaper output transformer and loudspeaker	Appreciable saving	Less volume, poorer tone, more distortion, more frequent failures hence more service calls
Use thinner gage metal for chassis, with less plating or just thin flash of copper	Lower materials cost and easier to punch	Chassis bends readily, upsetting alignment; easily damaged in handling or shipping; corrodes quickly in humid and salt air
Increase size of chassis	Lower assembly and wiring costs	None. Easier to service because circuits are easier to trace. Less danger of shorts
Put tubes wherever convenient	Simpler wiring, less labor	None, but serviceman must yank chassis to replace tubes that are underneath or crowded in
Provide test terminals or jacks at rear of chassis for servicing	Extra cost offset by easier aligning and troubleshooting both in factory and home	Allows diagnosis of trouble quickly in many cases without removing chassis
Use two equal-value resistors as f-m discriminator load	Extra resistor cost offset by speedup in f-m alignment	Allows serviceman to make direct connection of output meter without unsoldering
Make all fuses accessible without removing chassis	Extra cost offset by easier replacement	Allows quick checking and replacing of fuses blown by temporary line surges
Stamp date-coded serial numbers on all expensive components	Prevents unscrupulous firms from getting free replacement of parts over a year old	Improves manufacturer relations with honest organizations, eliminating need for suspicion of fraud and interposition of red tape
Hold up service manuals on new sets until production changes resulting from field experience have all been made	Saves cost of preparing and sending out notices of production changes or making new edition of manual	Makes repair of early sets difficult or even impossible, losing goodwill of both serviceman and owner of set
Use plastic cabinets	In large quantities, about half cost of comparable wood	None. About $100,000 tooling needed to get 1,000 cabinets a day. Striking styling possibilities
Use metal cabinets	Lower cost because dies are cheaper	Nonwarping, more durable, but almost impossible to repair scratches in finish
Use lighter wood cabinet, fewer glue blocks, less veneer	Cheaper because wood is high proportion of cost	Less durable cabinet, more subject to breakage, warping and loosening of joints
Use cold glue in wood cabinets	Cold glue sets faster hence is cheaper	Cabinet joints are weaker

Engineering Trends in Spot Welder Controls

Techniques for building electronic controls that meet reliability and quick-repair requirements of auto industry assembly lines, and details of six-thyratron timer circuit having potentiometer control of time for each sequenced function of a resistance welder

By
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PRESENT-DAY automobiles are built on a production basis, with each operation dependent on a preceding. As use of resistance welding increases, maintenance of controls becomes more of a factor in the flow of parts off the lines. The foreman responsible for the output of a particular line insists that the maintenance man keep his equipment in condition so that down time is minimized. Quick service or replacement of faulty control panels is a necessity.

To meet the requirements of the automotive industry, a welder control must be designed and constructed in such a way that a defective unit can be spotted and replaced in a few seconds. The defective unit can then be repaired later, in a more convenient location having the needed tools and test equipment. Factors that must be considered in order to meet these industrial requirements for electronic welder controls will now be taken up.

Quick change of defective units in a control system is essential. Quick-acting fasteners of the quarter-turn type are popular for holding chassis units in position on panels. Interchassis connections are made through husky connectors and plugs. External wiring to the electronic control unit is run to a permanently mounted terminal strip that also has plug-in connections to the chassis units. An entire chassis can thus be replaced in less than a minute, using only a screwdriver. External wiring is undisturbed during the change.

Quick conversion to a different type of operation is a highly desirable feature. If the quality of the metal being welded changes during production it may be necessary to change to pulsation welding in order to break through an oxide or coating in order to weld. This involves a different control that repeats the weld time at regular intervals so as to give several shots of weld current instead of the usual one. With interchangeable timer panels, the same power panel and welder connections may be used to produce pulsation welding, and changeover time is cut to a minimum.

Desirable Accessories

For fast gun welder operations the time required to get the welding points together becomes important. Once the points are together they will have to open only a short distance in order to move the gun to a new position. The use of an extra unit to produce a longer initial squeeze time is desirable. The initial squeeze time then delays the weld firing until the points are closed, and subsequent squeeze

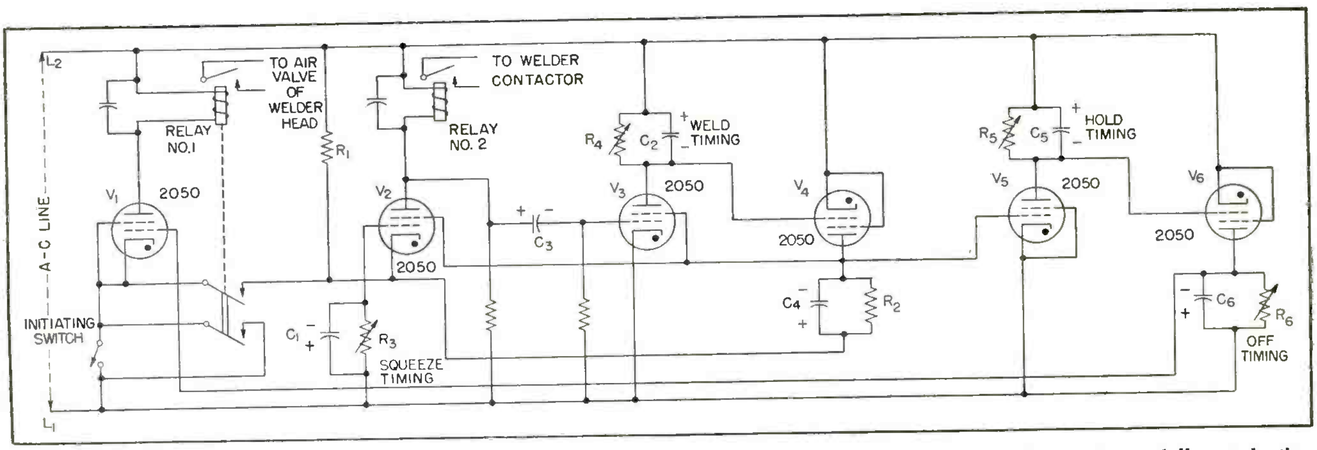
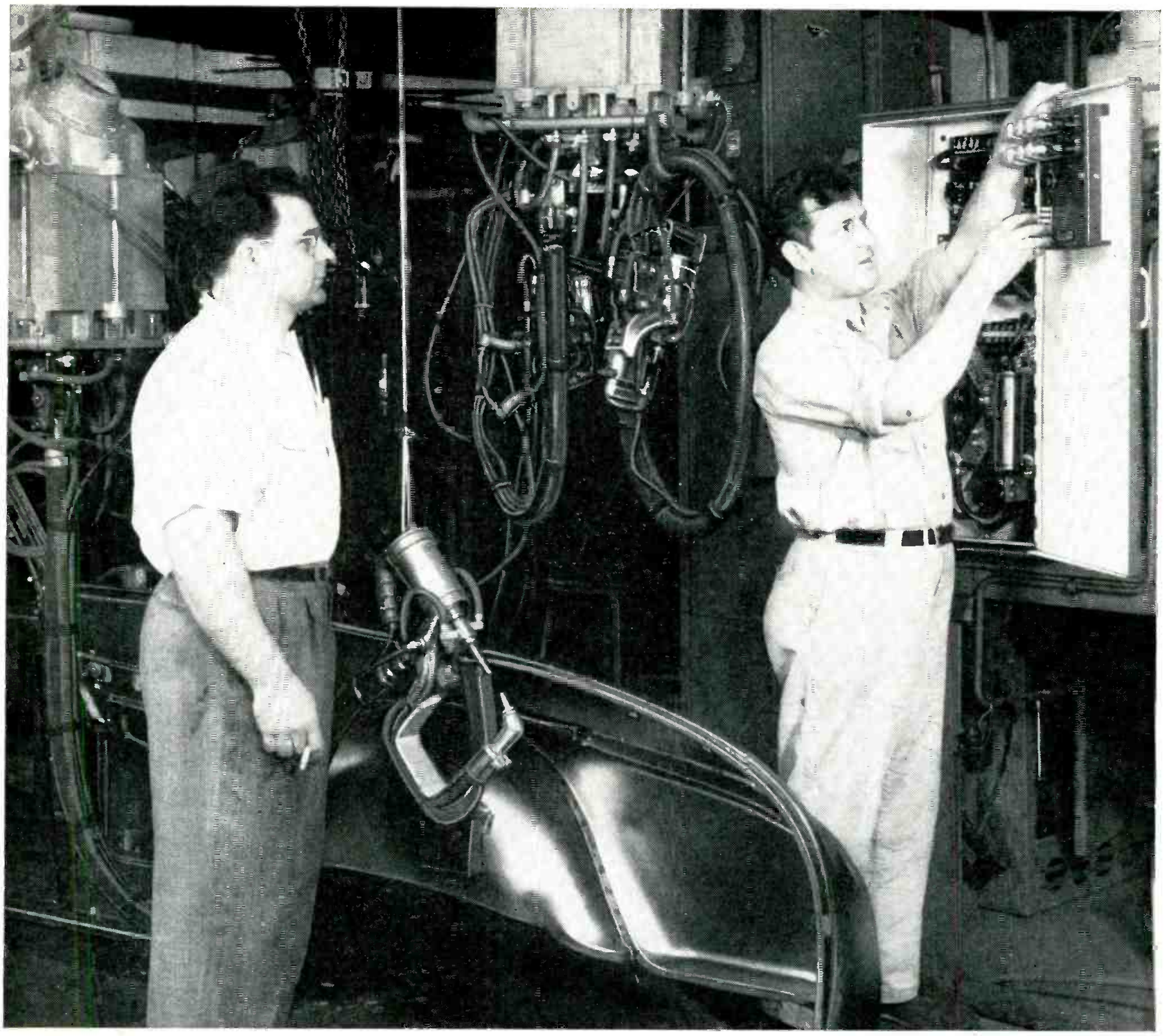


FIG. 1—Simplified circuit of sequence timer for resistance welder. At-rest condition is shown, in which V_3 and V_5 are fully conducting and the grid-cathode path of V_2 is conducting



Replacing timer chassis in electronic control system of resistance welder on auto fender assembly line. Entire operation is completed so quickly through use of quick-acting chassis fasteners and cable connectors that operator at left has time for only few puffs on cigarette while waiting for maintenance man to get his welder back into operation

periods may be considerably shorter so that the gun may be dragged along the work. This unit plugs into the regular timer panel.

Two pilot buttons are sometimes used on gun welders to give additional weld time on parts that are heavier and require more current. As the operator moves along the work, he pushes the button which gives the correct duration of weld current. The unit to accomplish this is also plugged into the regular timer panel.

The same type of electronic weld control may be used on a press welder in which a platen moves the parts into position. As the platen reaches position, a limit switch starts the control, which then processes the welder through the sequence. A release delay is necessary to get the guns out of the way before the platen retracts. This additional control is also plugged into the regular timer panel.

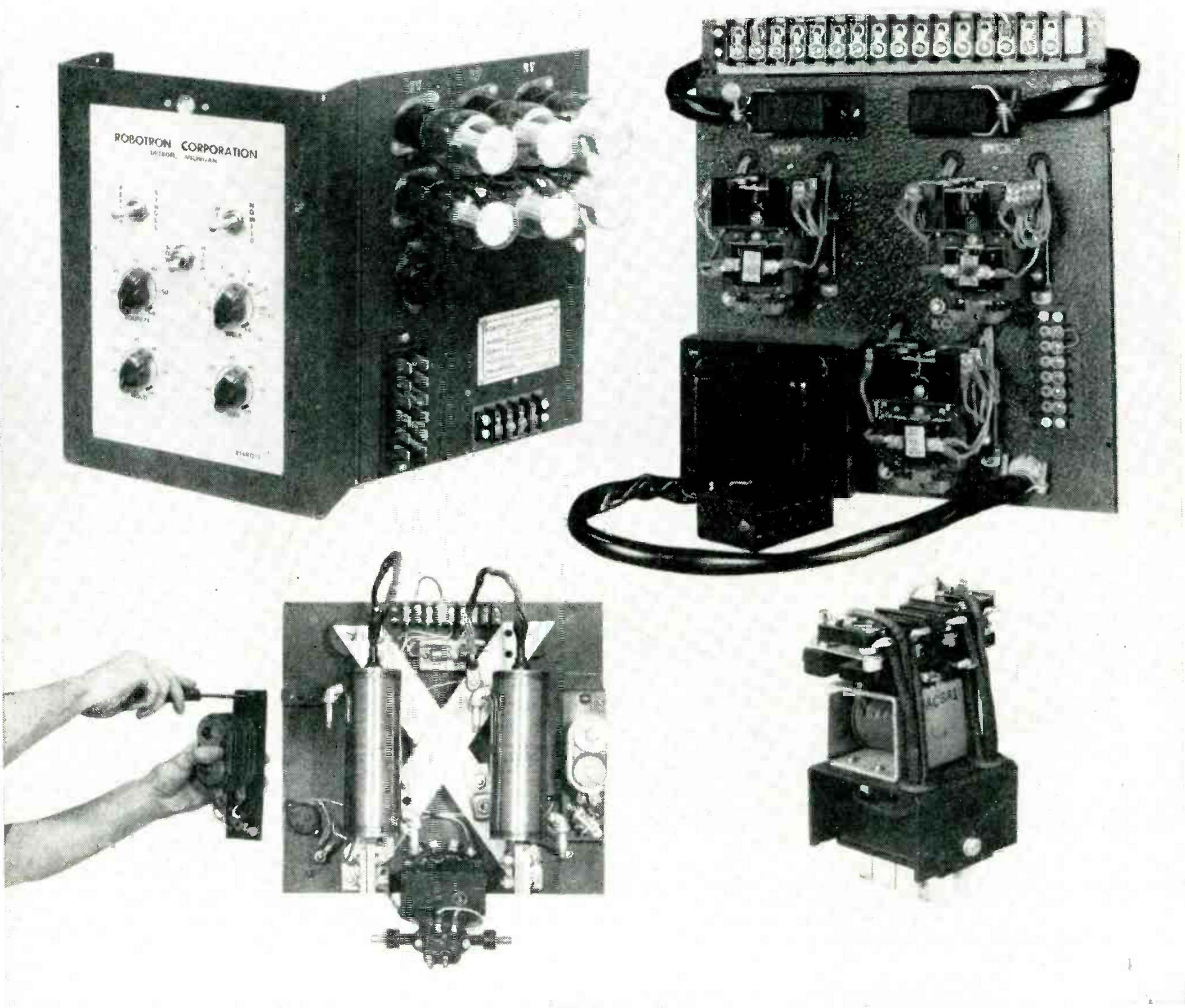
Speed Requirements

The limiting factor in the speed of gun welders as used on automotive production lines is the speed at which the welding points will close and open. This is limited by the action of the air valves and the delay in the bleeding of the air lines. As these components improve, automotive welding engineers are quick to ask for faster controls in order to use equipment at the fastest rate possible. They request a minimum time of 2 cycles squeeze (time for the welding points to get together and build up sufficient pressure), 2 cycles weld time (period of time during which current flows through electrodes), 1 cycle hold (time for molten metal to congeal and form a bond) and 3 cycles off (time for valve to open electrodes and move arm to new location). This total minimum time adds up to 8 cycles, which means a speed of 450 spots per minute if all times are minimum. While it seems that this maximum speed may never be used, there are certain conditions where the minimum time for any one operation may be necessary.

Full-cycle firing becomes more important on fast operations. For instance, the timer may be set on 2 cycles weld time for a fast repetitive operation. If the timer gives 2½ cycles of current there will be 3 positive cycles and only two negative cycles. This will tend to saturate the transformer, with subsequent breakdown. The use of circuits giving full-cycle firing is necessary. This is accomplished by using a resonant circuit. The inductance of the relay coil is shunted by the correct value of capacitance for resonance. As the thyratron passes only one pulse, the capacitor holds the relay closed for the additional half-cycle, insuring full-cycle firing of the weld current.

Electronic Switching

Electronic sequencing becomes essential when operating speed is stepped up. Relays have an inherent delay which limits their speed in changing from one circuit to another. Tubes replacing relays can make a change instantly. Small thyratrons are generally used due to their high current-carrying capacity and ruggedness. In timing circuits these tubes are desirable because the current they control is either on or off. They act more like a complete switch than a vacuum tube. Vacuum tubes depend upon many factors for amount of current flow, one of which is cathode temperature. With varying voltage conditions in automotive plants, fluctuations in heater potential have little effect on the current passed through the smaller thyratrons. The current passed through thyratrons is much greater than through vacuum tubes of similar size. The miniature type 2D21, the metal type 502A and the 2050 types of thyratrons each have an average rating of 100 ma. This is heavy enough so that these tubes can directly control the larger type relays which are used to control the valve and the weld circuit. All the tubes in modern timers are of the same



Example of electron timer having quick-disconnect plugs, book-type hinged chassis, and wide ranges of independent time adjustments for squeeze, weld, hold and off cycles, as required for use with resistance welders on auto assembly lines. Power panel at upper right, used with timer, is replaced by pulling out three plugs and turning three quick-acting fasteners. At lower left is ignitron contactor assembly for resistance welder, showing how plug-in copper-oxide rectifier is replaced. Lower right—plug-in relay type for easy interchangeability, although some pass only a few ma.

Because of the heavier current required to energize valves and fire ignitrons, octal-base plug-in relays with small pins sometimes fail due to overloading. The trend is toward heavier plug connections rated at 10 amperes continuous duty, which is sufficient for these welder applications. The contacts of the relays are also rated at 10 amperes, and to insure a clean break two of the four poles are connected in series. The heavier currents, which are a major cause of pigtail breakdown, do not pass through the pigtail connections. Only a few milliamperes of current, enough to lock in the timer once the pilot has been closed, pass through the pigtail leads of the relay.

The copper-oxide rectifier units which are used to pass a undirectional flow of current to the ignitors of the ignitrons have in some cases proved troublesome to change. One car manufacturer asked to have these units in a plug-in form for fast change.

Sequence Timing Circuit

An example of a circuit design that has adequately met auto industry requirements for efficiency and reliability as well as ease of maintenance is that of the Robotron model 3B weld timer shown in Fig. 1.

Identical type 2050 thyratrons are used throughout, simplifying the stocking of replacement tubes. Both the control grid and the shield grid may be used for control purposes. At 115 volts anode potential the control grid will hold the tube nonconducting until the grid bias goes below -2 volts. The shield grid is less critical and the tube will fire at about -4 volts shield grid potential. For accurate timing, the control grid is generally used. The shield grid will hold the tube nonconducting with a negative potential but is seldom used for timing.

The thyratron, being a grid-controlled rectifier, will conduct only when its anode is positive. The tube can be rendered nonconductive or blocked if a negative charge is placed on the grid between these positive pulses.

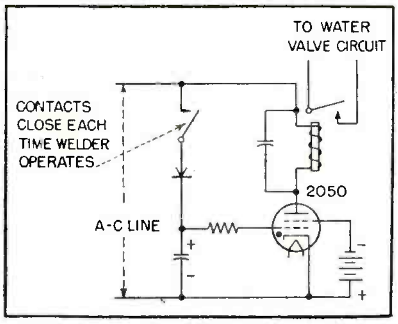


FIG. 2—Water-saving circuit for resistance welder

When the circuit of Fig. 1 is at rest, tubes V_3 and V_5 are conducting, charging weld time capacitor C_2 and hold time capacitor C_5. The squeeze time capacitor C_1 is charged by grid-to-cathode conduction of V_2 through R_3. Capacitor C_3 is being charged to a negative potential at its grid end by grid-cathode conduction of V_3.

When the initiating switch is closed, relay 1 is energized through V_1 and all of the contacts on it are closed. One set of contacts is used to lock in around the initiating switch and the other set to bring the cathode of V_2 to the potential of the L_1 side of the a-c line. The cathode end of R_1 is now at L_1 potential and the charging source for C_1 is removed so it now discharges through variable resistor R_3 for squeeze time.

When C_1 drains to a low enough value, tube V_2 will conduct and pull in relay 2 which starts the weld time. When V_2 conducts, the positive pulses which have previously been used to charge C_3 are effectively shorted to the L_1 side of the line. This brings the anode side of C_3 to L_1 and V_3 is blocked by a negative potential. With V_3 rendered nonconductive, C_2 now drains through variable resistor R_4 to a low enough value so that tube V_4 will finally conduct, giving the weld time.

When V_4 conducts, C_4 immediately charges to a negative potential at its anode side. This places a negative potential on the shield grid of V_2, which stops that tube from conducting, releases relay 2, holds V_3 nonconducting and blocks V_5. With V_5 blocked, C_5 can now drain through variable resistor R_5 (hold time) to a low enough value until V_6 will fire. When V_6 fires, the negative charge on C_6 is fed back to the grid of V_1, blocking that tube and releasing relay 1.

If the initiating switch is held closed, as is done in repeat operation, then as relay 1 opens at the end of the cycle the anode supply to V_4 is broken, rendering that tube nonconductive. This in turn releases the negative bias on V_2, V_3 and V_5 and these tubes immediately conduct, charging C_2 and C_5. As C_5 charges, it blocks V_6, which then allows C_6 to drain to a low enough value through variable resistor R_6 (off time) until V_1 fires again, starting another sequence.

Cooling Water Control

During the summer months the condensation formed around the coils of the welding transformer as they cool is a definite hazard. It is desirable to turn off the water flow as soon as the ignitron tubes and transformer have cooled down sufficiently. This usually takes about two minutes.

Means should be provided to turn on the water supply when the welder is first placed in operation and keep the water flowing as long as the welder is in use. Two minutes after the welder is stopped, the water flow should cease. This is accomplished with the circuit shown in Fig. 2. Closing the welder switch charges the grid capacitor positive as shown. This overcomes the negative bias on the other grid and the tube fires, pulling in the relay which closes the valve. The grid capacitor is of such value that it discharges in about two minutes. As long as the welder is being used, the capacitor is constantly being charged. After the last weld the capacitor drains off and the negative bias on grid 2 takes control, blocks the tube and turns off the relay controlling the water flow. Contacts on the relay are also provided to turn off the flow switch and open the ignitron firing circuit when the day's work is done.

The techniques and circuits herein described are readily applicable to other types of industrial electronic controls. The design principles involved are basic to widespread industrial acceptance of electron tube equipment on factory production lines.

TELEVISION ANTENNA

Convenience and economy are achieved when one transmitting antenna handles two or more closely spaced r-f carriers. Diplexers for such combination feed are impedance bridges having distributed parameter characteristics of coaxial lines. Power from two amplifiers operating at the same frequency can also be added with such devices

TELEVISION DIPLEXERS permit two or more radio-frequency signals to be transmitted simultaneously from one antenna without interaction of the signal generators. They are employed in the majority of television installations in this country to effect the combination of visual and aural carrier frequencies.

Diplexers were developed as a matter of sound engineering and economics: it is more convenient, and less expensive to arrange for one antenna to handle two or more closely spaced radio-frequency carriers than it is to install separate, close, non-interacting antenna systems.

Balanced Bridge

One of the first systems to be tried was the balanced bridge type of diplexer shown in Fig. 1. Both aural and visual outputs are balanced to ground. Bridge arm impedance values are so chosen that aural transmitter voltages will be equal at both visual transmitter terminals; hence, no aural carrier potential exists across the visual transmitter. Similarly, no visual carrier potential will exist across the aural transmitter.

Since the reactive elements must be isolated, they might be constructed in the manner shown, in which the reactance, a less than quarter-wave section, is effectively removed from ground by a shorted quarter-wave section.

If it were possible to make the reactances appear as an open circuit to the visual transmitter, and either a short circuit or extended transmission line to the aural transmitter, the diplexing function would be preserved and the reactances could be eliminated.

Figure 2 shows schematically a modified form of bridge diplexer[1] where bridge reactances are unnecessary. Visual signals are transformed at point *E* from an unbalanced to balanced voltage by the shorted quarter-wave section *E-G*. They are conducted across a short, heavy bar to inner coaxial line *D-H* and are transferred to output line *E-W* with effectively zero phase shift because of the properties of the open, inner coaxial, quarter-wave section. The visual signal, therefore, is placed on the pair of output transmission lines as a balanced, push-pull voltage. Video carrier voltage conducted along line *D-B* to point *A* will be equal to and out of phase with the voltage conducted along *E-C* to *A*. Therefore, cancellation of the visual carrier is obtained at the aural input.

Aural carrier power is equally divided at point *A* and is placed directly on the output lines through impedance transforming sections *ABD* and *ACE*. Ideally, no aural carrier gets into the visual carrier line because (recalling again the zero phase shift maintained by open quarter-wave section *D-H*) both inner and outer conductors of the visual input are at the same aural potential. For proper turnstile feed, one of the output lines is made 90 electrical degrees longer than the other at, usually, the visual carrier frequency.

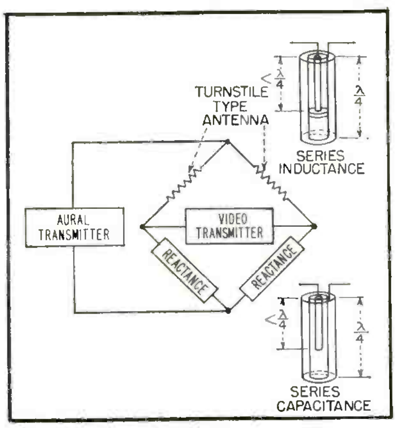


FIG. 1—Balanced bridge type of diplexer

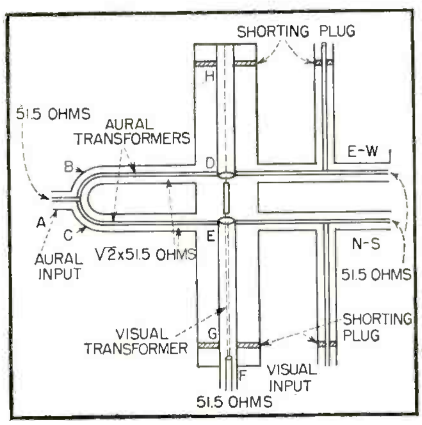


FIG. 2—Commercial type of balanced bridge arrangement

Slotted Bridge

Figure 3 shows a third type of bridge diplexer, called either a slotted bridge or coaxial hybrid junction[2,3]. This model is about as compact a unit as it is possible to make. Its unique feature is the slotted section which extends from the output lines back a quarter wavelength at the visual carrier frequency. To the aural input the slot makes little difference. It is

DIPLEXERS

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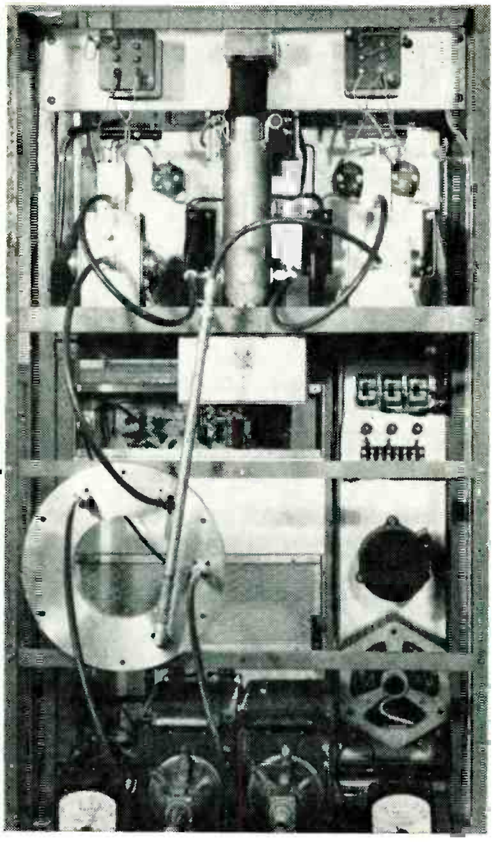

Coaxial hybrid ring or rat-race at lower left of this developmental transmitter adds the power output of two doubler stages

only necessary that the outer coaxial section from outputs to aural input have the proper impedance (37 ohms approximately) to transform the 51.5-ohm sound line to the 25-ohm impedance of the two output lines in parallel.

To the visual input, the slot acts as a balancing section, transforming an unbalanced to ground visual voltage at point 2 to a balanced, push-pull visual voltage at points 1-1. The visual signal sees the output lines in series, or sees their impedance as (for example) $2 \times 51.5 = 103$ ohms.

For proper matching, the characteristic impedance developed between center conductor *a* and the unshorted side of the split conductor must be approximately 73 ohms in the section 2 to 1-1. We might consider the inner coaxial section 2 to 1-1 as two transmission lines in parallel, having conductor *a* in common. One line is short-circuited one-quarter wavelength from the signal source (visual signal at 2) and therefore presents an open circuit to the source, so visual power incident at 2 is transmitted to 1-1 along a transmission line composed of conductor *a* and the unshorted side of split conductor *b*.

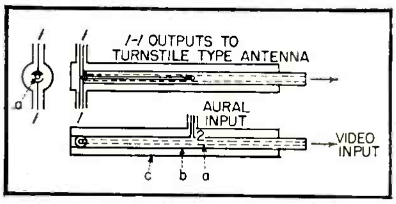

FIG. 3—Slotted bridge diplexer

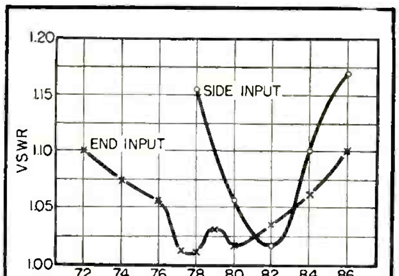

FIG. 4—Voltage standing-wave ratio versus frequency for slotted bridge type of diplexer

Aside from being able to handle present-day transmitter powers (up to 10 kw) the diplexer must meet rather stringent impedance requirements. We should like it mainly to accommodate the video carrier frequency and all video modulation products without noticeable selectivity. In other words, the video input to the diplexer should be almost perfectly matched to the video transmission line over a range of at least 5 megacycles.

Typical plots of voltage standing-wave ratio against frequency for the slotted bridge diplexer are shown in Fig. 4. With output lines terminated in matched 51.5-ohm loads, the visual input (end input) possesses a broad frequency characteristic, having a voltage standing-wave ratio of less than 1.05 in the region of interest (channel 5 in this case). A much narrower characteristic is exhibited by the aural input, which, however, does not have to be broad to meet ± 40-kc aural requirements.

Notching Filters

An entirely different philosophy of diplexing is embodied in the filter type system of Fig. 5.[4] Various coaxial element filter structures have been devised and are generally inserted as shown. The filter in the sound transmitter line passes the

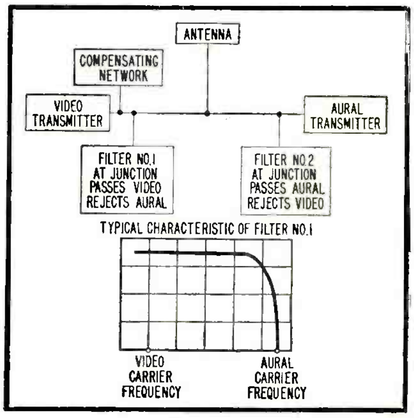

FIG. 5—Diagram of filter type diplexer

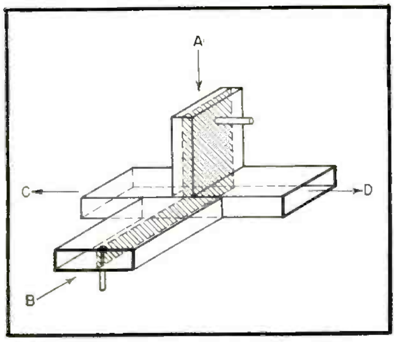

FIG. 6—Waveguide hybrid or magic T is useful above 1,000 mc

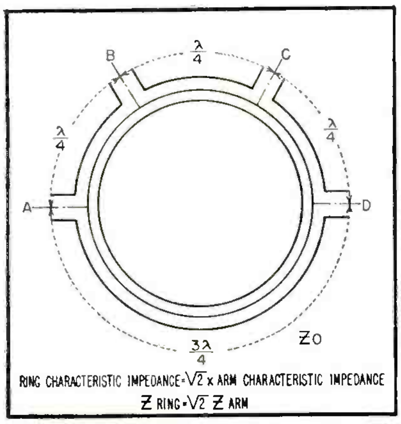

FIG. 7—Schematic of coaxial hybrid ring or rat-race

aural carrier and is adjusted to reject the visual carrier frequency. A reverse function is performed by the filter in the visual transmission line.

Unfortunately, aural and visual carriers are close together, percentage-frequency-wise, so that filters used are of a sharp cut-off variety. Such notching filters, as they are called, do not present a constant resistance to the video transmitter over the entire visual pass band; consequently, undesirable high video frequency transients appear in the picture, caused by the variation in voltage standing-wave ratio in the cut-off portions of the pass band. Furthermore, a sharp cut-off filter makes broadbanding of the transmitter output stage difficult, if not impossible. It is feasible, however, to insert a compensating network between visual transmitter and filter 1 so that broadbanding the transmitter output is possible, though video transients will still be broadcast.

An advantage of the filter-type system is that only a single transmission line is required to feed an antenna, whereas the bridge-type diplexers require two lines to the radiators. However, the double-output diplexers when combined with a turnstile-type antenna have a much wider bandpass characteristic than filter-type diplexers, and, for this reason apparently, have had much wider acceptance in television installations.

Magic T

If it is desired to have both diplexer inputs appear broad-band, as is the case when power from two low-powered video transmitters is added (one way of obtaining high uhf power), then another form of hybrid circuit becomes applicable. Figure 6 depicts a waveguide hybrid or magic T[5, 6, 7]. This device has intriguing properties and several ingenious uses.

Electromagnetic waves incident on arm *A* will propagate down that arm and into arms *C* and *D* of the T, but because of odd symmetry will not propagate down arm *B*. Similarly, a generator at arm *B*, ideally, will have its power divided equally between arms *C* and *D*, and the even symmetry characteristic of the *B*-arm signal will prevent its transmission up arm *A*. This device could give dual output, and would meet requirements that the signal generators do not interact. However, for necessary waveguide dimensions of 0.35 by 0.7 wavelength, this type of hybrid is practical only for frequencies above 1,000 megacycles. It also requires expenditure of considerable design and experimental effort to get broad-band probe matching and broad-band junction-matching irises. An alternate solution is a simple coaxial equivalent.

Rat-Race

The schematic of Fig. 7 shows a coaxial hybrid ring[5, 6, 7, 8] or rat-race. Characteristics of such a hybrid are properly deduced through an application of network theory combined with a judicious use of matrices. The starting point is to assume a general, 4-terminal device which is both linear and lossless; then in a comparatively short series of steps it is possible to develop the essential theory of the rat-race.

Average circumference is one and one-half wavelengths. Input and output terminals are one-quarter wavelength apart. The circular coaxial line is of constant characteristic impedance equal to the square root of two times the impedance of one of the arms. For the moment consider lines *B*, *C* and *D* to be properly terminated.

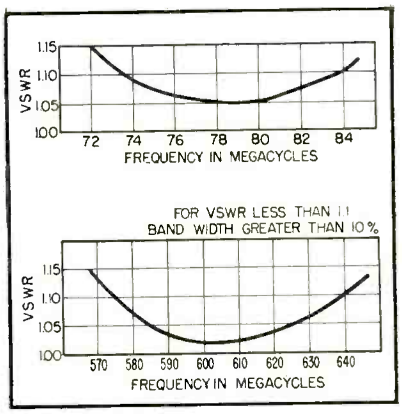

FIG. 8—Voltage standing-wave ratio versus frequency at any junction of the hybrid ring in two frequency ranges. Remaining junctions are terminated in 51.5-ohm loads

If an incident wave of length λ_1 enters the ring at *A*, it will divide equally at the junction. At points *B* and *D*, the subdivided waves, one going in each direction around the ring, arrive in phase with each other, while at *C* they arrive out of phase. If the incident wavelength is the same λ for which the ring is designed, complete cancellation will occur at *C*, and no voltage will exist at this point. Because there is no voltage, we could place any impedance at *C* without affecting the input impedance at *A*. Point *C* may be termed a balance point.

If an incident wave of length λ_1 ($\lambda_2 = \lambda_1$) incident at *C* will produce no voltage at *A*. We have then a desired combination of conditions for a diplexer; that is, a generator at *A* will not be aware of a generator at *C*, and vice versa, provided each source is of the proper frequency. Each output carries half of both aural and visual carrier powers, and here as before, the dual outputs serve to feed a turnstile type antenna.

Figure 8 shows plots of input impedance versus frequency for hybrid rings in two widely separated frequency ranges. Either ring can comfortably handle an entire television channel, since each possesses a greater than ten-percent bandwidth taken on the basis that the voltage standing-wave ratio be less than 1.1. This broad-band impedance holds for all terminals of the ring when the remaining connections are properly terminated.

Figure 9 shows assembled and dissembled views of a hybrid ring designed for operation at 611 megacycles. This first development model was, for all practical purposes, just like its schematic. The 51.5-ohm transmission lines connect to the type N fittings at all four arms. Center conductor diameter of the ring was approximately 0.2 inch, and the outer conductor diameter approximately 0.7 inch.

Halves of the outer conductor have been turned in a 12-inch square by ½-inch block of aluminum, and the two blocks when faced together form the complete sheath. The center conductor, 29.16 inches in circumference and rolled from brass, was lined up by Teflon spacers before being soldered to the connectors, and two thin spacers remain in the ring for support.

This particular ring diplexer was to function at 611.5 megacycles—midway between a video carrier frequency of 609.25 megacycles and a sound carrier frequency of 613.75 megacycles. Since the ring is inherently a fixed-frequency device, these departures from design center frequency lead to incomplete cancellation at the balance points, so that a small amount of visual transmitter power gets into the aural transmission lines and vice versa.

Figure 10 indicates the measured percentage of total power which is lost as frequency is varied around the ring's design center frequency. Power lost appears as cross-talk between aural and visual transmitters and in this instance was 27 db less than carrier power at the frequencies of operation, and greater than 20 db over almost a 100-megacycle range.

A 27-db rejection may be considered adequate for television operation, but is not particularly good as far as hybrid ring properties are concerned. That better rejection ratios were possible was demonstrated by a coaxial ring built for channel 5 operation. This second ring was constructed of standard 1⅝-inch tubing with $\frac{7}{16}$-inch diameter center conductor supported on Teflon beads, and occupied a rectangle of about three by six feet. Average sound power of 3.5 kw was fed into the ring loaded by a standard superturnstile antenna system. It was possible to measure only ½ watt at the balance point—a 7,000 to 1 ratio or slightly greater than 38 db. Cross-talk of this small magnitude is more satisfactory.

Power Adding

Another aspect of diplexing, and one in which the hybrid ring may be used more efficiently, is the combining of the outputs of two synchronized power units in order to obtain additive power. Addition of low-powered units is one answer to the problem of obtaining higher powers at ultra and very high frequencies.

Consider Fig. 7 again, and imagine two equal-powered, in-phase generators at *A* and *C*. Signals at *B* from each generator will arrive

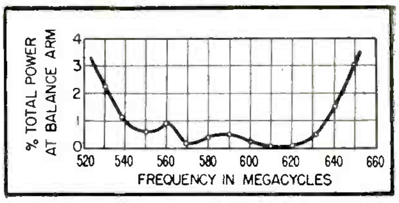

FIG. 10—Percent of power out at balance point plotted against frequency

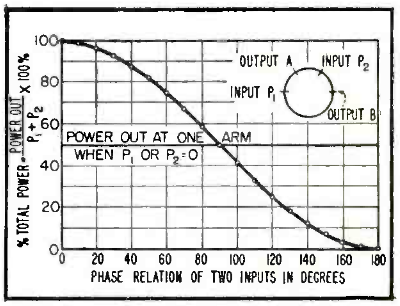

FIG. 11—Percent of total power out at one arm versus phase relation between inputs

in phase, and are additive at *B*. Signals at *D*, however, arrive out of phase, since the wave from *A* has to travel 180 degrees farther than the wave from *C*, so cancellation occurs at *D*. The summation of powers from *A* and *C* can thus be extracted at point *B*.

By similar super-position reasoning it may be agreed that if two equal, out-of-phase generators are placed at *A* and *C*, the summation of their powers may be extracted at point *D*, and no power will appear at *B*. Figure 11 shows calculated percentage total power out at one arm as the phase between two equal - powered, equal - frequency generators is varied. Measured powers agree closely.

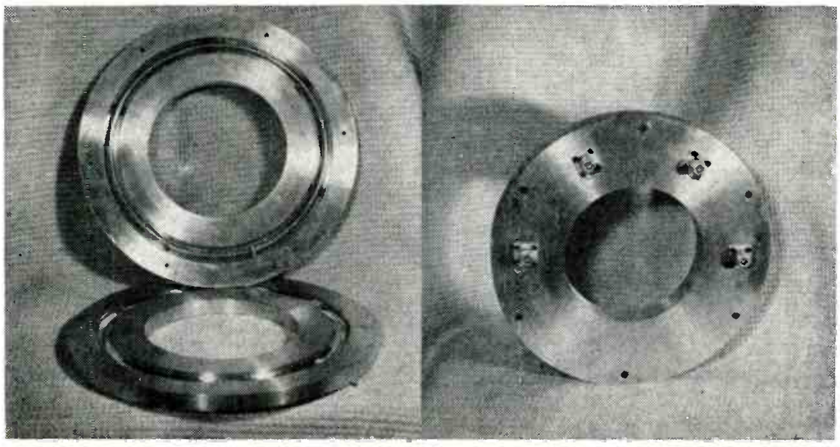

FIG. 9—Open and closed views of a hybrid ring or rat-race designed for 611 mc

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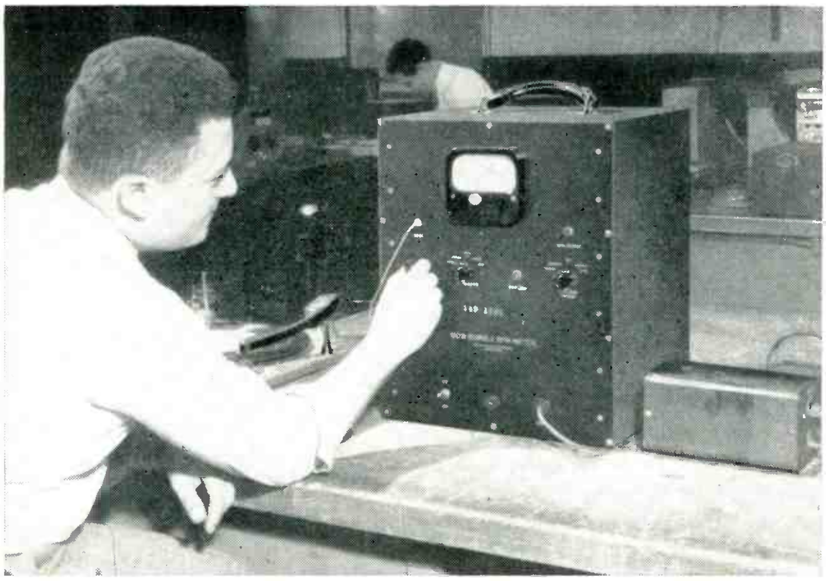
TESTING TURNTABLES



Equipment being used to test a standard production turntable

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THE INSTRUMENT to be described allows rapid testing of record players in production quality control for speed, extent of fluctuations in speed, and magnitude of unwanted low-frequency outputs. The equipment required includes a standard nominal 1,000-cps recording.

Controls are arranged in such a manner as to facilitate easy understanding of their function by ordinary personnel. All measurements made are based on a single reference-voltage setting, which allows them to be taken consecutively by merely moving the function switch to the desired position. A push-to-read switch is provided on the wow scales to prevent the delay that might otherwise be caused by the effect of switching transients on the long-time-constant circuits involved.

The design is unique in providing a means for measuring the relative amplitude of the spurious low-frequency output or rumble of the record player in the same instrument with wow and rpm measuring equipment. The use of a heterodyne method for making wow and rpm measurements greatly increases their accuracy.

Measurement Methods

Percentage wow is expressed as the maximum (peak) variation of turntable speed in terms of the average speed. Mathematically, percentage wow =

$$\frac{\text{Max. speed} - \text{min. speed}}{\text{average speed}} \times 100$$

Since a standard tone recording is used with the device, the above equation may be written in terms of the maximum and minimum frequency of the tone output.

$$\text{percentage wow} = \frac{f_{\max} - f_{\min}}{f_{\text{avg}}} \times 100$$

It was found convenient to express wow in terms of the output frequency of the recording at the nominal turntable speed. This eliminates a step in the wow measurement and results in errors that are not significant in production-line work. If desired, the wow readings may be corrected by multiplying by nominal speed divided by actual speed. The actual speed is read on the rpm scale.

Rumble is defined as the level of spurious low-frequency output caused by hum and vibration expressed in terms of the output from a standard nominal 1,000-cps recording. Revolutions per minute (rpm) scale calibration is in terms of the 78-rpm recording, but can be interpreted in terms of 33⅓ or 45-rpm recording.

The actual frequency of various standard tone records was found to vary from the nominal value. Therefore, a commonly available recording, the RCA No. 84522B (12–5–7C), was chosen for use with the device. The actual frequency of this recording is 1,013 cps when the turntable is revolving at a speed of 78.26 rpm. Calibration in terms of other standard recordings may be made by resetting the meter calibration resistors. This operation can be simply accomplished.

The accuracy obtained in the wow measurement is ± 0.1 percent up to 2-percent wow, and ± 5 percent of scale reading above 2-percent wow. Speed indications are accurate to ± 0.25 percent. Rumble indications are correct within 0.5 db at 100 cps.

The accuracy and repeatability of the wow and rumble measurements are such as to make the equipment eminently suitable for use in engineering work. For rumble measurements alone, the single instrument replaces several other pieces of test equipment including an attenuator, two filters, and a vacuum-tube voltmeter. The shielding provided is much more reliable than that generally obtained if several pieces of equipment are used. Previous to the construction of this instrument it was difficult to obtain a consistent reading of rumble from one day to the next even when the same

for Wow, Rumble and Speed

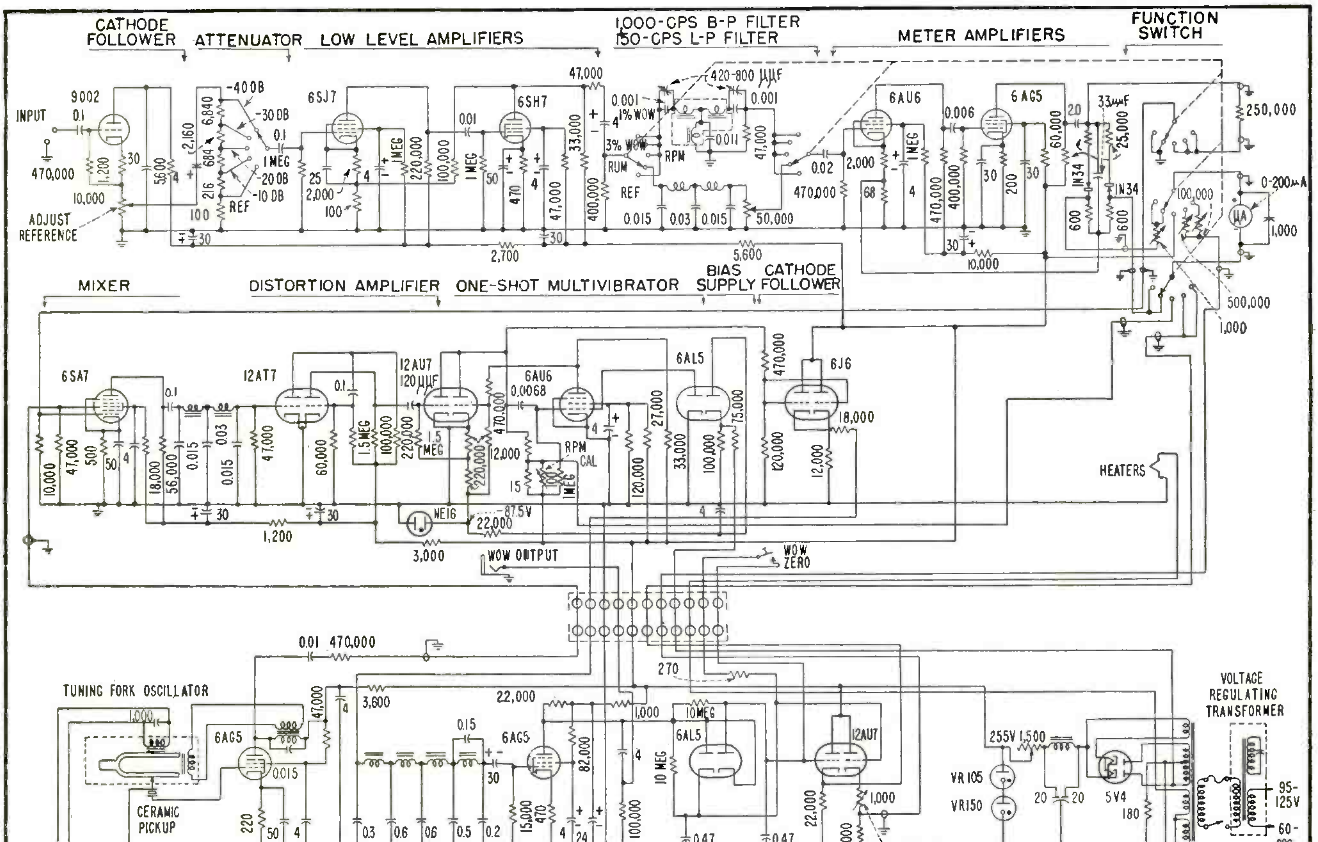
Equipment contained in a single cabinet is used for rapid testing of record players on production line. Signal is obtained from standard test record. Indications of the various characteristics are shown directly upon a calibrated meter

pieces of equipment were used. Now, readings that have been taken over a long period of time agree within 0.5 db.

The measurement of wow is of particular interest to the turntable manufacturer. It is also of importance to the radio-phonograph engineer who is charged with selection of a turntable that will allow reproduction of recordings with the quality desired. The presence of 3-percent wow is not particularly objectionable to the untrained listener when listening to some recordings. When listening to other recordings, especially when prolonged tones are presented, the presence of wow greater than 1 percent is detectable. Of course, the presence of wow even at levels lower than 1 percent may be undesirable in reproducers intended for studio work or, in any case, where high quality is important. The particular maximum level considered satisfactory will therefore vary with the application, but up to 1.5 percent is usually acceptable for radio-phonograph use.

Common Trouble Sources

The causes of wow have been ably discussed[1] and will be mentioned



Complete schematic of the wow, rumble and speed meter showing the modified tuning-fork oscillator with ceramic pickup (lower left) and voltage-regulating transformer (lower right) that is recommended for industrial use

only briefly here. Eccentricity of the turntable will cause wow to occur at the turntable speed—for example, 1.3 cps for a 78-rpm turntable. Warpage of the turntable surface will cause wow at this frequency also. Some types of warpage might theoretically cause wow at other than the fundamental frequency except for the fact that the record disc is a relatively unyielding surface and will prevent higher frequency wow from being produced from this source.

Any standard recording used must be of good quality and itself be free from warpage. The 1,000-cps standard recordings in common usage meet these requirements. Careful handling of the recordings is required.

Wow may occur at other frequencies owing to the motor drive-pulley arrangement. High-frequency wow components or flutter will be attenuated because of the turntable inertia to an extent depending on the frequency, the turntable inertia, and the stiffness of the coupling involved. In general, it was decided that wow components at frequencies above 30 cps were negligible. The wow caused by wobble of the drive pulley or by a slick spot on the drive pulley will occur at frequencies of roughly 7 to 15 cps in the usual record-player mechanism.

A wow output jack is provided on the instrument so that the waveform of any speed variation can be observed by use of an oscillograph. Observation of this waveform will afford a clue as to the source of the trouble. At the fundamental frequency of the turntable, for example, it must be produced by defects in the turntable itself as noted above. If the wow occurs at some higher frequency it may be traced to the motor shaft, or to the coupling mechanism. An erratic source of wow will be observed as such and might be traced to slippage of the coupling mechanism or to end play in some rotating part.

Input Circuit

The input impedance was made about 5 megohms in order to insure proper operation with high-impedance pickups. The input voltage may be any level from 0.1 to 5 volts rms. All measurements may be made at input levels as low as 1 millivolt rms except that the measurable rumble range will decrease to only 6 db below the reference signal.

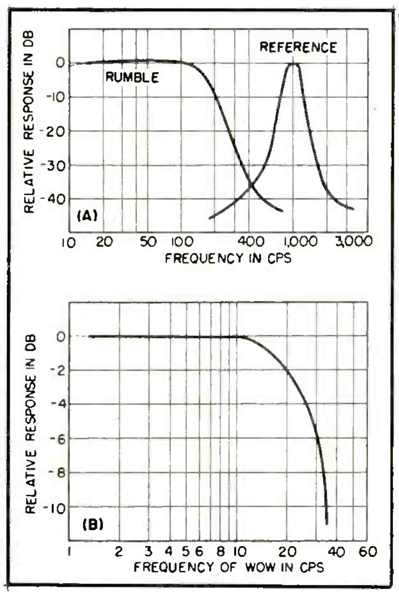


FIG. 1—Frequency response (A) on the reference and rumble scales and response (B) on the wow scale with 3-percent-wow input (B)

Frequency response of the reference and rumble filters is shown in Fig. 1A. The procedure for measuring rumble is first to set to a reference level by adjusting the continuously variable control in the input to produce a meter indication of the reference level. Then the 1,000-cps band-pass filter is switched out by the function switch and the 150-cps low-pass filter is switched in. The meter will now indicate the rumble level in decibels above or below the 1,013-cps reference signal. A step attenuator in the input stages allows the range of the rumble indication to be extended to 46 db below the reference level. A representative phonograph pickup may have a rumble level of −20 db. Rumble levels will not ordinarily be lower than −26 db.

The 1,000-cps band-pass filter is used when the reference level is set. This setting allows rumble levels to be measured that approach the level of the standard tone. The use of the filter when metering wow prevents spurious indications from being obtained due to the presence of low-frequency components encountered in the rumble.

The meter amplifier is a two-stage amplifier with negative feedback stabilization. The meter is placed across the output of this amplifier in the reference and rumble positions of the function switch.

When metering wow and rpm the output of the amplifier is fed into the mixer. Here it is heterodyned with the output of the 857-cps tuning-fork standard oscillator shown in the lower left corner of the circuit drawing. The difference freqency is distorted and used to trigger a one-shot multivibrator. This multivibrator has constant pulse length at all trigger rates. The plate current of the section that is nonconducting in the stable state is proportional to the difference frequency between the tone recording output and the 857-cps oscillator. The rpm metering is therefore accomplished by measuring the plate current in this section of the multivibrator.

Among the methods that have been previously used for wow detection are the use of a discriminator[2], and the use of pulse counter circuits.[3] The latter method was selected as being most satisfactory for use in this instrument because of the difficulty of producing a stable linear discriminator of suitable bandwidth for these frequencies. The pulsed output of the rpm multivibrator is fed through a cathode follower into a 30-cps low-pass filter. The output of this filter is directly proportional to the input frequency and reproduces variations in this frequency occurring at rates below 30 cps. This output waveform that represents the wow of the turntable is metered by means of a peak-reading vacuum-tube voltmeter circuit. The wow voltage is also fed to an output jack so that the actual waveform of the speed variations may be observed or recorded. The frequency response of the wow metering circuit is shown in Fig. 1B.

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High-Frequency Operation of TRANSISTORS

Discusses factors contributing to loss of gain in transistor amplifiers at high frequencies. Explains use of magnetic bias to reduce transit time and transit angle dispersion to extend range. Gives circuit and data on 23-mc amplifier with gain of 8

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IN ORDER TO UNDERSTAND the reasons for loss of high-frequency gain in transistors it is necessary to review briefly the fundamentals of conduction in semiconductors. Since presently available transistors use N-type germanium, only this material will be considered.

Conduction can take place by two mechanisms. Electrons may be transferred from one electrode to another as free electrons. This is the manner in which most metals conduct. A second method consists in removing an electron from a bound state at the positive electrode in which case the hole migrates to the other electrode, constituting a current. Both types of conduction can take place simultaneously, but since N-type germanium has a preponderance of free electrons in the bulk state, recombination takes place between holes and electrons, the former having a life of approximately 2 x 10^{-7} second[1].

The basic action by which the transistor amplifies can now be stated in a simple manner. The collector is operated at a high negative voltage, that is, 10 to 50 volts. Most of this potential drop takes place within a very small region around the collector contact, by reason of the barrier layer which impedes the flow of electrons from the metal to the semiconductor. Holes are injected at the emitter at a low voltage (0.03 to 0.3 volt) and under the influence of the field due to the collector current move to the collector, where they lower the barrier layer height, causing an increase of collector current.

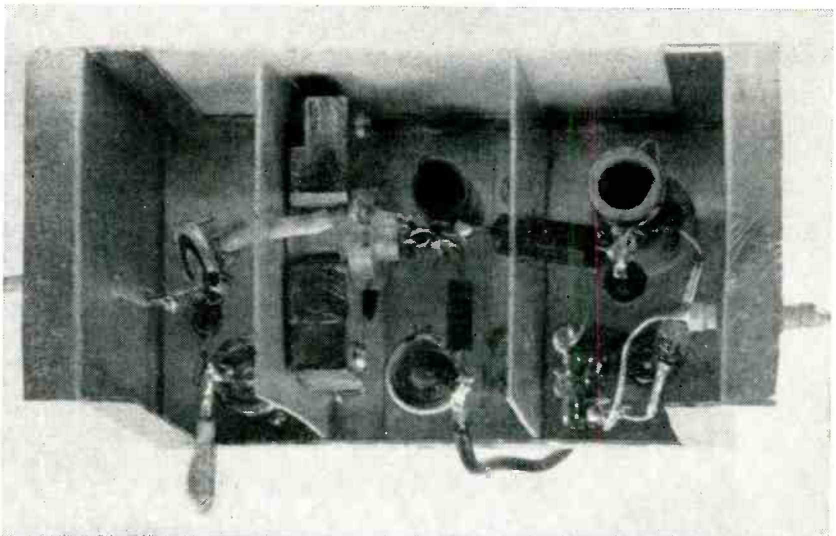
Transit Time

It is apparent that the transit time between emitter and collector will be controlled by the internal field strength in the crystal. Since the collector current is large compared to the emitter current, the field strength will be largely a function of the resistivity of the germanium and the collector current. Bardeen[1] presented a theoretical relationship from which

$$T = \frac{2 \pi S^3}{3 U_h \rho I_c}$$

where T = transit time, S = spacing, U_h = hole mobility, ρ = resistivity and I_c = collector current. An examination of the geometry of the type-A transistor shows that since all holes do not flow over paths of the same length, a dispersion in transit time results in a diffuse transit angle. This has the result of reducing the average value of collector modulation and is the primary cause for loss of high-frequency response.

The most important element in



Magnetic bias of 16,000 lines per square inch is provided by the small magnet visible in center compartment of the 23-mc transistor amplifier

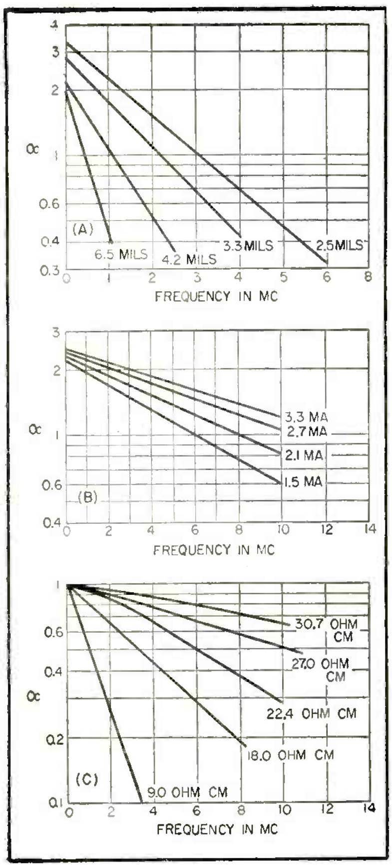


FIG. 1—Transistor characteristics show gain for short-circuited output α for various electrode spacings (A), collector currents (B) and bulk resistivities (C) as a function of frequency

determining the frequency response of type-A transistors is spacing, since it appears in the transit time expression as a cube function. Figure 1A shows the variation of α (current gain for short-circuit output) as a function of frequency. The spacings are taken from center to center of the electrodes, which are approximately 1 mil in diameter. Spacings less than 2.5 mils are not usable in the present design of transistors, and it is evident that high-frequency operations require the use of the minimum practical separations.

Since the internal field strength, accelerating the holes from emitter to collector, is proportional to collector current it would appear desirable to use the highest practical collector current. Figure 1B shows the variation of α with frequency for a family of collector currents. It has been found that currents of about 5 milliamperes are the maximum values that can be used without introducing instability due probably to overheating of the collector contact.

One of the most important variables in frequency response, one that has not been well controlled in presently manufactured transistors, is the bulk resistivity. Figure 1C shows the effect of this factor on α as a function of frequency. Since these measurements were made on different transistors chosen for bulk resistivity as the variable, the value of α has been normalized.

It has been established from the data presented that a high-gain—high-frequency transistor must have small emitter-collector spacings, small contact areas, high bulk resistivity and must be operated at the highest practical collector current.

Magnetic Bias

A recently discovered method[2] of extending the high-frequency range consists of applying a magnetic bias of the proper sign at right angles to the plane of the collector and emitter as shown in Fig. 2. This field acts in such a manner as to beam the emitter and collector currents along a more direct path. While it does reduce transit time, it also reduces the transit angle dispersion and thus increases the frequency range.

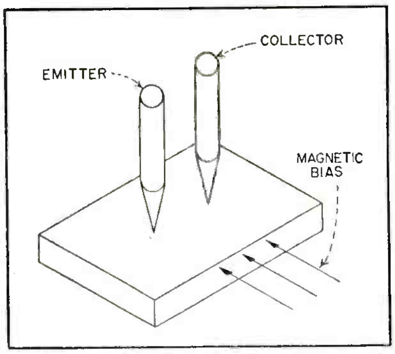


FIG. 2—Frequency range of transistors may be extended by applying a magnetic bias of the proper sign at right angles to the plane of the electrodes

Figure 3 shows a typical result using plus and minus magnetic bias fields. Not all transistors respond to the bias field in the same way, and more experimental work is in progress to determine the details of the effect.

It has been found that transistors having wide spacings show larger increases in α than those with small spacings and that transistors having small contact areas show higher values of α when magnetically biased. Thus the magnetic bias not only increases α at high frequencies but also decreases the variation between transistors.

Circuit Considerations

A handy circuit representation of the transistor at high frequencies can be obtained using a three-terminal network having one generator as shown in Fig. 4, where R_E is the input resistance, R_B the coupling resistance and R_C the collector resistance. Capacitor C_C is the barrier-layer capacitance and C the emitter-collector contact capacitance. The generator current may be represented by i_1 α_f ϕ_f R_C,

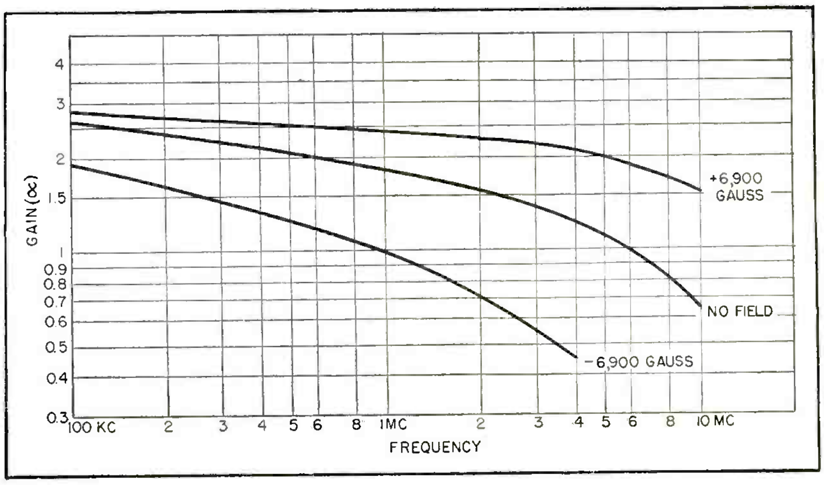


FIG. 3—Gain-response curves show importance of proper direction of magnetic bias field

where i_1 is the a-c input current, α_f the short-circuit current gain at frequency f, and ϕ_f is the phase shift with frequency f.

It is evident that the input impedance will depend largely on the load current flowing through R_B. At low frequencies this current is opposed to the input current i_1, and acts as a positive feedback. At higher frequencies the phase shift in α causes the input impedance to become complex and at very high frequencies, phase shifts of nearly 180 degrees will increase the input impedance. It should be remembered that complex load impedances obtained when tuned collector circuits are used will alter this condition. The collector impedance likewise can vary greatly due to feedback. At low frequencies, this positive feedback characteristic of a transistor reduces the collector impedance but at higher frequencies it becomes dependent on the input impedance which may be complex if tuned inputs are used. The barrier layer capacitance C is of the order of 1 $\mu\mu$f in the type A transistor and C_C is somewhat less, varying with collector voltage. The coupling resistance R_B does not change much with frequency but is a function of both emitter and collector current.

From the foregoing, it is apparent that care must be taken at low frequencies to insure sufficiently high input and output impedances to reduce the positive feedback. Much of the lack of d-c stability can be traced to inadequate coupling impedances. It is desirable to have both input and output impedance high at all frequencies both in and outside the amplifier passband, but some compromises must be made in order to obtain sufficient gain.

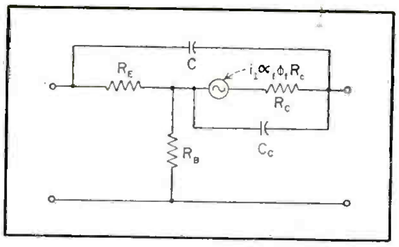


FIG. 4—Three-terminal representation of transistor at high frequencies

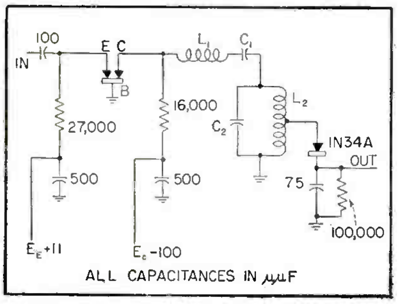


FIG. 5—Circuit of 23-mc amplifier used for testing high-frequency response of transistors

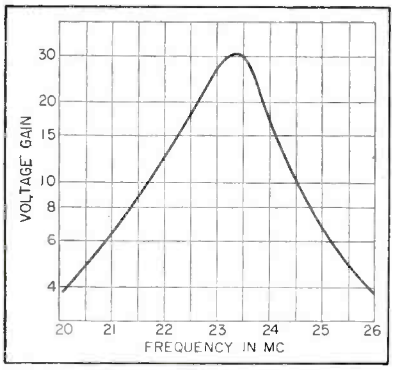


FIG. 6—Frequency response of amplifier circuit shown in Fig. 5

Design of a 23-mc Amplifier

The problems of high-frequency operation of transistors are best exemplified by examining a particular design. Figure 5 shows the circuit diagram for a 23-mc amplifier used for testing the high-frequency response of transistors.

Shunt feed of both the emitter and collector currents was used to insure high d-c stability. Since the emitter current was only 0.4 ma, it was possible to use a high value of emitter bias coupling resistance without unduly high bias voltage. In the collector or output network, L_1, C_1, L_2, C_2 constitute a band pass whose impedance is high at frequencies in the pass-band and remote from the pass-band. There are minima however on both sides, and some difficulty may be encountered if overall phase shifts are such as to satisfy the conditions for oscillation.

Transistor amplifiers should always be designed for high-impedance outputs, tapping the diode down on L_2 to meet the requirements for diode load resistor matching. Since the emitter is a current-fed element, the input impedance must be kept low at the frequency of amplification and high at all others. This can be satisfied in most cases with a series tuned input network if necessary to prevent oscillation at frequencies outside the pass-band.

Figure 6 shows the frequency response of the amplifier. The input impedance is approximately 1,000 ohms at 23 mc. The output impedance of L_2 C_2 was 16,000 ohms, thus the gain between 1,000-ohm input and output would be 8. This results in a gain bandwidth of 8.8 mc.

The transistors used with this amplifier had bulk resistivities of greater than 30 ohm-cm and spacings of 2 mils between emitter and collector. It should be noticed that present manufacturing methods lead to relatively few transistors which satisfy these requirements. However, it appears reasonable to expect that experience with manufacturing methods will allow the manufacturer to supply transistors within these specifications. The small magnet used gave a field strength of 16,000 lines per sq in. Slightly higher gain could have been obtained on most transistors if more field strength were available.

The stability with time was very good. No changes in gain of more than 5 percent were noticed for any given transistor over a period of several weeks of operation. Emitter voltages were not critical, and could be varied by 30 percent with very little change in gain. The collector voltage controlled the gain by varying the collector current, hence this voltage must be regulated to the same extent to which it is desired to hold the gain. This suggests that avc in this type of amplifier can be obtained by control of this voltage through auxiliary circuits.

The temperature stability was good for most of the transistors tested over the range from 40 F to 120 F. The d-c collector potential (E_C) at 120 F, however, is reduced to less than ⅓ the value at 40 F since the d-c collector resistance falls sharply at the higher temperatures. This results in lower maximum power output and reduced maximum voltage output at 120 F.

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Modulated-Light DENSITOMETER

Instrument for determining reflectivity and density of materials with low light intensity. An incandescent dial light is 100-percent modulated at 20 cps by a two-tube multivibrator-amplifier circuit. Reflected or transmitted light produces 20-cps phototube signal which is amplified by circuit which passes 20 cps but rejects 120-cps signals

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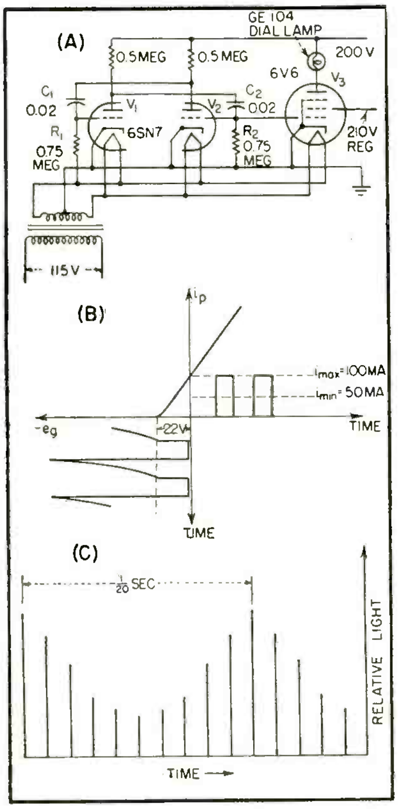


FIG. 1—Circuit shown in (A) excites dial light with 20-cps square wave to produce a 20-cps sinewave modulation of light output, as shown in (C). Operation is shown in (B)

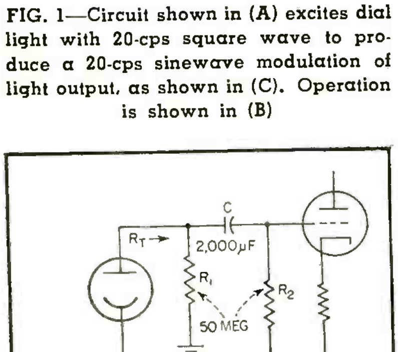


FIG. 2—Terminal impedance R_T seen by phototube is 25 megohms

It is usually desirable to keep the sensitivity of a light-measuring device as high as possible. High sensitivity permits the transmission or reflection coefficients of high-density and low-reflectivity materials to be measured with a small amount of light impinging on the medium. This is especially advantageous for chemical or biological applications where an excessive amount of heat would be detrimental to the specimen.

There are three basic light-measuring techniques: a light-sensitive element in conjunction with a d-c amplifier, a phototube whose output is periodically interrupted and applied to an a-c amplifier, and a phototube whose light input is periodically interrupted and whose output is applied directly to an a-c amplifier. The latter method combines two advantages. First, it eliminates the need for successive stages of d-c amplification, with their inherent instability and need for constant adjustment; and secondly, it reduces the average amount of light that falls on the medium, if the light is chopped at its source.

Another requirement for a good light-intensity meter is a stable zero reading in the absence of light; and if compensation circuits are provided the zero adjustment should have long-time stability. Also, the instrument should not have to be used in a dark room, nor should the optical path require shielding from background light. And it is desirable that the instrument be unaffected by such phototube characteristics as dark current and leakage.

The instrument described here employs an incandescent light source which is excited by an a-c current of such frequency and waveshape that 100-percent sinewave light-output modulation can be obtained. The average light flux is held constant and is independent of line-voltage fluctuations. The frequency of the light-flux modulation is a subharmonic of line frequency, giving sufficient stability so that sharply-tuned filters can be used. The instrument is devoid of leakage and dark-current effects, may be used in a normally lighted room, and no zero adjustment is necessary.

Light Modulator

It was found that a 20-cycle square wave produces 100-percent light-output modulation in a bulb of the GE 104 type. This is a conventional dial light, dissipating 6 watts at 125 volts. Figure 1A shows the light-modulating circuit. The 6SN7 is used as a multivibrator with the grid of one triode directly coupled to the grid of a 6V6. Resistors R_1 and R_2, together with the coupling capacitors C_1 and C_2, determine the frequency of the multivibrator which is set to 20 cps. The grid of V_1 is returned through R_1 to

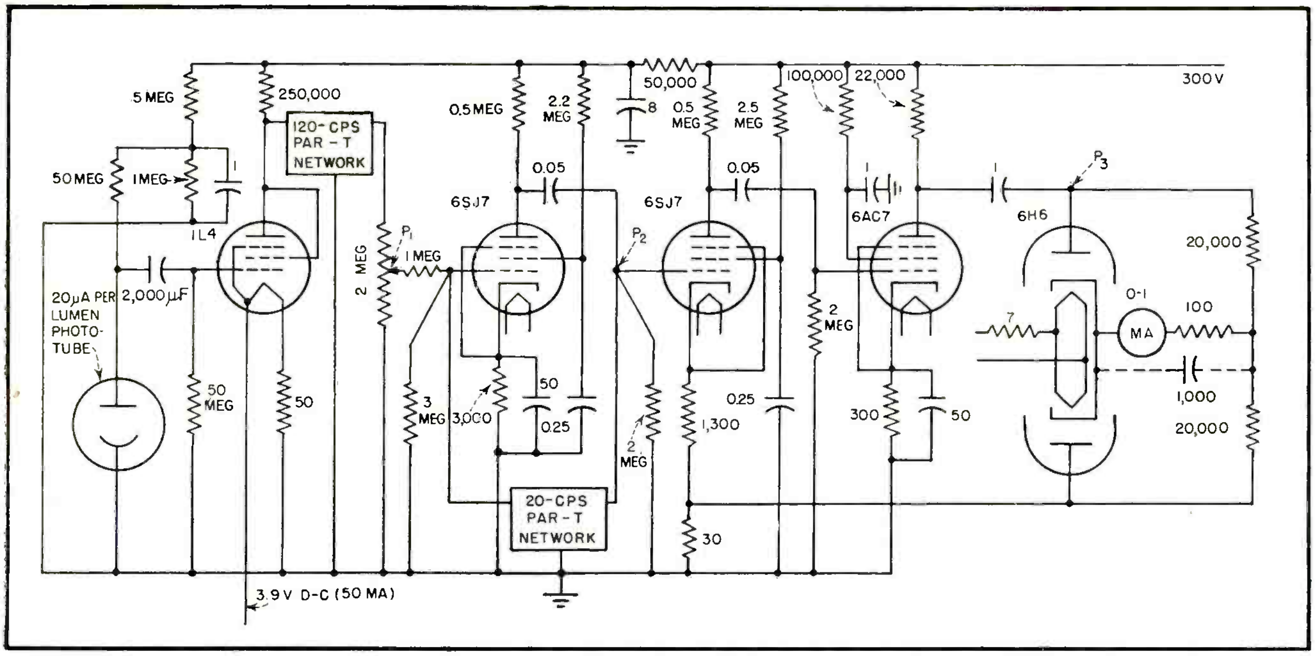


FIG. 3—Complete schematic of photometer portion. Filament voltage for 1L4 is obtained through dropping resistor from B supply

one side of the filament to derive a 3-v rms 60-cps signal for synchronization at the third subharmonic of the line frequency.

Figure 1B shows the operating conditions for the modulator on the i_p-e_g characteristic for the 6V6. With the constants chosen, the pentode is driven from cutoff to a value of 100 ma at 20 cps.

The voltage on the grid of the multivibrator oscillates about an average value, close to the cutoff value of the 6V6, in such a way that only the square-top portion cuts into the conducting region of the pentode. The pulse shape is square and was found to be best for sinusoidal light output from the bulb. The average plate current is 50 ma—well within the long-life operating rating of the lamp.

The light output of the lamp is made independent of line-voltage changes by making use of the fact that if the pentode screen voltage is kept constant, the plate current is independent of the plate voltage. Furthermore, the multivibrator is unaffected by line-voltage changes because the gain of a triode of the 6SN7 type, terminated by a high-resistance plate load, is constant. The lamp can be inserted in the cathode of the pentode with the proper choice of circuit constants if it is desirable to have one side at ground potential.

Figure 1C is a plot of one cycle of the light output produced by the lamp as measured by high-speed motion picture camera technique. The light output very closely follows a sine wave. Measurement of the a-c light output, simultaneously with the average value, shows that well over 90-percent modulation is obtained. Of course, more or less modulation can be obtained by limiting the spectral range covered, increasing or decreasing the driving voltage and hence the average temperature, or by use of a bulb with different luminescent and nigrescent characteristics.

20-cps Photometer

In designing a light-measuring instrument for use with the 20-cps modulated light source, many factors must be considered. The amplifier must have sufficient sensitivity at the signal frequency to provide adequate deflection of the indicating instrument, but it must also be capable of rejecting extraneous signals.

The useful sensitivity of any instrument is determined by the signal-to-noise ratio. Modern phototubes have a very small dark current so that most of the noise is of a thermal nature, generated by the resistor terminating the phototube.

The input signal is an a-c voltage with a well defined frequency and phase. The noise, however, is a random effect with a definite rms value. There are two ways to obtain high sensitivity: a selective amplifier followed by an averaging detector, or a broadband amplifier followed by a phase-sensitive detector. In both cases, the signal-to-noise ratio depends on the allowable time of observation. If, for instance, the bandwidth of an amplifier is 1 cps we have to wait at least 1 second until the voltage at the rectifier has been built up to its terminal value. If a phase-sensitive detector is employed, the integrating network after the rectifier has to have a time constant of one second, for the same signal-to-noise ratio.

Figure 2 shows the input circuit of the amplifier. The d-c load resistor of the phototube is R_1, and R_2 is the biasing resistor of the first amplifier stage. The coupling capacitor C has a negligible impedance for the signal frequency. The phototube is, therefore, terminated by a resistance R_T consisting of R_1 and R_2 in parallel. If k is the phototube constant in microamperes per lumen, L_m is the average value of a sinusoidally varying light flux in lumens, and R_T is the dynamic input impedance in megohms, the input voltage for the amplifier is:

$$E_S \text{ (rms)} = \frac{k\, L_m\, R_T}{\sqrt{2}} \text{ volts}$$

An instrument designed in such a

way that $L_m = 5 \times 10^{-7}$ lumen produces full scale deflection of the indicating instrument, k is 20×10^{-6} amperes per lumen and R_T = 25 megohms, will have an input voltage of $E_s = 177$ microvolts.

If the bandwidth of the amplifier is Δf cycles per second, the noise voltage at the amplifier input is E_n (rms) $= 1.3 \times 10^{-7} \sqrt{\Delta f \ R_T}$ which for a bandwidth of $\Delta f = 1$ cycle per second is E_n (rms) $= 0.65$ microvolt. If the meter at the amplifier output shows a deflection of 1,000 μa for an input voltage of 177 μv, the required amplifier gain is $G = 5.65$ μa per μv. The rms value of the meter current produced by noise is therefore $i = E_n G = 3.65$ μa.

This current appears as a series of pulses which occur at random rate with random amplitudes. If the bandwidth is 1 cps, the pulses are spaced by about 1-second intervals so that the needle is well able to follow them. The amplitude of the majority of the pulses is identical with the rms value of current. However, theory shows that a few percent of the pulses have four times this amplitude, which was found to be in good agreement with experimental results. The noise produces, therefore, needle deflections with an amplitude of 1.6 percent of the full meter scale and the signal-to-noise ratio is thereby determined.

These fluctuations can be avoided by mechanical damping in the meter or by an R-C filter as shown in Fig. 3, provided that the time of response is not important. The error in the reading due to noise nevertheless is not removed. An improvement in signal-to-noise ratio by a further increase in Q, and hence a decrease in Δf, would make the instrument too sluggish and is impractical; however, since signal voltage increases linearly with the input terminal resistance R_T whereas the noise voltage increases as $(R_T)^{\frac{1}{2}}$, a gain in signal-to-noise ratio can be obtained by increasing R_T.

Tuned Amplifier

Experiments were conducted with a phase-sensitive detector circuit and compared with the tuned amplifier to be described below. The superiority of the tuned amplifier was demonstrated in a series of exhaustive tests.

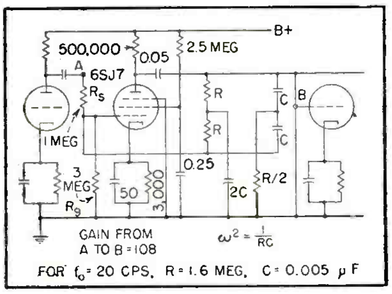


FIG. 4—Second stage of signal amplifier contains this 20-cps parallel-T feedback network

If the signal to be amplified is in the low-frequency range, say 20 cycles, it is impossible to obtain narrow-bandpass filters with conventional resonant circuits containing inductance and capacitance. For such low frequencies, however, circuits with only resistors and capacitors are available which give the desired bandpass characteristics. One of the best solutions is the use of a parallel-T network as a negative feedback element.

Figure 4 shows one amplifier stage in which a parallel-T network is used as a degenerative feedback element. The network has zero transmission for a frequency f_o if the parameters are chosen as shown. Thus no degeneration exists at f_o. At all other frequencies, the gain of the amplifier is reduced. The steepness of the frequency response depends on the terminating impedance. If the amplifier is controlled from a voltage source with an internal impedance which is small in comparison with the output impedance of the network, a resistor R_s has to be inserted. The value of the biasing resistor R_g can, of course, be kept high enough to avoid any damping effect on the network.

A 6SJ7 pentode is used as the amplifier. The network was tuned to 20 cycles.

If the tube is used as a straight amplifier, a gain of 240 at 20 cycles is realizable. With the network connected as shown, this gain is reduced to 108. Figure 5A shows the relative response characteristic of the stage with feedback. The bandwidth at the half-power point is less than 1 cycle per second. It should be noticed that the frequency selectivity curve is steeper than that which could be obtained if a tuned L-C circuit at 20 cps were used as the plate load. The steepness of this characteristic depends on the matching of the resistors and capacitors and a Q of 25 or better can be obtained with 2-percent components.

Any attempt to include more than one stage in the parallel-T feedback circuit requires an extremely linear phase characteristic in the amplifier in order to avoid a change from negative to positive feedback at very low or very high frequencies. This demands that the amplifier response be flat down to frequencies less than one cycle per second. If conventional R-C coupling is used, the coupling capacitor and cathode bypass capacitor become prohibitively large.

Overall Circuit

Figure 3 shows the complete circuit diagram of the light-intensity meter, whose design was based on the above considerations. A four-stage amplifier is used with a parallel-T network across the second tube. The phototube is terminated dynamically by a resistance of 25 megohms. The phototube plate voltage is supplied through 50 megohms and a second 50-megohm resistor is used as biasing resistor for the first stage. The instrument is designed to give full deflection in a one-milliampere meter for a light flux of 5×10^{-7} lumen. This corresponds to an input voltage at the first grid of 177×10^{-6} volts.

The input level to the first stage is so low that the stray voltage from the 6-volt heater supply of an indirectly heated tube can be harmful. Consequently, a filament-type input tube connected as a triode is used. The heater current of 50 milliamperes is derived from the B+ power supply. A bias voltage of 2.5 volts is obtained by inserting a 50-ohm resistor between filament and ground. This bias is of extreme importance since grid current must be avoided to prevent reduction of the dynamic load resistance of the phototube. An active parallel-T network tuned to 120 cps is inserted between the first and second stages to eliminate the 120-cycle modulation due to artificial light.

Figure 5B shows the relative response characteristic of this network. The gain of the first stage including the 120-cycle attenuation network is 2.6.

For many applications, the phototube has to be housed in a separate search unit. If a shielded cable is used between the terminating resistor of the phototube and the amplifier input, microphonic effects make the handling of the search unit impractical. If the cable is tapped just slightly, voltage surges are produced which cause fluctuations of the meter needle. It was first thought that these surges were due to capacitance changes in the cable. Later, however, it was found that the surges exist even with no voltage supplied, and it is felt that the effect is probably of a piezoelectric nature. These difficulties can be avoided by including the first triode in the search unit. The output impedance of the tube is so low that any shielded cable can be used.

A barrier-layer photo element can be employed instead of the phototube, so that a wider spectral response is obtained. In addition, the photo element is a low-impedance generator and can be coupled to the grid of the first amplifier stage by means of a transformer. Leads from the element to the transformer are insensitive for hum pickup and microphonic effects. The transformer is mounted in the main amplifier chassis, so that the search unit becomes very small since now it has to contain only the photo element.

A calibrated volume control P_1 is inserted between the first and second stages. This control must be inserted here if the instrument is to have a full-scale sensitivity range of 1,000 from 0.5×10^{-6} to 0.5×10^{-3} lumen. This means then that the input voltage varies from 177×10^{-6} to 177×10^{-3} volt and the input to the second grid varies from 0.460×10^{-3} to 0.460 volt.

If the second stage has a gain of 100, it must be capable of delivering 46 volts undistorted. This is not practical if we wish to maintain a high degree of linearity in spite of deterioration of tube characteristics. If the volume control is used as shown, the voltage at the grid of the second stage will never exceed 0.460×10^{-3} volt. It is clear that even the highest light input will not cause overloading of the first grid since this corresponds to 0.460 volt.

Meter Rectifier

Special care must be taken in designing the rectifier. The meter must indicate the average output voltage in order to maintain a good signal-to-noise ratio. The circuit should be linear over above twice the useful range so that accurate calibration can be maintained in spite to tube ageing. If diodes are used, the contact potential will cause a reading of the meter in the absence of signal. This reading can be made negligible, about 0.5 percent of full scale, by reducing the filament voltage. This is accomplished by inserting a 7-ohm resistor in the filament circuit.

Figure 3 also shows the circuit of the rectifier which uses a double-diode 6H6. It is preceded by two amplifier stages with 20-db negative feedback from the diode output to the cathode of the first of these stages. A one-milliampere meter with 70 ohms resistance is used, and a voltage of 23 volts at point P_3 produces full-scale deflection. At point P_2, 40×10^{-3} volts will produce full-scale deflection. The overall relative frequency response curve of the instrument is shown in Figure 5C. The half-power bandwidth is about 1 cycle per second, and the effect of the active 120-cps network is indicated by the 98-db dip at 120 cps. The 0-db point at 20 cps represents an input of 177×10^{-6} volt.

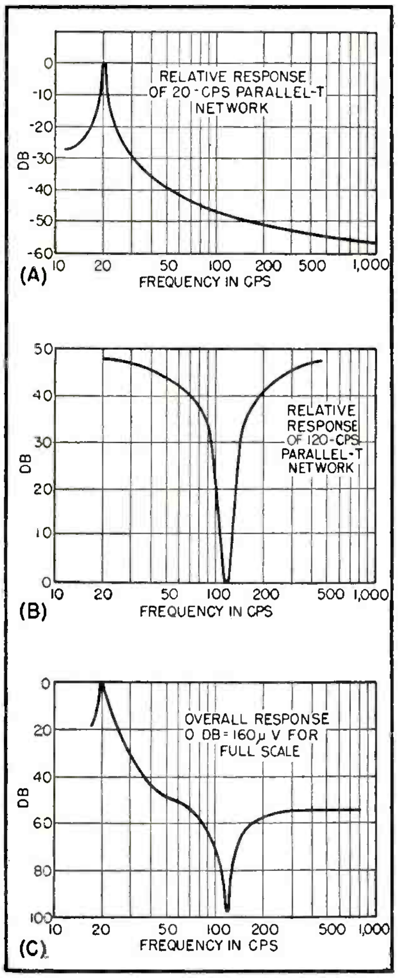


FIG. 5—Individual parallel-T network responses are shown in (A) and (B). Overall response curve (C) shows 98-db dip at 120 cps, which permits use of instrument in normally lighted room

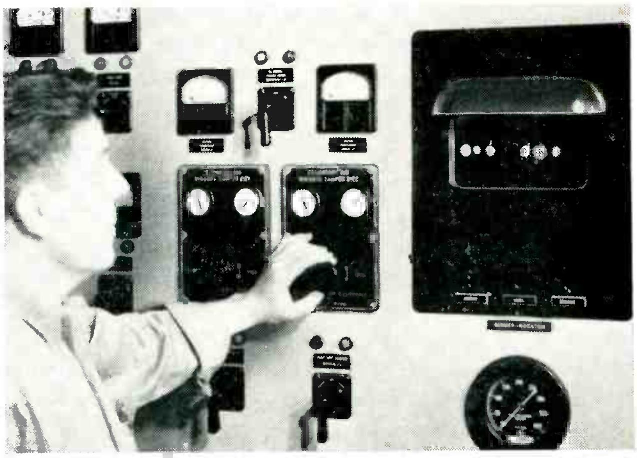
Conclusion

The overall voltage gain of the amplifier is 150,000. This is a small value for a high-sensitivity instrument, but the high-efficiency system of modulation used makes it possible to obtain full deflection of the meter with a light flux of only 0.5 microlumen. There are no special problems with regard to feedback so that the location of components and the choice of ground connections are not critical.

The instrument needs no zero adjustment since with no incident light there is no signal developed. Furthermore, the 98-db rejection for 120 cps makes possible the use of the instrument in a normally lighted room.

The compactness of the search unit, especially in the case when a barrier-layer cell is used together with the stable high sensitivity and linear output, makes the instrument particularly useful in the biophysical field for such purposes as oxymeters and shadow cardiographs. An instrument similar to the one described has been constructed by S. Guilford of the National Bureau of Standards to be used as a hemoglobin densitometer in cardiovascular diseases research at Walter Reed Hospital.

For applications in spectral densitometers, the advantage of the wide spectral response of the barrier-layer cell can be obtained without the disadvantage of having to use rotating shutters, time gates or stabilized power supplies.



Arrangement of mirrors and camera pickup at left enables operator to look into six furnaces at a glance on remote monitor screen at extreme right

Closed-Circuit Industrial

Wired system employs new type image dissector with translucent cathode that permits use of wide-angle lenses. Three cables carry sync pulses and video signal to remote monitor, which may be up to 1,000 feet from the camera. Resolution is 300 lines per inch

By ROBERT W. SANDERS*

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INDUSTRIAL APPLICATIONS of television are constantly increasing in number and importance. The equipment to be described was originally designed for power plant use where a need for remote viewing of the boiler water level at the control room was necessary. It later became apparent that other industries have as great, or even greater, need for such a system, so the Utiliscope was designed as a universal system. It has a standard 4-to-3 aspect ratio, and the vertical and horizontal resolution is 300 lines, as shown in the test pattern of Fig. 1.

Main Components

The three component units of the industrial system are shown in Fig. 2. The camera pickup unit uses an image dissector tube whose advantageous characteristics are as follows: (1) It is an instantaneous-type tube, thus no shading compensation is necessary. (2) The tube has no heater, hence it is extremely rugged and its life is not limited by the filament or thermionic emission. (3) The gamma of the tube is unity and linear over extreme contrast ranges. (4) The tube uses an eleven-stage electron multiplier which is not subject to microphonics and will deliver a video signal of approximately ½ volt in amplitude. (5) The spectral response of the dissector is such that it peaks in the near infrared (approximately 8,000 angstroms) sector of the spectrum.

Because of these advantages, particularly the instantaneous characteristics and high video output, the Utiliscope is reliable and simple to operate. Simplicity of operation is of major importance in industrial television applications. Another important requirement, continuous operation with low service time, is accomplished by using a minimum number of tubes in the overall system. The complete system requires only fifteen standard receiving type tubes plus cathode-ray tube and image dissector.

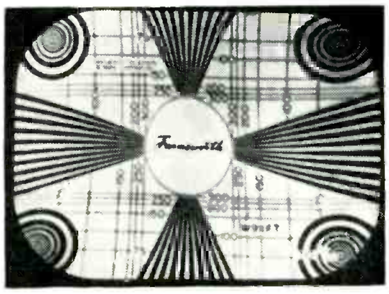

FIG. 1—Test pattern sent by industrial tv system shows 300-line resolution

The camera unit is connected through a multiple-conductor cable to the power unit. These units may be separated by as much as twenty-five feet. This sending end is then coupled by three coaxial cables to the monitor, which may be separated by a distance of one thousand feet or less. These three cables transmit the video, horizontal sync pulses and vertical sync pulses to the monitor. The use of three cables, rather than

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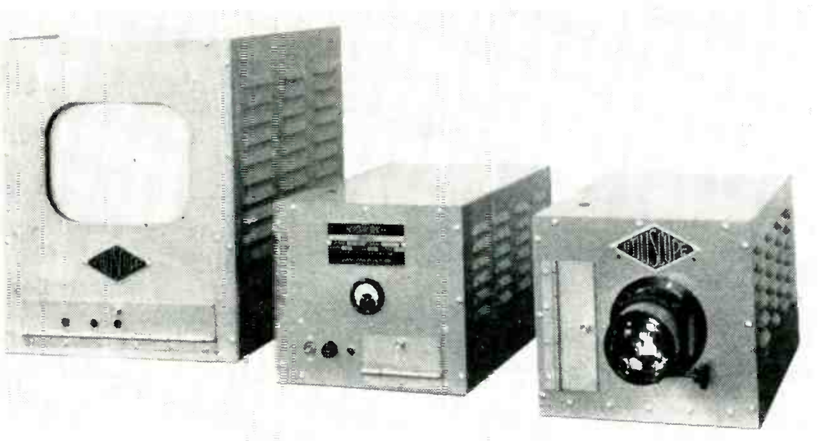


FIG. 2—A complete setup consists of camera, monitor and power units

Television

one cable carrying a composite signal, adds to simplicity.

Overall System

Figure 3 is a block diagram of the complete system. The image is focused optically on the cathode of the dissector. Deflection and focus power and the multiplier voltage are supplied to the dissector from the power unit. The video signal from the dissector and blanking pulses are fed in to the automatic black-level setter. The composite signal is then amplified and matched to the line.

The vertical oscillator in the power unit supplies vertical deflection power to the camera unit as well as vertical sync pulses for the monitor and vertical blanking pulse former. The beam relaxor supplies horizontal scanning power to the dissector and horizontal blanking pulses to the blanking pulse former, which mixes, clips, and shapes the horizontal and vertical blanking pulses. The beam relaxor also supplies horizontal sync pulses to the monitor and furnishes high-voltage pulses which are rectified to furnish multiplier and cathode voltage to the dissector. The vertical sync pulses trigger the vertical deflection oscillator in the monitor unit. Horizontal pulses are amplified and fed to the monitor beam relaxor. This beam relaxor supplies horizontal deflection and high-voltage pulses which are rectified to supply approximately 8 kv to the picture tube. The video signal from the camera is amplified and applied to the grid of the picture tube. A 1N34 is used as the d-c restorer.

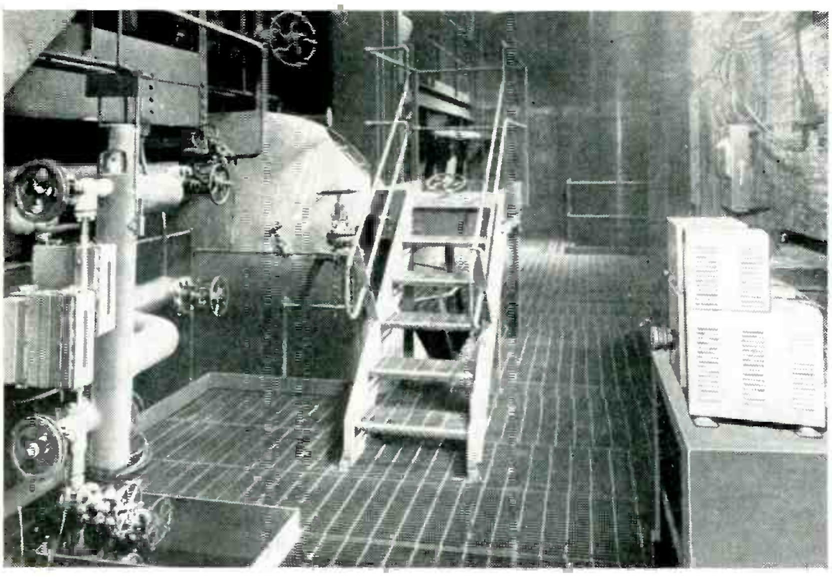
Figures 4, 5 and 6 are schematic diagrams of the camera, power unit, and monitor respectively. The lens used in the camera unit has a 90-mm focal length and a speed of f :1.4 or better. The lens is coated for 7,000 A transmission. The mounting uses a rack gear and pinion type focus adjustment, and the angle of coverage for a two-inch horizontal scan is approximately 27 degrees.

Image Dissector

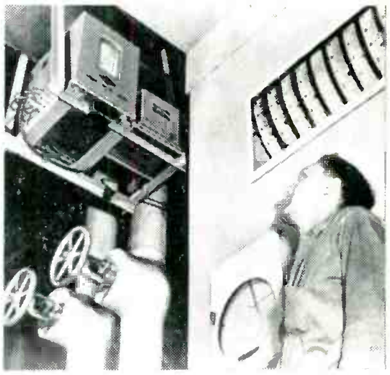
Figure 7 shows a photograph of the dissector. The front of the tube (right) is the translucent cathode which replaces the solid cathode of earlier tubes of this type. This construction permits the use of fast, wide-angle lenses, and eliminates picture degradation due to light reflecting from the walls of the tube.

Directly behind the cathode are five rings, behind which lies the nickel-wall anode. The anode is 400 volts positive with respect to the cathode, and the five rings are at intermediate voltages with 75-volt intervals. The purpose of the rings is to improve the field in the vicinity of the cathode and decrease the amount of distortion.

An eleven-stage multiplier is



Camera at right views level of liquids in two tubes at left in this industrial application of the television system



Operator sees liquid levels on remote monitor screen mounted at the rear of the tube. The aperture, which in most cases is a 30-mil square, is located at the front of the multiplier housing.

Each multiplier stage has a gain of 3 or 4 when the voltage per stage is 200 volts. Total gain of the 11-stage multiplier is over 1 million. The Ag-Mg type of multiplier is used instead of the Cs-O-Ag which was used in the solid-cathode type dissector in order to provide better uniformity in multiplier performance from tube to tube and eliminate the problem of cesium shorts in the multiplier. The tube is relatively nonmicrophonic. The cathode photosensitivity is approximately 20 μa per lumen.

Figure 8 shows the dissector coil assembly that contains the horizontal deflection coil, vertical deflection coil and focus coil. The horizontal coil is the inner coil and is approximately nine inches long. The vertical coil is a toroidal type approximately one inch long wound over an iron form. This coil fits snugly on the horizontal coil and is directly behind the focus coil. These two coils are rotated 90 degrees, electrically, with respect to each other. The focus coil is semilayer-wound directly over the dissector cathode in the coil assembly housing. The coil assembly can be rotated to align the picture.

Video Amplifier

A schematic of the video unit is included in Fig. 4. Its function is to mix the blanking pulses with the video from the dissector collector, provide an automatic black level setting, amplify the composite signal, and match the output to the transmission line.

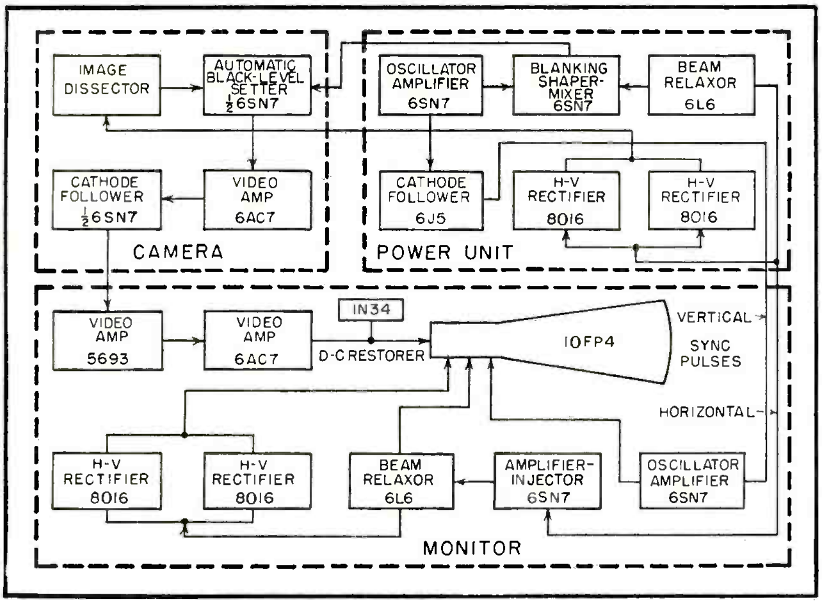


FIG. 3—Block diagram of image dissector industrial television system

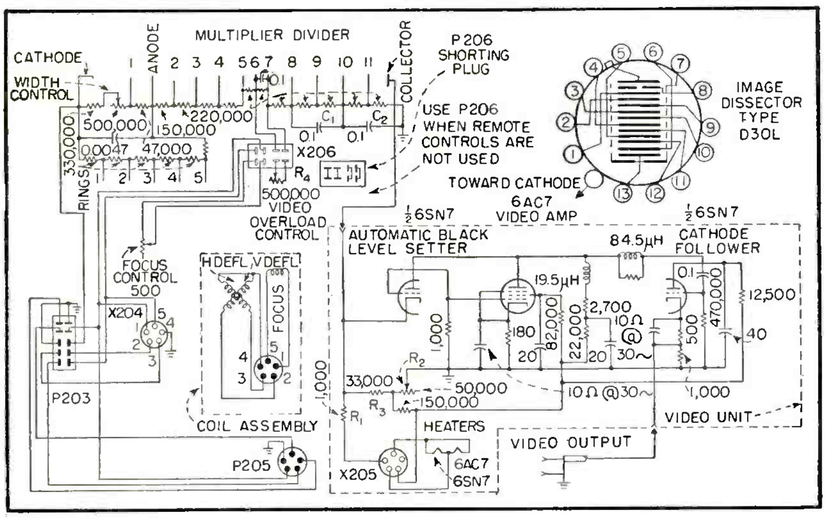


FIG. 4—Circuit showing image dissector connections and camera video unit

The operation of the automatic black level setter is as follows: Relatively large blanking signals are fed to the cathode in series with the video from the dissector collector. This video is developed across R_1 which is the dissector collector load. The d-c voltage developed across R_1 due to random noise in the dissector will remain constant. Any light which strikes the dissector cathode will cause a corresponding increase in collector current, hence increased negative voltage of the collector. Since more light causes more electrons to flow to the collector, the collector becomes more negative with respect to ground.

The initial clipping level of the automatic black-level setter can be properly adjusted by applying just enough positive voltage to its cathode to allow only a very small amount of the blanking pulses to come through. This is accomplished by varying R_2 to give the proper potential. An isolating resistor R_3 is used to minimize the capacitance across the collector load. Any light on the dissector cathode will cause more negative voltage to appear at the clipper cathode, which will pass through the diode, so the pedestal will always be full but no video can ever extend beyond the black level.

The 6AC7 video amplifier has a gain of approximately 18, and the cathode follower provides a low-impedance output for the video line with a gain of approximately 0.3.

The dissector multiplier voltage divider is shown in the upper left-hand portion of the schematic. The overall voltage across the multiplier is approximately 2,000 volts. Capacitors C_1 and C_2 improve the low-frequency response of the multiplier due to the high impedance of the multiplier divider. Actually the width control is an overall size adjustment in that it changes the cathode-anode voltage. An increase in this voltage will decrease the width of the scanned image and also the height of the image.

The video overload control R_4 controls the gain of the multiplier. It is necessary due to variation in dis-

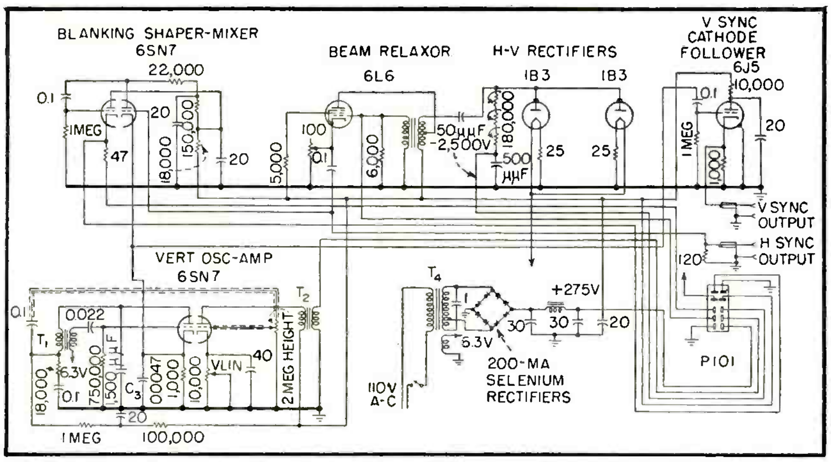


FIG. 5—Sync pulses and video are fed to monitor by three separate cables

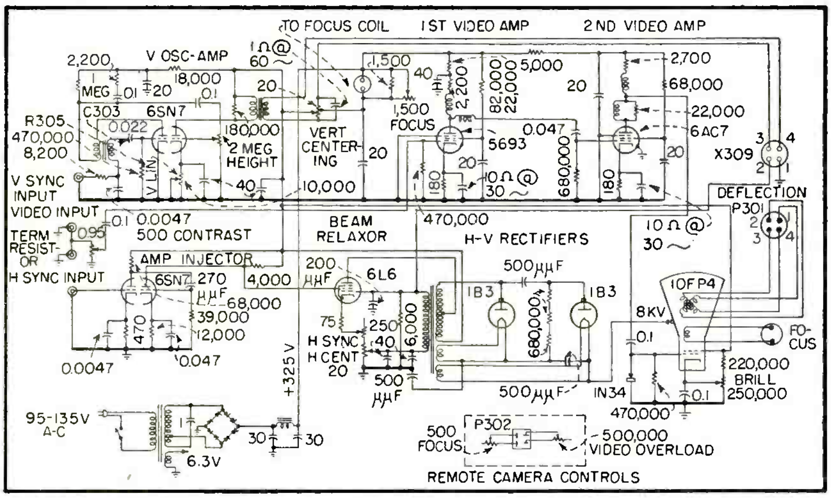


FIG. 6—The power unit supplies all operating voltages for the camera unit

sector tubes and extreme light conditions which may be encountered, otherwise the last stages of the multiplier might be overloaded. Since this overload problem concerns only the last two or three multiplier stages, control is in the sixth stage.

Figure 9 shows clearly the power unit which delivers heater voltage, B+ voltage, multiplier voltage, scanning power and blanking signals to the camera unit, and also supplies vertical and horizontal sync pulses to the monitor. It draws approximately 100 watts and will operate on a line voltage of between 95 and 135 volts. A self-regulating type power transformer is used.

Figure 5 shows a schematic of the power unit. A single 6L6 in a beam relaxor circuit is used to provide horizontal scanning power for the camera as well as to supply high-voltage pulses to the multiplier voltage supply rectifiers. The beam relaxor is a horizontal deflection power oscillator of *L* and *R* type. The frequency of this type oscillator is determined by the inductance in the plate circuit and the internal resistance of the tube. The inductance in the plate circuit is approximately 100 mh and is determined by the impedance of the deflection coils and the transformer ratio. The frequency of the oscillator can be varied by changing the resistance in the cathode of the tube. This is a free-running oscillator which operates at a frequency of 21.5 kc. This frequency is controlled by the adjustable cathode resistor. This control is not critical but may vary slightly from transformer to transformer. This horizontal deflection circuit was chosen for stability and durability.

Figure 10 shows a close-up of the horizontal deflection transformer. This transformer consists of a grid winding of approximately 100 turns. The 500-turn plate winding is wound directly over the grid winding. The high-voltage winding consists of 300 turns connected in autotransformer fashion. The transformer must serve three interdependent functions. It must provide scanning power to the camera, the high voltage for the dissector multiplier, and its return time must be slightly faster than the blanking return time. These criteria must be met with satisfactory scanning linearity. The return time of this transformer is 5.7 microseconds or 0.12 *H*. A damping resistor removes the overshoot which would otherwise occur through the scanning coils causing severe nonlinearity.

The positive impulse derived from the horizontal deflection transformer is rectified by the two 1B3's in parallel. This provides a negative voltage of approximately 2,500 volts. Since the current drain very nearly approaches the current rating of a single 1B3, two are used in parallel. This is done as an added precaution against failure in the field.

The vertical deflection circuit, which consists of the dual triode, must supply vertical deflection power to the camera, vertical blanking pulses to the blanking mixer and vertical sync pulses to the monitor. One-half is used as a blocking oscillator. The lower end of the

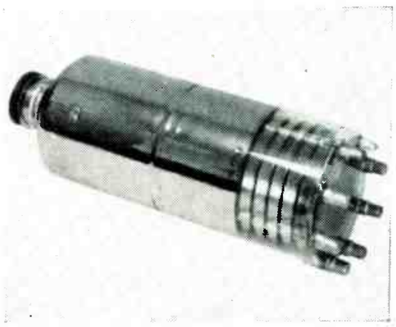


FIG. 7—Translucent-cathode image dissector tube

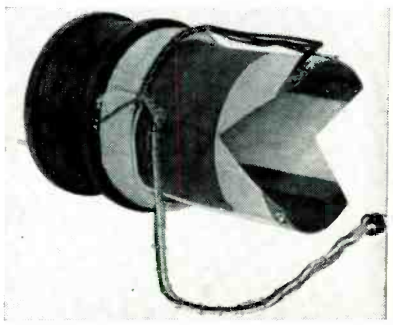


FIG. 8—Image dissector deflection and focus coils

blocking oscillator transformer is returned to the 6.3-volt heater winding on the power transformer. A resistor is inserted in the cathode circuit of the vertical oscillator. A positive pulse is developed across this resistor which is used for blanking and monitor synchronization. Capacitor C_3 reduces the horizontal pickup on this lead. Transformer T_2 is the vertical output transformer used to present the proper plate load impedance on the vertical amplifier from the vertical scanning coils.

One section of the blanking mixer tube is used to mix the horizontal and vertical blanking pulses while the other section is used as a cathode follower. A positive vertical pulse is fed to the cathode of the blanking mixer. A negative horizontal pulse from the beam relaxor cathode is injected on the grid of the blanking mixer. A very low plate voltage is used, hence the blanking pulses cause very early saturation of the tube. This causes the base line of the blanking pulses to be absolutely flat which is extremely important, otherwise at low light levels a shading component will appear. The values of R_4 and R_5 were picked very carefully to provide proper phasing of the horizontal blanking pulse with respect to the initial sync pulse delivered to the monitor.

A cathode follower isolates the cathode of the vertical oscillator from the monitor vertical oscillator. If this is not done a large pulse is fed back to the power unit from the monitor vertical oscillator. This pulse, if applied across the cathode resistor of the power unit vertical oscillator, is slightly out of phase with the cathode pulse and will make it impossible to derive a clean vertical blanking pulse from this point.

The horizontal synchronizing pulse is derived across the cathode resistor of the 6L6 beam relaxor. This provides a low-impedance source of horizontal sync pulses. The amplitude of these pulses will vary as the frequency of the beam relaxor is changed. However, a pulse amplitude of only ½ volt is ample to insure positive synchronization of the monitor and higher amplitudes are not detrimental. The cathode resistor obviously cannot be shorted since this would reduce the pulse amplitude to zero.

Monitor

The monitor is quite conventional and will not be treated in detail. All controls are available from the front. Brilliance, contrast and focus controls are screwdriver adjustments. Other controls are behind a hinged door. Two controls are provided on the monitor for remote operation of the camera unit from the monitor position when desirable.

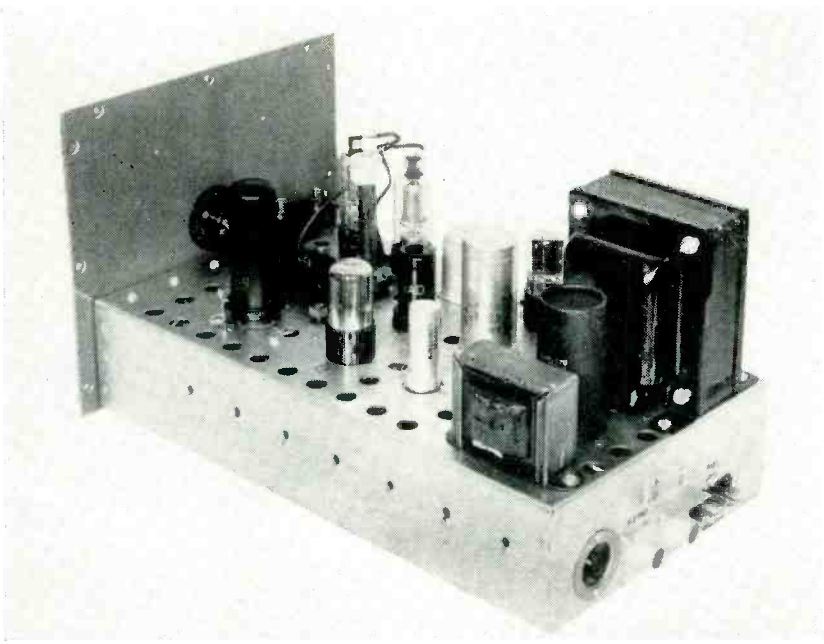


FIG. 9—Power unit with cover removed to show placement of components

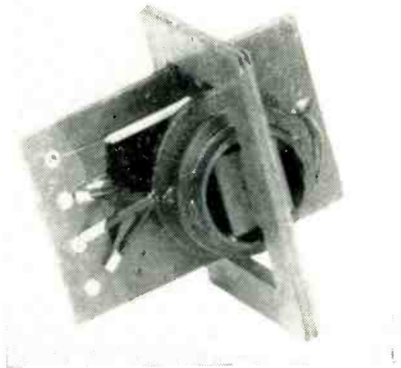


FIG. 10—Horizontal deflection transformer

A 6L6 is used in a beam relaxor circuit to provide horizontal deflection and high voltage for the picture tube. Circuitwise, this is quite similar to the beam relaxor on the power unit. Synchronization is controlled by injecting the horizontal sync pulse from the power unit on the screen of the 6L6 and controlling the frequency by means of a variable cathode resistor.

The monitor beam relaxor transformer is similar to the power unit beam relaxor transformer with the addition of two heater windings for the 1B3 rectifiers. The transformer is designed to match a 2 mh deflection yoke. It also provides 8,000 volts for the picture tube; the return time must be faster than the camera blanking time. Two 1B3 tubes are used in a voltage doubler circuit to provide the picture tube high voltage.

The vertical deflection system is very similar to the camera vertical deflection system. Frequency determining elements are fixed and the oscillator will stay in sync over large variations of voltage and other parameters. The vertical sync from the power unit is injected directly into the vertical oscillator.

The grid, cathode and plate time constants of the horizontal sync amplifier were chosen to properly phase the triggering of the beam relaxor with respect to the blanking pulse. The monitor raster has approximately ⅛ inch blanking on either side.

Acknowledgment is given to the Diamond Power Specialty Corporation of Lancaster, Ohio, who sponsored the development of the equipment and who are the exclusive sales agents.

The DIOTRON... An Aid To RMS Instrumentation

Novel circuit comprising temperature-limited diode, d-c amplifier, and feedback path solves wide variety of electronic problems. Simple unit provides basis for true square-law voltmeter, wattmeter, video program level meter, and several computing elements

By R. D. CAMPBELL

Reed Research, Inc.
Washington, D. C.

During recent years a need has grown for a vacuum-tube voltmeter whose indication depends only on rms values. When nonsinusoidal waveforms are to be measured, and particularly when the signal is a random noise, reliable data cannot be acquired from any rectifying instrument.

Bolometric and thermocouple devices accurately give rms values independently of waveform, but suffer from two serious difficulties: (1) The instruments are sluggish, and brief samples of signal cannot be measured. (2) Both devices operate close to the burnout point. This often forces the designer to incorporate an overloading amplifier stage to protect the instrument, with the result that large spikes, such as those of noise, are clipped. To this error is added uncertainty during the recovery period after overload.

The circuit of Fig. 1 constitutes the basis of a vacuum-tube voltmeter which overcomes these defects. As indicated, the diode and d-c amplifier form a tight feedback loop which will regulate the diode plate current with considerable accuracy. Since the voltage at the diode plate is always sufficient to collect all the emitted electrons, a constant value of space current implies a constant filament temperature and accordingly a constant value of filament heating power. It is upon this last relation that the properties of the device are based.

Theory

If a source of a-c is introduced into the filament along with the d-c of the feedback loop, the circuit must immediately regulate away part of the latter in order that the average filament power remain constant. The defining equation for this behavior is

$$I_{a\text{-}c}^2 R_F + I_{d\text{-}c}^2 R_F = \text{constant}$$

Since the filament is of fine diameter, skin effect may be neglected below 100 mc and a simpler form of the equation results.

$$I_{a\text{-}c}^2 + I_{d\text{-}c}^2 = \text{constant}$$

Since the effect of introduced a-c depends only on the heat it produces, it is evident that the circuit constitutes the basis of a vacuum-tube voltmeter which truly reads only rms values. Such a meter will at all times agree with a thermocouple and has these additional advantages: (1) A thermocouple operates close to its burnout current, whereas the diode circuit operates at 12 percent of its burnout current. (2) Thermocouple time-constants are of the order of 0.5 second. The diode and amplifier loop can be made to have a time constant of 15 milliseconds for all applied frequencies above 1 kc. (3) The accuracy of the device is that usually associated with feedback devices, and the accuracy of the readings depends only on the values of a few precision wirewound resistors.

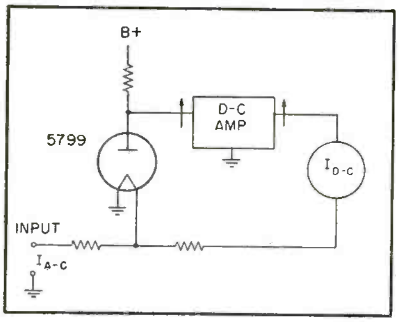


FIG. 1—Diode and d-c amplifier form feedback loop which accurately regulates diode plate current

Linear Power Scale

The circuit of Fig. 2 shows a practical vacuum-tube voltmeter constructed on this basis. It will be noted that the diode filament is heated from a negative bias and that the d-c amplifier supplies a current which subtracts from this. This refinement is necessary in order that the feedback be degenerative for signals fed through the capacitance and leakage of the diode as well as for those signals which are thermally transmitted. Two additions have been made to the feedback path from amplifier output to input. First, a new path, consisting of a single capacitor, decreases the bandwidth of the amplifier so that filament temperature variations during a cycle are not amplified and transmitted around the loop to produce an additional heating current not indicated by the d-c meter. Secondly, the R-C network from output cathode to diode filament supplies first-derivative damping for optimum stability and speed of response. Both of these circuits can be adjustable, so that high frequencies can be measured in the shortest possible time without sacrificing accuracy when low frequency measurements must be made.

Since the defining equation

$$I_{a\text{-}c}^2 + I_{d\text{-}c}^2 = K$$

is a circle, it is evident that this meter will have a voltage scale expanded at the top and very cramped at the bottom, quite similar to the usual thermocouple calibration. A power scale fitted to this instrument will be slightly expanded at the top and linear throughout the remainder of the range. By means of a simple approximation, complete scale linearity in power may be achieved. If the defining equation is expanded in series solution for $I_{d\text{-}c}$ we have

$$I_{d\text{-}c} = K^{1/2} - \frac{1}{2\,K^{1/2}}\, I_{a\text{-}c}^2 - - - -$$

and a linear relation exists between $I_{d\text{-}c}$ and $I_{a\text{-}c}^2$ provided that $I_{a\text{-}c}$ is restricted to small values. For engineering purposes, $I_{a\text{-}c}$ may be as great as 45 percent of the initial value of $I_{d\text{-}c}$, with a resulting error of only 0.8 percent.

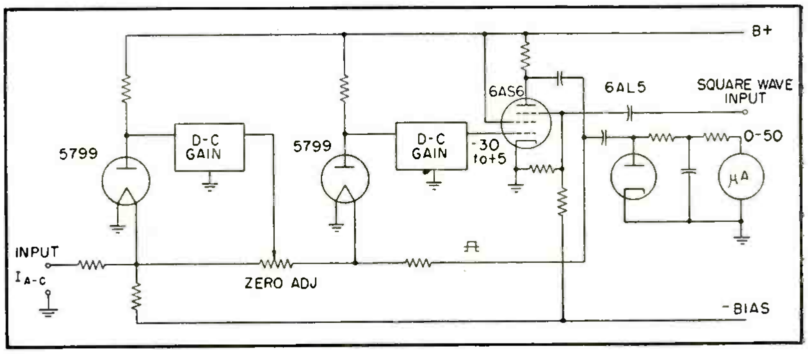


FIG. 3—Block diagram of vacuum-tube voltmeter with linear voltage scale

The circuit of Fig. 2 is arranged in this manner, and $I_{a\text{-}c}$ is always restricted to small values. Accordingly, the scale is linear in watts. The full scale deflections are 0.775, 2.45, 7.75, 24.5 and 77.5 input volts, which correspond to 1, 10, 100 milliwatts, 1, and 10 watts when the instrument is bridged across a 600-ohm load. The frequency response of the commercial version of this instrument extends from 40 cps to 10 mc and the response time is the order of 15 milliseconds for all applied frequencies above 1 kc.

It is fortunate that in many practical applications a linear power scale is just as acceptable as a linear voltage scale. In measurements of random noise, in fact, the former is usually preferable.

Linear Voltage Scale

In those cases where a linear voltage scale is essential, an extension of the basic scheme may be employed. Figure 3 is a block diagram of such a system. Here two diodes are so arranged that the filaments are independent for a-c signals but are essentially in parallel for d-c signals produced in the first feedback loop. The second diode is arranged to control a local source of square-wave a-c which constitutes the heating power in its own feedback path. The frequency and wave shape of this local source of heating power may be selected by the designer to give easy measurement and simplicity of control.

With this arrangement the output

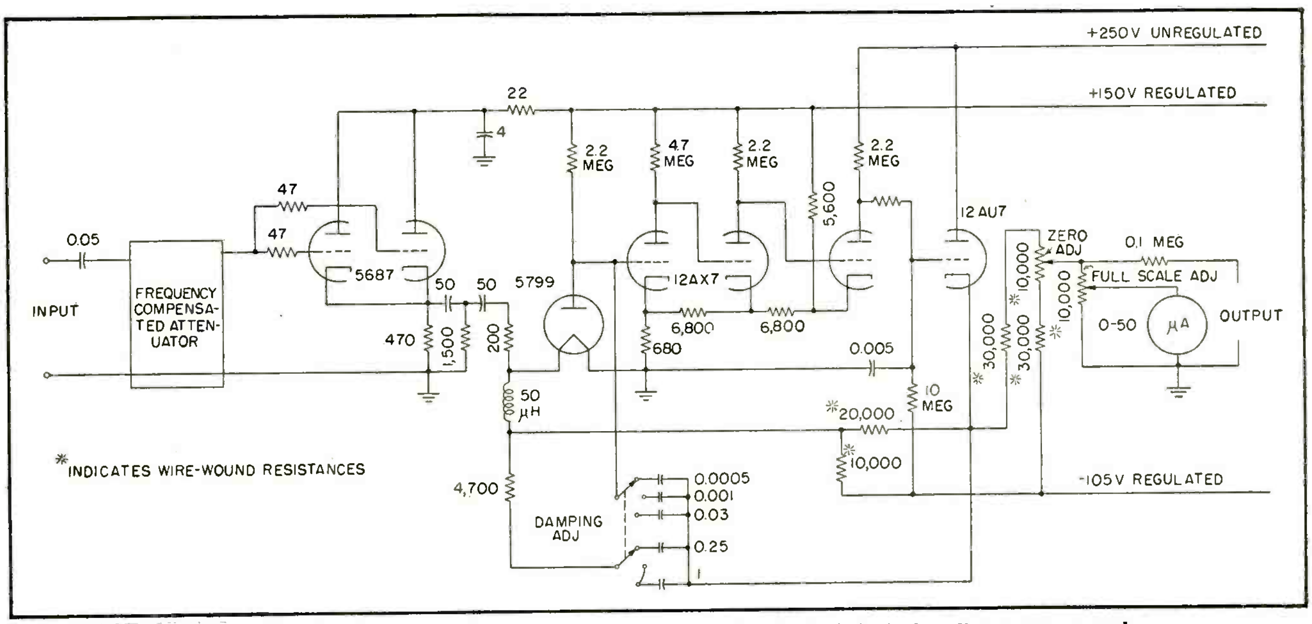


FIG. 2—Wide-band vacuum-tube voltmeter using temperature-limited diode has linear power scale

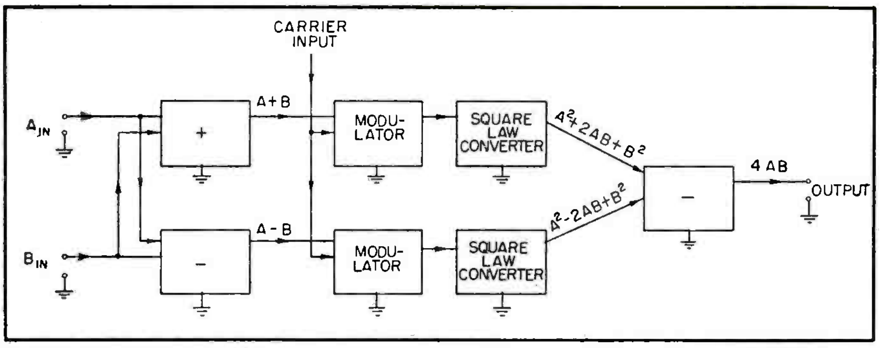


FIG. 4—Two signals, *A* and *B*, can be multiplied by the arrangement shown

voltage must be accurately proportional to the rms input voltage, provided the zero has been properly set, whether the two diodes are identical or not. The only source of error worth noting is that which might be caused by a gradual change in waveform of the local source of heating power. This might result in a change in rms value which would not be indicated by the peak-reading instrument. For this reason, it is unwise to use a multivibrator as the source of square-wave a-c, since the ratio of on to off time for such circuits is not usually very stable.

The most convenient diode for any of the foregoing arrangements is the Victoreen type 5799, since the necessary filament current for temperature limited operation is only 6 ma. Computation based on the internal geometry of this tube places the resonance of the filament above 400 mc. Accordingly, the device should be directly applicable as the first detector in vhf propagation studies and as the second detector in signal-to-noise measurements at i-f frequencies. For these purposes, about 0.7 milliwatt should be delivered to the filament for full-scale deflection, and the filament resistance is 135 ohms. The wide-band instrument of Fig. 2 is of course directly applicable to power level monitoring on video program loops.

Other Possibilities

Electronic addition, subtraction, time integration and time differentiation can easily be accomplished by well-known techniques. However, successful circuitry has not existed for multiplying or dividing two voltages, for integrating or differentiating one voltage with respect to another, or for triangle solution. In consequence, these latter problems have been attacked by mechanical methods involving servomechanisms, with a resultant minimum time for problem solutions of the order of 0.1 second. The diode-amplifier-feedback loop arrangement can solve such problems with far greater speed wherever the inherent error of about 0.5 percent in each step can be tolerated.

The basic circuit of Fig. 2 with a restriction on the size of the input signal has been shown to constitute a computer element capable of producing an output proportional to the square of the input, and possessing good accuracy and speed of response. Since accurate and simple methods exist for interchanging a slowly varying d-c and an amplitude-modulated carrier, no serious complication arises from the a-c to d-c conversion which occurs within the diode itself. The basic circuit of Fig. 2, together with any necessary modulator or demodulator, can therefore be thought of as a building block that produces a square.

This computer element, by feedback methods, can be made to extract square roots by forcing itself to acquire an input signal such that the output equals the voltage whose square root is desired. A pair of such blocks then constitute a multiplier as indicated in the block diagram of Fig. 4. Here the two voltages to be multiplied, A and B, are assumed to be slowly varying d-c. Ordinary electronic addition and subtraction produces two new voltages equal to $A + B$ and $A - B$. These two voltages are then converted to amplitude-modulated carriers and fed to diode circuit blocks which produce a square. The outputs are then proportional to $(A + B)^2$ and $(A - B)^2$. Their difference is therefore proportional to

$$A^2 + 2AB + B^2 - A^2 + 2AB - B^2 = 4AB$$

In a manner analogous to that employed for square root computation, the process of division may be accomplished by including gain and feedback around the multiplier of Fig. 4.

The combination of these processes, together with one more block having unrestricted input range, then permits right triangle solution for all cases where angular data can be provided (or taken out) in terms of a trigonometric function of the angle, rather than in terms of the angle itself. Since the filament may carry currents of three different frequencies just as well as two, the extension to vector computation is obvious.

In most practical cases the device can also integrate or differentiate one voltage with respect to another. It seems reasonable to suppose that any quantities which will be dealt with in electronic computation will not only be analytic functions of each other, but will also be continuous in time and have continuous first derivatives with respect to time, whether time enters the problem directly or not. If so, we may write

$$\int A dB = \int A \frac{dB}{dt} dt$$

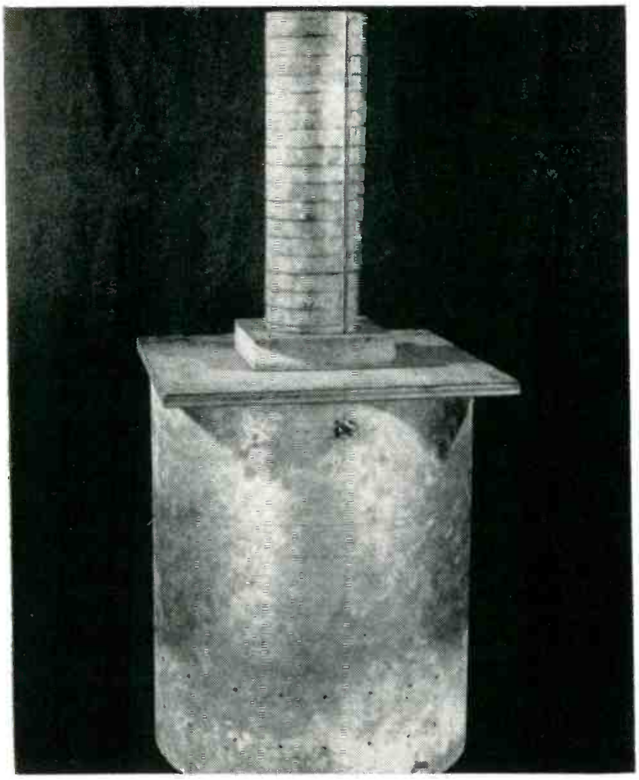
and the integration involves ordinary differentiation and integration with respect to time and multiplication by methods already described. Similarly

$$\frac{dA}{dB} = \frac{\frac{dA}{dt}}{\frac{dB}{dt}}$$

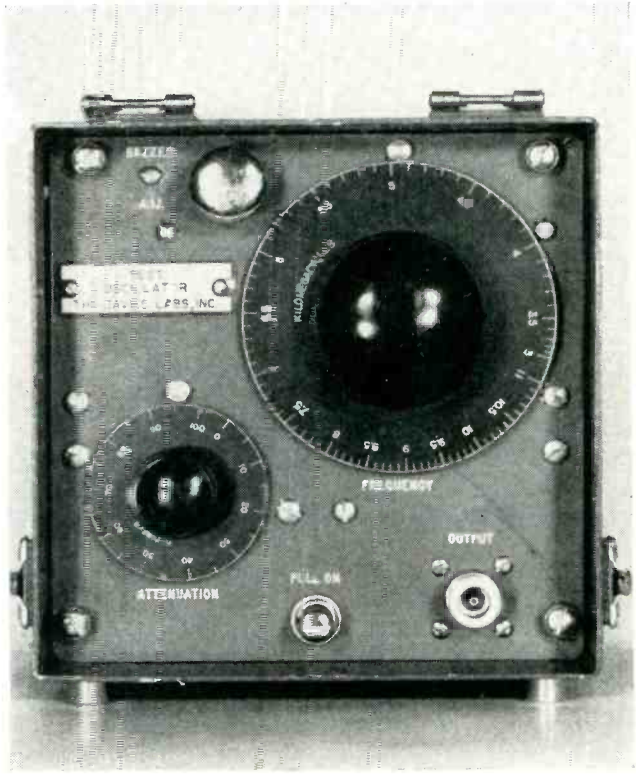
and the process involves ordinary time differentiation and division.

For certain of the applications outlined above, a diode is not essential and a thermistor, for example, would do equally well. Investigation of feedback around other available nonlinear circuit elements may lead to other useful and novel circuits having pleasing and desirable properties.

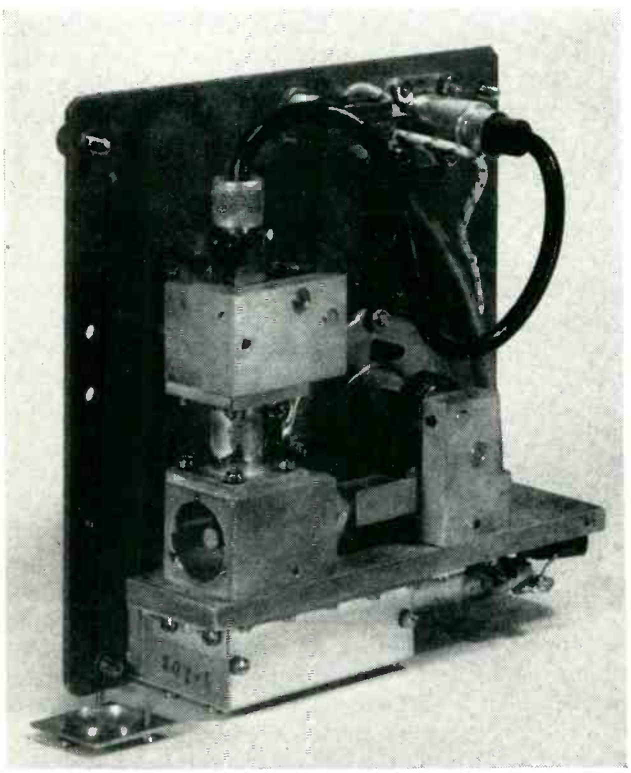
Kilomegacycle Buzzer



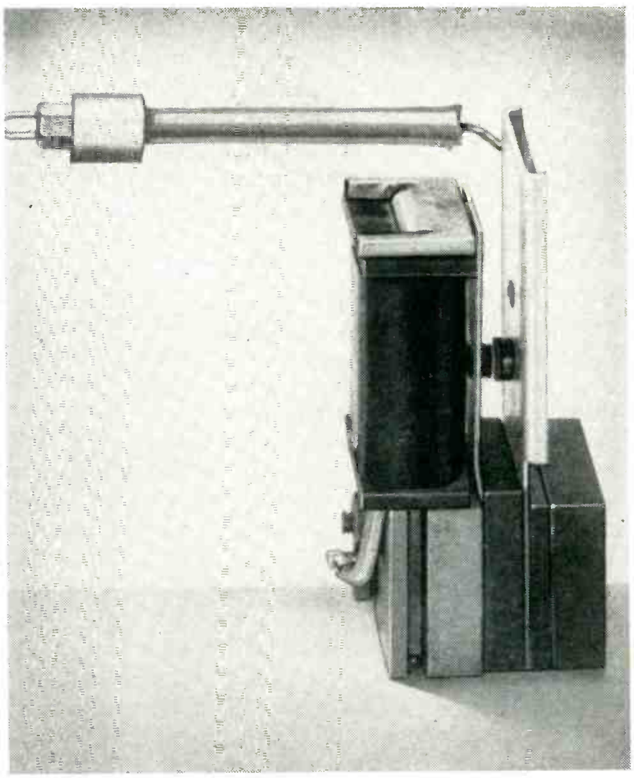
The Ashcan model. Overall can is 22⅝ in., depth to bottom plate, 14-15/16 in. and 18¾-in. diameter, wooden plunger is 5⅜ in. in diameter



Front panel view of the oscillator, showing single adjustment for buzzer. The dial for frequency control is directly calibrated in kilomegacycles



Internal view of oscillator with batteries and cavity end plate removed. Attenuator rack and pinion at right



Buzzer removed from its shield. The small loop protrudes into the cavity

Test Oscillator

Pulses of broad-band energy are injected into a tunable cavity at 800 cps. Output at any desired frequency between 3 and 11 kmc can be selected. A piston attenuator permits variable output up to 200 microvolts into a 50-ohm load. Development technique is traced from a model twenty-five times desired scale

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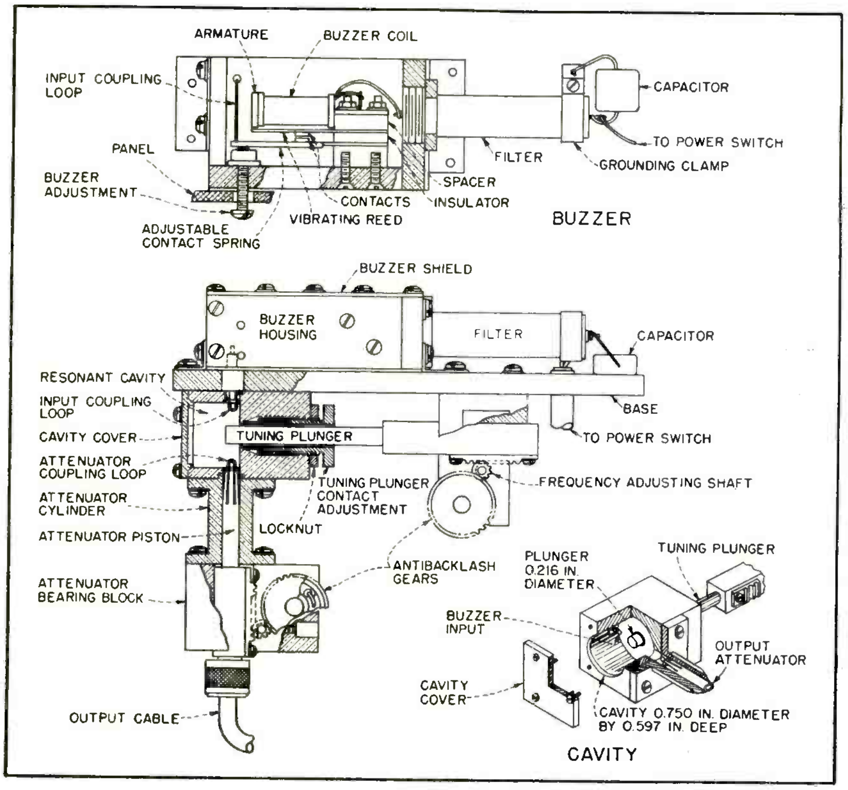


Mechanical layout of the oscillator, with detail of cavity at lower right. The buzzer generator is coupled to the cavity through a loop

Although activity in the kilomegacycle region has increased greatly in recent years, signal sources are still largely restricted to narrow-band tuning. This is an annoyance when testing fixed-frequency detecting devices, and a real handicap in testing wide-range receivers.

One of the latest instruments to help solve this problem is a simple, compact test oscillator covering 3,000 to 11,000 mc in one continuous tuning range. No tubes are used. A battery-driven buzzer operating on the doorbell principle provides audio-modulated signals everywhere in the band, and a plunger-tuned cavity selects the desired frequency. A piston-type attenuator controls the output level.

Scaled-Up Model

The lack of wide-range signal-generating equipment was in itself a difficulty during the oscillator's development. Problems in tuning-cavity design showed the desirability of experimental work, but no satisfactory signal source was available. An interesting application of the model technique in reverse solved the difficulty by providing a cavity in which every dimension was twenty-five times the corresponding dimension of the cavity in the final unit. Thus, frequencies were scaled down into the scope of readily available test equipment.

The simplicity of the buzzer test oscillator is evident from the schematic diagram in Fig. 1. A buzzer, energized by the 3-volt battery through the r-f filter produces short, sharp pulses of current, which are coupled into the cavity through the input coupling loop. The cavity is sharply resonant at a single frequency determined by the position of the tuning plunger. It selects a component from the broad spectrum of frequencies comprising the buzzer output. This signal is coupled to the loop on the variable-attenuator piston that controls the output amplitude. The output signal is in the form of short pulses of r-f energy recurring at the rate of 800 per second. Maximum output voltage is at least 200 microvolts into a 50-ohm load.

The original unit employed an open-ended cylindrical cavity, which was poor from the shielding standpoint. The tuning dial calibration was considerably cramped at one end of the scale, and the available output signal varied appreciably over the frequency range. The desire to improve these characteristics led to the use of the scale model.

The Ashcan

In this development, an expanded model was used rather than the smaller scale customarily employed in antenna experiments. All measurements were made in the region of 120 to 440 mc, where suitable equipment was readily available and the frequency data multiplied by an appropriate factor. The idea for the use of this method was derived from experiments performed by Barrow and Mieher[1] at MIT.

Since the actual cavity in the unit was approximately ¾ inch in diameter by one inch long, a model twenty-five times this size was considered reasonable. Accordingly, a local tinsmith was commissioned to make a large cylinder 18¾ inches in diameter and 25 inches long, and a smaller cylinder, to simulate the tuning plunger, six inches in diameter and 36 inches long. The material used was 22-gage galvanized steel, and the appearance of the assembly made its title certain: the Ashcan.

It was fitted with a plywood cap over the large cylinder, through which the smaller cylinder could move. The inside of the wood cap was covered with copper sheet and suitable fingers made contact with the two cylinders. The inner cylinder was capped to simulate the solid plunger to be used in the actual cavity. Standard uhf connectors were mounted in the wall of the outer cylinder near the capped end to serve as connections to the small coupling loops mounted on the inner ends of these connectors.

The coupling loops were positioned 90 degrees apart around the circumference of the cylinder, as this was the position desired in the final uhf cavity. One of these loops was used to feed energy into the cavity from an oscillator covering the desired frequency range, and the other loop was used for output coupling. A type 1N21B crystal and microammeter served as a detector. Frequency measurements were made by means of a General Radio type 720-A heterodyne frequency meter.

Despite the crude construction and use of sheet steel for the inner and outer cylinders, the Q of the cavity was in the vicinity of 1,000, permitting precise settings to be made. Lines drawn on the portion of the inner cylinder extending above the wooden cap permitted reading of length of plunger inside the cavity.

The first tests made with an open-ended cavity showed the same tuning curve as the original buzzer test oscillator cavity unit, as well as the rather wide variation of output previously noted. Data given by Barrow and Mieher suggested that the low-frequency end of the tuning curve could be controlled through a considerable range by the use of a closed cavity. Appropriate adjustment of the spacing between the plunger and the end of the cavity at the limit of plunger travel was necessary. It was also reported that the cavity oscillations were very weak in an open-ended cavity at the high-frequency end of the tuning range.

It appeared that closing the open end of the cavity would, in our case, achieve the results desired. This effect was tried and found to improve Q throughout the operating range and to provide a much flatter

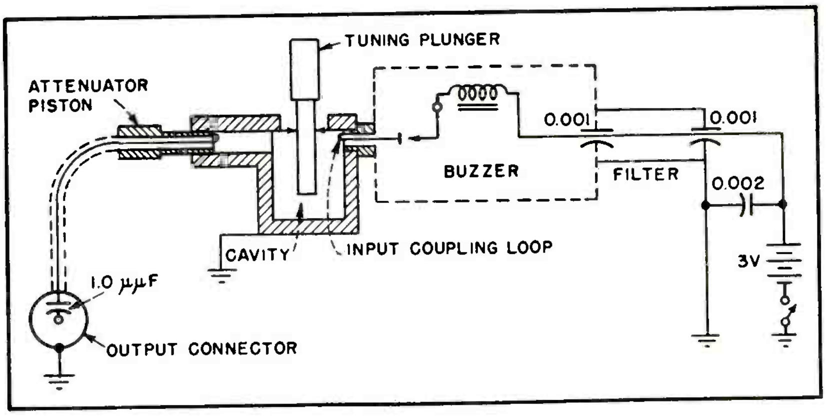


FIG. 1—Circuit of the buzzer test oscillator

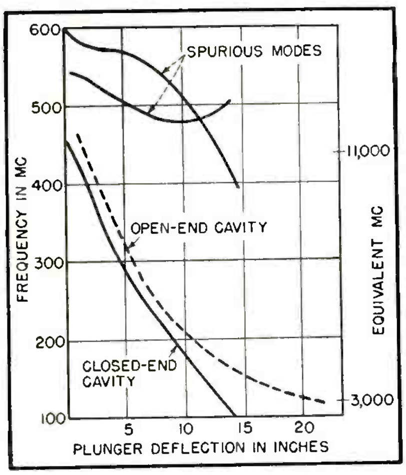


FIG. 2—Calibration of the scale model, showing improvement resulting when end was closed. Spurious modes are outside operating range

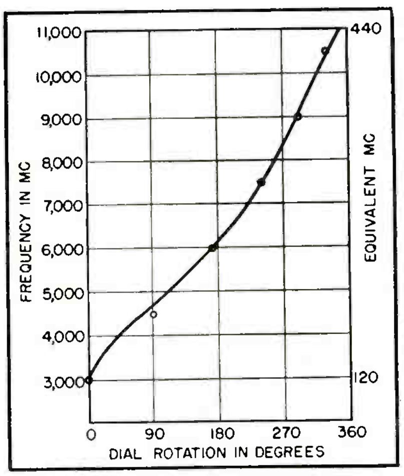


FIG. 3—Calibration of buzzer oscillator. Small circles are values predicted from large-scale model for which an equivalent frequency scale is shown

tuning curve, as shown on Fig. 2. However, resonances at higher modes became apparent. This condition was undesirable since it meant that more than one resonance frequency could exist for a given setting of the tuning plunger. The unwanted modes were identified[2] as the $TE_{1,1,1}$ and the $TE_{0,1,1}$ types.

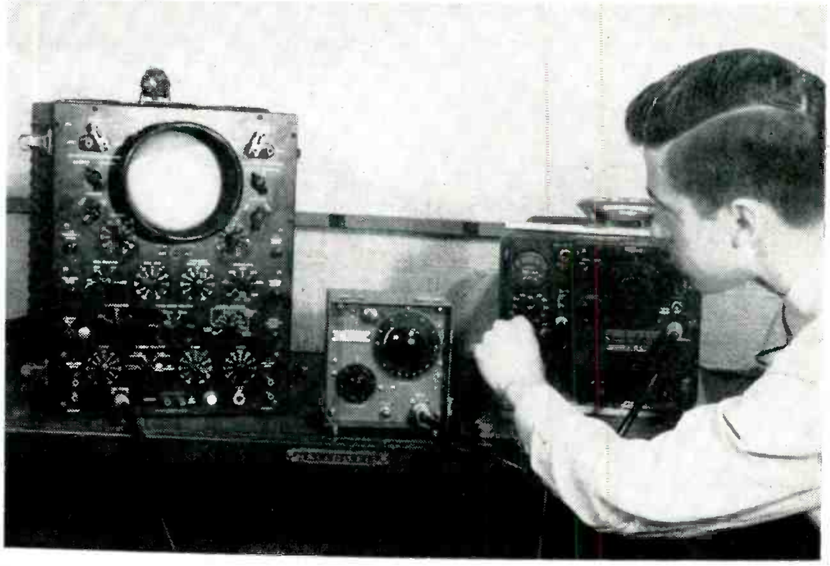
Mode Suppressors

In the large-scale sheet-metal Ashcan it was a simple matter to introduce a set of mode-suppressing slits[3] that eliminated the $TE_{1,1,1}$ mode of oscillation. However, since the $TE_{1,1,1}$ is appreciably higher in frequency than the desired $TM_{0,1,0}$ and unlike the latter is a function of cavity length, it was decided to make the cavity shorter. This change raised both the undesired modes out of the chosen frequency range of the oscillator. The mode suppressing slits became unnecessary. The final position of the $TE_{1,1,1}$ and $TE_{0,1,1}$ modes is indicated at the top of Fig. 2.

It should be noted that the desired resonance curve represents a transition from the $TM_{0,1,0}$ mode (when the tuning plunger is entirely backed out of the cavity) towards the $TM_{0,0,p}$ mode[1], which would occur when the plunger almost touched the opposite end wall. However, the resonant frequency would then be much below that required for this application and motion of the plunger is stopped while operation is still a combination of the two modes mentioned above.

Experimental work at the Ashcan's convenient frequency range and physical size having been concluded, the resulting design was scaled back to 3,000-to-11,000-mc dimensions. The closed-end cavity now employed presents much less of a shielding problem than the original open-end unit. Provision was made for batteries, buzzer, and a piston-type attenuator with 100-db range.

The action by which the buzzer excites the cavity seems to be a high-frequency oscillation causing a pulse of perhaps five amperes maximum amplitude in the contacts at their break, when the voltage across the coil rises sharply to a value over 200 volts. It is necessary that each pulse be clean, and that the repetition rate be high enough to furnish an easily distinguished audio note for the operator's convenience while not being so high that the average battery current is excessive.



Test oscillator being used with receiver. In this case, reception is at harmonic of receiver local oscillator

Selection of Buzzer

Several commercial buzzers were tried. Inherent unsuitability for this application ruled out some units—for example, a standard power-pack vibrator was found to have excessive bounce at contact make, causing one or more break pulses at this time. Other buzzers drew more battery current than operating economy could permit, had an unstable repetition rate or operated at a frequency outside the desired range. The buzzer finally employed was conventional, but it was carefully designed and constructed to avoid the above faults. The operating value of 800 cps was chosen as a modulation value permitting low battery current and yet capable of being distinguished through receiver noise.

In use, the buzzer test oscillator has been found to perform almost exactly as the large scale model had predicted, as shown by the calibration curve of Fig. 3. Available test equipment has not permitted a full search of the upper frequency region to make sure that the undesired modes of oscillation are in the same relative position that model tests had shown. At each frequency where tests have been made, the agreement with the model's results has been excellent.

The unit is compact and rugged, weighing less than 11 pounds complete. The current drain on the self-contained batteries is between 30 and 150 ma, depending on buzzer adjustment. When operated at normal temperatures the battery life for continuous operation should be in excess of 300 hours, or considerably more for intermittent operation. The oscillator thus provides a completely self-contained, relatively trouble-free, portable source of uhf signals. No heating-up time is required, the unit being ready for operation as soon as the battery switch is thrown.

The first example of a test oscillator of this sort was made at the Radio Research Laboratory[4] at Harvard during the war. A second model was later made by the Naval Research Laboratory, Bellevue, D. C., and the design development described here was supported by the Bureau of Aeronautics of the Department of the Navy.

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CASTING RESIN

Step-by-step instructions for potting electron tube assemblies in NBS casting resin, including typical sources of ingredients, preparation and mixing, use of air-piston injector for filling, curing data, fire and explosion precautions, and product design aspects

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Although a great deal of general literature on the so-called NBS casting resin has been written, little data as to actual preparation techniques and application has been available. It is the intent of this article to present workable preparation and usage details.

Basically, this resin combines the requirements of reasonable mechanical properties and castability with excellent electrical properties, as indicated in Table I. The formula is quite simple, but formulating techniques are somewhat involved and require great care.

Preparation of Ingredients

The actual ingredients should be obtained in advance. Those starred below should be stored under refrigeration. By weight, we use the following proportions and brands:

2.5 Dichlorostyrene monomer	33.0%*
Styrene monomer	21.0%*
Polydichlorostyrene	21.5%
Polystyrene P-8 (Koppers)	11.0%
Divinyl benzine solution	0.5%*
HB-40 (Monsanto)	13.0%
Benzoyl peroxide	0.2%

The preparation of the ingredients is exceedingly important and may best be given step by step, along with our source information.

The 2.5 dichlorostyrene monomer is obtained from Dow Chemical, Midland, Michigan. As supplied, it contains an inhibitor which is used to decelerate polymerization, to make possible reasonable transit and storage. This inhibitor must be removed. Removal of the inhibitor must be done as close to actual use as possible. Uninhibited material may start to polymerize at room temperature in a matter of hours. The technique of inhibitor removal is shown in Fig. 1A. The activated alumina can be obtained from Aluminum Co. of America. The noninhibited material must be kept under refrigeration below 40F until used.

Excellent results are obtained with Koppers styrene monomer, obtainable from Koppers Co., Inc., Chemical Div., Pittsburgh, Pa. Freedom from dissolved gases is an important consideration if bubble-free material is desired, and containers should therefore be kept tightly closed. This material is also treated with inhibitor, and the setup shown in Fig. 1A must again be used to extract the inhibitor. This monomer also is highly inflammable.

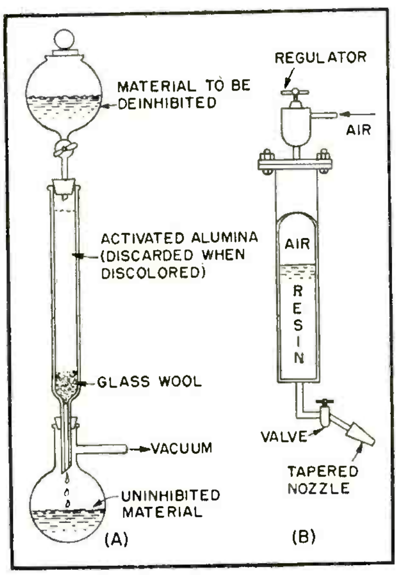

FIG. 1—Simple filter for removing inhibitors from casting resin monomers, and air-piston injector developed by Emerson for applying the prepared product. Source of vacuum for filter can be a vacuum cleaner

No treatment of polydichlorostyrene is necessary. We obtain the material itself from Mathieson Chemical Co., Niagara Falls, N. Y.

In order to facilitate preparation we use Kopper P-8 polystyrene in small bead form. This greatly reduces mixing time.

Divinyl benzine solution is best stored under refrigeration, and is obtainable from Dow Chemical as Experimental Monomer Q-302.4. No special preparation is necessary.

Monsanto HB-40 is procurable from Monsanto Chemical Co., 445 Park Ave., New York, N. Y. Unless especially clear cast items are needed, no preparation of this material is necessary. If extra-clear material is desired, the filtration process shown may be used. Viscosity of HB-40 makes this a tedious job, and the resulting resin clarification is not too satisfactory.

Benzoyl peroxide is obtainable from Eastman Kodak, Rochester, N. Y. This is an unstable material, prone to explosion. As supplied, it contains a filler material intended to deaden its sensitivity. This material must be removed for proper action. The removal of filler is a simple process, and involves only normal and reasonable safety precautions:

(1) *Do not handle large amounts.*

(2) *Do not grind or otherwise submit to abrasion or impact.*

(3) *Keep from flame or sparking of metal mixing tools.*

Removal of filler is accomplished by a simple precipitation process. Dissolve a suitable quantity of filled benzoyl peroxide in a quantity of acetone C. P. When dissolved, add enough cold water to produce a heavy white precipitate. Filter the suspension through a disc of filter paper. The material remaining is filler-free benzoyl peroxide. This

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material is exceedingly sensitive and must be carefully handled. When thoroughly dry, it is ready for use. If an oven is used for desiccation, do not exceed 50 C or selfignition may occur.

Mixing

The actual mixing process requires a ballmill or other form of enclosed milling device. Many methods of combining ingredients are possible, but laboratory experience has shown milling to be best suited.

The fluid ingredients, which are styrene, polydichlorostyrene monomer, HB-40 and divinyl benzine solution, are combined after being carefully weighed. Fumes are moderately toxic and require ventilation. The benzoyl peroxide is also added and dissolved. Thorough mixing of these ingredients will be brought about with little effort by normal stirring.

The addition of the polydichlorostyrene and polystyrene may offer difficulty with lump formation if care is not taken. It has been found convenient to premix these two ingredients, then add them rapidly to the fluids, stirring constantly. The container is at once closed and immediately placed on the rolling mill.

The material is then milled until all lumps have disappeared. This may be done at normal room temperature. The mixed material, taking about 12 hours of milling, must be refrigerated at once or polymerization will occur. All materials must be allowed to return to room temperature prior to exposing to air, or surface condensation will occur. A disastrous loss of electrical properties attends this moisture absorption.

Potting and Curing

The actual preparation of the resin is less complicated than it seems, and reasonable care will result in a reliable product.

The dispensing of a product with as high a viscosity as NBS casting resin presents quite a problem.

Table I—Physical Properties of Casting Resin Developed by National Bureau of Standards

Water Absorption (24-hour immersion)	Less than 0.01%
Volumetric Shrinkage	8.0%
Power Factor (100 mc—50% RH)	0.0004-0.0008
Dielectric Constant (100 mc—50% RH)	2.5
Dielectric Strength (1/16 in. sample)	610-660 v per mil
Resistivity	10^{17} meg-cm

Pour potting may be used, but if any quantity of work is to be done, the air-piston injector shown in Fig. 1B is recommended. It is merely a cylinder with an outlet, into which casting resin is put. Air is admitted to the top by means of a pressure regulator. This forces the resin from the nozzle at the bottom when the base valve is opened.

The nozzle is tapered so it can be pressed into a hole in the container to be filled. The flow ceases when the valve is closed. Oil and dirt in the air supply collect on the top surface of the resin along with untrapped moisture, and are discarded. This injector permits bottom-up potting, which assures a better fill and minimizes air entrapment problems.

Design Aspects

The curing of potted articles requires the use of ovens which are free from open flame or incandescent filaments, as inflammable vapors are released during curing. A cure is generally secured after 12 hours at 50 C. The use of higher temperatures is risky, as is the presence of oven hot-spots; both result in excessively rapid polymerization, a poor material and likelihood of component damage. Longer time periods for curing will generally yield a more stable end product, with improved mechanical properties.

Casting resin of the type described has considerable shrinkage. Tubes and other incompressible components must therefore be protected by a compressible sleeve member of some sort. Care in selection of the sleeve material must be taken to assure it does not stop resin polymerization.

Inductances and circuit capacitances are changed by this casting resin. Experimentation with circuit constants before and after potting is essential in r-f circuits. In many types of equipment the values will vary enough, when potted, to affect operation.

A polystyrene case may be used to contain components for potting if care is taken in curing to avoid high temperatures. A polydichlorostyrene case will withstand higher cures and longer schedules.

The amount of catalyst (benzoyl peroxide) used has a great effect on the quality of the finished product. A larger amount will yield a poor mechanical product, and may cause loss of assemblies due to evolution (rapid polymerization).

Components used must be able to withstand temperatures in excess of the 50 C curing heat. Considerable exothermic (selfgenerated) heat occurs during curing. Lengthy room temperature curing will avoid this problem.

Potting failures due to lead breakage or failure of polymerization will occasionally occur, and should not be looked upon necessarily as failure of the technique. They can in many cases be traced to faulty technique, but in some cases they are without explanation. Generally a familiarity with the techniques involved will yield trouble-free results.

This work was performed with the assistance of the National Bureau of Standards. Special acknowledgment for assistance in the work described is due Phillip Franklin and Emma Lee Hebb of NBS.

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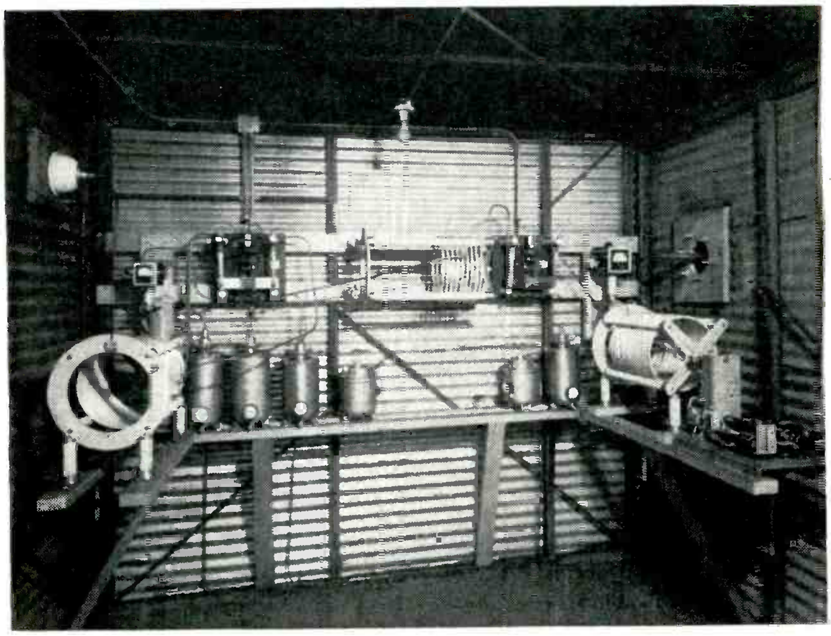
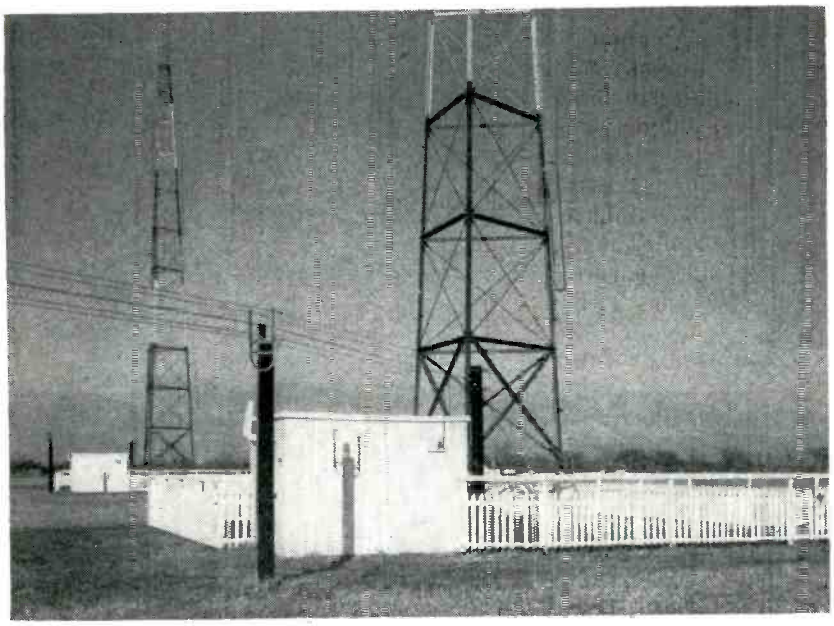


Interior view of one of the nine antenna tuning houses



Sampling loops to feed the phase monitors are mounted on each tower

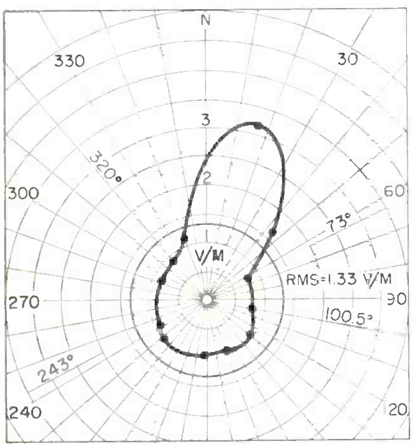


FIG. 2—Measured day-time pattern at 50 kw

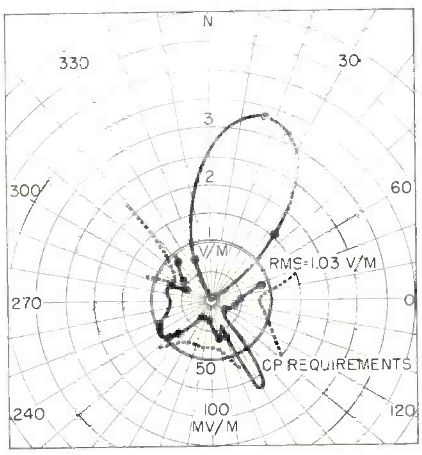


FIG. 3—Measured night-time pattern at 25 kw

coupled to both coils. Controls for these motor-driven coils are located under the phase monitors in the transmitter building, at one central location. At this central point are located all control and monitoring facilities to adjust and observe the operation of the antenna array.

Pattern change is accomplished by single pushbutton control, operating a series of some 30 r-f contactors to rephase and retune the nine towers for the desired pattern. The day and night-time patterns are illustrated in Fig. 2 and 3.

The room or cubicle which houses the phasing equipment is 12 feet deep by 24 feet long. Its walls are constructed of two thicknesses of ¾-inch plywood, with a sheet of aluminum interspaced for shielding purposes. The room has four 6 × 6-foot cubicles along the front, one for each of the distribution tanks required.

The phasing networks associated with each tank are also located in the cubicle corresponding to the tank circuit from which it is fed. Four phase monitors are used so that several phases can be seen simultaneously.

Two sampling loops are mounted on each of the center north-south row of towers, and one loop on each of the other six towers. These loops are constructed of one-inch steel tubing and mounted 20 feet above the base insulators. The center north-south row feeds one phase monitor, and each of the three east-west rows feeds a phase monitor. Solid dielectric coaxial cable is used for the sampling lines.

A feature of the transmitter which was found to be a real time saver is the variable inductive coupling to the final amplifier tank inductor. The adjustable coupling together with the variable tank capacitor provide a means of matching the power amplifier to the resistance of the load under operating conditions.

Excitation to the final stage can also be adjusted under operating conditions. During this adjustment period, the load impedance varies over very wide ranges, but due to the flexibility of the transmitter and its output circuits, power is maintained at the specified value during the adjustment of the array.

GEIGER COUNTER for Lectures

Circuit and construction details of reliable portable Geiger counter providing up to 50 watts audio output for demonstrations. Auxiliary indicators are Strobotron flasher and thyratron-driven rate meter

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DISSATISFACTION with the performance of commercially available Geiger counters with sufficient power output for lectures and demonstrations before large assemblages led to a series of experiments from which an instrument with high power output, low hum level, and good overall performance under a variety of conditions was developed.

Customarily, when a high power output is required from a Geiger counter, the output of the instrument is connected to the input of an adequate public address system. This produces plenty of noise, but also an unavoidably high background of hum in most instances. Custom-built instruments of this general type are commonly as large and costly as a piano.

For effective lecture demonstrations, a Geiger counter must have a power output sufficient to disrupt love's young dream in row 15 and awaken the halfback in row 37, while at the same time having a low enough hum level to satisfy the engineer in row 2, and mechanical construction pleasing to the instrument-maker in row 5. Unless the lecturer is a former baggage-smasher who also enjoys spending his spare time in repair work, the instrument must be readily movable, yet rugged enough to stand repeated transportation.

To keep first and maintenance costs low, components should as far as possible be standard items, available over the counter in any medium-sized city. This has been achieved in the circuit shown in Fig. 1, which provides 50 watts of audio output for lecture-hall loudspeakers.

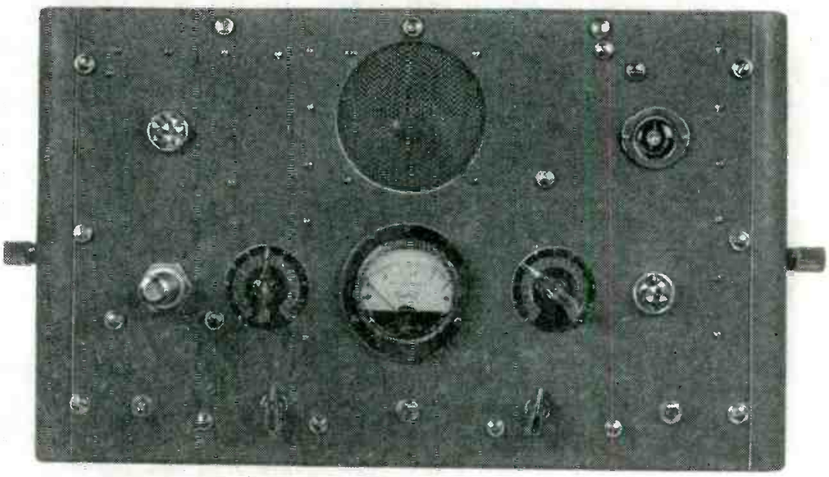
Design Details

Because the life of the Victoreen 1B85 thyrode counter tube is determined by the number of counts, and because the tube may be damaged by warmup surges of the power supply, disconnect switch S_2 is provided. This also controls a pilot light, which is on when the high voltage is connected to the counter tube. In the off position, a 1-megohm resistor is connected across the high-voltage supply to reduce the voltage slightly.

The first two stages of amplification are entirely standard except that the cathode and screen bypass capacitors need not be large. The circuit is designed to amplify surges rather than complex sinusoidal waves, and tone quality need not be considered. Sensitivity of the 6J7 input circuit increases as the input resistors increase in value, but hum pickup and instability increase faster than signal output after a certain point.

Power supply for the first two stages, as well as high voltage for the counter tube, is obtained from a small power transformer which supplies 940 volts at 1 ma and 250 volts at about 40 ma by use of a step-and-a-half voltage addition circuit.

It was necessary to shield the re-



Indicators and controls are arranged in three rows on front panel of counter. Top row, left to right: pilot lamp; monitor speaker; Strobotron flasher tube. Center row: counter tube projecting straight out from panel; volume control; rate meter; power supply control; pilot lamp. Bottom row contains three toggle switches and two tap switches sistors of the first stage and the Geiger tube socket with a heavy aluminum can to prevent electrostatic pickup and to surround the first tube with a magnetic shield to prevent electromagnetic pickup. An aluminum shield between the power supply and the audio elements of the first two stages reduced hum to a negligible value. Magnetic and electrostatic shielding, by use of a sheet-steel partition, was found necessary between the first two stages and the driver-power amplifier stages to prevent oscillation and magnetic pickup.

The 6F6 pentode-connected driver and the power amplifier using a pair of 6L6's connected in push-pull class AB_2 are standard in circuit arrangement.

To permit use of the instrument in small classrooms and in the laboratory where a 50-watt audio output is undesirable, switch S_4 is provided so the front end and the auxiliaries can be used separately. This permits use of the counter with no audio output (position 1), with 4-watt output on the local speaker (position 2), with both local and external speaker operated from the power amplifier (position 3), and with all output connected to the external speaker (position 4). The cooling fan for the power stage is also controlled by this switch, so that it is inoperative when not needed.

Coupling of the first two stages to the driver-power amplifier stages is unconventionally accomplished by use of a neon-tube base clipper. With this arrangement, any output surges in the plate circuit of the 6SJ7 that are smaller than the striking voltage of the neon tube are not passed on to the 6F6 driver. Those large enough to fire the neon tube also drive the 6F6 grid strongly positive. This arrangement effectively eliminates hum originating in the first two stages or picked up by them, as well as tube noise and microphonics. In order that the first two stages can be used independently; leaving the power stage available for other uses, switch S_6 is provided to connect the first stage to either the intermediate jack or the neon coupler. This permits external input to the power stages. Motorboating of the neon tube circuit is prevented by putting a sweaty fingerprint on the bulb base or connecting the capacitor side to ground through a 10-megohm resistor as in Fig. 1.

Auxiliary indicators, consisting of a Strobotron flasher and a rate meter, are operated from a parasitic circuit shunted across the driver plate transformer. The Strobotron flasher is entirely conventional, and is powered by a transformerless voltage doubler using selenium rectifiers. Switch S_3 is provided to disconnect this for count rates exceeding about 200 per second. The Strobotron tube is mounted on the panel by means of a tuning-indicator bracket, and the panel hole is rimmed with the accompanying bezel, reamed out to allow full visi-

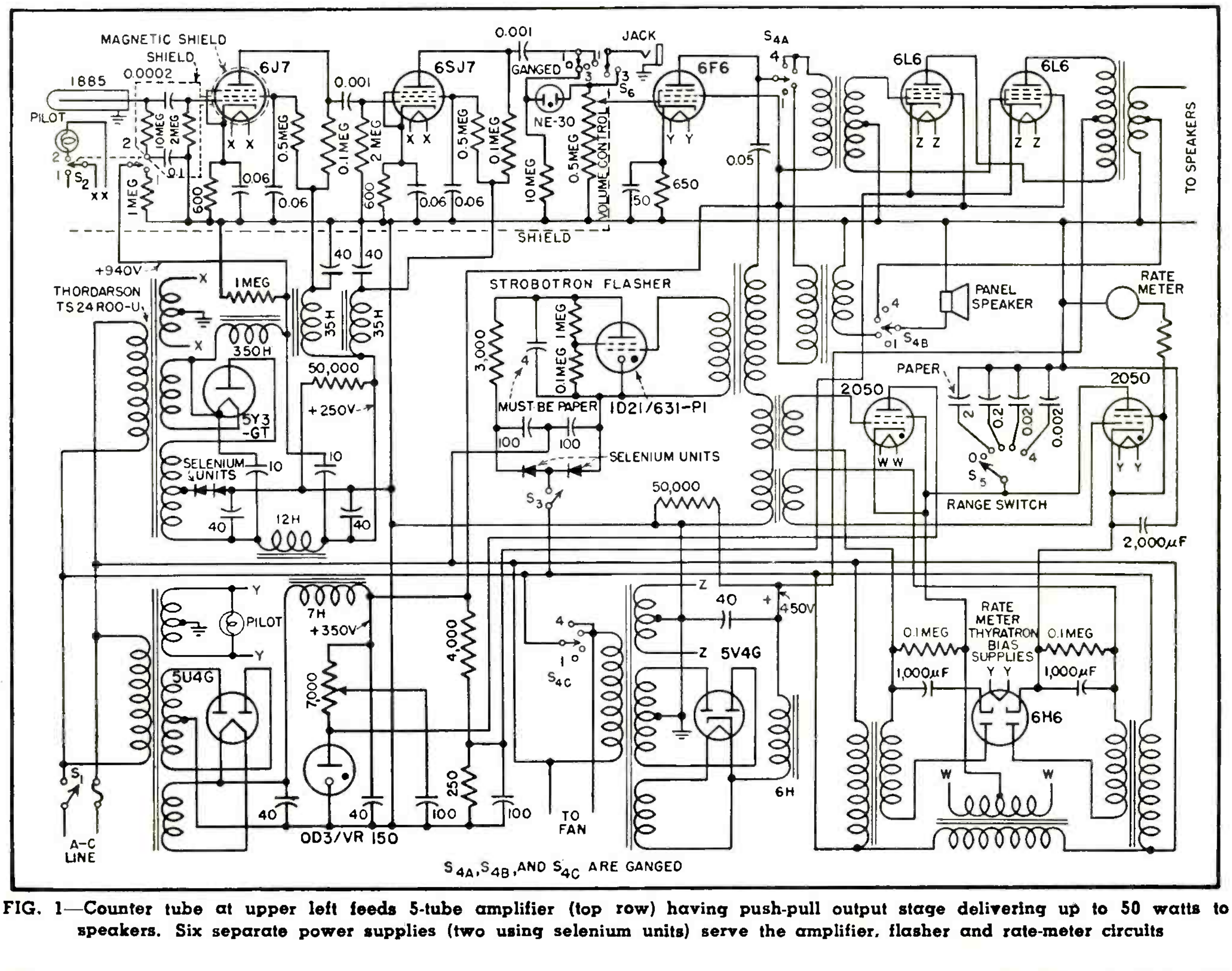


FIG. 1—Counter tube at upper left feeds 5-tube amplifier (top row) having push-pull output stage delivering up to 50 watts to speakers. Six separate power supplies (two using selenium units) serve the amplifier, flasher and rate-meter circuits

bility of the Strobotron flasher.

The rate meter is a thyratron adaptation of the Grinnell recorder, with constants chosen so that the values are in decade relation to each other, position 1 of S_5 being 10^1 counts per second, position 2 being 10^2 counts per second, etc. A separate filament supply is required for the first thyratron, because its cathode-ground potential exceeds the safe limit for the tube once per count. At high counting speeds, the capacitance of the filament transformer must be considered in evaluating the charging capacitor. Grid bias is provided for each tube by use of a small transformer, one half of a 6H6 diode, and a filter capacitor. About 30 volts of negative grid bias was found desirable in this application. If desired, the 0 position of the switch can be connected to a 20-μf capacitor to provide a one-count-per-second range, provided some improvements are made in the regulated power supply or the rate meter series resistor is changed for this range only.

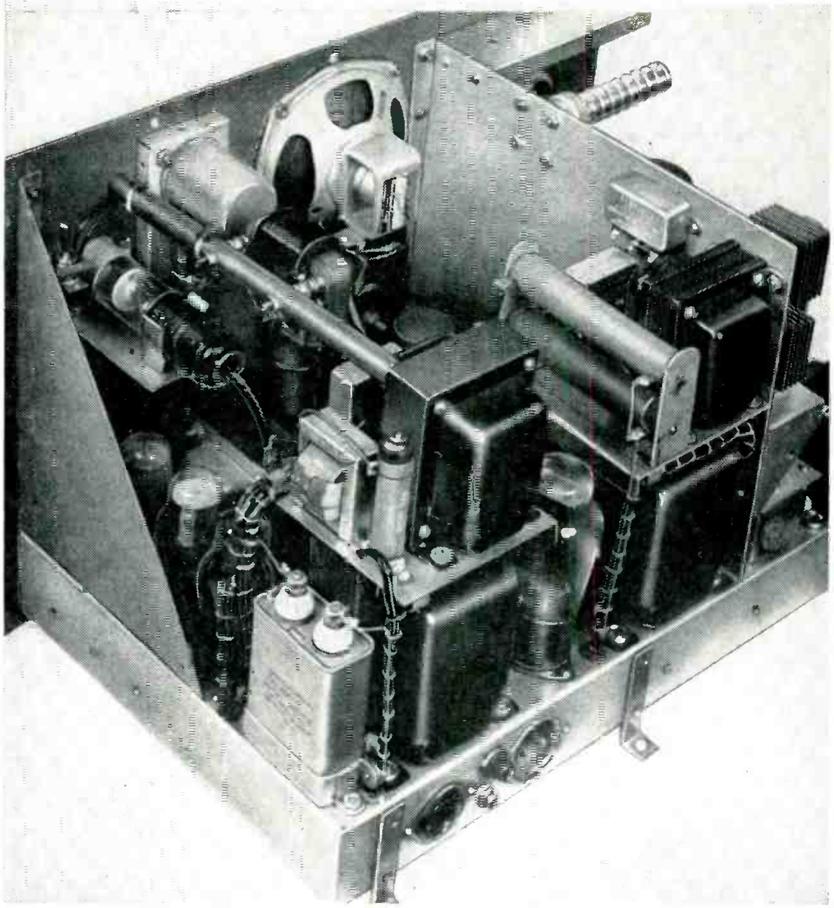
Calibration by formula was found entirely satisfactory[1,2,3]. With the constants shown and a 0-1 d-c milliammeter, the top mark of all ranges will be substantially correct if the total resistance across the 2,000-μf smoothing capacitor is about 8,700 ohms.

The transformers feeding the thyratron grids can be any small single-plate-to-single-grid a-f transformers, although counting-rate meter transformers will perform best if they are on the same core.

Mechanical Construction

Because this instrument must function satisfactorily in the office and laboratory, must be readily movable from place to place and must work dependably in new locations, preferably without any intervening repair work, special attention was paid to the mechanical construction. To prevent undue flexion in transit, panel and chassis were firmly bolted together, with shields forming angle braces.

To facilitate transportation, strong garage-door handles were firmly bolted to the ends of the case. The back of the chassis was anchored to the back bottom of the case by three angle brackets and bolts.



Driver and power amplifier stages, their power supplies, flasher components and rate meter components. Small fan near speaker operates only when power amplifier is turned on. At right of shielding partition are first two stages and strobotron power supply, with spare counter tube mounted on partition at top. No heat-producing component is boxed in

Vibration of components in transit was minimized by use of tie strips, cabling of leads, and careful anchoring of parts and cables at strategic points.

As constructed, this counter fits conveniently into a standard 12 x 12 x 20-inch cabinet, with a 12 x 18-inch panel and a 11 x 17-inch chassis base. Weight is about 65 pounds. By rearranging the components and shaving the factors of safety, reduction in both weight and bulk is possible, at an increase in first and upkeep cost and a loss of dependability. With a smaller volume, cooling also becomes a problem, and packing-factor troubles loom.

Performance

Tests of this counter under a variety of conditions, before audiences of various types from engineering groups to casehardened luncheon-club assemblages, disclose that its performance is very effective if accompanied by carefully-prepared lectures, devoid of fumbles.

Sonic output is about 50 watts at 1,000 counts per second, but does not appear to be very loud, perhaps because of the absence of the ordinary background noises. A 50-watt lamp, arranged so that it can be plugged into the output and illuminated brightly on demand, was found a desirable lecture adjunct.

Because of the rugged construction and the use of plug connectors, the counter can be brought into the lecture hall, connected, and put into operation in about two minutes, with confidence that it will perform satisfactorily.

REFERENCES

(1) S. W. Grinnell, Some Instruments Used by Division 10, NDRC, for the Continuous Recording of Micrometeorological Conditions, *OSRD 6088*, 1945, p 6, 24 and Fig. 3.

(2) R. L. Ives, Kick-Coil Operation of Impulse Registers or Counters, *Instruments*, 21, p 444, 1948.

(3) R. L. Ives, Capacitor Discharge Recorder Applications, ELECTRONICS, p 104, Feb. 1949.

Sync Separator Analysis

Response of a sync separation circuit to the nonsinusoidal composite television signal is analyzed. Equations are given for circuit design and calculated values are compared with measured values for monoscope and broadcast test pattern inputs

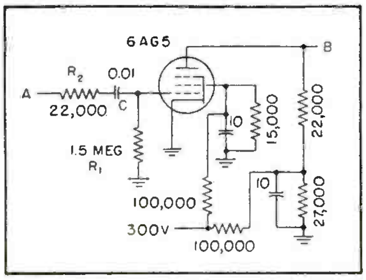


FIG. 1—Sync clipper circuit analyzed in text

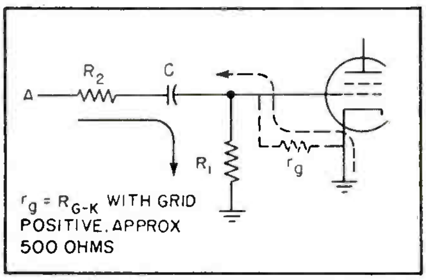


FIG. 2—Solid arrow shows discharge path for C and dashed arrow the charging path

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CIRCUITS used for sync separation are not complex in nature but their response to the composite television signal is quite different from that which a conventional sinusoidal analysis would show.

The requirements for an ideal sync separation system are threefold, namely:

(1) The sync pulses should be entirely free of any video signal or the blanking pedestal.

(2) The horizontal sync pulses should all have the same amplitude and shape; moreover, the vertical sync and equalizing pulses should be consistent in their waveforms also.

(3) A reasonable amount of noise immunity should be achieved in the separating system.

These requirements should be met for all conditions of modulation, percent sync and picture content that are within the FCC requirements.

The sync separation circuit to be analyzed is shown in Fig. 1. The input signal at point *A* is a composite video signal with positive sync pulses and the sync pulses alone are obtained at point *B*. With the proper choice of the constants in the grid circuit, the grid of the 6AG5 will restore in the sync pulse region.

The location of the restoring point in the sync pulse region is dependent upon the ratio R_2/R_1 as will be shown subsequently. The tops of the sync pulses are removed since grid current is drawn during this time, attenuating that portion of the sync above the restoring level by the ratio of r_g to R_2 (see Fig. 2), while the bottoms of the sync pulses and the video signal are removed since they are below the low cutoff point (-1 to -1.5 v) established by the low plate and screen voltages of the 6AG5.

With the grid of the 6AG5 restoring near the blanking level the noise immunity of this circuit is quite good. However, restoring in this region rather than near the sync tips tends to make the restoring level more critical since changes in the restoring level due to variations in the average video signal or the advent of the vertical sync pulses will cause a variation in the shape or width of the sync pulses at the output of the sync clipper since the sync pulse is trapezoidal rather than rectangular in shape.

The variation due to changes in the average video signal is usually slow enough to be negligible, while that due to the vertical sync pulses may be eliminated by using a large enough coupling capacitor as will be shown later. While increasing *C* above a certain minimum value does not affect the restoring level, it will decrease the immunity of the circuit to some types of noise.

Pulse Amplitude

The magnitude of the sync pulses desired at the output of the clipper as well as the size of the input composite signal play a large part in determining how far down from the sync tips we may restore without having video and pedestal present in our clipped sync output. For example, with a 25-v peak-to-peak composite signal at point *A* with 20-percent sync, or 5 v of sync, we will only have 30 percent, or 1.5 v of sync at the clipper grid if we are restoring 70 percent down.

To keep the sync clean, the cutoff point of the tube, determined largely by the screen voltage, must be closer to zero than —1.5 v, or we must restore closer to the sync tips with perhaps some decrease in noise immunity. With the cutoff point

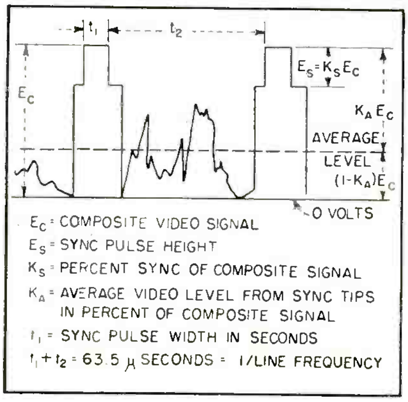


FIG. 3—Composite video signal fed to circuit of Fig. 2

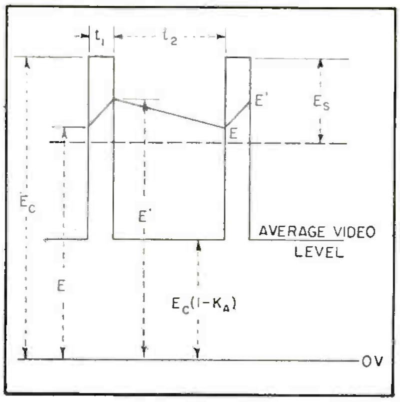


FIG. 4—Idealized input signal used for analysis of the circuit action

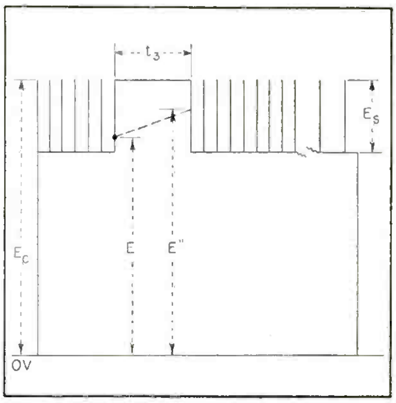


FIG. 5—Idealized waveform during vertical blanking time

closer to zero the magnitude of the sync pulses in the output will be less.

It is proposed to show a method for calculating the following:

(1) The restoring level at the grid of the clipper tube, assuming for the present that the vertical sync pulses have no effect on this level.

(2) The variations in this restoring level with different values of percent sync in the composite video input signal and with changes in average picture content.

(3) The value of the coupling capacitor above which any increase in capacitance has no effect on the restoring level when the vertical sync pulses are not considered.

(4) The change in restoring level due to the vertical sync pulses with various values of coupling capacitors larger than the value found in item 3 above.

(5) The minimum value of the coupling capacitor to eliminate this change in restoring level during vertical sync pulse time.

Restoring Level

For these calculations we need only consider that portion of the circuit shown in Fig. 2. For the first three computations the input signal at point A is as shown in Fig. 3. The concept of an average level (K_A) for the video signal is not strictly rigorous unless we have a constant video signal such as given by a test pattern. Since all measurements made in this article were taken using a test pattern and since the variations in the restoring level from line to line are small, the average level K_A is taken over a complete field for the purpose involved.

(1) In calculating the restoring level when neglecting the vertical sync pulses two assumptions are made. Capacitor C discharges between sync pulses through $R_1 + R_2$ toward the average level, E_c (1 — K_A). We may neglect R_2 as compared with R_1. Capacitor C is charging during the sync pulses toward the sync tips through $R_2 + r_g$. We may neglect r_g as compared with R_2.

For purposes of computation, the idealized signal is shown in Fig. 4. Then E and E' represent the charge on capacitor C at the end of the discharge and charge times respectively. Since the voltage across C at the end of the charge time equals the voltage at the beginning of the sync pulse plus the amount the capacitor is able to charge up, we may write Eq. 1. Similarily, we may write Eq. 2 by noting that the voltage across C at the end of the discharge time is equal to the voltage at the beginning of the discharge minus the amount the capacitor has discharged during the time interval.

$$E' = E + (E_c - E)\,(1 - e^{-t_1/R_2C}) \qquad (1)$$

$$E = E' - [E' - E_c\,(1 - K_A)]\,(1 - e^{-t_2/R_1C}) \qquad (2)$$

To simplify the notation let

$$\frac{t_2}{R_1C} = x \quad \text{and} \quad \frac{t_1}{R_2C} = y$$

$$\text{Then } E' = E_c - (E_c - E)\,e^{-y} = E_c\,(1 - e^{-y}) + E\,e^{-y} \qquad (3)$$

$$E = E_c\,(1 - K_A) + E'e^{-x} - E_c\,(1 - K_A)\,e^{-x} = E_c\,(1 - K_A)\,(1 - e^{-x}) + E'\,e^{-x} \qquad (4)$$

It is immaterial whether we solve at this time for E or E' since they are almost equal.

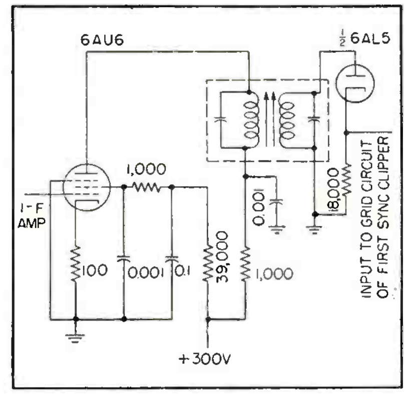
Solving for E by inserting Eq. 3 in Eq. 4,

$$E = E_c\left[1 - \frac{K_A\,(1 - e^{-x})}{1 - e^{-x}\,e^{-y}}\right] \qquad (5)$$

To simplify Eq. 5, consider the series

$$e^z = 1 + z + \frac{z^2}{2!} + \frac{z^3}{3!} + \ldots$$

As long as z is less than 0.1 we may use the approximation $e^z \approx 1 + z$ with an error less than 1 per-



Circuit of narrow-band sync amplifier and sync detector that caused rounding of pulses shown in Fig. 6

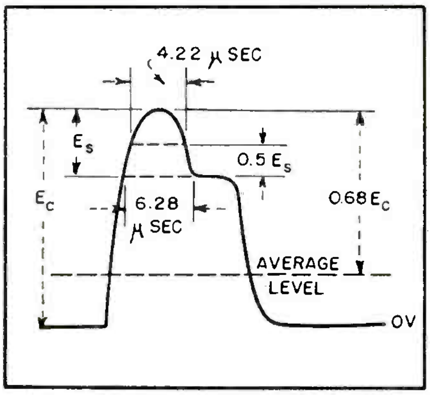


FIG. 6—Horizontal sync pulse at clipper grid with the tube removed from its socket shows rounding

cent. If x and y are less than 0.1,

$$1 - e^{-x} = 1 - \frac{1}{1+x} = \frac{x}{1+x}$$

and $$1 - e^{-x} e^{-y} = \frac{x + y + xy}{(1+x)(1+y)}$$

Let us define $$K_1 = \frac{1 - e^{-x}}{1 - e^{-x} e^{-y}} = \frac{x}{x + \frac{y}{1+y}}$$

If we restrict y to being 0.05 or less we may then approximate with less than a 5-percent error by calling

$$K_1 \approx \frac{x}{x+y}$$

Substituting the values of x and y and simplifying,

$$K_1 = \frac{1}{1 + \frac{R_1}{R_2}\frac{t_1}{t_2}} \qquad (6)$$

so Eq. 5 becomes

$$E = E_c (1 - K_A K_1) \qquad (7)$$

Let us define the restoring level as $L = (E_c - E)/E_s$. Examination of Fig. 4 shows that when this ratio is zero we are restoring at the top of the sync tips and when it is 1 we are restoring at the blanking level. Using Eq. 7 and $E_s = K_s E_c$

$$L = \frac{K_A K_1}{K_s} \qquad (8)$$

Change in Restoring Level

(2) Examination of Eq. 8 shows that the restoring level moves closer to the blanking level with a whiter picture (K_A increasing) and/or a decrease in the percent sync in the input signal (K_s decreasing).

(3) Examination of Eq. 6 shows that K_1 is independent of C as long as our assumption of y being 0.05 or less holds. This means that for any set of constants R_1 and R_2 the restoring level is independent of C as long as it is greater than the value given below. This, as stated previously, does not mean that the value of C will not affect the change in restoring level due to the vertical sync pulses.

For $$y < 0.05 = t_1/(R_2C)$$

$$C'_{min} = \frac{20t_1}{R_2} \qquad (9)$$

(4) During the time when the vertical sync pulses are present, capacitor C of Fig. 2 is charging toward the sync tips. This charging time may be assumed to be $3H$ or 190.5 μsec (see Fig. 5). The voltage E'' on the capacitor at the end of the vertical sync pulses is the voltage at the beginning plus the amount the capacitor charges or

$$E'' = E + (E_c - E)(1 - e^{-t_3/R_2C})$$

The restoring level at the end of the vertical sync pulses L_v expressed as percent of sync down from the sync tips is then

$$L_v = \frac{E_c - E''}{E_s} = \frac{(E_c - E)}{E_s} e^{-t_3/R_2C} \qquad (10)$$

But $(E_c - E)/E_s = L$, the restoring level considering only horizontal sync pulses. We have therefore

$$L_v = L e^{-t_3/R_2C} \qquad (11)$$

Equation 11 shows the change in the restoring level after the vertical sync pulses.

(5) In a manner similar to that in which Eq. 9 was developed we may compute a value of the coupling capacitor C necessary to reduce the change in restoring level after the vertical sync pulses to a 5-percent change.

From Eq. 11, $e^{-t_3/R_2C} = 0.95$

or $$\frac{t_3}{R_2C} \approx 0.05$$

or $$C''_{min} = \frac{20t_3}{R_2} \qquad (12)$$

Thus C''_{min} is the minimum value of C necessary to eliminate the shift in restoring level caused by the vertical sync pulses.

Measured Values

To illustrate all of the above points the components in an actual circuit were measured as 21,000 ohms for R_2, C of 0.01 μf and R_1 as 1.5 megohms. Measurements were made at the sync clipper grid with a suitable oscilloscope to measure sync pulse width and percent sync without excessive loading of the grid resistance R_1. Since the probe used with the scope had an input impedance of 5 megohms, this is taken into account by using a value of 1.155 megohms for R_1, the value of a parallel combination of 1.5 meg with 5 meg.

Using an r-f monoscope signal the percent sync was 17.5 percent ($K_s = 0.175$) and the average level measured down from the sync tips was 68 percent ($K_A = 0.68$) at the clipper grid with the tube removed. The relatively low percentage of

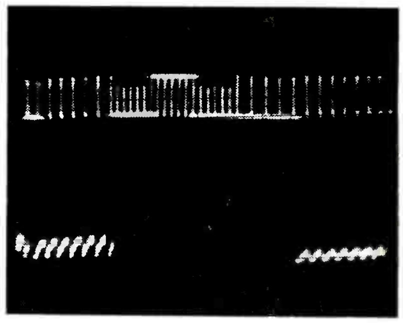
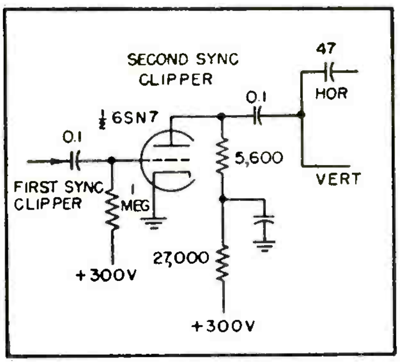


FIG. 9—Composite video signal at clipper grid with tube out



Circuit of second sync clipper whose output feeds the horizontal discriminator and vertical integrator

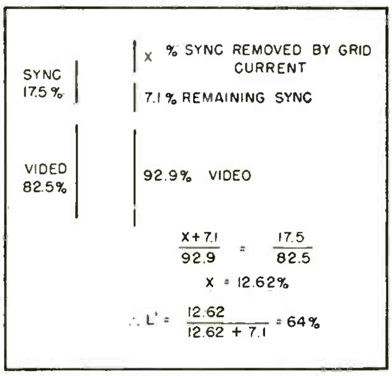


FIG. 7—Sample calculation of measured restoring level

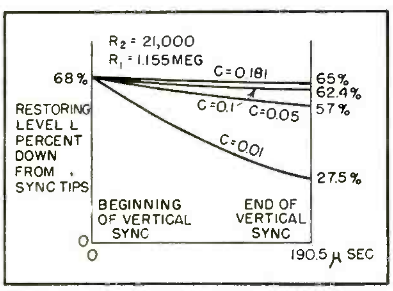


FIG. 8—Exponential change in restoring level during vertical sync pulses with various values of C

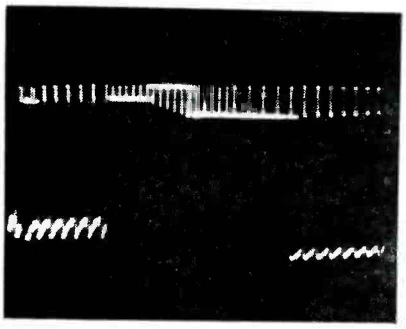


FIG. 10—Composite video signal at clipper grid showing restoring level

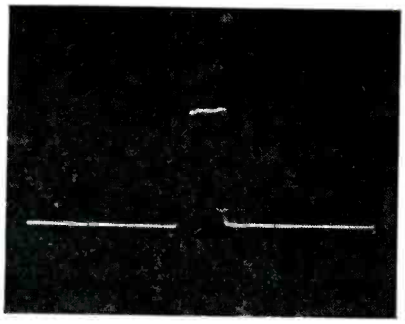


FIG. 11—Horizontal sync pulse before vertical sync pulse, 7.4 μsec wide

FIG. 12—Horizontal sync pulse after vertical sync, 5.2 μsec wide

sync and the rounding of the sync pulses as shown in Fig. 6 are due to a narrow-band sync amplifier used for greater noise immunity in the particular receiver on which these tests were made. This rounding of the sync pulses makes it more difficult to find the correct value for the charging time, t_1, so measurements of the sync pulse width were made at the top of pedestal and at 50 percent up toward the sync tips with results as shown in Fig. 6.

With the clipper tube back in the socket the percent sync was 7.1 percent before the vertical sync pulses and 14.0 percent after these pulses. From these readings we may find the measured restoring levels in percent down from the sync tips as shown in Fig. 7. The results are $L' = 64$ percent and $L_v' = 23.3$ percent.

To calculate the restoring levels we must know t_1 and t_2. When the sync pulses do not have a fast rise time a trial and error method for finding t_1 must be used. When the sync pulses are trapezoidal in shape with a fast rise time a close estimate of t_1 may be made; however this trial and error method should give more accurate results. Let us first assume $L = 65$ percent. Then interpolating linearly from Fig. 6 for t_1 between the bottom of the sync pulse and the 50-percent point we have $t_1 = 4.84$ μsec and $t_2 = 58.66$ μsec.

Putting the values into Eq. 6, $K_1 = 0.1805$. From Eq. 8, $L = K_1K_A/K_s = 70.2$ percent. Since this does not check with our assumed value of L we next assume $L = 68$ percent and find t_1 to be 4.96 μsec and $t_2 = 58.54$; K_1 is now 0.177 and L is 68.7 percent. The calculated value of L is between the two values and may be assumed to be 68.4 percent. This compared with the measured value of $L = 64$ percent. To find the calculated value of L_v from Eq. 11,

$$L_v = L\, e^{-t_3/R_2C} = 27.5 \text{ percent,}$$

as compared with the measured value of 23.3 percent.

Checking assumptions of the value of x and y,

$$x = t_2/(R_1C) = 0.0051 \text{ and } y = t_1/(R_2C) = 0.0236.$$

Since x is less than 0.1 and y is less than 0.05 the assumptions are verified.

Coupling Capacitor

Using Eq. 9, we may find for particular values of R_1 and R_2 the value of capacitance above which any increase in capacitance has no effect on the restoring level when the vertical sync pulses are neglected. This value is

$$C'_{min} = 20t_1/R_2 = 0.0047\ \mu\text{f}.$$

Table I—Calculated and Measured Values

With 6AG5 Clipper Out	WCBS	Monoscope
Percent sync—K_s	24%	17.5%
Average level from sync tips—K_A	66%	68%
Width of hor. sync pulse at bottom	6.74 μsec	6.28 μsec
Width of hor. sync pulse at 50% point	4.34 μsec	4.22 μsec
With Tube in Socket		
Percent sync at clipper grid before vertical sync pulse	12%	7.1%
Percent sync at clipper grid after vertical sync pulse	20.6%	14.0%
Measured Restoring Levels		
Before vertical—L'	56.8%	64 %
After vertical—L'_v	18.0%	23.3%
Calculated Restoring Levels		
Before vertical—L	53 %	68.4%
After vertical—L_v	21.4%	27.5%

The larger the value of C, the less will be the change in restoring level due to the vertical sync pulses. To compute this necessary value of C to reduce this restoring level change to 5 percent from Eq. 12,

$$C''_{min} = 20t_3/R_2 = 0.181\ \mu\text{f}.$$

Figure 8 shows the effect of various values of the coupling capacitor on the restoring level change during the vertical sync pulses. These curves were found using Eq. 11 with R_2 of 21,000 ohms.

As a further check, measurements were made on WCBS with a test pattern. The results of this and the above work are shown in Table I. The calculated and measured values of the restoring levels check well within the accuracy of the measurements.

Shown in Fig. 9 and 10 are photographs of the composite signal at the sync clipper grid with the tube out and with it in. This illustrates the restoring level variations with $C = 0.01$ μf. The photographs of Fig. 11 and 12 show the horizontal sync pulses before and after the vertical sync pulse respectively after another stage of amplification which has widened both pulses slightly.

The sync pulse before the vertical sync pulse is 27.7 percent wider than the one after this pulse; this may cause some trouble in the afc circuit for the horizontal sweep. Figure 8 shows that in order to eliminate this effect the coupling capacitor should be at least 0.1 μf when $R_1 = 1.155$ meg and $R_2 = 21{,}000$ even though the noise immunity may suffer somewhat.

The writer thanks Bernard Amos for his comments and encouragement in the writing of this article.

VHF Field Intensities (Continued from page 112)

located representing (F, D_1), and this point is projected horizontally to a point on scale A.

(2) H is determined and a line is constructed through H and the point on scale A. This line intersects B at some point.

(3) A point representing the frequency and the total distance (F, D) is determined on graph 2, and this point is projected horizontally to scale C.

(4) A line is constructed passing through the points on scales B and C and intersecting scale D.

(5) The estimated field intensity in db, referred to one microvolt per meter, is taken at the point where this line intersects scale D.

For estimating field intensity over smooth land, scale A is not used and H is taken as being zero.

The transmission estimates made by use of this nomograph are based on standard conditions. The data that are obtained are in general agreement with experience for smooth or mountainous terrain. The factors affecting vhf transmission are both natural (such as meteorological effects, type of soil and surrounding vegetation) and artificial (for example, antenna height, antenna gain, transmitter power and transmission-line loss). The latter items can be taken into consideration when making an estimate and a new equivalent field intensity (equivalent on the basis of a half-wave antenna) can be found.

A sample calculation can be made between locations X and Y by using the profile given in Fig. 1. Assume the following: at the transmitter end a 100-watt 150-mc transmitter using a three-element parasitic antenna having a gain of 6 db mounted on a 90-foot pole; on the receiving end another three-element 6-db-gain antenna mounted on a 30-foot pole; a combined transmission-line loss of 3 db at both ends. The answer is + 14.5 db.

By comparing the estimated data with the receiver input level requirements one can determine whether or not the circuit will be probably satisfactory. For the average receiver the performance can be taken from Table I.

In making the above comparison one must take into consideration the amount of man-made noise present in the receiver area. The above figures are based on average noise conditions but in extremely noisy areas it may be necessary to increase the figures by about 20 db.

In order to compare the above data with receiver sensitivity, it may be desirable to convert field intensity, which is given in terms of db above one microvolt per meter, to microvolts appearing at the receiver terminals. This can be done by means of Fig. 3. This figure assumes a half-wave antenna connected to the receiver terminals (72 ohms input) by means of a zero-loss transmission line. The voltage (for half-wave antennas) appearing on the receiver terminals is $0.32LE$ where L is the length of the antenna in meters and E the field intensity in microvolts per meter.

For the previous example, + 14.5 db equivalent field intensity at 150 mc corresponds to approximately 1.7 microvolts at the receiver terminals.

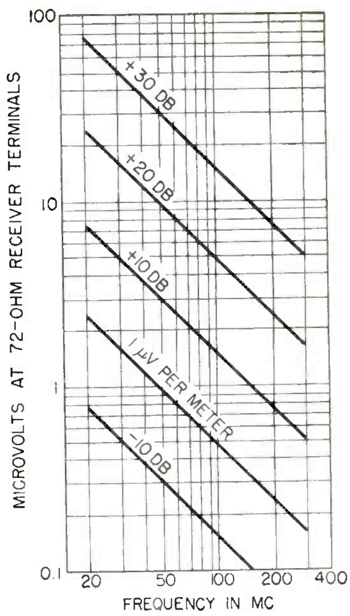


FIG. 3—Conversion graph for receiver input voltage

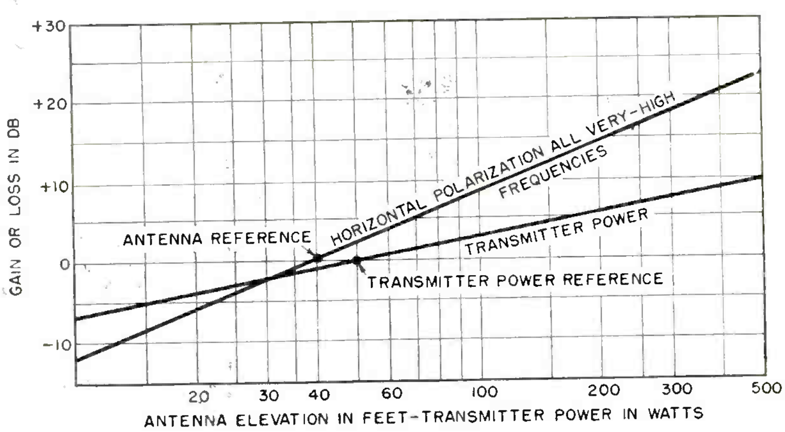


FIG. 2—Conversion graph for antenna elevation and transmitter power

Table I—Expected Circuit Performance With Average Receiver

Frequency Range in Mc	Equivalent estimated field intensity in db referred to 1 μv per meter		
	Probably Unsatisfactory	Questionable	Probably Satisfactory
20–40	< − 5db	− 5 to + 5db	> + 5db
40–70	< 0	0 to + 10	> + 10
70–100	< + 5	+ 5 to + 15	> + 15
100–120	< + 10	+ 10 to + 15	> + 15
120–160	< + 10	+ 10 to + 20	> + 20
160–220	< + 15	+ 15 to + 20	> + 20
220–260	< + 15	+ 15 to + 25	> + 25

TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Tubes Control Color Prints 116
Parallel-Pair Resistance Table of RMA Values 116
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Tubes Control Color Prints

MANY a company which wanted, say, 100 prints of its product in color for use by salesmen or point of sale displays, has winced when it got the estimate and decided to use black and white prints instead.

Electronic controls, plant air conditioning and improved transfer dyes have proved to be economical investments at Dye-Trans Color Photo Inc., of Oceanside, Calif., which has mechanized the dye transfer process of making color prints to about $24 a dozen for full-color 8 by 10-in. size and much less for larger runs.

Normally, filters are matched visually to the original color by an operator, but in a short time his eyes become tired and lose accuracy. Engineers at Dye-Trans combined an electronic scanner and a densitometer which keeps on judging colors accurately. The color separation and filter selection employs electronic gear which translates its readings into choice of the correct filter. Variations of one percent are the maximum compared with around 25 percent by conventional methods.

Dyes of the type used for fast fabrics prevent early fading of the color prints. Dye-Trans maintains uniform strength by means of electronic gages which can register imperceptible changes as little as one percent. Paper stretch and uniform drying of each matrix used in the color printing is controlled in the interest of exact registry by especially designed drying cabinets with closely regulated temperatures and slowly circulating air which reduces humidity gradually.

By these and other control methods, the new company is turning out prints at the rate of one every four minutes. The number of prints from each set of matrices is being limited to 100, although tests show much higher runs are possible. For subsequent prints,

(Continued on p 118)

Parallel-Pair Resistance of RMA Values

THE TABLE shown below gives the nominal resistance resulting from putting standard RMA resistors in parallel. Although some values are given to four-figure accuracy, only the first two figures are significant because the RMA resistors making up the pair may have at least five-percent tolerances.

Table of Resistance For Parallel Pairs of Standard RMA Values

	10	12	15	18	22	27	33	39	47	56	68	82
10	5	5.46	6	6.43	6.88	7.30	7.68	7.96	8.24	8.48	8.72	8.91
12	5.46	6.00	6.67	7.20	7.71	8.38	8.80	9.23	9.58	9.88	10.2	10.5
15	6.00	6.67	7.50	8.81	8.92	9.64	10.3	10.8	11.4	11.8	12.3	12.7
18	6.43	7.20	8.18	9.00	9.90	10.8	11.6	12.3	13.0	13.6	14.2	14.8
22	6.88	7.71	8.92	9.90	11.0	12.1	13.2	14.1	16.0	15.8	16.6	17.4
27	7.30	8.38	9.64	10.8	12.1	13.5	14.8	16.0	17.2	18.2	19.3	20.3
33	7.68	8.80	10.3	11.6	13.2	14.8	16.5	17.9	19.4	20.8	22.2	23.5
39	7.96	9.23	10.8	12.3	14.1	16.0	17.9	19.5	21.3	23	24.8	26.4
47	8.24	9.58	11.4	13.0	15.0	17.2	19.4	21.3	23.5	25.6	27.8	29.9
56	8.48	9.88	11.8	13.6	15.8	18.2	20.8	23.0	25.6	28.0	30.7	33.3
68	8.72	10.20	12.3	14.2	16.6	19.3	22.2	24.8	27.8	30.7	34.0	37.2
82	8.91	10.47	12.7	14.8	17.4	20.3	23.5	26.4	29.9	33.3	37.2	41
100	9.09	10.71	13.0	15.2	18.0	21.3	24.8	28.1	32.0	35.9	40.5	45.0
120	9.23	10.91	13.3	15.6	18.6	22.0	25.9	29.4	34.0	38.2	43.4	48.7
150	9.38	11.11	13.6	16.1	19.2	22.9	27.0	31.0	35.8	40.7	46.8	53.0
180	9.47	11.25	13.8	16.4	19.6	23.5	27.9	32.0	37.3	42.7	49.3	56.3
220	9.57	11.37	14.1	16.6	20.0	24.0	28.7	33.1	38.7	44.6	51.95	59.7
270	9.64	11.49	14.2	16.9	20.3	24.6	29.4	34.1	40.0	46.4	54.3	62.9
330	9.71	11.57	14.35	17.1	20.6	25.0	30.0	34.9	41.1	47.9	56.4	65.7
390	9.75	11.61	14.44	17.26	20.8	25.2	30.4	35.4	41.9	49.0	57.9	67.8
470	9.79	11.70	14.53	17.34	21.0	25.5	30.8	36.0	42.7	50.0	59.4	69.8
560	9.82	11.75	14.56	17.44	21.2	25.8	31.2	36.4	43.3	50.9	60.6	71.5
680	9.86	11.79	14.68	17.53	21.3	26.0	31.5	36.9	44.0	51.7	61.8	73.2
820	9.88	11.82	14.73	17.61	21.4	26.1	31.7	37.2	44.4	52.4	62.8	74.5
1000	9.90	11.85	14.78	17.68	21.5	26.3	32.0	37.5	44.9	53.0	63.6	75.8

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matrices are soaked again in the dyes and the process repeated. Conventional methods find 10 color prints from one set of matrices is good and 20 or more exceptional. The time required for each print also is much longer than by the new process and skilled artisans must do the work.

Full color presentations of products has meant fine-screen four-color engraving or lithographing, with high plate costs, or individually processed color prints costing as high as $40 to $65 a print. The new type print, priced at $2 apiece in small runs and less in larger runs, will be made available through franchised commercial photographers and advertising agencies.

Shuttle Detector

AN ELECTRONIC shuttle detector in conjunction with dynamic braking control has been successfully applied to large felt looms to ascertain when a faulty shuttle flight occurs and to stop the loom before there is resulting damage to the fabric. Formerly, mechanical stops were used.

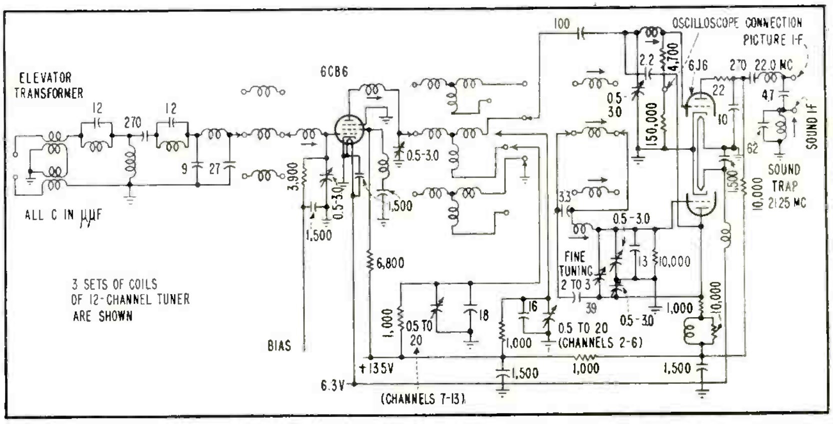
The equipment consists of two coils with cores connected by a bar magnet, a rotary switch, and a small control panel. The coils are imbedded in the lay; the switch is coupled to the loom topshaft. The electronic circuit is, in effect, a switch which closes as a result of the signal transmitted to it when the shuttle, in which a soft iron plate is embedded, passes over the coils. This electronic switch is connected in parallel with the rotary switch, and the two switches are together in series with the braking control of the G-E equipment.

During the sixty-degree interval in which the rotary switch is open, the electronic switch must be closed (signifying proper shuttle travel) for the loom to continue to operate. If the shuttle is late in its flight for any one of several reasons, opening of the rotary switch interrupts current flow to the braking relay and the direct current is applied to the driving motor. The device provides detection early in the loom lay cycle, and at a point where stored energy is low.

THE FRONT COVER

PHOTO-ETCH PROCESS used in manufacturing the RCA printed-circuit tuner begins with the photographing of the required coil arrangement. A contact print is made from the negative on a copper-clad sheet of phenolic plastic coated with a light-sensitive material. The print of plastic sheet is developed and placed in an etching solution where that part of the copper not covered by the circuit pattern is etched away. The desired copper circuit is left on the plastic sheet. The sheet is then placed in a die, cut into separate sections and pierced for contacts.

Circuit of Photo-Etch Tuner



Complete circuit of the RCA tuner shows the low-pass pi network and *m*-derived bandpass filter

THE PRINTED-CIRCUIT front end developed by RCA engineers is a turret-type tuner covering television channels 2 through 13, intended for use with stagger-tuned i-f systems such as used in the RCA 8TS30 receiver.

The input circuit consists of a pair of elevator transformers, with terminations for matching the tuner to a balanced 300-ohm line, followed by a high-pass filter section with cutoff at approximately 47 mc, and maximum attenuation at 23.5 mc for i-f rejection. This is followed by the tuned input section, composed of a low-pass pi network with cutoff tuned for each channel, providing gain and selectivity at the grid of the r-f amplifier, and reducing oscillator radiation at the antenna.

Controlled negative resistance has been introduced at the r-f grid to lower the input conductance on the high channels, and to neutralize partially the effects of cathode inductance. The constants and configuration of the pi network are arranged to provide a varying impedance transfer to the grid, and have been selected to provide optimum noise factor for all channels, rather than perfect impedance match. This compromise favors operation with indoor and built-in antennas.

The output of the r-f amplifier contains a double-tuned *m*-derived bandpass filter with the frequency of maximum attenuation tracked at approximately the image frequency of each channel. Use of the *m*-derived circuit provides high image attenuation and at the same time reduces oscillator feed-through to the r-f amplifier plate.

The circuit configuration and constants and the introduction of negative resistance at the mixer grid are such as to provide essentially constant gain and selectivity on all channels. Adjustable elements have been provided in each circuit to permit alignment for proper characteristics.

The oscillator employs a Colpitts

(Continued on p 144)

THE INSIDE STORY:

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The *exclusive* difference in Sprague molded phenolic tubulars is that: *each is made by the same dry-assembly process as large metal-encased oil capacitors.* They cannot be contaminated during manufacture!

Every Sprague molded tubular from 200 to 12,500 volts is molded *dry.* After molding it is impregnated under high vacuum through an opening in the eyelet terminal. A lead is then inserted and the terminal solder sealed. Result? A capacitor that offers you superior heat and moisture protection . . . top insulation resistance . . . high capacitance stability and retrace under wide temperature variations.

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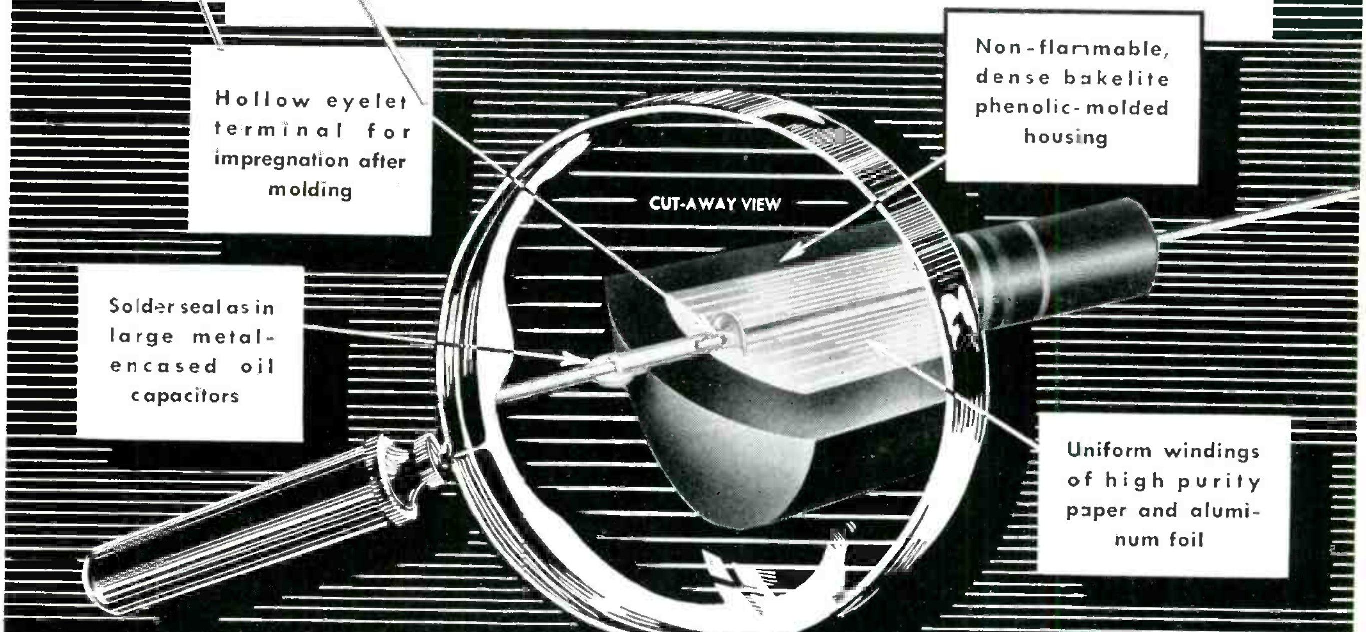

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SPRAGUE ELECTRIC COMPANY
North Adams, Massachusetts

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Recording Microwave Refractometer 120
Phototransistor 122
Wideband Series-Parallel Transformer Design 122
Radiation Alarm with 0.5-Second Response 162
Television Picture Evaluation 163
Multiplier Phototube Improvements 166
Transistor and Fieldistor 167
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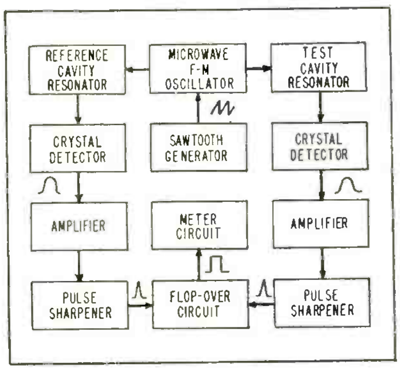
Recording Microwave Refractometer

SMALL DIFFERENCES in frequency between two resonant cavities can be accurately measured and recorded by a refractometer recently developed at the National Bureau of Standards. The instrument can be adjusted over a wide band of microwave frequencies for measurements of dielectric constants of lossless gases and changes in the dielectric constant of such gases and very low-loss liquids and solids. Its extremely high sensitivity permits operation with small test samples.

The microwave refractometer should be readily adaptable to manufacture as a field instrument since the components and circuits are straightforward and compact. It has direct application in several fields of research and production, providing a convenient method for continuous monitoring of impurities in gases or liquids and for rapid testing of small solid samples. It can also be used as an ultramicrometer and to measure the thermal expansion of cavity materials.

The key operating principle of the refractometer is the comparison of two cavity resonators. A test sample (gas, liquid, or solid) is introduced into one of two otherwise identical cavities. The resultant difference in resonance frequency between the two cavities is then a measure of the dielectric constant of the test sample. Tests have shown that the sensitivity of the present instrument under laboratory conditions is 200 cycles per second at an operating frequency of 9,000 megacycles.

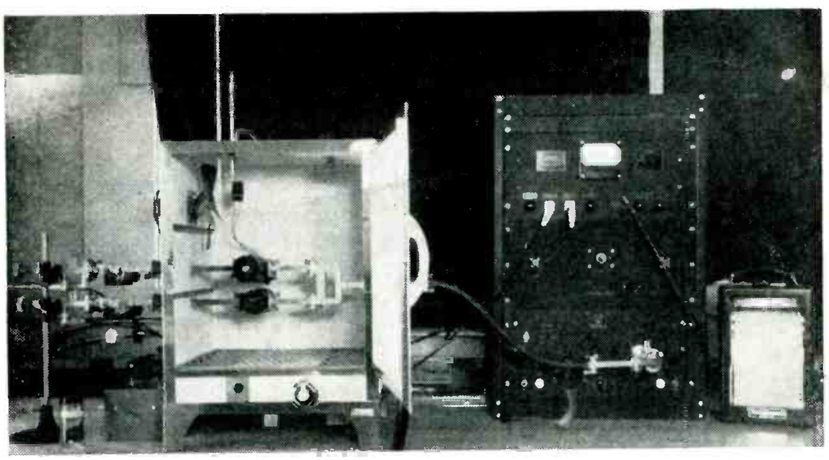
A klystron oscillator is used as a microwave signal source and is frequency-modulated with a sawtooth wave. The r-f output from the klystron is fed to a T-junction which sends equal parts of the signal to the two cavity resonators, one functioning as a test cavity, the other as a frequency reference. The cavity outputs are then fed through identical crystal detectors, amplifiers, and pulse sharpeners as shown in the block diagram. The pulse pairs, repeated at a rate determined by the sawtooth frequency, then go to a trigger circuit. The first pulse turns it on and the second turns it off. The output of the trigger circuit is a rectangular wave with constant amplitude but variable width. The average value of this wave as measured in a meter circuit is then directly proportional to the frequency difference between the two cavities, provided that the on time of the trigger circuit is also directly proportional to the frequency difference. The circuits have been designed to give this linear relation between time and frequency.



Block diagram of recording microwave refractometer

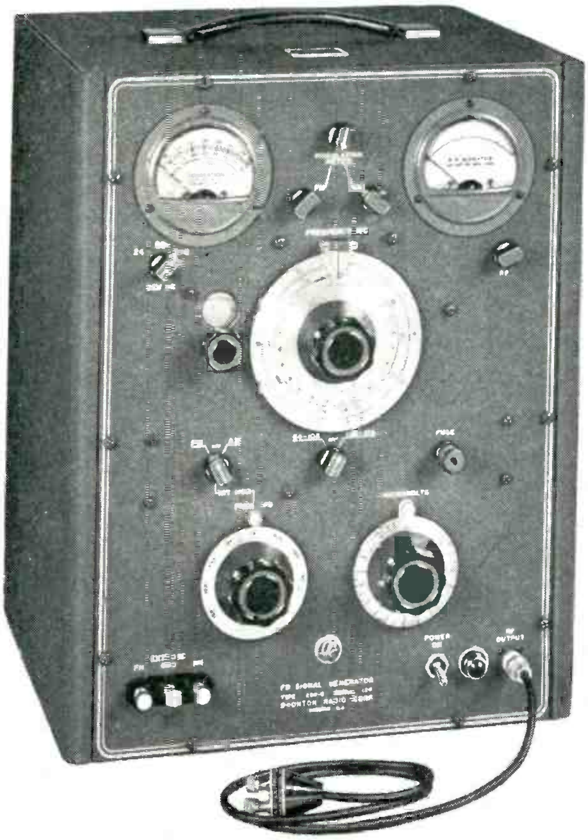
In calibrating the microwave refractometer, it is desirable to use rare gases such as argon or helium whose dielectric constants have been measured very precisely at optical frequencies. For convenience the reference cavity is equipped with a tuning plunger calibrated in terms of the gas pressure in the test cavity.

The maximum sensitivity achievable by the refractometer is determined by its short-time stability, which depends essentially on background noise. Long-time stability depends chiefly on variations in temperature difference between the two cavities and the drift in center frequency of the klystron with temperature. When long-time stability is needed, both of these effects



Refractive index of an artifically-controlled atmosphere is being measured by the refractometer. The difference in frequency of the two cavities is measured and recorded

Laboratory Instruments for TELEVISION



Type 202-B
FM SIGNAL GENERATOR

Frequency Range
54-216 mc.

Additional coverage from 0.4 to 25 mc. with accessory UNIVERTER Type 203-B

UNIVERTER
Type 203-B

AVAILABLE AS AN ACCESSORY is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

- **R. F. RANGE:** 0.4 mc. to 25 mc. (0.1 mc. to 25 mc. with no carrier deviation).
- **R. F. INCREMENT DIAL:** ± 250 kc. in 10 kc. increments.
- **R. F. OUTPUT:** 0.1 microvolt to 0.1 volt, ± 1 db. Also approximately 2 volts maximum (uncalibrated).
- **OUTPUT IMPEDANCE:** Approximately 60 ohms at 0.1 volt jack, 470 ohms at 2 volt pin jack.

FM SIGNAL GENERATOR
Type 202-B

The Type 202-B FM Signal Generator is specifically designed to meet the exacting requirements of television and FM engineers working in the frequency range of 54 megacycles to 216 megacycles. Following are some of the outstanding features of this versatile instrument:

- **RF RANGES:** 54-108, 108-216 mc. ± 0.5% accuracy. Also covers 0.4 mc. to 25 mc. with accessory 203-B Univerter.
- **VERNIER DIAL:** 24:1 gear ratio with main frequency dial.
- **FREQUENCY DEVIATION RANGES:** 0-24 kc., 0-80 kc., 0-240 kc.
- **AMPLITUDE MODULATION:** Continuously variable 0-50%, calibrated at 30% and 50% points.
- **MODULATING OSCILLATOR:** Eight internal modulating frequencies from 50 cycles to 15 kc. available for FM, AM.
- **RF OUTPUT VOLTAGE:** 0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.
- **FM DISTORTION:** Less than 2% at 75 kc. deviation.
- **SPURIOUS RF OUTPUT:** All spurious RF voltages 30 db or more below fundamental.

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM Signal Generator and Type 203-B Univerter.

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can be controlled by proper temperature regulation.

With solids and liquids very high sensitivity to small changes in dielectric constant could be obtained by filling the entire test cavity with the material. Except in the case of practically lossless substances, this would seriously decrease the Q of the cavity. If only a small fraction of the cavity volume is occupied by a low-loss substance (a small diameter cylinder is convenient for this work) the Q would not be appreciably affected and sufficient sensitivity would be maintained. The position of the sample with respect to the electric field in the cavity will determine the sensitivity of the refractometer to changes in dielectric constant. Small liquid samples can be measured by placing the liquid in a quartz tube.

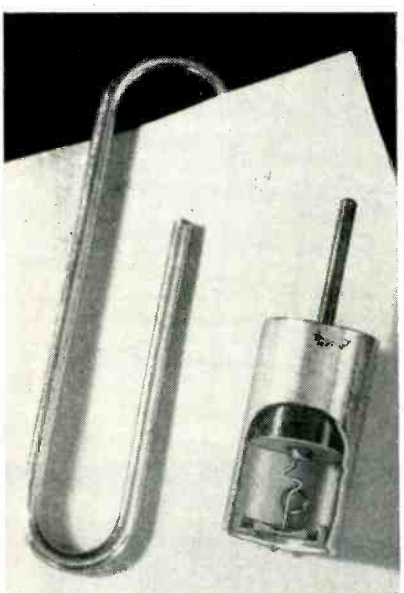
The restriction to low-loss materials is necessary because the present equipment is sensitive to changes in the Q of the test cavity. However, a direct extension of present techniques would avoid this limitation completely and permit simultaneous recording of changes in dielectric constant and loss.

In measuring the dielectric constants of gases it is often convenient to use a flow technique in which a continuous stream of gas is drawn through the test cavity. This method has actually been used in a preliminary experiment to record variations in the dielectric constant of an artificially controlled atmosphere.

Similar measurements of the atmosphere are needed in radio propagation and meteorology. The recording microwave refractometer is now being studied for possible application to measurement of atmospheric refractive index. Such measurements might help to explain how high radio field intensities are produced at great distances by atmospheric scattering and duct processes. Many of the radio observations thus far made at frequencies above 30 megacycles cannot be explained by the ordinary refraction and diffraction calculations. Above 30 megacycles the change in refractive index with altitude and the fluctuations in refractive index in any small region of the atmosphere have a direct effect on radio propagation.

Phototransistor

THOUGH still in the experimental stage, the Bell Telephone Laboratories' new photoelectric transistor is expected to become an important component in the field of electronics.



Phototransistor has a single contact which rests on one side of a thin germanium disc. Light on other side of disc controls current flow

The extreme compactness of the device is illustrated in the accompanying photograph. Operation of the phototransistor is similar to that of its parent device, the transistor, except that current flow is controlled by light rather than by the current of the emitter. Only one contact, the usual collector, is required, as shown schematically in Fig. 1.

This contact rests in a depression in a disc of germanium at a place where the germanium thickness is only 0.003-inch thick. Varying amounts of light falling on the opposite side of the germanium will cause corresponding variations in the collector current.

In operation, the collector is biased negatively with respect to the peripheral contact through a resistance R. Load power responses of the order of several tenths milliwatt per millilumen can be realized, and light modulation up to 200 kc has been followed with good fidelity.

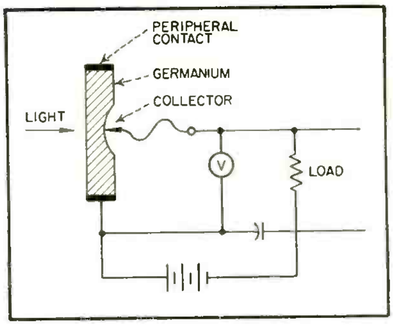


FIG. 1—Schematic representation of phototransistor

Other advantages include low impedance and high sensitivity to the wavelengths emitted by incandescent light bulbs.

Wideband Series-Parallel Transformer Design

By VINCENT C. RIDEOUT
University of Wisconsin
Madison, Wisconsin

SERIES-PARALLEL tuned transformers may be used to match a low-impedance transmission line to a higher impendance line (Fig. 1A), or to give a flat-band connection between a low-impedance line and the capacitive input or output of an amplifier (Fig. 1B). Maximally-flat-response formulas are based upon a filter theory approach which uses the fact that the series-parallel transformer may be put into the

(Continued on p 160)

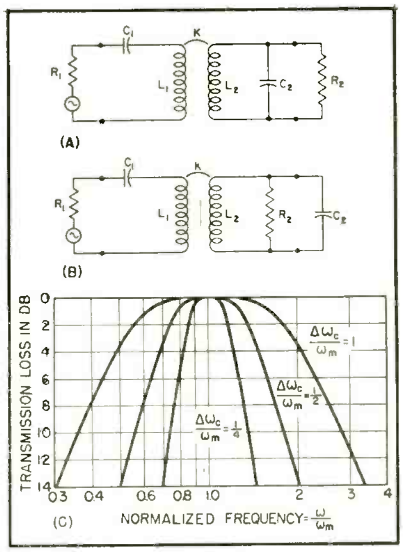
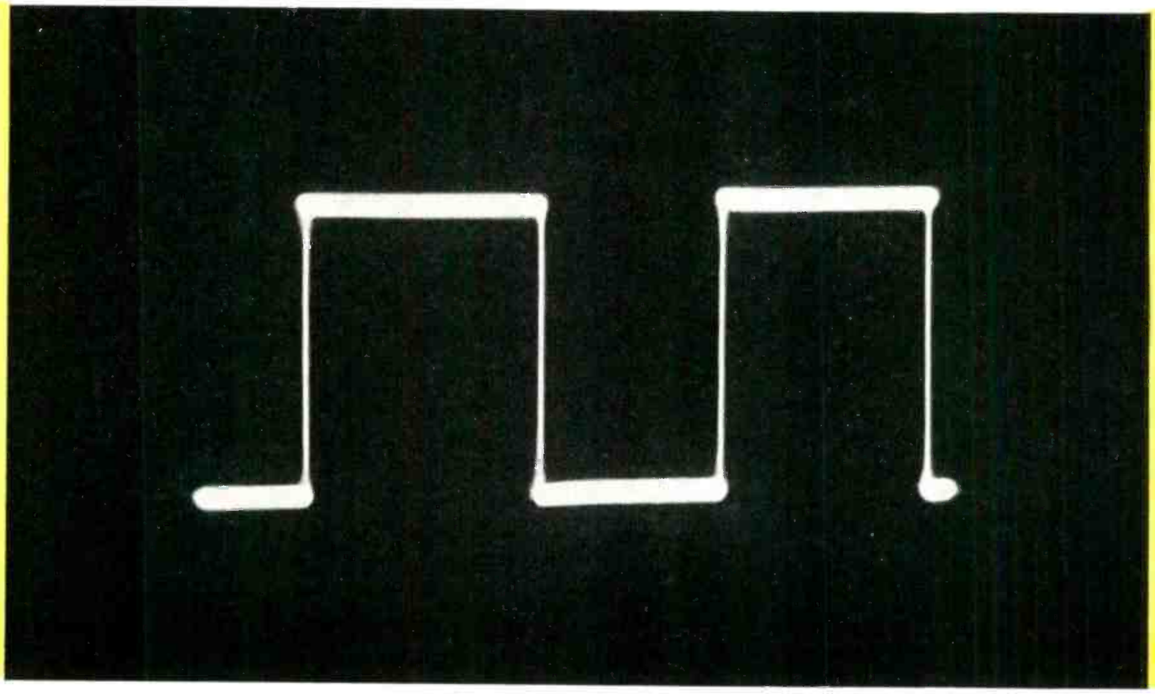


FIG. 1—Series-parallel transformers and normalized response curves for various bandwidth-to-midfrequency ratios

Kodak
TRADE-MARK

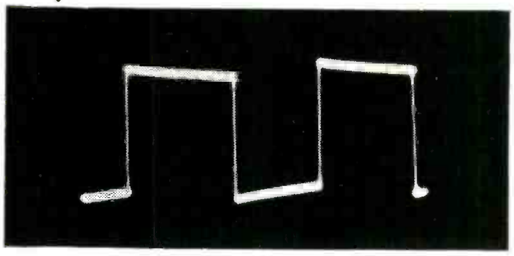
PHOTOGRAPHY

helps adjust an amplifier

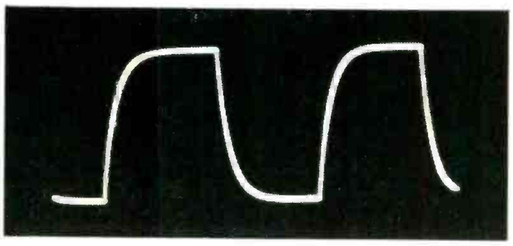


A perfect square wave, photographed by engineers of Allen B. Du-Mont Laboratories, Inc., at the output of a high-frequency amplifier. This is the result of repeated adjustment and readjustment of a compensated attenuator and peaking coils.

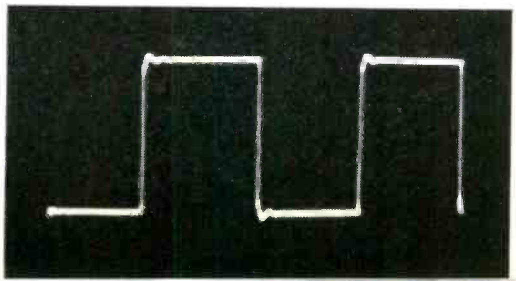
Improper adjustment results in poor low-frequency response. Note tilt in top and bottom flats. Percentage of tilt is a measure of low-frequency response and low-frequency phase shift.



Effect of "under peaking" of high-frequency compensating inductances. Note that rise time of square wave has been distorted so that the leading edge is rounded instead of sharp.



"Over peaking" with extremely fast rise. This produces "ringing" in the leading edge of the square wave.



Far subtler differences than shown here can have large effects on performance.

How can you remember the all-important details of wave form? How can you show improvements achieved in the course of design changes and adjustments? How can you prove that a circuit long since gone from your bench behaved in a certain way?

With photography, of course. It's simple, it's indisputable, and it's permanent!

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INSTRUMENT RECORDING
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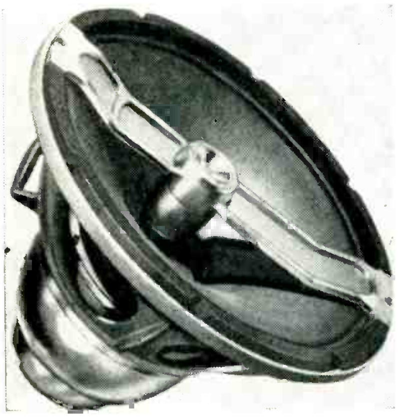
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Broadcast Engineers Are Offered a Wide Selection of Audio Equipment . . . Long Life and Small Size Continue as Major Factors in Tube Design . . . Current Catalogs and Other Manufacturers' Publications Are Summarized



Wide-Range Loudspeaker

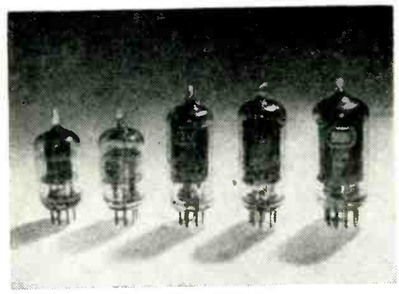
JENSEN MFG. CO., DIVISION OF THE MUTER CO., 6601 S. Laramie Ave., Chicago 38, Ill. Model G-610 Triaxial loudspeaker spans the full frequency range of the ear. It actually consists of three distinct and separate loudspeaker units combined into one assembly no larger than a conventional 15-in. speaker and can be mounted in any cabinet or baffle suitable for a 15-in. unit. An electrical crossover network built into a separate chassis unit divides the input into separate bands of frequencies which are fed to the individual speaker units. Frequency response extends to at least 18,000 cycles with exceptional uniformity. Complete technical information is given in data sheet 160.

Micro-Manometer

CLARKE INSTRUMENT CORP., 910 King St., Silver Spring, Md. Model 179 micro-manometer is particularly adapted to the accurate measurement of pressures in the 5 to 50-micron range. It consists of the sensing unit and a separate sensitive and stable electronic indicator which can be mounted at some distance from the sensing unit. Indication of the pressure is independent of condensable vapor in the system and is read directly from the scale of a 4-in. meter calibrated in 1-micron steps and having a full-scale value of 50 microns.

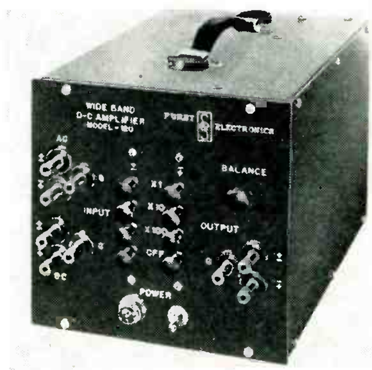
Audio Oscillator

RADEX CORP., 2076 Elston Ave., Chicago 14, Ill. Model 500 audio oscillator was designed to meet the need for a lightweight, compact unit which retains the qualities of an R-C tuned oscillator with a wide range of output frequencies. It is desirable for use in conjunction with distortion meters or where an accurate check is to be made of any electronic circuit. Output is 10 volts into 2,000 ohms; internal impedance, 100 ohms at full output; frequency range, 14.5 to 145,000 cycles in 4 ranges; distortion, 0.25 percent with high impedance loads, 1.0 percent with 2,000-ohm load; power required, 30 watts, 110 volts a-c, 50 or 60 cycles.



Miniature Tubes

GENERAL ELECTRIC CO., Schenectady, N. Y., offers five new types of miniature tubes designed especially for long life and dependable service under conditions encountered in mobile and aircraft service. Type 5749 remote cutoff pentode has a transconductance of 4,400 μmhos and a plate current of 11 ma. The 5750 pentagrid converter for superhet receivers features a conversion transconductance of 475 μmhos. Features of the other three are as follows: the 5725 semi-remote pentode has a control grid and suppressor grid useful as independent control elements; the 5726 twin diode features high perveance; the 5686 pentode power amplifier has multiple leads on the cathode and screen grid which facilitate r-f by-passing at high frequencies.



Wide-Band D-C Amplifier

FURST ELECTRONICS, 12 S. Jefferson St., Chicago 6, Ill. Model 120 wide-band d-c amplifier has been designed to serve as a preamplifier in connection with a-c and d-c oscilloscopes, v-t voltmeters and similar instruments to extend their ranges to smaller signals. It has a frequency response d-c to 100,000 cycles within ± 1 db, 6 db down at 200,000 cycles. Noise and hum are less than 40 μv at maximum gain

HERE'S HOT NEWS FOR YOU!

RAYTHEON

FILAMENTARY SUBMINIATURES

OFTEN OUTPERFORM HEATER-CATHODE TUBES

A rugged triode which has passed tests up to 900 g. high impact shock and is particularly suited as an osc. up to 500 mc.

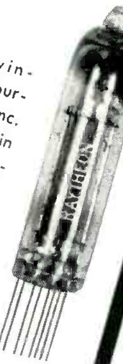
1. They're *Rugged.* Many Raytheon filamentary subminiature types are just as shock resistant as the best ruggedized heater-cathode types. Many filamentary types also stand amazingly high accelerations.

2. They're *Long-Lived.* Some Raytheon filamentary subminiatures have less than 1.5% rejects at 5000 hours. Others are designed for unusually high performance and shorter life. A wide range of tube designs are available.

3. They have *Low Microphonic Output.* Some Raytheon filamentary subminiatures actually have less microphonic output than the best heater-cathode types, particularly at frequencies below that of filament resonance for which 6000 cycles per second is typical.

4. They use *Low Operating Power.* For example, a voltage gain of 60 db may be obtained with only 0.019 watts of A power and less than 0.0001 watts of B power. Similarly many other electronic functions may be performed with a minimum of power, thus facilitating subminiaturization of equipment by reduction of heat.

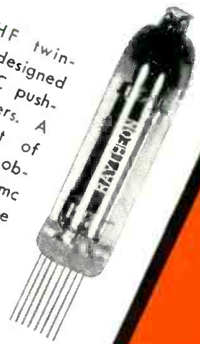
5. *New types are constantly coming along.* Raytheon is constantly introducing improved types with new standards of performance. For example consider these filamentary long life types developed for the U. S. Navy.



Medium-mu Twin-Triode for general purpose uses up to 500 mc. The total filament drain is only 120 ma per section yet the transconductance is 2300 umhos for each section. A similar tube, but of higher mu, is capable of unusual performance as a 400 mc mixer.

Ask us to mail you a copy of the NEW Raytheon Special Tube Characteristics Chart

Remote cutoff 100 mc. pentode. The filament current is 60 ma. A remote cutoff twin pentode also has been developed for push-pull Class A amplifiers.



This VHF twin-tetrode is designed for Class C push-pull amplifiers. A power output of 600 mw can be obtained at 300 mc from a 135v plate battery.

RAYTHEON

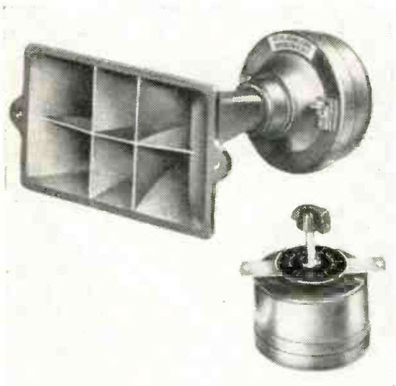
Excellence in Electronics

RAYTHEON MANUFACTURING CO.

SPECIAL TUBE SECTION
Newton 58, Massachusetts

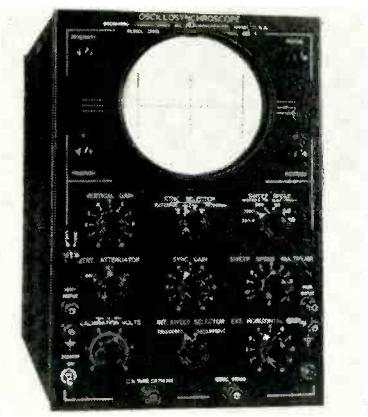
SUBMINIATURE TUBES
GERMANIUM DIODES and TRIODES
RADIATION COUNTER TUBES
RUGGED, LONG LIFE TUBES

referred to input terminals. Gain is set at 100. Input impedance is 1 megohm for single-ended; 2 megohms for push-pull signals.



Tweeter and Filter

ATLAS SOUND CORP., 1449 39th St., Brooklyn 18, N. Y. Model HR-2 multicellular tweeter reproducer and high-pass filter is designed for use in connection with any suitable type of cone speaker woofer. The horn, being of six-cell construction, offers a wide-angle distribution pattern and the response is clean and efficient to 15,000 cycles. The unit will handle 25 watts of program material above 1,000 cycles.

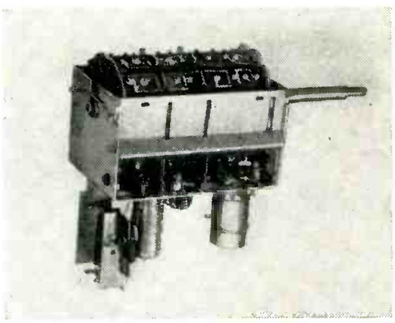


Oscillosynchroscope

BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass. Model ON-5 oscillosynchroscope is designed to provide wide-band amplifier and versatile sweep facilities in a single portable unit. It is well adapted to the study of pulse and transient phenomena and is useful in all conventional oscillographic applications. Vertical amplifier response is flat within 3 db from 5 cycles to 5 mc. The horizontal amplifier is direct-coupled with h-f response extending to 500 kc. Triggered sweep speeds from 1.0 μsec per in. to 25,000 μsec per in. and recurrent sweeps of 10 to 100 kc are available.

Rectangular Picture Tube

GENERAL ELECTRIC CO., Syracuse, N. Y. The 14CP4 rectangular tv picture tube is a 14-in. tube with a useful picture area of 99 sq in. and a neutral density faceplate for increased picture contrast and detail. Its electron gun is designed to be used with an external ion-trap magnet for prevention of ion-spot blemish. Maximum ratings are: anode voltage, 14,000 v; grid no. 2, 410 v; grid no. 1, 125 v negative and 0 volts positive bias.

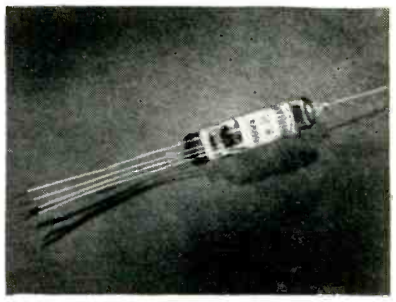


Twelve-Channel TV Tuner

RADIO CORP. OF AMERICA, Harrison, N. J., has announced the type 206 E3 twelve-channel tv tuner employing printed-circuit coils and rotary-turret switching. The unit is for use with a stagger-tuned picture i-f system having a carrier of 25.75 mc and a sound i-f system having a carrier of 21.25 mc. This tuner provides a voltage gain of between 28.7 and 34.9 db for all channels under typical operating conditions. It is particularly useful in providing improved performance from receivers in fringe areas as well as from those operated with built-in antennas.

Tape Recorder

SONAR RADIO CORP., 59 Myrtle Ave., Brooklyn 1, N. Y., has introduced the T-10 high-fidelity, high-quality tape recorder for home and semi-professional use. The power amplifier has inputs for 2 low-gain and 3 high-gain microphones or radio. Frequency response is 20 to 20,000 cps, within 1 db, with a wow and flutter of less than 0.3 percent.



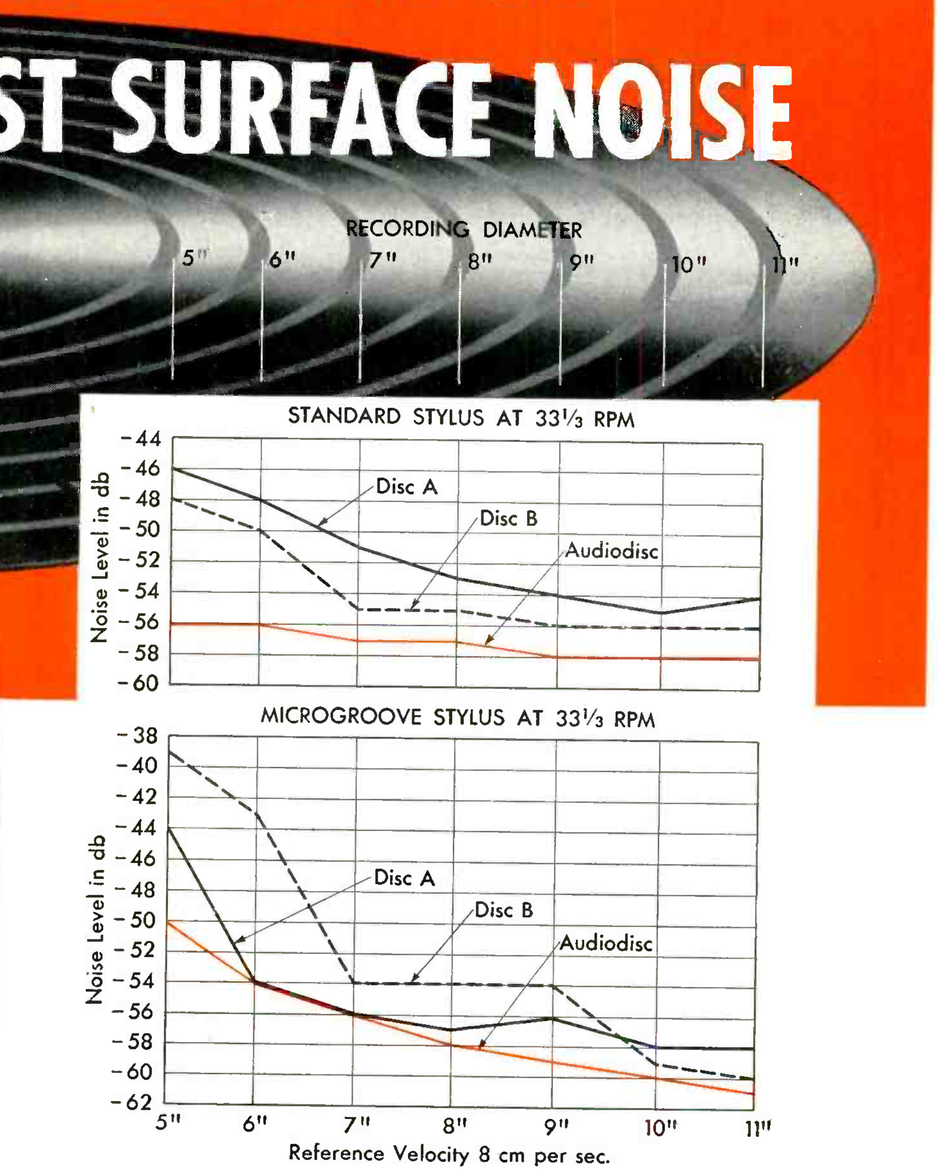
Subminiature Pentode

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., is producing the CK5889 subminiature pentode designed for electrometer applications. Its more important design features are a 7.5-ma low microphonic filament, double-ended construction and a metallic guard ring. Maximum grid current is 3×10^{-15} amperes but the nominal value will be

(Continued on p 178)

Improved Lacquer Formulation gives

audiodiscs*



GEORGE M. SUTHEIM, *Audio's Chief Chemist, has developed* two major improvements *in Audiodisc lacquer*

First was the moisture-resisting lacquer, perfected in 1948. This made all Audiodiscs permanently resistant to humidity—put an end to the "summer troubles" that had plagued the recording industry from the very start. This was followed by his development of the improved, low-surface-noise lacquer—a significant contribution to recording quality.

Mr. Sutheim, a graduate of the Institute of Technology in Vienna, is a chemist of exceptional experience in the field of lacquers and emulsions. He authored "The Introduction to Emulsions" and contributed largely to Dr. J. J. Mattiello's "Protective and Decorative Coating." He has also written many articles on coatings, films, etc., for both French and English periodicals.

Plotted above are actual surface noise measurements made on an Audiodisc, and on two other makes of discs. Note particularly the *consistently lower noise level* of the Audiodisc.

This drastic reduction in surface noise is the result of an improved lacquer formulation — perfected last Fall, after almost 4 years of research. It has been gradually introduced into production, and since the first of the year, *all* Audiodiscs have been of the improved formulation.

Basically, it contains the same time-tested ingredients that have been used so successfully for the past decade. And it offers the same advantages of recording quality, uniformity, smooth cutting, long life and ease of processing.

The importance of this improvement will be appreciated by all professional recordists.

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris.

*Reg. U.S. Pat. Off.

AUDIO DEVICES, INC.

444 MADISON AVE., NEW YORK 22, N. Y.

Export Dept.: ROCKE INTERNATIONAL, 13 East 40th St., New York 16, N. Y.

THEY SPEAK FOR THEMSELVES

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

FCC Organizational Changes

THE Federal Communications Commission has announced the following organization and personnel changes concerning its broadcast engineering work:

The f-m, noncommercial educational (f-m) and facsimile broadcast functions of the F-M Broadcast Division, together with the personnel dealing with those functions, and the functions and personnel of the A-M Broadcast Division, are being placed in a new division to be called the Aural Broadcast Division. James E. Barr is to be chief of this division.

Functions and personnel of the F-M Division concerned with auxiliary broadcast (including developmental, remote pick-up, and studio-transmitter services) are being transferred to the Television Broadcast Division.

Cyril M. Braum, chief of the present F-M Broadcast Division, is being made chief of the Television Broadcast Division to fill the vacancy created by the promotion of Curtis B. Plummer to chief engineer.

Functions and personnel concerned with international broadcasting are being transferred from the Television Broadcast Division to the immediate office of the chief engineer.

This new inflateable rayon radome displayed at Fort Monmouth is selfsupporting and therefore requires less radar-opaque material. Once inflated, it requires only as much pressure as that generated by the conventional tank-type vacuum cleaner. Its purpose is to protect the pedestal and antenna of radar set against Arctic cold

Parts Distributors Show

OVER two hundred manufacturers exhibited their wares at the 1950 Parts Distributors Conference and Show held at the Hotel Stevens, Chicago, May 22–25. The affair was conducted by Radio Parts & Electronic Equipment Shows Inc. which in turn is sponsored by the Association of Electronic Parts and Equipment Manufacturers (Midwestern sales managers group); Radio Manufacturers Association; Sales Managers Club, Eastern Group; West Coast Electronic Manufacturers Association; and National Electronic Distributors Association.

Credit for the successful affair goes to the show officers: K. C. Prince, general manager; J. J. Kahn, president; W. W. Jablon, vice-president; L. A. Thayer, treasurer; W. O. Schoning, secretary; and directors Sprague, Golenpaul, Jenkins, Hansen and Howard, plus many other cooperating groups including the Representatives of the Radio Parts Manufacturers Inc.

Exhibits numbering 290 filled the exhibit hall and demonstration rooms on the fifth and sixth floors. Fifty companies showed components and accessories; 28, television antennas; 16, loudspeakers; 12, transformers; 12, electron tubes; plus others exhibiting tape and disk recorders, needles, test equipment as well as all other kinds of parts and equipment.

Signal Corps Exhibits at Fort Monmouth

ARMED FORCES WEEK ending May 20, 1950 was celebrated at Fort Monmouth, N. J., Signal Corps Center by open house for both military and civilian visitors. Exhibits housed in tents or in their own mobile trailers were arranged to show a cross-section of the activities in which the various laboratories are engaged. Nearly 60,000 visitors were estimated to have seen the hundreds of standard equipments, prototypes and mock-ups displayed.

One tent housed a historical display that traced the rise of the Signal Service from Civil War days. Besides documents relating to the founder, Gen. Myers, an Army surgeon, there were several equipment firsts, including Major Armstrong's superheterodyne built in France during the first World War.

In direct contrast were the Watson Laboratory developments in high-definition radar suitable for airport ground surveillance and a cloud-height finder to show graphically the thickness and elevation of a cloud layer directly overhead.

In the field of communications, one striking development is a vhf 1-kw amplifier that automatically tunes itself to the frequency of the 100-watt driving signal and matches its output into an antenna.

Other exhibits included the MARS network station K2USA, radar with moving-target indicator, long-range navigation equipment, rocket telemetering devices, improved power supplies, arctic shelters and a teletypewriter repair school.

RCA Expands Tube Manufacturing

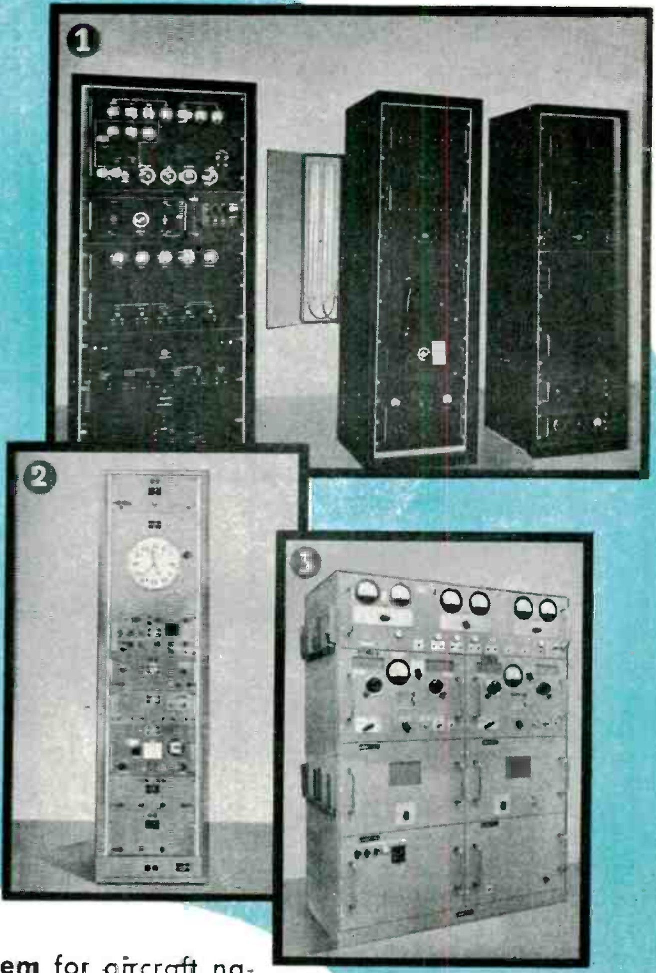
PURCHASE of a new building by RCA provides an extra 126,000 sq ft of space to expand electron tube manufacturing facilities at its Harrison, N. J., plant. This highlights a major program of expansion (of plant facilities, machinery and personnel) by the RCA Tube Department to meet increased requirements of the television and electronic industries. Over 500 additional people will be employed at the new building.

Currently, all of the company's tube plants—at Indianapolis, Lancaster, Marion and Harrison—are

Lavoie

DEVELOPED and PRODUCED

ELECTRONIC SYSTEMS



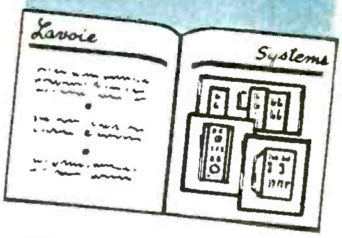
For Example:

① **VHF Omnidirectional Radio Range System** for aircraft navigation. This system has been standardized by international agreement as the best method of short range navigation for aircraft.

② **Time Standard.** A precision time standard, providing standard frequency and time service.

③ **Range Transmitter.** A 200 to 400 KC four course aural A-N Radio Range Transmitter with an output of 100 watts. Adcock or loop antenna; simultaneous voice modulation; telephone dial remote control.

. . . DEVELOPED • DESIGNED • PRODUCED by LAVOIE LABORATORIES and typical of both LAVOIE engineering versatility and LAVOIE manufacturing skill. As UHF *specialists*, we have the experience and the facilities for precise production at low cost.



LAVOIE FACILITIES REPORT

• Address us on your letterhead—and we shall be glad to send you a copy, or consult with you at your convenience.

Lavoie Laboratories, Inc.

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

RCA'S new Harrison tube plant

running at full capacity and progressively achieving new all-time highs in the volume of their output. All are working on extended-hour, extra shift schedules, and collective employment is at its peak.

MEETINGS

JUNE 26-30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

JUNE 26-JULY 22: Summer Electronics Symposium (Microwave Electron Tubes), University of Michigan, Ann Arbor, Mich.

JULY 24-AUG. 19: Summer Electronics Symposium (Semiconductor Electronics), University of Michigan, Ann Arbor, Mich.

JULY 24-27: Conference on Ionospheric Physics, The Pennsylvania State College, State College, Pa.

AUG. 27-31: NEDA National Convention and Exhibition, Cleveland Public Auditorium, Cleveland, Ohio.

AUG. 28-31: APCO National Conference, Hotel Hollenden, Cleveland, Ohio.

SEPT. 11-23: URSI Ninth General Assembly, Zurich, Switzerland.

SEPT. 13-15: 1950 IRE West Coast Convention and Sixth Annual Pacific Electronic Exhibit, Municipal Auditorium, Long Beach, Calif.

SEPT. 18-22: Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo, N. Y.

SEPT. 25-27: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

SEPT. 30-OCT. 8: Third Annual National Television & Electrical Living Show, Chicago Coliseum, Chicago, Ill.

OCT. 3-5: AIEE District No. 2 Meeting, Lord Baltimore Hotel, Baltimore, Md.

OCT. 23-27: AIEE Fall General Meeting, Skirvin Hotel, Oklahoma City, Okla.

Electronic Aero-Aid Tests

FIELD operations were recently completed at Hill Air Force Base near Ogden, Utah, on a comprehensive evaluation of a new electronic aid to air navigation. This evaluation has been carried out jointly by engineers of Airborne Instruments Laboratory, Mineola, N. Y., and of Aero Service Corporation, Philadelphia, Pa., assisted by several government agencies, including the U. S. Air Force and the Civil Aeronautics Administration.

The tests were carried out under a contract between the All-Weather Flying Division of the USAF and AIL as prime contractor. Aero Service Corp., as subcontractor, was responsible for certain phases of the work. The basic planning of the tests was done by the Air Navigation Development Board, a governmental board having general cognizance over the development of aids to air navigation. The board consists of representatives from CAA, the Air Force, the Army and the Navy.

The principal equipment which was tested is the Visual Omnidirectional Range, or VOR. The VOR station located just west of Ogden was selected for these tests as being typical of a valley installation in mountainous terrain. Previously, the same group had tested the VOR stations located at Philipsburg, Pa., and at Patuxent River, Md. These sites were chosen as typical of a mountain-top installation and of a flat-land installation, respectively.

During the tests a C-47 aircraft was tracked by shoran (Short Range Navigation), a war-developed aid to precision blind bombing. At intervals, photographs were taken of an array of instruments which could then be interpreted at some later time. In the course of the tests of the Ogden VOR some 22,000 pairs of photographs were taken of the two instrument panels. Altogether, 55,000 pairs of photographs were made.

In addition to the VOR equipment, a special distance measuring equipment or DME was tested. This equipment provides the aircraft pilot with a simple direct visual reading of his distance away from the VOR-DME station, while the VOR provides similar information of his magnetic bearing from the station.

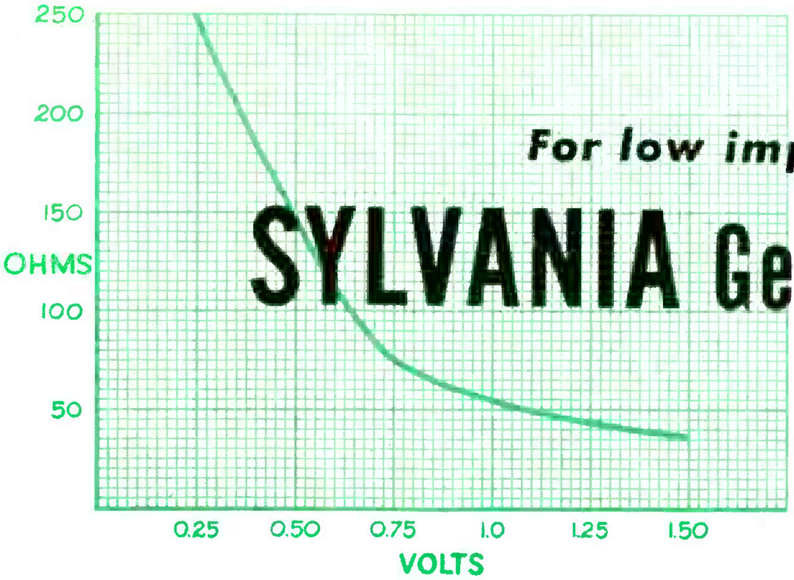
A considerable number of VOR stations have been installed and are being operated throughout the U. S. by the CAA. These are coming into use by military, commercial and private aircraft. The DME feature, while not a part of the present stations, will become one within the next few years. For these tests, a special experimental model equipment was installed at each of the sites tested. It is anticipated that as these newer facilities come into widespread use, the older and less versatile low-frequency four-course ranges will be retired from use.

UHF Experiments Planned

CHEYENNE MOUNTAIN, Colorado, has been selected as the most suitable site for a series of uhf radio experiments conducted by the Central Radio Propagation Laboratory of the National Bureau of Standards. The transmitters placed on this point (9,300 feet above sea level) will be used in obtaining the radio propagation information needed for the development of systems of air navigation, air traffic control and aircraft communication. Measurements will be made over a simulated aircraft-to-ground radio propagation path by use of sensitive receiving stations located on a radial path extending eastward to distances of about 400 miles.

The research is undertaken as one of the many services of the Laboratory to all users of radio, including the Department of Defense, the Civil Aeronautics Administration, the Federal Communications Commission and other government agencies, as well as the radio indus-

(Continued on p 202)



For low impedance applications...

SYLVANIA Germanium Diodes

Typical 1N56 Resistance Characteristic

1N56 DIODE with a potential of +1 volt will pass a current of 15 ma. or more. With a potential of −30 volts, less than 300 μa. will flow.

For Carrier Communications

1N71 VARISTOR—The 1N71 consists of 4 matched low impedance diodes each of which, with +1 volt impressed, will pass a current within one ma. of the average current of the four.

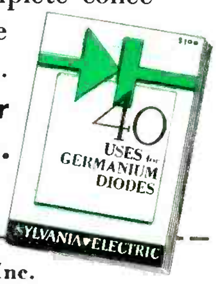
All Germanium Diodes are notable for their low forward impedance. But the 1N56 is specially engineered to make the most of this quality.

Use this diode for high efficiency circuits with low input and output impedances. Use it for relay activation, heavy current and surge applications with low impedance coils, transformers and condensers.

Try the 1N71 varistor in carrier telegraphy and telephony work. The low shunt capacitance insures high efficiency throughout the high frequency range. You will find this varistor equally efficient in low impedance modulator circuits of the carrier suppression or carrier transmission type.

Both the 1N56 Germanium Diode and 1N71 Varistor are available from Your Sylvania Distributor. Also ask him for a copy of the new book "40 Uses for Germanium Diodes." Priced at only $1.00, it is the most complete collection of germanium diode applications yet published.

Call him today . . . or mail the coupon below.



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

SYLVANIA ELECTRIC

Sylvania Electric Products Inc.
Dept. E-1007, Emporium, Pa.

Please send me a copy of "40 Uses for Germanium Diodes." Enclosed is $1.00.

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NEW BOOKS

Recent Advances in Radio Receivers

BY L. A. MOXON. *Cambridge University Press, New York,* 1949, 183 *pages,* $3.75.

ABOUT half of this book is devoted to one of the most important concepts in present-day receiver design —that of noise factor. Its applications to minimum noise factor design of amplifiers and mixers are covered along with procedures for measurement of noise factor. The remainder of the book is a miscellaneous collection of odds and ends which the author has apparently studied and used. Chapter titles are selfexplanatory: Intermediate Frequency Amplifiers; Trends in Practical Receiver Design; Some New Kinds of Receivers; Some New Circuit Tricks.

Unfortunately, the style wanders between conciseness and looseness. A number of unfortunate typographical errors (such as in the basic definition of noise factor) and poor use of the English language (as in a sentence using "very high bandwidths and . . . . narrow bandwidths" as a parallel construction) detract from the utility of the book. However, in spite of the many criticisms that may be leveled at the author for his errors, there are many examples of clear thinking on his part, which bring out points in the noise factor concept not always appreciated by receiver designers. The first half of the book is worth-while reading for anyone associated with the subject. The second half of the book reads like a review article for a magazine and contributes nothing of consequence.

A book of about the level of the first half of the book reviewed, and of about the same size, devoted entirely to the concept of noise factors and its impact on modern receiver design, would be welcomed. Moxon has tried to fill this need, but has not quite succeeded.—MATTHEW T. LEBENBAUM, *Airborne Instruments Laboratory, Mineola, N. Y.*

RELEASED THIS MONTH

Electronics Engineering Master Index 1947-1948; *Electronics Research Pub. Co., New York; $19.50.*

Electronic Navigation; Leonard M. Orman; *Weems System of Navigation, Annapolis; $4.50.*

Electronics—Principles and Applications; *Ralph R. Wright; Ronald Press; $5.50.*

Electronic Valves *(Philips Technical Library); Elsevier Pub. Co., New York; Book II, $2.75; Book III, $1.90; Book IV, $5.00.*

Questions and Answers in Television Engineering; *Rabinoff and Wolbrecht; McGraw-Hill; $4.50.*

Aerials for Metre and Decimetre Wavelengths

BY R. A. SMITH. *Cambridge University Press, New York,* 1949, 218 *pages,* $3.75.

THIS volume is one of the Modern Radio Technique Series which deals with the advances made in Great

(Continued on p 134)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles that ELECTRONICS has Published

Automatic Focusing

DEAR SIRS:

SINCE I MISSED Mr. Kallmann's IRE presentation, your story in the April issue on Optar is a very welcome substitute, especially because the subject matter is one that has also engaged my attention.

Some four years ago, I submitted to the Bureau of Ships (Navy Department), for certain radar applications, an almost identical method of automatic image focusing. This was based upon some original experimental work of about 15 years ago, in which the image field was scanned laterally by a lens, which was also given an axial motion sufficient to vary the focus within the required range; a photocell and a small optical aperture completed the arrangement. When in sharp focus, the highlights and shadows produce abrupt discontinuities in the rapidly changing illumination of the photocell, whose amplified a-f output is heard as a strong band of random noises. With out-of-focus, fuzzy images, the illumination discontinuities are gradual or hardly discernible, so that the signal noise is weak and in a lower frequency band. Suitable responders provided the focusing control.

I have also applied these principles of automatic focusing with some additional arrangements for use in an aid-to-the-blind device. In this a tone signal is produced in which loudness corresponds to image brightness, pitch corresponds to image distance, and tone quality corresponds to image color.

All of these correlations between visual and aural characteristics are obtained by a very simple arrangement with only one moving part, driven by a spring motor.

B. MIESSNER

Miessner Inventions, Inc.
Morristown, N. J.

Industrial Revolution?

DEAR SIRS:

LET ME be one of the readers (and I'll bet it will be many times the five you specified) to urge the publication of the electronic problems series proposed in the "Quiz" paragraph in the March, 1950 issue.

While commenting on *Crosstalk* I should like to call your attention to the article on "Egg Processing Equipment" in *Tubes at Work,* same issue, in connection with your paragraph on cybernetics,

(Continued on p 208)

A NEW LINE OF TV TEST EQUIPMENT FOR PRODUCTION LINES . . .

Designed and Field Tested for Speed Testing by your line operators . . . . .

THE MARKA-SWEEP
MODEL RFP

SWITCHABLE 12 CHANNEL RF SWEEP with CRYSTAL POSITIONED MARKERS—

- SAWTOOTH SWEEP: No phasing controls—
- SWEEP WIDTH: 15 megacycles
- ALL ELECTRONIC: No mechanical moving parts.
- MARKER PIPS ALWAYS VISIBLE: Crystal positioned pix and sound carrier pulse type marks not affected by test circuit.
- OUTPUT LEVEL and IMPEDANCE: Approx. 0.5 volts from 70 ohms unbalanced, 1.0 volt from 300 ohms balanced into open circuit —
- ATTENUATORS: Switched and continuously variable independent controls on sweep and marker pips —
- BASELINE establishes true zero amplitude
- MODEL RFB at lower price with crystal controlled "birdie" markers and CW at TV pix and sound carriers and 4.5 mc at CW available.
- POWER SUPPLY: Electronically regulated —

Price $795.00

THE MARKA-SWEEP
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Britain during the war. The author discusses the theory and technique of antennas for the wavelength range between 12 meters and 10 cm, and deals primarily with linear antennas and dipoles.

The first four chapters cover the basic theory of the linear antenna and give a concise and excellent discussion of polar diagrams, input impedance, mutual impedance, power gain, reciprocity and other elements of antenna theory. The impedance properties are based largely on the sinusoidal theory, but a short discussion of the integral equation method and the theory of the biconical antenna along with a comparison of theory and experiment serves to give the reader some orientation as to the present state of the fat dipole theory.

Chapter 5 discusses reflectors and directors and their effect on the polar diagram and input impedance. Chapters 6 through 14 deal with the applications and techniques of antenna design which have been selected to illustrate the general principles. These applications include receiving and transmitting antennas for low-frequency radar, aircraft antennas, wide-band antennas and slot antennas. The applications are selected mainly from British experience.

Dr. Smith closes his book with a short chapter on antenna noise and its effect on the receiver. The book is written in a very readable fashion and has a fairly complete list of references. It is recommended to those engineers who have occasion to design or use antennas.

—HENRY JASIK, *Airborne Instruments Laboratory.*

Cathode-Ray Tube Traces

BY H. M. MOSS. *Published by Electronic Engineering,* 28 *Essex Street, Strand, London, W. C.* 2, *England,* 66 *pages,* 10/6.

THE MAIN purpose of this book is to analyze the more common cathode-ray tube traces by means of the geometrical theory of the pattern. The text is chiefly mathematical derivations of the formulas of the more common waveshapes, with little attention given to the production of the waveform or the specific

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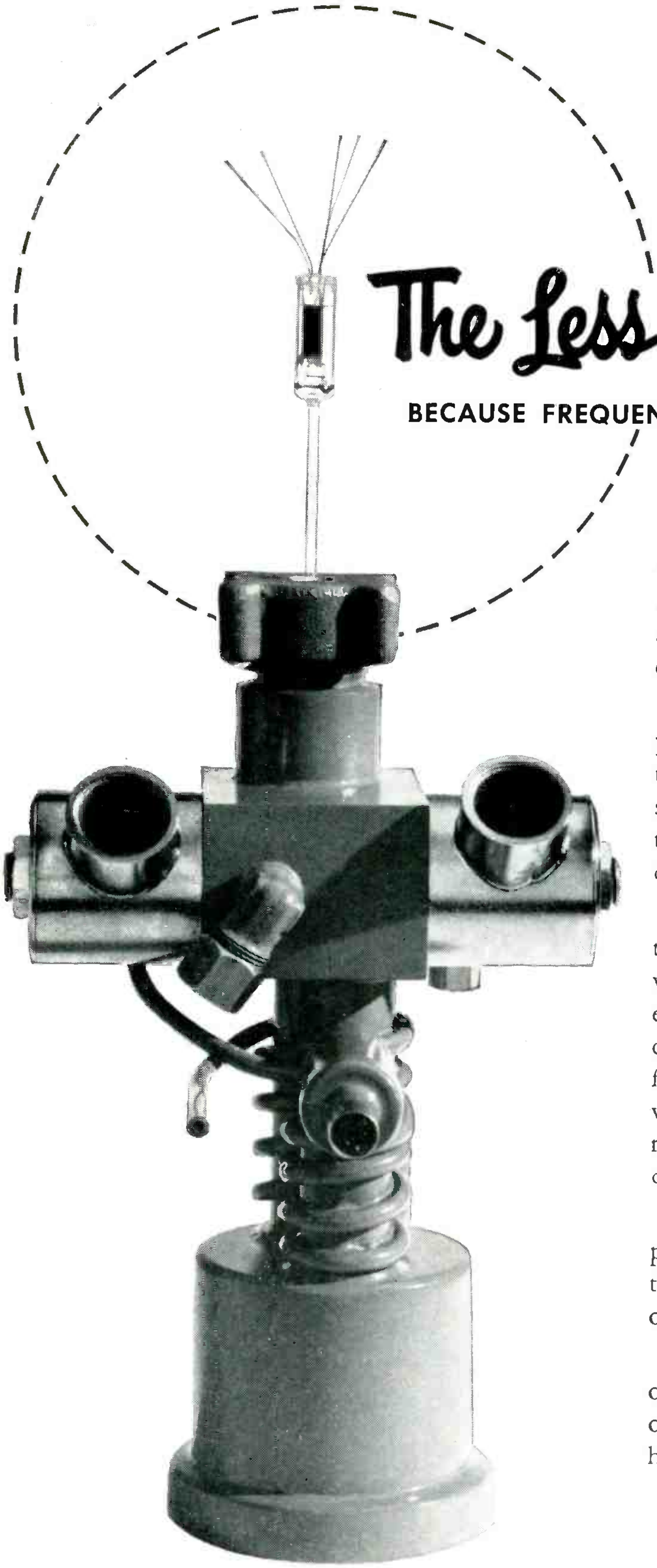

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circuit from which it was obtained. This is a novel approach and certainly worthy of the engineer's attention.

This is an excellent book for the engineer who has had considerable experience with the cathode-ray oscillograph. The author presupposes a knowledge of oscillography and electron physics, so that the book is not suitable for beginners.

Chapter 1 is devoted to the basic theory of the Lissajous figure and its geometric derivation. Various cases are discussed and the formulas for determining phase angle and frequency ratio are derived.

Chapter 2 is concerned with straight-line time bases, covering both sinusoidal and linear time bases. The same mathematical treatment is accorded to every topic. Chapter 3 covers the other types of time bases, chiefly circular and spiral.

Chapter 4 deals with Fourier analysis of complex waveforms, with considerable attention given to the subject of beats. Chapter 5 discusses amplitude-modulated waves, giving a careful distinction between modulated waves and beats.

This book may be summarized as being an excellent and careful mathematical text for the engineer specializing in oscillography. It is well written, and judiciously illustrated with very excellent oscillograms.—J. H. RUITER, *Allen B. Du Mont Laboratories, Instrument Division, Clifton, N. J.*

The Recording and Reproduction of Sound

BY OLIVER READ. *Howard W. Sams & Co., Inc., Indianapolis, Indiana,* 1949, 364 *pages*, $5.00.

THIS is a book written more from the point of view of the technician than that of the engineer. It begins with a brief discussion of sound waves, the ear and music, followed by a chapter on the history of acoustical recording. The historical material, although incomplete, is fascinating reading for anyone interested in the field of the storage and reproduction of music. Basic methods of recording are then considered as a group, with subsequent individual chapters on disk and magnetic recording. Microphones

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THE G-R Type 759-A and -B Sound-Level Meters have built-in calibrators for their electrical circuits; no means are readily available, however, to check the condition and calibration of their associated microphones.

The new Type 1552-A Sound-Level Calibrator is introduced as a simple, convenient and accurate method for calibrating both the microphone and the over-all system. Essentially it consists of a small, stabilized and rugged loud-speaker mounted in an enclosure which fits over the microphone in the sound-level meter. The acoustic coupling between the calibrator and the microphone is fixed and can be repeated accurately. Any audio oscillator with a harmonic content of less than 5%, supplying 2 volts at 400 cycles, can be used to operate the calibrator. A 500-ohm potentiometer is required as an output control if the oscillator is not equipped with such a control. An accurate vacuum-tube voltmeter is needed to measure the voltage across the calibrator.

The level at which the calibrator is used is such that its operation is not affected by ordinary background noises. This simple device is an ideal means not only for assuring consistency of calibration and locating defective microphones, but also for inter-standardization of several sound level meters.

The audio oscillator, v-t voltmeter and potentiometer shown in the set-up photograph are standard G-R items. If you need these or if you do not know about the complete line of G-R noise and vibration measuring and analyzing equipment. WRITE FOR THE "NOISE PRIMER".

The Sound-Level Calibrator was designed for use primarily with the Shure Brothers Type 9898 microphone as used on the G-R Type 759-B Sound-Level Meter. It can be used on other microphones such as the Brush BR2S Sound Cell Microphone and the Western Electric Type 633-A Dynamic Microphone.

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and loudspeakers are treated, and considerable material on pickup devices and tone-arms is given.

Although perhaps not an outstanding contribution to the literature of electrical sound recording and reproduction from the engineer's point of view, the book contains much useful material for the technician and for the enthusiast who is interested in phonograph recording and reproduction. It brings together in one set of covers information which until now has largely been scattered through back issues of periodicals and various instruction manuals.

The opinions or assertions contained in this review are those of the reviewer, and are not to be construed as official or reflecting the views of the Department of the Navy.—EMERICK TOTH, *Naval Research Laboratory, Washington, D. C.*

Facsimile

BY CHARLES R. JONES. *Murray Hill Books, Inc., New York,* 1949, 422 *pages,* $6.00.

A FEW steamship catastrophes in the early years of the century provided a stimulus that did much to advance the cause of wireless, even though the average person never experienced first-hand contact with the science. Facsimile has had no such favorable opportunity. In an age when the telephone is used increasingly over the telegraph and spot news over the radio competes with the printed word, one wonders what chance facsimile has against television for more than a few special uses. It may well be that Ultrafax, a facsimile system utilizing television techniques, is the trend. Only time will provide the answer.

However this may be, anyone interested in the story of facsimile, how it works and what the commercial equipment is like will find much to interest him in this book.

It describes in detail eight commercial systems with many details of the transmitting apparatus, receiving apparatus, transmission facilities and synchronizing means, and even includes a considerable number of pages of service notes. Other chapters cover the application of facsimile to various services,

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the existing standards and broadcasting.

In the first chapter, the author gives a brief but excellent history of the art. The references cited are wholly patent numbers rather than technical articles. Of course, only a very small number of the total patents on the subject are cited, but it does emphasize the author's story of the important inventions in this science.

Radio engineers will be disappointed in not finding much material on bandwidth requirements and comparisons with such other communication methods as the teletypewriter and television. Also, little is included on the economics of facsimile and no information on the number of transmitters and receivers in use at the present time. Except in Chapter I, there are no references. The book itself, however, will be a valuable reference as to what facsimile was like in 1949.

The text is generously provided with pictures, charts and circuit diagrams and a comprehensive glossary.—W. C. WHITE, *General Electric Co., Schenectady, N. Y.*

THUMBNAIL REVIEWS

OCEAN ELECTRONIC NAVIGATIONAL AIDS. Revised Edition (1949), CG 157. Available from U. S. Government Printing Office, Washington, D. C., 73 pages paper-covered, $.50. Details of loran, radiobeacon and radarbeacon systems, radio direction-finders and radar ship equipment, prepared by the U. S. Coast Guard to answer inquiries received on these subjects. Included are advisory minimum specifications for marine radar, loran and d-f equipment.

A MEASURE FOR GREATNESS. By David O. Woodbury. McGraw-Hill Book Co., New York, 1949, 230 pages, $4.00. Short biography of Edward Weston, electrical inventor and co-founder of the instrument company bearing his name. Emphasis is placed on the many personally prosecuted patent infringement suits, mostly around the turn of the century, that are described in fascinating human-interest anecdotes by the author and concluded thus: "His judgment was sound: in every case, by intense application and the devotion of all his time and strength, he won. Finally he stood on top, having beaten small fry and giants alike, and made the Weston Electrical Instrument Company the unassailable leader in its field."

ARRL AMATEUR RADIO MAP. American Radio Relay League, West Hartford, Conn. Revised edition, 1950, 30 by 40 inches, four colors, on heavy map paper, $2.00. Modified equidistant azimuthal projection of the world centered on Wichita, Kansas, allowing distance measurements and great circle bearings of reasonable accuracy between points in U. S. A. and the

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rest of the world. Also gives time zones. A somewhat similar map of the world, based on New York City, is obtainable from U. S. Coast and Geodetic Survey as Map No. 3042, for 40 cents.

AUTHOR'S GUIDE FOR PREPARING MANUSCRIPT AND HANDLING PROOF. Prepared and Published by John Wiley & Sons, Inc., New York. 1950, 80 pages, $2.00. Suggestions that simplify writing and handling of technical book manuscripts and revising existing editions.

INDUSTRIAL ELECTRONIC CONTROL. By W. D. Cockrell. McGraw-Hill Book Co., New York, 1949, Second Edition. 385 pages, $4.00. Revised to cover closed-cycle control or regulating systems, new counting circuits and new instrumentation and control equipment. Questions have been added after chapters and illustrations changed over to ASA symbols for *L* and *C*.

EFFECTIVE TEACHING. By Fred C. Morris. McGraw-Hill Book Co., New York, 1950, 86 pages, paper-covered, $.60. Manual for engineering instructors, covering planning and organization of instruction, instructional aids, conducting classes, testing and grading, and instructor self-appraisal and selfimprovement.

AN INDEX OF NOMOGRAMS. Compiled and edited by D. P. Adams. Published jointly by The Technology Press and John Wiley & Sons, 1950, 174 pages, $4.00. Compilation of approximately 1,700 alignment diagram references in all fields of engineering and science, of which 211 deal with electricity, electronics and radio.

OPERATION AND CARE OF CIRCULAR-SCALE INSTRUMENTS. By James Spencer. Instruments Pub. Co., Pittsburgh, 1949, 90 pages, $1.50. Tools, equipment and procedures for taking meters apart, making repairs and assembling again are described and illustrated, with separate trouble charts for d-c instruments and a-c instruments. Wattmeters, frequency meters, power-factor meters and synchroscopes are also covered.

VADE-MECUM. Published by P. H. Brans, Ltd., Antwerp and distributed in North America by Editors and Engineers, Ltd., Santa Barbara, Calif. New 8th edition, 1950, 508 pages, $3.20. Compilation of characteristics of over 15,000 different types of tubes in use throughout the world. New data not in previous editions was supplied by 247 tube manufacturers. New types listed include nonodes, transducers, accelerometers, phasitrons, crystal diodes and transistors. Military types used by the British, American, Australian, French, German, Italian, Russian and Japanese armed forces are included.

TRANSIENT PERFORMANCE OF ELECTRIC POWER SYSTEMS. By Reinhold Rüdenberg, Gordon McKay, Prof. of E. E., Harvard Univ. McGraw-Hill Book Co., New York, 1950, 832 pages, $12.00. Enlarged edition in English of classic German text dealing with phenomena in lumped networks and covering the reaction of electric circuits and their associated machines and apparatus to any nonstationary influence. Traveling waves on lines with distributed parameters are to be treated in a separate book. Communication problems are excluded but many of the solutions given can be applied to that field.

ELECTRONIC ENGINEERING MASTER INDEX 1947-1948. Electronics Research Pub. Co., New York, 1950, 339 pages, $19.50. Third volume of its type (previous ones covered 1925-1945 with 15,000 entries and 1946 with 7,500 entries), with many more publications indexed this time and with patents and declassified documents now included to give a total of over 18,000 entries for the two years. Cumulative cross-index is included, covering all three volumes.

(Continued from p 118)

circuit, and is temperature compensated for best characteristics on all channels. The high-channel oscillator coils are of metallized construction, while the low-channel coils are of conventional wound construction to provide uniform temperature stability.

Fine tuning is provided by a variable dielectric capacitor, connected directly across the tank circuit. The two stator plates are constructed in a single rigid molded assembly using Mycalex insulation. The variable dielectric cam is made of glass-base melamine for low loss and temperature stability. This construction, together with the direct tank circuit connection of the plates, which results in wide plate spacings, minimizes the possibility of microphonics and also minimizes oscillator chassis current paths which might result in undesirable radiation.

The mixer plate circuit contains a tuned low-pass filter section for the picture i-f output and a high-Q trap providing sound i-f attenuation for the picture output as well as sound i-f output. The low-pass filter configuration minimizes oscillator feedthrough to both sound and picture i-f grids. The picture converter i-f coil, while designed to provide output nominally at 22 mc, has sufficient range of adjustment to work at any frequency in that vicinity to match various stagger tuned i-f combinations. The gain of the unit from the antenna to the first picture i-f grid is from 28 to 35 db over the 12 channels. Measurement of the oscillator radiation, in terms of oscillator voltage produced across 300 ohms at the antenna terminals, shows less than 3,000 microvolts for the low-band channels, an average of 7,500 on the high-band channels with a maximum of 10,000 on channel 10.

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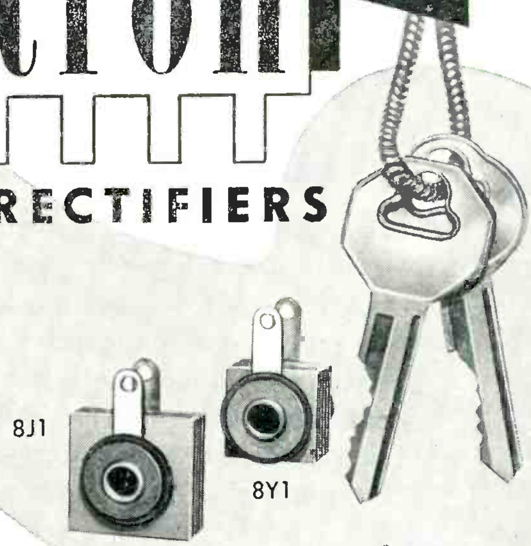

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family of plate current versus plate voltage curves for any receiving tube. A standard rectangle is displayed along with the characteristic curves to provide a direct scale for voltage and current readings.

The plate voltage applied to the tube under test is swept continuously from zero to predetermined positive values. The voltage drop appearing across the plate load resistance is then a measure of the plate current. This voltage drop is applied to the vertical deflecting plates of a cathode-ray tube and the plate voltage applied to the horizontal plates.

The combined voltages generate a plate current-plate voltage curve on the crt screen for the entire sweep interval. The sweep sequence is repeated automatically for several values of grid bias, forming the family of plate characteristic curves. A series of bright dots appearing at the end of each curve in the family gives a useful representation of the load line of the tube for the operating conditions selected.

A visual representation of plate current plotted against grid voltage is also provided. In this case, the display is particularly convenient since grid voltage increments are directly defined by calibrated vertical bars appearing on the screen; a standard current reference is given by a horizontal bar. All of the possible displays are produced by the curve generator without overloading the tube under test. Overall accuracy of voltage and current readings from the tube screen is within plus or minus five percent.

A complete family of curves is retraced sixty times a second and the resulting image is stationary and

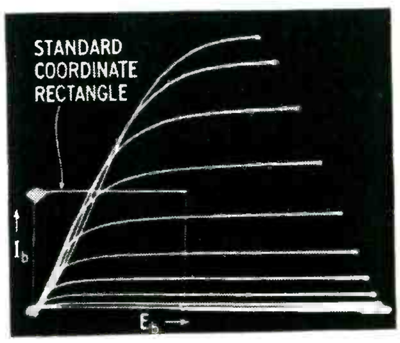


Plate characteristics of a 6AC7 as shown on the screen of a cathode-ray tube

free from flicker. Characteristic curves may be quickly obtained in permanent form by photographing the screen image.

All driving signals are produced by a single oscillator. Voltage excursions for the tube under test are obtained from the oscillator in the form of a rising sawtooth wave whose magnitude is controlled without any oscillator loading effect. A cathode follower isolates the power supply for the tube under test from the rest of the generator circuit, so that only the plate current of the tested tube is plotted on the oscilloscope.

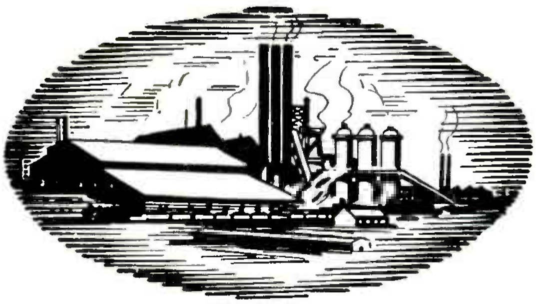
Step Counter

When the sawtooth plate sweep signal is most negative, the master oscillator sends a pulse into a pulse former. Pulses from the pulse former then operate a step counter to provide a fixed bias voltage for the grid of the tube under test, successively becoming more positive. Each time the plate voltage is driven negative the grid bias voltage rises to a new level. These stepwise increasing bias voltages are fed through a video divider which reduces their amplitude to the desired level.

From the divider, the stepped voltages go through a cathode follower to the test grid. A special control acting on a clipper circuit allows manual selection of a definite calibrated voltage for the highest positive grid step.

A special linearizing circuit provides for uniform increments in the step sequence of grid voltages, each oscillator pulse, through an inverse feedback arrangement, transferring a fixed charge into a large capacitor. The feedback can be controlled manually to provide any size grid voltage increment. The number of steps is controlled indirectly by the output of a step counter, arresting the entire process after a predetermined number of steps.

Two circuits have been included which are not vitally necessary but which add to convenience and reliability. One is a servo-sweep circuit whose timing is controlled through the frame synchronizing switch. This circuit is especially



useful for viewing the step-function signal at the grid of the tube under test. Another circuit, using four tubes, identifies the curves which have positive values of grid bias by means of a small marking pip superimposed on the positive grid lines.

Checking Crystals

By P. O. FARNHAM
Aircraft Radio Corp.
Boonton, N. J.

MAINTENANCE and repair of military aircraft radio communications equipment in large quantities has evolved a means of checking crystals with a fundamental frequency in the region between 6 and 13 mc are considered. The equipment, the frequencies and the procedures can be modified slightly to include many other applications.

The equipment is arranged as shown in Fig. 1. Outputs at 10, 100 of 1,000-kc intervals can be selected at will from the substandard of frequency. Each of the receivers is equipped with a beat-frequency oscillator that can be turned off if the receiver is used as a detector for beats from two other signal sources.

Direct frequency calibration is provided on the tuning dials of the receivers and the two tunable oscillators. Headphones and an output meter are used to indicate beat-frequency output from a receiver.

Before making measurements, the 1,000-kc crystal frequency of the substandard (5th harmonic) is checked against the 5-mc standard frequency signal from WWV by feeding both these signals to receiver 1 tuned to 5 mc. The 100-kc substandard intervals are next checked with receiver 2 in the beat-frequency condition. Beats should be observed only at each 100-kc scale line of the receiver dial.

With receiver 2 set nearly to zero beat on an even 100-kc mark (for example, 8 mc) the 10-kc intervals are then switched on in the substandard. The same beat frequency should be observed. As the receiver is tuned slowly towards 8.1 mc, it should be possible to count ten beats. Leaving the receiver near zero beat at the tenth count, the

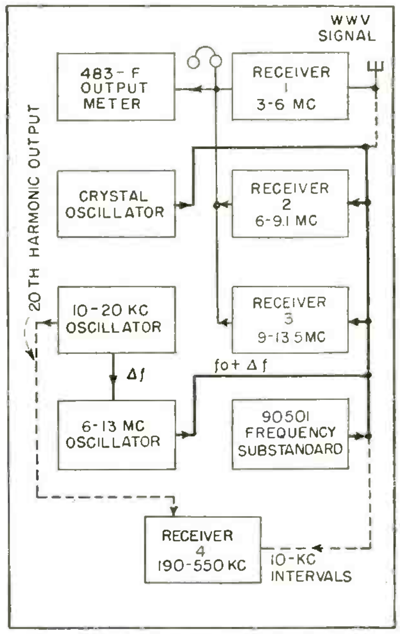


FIG. 1—Complete setup of receivers and oscillators for crystal calibration

100-kc interval is again switched in from the substandard. The beat frequency tone remains the same.

Measurement Method

The method of measurement of crystal oscillator frequency can be most clearly followed with a numerical example. Receiver 2 is used for crystal frequencies from 6 to 9 mc, receiver 3 for crystal frequencies from 9 to 13 mc. Assume that the frequency indicated on the nameplate of the crystal is 7,361.1 kc, which will be called f_c. Using receiver 2, set the 6–13 mc oscillator accurately to the substandard 10-kc harmonic that lies somewhere between 10 and 20 kc below f_c.

In this example, the oscillator will be set to 7,350 kc and this frequency will be called f_o. The 10–20-kc oscillator is then turned on to modulate the 7,350-kc output and produce an upper sideband output adjustable from 7,360 to 7,370 kc.

The frequency of the 10–20-kc oscillator will be called Δf. The value of f is adjusted to produce zero-beat in the receiver output between the crystal and the upper sideband frequency of the 6–13 mc oscillator. The true crystal frequency f is obtained by adding the values of f_o and Δf.

The output-meter is used as a zero-beat indicator when bringing the 6–13 mc oscillator to zero beat with the desired 10-kc harmonic of the substandard. To establish the modulation frequency Δf of the 10–20-kc oscillator it is necessary to beat the crystal frequency and the modulated output of the 6–13-mc oscillator together in receiver 2.

The 10–20-kc oscillator is tuned approximately to 11.1 kc (for this case the value of $f_c - f_o$). Near this setting and with the receiver gain reduced to prevent pickup of an undesired sideband output ($f_o + 2\,\Delta f$) a relatively clean beat output tone of low frequency should be obtained from the receiver. This signal corresponds to pickup of the desired sideband output ($f_o + \Delta f$). It is distinguished from pickup at the undesired sideband by being free of extra, high-frequency beat components.

The receiver should be tuned to maximum beat output and then the 10–20-kc oscillator adjusted for zero-beat output using the output meter. If this reading of Δf should come out 11.65 kc, this value will then be added to 7,350 (f_o) giving an actual crystal frequency f of 7,361.65 kc. The error ($f - f_c$) based upon the value stamped on the crystal holder will then be + 0.55 kc or the percentage error will be + 0.00748 percent.

If the actual crystal frequency f should be such that zero-beat setting of the 10–20 kc oscillator lies off its tuning range, it will be necessary to re-establish the setting of the 6–13-mc oscillator.

Suppose the actual crystal frequency f had been 7,359.3 kc instead of 7,361.65 used in the example. It would then be necessary to tune the 10–20-kc oscillator to a Δf value of 9.3 kc.

Since this value is not attainable, f_o (the 6–13-mc oscillator) must be reset to a new lower value of 7,340 kc. The value for Δf will then be 19.3 kc.

Similarly, if the actual crystal frequency were much higher than its nameplate value, it would then be necessary to reset the 6–13-mc oscillator to a new higher value of 7,360 kc. In either case, the actual frequency of the crystal is given by $f = f_o + \Delta f$.

Receiver 4 is used as a detector for beats between the substandard 10-kc intervals and the 20th harmonic of the 10–20-kc oscillator when it is desired to check the frequency calibration of the latter unit.

Thermistor Thermostats

By Albert H. Taylor

Radio Ranch
Alamosa, Colorado

Thermistors, a type of semiconductor with large but stable negative temperature coefficient, are now manufactured in numerous types for a variety of purposes. Many of them are inexpensive, and a few types are available from war surplus sources. Because of the sensitivity and quick response of some thermistors, they are particularly suitable for thermostat and remote thermometer applications.

The accompanying two circuits were designed for simplicity and low cost, and are used to control refrigerators. They could easily be adapted to other thermostatic applications. In both, the thermistor is excited by a-c to avoid polarization, and the thermistor dissipation is kept low enough so that with the thermistor in air there is no noticeable heating error. More excitation could be used in water. The thermistor used is in each case a Western Electric V-514.

The simpler circuit of Fig. 1 uses a small thyratron with a-c anode supply and d-c grid bias upon which the a-c signal from the thermistor is superimposed. The tripping temperature is adjusted by setting the grid bias with R_5. This thermostat holds the temperature of a domestic refrigerator within one degree at about 5 C.

In this application the sole drawback is radio interference. The interference did not disturb a good communications receiver at 5 to 18 mc in the same room, but it is severe on a broadcast receiver. Enclosure in a shielded box with all leads filtered and bypassed to a good ground would be necessary to eliminate this disturbance.

The circuit of Fig. 2 employs an a-c bridge, and a-c amplifier stage, a differential detector, and a sharp-cutoff d-c keying amplifier. The bridge is excited at 60 cycles from the same transformer winding which heats the tubes, and the center leg of the differential detector is excited from the 60-cycle line through an ordinary plate-to-grid interstage transformer used stepping down.

The sensitivity is about the same as that of the thyratron circuit and no radio interference has been observed. The tripping temperature is adjusted by varying the bridge arm adjacent to the thermistor.

Design Considerations

The resistance of a thermistor at any temperature can be calculated by the equation $R = Ae^{B/T}$ where A and B are constants and T is the temperature in degrees Kelvin, that is to say, 273 degrees plus the temperature in degrees centigrade. If A and B are given, the resistance can be calculated for any temperature with the help of a table of exponential functions (such as that in the Smithsonian Physical Tables) or the log-log scale on certain slide-rules.

To determine the constants of an unknown thermistor one can measure its resistances R_1 and R_2 at two temperatures T_1 and T_2 and solve for A and B the two simultaneous equations $R_1 = Ae^{B/T_1}$ and $R_2 = Ae^{B/T_2}$. The solution, using natural logs, is

$$\ln A = \frac{T_1 \ln R_1 - T_2 \ln R_2}{T_1 - T_2}$$

and

$$B = \frac{T_1 T_2}{T_2 - T_1} \ln \frac{R_1}{R_2}$$

The type of thermistor to be pre-

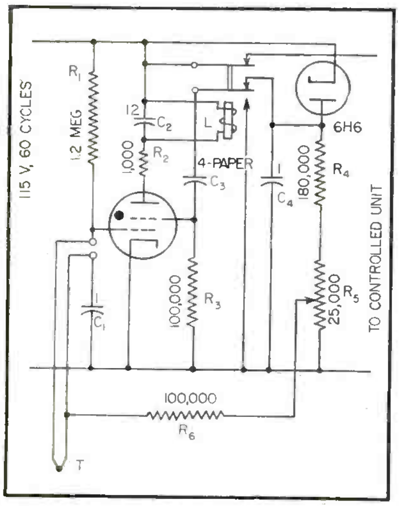


FIG. 1—The thyratron may be a 2050, 1665, 2051 or 2D21

ferred depends upon the application and the operating temperature. The V-514 is embedded in glass for immersion in liquids, but nevertheless follows very quickly a sudden change in temperature, making 0.9 of its total resistance change in one second. It is intended for rapid, accurate calorimetry and resistance thermometry and is really too good for a refrigerator. It starts the refrigerator immediately whenever the door is opened.

A typical V-514 has A equal to 0.0364 and B equal to 3,896 C. At 0 C the resistance is 58,200 ohms; at 40 C it is 47,200 ohms. A safe current at these temperatures is 100 microamperes, which means that the change of 4 degrees produces a change of 1.1 volts across the thermistor. Operation at higher or lower temperatures would require a different thermistor or a different input circuit if the same sensitivity is to be maintained.

If a V-514 were to be used for controlling a crystal oven at 50 degrees, where its resistance is only about 6,000 ohms, the thermistor current should be increased to maintain the same dissipation as before, and a step-up transformer should be interposed between the thermistor and the tube. At very low temperatures, the resistance would be so high that there would be trouble from stray capacitances and hum pickup.

The thyratron in Fig. 1 is biased far enough below cutoff so that positive half cycles of the thermistor and anode voltages do not fire it at temperatures above the regulating temperature. When the thermistor resistance increases with falling temperature, the tube fires and operates the relay to open the motor circuit, which must be on the normally-closed relay contacts.

The low anode voltage, used for simplicity and economy, necessitates several precautions. First, a relay with comparatively little inductance is preferred in order that transients across the coil shall not snuff the tube and make the contacts chatter. A 24-volt, d-c, 250-ohm coil in a relay from the SCR-274-N equipment was found preferable to a 115-volt coil.

To eliminate chatter it was also found advantageous to connect C_3

and R_3 to the thyratron shield grid as shown. Thus, when the thyratron snuffs and the relay is released to start the motor, the extra contacts on the dpdt relay operate to throw a large negative surge on the shield grid thru C_3. This blocks the tube until the switching transients subside.

Before the refrigerator warms up again, the extra electrons leak off from shield grid to ground, through R_3, leaving C_3 charged. This results in a positive surge being applied to the shield grid when the thyratron fires again and C_3 is discharged, and tends to keep the tube fired until the switching transients have again subsided.

To prevent damage to the thyratron, R_2 limits the instantaneous peak current to the peak rating of the tube (1 ampere for 2050).

Figure 2 is a crude form of direct-reading a-c bridge and detector which have been used in very precise resistance thermometry. The balanced bridge eliminates the constant component of about 6 volts which was present in Fig. 1, and allows an amplifier to be used.

The differential detector is necessary for a sense indication with the bridge, so as to distinguish between unbalance voltages due to upward and downward variations of temperature. The keying tube should be a type having high mutual conductance and sharp cutoff. It is blocked and unblocked by the detector output in accordance with bridge unbalance.

The controlled device can be fed through either the normally-open or normally-closed relay contacts of

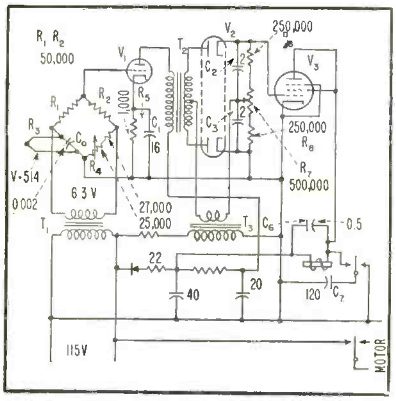


FIG. 2—Improved circuit uses a 5,000-ohm relay that makes at 16 ma and breaks at 8 ma

the relay used; but it was found preferable to feed the refrigerator motor through the normally-open contacts and to connect C_7 to one set of contacts as shown to hold the relay closed after making until transients subside.

The tube circuit operates rather gradually in response to a slow drift of temperature, so that the normally-closed contacts open slowly and arc severely as the coil is gradually energized by increasing plate current. The normally-open contacts, on the other hand, are both made and broken quickly because of the inherently unstable magnetic equilibrium of a typical relay.

Adjustment

The heater transformer and tubes and wiring have capacitances to ground which are not likely to be symmetrical. An unbalance due to this cause produces an out-of-phase component which does not show in the output of the differential detector, but which may overload the amplifier. To balance it, open the primary (high side) of T_3 and connect a high-resistance d-c voltmeter across C_2 or C_3. An a-c vtvm or a scope may be used across T_2 primary with blocking capacitor.

Balance the bridge, with the thermistor in its operating position at operating temperature, by adjusting R_4. Connect C_0 of the necessary size across whichever bridge

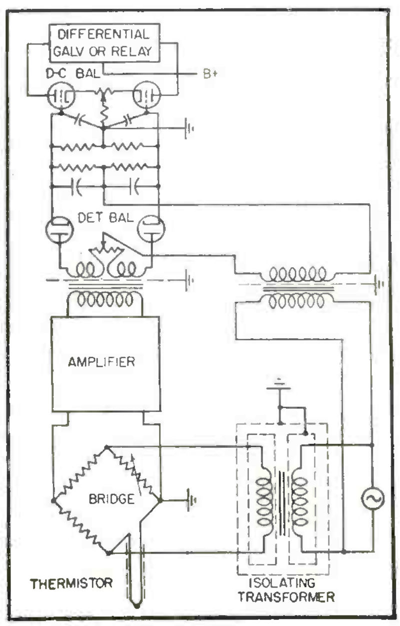


FIG. 3—Circuit for precise thermometer or thermostat

arm may require it for perfect balance, readjusting R_4 for finer balance.

To balance the differential detector, remove keying tube V_3 and connect a high-resistance d-c voltmeter across the detector output. With the bridge not excited or with amplifier tube V_1 out of the socket, but with T_3 connected, adjust R_7 for zero output.

Triode rather than pentode connection of the keying tube is preferable to avoid excessive screen current at zero bias.

Sensitivity

The sensitivity which can be utilized in a more elaborate version of Fig. 2, shown simplified in Fig. 3, is limited only by stability. The thermistor is stable enough to hold calibration to 0.01 C-degree or better if a suitably aged unit is chosen, according to one of the engineers of the principal manufacturer. Its inherent sensitivity and higher impedance gives it an advantage over the platinum thermometer and both it and its circuit are less expensive. The most obvious way to increase the sensitivity of a resistance thermometer or thermostat is to increase the amplification. The balanced d-c amplifier and differential milliameter or relay indicated in Fig. 3 are also much more sensitive than the tube operating near cutoff as shown in Fig. 2. If the sensitivity is to be increased very much, the bridge should be excited by an oscillator at about 500 cycles through an isolating transformer such as General Radio type 578 or a Leeds & Northrup equivalent. The amplifier is designed for that frequency only but not sharply tuned.

For thermometry only, without control action, the null method is best, calibrating the bridge arms and using the amplifier solely as a bridge detector. Headphones could replace the differential detector.

The author once constructed a differential thermometer on the principle of Fig. 3 which read to 0.001 degree C the difference in temperature between two platinum thermometers. It is believed that this project would have been easier with thermistors because of the greater sensitivity and the lesser effect of lead resistance.

(continued from p 122)

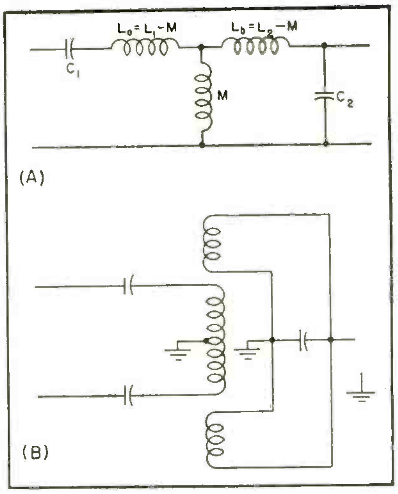


FIG. 2—Series-parallel transformer in equivalent-T form is shown in *(A)*. Inductive coupling *(B)* must be used in balanced-to-unbalanced transformers

form of a half-section constant-k band-pass filter plus an ideal transformer. The bandwidth Δf_c between cutoff frequencies f_1 and f_2 of the constant-k filter becomes the bandwidth between one-db points on the corresponding transformer. Let f_m be the geometric mid-frequency. We then have

$$f_2 - f_1 = \Delta f_c \equiv \Delta\omega_c/2\pi \quad (1)$$

$$\sqrt{f_1 f_2} = f_m \equiv \omega_m/2\pi \quad (2)$$

The design formulas for a maximally-flat transformer of the form shown in Fig. 1 may be expressed in terms of $\Delta\omega_c$, ω_m, the generator (or load) resistance R_1 and the input (or output) capacitance C_2.

$$C_1 = \Delta\omega_c/\omega_m^2 R_1 \quad (3)$$

$$L_1 = [1 + (\Delta\omega_c/\omega_m)^2]R_1/\Delta\omega \quad (4)$$

$$R_2 = 1/\Delta\omega_c C_2 \quad (5)$$

$$L_2 = 1/\omega_m^2 C_2 \quad (6)$$

$$k = M/\sqrt{L_1 L_2} = \frac{\Delta\omega_c/\omega_m}{\sqrt{1 + (\Delta\omega_c/\omega_m)^2}} \quad (7)$$

The amplitude response of this transformer is geometrically symmetrical about f_m, with a loss curve given by $p = 1 + \frac{1}{4}(\Delta\omega/\Delta\omega_c)^4$ where $\Delta\omega$ is the bandwidth between any two points of equal loss. In Fig. 1*C* loss curves are plotted against normalized frequency for three values of the ratio $\Delta\omega_c/\omega_m = (f_2 - f_1)/\sqrt{f_1 f_2}$.

EXAMPLE: A matched input transformer is to be designed to connect a coaxial line ($R_1 = 50$ ohms) to the first tube (a 6AK5, $C_g = 8.5\ \mu\mu$f) of an amplifier. One-db points are to be at $f_1 = 80$ mc

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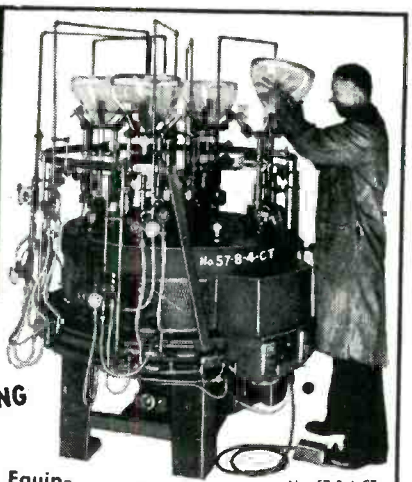

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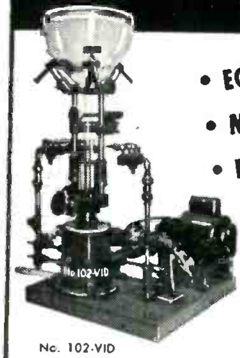

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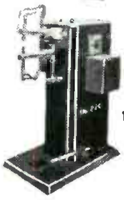

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and at $f_2 = 120$ mc. The design formulas give:

$\Delta\omega_c = 2\pi\ (120 - 80)\ 10^6 = 2.51 \times 10^8$ rad/sec

$\omega_m = 2\pi\sqrt{120 \times 80} \times 10^6 = 6.15 \times 10^8$ rad/sec

$C_1 = 13.27\ \mu\mu f$

$L_1 = 0.2325\ \mu h$

$R_2 = 468$ ohms

$L_2 = 0.311\ \mu h$

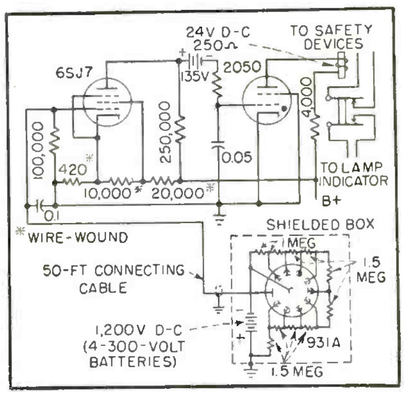
$k = 0.378$

It may be preferable to build the T (or π) equivalent of the transformer as shown in Fig. 2A. Since $M = k\sqrt{L_1L_2} = 0.102\ \mu h$ in our example, $L_a = 0.130\ \mu h$ and $L_b = 0.209\ \mu h$. It is obvious that certain designs may call for a negative L_a or L_b and so cannot be built in equivalent T (or π) form. In the case of balanced line inputs a construction such as that shown in Fig. 2B may be used.

Radiation Alarm with 0.5-Second Response

PULSE-TYPE ionization chamber circuits for radiation detection fail to operate if the radiation intensity rises high enough and fast enough. Direct-current amplifiers used with ionization chambers have shown either a high pickup sensitivity for switching transients, or a slow response if transients were eliminated by bypassing.

The detector shown in the accompanying circuit diagram was designed with the following requirements in mind: (1) Activation of alarm circuit within 0.5 second after intensity reached predetermined level, (2) freedom from false alarm such as might be caused by circuit failure, instability or pickup, (3) assurance of proper



Rapid response radiation alarm circuit

operation even though radiation levels rise well above alarm level in a matter of miscroseconds, and (4) provision for remote operation.

The circuit comprises a battery-operated photomultiplier tube and, one stage of d-c amplification which provides an output signal of the right polarity to fire the relay-operating thyratron. The signal fed to the thyratron grid is smoothed by the 0.05-second time constant network. An anthracene crystal is employed as a scintillator.

Experimental Tests

Tests made with radiation intensities of 1½ and 3 times tripping level show response time to be 0.13 and 0.03 second respectively. Tripping intensity for circuit shown is 0.3 mr per second. Using a 1P21 photomultiplier in place of the 931A, and a 1-meg—0.01-μf grid-leak, the tripping intensity is reduced to 0.03 mr per sec. A further improvement in sensitivity could be realized by providing fixed bias to eliminate background signal and by using a larger input resistor for the 6SJ7.

According to the authors of an article describing this piece of equipment (R. L. Macklin and E. R. Rohrer, *Rev. Sci. Inst.*, p 966, Dec. 1949), the anthracene scintillator will also respond to fast neutrons, but the intensity required is rather beyond that available with small gamma ray from neutron sources. Thus over-all operation checks are periodically made with a small gamma-ray source to ensure that the equipment is connected and functioning properly. The original paper describes work performed for the AEC by Carbide and Carbon Chemicals Corp., Oak Ridge, Tenn.

Television Picture Evaluation

EVALUATION of a television image, as seen by the ultimate viewer, is a subjective rating of the quality of the image. It is desirable that some quantitative means for evaluation be established, and that as nearly as possible, the same scale be used for the various impairments.

Two techniques have been ex-

plored for establishing such a rating of image quality, as outlined by P. Mertz, in a paper entitled "Quality Rating of Television Images" presented at the 1950 IRE National Convention. The first employs the time-honored system of presenting an observer with pairs of pictures having slightly different, but known characteristics, and asking him to vote his preference for each pair. A television picture of a lantern slide, with a wide range of controlled echo, is presented side-by-side with an optical projection of the same slide, with varying and controllable degrees of focusing. Color and contrast compensation are provided by a tinted projection screen and a controllable side light on the projection screen. By this system, the impairing effect of the echo is compared in subjective seriousness to that of a sharpness degradation.

By analyzing the vote between off-focus projections and television pictures, it is possible to determine how much the preference amounts to in the case of any given pair. The vote analysis consists of setting as one limen the difference between two pictures where 75 percent of the observers prefer the one to the other. The vote distribution is found to follow approximately the normal error law, so that the difference becomes two limens where the preference vote is about 91.1 percent, and three limens for 97.8 percent. The image quality difference between two pictures is measured by the number of liminal units computed from the vote preference.

Another Technique

The second system consists of presenting to the observer a picture affected by differing and controlled amounts of a given impairment in random sequence. The observer is asked to rate the impairment with any one of seven classifications from 1 (not perceptible) to 7 (not usable). The echo amplitudes are then plotted against the seven possible comments, and the resulting curve represents a median. From the distribution of votes around this median, it is also possible to set up a system of liminal difference ratings for the pictures. One

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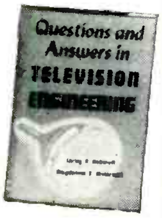

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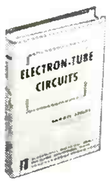

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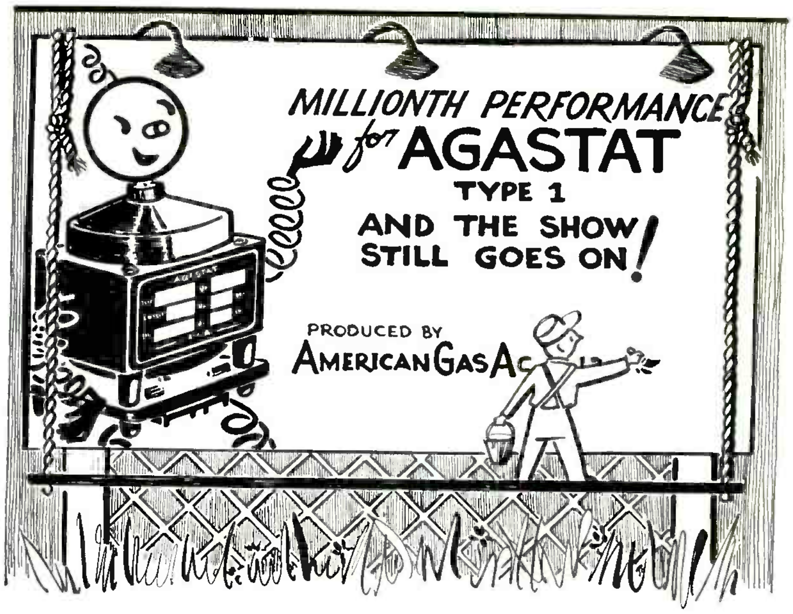

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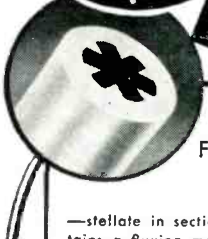

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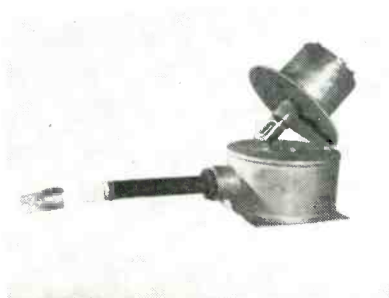
The first system is somewhat more complicated to set up, but the results obtained are more absolute, since only a comparison is involved, rather than evaluation in terms of words. The comparison system has also been applied to the comparison of sharpness as a quality parameter of the picture with highlight luminance and contrast ratio.

Multiplier Phototube Improvements

PHOTOMULTIPLIER tubes have become standard equipment in the fields of nuclear research, astronomy, photoelectric spectrometry, and other fields involving light measurements at extremely low intensities. A significant improvement in the type 1P21 has recently been announced by the RCA Tube Department.

The equivalent noise input of the improved 1P21 has been reduced to 5.1×10^{-13} lumen at room temperature. This value represents a sixfold reduction in operational noise and permits a corresponding reduction in the lower limit of measurable light intensities.

Typical application of the new tube in atomic research involves the use of a light-piping technique to measure radiation generated by a cyclotron. To overcome the problem of introducing a test instrument into the cyclotron itself, this technique utilizes a long light-conductive rod of quartz or clear plastic with a phosphor on the end of it. Flashes of light or scintillations produced when radioactive particle radiation strikes the phosphor are



Light-piping device for remote detection of radioactivity using an anthracene crystal coupled to a 1P21 multiplier phototube by a lucite rod conducted down the rod to the phototube, which is housed in a light-tight box outside the cyclotron. In this way radioactivity caused by the cyclotron beam can be conveniently and accurately measured.

The photograph shows the unit used in the Rochester cyclotron. The heavy shield guards the photomultiplier from the strong magnetic fields surrounding the cyclotron. The top section houses a 6J6 cathode follower which permits sending the photomultiplier signal over a 300-foot 93-ohm cable.

The anthracene crystal is mounted on the end of an 8-inch lucite rod which conducts scintillations caused by radioactive particles striking the crystal. The lucite rod is covered with black paper to keep out room illumination, and the crystal is wrapped with aluminum foil which is penetrable to the radioactive particles.

Transistor and Fieldistor

By Otmar M. Stuetzer

Controls and Systems Laboratory
Air Materiel Command
Wright Field, Ohio

Recently, development work on a high-input-impedance crystal amplifier, the fieldistor, was disclosed by the Air Force. It is related to and was evolved from the Bell transistor[1]. Although in the early stages of development and not industrially available, a brief comparison of the devices shall be given.

The transistor, fieldistor and germanium and silicon photocells have one essential element in common; a rectifying metal-to-semiconductor-contact, operated in the direction of high resistance. We will choose a germanium high-back-voltage rectifying contact to remind the reader of the present concept of such a function[2].

On a free surface, as well as under a negatively-charged metal electrode, the semiconductor is bound by a double layer, very much related to the one on a metal surface, which counteracts the enormous pressure of the electron gas. In our case it consists of a negative surface charge and a positive space-charge layer underneath, about 10^{-4}

cm thick. The latter is formed by the positively charged donator ions, about 10^{-6} cm apart, which are not compensated by free electrons as in the interior of the crystal.

A few mobile electrons, decreasing in number from 10^{18} from the inner part of the barrier layer to around a millionth of this value right under the surface, account for one part of the conductivity. If the carrier density decreases below a certain value, conduction due to defect electrons, or holes, becomes important. This will occur first close to the surface, as indicated roughly in Fig. 1 illustrating our concept. It might be increased by acceptor surface contaminations.

For the electron current indicated by arrows as flowing from the collector electrode into the semiconductor the barrier layer constitutes a high impedance; currently used contacts show about 10^4 to 10^5 ohms.

In this rather simplified concept surface charge, space-charge layer thickness, electron distribution, and hole distribution are in a complex mutual equilibrium. All semiconductor amplifiers or transducers work by disturbing this equilibrium, thus modulating the thickness of the space-charge layer and hence the impedance seen by the collector current.

In the semiconductor photocell f-i carriers are knocked out of the crystal lattice by photons. They diffuse into the barrier layer, decreasing its depth. In general, this action leads to a higher collector current. Sometimes the decrease in hole surface conduction, however, may be dominant.

The transistor is explained most simply by assuming that the current injected into the crystal by a second contact point, the emitter, is mostly carried by holes. These are attracted by the negatively-charged collector and modulate the

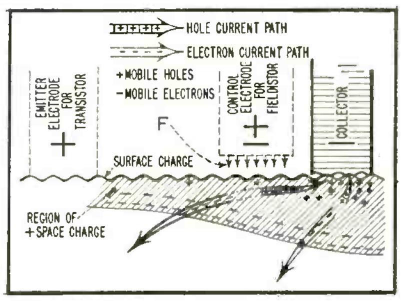


FIG. 1—Rectifying germanium contact control configuration

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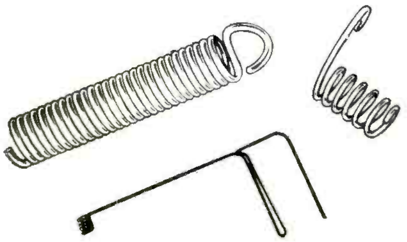

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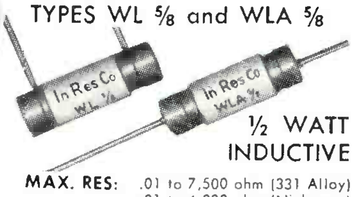

½ WATT INDUCTIVE

MAX. RES: .01 to 7,500 ohm (331 Alloy)
.01 to 4,000 ohm (Nichrome)
.01 to 1,250 ohm (Manganin)

BODY SIZE: ⅝" lg. by 3/16" diam

TOLERANCE: STANDARD 1%

TYPES WL and WLA

1 WATT INDUCTIVE

MAX. RES: .01 to 15,000 ohm (331 Alloy)
.01 to 8,000 ohm (Nichrome)
.01 to 2,500 ohm (Manganin)

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barrier depth around the collector.

The fieldistor applies a high electrostatic field F between the surface of the crystal and a control electrode, as indicated in Fig. 1. If the distance between is small enough (around 10^{-3} to 10^{-4} cm) a small voltage applied will create the high field strengths necessary for obtaining a controlling effect (around 10^4 volts per cm). The surface charges associated with the field will create free carriers according to Shockley and Pearson[3].

Impurities on the surface have a pronounced influence, possibly by electrochemical processes moving or creating acceptors or donors. The experimental fact is that sufficiently high field strengths of either sign will increase the current through the collector electrode.

Present Day Devices

The transistor, where the controlling electrode or emitter touches the surface and is operated in the forward direction, has necessarily a low input impedance. Its output impedance is close to that of the collector point contact. Representative values are 300 and 20,000 ohms respectively. The signal is applied on top of a bias current of several milliamperes at a few volts. As the current amplification factor is around unity, the transistor can be classified as a voltage amplifier.

The fieldistor has theoretically an infinitely high d-c input impedance like a vacuum triode, if we disregard leakage currents. Its output impedance is that of the contact. It needs only extremely small currents to control the collector current and may thus be considered as a current amplifier. A bias of around 10 volts is required. The voltage amplification is around unity for

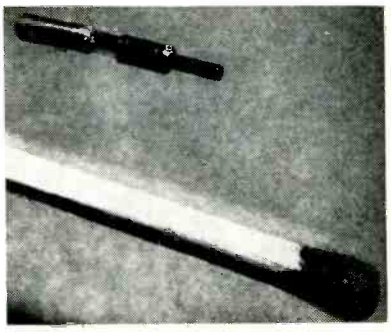

FIG. 2—Subminiature fieldistor

good samples and at low frequencies.

As the fieldistor resembles rather closely a vacuum triode, its performance can best be judged by its transconductance, the ratio of collector current change per volt signal. Twenty micromhos is a representative value, which looks very poor compared to vacuum tubes. Much higher values have been observed occasionally.

The noise figure of the two devices is about equally bad, which is to be expected.

The manufacturing of the fieldistor involves some problems, as the control electrode or electrodes have to be very close to the surface.

A subminiature model of the fieldistor is shown in Fig. 2.

For further information on performance and technique the author refers to more detailed publications.[4, 5]

REFERENCES

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(2) J. Bardean and W. Brattain, *Phys. Rev.* 75, p 1,208, 1949.
(3) W. Shockley and G. L. Pearson, *Phys. Rev.* 74, p 232, 1948.
(4) O. M. Stuetzer, Microspacer Electrode Technique (Submitted for publication in *Proc. IRE*).
(5) O. M. Stuetzer, High Input Impedance Crystal Amplifier (Submitted for publication in *Proc. IRE*).

Linear Sweep Generation

By DAVID SAYRE
Oxford, England

THE CONSTANT-CURRENT triode circuit can be made the basis of two linear sweep generators, one to generate a negative-going sweep and the other to generate a positive-going sweep. These circuits are accurate, reliable, easy to design and very economical.

Mathematical analysis indicates the desirability of using a high-μ tube. It is also desirable to use a tube with a short grid base, to minimize the effect of tube change on the exact cathode voltage and hence on plate current. The 6SL7 meets both these requirements very well.

Negative-Going Sweeps

If the constant current is made to pass through a capacitance C, as in Fig. 1, a negative-going linear sweep is formed at the plate;

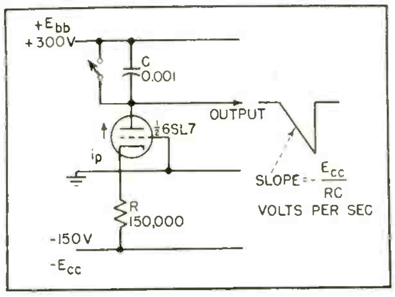

FIG. 1—Basic negative-going linear sweep generator

as long as the switch is closed the plate will be at E_{bb} volts and i_p will flow through the switch. When the switch is opened i_p must flow through C. The rate of change of voltage at the plate is $-i_p/C = -E_{cc}/RC$ volts per second. For the values of Fig. 1 the sweep thus falls at the rate of 1 volt per microsecond. By proper choice of these values sweep speeds much faster or much slower than this can be obtained. The sweep will continue until it has dropped to about 50 volts, or until the switch is closed again. At the end it will be falling about 2 percent slower than at the start.

Electronic Switch

For most applications the chief difficulty of this circuit is the switch. If the sweep is to run continuously the simple arrangement of Fig. 2 may be used. Here V_2, which acts as the switch, is turned on very hard momentarily by the incoming pulses and each time rapidly raises the output voltage to 300 volts. Since under such circumstances a section of a 6SN7 can conduct 100 ma or more, the duration of the pulses need be only $i_p/100$ (i_p in ma) of the duration of the sweep. For $i_p = 1$ ma a duty

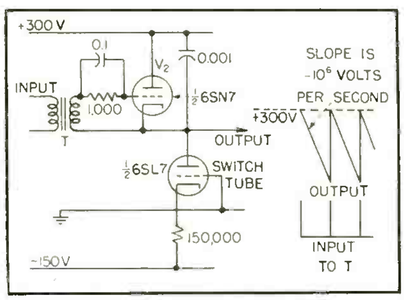

FIG. 2—Practical continuously-running negative-going linear sweep generator, using pulse input to actuate electronic switch

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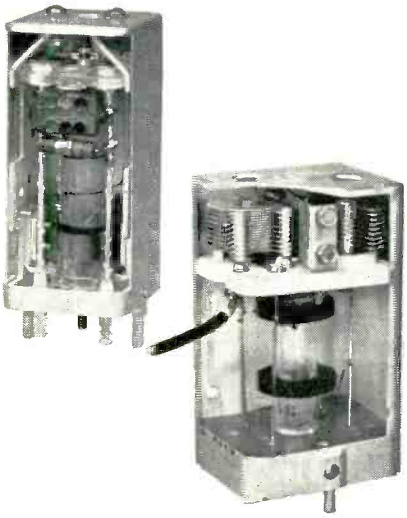

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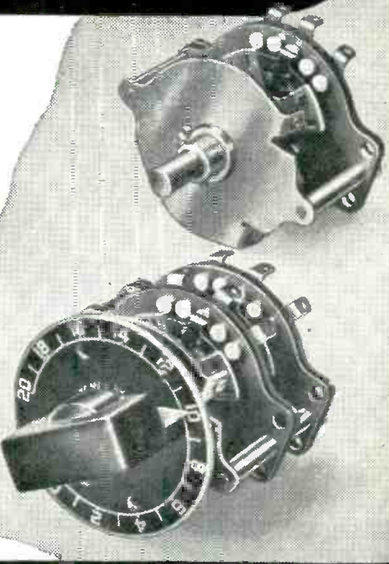

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During the sweep run-down, V_2 is cut off by grid-current bias accumulated across the grid RC network. Transformer T can be any pulse transformer. Usually there will be a blocking oscillator elsewhere in the circuit, in which case V_2 can simply be driven from the third winding on the blocking oscillator pulse transformer.

Positive Going Sweep

To obtain a positive-going sweep one must put C in the cathode circuit of the constant-current triode as in Fig. 3. This, however, causes the sweep to appear on the cathode; to keep the current constant, the sweep must be placed on the grid also. This is accomplished by C'. No current can be allowed to pass through C', however, for any such current would alter the current through C itself. For this reason the grid is returned to ground not by a resistor but by diode V_3, which is cut off all during the sweep.

As long as the switch is closed current i_p flows through it. When it is opened the current is diverted into C and the sweep rises at a rate of $i_p/C = E_{cc}/RC$ volts per second. The sweep will continue until the cathode of V_1 has risen to within about 50 volts of E_{bb} or until electronic switch V_2 is closed again by an input pulse.

With the values indicated, the positive-going circuit is suitable for generating a 250-volt linear sweep with a slope of 1 volt per microsecond. If the sweep is to run continuously the grid of switch tube V_2 should simply be supplied with short positive pulses. If single sweeps are required a negative gate of the desired duration must be supplied.

Comparison with Other Circuits

The positive-going circuit contrasts favorably with the ordinary bootstrap linear sweep generator. However, in the bootstrap circuit the charging current for C must flow through C' and both must be recharged after each cycle. Higher duty cycles are therefore easily obtained with the positive-going circuit. For the same reasons C' in the bootstrap version must be

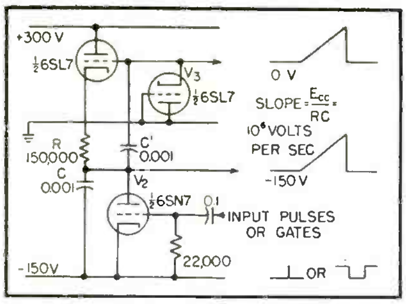


FIG. 3—Practical positive-going linear sweep with switch tube

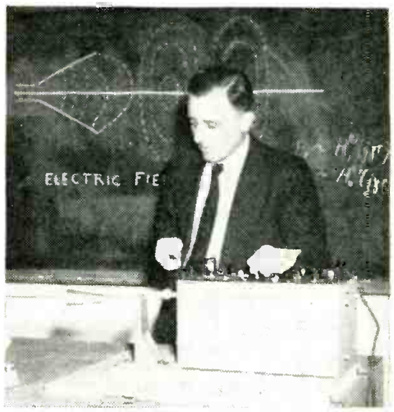
larger than C by a factor of 10 or more, whereas in the circuit of Fig. 3 it can be as small as 0.001 μf.

The two linear sweep generators described may properly be termed precision circuits. They are suitable for such applications as linear time-modulation, the measurement of short time-intervals as in radar ranging, and the generation of linear functions in electronic computers. Their accuracy is intermediate to those of the two principal methods now employed, the bootstrap and the Miller feedback circuits, being slightly better than the former and slightly poorer than the latter.

It is a characteristic of both these circuits that their output impedance is almost purely capacitive. Consequently the circuit which they are intended to drive may present an input admittance which is capacitive with no harmful effects other than a decrease in the slope of the sweep, but may not present a resistance without some differentiation of the sweep occurring. In this respect these generators resemble the bootstrap circuit but are inferior to the Miller feedback circuit, which has a low output impedance and can drive any type of load.

Surface Wave Transmission Line

A SINGLE wire, coated with a special insulation and terminated in funnel-shaped impedance-matching devices, as shown on the next page is a high-efficiency transmission device for microwaves. Signal Corps engineers at Fort Monmouth predict this sort of surface wave transmission line will replace coaxial cable and waveguide for many applications. Experimental models of the transmission line show its efficiency to be ten times that of com-



parable types presently in use. The device has been named, "The G-String"—after its inventor, George Goubau of the Signal Corps Engineering Laboratories.

SURVEY OF NEW TECHNIQUES

TO PRODUCE a stereoscopic effect, two television cameras are mounted side-by-side to view the object from slightly different angles. The tv signals corresponding to the two offset scenes are then transmitted to two kinescopes. The separate images are combined and viewed through special filters to give the three-dimensional pictures.

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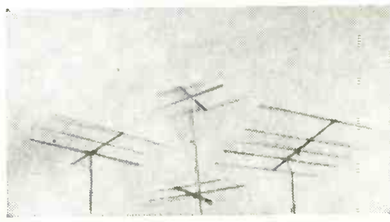
NEW PRODUCTS

(continued from page 126)

1×10^{-15} amperes. In the single-stage circuit the tube has sufficient reserve emission to provide operation for several thousand hours. In multistage circuits the filament power may be reduced to 5 mw or approximately 6 ma at 0.85 volt with stable, long-life operation.

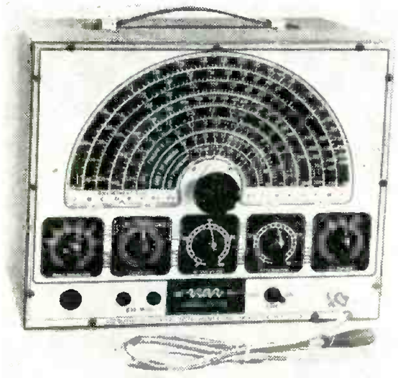
Mobile Transmitter-Receiver

GENERAL ELECTRIC CO., Syracuse, N. Y. Type ES-12-A mobile radio transmitter-receiver is a 10-watt unit designed to improve performance in the crowded r-f spectrum. Features include triple-tuned transformers for extra-high selectivity, peak audio output of 2 watts, adjustable i-f gain control, and built-in low-pass harmonic filter that reduces interference to other services, including television.



TV Antennas

LA POINTE-PLASCOMOLD CORP., Unionville, Conn. The J series of Yagi antennas feature high-gain and pinpoint directivity for fringe-area reception. Available in 3, 4 and 5 elements, the antennas incorporate clamp-type construction and are shipped completely assembled. Use of newly developed laboratory measuring equipment has made possible the construction of precision matching transformers (driven elements) insuring a perfect match to a standard 300-ohm transmission line.

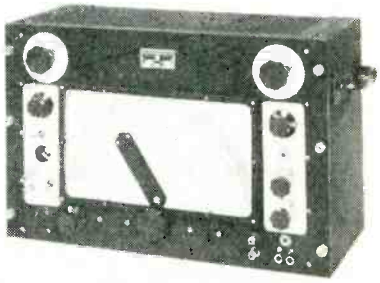


Signal Generator

APPROVED ELECTRONIC INSTRUMENT CORP., 142 Liberty St., New York 6, N. Y. Model A-200 signal generator's external appearance features nonglare multicolor frequency dial scales and controls in one convenient line. Controls from left to right are band selector, selector modulation, attenuator and multiplier. The unit covers eight r-f bands; 100 to 250 kc; 190 to 500 kc; 420 to 1,000 kc; 1,000 to 3,000 kc; 3.0 to 9.0 mc; 9.0 to 25 mc; 18 to 50 mc and 27 to 75 mc.

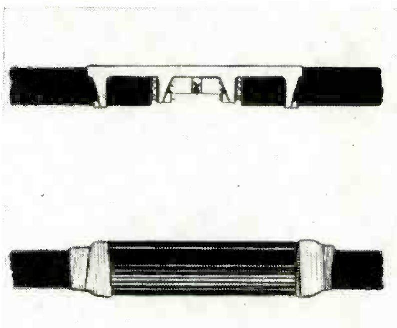
Dynamic Microphones

AMERICAN MICROPHONE CO., 370 South Fair Oaks Ave., Pasadena 1, Calif., announces two new type dynamic microphones. Model D33 is designed for all audio pickup in tv, a-m and f-m broadcasting and recording; and the D22 is designed for less critical public address and recording. The D33 has two impedances (33-50 and 250 ohms) with an adjustable jumper for changing from 30-50 to 250 ohms. The D22 has two impedances: low (30-50 ohms) and high (40,000 ohms) with jumper for convenient changing. Both models have omnidirectional pickup, high output levels, minus 52 db. No preamplifier is required.



Audio Sweep Oscillator

THE CLOUGH BRENGLE CO., 6014 Broadway, Chicago, Ill. Model 282-A Audiomatic generator functions as an audio sweeper and a beat-frequency-type audio oscillator with less than 0.5-percent distortion. A continuously adjustable swept segment width between 500 and 10,000 cycles can be selected to start at any frequency between 50 and 32,000 cycles. Thus discontinuities in a response curve may be spread out and examined in great detail.



Coax Splicing Clamp

BRACH MFG. CORP., 200 Central Ave., Newark, N. J., has produced a new copper clamp for splicing coaxial cable. The accessory will prove very convenient when a householder wishes to remove a receiver to another portion of the room beyond the range of existing cable length. Illustrated are (1) two ends of coax cable joined and

held by the clamp, and (2) the Vinyl sleeve fitted over the connection and taped at the ends.

Broadband Noise Source

POLYTECHNIC RESEARCH AND DEVELOPMENT CO. INC., 202 Tillary St., Brooklyn 1, N. Y. Type 904 vhf-uhf noise generator permits direct measurement of the noise factors of r-f amplifiers and receivers operating in the range from 10 to 1,000 mc. A coaxial diode placed in a well-terminated 50-ohm transmission line is used to generate noise power. A front panel control adjusts diode filament voltage, the resulting plate current being indicated on a d-c milliammeter calibrated to read noise factor directly in db.

Heater-Cathode Rectifier

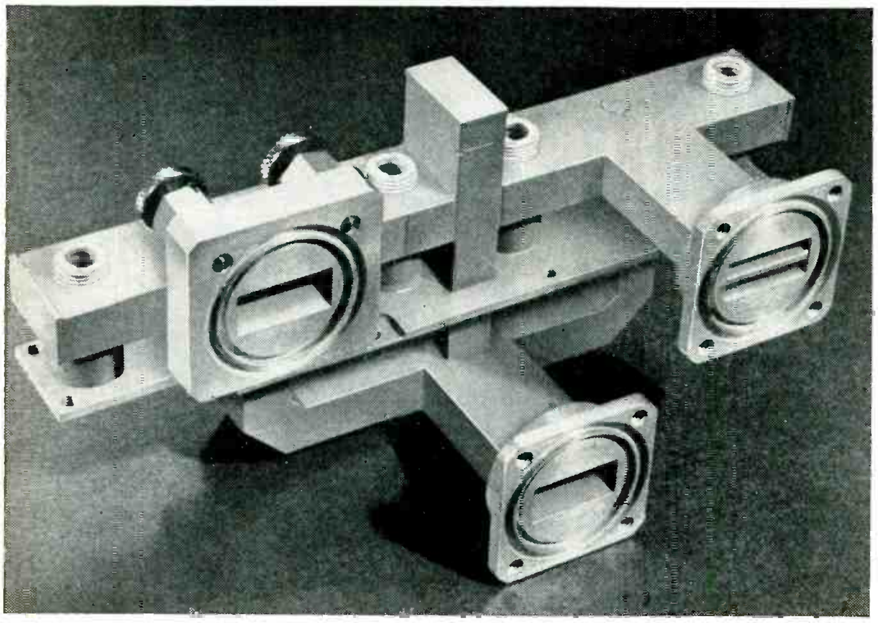
SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 6AX5GT full-wave heater-cathode type rectifier does not require a special filament transformer. This characteristic prevents excessive voltages across filter capacitors that often occur during warmup of filamentary type rectifiers. High d-c output also makes the tube suitable for rectifier replacement in automobile radio receivers.

Coils and Chokes

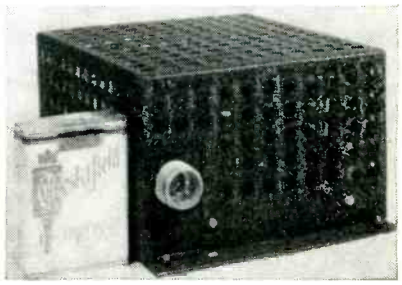
SHALLCROSS MFG. CO., 10 Jackson Ave., Collingdale, Pa., has introduced a new line of coils and chokes adaptable to tailor-made specifications. Types include high-Q r-f chokes, progressively-wound slug-tuned broadcast coils and oscillator coils. The r-f chokes may be made up as two separate coils having a specified coupling coefficient. High-permeability iron cores are sometimes used to provide greater inductance in a small unit.

Pressure Transmitter

FREDRIC FLADER, INC., 583 Division St., North Tonawanda, New York. The Teledyne electrical pressure transmitter, for use with corrosive mediums such as red fuming nitric acid, employs four active 300-ohm bonded strain gages arranged in a Wheatstone bridge circuit. It is available in ranges from 100 to 5,000 psi. Powered by a maximum voltage of 18 volts, the instrument produces a full scale output of 50 mv open circuit. Output is linear with pressure and its repeatability is better than 0.25 percent of full scale. The undamped natural fre-

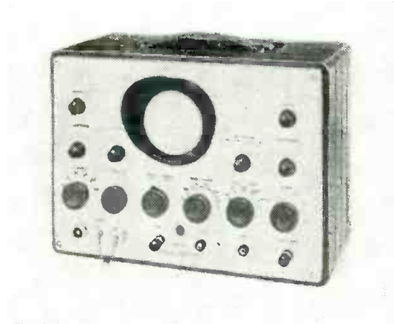


quency is over 1,500 cps, depending upon the range.



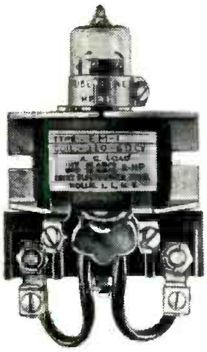
Phase Adapter

VARO MFG. CO., INC., Box 638, Garland, Texas. Model 160 electronic phase adapter changes single-phase, 115-volt 400-cycle current to three-phase, 115-volt at 100 va. Output voltage on all phases is equal to input voltage ± 3 percent over wide ranges of input voltage and frequency, load and power factor, temperature and altitude. It has no moving parts. Weight is $6\frac{3}{4}$ lb and volume, 168 cu in.



Service-Type Oscilloscope

RADIO CORP. OF AMERICA, Harrison, N. J. Type WO-57A portable oscilloscope, especially suited to television servicing, is an instrument of high sensitivity and wide frequency range which is equally useful in shop, lab or factory, for viewing and measuring square waves, pulses and tv sync signals. Deflection sensitivity of the instrument is better than 30 mv per in. Frequency response of the vertical amplifier is flat within 2.3 db from 0 to 500 kc, down only 6.8 db at 1 mc and useful beyond 2 mc. Featured are a direct-coupled vertical amplifier which is used to provide flat low-frequency response, a high-frequency square-wave response up



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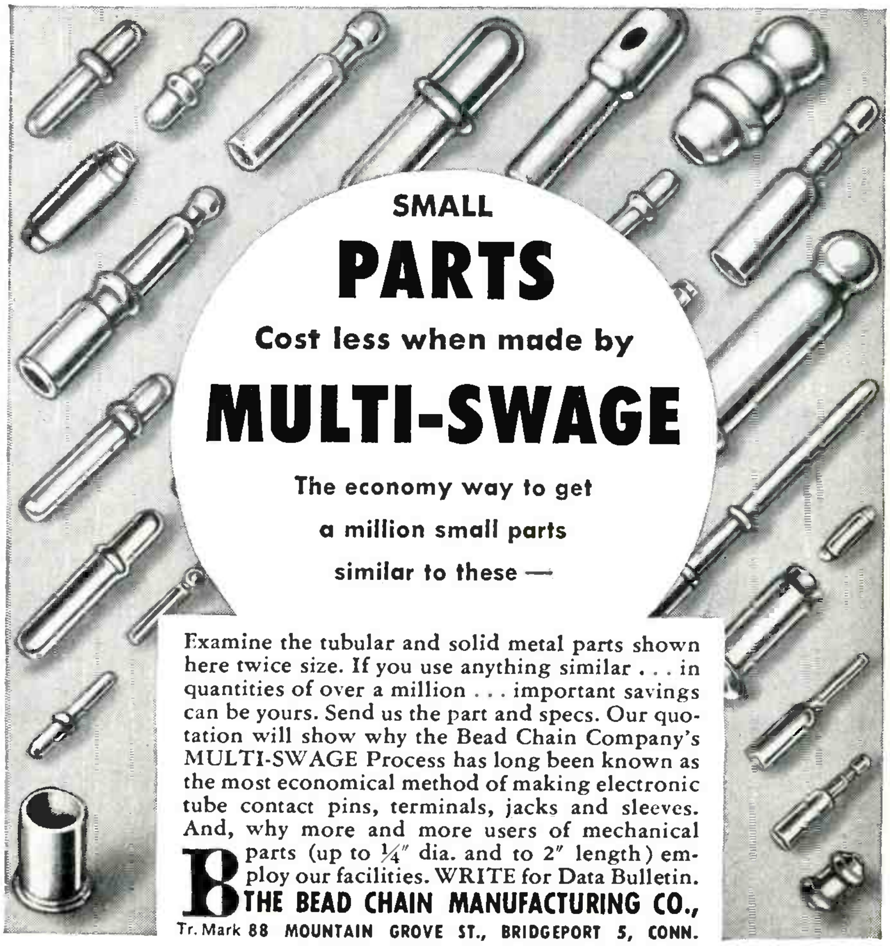

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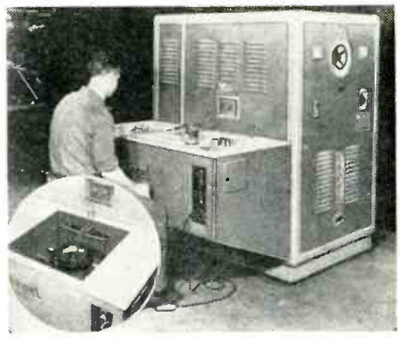
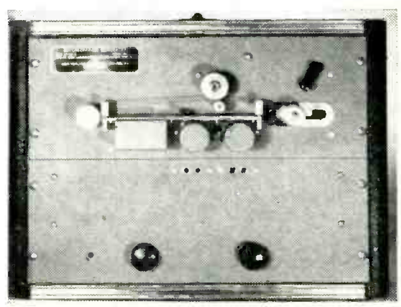
to 100 kc, a tilt and overshoot of less than 2 percent and a linear sweep range from 15 to 30,000 cps.



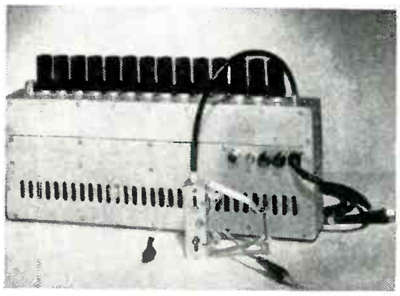
Work and Quench Table

LEPEL HIGH FREQUENCY LABORATORIES, INC., 39 W. 6th St., New York 23, N. Y., has designed a combination work table and quench tank that can be easily attached to vacuum-tube or spark-gap converters. With the sink cover on, the combination unit forms a work table 29 in. × 56 in. for mounting work coils and fixtures; with the sink cover off (illustrated lower left) there is a quench tank 24 in. × 24 in. × 18 in. deep, fed by a 1-in. water line, solenoid controlled. Heating and quenching cycles are controlled by a three-circuit timer operated by pushbutton or foot-switch.



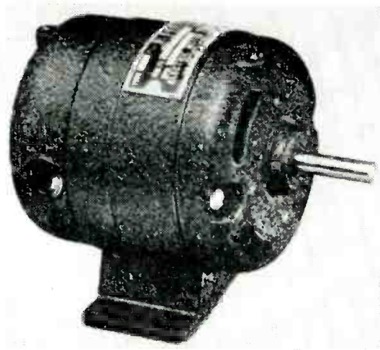
Reverberation Generator

AUDIO FACILITIES CORP., 608 Fifth Ave., New York 20, N. Y., offers the artificial reverberation generator, a new unit for the addition of reverberation to radio, video and recorded sound channels. It uses a magnetic tape delay system combined with a new re-entrant electronic system. Consisting of two 7-in. rack panels, the basic unit will work in conjunction with most broadcast-type audio consoles. For use in other services the instrument is available with its own microphone preamplifier, isolation amplifier, control panel, vu meter and sound effects filter.



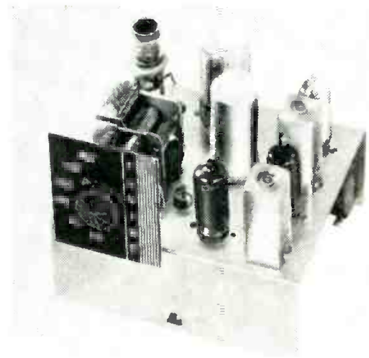
Chain Pulse Amplifier

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 214 chain pulse amplifier has been specifically designed to amplify very fast pulses and transients. Employing fourteen 6AH6 vacuum tubes in a traveling-wave circuit, it has a bandwidth of 40 kc to 100 mc and a gain of 30 db. The input impedance of 180 ohms is designed to match the output impedance of the series 200 wide-band chain amplifiers for additional gain up to 60 db. The amplifier finds many applications in nuclear physics, radar, high-speed oscillography, television testing and general laboratory measurements.



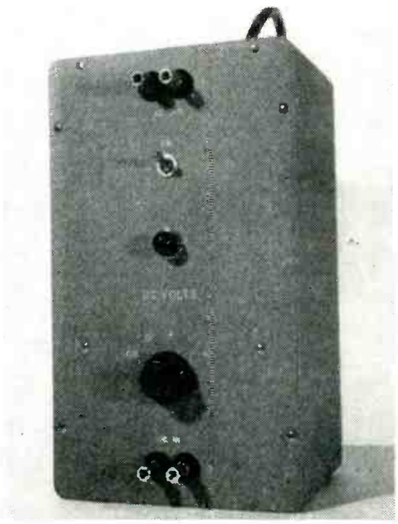
Fractional H-P Motor

ELECTRIC MOTOR CORP., DIVISION OF HOWARD INDUSTRIES, INC., Racine, Wisc., has announced development of model 1100 fractional h-p motor. The dynamically-balanced single-shaft unit is a brush-type universal motor of 1/20 h-p intermittent duty and 1/25 h-p continuous duty. It can be equipped with any of the company's gear reduction units with hundreds of ratios available for low output speeds.



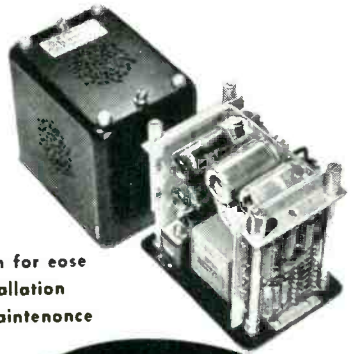
Broadcast Tuner

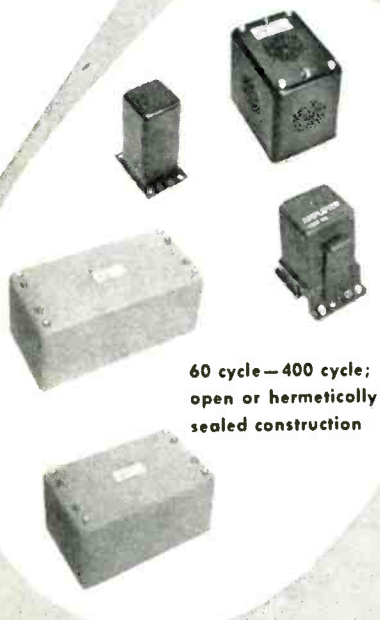
APPROVED ELECTRONIC INSTRUMENT CORP., 142 Liberty St., New York, N. Y. Model A-600 AC broadcast tuner is a standard superheterodyne in miniature size. Audio output is adjustable in 10, 5 and 1-volt steps. Power consumption is 25 watts, and total current, 25 ma. The power supply is a standard 117-volt, 60-cycle full-wave rectifier.



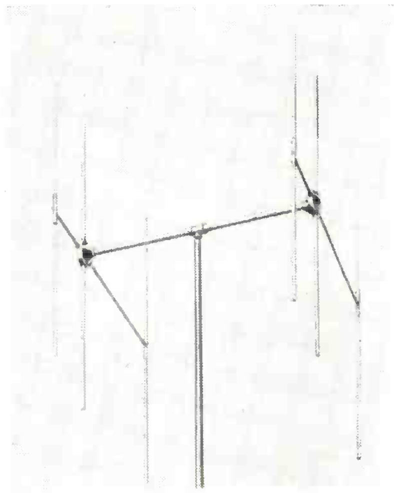
D-C Millivoltmeter

INDUSTRIAL CONTROL Co., 1462 Undercliff Ave., New York 52, N. Y. Type 200-A d-c millivoltmeter can detect d-c voltages as low as 5 μv, or with suitable shunts, currents to a level of 10^{-11} ampere. Output is an a-c voltage, the rms magnitude of which is precisely 1,000 times that of the d-c input. There is no drift in the instrument. No zero set or balance controls, or calibration checks during measurement are





necessary. A dynamic range of 10,000 to 1 and linearity of the output-input proportion are other advantageous features.

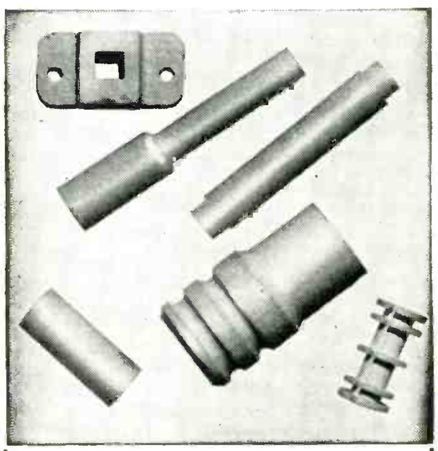


Bidirectional Antenna

The Workshop Associates, Inc., 66 Needham St., Newton Highlands 61, Mass., has announced a high-gain bidirectional antenna for straight line communication. Present models cover the frequencies from 30 to 50, 74 and 140 to 174 mc. Each antenna has a 4.5-db gain in each of two opposite directions, a 68-deg horizontal half-power angle, and a front-to-side ratio of over 30 to 1. The antennas are designed for communication to several stations along a straight line. High gain decreases the number of separate installations required, and rugged construction enables maintenance-free operation.

Sharp-Cutoff Pentode

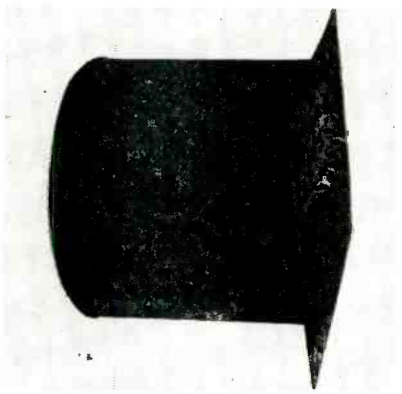
Radio Corp. of America, Harrison, N. J. The 6AS6 sharp-cutoff pentode of the 7-pin miniature type is designed so that grid 1 and grid 3



can each be used as independent control electrodes. It is especially useful in gated amplifier circuits, delay circuits, gain-controlled amplifiers and mixer circuits. The tube can also be used as an r-f amplifier at frequencies up to about 400 mc.

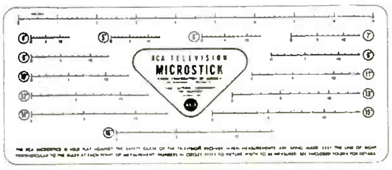
Crystal Calibrator

MEASUREMENTS CORP., Boonton, N. J. Model 111 crystal calibrator is used for the frequency calibration of equipment in the 250 kc to 1,000-mc range. Frequency accuracy is ± 0.001 percent. A new circuit arrangement utilizes the cross-modulation products of three separate oscillators operating at the fundamental frequencies of 0.25, 1.0 and 10 mc. It contains a receiver with a sensitivity of 2 microwatts.



Frequency-Sensitive Relay

VARO MFG. CO., INC., Box 638, Garland, Texas. The 900 series frequency-sensitive relay, designed to open a 400-cycle supply circuit when the frequency falls below a predetermined safe point, has 5-ampere dpdt contacts. It may be used on voltages from 75 to 150 at frequencies from 350 to 1,000 cps without injury to the relay circuit.



TV Microsecond Scale

RADIO CORP. OF AMERICA, Harrison, N. J. The Microstick is a transparent ruler for measuring the duration in μsec and determining the frequency of video signals displayed on the kinescope of a tv receiver. It is intended primarily to aid students and technicians in gaining a clearer understanding of time factors in tv. It is also useful in determining picture bandwidth of receivers, calibration of test-pattern wedges, frequency of beat interference and ringing, and other measurements helpful in servicing tv receivers. An illustrated descriptive folder is available.

D-C/A-C Chopper

STEVENS-ARNOLD INC., 22 Elkins St., South Boston 27, Mass. Type 268 d-c/a-c chopper is rated at 10 to 500 cps. It may be used as a modulator to convert pure d-c into pulsating d-c or a-c; and as a demodulator to reconvert to d-c. Contact arrangement is spdt, break-before-make, in air. Nominal ratings are 10 volts, 0.001 ampere d-c, but both values may be exceeded

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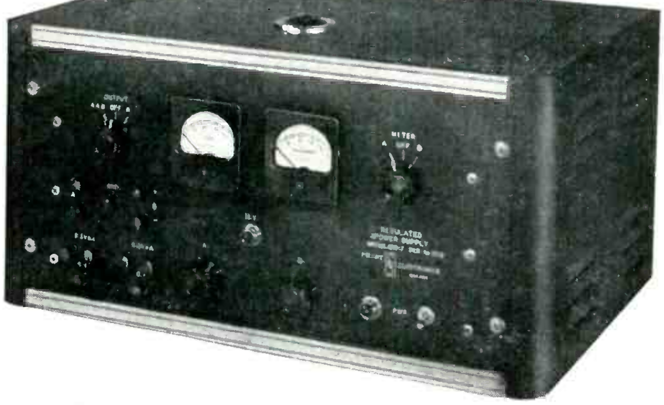

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- 6.3 and 12.6 V.A.C. Outputs Provided.
- A.C. Ripple Less than 10 Millivolts.

MODEL 1210

- Precise Electronic Regulation.
- 2 Independent Sources of Power.
- 0-500 V.D.C. at 0-150 Milliamperes. Continuously Adjustable.
- 0-500 V.D.C. at 0-300 Mils if the 2 Sources are Combined.
- Both D.C. Outputs Metered for Voltage or Current.
- 6.3 or 12.6 V.A.C. Outputs Provided.
- A.C. Ripple Less Than 10 Millivolts.

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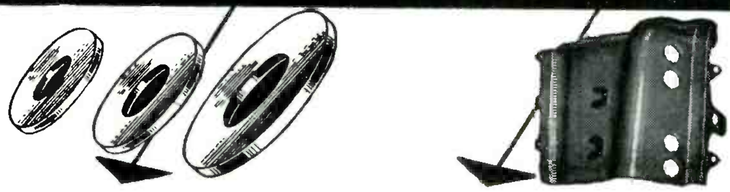

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on an intermittent basis, for example, in servomechanism applications.

Two-Way Mobile Radio

MOTOROLA INC., 4545 Augusta Blvd., Chicago 51, Ill., is producing a new f-m two-way mobile radio unit designed specifically for adjacent-channel systems. The Uni-Channel Sensicon Dispatcher is available for operation in the 25 to 50-mc or the 152 to 174-mc land mobile service bands. Outstanding engineering elements are the instantaneous deviation control of the transmitter carrier and the broad-nose steep skirt selectivity characteristic of the receiver. Rated r-f power output is 12 watts in the low band and 10 watts in the high band. Models are available for operation from 6-volt d-c or 117-volt a-c primary power sources.

Standoff Capacitor

ELECTRICAL REACTANCE CORP., Franklinville, N. Y. The MCS metal-clad standoff capacitor has a capacitance of 1,500 $\mu\mu$f $\pm$ 500 $\mu\mu$f and is a quick-mounting type with a solid axial terminal. The ceramic tube is enclosed in a cadmium-plated metal case with a specially developed end seal for protection against humidity and temperature changes.

TV Receiving Tubes

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces the types 1V2, 6AU5GT and 6CB6 television receiving tubes. Principal application of the 1V2 miniature half-wave rectifier is as a high-voltage rectifier. The 6AU5GT beam power amplifier is intended for use as a horizontal deflection amplifier. The 6CB6 miniature-type sharp-

cutoff pentode is to be used as an i-f amplifier replacing, in many circuits, the 6AG5.

Vibrating Switch

SERVOMECHANISMS, INC., Old Country and Glen Cove Roads, Mineola. N. Y. The Mini-Chopper, type CP-101, is a miniature electromechanical device for converting a d-c signal into an a-c signal. Conversely, it can be employed to translate an a-c signal into a pulsating d-c signal. The unit fits a standard 7-pin miniature tube socket and can be clamped in place using the tube shield. Contacts are spst.

Literature

Geiger-Counter X-Ray Spectrometer. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y. A 24-page booklet covers the new Geiger-counter x-ray spectrometer, a high-precision analysis instrument. Technical description, outline of performance, illustrations and charts are included.

High-Fidelity Equipment. University Loudspeakers Inc., 80 South Kensico Ave., White Plains, N. Y. A new six-page illustrated catalog devoted to a line of high-fidelity equipment includes cone speakers, tweeters, tweeter adapters, crossover networks and coaxial speaker systems. The publication gives complete installation instructions for each model and also announces the new 12-in. 30-watt wide-range cone speaker.

Sweep Generators. Manufacturers Engineering & Equipment Corp., Willow Grove, Pa. Two four-page folders describe and illustrate the Sweepmaster I video sweep generator and Sweepmaster II r-f and i-f sweep generator. Chief features, specifications and applications are given, and standard equipment for each is listed.

Connector Bulletin. Cannon Electric Development Co., 3209 Hum-

boldt St., Los Angeles 31, Calif., has issued a revised 48-page, two-color engineering bulletin on types K and RK connector series which are widely used in aircraft, radio, radar, phone recorder connectors, Geiger counters, instruments, geophysical and camera equipment, transmitters, control panels, oscillographs, potentiometers, c-r recorders, general electrical and electronic equipment.

Radio Parts. The Ucinite Co., Division of United-Carr Fastener Corp., Newtonville 60, Mass. A 33-page loose-leaf-perforated catalog covers a wide variety of radio parts including anode connectors, sockets, tv components, connectors, stand-off terminals, lamp socket assemblies and shock mounts. Dimensional drawings and descriptions are given.

Sharp-Cutoff Pentode. Radio Corp. of America, Harrison, N. J., has published a four-page technical bulletin on the 5879 sharp-cutoff pentode of the 9-pin miniature type intended for use as an audio amplifier in applications requiring reduced audio noise. The tube described is especially useful in the input stages of medium-gain public-address systems, home sound recorders and general-purpose audio amplifiers.

Motor Starting Capacitor. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin 511 illustrates and describes type ETW 4190 electrolytic motor-starting capacitor in Bakelite container which is $1\frac{7}{16}$ in. in diameter and $2\frac{3}{4}$ in. long. Capacitance and voltage rating of the unit described are 110 volts a-c, 60 cycles, 124 to 149 μf and maximum ambient temperature, 65 C.

Vibration Isolators and Mounting Bases. The Berry Corp., 177 Sidney St., Cambridge 39, Mass. Catalog 502 illustrates and describes unit-type air-damped mounts and mounting bases used to protect electronic equipment and other sensitive apparatus against shock and vibration in aircraft applications. Photographs and dimensional drawings, plus tables of available load ratings, help the designer in specifying suitable mountings.

Electric Timing Motors. Haydon Mfg. Co., Inc., Torrington, Conn., offers an informational catalog of special interest to users of electric timing motors as components of their products. The 8-page 2-color, file-size booklet gives a comprehensive listing of available electrical timing motors. A full line of standard motors is shown, complete with photographs, dimensional drawings, circuit diagrams and data on standard specifications and ratings of each unit. Ask for catalog No. 322.

Components. Electrical Reactance Corp., Franklinville, N. Y. The Datalog is a 32-page booklet for producers of television and radio equipment and other electronic devices. In addition to complete Hi-Q product information on capacitors, trimmers, resistors and choke coils, it contains a great deal of helpful technical data carefully arranged for convenient, quick reference.

Miniature Tube Guide. Hytron Radio & Electronics Corp., Salem, Mass., recently issued the new 4th edition of the reference guide for miniature electron tubes. It lists all minatures to date, regardless of make, and similar larger prototypes. Included are 132 tubes, 41 of them new, and 70 basing diagrams.

TV Optical Projector. Gray Research and Development Co., Inc., 16 Arbor St., Hartford 1, Conn. A recent 6-page folder illustrates and describes the Telop television optical projector for use with film cameras. The unit described features four optical openings for dual projection of opaque cards, photographs, art work, glass slides, transparencies, strip material and small objects.

Geiger Counter Booklet. National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D. C. The nature, construction and use of the G-M counter is concisely presented on an elementary level in a new booklet, Circular 490. Included are a number of examples of special forms of counters which have been developed and a discussion of some of the electronic circuits commonly used to obtain an indication of the response of the counter to radiation. A bibliography of scientific papers is also presented. The booklet is available from the Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C., at 20 cents a copy.

Germanium Diodes. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has published a new booklet, profusely illustrated with typical circuits for forty basic germanium diode applications. Text of the booklet is grouped in three sections which describe germanium diode applications in radio and television receivers, radio transmitters and amplifiers, and a wide range of instruments and supervisory circuit devices.

Nuclide Chart. General Electric Co., Schenectady 5, N. Y. Information on more than 1,000 kinds of atoms is given on a new chart being distributed free to scientists in industrial laboratories, colleges and universities. Printed in checkerboard fashion each of the 96 chemical elements which were known at the beginning of the year is given in a horizontal line, in which a square is devoted to each kind of atom or isotope of that element. Position of the square on the chart shows the composition of its atomic nucleus.

Insulation Tester. The Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y. Bulletin 465 describes the Major Megohmer, a new small, portable, handcrank insulation tester. The instrument treated combines small size and weight with constant pressure d-c generator, and features an extra ohm scale.

Six New Tubes. Eitel-McCullough, Inc., San Bruno, Calif., has issued a small 10-page booklet illustrating and describing six new tubes: the 16AP4 tv picture tube, the 4E27A/5-125B power pentode, the 4X150G power tetrode, the 592/3-200A3 power triode, and the 3X10-000A3 and 3W10000A3 power triodes.

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Literature on request

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NEWS OF THE INDUSTRY

(continued from page 130)

try in general. The part of the program relating to the development of a common system of air navigation and traffic control is sponsored by the Air Navigation Development Board.

Flight Radio Operators

A RECENT report from the Civil Aeronautics Board indicates that radiotelephone communication from aircraft in overwater flight is so reliable that a properly licensed navigator-operator will be sufficient in the future. At the same time, CAB indicates that under certain conditions of oversea flight it would be advisable for aircraft to be provided with equipment for contacting surface vessels on the international distress frequency of 500 kc, using radiotelegraphy. At the FCC, however, doubt exists that Atlantic City regulations permit carrying such an operator whose qualifications are less than Second Class Radiotelegraph. The Commission is prohibited from waiving requirements of a licensed operator in the case of a station where an operator is required to be provided for safety purposes. The operator unions oppose complete adoption of radiotelephone on the grounds that only a skilled radio-telegraph operator can successfully establish emergency communications.

New Betatron Installed

ONE of the most powerful atom smashers of its type in the world, a 100,000,000-volt betatron built by the General Electric Co., is now installed and undergoing tests at the University of Chicago. The 160-ton unit is being used for atomic research and x-ray studies by the experimental staff of the University of Chicago's Institute for Nuclear Studies. Effects of powerful radiation on biological organisms will also be studied.

Operation of the betatron involves use of a huge electromagnet to accelerate and maintain electrons in a circular path around a doughnut-shaped acceleration chamber. At a predetermined time, the path of the electrons is changed slightly so they strike a small piece of metal inside the chamber, producing an x-ray beam. These x-rays are many times more penetrating than those produced by conventional x-ray machines and by radioactive substances such as radium.

ELK ELECTRONIC LABORATORIES, specializing in design and development of test equipment for the communications, radar and allied fields, have moved to larger modern quarters at 333 W. 52nd St., New York, N. Y.

GENEVA ELECTRIC & TELEVISION CORP. recently acquired 73 percent of the stock of Continental Electric Co., Geneva, Ill., manufacturer of phototubes and photoconductive cells. Continental Electric, in the reorganization, acquires a new building and will set up facilities for the manufacture of tv picture tubes of all sizes.

TELREX, INC., Asbury Park, N. J., designers and manufacturers of antennas, will supplement existing facilities with a new laboratory now being constructed in Belmar, N. J.

POTTER INSTRUMENT CO., INC., manufacturer of high-speed electronic counters, computers and associated equipments, has moved from Flushing, N. Y., to a new plant at 115 Cutter Mill Road, Great Neck, N. Y.

SPELLMAN TELEVISION CO., INC., manufacturers of high-voltage power supplies, coils and projection tv equipment, recently moved to new and larger quarters at 3029 Webster Ave., Bronx, N. Y.

THE HELIPOT CORP., manufacturers of equipment for precision electronic circuits, recently moved into a modern new home in South Pasadena, Calif.

CLAUDE NEON, INC., New York, N. Y., recently acquired 100 percent of the stock of Standard Electronics Corp. The new Claude Neon subsidiary has taken over Western Electric Co.'s inventories of a-m and f-m transmitting equipment, replacement parts, product designs and drawings, and will service and supply replacement parts for all Western Electric broadcast transmitting equipment in the U. S.

ACCURATE MFG. CO., manufacturer of friction and rubber tapes, has completed expansion of its plant at Garfield, N. J., for the improvement of processing and products.

MARVIN HOBBS, consulting electronics engineer of Chicago, Ill., has been appointed deputy executive director of the Electronics Division of the Munitions Board in the Department of Defense.


M. Hobbs

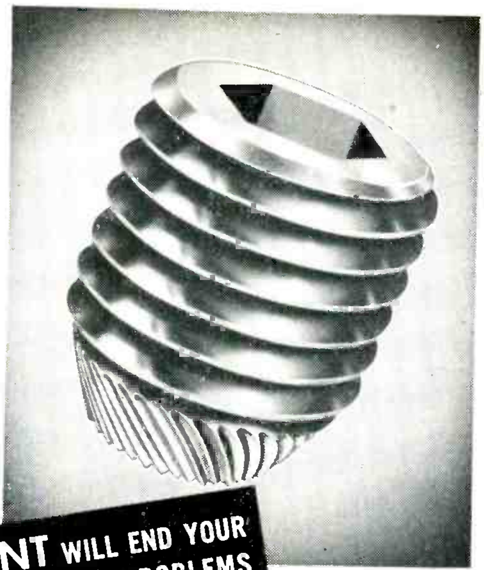

W. A. Mussen

WILLIAM A. MUSSEN, previously associated with the U.S. Naval Ordnance Laboratory in radio proximity fuze development and instrumentation, was recently appointed supervisor of the electronics laboratory at Southwest Research Institute, San Antonio, Texas.

HORACE E. SLONE, radio engineer for the FCC since 1946, is now electronic engineer for the Commission's new Office of Formal Hearing Assistants.

H. A. MCILVAINE, identified with early crt experiments, has been elected president of Continental Electric Co., Geneva, Ill., manufacturers of thyratrons, rectifiers and other industrial tubes. The company expects to set up facilities soon for the manufacture of all sizes of television picture tubes, cold-cathode 8-foot fluorescent lamps and bactericidal lamps.

S. M. DECKER, formerly assistant chief engineer at Garod Radio Corp., has been appointed assistant chief engineer of the television department of Air King Products Co.,



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WITH MONEY-SAVING KNURLED POINT
"WON'T SHAKE LOOSE"

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Only *with* CO-AX

air-spaced articulated
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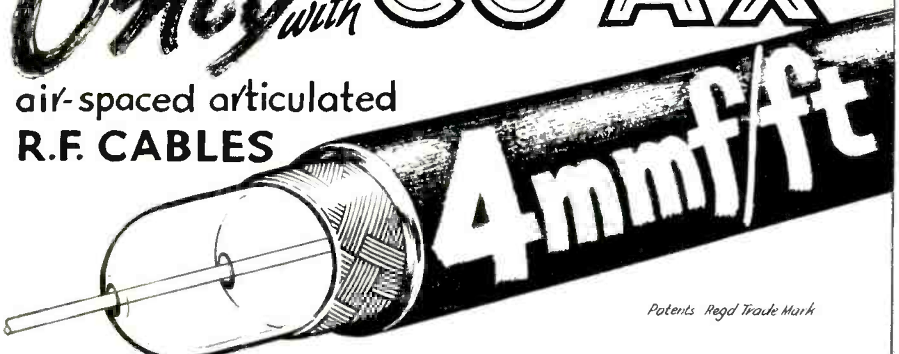

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Billed in Dollars Settlement by your check. Transaction as simple as any local buy.

LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft at 100 Mc/s.	LOADING Kw at 100 Mc/s.	O.D."
A 1	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

HIGH POWER FLEXIBLE

LOW CAPAC TYPES	CAPAC mmf/ft	IMPED OHMS	ATTEN db/100ft 100Mc/s	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.1	1.03

PHOTOCELL CABLE

V.L.C. ★

★ *Very Low Capacitance cable.*

TRANSRADIO LTD
CONTRACTORS TO H.M. GOVERNMENT
138A CROMWELL ROAD·LONDON SW7. ENGLAND
CABLES: TRANSRAD. LONDON.

ATR

"A" BATTERY ELIMINATORS

Makes it easy
to DEMONSTRATE AND TEST D.C. APPARATUS FROM A.C. LINES

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New Models . . . Designed for testing D. C. Electrical Apparatus on Regular A. C. Lines. Equipped with Full-Wave Dry Disc Type Rectifier, Assuring Noise-less, Interference-Free Operation and Extreme Long Life and Reliability.

✓NEW MODELS ✓NEW DESIGNS ✓NEW LITERATURE

"A" Battery Eliminator, DC-AC Inverters
Auto Radio Vibrators

ATR *See your jobber or write factory*

AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA–U. S. A.

Inc., Brooklyn, N. Y., manufacturers of radios, wire recorders and television receivers.

ALFRED ZUCKERMAN, chief engineer in charge of design and development, is now also vice-president of David Bogen Co., Inc., New York, N. Y., manufacturers of sound equipment.

A. Zuckerman

D. B. Sinclair

DONALD B. SINCLAIR has been promoted from assistant chief engineer to chief engineer at General Radio Co., Cambridge, Mass. He succeeds Melville Eastham who retired early this year.

HARRY R. SEELEN, manager of the services group for the past seven years, has been appointed manager of the engineering section of the RCA tube department, Lancaster, Pa.

PHILLIP B. LAESER has been promoted from chief television engineer to manager of radio and television engineering for The Journal Co., Milwaukee, Wisc.

ROBERT W. SANDERS, for the past eleven years chief engineer of the advance development section at Capehart-Farnsworth, Ft. Wayne, Indiana, has been appointed chief radio and television engineer at the Los Angeles plant of the Hoffman Radio Corp.

FREDERIC C. YOUNG, formerly vice-president in charge of research and engineering and a director of Stromberg-Carlson Co., recently became vice-president of Designers for Industry, Inc., Cleveland, Ohio.

DONALD E. STEELE, recently resigned from the engineering specifications department of Raytheon Mfg. Co., Waltham, Mass., has joined Arthur E. Akeroyd, manufacturers' representative, Boston, Mass.

LYNN C. HOLMES, senior electrical engineer in the research laboratory since 1943, was recently made associate director of research at Stromberg-Carlson's research laboratory, Rochester, N. Y.

L. C. Holmes

L. T. DeVore

LLOYD T. DEVORE, formerly on the staff of the electrical engineering department at the University of Illinois, was recently named manager of the Electronics Laboratory of General Electric Co., Syracuse, N. Y.

ALBERT C. HALL, director of MIT's dynamic analysis and control laboratory since 1946, has been appointed associate technical director of Bendix Aviation Research Laboratories, Detroit, Michigan.

HAROLD HIGGS, previously chief of electronic service for the Bell Aircraft Corp., has been named chief electronics engineer of Jeffers Electronics Inc., Dubois, Pa., a subsidiary of Speer Carbon Co., St. Marys, Pa.

HAROLD W. SCHAEFER, formerly director of research and engineering on radio and television receivers for Westinghouse, was recently appointed special assistant to the director of research and engineering at Philco Corp., Philadelphia, Pa.

LOUIS KAHN, formerly assistant chief engineer, was recently appointed director of research of Aerovox Corp., New Bedford, Mass.

DAYTON ULREY has retired as chief engineer of the Lancaster, Pa., plant of the RCA tube department, and has been retained as consultant to the company.

 (continued from p 132)

and also in connection with recent features on computers and related instrumentation in *Time* and the *Saturday Evening Post.* Without going into the argument as to whether these machines can *think*, the egg processing machinery seems to be a perfect answer to those who scoff at Wiener's thesis that a second industrial revolution is upon us.

ROBERT T. NAGLER

Nagler Radio and Electric Service
Prairie Du Sac, Wisconsin

Helical Antennas

DEAR SIRS:

PROBABLY unknown due to lack of publicity during the war, the work on Helical Aerials undertaken by C. S. Franklin of the Marconi Company, England, prior to the war has not received recognition in any of the excellent articles on the subject which have been appearing in ELECTRONICS.

As I feel that you may care to make some reference to this early work, I send you copies of British Patent Specifications No. 573896 and 576159 filed in 1941 and 1942 respectively. Work on helical aerials reached the stage of test on commercial circuits but had to be stopped owing to the then existing circumstances.

J. G. ROBB

Late Director of Research,
Marconi's Wireless Telegraph Co., Ltd.
Chelmsford, England

Audio Oscillations

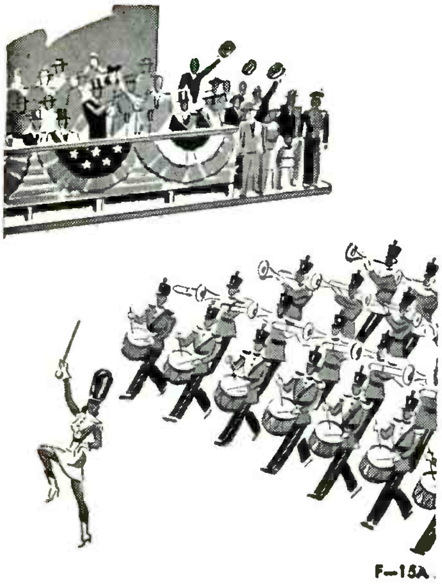
DEAR SIRS:

YOUR INTEREST in lamp filament oscillation (*Crosstalk*, March, 1950), prompts me to comment that oscillation in the audio-frequency range is a characteristic of the minute filaments of 1.3-volt penlight (flashlight) lamps having integral lenses.

My own observation has shown that these penlight lamps, when energized with a constant, filtered, battery source, will project a modulated light beam with a frequency in the hiss region, probably at 10,000 cycles or more, which may be detected by a high-pass photocell amplifier.

DELMAR L. BROWN

Supt. Testing Department
Portland General Electric Co.
Portland, Oregon



F—15A

HERE'S A

Parade

YOU WON'T WANT TO MISS...

Everybody loves a parade but here's one that's particularly interesting to YOU because it's packed with "pocket-book" appeal. It's a never-ending parade of products and services designed to help you do *your* job better, quicker and cheaper. You're in the "reviewing stand" for this parade because it comes to you in the advertising pages of every issue of this magazine. Alert manufacturers use these advertising pages to get the *news* about their products and services to *you*... quickly and effectively. To be well-informed about the latest developments in *your* industry... and to stay well-informed... *read all the ads too.*

McGRAW-HILL PUBLICATIONS

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FOR THE FIELD OF ELECTRONICS

FINE RIBBONS OF TUNGSTEN and Molybdenum

Quality and accuracy in our fabrication of Tungsten & Molybdenum Ribbons have characterized our service to the Electronic industry.

A development of

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NITROCELLULOSE
SYNTHETIC
MOISTURE RESISTANT
THERMO PLASTIC
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1532 South 50th Court
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Write Us for Additional Information

MICROMETER FREQUENCY METER for checking transmitters, from .1 to 175 mc, within 0.0025 per cent.

LAMPKIN LABORATORIES, INC.
Bradenton, Fla., U. S. A.

EL-TRONICS, INC.

Research, development, and manufacture of electronic equipment—a single model to large quantities.

WRITE TODAY FOR FREE RESUME OF OUR PLANT FACILITIES

Specialists in Geiger-Muller equipment

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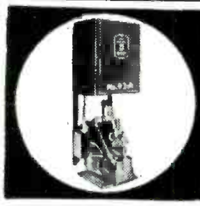

EISLER Manufactures Complete Equipment for:

SPOT WELDERS, Electric, for ¼ to 250 KVA.
TELEVISION TUBE GLASS WORKING EQUIPMENT.
TRANSFORMERS, Special and Standard Types.
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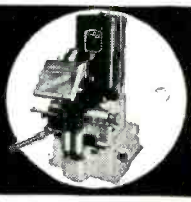
FLUORESCENT TUBE Manufacturing Equipment.
NEON SIGN MAKERS EQUIPMENT.
ELECTRONIC EQUIPMENT, Vacuum Pumps, etc.
WET GLASS SLICING and Cutting machines for Laboratory use.

EISLER ENGINEERING CO., Inc. 751 So. 13th St., Newark 3, N. J.



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high speed *high sensitivity*

SHORTED TURN INDICATOR

The Karton Shorted Turn and Open Circuit Coil Checker — Model 101B — indicates single shorted turns of #44 wire in unmounted coils. Standard mandrel 3/16 x 1/4 for all average size coils. Regulated vacuum tube circuit. Jack for audio indication to supplement 1-ma. meter. Prompt deliveries. Price $150.

KARTRON Huntington Beach, Calif.

SUB-MINIATURE PRINTED ELECTRONIC CIRCUITS

produced from your schematics or existing electronic equipment. Circuits fired on ceramics or air dried on plastics and paper bases. Confidential service.

PLASTICS & ELECTRONICS CO.
272 Northland Ave., Buffalo 8, New York

STABLE AT TEMPERATURES FROM −40° to +40°F.

THE NON-MELTING, WATERPROOFING AND INSULATING SILICONE COMPOUND. FOR IGNITION SYSTEMS AND ELECTRONIC EQUIPMENT. MEETS ALL THE REQUIREMENTS OF AN-C-128a.

For more data on DC 4 Silicone compound write Dept. E-4

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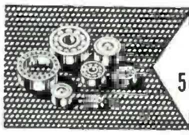

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Miniature ball bearings for application in precision mechanisms minimize friction and wear. High load capacity. Least weight and space. Special designs and complete engineering service for your application. Write for catalog E.

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INCORPORATED
KEENE, NEW HAMPSHIRE, U.S.A.

Professional Services

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in

Radio, Audio, Industrial Electronic Appliances

SEARCHLIGHT SECTION

(CLASSIFIED ADVERTISING)

Continued on pages 211-234

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

WANTED: ELECTROSTATIC Capacitor Engineer—Experienced in design, processing and manufacture of paper dielectric capacitors. Knowledge of noise filters, metallized paper capacitors, ceramic capacitors, and mica capacitors desirable. Write full particulars as to experience—confidential. P-6582, Electronics.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

EMPLOYMENT AGENCY

ELECTRICAL ENGINEERS: Teaching: Power, Electronics. All ranks to Head Department Universities. Atlantic-Pacific. To $8000. Give phone, Photo, Qualif. Cline Teachers Agency, East Lansing, Mich.

POSITIONS WANTED

RADIO-ELECTRONICS Technician: American, age 27, single, desires long term position anywhere in Philippines. Amiable disposition. Speaks some Tagalog and Visayan. 10 years military, amateur and commercial radio experience. PW-6165, Electronics.

PATENT ENGINEER—Attorney now a U. S. Patent Examiner of complex electronic, electrical arts (4 yrs); Electrical Engineer 5 yrs; Member of State Bar 13 yrs; seeks responsible patent connection. PW-6809, Electronics.

ELECTRONICS ENGINEER, graduated M.I.T. 1943 with B.S. and M.S. degrees, specializing in pulse communication systems desires permanent position. PW-6649, Electronics.

AUDIO, TV Field Eng: 10 yrs. practical experience in maintenance of professional audio, TV and radar equip., design and maintenance custom home music systems. Member A.E.S., Asso. A.I.E.E. Good tech. educational background, exc. references, exp. customer relations. Extremely conscientious. Presently mag. TV service lab. and field service tech., electronic organs. Desire field work, H. F. audio or TV. Prefer Wash., D. C. area, consider other. PW-6882, Electronics.

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$1.20 a line, minimum 4 lines to figure advance payment count 5 average words as a line.

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BOX NUMBERS in care of any of our New York, Chicago or San Francisco offices count 1 line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH

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AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

ELECT.

NEW ADVERTISEMENTS received by June 29th will appear in the August issue, subject to limitation of space available.

The publisher cannot accept advertising in the Searchlight Section which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

ELECTRONICS ENGINEERS FOR CONSULTING LABORATORY

Unusually suitable openings for engineers who prefer a small company, are interested in specializing in VHF and Microwave antennas and propagation, and who have carried real responsibility in this or a closely related field. Location: Long Island, N. Y.

P-6853, Electronics
330 W. 42nd St., New York 18, N. Y.

REQUIRE KEY MEN FOR RESEARCH LABORATORIES

Outstanding opportunities now available in undertaking highly responsible research and development work in important electro-mechanical instrumentation laboratories. Require section chiefs with MS or PHD degree in E.E., M.E., or Physics with scholastic achievement in upper 10% of class.

Important to have more than 5 years practical experience in developmental work, supervision of projects or group activities to qualify applicant to supervise and direct several diversified projects and administer related activities.

Men with proven ingenuity, imagination, creative ability and with a record of tangible accomplishments can command attractive salaries.

P-6796 (A3), Electronics
520 N. Michigan Ave., Chicago, Ill.

ENGINEER — RADIO AND TELEVISION

Experienced Engineer for research, Design and development of Television Components. Location Summit, New Jersey area. Send complete resume to

P-6696, Electronics
330 W. 42nd St., New York 18, N. Y.

SCIENTISTS AND ENGINEERS

Wanted for interesting and professionally challenging research and advanced development in the fields of microwaves, radar, gyroscopes, servomechanisms, instrumentation, computers and general electronics. Scientific or engineering degree or extensive technical experience required. Salary commensurate with experience and ability. Direct inquiries to Mgr., Engineering Personnel, Bell Aircraft Corporation, P. O. Box 1, Buffalo 5, N. Y.

ELECTRONIC ENGINEER

At least 5 years post college experience in development, D.C. Amplifier, digital computers, pulse and servo-design. Established company, classified work, New York City.

P-6819, Electronics
330 W. 42nd St., New York 18, N. Y.

PROJECT RADIO ENGINEER

To take responsible charge of design of radio communications systems between the Hawaiian islands. Experience in VHF and Microwave links design desirable. College training or equivalent necessary. Live in Honolulu.

MUTUAL TELEPHONE COMPANY
Box 2200, Honolulu, T.H.

RCA VICTOR Camden, N. J.

Requires Experienced Electronics Engineers

RCA's steady growth in the field of electronics results in attractive opportunities for electrical and mechanical engineers and physicists. Experienced engineers are finding the "right position" in the wide scope of RCA's activities. Equipment is being developed for the following applications: communications and navigational equipment for the aviation industry, mobile transmitters, microwave relay links, radar systems and components, and ultra high frequency test equipment.

These requirements represent permanent expansion in RCA Victor's Engineering Division at Camden, which will provide excellent opportunities for men of high caliber with appropriate training and experience.

If you meet these specifications, and if you are looking for a career which will open wide the door to the complete expression of your talents in the fields of electronics, write, giving full details to:

National Recruiting Division
Box 700, RCA Victor Division
Radio Corporation of America
Camden, New Jersey

RESEARCH ENGINEERS

1—THEORETICAL TUBE DESIGN ENGINEER. Physicist or E. E. with 5-10 years experience in gas and vacuum tube design.

1—RESEARCH AND DEVELOPMENT ENGINEER with experience on crystal diodes and transistors. Good knowledge of physics of solid state and semi conductors required.

1—TUBE QUALITY CONTROL ENGINEER. Knowledge of tubes, circuits and statistical control methods essential.

Work will be in the Eastern Pennsylvania Laboratories of a large, well-established manufacturer. These are permanent positions with excellent opportunities and facilities. Candidates must be U. S. citizens. Send complete details of training, experience, aptitudes and salary.

Our staff is aware of this advertisement.

Write today to:

P-6822, Electronics
330 W. 42nd St., New York 18, N. Y.

RADAR, COMMUNICATIONS *and* SONAR TECHNICIANS WANTED

For Overseas Assignments

Technical Qualifications:

1. At least 3 years' practical experience in installation and maintenance.
2. Navy veterans ETM 1/c or higher.
3. Army veterans TECH/SGT or higher.

Personal Qualifications:

1. Age, over 22—must pass physical examination.
2. Ability to assume responsibility.
3. Must stand thorough character investigation.
4. Willing to go overseas for 1 year.

Base pay, bonus, living allowance, vacation add up to $7,000.00 per year. Permanent connection with company possible.

Apply by Writing to
A-1, P. O. Box 3414
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Men qualifed in RADAR, COMMUNICATIONS or SONAR give complete history. Interview will be arranged for successful applicants.

SEVERAL ENGINEERS

Needed by contractor for work at Naval Air Missile Test Center, 50 miles northwest of Los Angeles. College Degree and experience essential. Radar, digital computer or general pulse technique experience required.

ELECTRONIC ENGINEERING CO. OF CALIFORNIA
180 South Alvarado Street
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ELECTRONIC ENGINEERS
AT
DuMONT TELEVISION

SENIOR ENGINEERS (5)
B.S. in E.E.

1—Experienced VHF and UHF Equipment. Design and Propagation Measurement.

2—Experienced in Signal Circuits of AM, FM or TV Receivers.

3—Experienced in TV Deflection Circuits.

4—Experienced in Design of Wide Band IF and RF Amplifier Circuits applicable to VHF Equipment. Must have experience in use of Test Equipment and VHF Spectrum.

5—Experienced in Television or other Electronic Development Work, Special Wave Form Generation, Synchronization and C.R.T. Deflection.

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For positions No. 2 & 5 listed above

FOR TRANSMITTER DIVISION

2 years' experience, knowledge of Video Amplifiers, Counter Circuits, Cathode-ray & Indicators, Radar exp.

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Experience in Mechanical Design and Specification of Radio, TV or Electronic Equipment. Preferably expd in Design of Mass Production.

Apply in person or write:

ALLEN B. DuMONT LABORATORIES, INC.
35 MARKET ST.
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Att: M. Bruinooge, Personnel Dept.

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SENIOR ELECTRONIC CIRCUIT PHYSICISTS
for
Advanced Research and Development

MINIMUM REQUIREMENTS:

1. M.S. or Ph.D. in Physics or E.E.

2. Not less than five years experience in advanced electronic circuit development with a record of accomplishment giving evidence of an unusual degree of ingenuity and ability in the field.

3. Minimum age 28 years.

Hughes Aircraft Company
Attention: Mr. Jack Harwood
CULVER CITY, CALIFORNIA

PHYSICISTS
SR. ELECTRONIC ENGINEERS

Familiar with ultra high frequency and micro wave technique.
Experience with electronic digital and/or analog, computer research and development program.
Salaries commensurate with experience and ability. Excellent opportunities for qualified personnel.

Contact:
C. G. Jones, Personnel Department
GOODYEAR AIRCRAFT CORPORATION
Akron 15, Ohio

POSITION OPEN FOR SENIOR ELECTRONIC ENGINEER

Top Grade Senior Design Engineer—Electronic Circuits. Engineering Degree, 5-10 Years' Good Experience. Wanted for Original Development Work on Industrial Electronic Controls. Permanent Addition to Engineering Staff of Growing New England Concern not Dependent on Military Contracts. Top salary dependent upon ability and experience. Send complete resume to

P-6755, Electronics
330 W. 42nd St., New York 18, N. Y.

POSITION VACANT

Electronic materials development engineer wanted to take charge of development and control laboratory. Man with at least 5 years experience in vacuum tube production, engineering and development, degree in Engineering Physics, Electrical Engineering or Chemistry and some experience in vacuum tube material required. Minimum age 30. Work is primarily with cathode and emission problems. Give details including age, education, experience, marital status, references, availability and salary expected.

P-6943, Electronics
330 W. 42nd St., New York 18, N. Y.

Highest Prices Paid

for manufacturers' over-runs and closeouts of electronic parts.

RAND RADIO CORPORATION
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WANTED

Inked Tape Recorders for code reception.
BC-1016 preferred.
write
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WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6863, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

W-6864, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

INSULATORS; POLE LINE HARDWARE; GUY STRAND WIRE; COPPERWELD WIRE; WESTERN ELECTRIC TOOLS; SPLICING SLEEVES.

VICTOR-BERNARD INDUSTRIES
NE Cor. 22nd & Lehigh Aves., Phila. 32, Pa.

WILL BUY ALL

BC-348'S WITH DYNAMOTORS

Letters "J", "N" & "Q" ....$60.00 ea.
All others except "C" ....$50.00 ea.
Ship via Express C.O.D. subject to Inspection to:
H. FINNEGAN
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500 RECEIVERS-TRANSMITTERS 4 to 6 Watts.
45 SCR-206—45 SCR-503
SURPLUS, COMPLETE, BRAND NEW, UNUSED.
Offers FOB New York to be submitted with complete lists of units composing each item to

W-6826, Electronics
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PRODUCTION MATERIALS

(Excepting Bulbs, Flares and Wire) for Tube Type 813. For Specifications and Quantities, write

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RADAR SETS

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Mark 8 Model 2 Gyro stable element designed for use in stabilizing large caliber naval gun......$2,500.00

APS-2	Airborne	10 CM, Major Units	New
APS-3	Airborne	3 CM, Compl.	New
APS-4	Airborne	3 CM, Compl.	Used
APS-15	Airborne	3 CM, Major Units	New
SD-4	Submarine	200MC, Compl.	New
SE	Shipboard	10 CM, Compl.	New
SF-1	Shipboard	10 CM, Compl.	New
SJ-1	Submarine	10 CM, Compl.	Used
SL-1	Shipboard	10 CM, Compl.	Used
SN	Portable	10 CM, Compl.	Used
SO	Portable	10 CM, Compl.	Used
SO-1 & 2	Shipboard	10 CM, Compl.	Used
SO-8 & 13	Shipboard	10 CM, Compl.	Used
Mark 4	Gunlaying	800MC, Less Ant.	Used
Mark 10	Gunlaying	10 CM, Compl.	New
		Less Rack	New
		Less Rack	Used
CPN-3	Beacon	10 CM, Major Units	Used
CPN-6	Beacon	3 CM, Complete	New
CPN-8	Beacon	10 CM, Complete	New
		Less Ant.	New
SCR-533	IFF/AIR	500MC,	New
Search Tracer			
Airborne Radar Altimeter		500MC. Complete	New

WRITE FOR INFO

TEST EQUIPMENT

TS 268/U to provide a means of rapid checking of crystal diodes IN21, IN21A, IN21B, IN23, IN23A, IN23B. Operates on 1-½ volt dry cell battery, 3 x 6 x 7, New $35.00

3 cm. wavemeter, Ordnance type micrometer head new: Absorption type $85.00
9000-9500 MCS Transmission type $92.50
SL wavemeter, Type CW60ABM $125.00
10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10CM Directional Coupler $350.00
10 cm horn assembly consisting of two 5" dishes with dipoles feeding single type "N" output. Includes UG28/U type "N" "T" junction and type "N" pickup probe. Mfg. cable. New....$15.50
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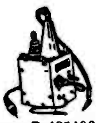
10 cm. echo box. Part of SFI Radar W/115 volt DC tuning motor Sub Sig 1118AO....$47.50
THERMISTER BRIDGE: Power meter 1-203-A. 10 cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case....$72.50
W.E. I 138. Signal generator, 2700 to 2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter, 115 input reg. Pwr. supply. With circuit diagram $150.00
TS 89/AP Voltage Divider. Ranges 100: ½ for 2000 to 2000v. 10:1 for 200 to 2000v. Input Z 2000 ohms. Output Z 4 meg ohms flat response 150 cy to 5 meg cy....$42.50



ASI4A/AP—10 cm Pick up Dipole with "N" Cables....$4.50
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3 cm Echo Box, motor Drive. "N" input $35
TS-3C/AP Power Measuring Bridge 3 cm $190
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C Band "T" gold-plated at....$97.00
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Adaptor, round to square cover....$5.00
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Flange Coupling Nuts....$ .50
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1⅝" RIGID COAX

Right Angle Bend $35.00
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Straight Sections 15' APX....$2.50/Ft.

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15 KV at 30 Ma DC, Bridge Rectifier, Western Electric ....$125.

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Directional coupler, UG-40/U-take off, 20 DB..$17.50
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Broad Band Directional coupler type "N" take off, choke to cover, 23 DB, calibrated....18.50
Directional coupler, APS-31, type "N" take off, 28 DB 17.50
Bi-directional coupler, type "N" take off....22.50
Flexible Section 18" long....12.00
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WE attenuator 0 to 20 DB, less cards, bell size guide 12.50
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Rotary Joint, choke to choke with deck mounting 10.00
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Wavemeter-Thermistor MTG Section 6.00
2K25/723 AB Receiver, Local Oscillator Klystron Mount, complete with Crystal Mount, Iris Coupling and Choke Coupling to TR....22.50
TR-ATR Duplexer Section for above....8.50
723AB Mixer—Beacon Dual Oscillator Mount with Crystal Holder. Used....12.00
723AB Mixer—Beacon Dual Oscillator Mount with Matching Slugs and tunable termination, new..24.50
Bi-Directional Coupler, type "N" termination, 26 DB, calibrated, 1¼ x ⅝" guide....24.50
12" Flexible Section 1¼ x ⅝" guide....10.00
Crystal Mount in Waveguide....17.50
SO-3 Echo Box, Transmission type cavity with bellows 28.50
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"S" Curve 18" long....5.00
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APS-31 Mixer Section for mounting two 2K25s, Beacon Reference Cavity, 1B24 TR Tube....42.50
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Receiver Front End, complete, C/0 Dual 723AB Klystron mount. TR-ATR Duplexer Section, 2 stage 30 MC. Preamplifier, new, with ALL tubes..59.50
Random Lengths of Waveguide 6 to 18" long....1.00 per f.

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D-164699 for MTG in "X" band Guide	$2.50	D-171812	$.95
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		D-171528	$.95
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		D-171121	$.95
		D-98836	$1.50
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		D-163357	$2.00
		D-99946	$2.95

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3,000 MC BAND

90° Twist, circular cover to circular cover....$25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
Waveguide Switch—Transposes one input to any of three outputs. Standard 1½" x 3" square flanges. Complete with 115V drive motor. Raytheon CRT24AAS, new $150.00
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AN/APR5A 10 cm antenna equipment consisting of two 10 CM waveguide sections, each polarized. 45 degrees ....$75.00 per set
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PHASE SHIFTER. 10 CM WAVEGUIDE, WE TYPE FS-683816. E PLANE TO H PLANE, MATCHING SLUGS. MARK 4....$95.00
721A TR cavities. Heavy silver plated....$2.00 ea.
Coax Xtal Mount for Type "N" tunable....$15.00
10 CM Mixer $3.00

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Directional Coupler, Type "N" take off....$22.50
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SHORT RIGHT ANGLE BEND ¼" I.C....$2.50
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UG103U	.45
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⅞ Coax Male Fitting thd or unthd	.95
X Band Circ. Choke Flange	.50
X Band Flat Contact Flange ⅛ Thk	.25
Contact Ring ¼" Thk 1⅜ dia. hole	.25
UG 53/U, Cover	$4.00
UG 54/U, Choke	4.75
UG 55/U, Cover	4.00
UG 56/U, Choke	4.75
UG 65/U, Contact	6.50
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UG 148/U, Choke	4.00
UG 150/U, Contact	3.00
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UG 40/U, Choke	.80

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COMMUNICATIONS EQUIPMENT COMPANY

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G.E. #6E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance....$6.50
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G.E. K2450A. Will receive 13KV.4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E....$34.50
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Pulse 131-AWP L-421435....$6.00
Pulse 134-BW-2F L-440895....$2.25
RAY—WX4298F....$39.50
G.E.—K6324730....$50.00
G.E.—K9216945....$50.00

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BC 758A Pulse modulator....$395.00
725A magnetron pulse transformers....$18.50 ea.

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D-168184: .5 microsec. up to 2000 PPS. 1800 ohm term....$4.00
D-170499: .25/.50/.75 microsec. 8 KV. 50 ohms imp....$16.50
D-165997: 1¼ microsec....$7.50

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BC 9318 420-50-100 mile range 5" scope w/mtg. rack, indicator amplifier, BC 932B, visor, New w/ tubes....$24.50
BC 704A 9-36-90 mile range 5" scope....$17.50
BC 937A & BC 938A 12" PPI & "A" scope. Complete desk Rack assy w/osc. control unit, rec., pwr. supls. in unused cond. but shelf worn....$300.00
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D-164960: 2.04 mfd @ 200 vdc, 0 to plus 55 deg C $2.50
D-163344: 2.16 mfd @ 200 vdc, 0 to plus 55 deg C $3.00
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D-161270: 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg C....$8.50

30 US ARMY SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig Corps #2A289-233-A. New....$39.50 per set

MAGNETRONS

Tube	Frq. Range	Pk. Pwr. Output
2J27	2865-2992 mc.	275 KW.
2J31	2820-2880 mc.	265 KW.
2J21 A	9345-9405 mc.	50 KW.
2J22	3287-3333 mc.	265 KW.
2J26	2992-3019 mc.	275 KW.
2J27	2965-2992 mc.	275 KW.
2J32	2780-2820 mc.	285 KW.
2J37		
2J38 Pkg.	3249-3263 mc.	5 KW.
2J39 Pkg.	3267-3333 mc.	87 KW.
2J40	9305-9325 mc.	10 KW.
2J49	9000-9160 mc.	58 KW.
2J34		
2J61	3000-3100 mc.	35 KW.
2J62	2914-3010 mc.	35 KW.
3J31	24,000 mc.	50 KW.
5J30		
714AY		
718DY	2720-2890 mc.	250 KW.
720BY	2800 mc.	1000 KW.
720CY	2860 mc.	1000 KW.
725-A	9345-9405 mc.	50 KW.
730-A	9345-9405 mc.	50 KW.

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728 AY, BY, CY, DY, EY, FY, GY
700 A, B, C, D
706 AY, BY, DY, EY, FY, GY
Klystrons. 723A/B $12.50; 707B W/Cavity
417A $25.00 2K41

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$8.90
5200	21/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons $24.50 ea.

GE Magnets type M7765115, GI Distance Between pole faces variable, 2 5/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. 1⅝" Now Part of SCR 584 $34.50

"CW" MAGNETRONS

QK 62	3150-3375 mc.
QK 59	2675-2900 mc.
QK 61	2875-3200 mc.
QK 60	2800-3025 mc.

New, Guaranteed Each $65.00
QK 915 Raytheon....$150.00

FILAMENT TRANSFORMER

for above 115V/60 cy Pri; four 6.3V/ 4A Sec. 50000VT....$27.50
Magnetron Kit of four QK's 2675-3375 inc. w/transformer....$250.00

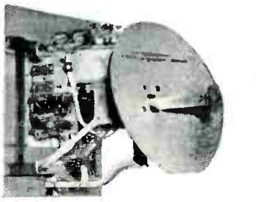
R. F. EQUIPMENT

APS-31 RF Head less Receiver Section....$400.00
APR-4 Receiver. Compl Less Tu....$400.00
APR-5 Receiver. 1000 to 6000 Mc. Complete $375.00
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT-39/APG 5 & APG 15. Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Rcvr. Uses 2040, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver plated....$49.50
APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B) Pulser. 714 Magnetron 417A Mixer all ⅞" rigid coax. Incl. rcvr. front end....$210.00
Beacon lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice....$47.50 ea.
T-28-/APN-19 10 cm. radar Beacon transmitter package. Used, less tubes....$59.50 ea.
Pre-Amplifier cavities type "M" 7410590GL, to use 446A lighthouse tube. Completely tunable. Heavy silver plated construction....$37.50 ea.
RT/32APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR 723 A/B local osc. and beacon mount, pre amplifier. Used but Good cond....$97.50
AN/APS-15A "X" Band compl. RF head and mod. incl. 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1824, TR, rcvr and ampl. duplexer. HV supply blower, pulse xfmr. Peak Pwr. Out: 45 KW apx. input: 115, 400 cy. Modulator pulse duration .5-2 microsec., apx. 13KV. PK, Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg....$350.00
S BAND AN/APS2. Complete RF head and modulator, including magnetron and magnet, 417A mixer, TR receiver duplexer, blower, etc., and complete pulser. With tubes, used, fair condition....$75.00
ASB-500 Megacycles Radar Receiver with two GI 446 lighthouse cavities, new less tubes....$37.50
10 CM Rec Assy. Less Local OSC. Tube. Consists of mixer stabilizer cavity 30 MC preamp AFC. Ino. Amp. plugs & cables p/o APS2....$37.50
#SCR-520 RF Head Compl. with Hard Tube Pulser c/o 2 Aluminum Drums MTD. In Tandem. Compl. W/Tubes....$350.00
Mark 4 Radar Console (FD) Compl "L" Band RF Pkg. c/o Magnetron CSC, Pulser, Rcvr. H.V. Power Supply. Complete....$850.00

30 MC IF STRIP

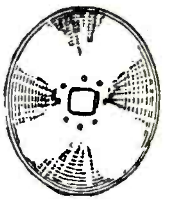
P/O APS-15 Radar using 6AC7's 2-3 Mc BW 20DB Gain. New & Complete IF Amplifier Video Sect. Less Tubes....$17.50

YD-2 MARKER BEACON EQUIP. Compl. Installation in Trailer w/Gas Generator—WRITE.



MICROWAVE ANTENNAS

APS-4 3 cm. antenna. Complete. 14½"dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New, complete....$65.00
AN-122 Dipole Assy....$22.50
LP-21-A ADF Loop W-Selsyn and Housins, New $8.00
DAK Belline Tossi DF Loops....$125.00
Adcock DF Arrays, Complete....$65.00
SA Radar 200 Mc Bed Springs. Complete with Pedestal. Less Drive....$600.00
APS-15 Antennas. New....$99.50
AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00)....$250.00
AN/TPS3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New in 3-carrying cases....$89.50
RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4' x 3' rectangle, now....$35.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam, 115 v.a.c. drive. New....$100.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism....$65.00
AS125/APR Cone type receiving antenna. 1030 to 3208 megacycles. New....$4.50
140-600 MC. CONE type antenna, complete with 25 sectional steel mast, guys, cables, carrying case, etc. New....$49.50
ASD 3 cm. antenna, used, ex. cond....$49.50
YAGI ANTENNA AS-46A. APG-4, 5 elements....$14.50
Dish for Parabola 30" $4.85
AS17/APS 10 CM Antenna. APS-2 30 inch Dish with ⅞ Coax Dipole and fittings. New and Compl. with 24 V DC Drive motor, selsyn. 360 Deg. Rotation and Vertical Tilt....$94.50
RC-224 Antenna, 10 CM, 30" Dish P/O. SCR-717 Radar, New and Complete...$94.50



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SONAR

QCU Magneto striction head RCA type CR 278225—New....$95.00
Stainless Steel streamlining housings for above $18.50
QBG Driver Amplifier. New....$200.00
QCU Magneto striction head, coil plate assembly, new....$14.50
QCQ-2/QCS Magneto striction head coil plate assembly $14.50
QCQ2 Sonar complete set—Write for details.
QC-RCA magneto striction head assy. consists of coil, plate, nickle diaphragm plate, milled steel body unassembled....$65.00
Supersonic Oscillator RCA 17-27 Kc. Rec. Driver, Csc. 116 v 60 cy. AC. Designed for use w/200 watt driver. New less tubes....$39.50
WEA-1 Console. Consists of Rec. Ind. Osc. Remote training control 200 watt driver amp. 17-27 kc range....$450.00
QCQ 2 Console Sub. Sig. Co....$450.00
QBF Sonar mfg. WE complete console consists of 10-40 kc rec. driver osc. ind. & control unit, and driver amplifier 22-28 kc. Write
QJA Sonar QBF w/QJA adaptor kits w/cathode ray tube indication. Write
QCQ-2 Sonar Compl. Less Hoist—Write

I.F.F.

1 KW Pulsed Output Pkg. Tunable 154-186 mc. adj. modulating pulses 4-10 micro sec. comp. 115v 60cy ac pwr. supply. Video output receiver. New w/tubes....$350.00
Wavemeter for above....$75.00
Dipole Array for above....$85.00
BC 800 XMTR. RCVR. Unit New....$55.00
BC 929 Indicator New....$35.00

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131 Liberty St., New York, N. Y. Dept. E-7 P. J. PLISHNER **Phone: Digby 9-4124**

FULLY GUARANTEED **BRAND NEW SURPLUS OFFERED BY A LEADING**

A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w.; 4/5 r.p.m. **Price $3.00 ea. net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake. **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net.**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $4.25 each net.**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-49-6 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, .3 amps., 10 watt, output. **Price $34.50 each net.**

FPE-25-16 Diehl Low-Intertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., .85 amps. **Price $10.00 each net.**

CK 2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

CK5 Pioneer, 2 phase, 400 cycle. **Price $20.00 ea. net**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $8.50 each net.**

Kollsman Type 776-01 400 cycle 2 phase drag-cup type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $10.00 ea. net.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.
Price $17.50 each net.

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $10.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Sperry A5 Autopilot Indicator: contains Pioneer AY20 autosyn 26 V., 400 cycle. **Price $9.50 ea. net**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

Type C1 outo-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

C. A. A. approved instrument repair dept. No. 3564.

D.C. MOTORS

5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $3.90 each net.**

A-7155, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $3.75 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D. C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V. D. C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. **Price $4.75 ea. net**

D.C. ALNICO FIELD MOTORS

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

5069600 Delco 27.5 V. 250 R.P.M. **Price $9.75 ea. net**

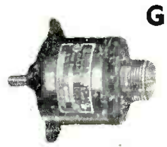
706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower assembly. **Price $10.00 ea. net**

5071895 Delco 27.5 V. 250 R.P.M. **Price $8.50 ea. net**

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear. **Price $6.75 ea. net**

GENERAL ELECTRIC D. C. SELSYNS



8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8TJ9-PAB Transmitter 24V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked—10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

G. E. Servo Amplifier Type 2CV1C1, 115 V. 400 cycle **Price $9.00 ea. net**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

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37 EAST BAYVIEW AVE., GREAT NECK, N. Y.
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SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY

INVERTERS

Wincharger Corp. Dynamotor Unit. PE 101-C. Input 13, V.D.C. or 26 V.D.C. D.C. AT, 12.6 or 6.3 amps. Output 400 V.D.C. AT. .135 amps., 800 V.D.C. AT. .02 amps., 9 V.A.C. 80 cycle at 1.12 amps.
Price $10.00 each net.

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter.
Price $115.00 each net.

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A.
Price $22.50 each net.

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A.
Price $20.00 each net.

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts.
Price $100.00 each net.

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $12.00 each net.**

PE218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

METERS

Weston Frequency Meter. Model 637, 350 to 450 cycles, 115 volts.
Price $10.00 each net.

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C.
Price $4.25 each net.

Weston Ammeter. Model 506, Type S-61209, 20-0-100 amps. D. C.
Price $7.50 each net with ext. shunt.

Weston Ammeter. Type F-1, Dwg. No. 116465, 0 to 150 amps. D. C.
Price $6.00 each net.
With ext. shunt $9.00 each net.

Westinghouse Ammeter. Type 1090-D120, 120-0-120 amp. D. C.
Price $4.50 each net.

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement.
Price $15.00 each net.

RECTIFIER POWER SUPPLY

General Electric, input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F3. Size: Height 46", width 28", depth 17½". **Price $200.00 each net.** New

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle.
Price $5.50 each net.

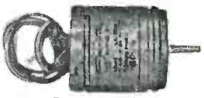
AY14D, 26 V., 400 cycle, new with calibration curve.
Price $15.00 each net.

AY20, 26 V., 400 cycle.
Price $7.50 each net.

AY5, 26V., 400 cycle. Has hollow shaft.
Price $7.50 ea. net

PRECISION AUTOSYNS

AY101D, new with calibration curve.



PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve.
Price $35.00 each net.

AY130D, new. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $15.50 each net.

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $30.00 each net.

PIONEER TORQUE UNIT

Type 12602-1-A. Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.
Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor.
Price $8.50 each net.

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle.
Price $17.50 each net with tubes

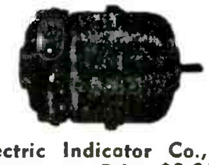
ALL PRICES, F. O. B. GREAT NECK, N. Y.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS



PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m.
Price $12.00 each net.

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase.
Price $14.00 each net.

PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C.
Price $9.75 ea. net

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle.
Price $20.00 each net.

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage.

Price $15.00 each net.

7G Generator, 115 V., 60 cycle.
Price $30.00 each net.

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle.
Price $3.25 each net.

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle.
Price $4.50 each net.

5G Generator 115 volts, 60 cycle.
Price $50.00 each net.

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 each net.**

5SF Repeater, 115/90 V., 400 cycle.
Price $19.00 each net.

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer. 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

INSTRUMENT ASSOCIATES

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TEST EQUIPMENT

I 135 Test Set
BC 771 Frequency Meter
BC1287 Scope
TS 62/AP
TS 13/AP
TS 102A/AP
TS 251
BC 221 Freq. Meter
I 222 Signal Generator
LM Frequency Meters

RC 150 EQUIPMENT

Receiver BC 1161 A
Transmitter BC 1160 A
Control Unit BC 1162A
Signal Generator I-198A

Miscellaneous Specials

1D6/APN4 - Scope
R 78/A PS 15 - Scope
R7/APS 2 Receiver and Scope
ASB7 Scope
SCR 522 Receiver-Transmitter
MN26 C- or Y Receiver
RA 10 Receiver
BC 639 Receiver
RA 42 Rectifier
TA2J24 Transmitter
SCR 269 G Compass Installation
ARN7 Compass Installation
MN 26 Compass Installation
ILS Installation (BC733 & R89)
SCR 584 components
R 132/TPS10 Radar Receiver
MD22 - URA/T1 Modulator
AN/APR1 Receiver and Tuning units
ASB 7 Complete Radar Installation
BD 71—6 position Field Switchboard
EE8 Field Phones
RM 29 Remote Phone Control
SCR 183 complete
ARC/I Transceiver
ART 13 Transmitter
BC348 Receiver
RTA1B Transceiver
Model 15 Radar Trainer

PRICES OF ABOVE UPON REQUEST

T-85/APT5 UHF TRANSMITTER

Operating over a frequency range of 300 to 1400 MCPC with a nominal output of from 10 to 30 watts. Unit is equipped with 110 V 60 CPS filament transformer; blower; lecher wire test frequency set, and 8 tubes —1-931A; 2-6AC7; 2-6AG7; 1-6L6G; 2-829B; 1-3C22 (GL522) (oscillator).
New in original box with Operating Instruction Manual.......... **$69.50**

Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½" x 9" x 4¼", provided with shoulder straps.

This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal $89.50.

Battery charger is extra at $19.95.

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 3½" x 8" x 15½" operating on 152 to 162 megacycles. It is six volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit.

Brand new, ready to go **$129.50**

Extra 18" stub type antennae are available, **$2.95**

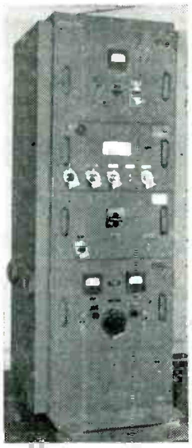
Extra handsets (cradle type) **$5.95.**

Extra control units which house a PM speaker and provide mounting for handset **$4.95.**

A combination of both the handset and control box **$9.95.**

ARROW has the VALUES!

RADIO EQUIPMENT R. C.-100-B



This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

Radio equipment RC-100-B consists of Cabinet CH-118 in which are mounted Transmitter BC-769, Keying unit BC-770, Radio Receiver BC-768, Rectifier RA-52, Wave Trap FL-25, wiring and Blower. Additional equipment consists of Antenna unit AN-82B; Transmission line MC-377, air compressor M-349, Oven M-348, control box BC-773, Amplifier BC-783B and associated cords and hardware.

Primary requirements are 110 to 120 volts, 50 to 60 cycle for the entire unit and accessories.

Cabinet CH-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet.

Transmitter BC-769 is designed to transmit RF pulsed signals at 470 megacycles with the use of two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines.

Keying unit BC-770 furnishes the pulse of the Transmitter.

Receiver BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation.

Rectifier RA-52 produces the high voltage. An 0-15 kilovolt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an 0-20 milliammeter is connected to the ground return to measure the average current drawn.

Antenna AN-82B consists of 24 vertically polarized, half wave radiating elements, a reflecting screen, open-wire transmission line sections and a concentric-line terminating section or elevator.

Wave trap FL-25 is used to separate received and transmitted signals.

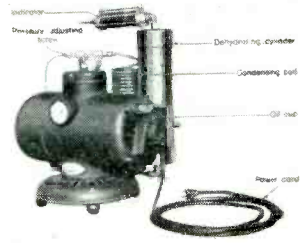
Transmission line MC-377 is of ⅞ inch air-dielectric, 70 ohm concentric line type and is assembled by means of solderless air tight connectors.

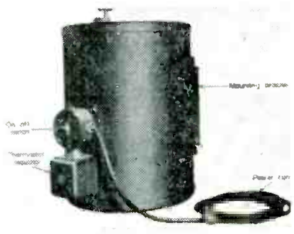
Control Box BC-773 contains necessary controls for operation.

Amplifier BC-783-B is used to amplify the output of Receiver BC-768 for suitable oscilloscope presentation.

Air Compressor M-349

together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 Cycles.





Oven M-348

is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110V AC 60 cycles.

Frequency Meter BC-771

Frequency Meter BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source.

The circuits consist of an r-f oscillator, a crystal oscillator, a 30,000 cycle oscillator and associated mixer, multiplier, and amplifier tubes. The crystal oscillator is used to set the r-f oscillator to exactly 94 or 98.7 megacycles.

For tuning Radio Transmitter BC-769 to 470 megacycles, the signal from the radio transmitter is mixed with the fifth harmonic of the r-f oscillator, operating at 94 megacycles, to produce an audio-beat frequency. For tuning Radio Receiver BC-768 to 493.5 megacycles, the fifth harmonic r-f oscillator, operating at 98.7 megacycles and modulated by the output of the 30,000 cycle oscillator, is fed into the radio receiver.

The entire RC 100 as described above—all brand new—complete— **$595.00**
F.O.B. Warehouse

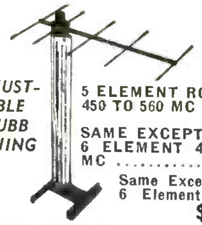
Technical Manual TM11-1113B is furnished with the complete set.

Prices on individual components will be furnished on request.

ARROW SALES, Inc.
Dept. ES
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

All items FOB warehouse. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

ASB YAGI ANTENNA



ADJUSTABLE STUBB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

Double stacked antennas can be supplied with hydraulic remote controls at $29.50 per set additional.

PULSE TRANSFORMERS

UTAH 9262	$1.50
UTAH 9278	$1.50
G. E. 68G-627	$3.75
AN/APN-9 (901756-501)	$1.25
AN/APN-9 (901756-502)	$1.25
AN/APN-4 Block. Osc	.88

CAPACITORS

MOLDED OIL-IMPREGNATED PAPER

.02 MFD	200VDC	.04½ Ea.	$3.00 per 100
.05	200	.04½	3.00
.1	200	.04½	3.00
.25	200	.06	4.00
.1	400	.09	6.00
.005	600	.04½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$2.95
60 MFD	330 VAC	$4.89
32 MFD	2500 VDC	$10.80
7 MFD	660 VAC	$2.95
3.5-.5 MFD	1000 VDC	.77
.1 MFD	7000 VDC	$1.79
.045 MFD	16 KVDC	$4.70

SPECIAL
2 MFD 12,500 VDC
INERTEEN TYPE FP
$23.95

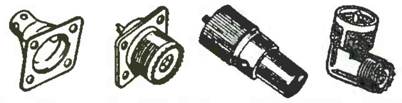
KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles 2 Phase—5 Watts—2650 RPM Will Operate Satisfactorily at 60 Cycles Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

COAXIAL CONNECTORS



83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.68
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.63	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.28	UG-27/U	.68	UG-190A/U	3.82
83-1SP	.28	UG-29/U	.83	UG-191/AP	.57
83-1SPN	.28	UG-30/U	.94	MX-195/U	.41
83-IT	1.12	UG-34U	12.80	UG-197/U	1.33
83-22AP	1.10	UG-36/U	12.80	UG-206/U	.58
83-22F	1.48	UG-37/U	12.80	UG-255/U	.82
83-22R	.48	UG-58/U	.57	UG-264/U	1.74
83-22SP	.60	UG-85/U	.62	MX-367/U	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

GENERAL ELECTRIC FG-172 THYRATRONS

$14.50

$10.00 EA. IN LOTS OF 10

BRAND NEW
ORIGINAL CARTONS
FULLY GUARANTEED

GENERAL ELECTRIC FG-32 TUBES

$4.25

$3.75 Ea. - Lots of 10
Brand New
Original Cartons

IGNITRONS

GL-415/5550	$22.00
WL-681/5550	$22.00
WL-652/5551	$38.00

SELENIUM RECTIFIER STACKS

FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT 18, DC VOLTS OUTPUT 14.5		MAXIMUM RATINGS AC VOLTS INPUT 40, DC VOLTS OUTPUT 34	
1.2 Amps	$2.64	0.6 Amps	$3.00
2.4	3.07	1.2	3.44
6.4	4.09	3.2	5.15
13.0	7.67	6.0	9.32
17.5	8.69	9.0	10.05
26	15.33	12	18.64
39	23.00	18	20.12
52	30.67	24	35.96
65	38.33	36	41.24

All voltage and current ratings based on continuous operation in 35°C. (95°F.) ambient, self-cooled. Current ratings can be increased up to 2½ times normal ratings by intermittent operation or forced cooling.

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy 1 ϕ DC 30 Volts 60 Amps. Brand New — Original Packing $38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts 15 Amps. Brand New—Original Packing......$9.50

NAVY MODEL AIA ANTENNAS

3 CM Conical Scan Aircraft Intercept Antenna Assys. Brand New $120.00

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM * $86.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) ....* $450.00
- Galvin Model CES-1 Standard Crystal Test Set * $45.00
- TS-10A/APN Delay Line Test Set.........$25.00
- TS-19/APQ-5 Calibrator $75.00
- AT-48/UP "X" Band Horn..................$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC..........................$11.75
- Raytheon VR-5 Constant Voltage Transformer Input 95/130 V 60 cy—Output 115 V 500 W * $38.50
- Sola Constant Voltage Transformer Input 95/125 V 60 cy.—Output 15.8 V 285 VA..............$24.70
- Federal Constant Voltage Transformer Input 95/135 V 50/60 cy—Output 115 V 210 W..........$34.00
- Sola Constant Voltage Transformer—Input 95/125 V 60 cy.—Output 115 V 90 VA—Price on request.
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP. ....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets. (pair) $16.95
- Navy Model LD-3 Combined Heterodyne Freq. Meter and Crystal Controlled Calibrator Equip. Mfd. by General Radio—100 KC to 5000 KC—Input 115 V 60 cy ....* $370.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps $9.00

All Items New Except Where Noted * (Exc. Used Condition)

TYPE "J" POTENTIOMETERS

38c each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	½"	50K	5/8"
200	SS	10K	SS	50K	SS
500	½"	15K	½"	100K	5/8"
650	½"	15K	SS	100K	SS
1000	SS	20K	SS	150K	½"
5000	3/8"	25K	1½"	200K	SS
6500	SS	25K	SS	250K	SS
10K	3/8"	30K	1 1/8"	1 MEG	SS

Triple 100K - 3/8" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

STANDARD BRANDS ONLY — TUBE SPECIALS — BRAND NEW FIRST QUALITY

RECEIVING TUBES

OZ4G	.59
1A3	.45
1AB5	.73
1B3GT	1.18
1L4	.66
1R4	.29
1R5	.69
1S4	.86
1S5	.64
1T4	.64
2X2/879	.49
2X2A	.79
3A4	.61
3A5	.96
3A8GT	1.76
3B7/1291	.29
3D6/1299	.29
3Q5GT	.79
3S4	.61
5R4GY	1.30
5T4	.89
5U4G	.59
5V4G	.84
5Z3	.65
6AB7/1853	.99
6AC7/1852	.79
6AC7W	1.45
6AG5	.89
6AG7	1.19
6AJ5	.89
6AK5	1.20
6AK6	.82
6AL5	.69
6AQ5	.72
6AQ6	.65
6AS7G	4.22
6AT6	.54
6AU6	.72
6AV6	.55
6BA6	.65
6BA7	.86
6BE6	.65
6BG6G	1.72
6BH6	.72
6BJ6	.72
6C4	.21
6F6	.69
6H6	.49
6J5	.49
6J6	.89
6J7	.72
6K6GT	.52
6K7	.54
6K8	.83
6L6	1.22
6L6G	1.11
6L6GA	.87
6SB7Y	.79
6SC7	.66
6SF7	.72
6SG7	.69
6SH7	.44
6SJ7	.59
6SL7GT	.69
6SN7GT	.79
6SN7W	1.45
6V6	1.07
6V6GT	.59
6W4GT	.65
6X4	.59
6X5GT	.59
7F7	.79
7N7	.79
10Y	.19
12A6	.24
12AH7GT	.87
12AT6	.59
12AT7	.99
12AU6	.72
12AU7	.86
12AX7	.86
12BA6	.64
12BA7	.86
12BE6	.64
12C8	.59
12SG7	.69
12SH7	.49
12SJ7	.49
12SK7	.59
12SL7GT	.69
12SN7GT	.79
12SR7	.69
28D7	.61

CATHODE RAY

2AP1	3.65
2AP5	5.95
3AP1	4.63
3AP4/-906P4	5.94
3BP1	2.59
3CP1	1.87
3DP1A	5.75
3EP1	2.92
3FP7	.98
3HP7	4.91
4AP10	5.35
5AP1	3.75
5AP4	4.75
5BP1	2.40
5CP1	2.87
5CP7	3.76
5FP7	1.05
5HP4	3.35
5JP2	9.55
5LP1	13.95
5MP1	10.65
7BP1	12.87
7BP7	4.95
7BP14	14.95
9GP7	9.85
9LP7	3.88
10BP4	21.95
10FP4	28.88
12DP7	12.85
12GP7	12.85
902PI	3.95
905	4.47
913	4.90

PHOTO CELLS

1P24	.29
918	.88
919	1.79
923	.97
927	1.67
931A	3.22
1645	1.67

THYRATRONS AND IGNITRONS

OA4G	.95
EL-C1A	3.35
2A4G	1.15
2D21	1.09
3C23	3.20
3C31/EL-C1B	3.35
4C35	21.00
EL-C5B	8.95
C6J	4.44
FG-17	2.89
FG-33	11.95
FG-67/-1904	8.85
FG-81A	4.95
91	5.85
FG-95	20.60
FG-105	9.95
FG-172	14.50
WE-355A	14.15
393A	5.77
394A	3.77
GL-415/-5550	22.00
KU-610	6.35
KU-628	16.90
KU-634	17.20
WL-652/-5551	38.00
WL-672	13.25
WL-677	24.00
WL-681/-5550	22.00
722A	3.75
873/973	6.95
884	1.35
885	1.20
1665	.97
1904	8.85
2050	.83
2051	.49

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OA2	1.32
OB2	1.75
1B22	3.87
1B23	8.95
1B24	4.90
1B26	4.50
1B29	2.90
1B32	3.15
1B36	4.50
1B42	9.80
1H20	.58
2B22	1.41
2C22	.22
2C26	.27
2C34	.28
2C44	.79
2E22	1.25
2J21A	8.95
2J22	8.95
2J26	7.80
2J27	13.70
2J31	9.60
2J32	14.45
2J33	19.90
2J34	19.90
2J37	13.70
2J38	12.70
2J41	132.50
2J48	14.95
2J61	36.20
2K23	23.95
2K25	19.95
2K28	19.95
2X2A	.79
3B22/EL-1C	1.12
3B23	4.75
3B24	1.25
3B27	1.29
3C24	.44
3J31	39.25
4-125A	26.95
4-250A	36.75
4A1	.58
4B22/EL-5B	5.20
4B25/EL-6CF	8.70
4C28	21.65
4E27	12.75
5D21	26.50
5J23	14.20
5J29	14.20
6C21	19.88
6J4	5.20
7-7-11	.89
10T1	.58
10Y	.19
15E	1.25
15R	.75
REL-21	3.25
24G	.44
RK-25	2.11
FG-32	4.25
RK-34	.28
REL-36	.78
RK-47	4.92
EF50	.45
VT-52	.36
53A	3.82
RK-59	2.44
RK-60/1641	.59
RK-72	.92
RK-73	.92
VR-75/-OA3	1.10
75T	3.80
VR-78	.34
VR-90/OB3	.81
VT-98(BR)	29.90
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
VR-105/-OC3	.72
WE-113A	1.32
WE-124A	3.80
VT-127A	2.40
VR-150/-OD3	.65
FG-190	12.15
203A	6.40
203B	4.33
204A	27.90
CE-206	3.15
211	.62
WE-215A	.24
221A	1.95
227A	2.40
WE-231D	1.25
RX-233A	2.95
WE-244A	4.20
WE-245A	1.35
WE-249C	1.88
WE-254A	4.90
WE-257A	2.77
WE-271A	6.75
WE-283A	1.27
WE-300B	7.50
304TH	3.86
304TL	1.25
307A	3.90
WE310A	7.50
WE-313C	3.15
316A	.66
350A	2.80
350B	1.95
354C	19.50
WE-356B	4.45
361A	4.75
371B	.82
388A	2.95
417A	10.65
434A	3.65
446A	.79
446B	1.95
450TH	19.70
450TL	32.50
451	1.75
471A	2.75
SS-501	11.50
503AX	1.47
506AX	1.47
507AX	1.47
527	9.75
530	17.20
531	17.80
532A	3.15
559	1.41
561	1.45
579B	5.85
HY615	.29
WL-670A	8.70
700B	16.90
700C	16.90
700D	16.90
701A	3.67
702A	2.95
702B	3.87
703A	3.90
704A	2.75
705A	1.17
706AY	45.00
706BY	45.00
706CY	17.95
706FY	45.00
706GY	45.00
707A	5.22
707B	6.95
708A	4.85
709A	4.87
710A	2.25
713A	1.45
714AY	6.95
715A	6.75
715B	9.95
717A	.97
721A	3.93
723A	6.95
723A/B	11.95
724A	3.22
724B	3.22
725A	8.95
726A	14.50
730A	10.95
731A	2.45
WL-787	9.80
800	1.88
801A	.48
802	4.25
803	4.87
804	8.95
805	4.75
807	1.40
808	2.19
809	2.40
810	7.95
811	2.11
813	7.25
814	3.79
815	1.72
816	.97
826	.57
828	13.48
829	4.91
830B	3.35
832	4.91
832A	5.50
836	.89
837	1.38
838	2.93
841	.49
843	.59
851	27.50
852	6.40
860	4.50
861	17.70
864	.19
865	.88
866A	1.15
869B	27.00
872A	1.88
874	1.65
876	.39
878	1.85
954	.39
955	.39
956	.49
957	.49
958A	.49
959	.49
991	.29
1005	.24
1201/7E5	.29
1203/7C4	.19
1294/1R4	.29
1299/3D6	.29
1602	.68
1613	.61
1616	.87
1619	.19
1624	.69
1625	.19
1626	.29
1629	.29

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MONTHLY BULLETINS

SEND IN YOUR NAME AND ADDRESS TO GET ON OUR MAILING LIST

All material brand new and fully guaranteed. Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna.

LECTRONIC RESEARCH LABORATORIES

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Telephones - MARKET 7-6590 and 6591

OUR JULY SPECIAL
2" Sun 0-50 milliamp meter. Square Bakelite case. 0-100 scale $1.69 ea.

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N.Y.

GUARANTEED SURPLUS

HIGH WATTAGE ANTENNA RELAY
110/220 volt 60 cycle coil. D.P.D.T. rated at 5000 V. 15A Heavy duty paralleled contacts. Sturdy construction. Isolantite insulation. Base 8" x 10½". Made by Monitor-Controller....................$18.50

ANTENNA RELAY
Same Specs. as above but D.P.S.T. Base size 4½" x 10½"...$12.95

PANEL METERS
BRAND NEW
Govt Surplus

3" Simpson 75-0-75 Microamps................$5.95
2" Gruen 0-500 Micramps (Volt Scale)........ 3.25
2" GE 0-5 MA (Amp Scale).................... 1.95
2" Simpson 0-5 MA. Basic. Square............ 2.25
2" Westinghouse 0-10 MA..................... 2.25
2" Simpson 0-20 MA (Amp Scale).............. 1.95
2" Sun 0-25 MA (0-100 Scale)................ 1.95
2" GE 0-50 MA............................... 2.45
2" Gruen 0-50 MA............................ 1.95
2" GE 0-1 Amp RF............................ 1.95
2" Simpson 0-2 Amp RF (Square).............. 1.95
2" GE 0-4 Amp RF............................ 1.95
2" GE 0-250 MA AC........................... 3.50
2" Sun 0-20 Volts DC........................ 1.75
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2" GE 0-30 Volts DC (1000 ohms/volt)........ 2.95
2" Triplett 0-300 Volts AC.................. 2.95
2" GE 0-30 Amps DC.......................... 1.95
2" GE 0-25 Volts AC, Linear (0-100 Scale).... 3.50
3" Westinghouse 0-2 MA...................... 3.75
3" Westinghouse 0-15 MA (Square)............ 3.75
3" Westinghouse 0-20 MA..................... 3.75
3" Western Electric 0-80 MA................. 2.75
3" GE 0-200 MA DC........................... 3.75
3" Triplett 0-75 Amps AC.................... 2.95
3" GE 0-15 Volts AC......................... 3.95
3" GE 0-1 Amp DC............................ 3.95
3" Westinghouse 0-2 Amps DC................. 3.95
3" Westinghouse 0-1 MA (Basic) KV Scale..... 3.95
3" Westinghouse 0-750 Volts DC (1000 Ohms/Volt) 4.50
3" Weston 0-1 Volt DC....................... 3.95

FILAMENT TRANSFORMERS
110 V 60 CY Pri. Cased.
2.5 Volt 10 Amp.................... 3.49
2.5 Volt CT 21 Amps................ 4.75
5 Volt 4A, 6.3V, 3A................ 2.45
2.5V CT 20A, 2.5V CT 20A........... 6.95

CHOKE BARGAINS
6 Henry 50 ma 300 ohms................3 for $0.99
8 Henry 150 ma 140 ohms...................... .99
1.5 Henry 250 ma 72 ohms..................... .59
6 Henry 400 MA 97 Ohms....................... 3.95

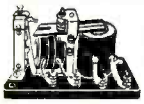
HEAVY DUTY RHEOSTAT
25 Ohms. 675 Watts Max. with Knob and Hardware.................$3.95
10 for $29.50

FILAMENT TRANSFORMER
6.3 volts at 12 amps. Primary 110 volts 60 cy. Size 3¼"H x 2⅞"W x 3"D. WT. 3½ lbs. As Illustrated. $1.69 ea.

SENSITIVE RELAY
Breaks at 3 MA. Beautifully Constructed and delicately pivoted. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only.........................99 ea.

500 MICROAMP RELAY
Delicately balanced, S.P.D.T., 10,000 ohm coil. Trips at .4 to .5 MA. 2⅝" x 2⅝" x 1⅝" high..$2.95

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle



Breaks at 640 Milliamps but easily adjustable for other currents. Terrific values at only..........$2.95
10 for 25.00

CERAMICONS
MMF: 1.5, 2, 3, 8, 10, 20, 22, 120, 500...... .05 ea.

LINK TEST SET
Type #1410. Contains two 3½" meters—a 75-0-75 microamp Galvanometer and a 0-1 MA multi-scale meter. Has tap switch for changing ranges. Ranges are as follows: 75-0-75 microamps, 1 MA, 2.5 MA, 50 MA, 25 volts, 500 volts. Ideal for balancing discriminators and general lab use. Housed in hard wood case with hinged cover. 10" x 8" x 4½". Only......................................$14.95 ea.

RESONANT RELAY
Available in frequencies of 240 cps and 442 cps. Enclosed in octal metal tube cover. Will control thyratron or slow acting relay..................$1.69

HIGH CURRENT MICAS
Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	Amps 300 Kc	KV DC	Price Each
.08	60	42	4	$27.50
.1	70	50	4	29.50
.65	60	42	5	24.50
.037	45	35	6	26.50
.02	40	30	9	29.50
.02	55	38	10	29.50
.0117	40	27	14	24.50
.0075	39	27	15	24.50
.009	40	25	15	29.50
.00978	40	25	15	29.50
.01	43	28	15	29.50
.0025	23	15	20	29.50
.00315	26	18	20	29.50
.004	30	20	22	33.50
.0033	25	16	25	35.50
TYPE G3 4" HIGH, 5" DIAMETER				
.0013	15	9	15	14.50
TYPE G2 3" HIGH 3½" DIAMETER				
.00057	8	4	10	4.95
.01	25	17	7	6.95
TYPE GI ½" High 2/16 DIAMETERS				
.00024	4	2	6	3.95
.0047			6	5.95

SILVER MICA CAPACITORS
MMF: 10, 47, 50, 60, 340, 750, 780, 1000... .09 ea.

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for.........................$1.90

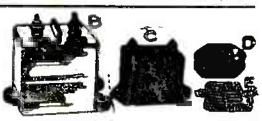
Thermal Time Delay Relay. 15 to 3 seconds, plugs into 4 prong Tube Socket Glass Enclosed 250 V.. .75

PRECISION 1% W.W. RESISTORS
Ohms: 2K, 2500, 5K, 8500, 95K, 750K.... .25 ea.

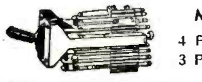
PLUG IN CAPACITOR
8 x 8 Mfd 600 volts DC, Oil filled. Plugs into standard 4 prong socket. 3¾ h x 3⅛ w x 1⅞ d......$1.39

GENERAL ELECTRIC Type PBC Instantaneous Overcurrent Relay. Adjustable from 100 to 200 MA. Electrical and Manual Reset, 4 PDT, Reset 110 Volts 60 Cycles...................................$7.95

BAKELITE CASED MICAS



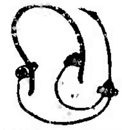
MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	C .001	3 KV	$ .90
E .01	600	.26	C .002	3 KV	.95
D .02	600	.26	D .005	3 KV	.70
E .027	600	.26	C .005	3 KV	1.24
C .01	1 KV	.45	C .006	3 KV	1.50
C .07	1 KV	.55	D .002	3 KV	.70
D .02	1200	.35	C .0001	5 KV	.70
C .024	1500	.65	C .0005	5 KV	.85
C .033	1500	.75	C .0015	5 KV	1.60
C .015	2 KV	.80	C .003	5 KV	1.90
C .02	2 KV	.90	C .005	5 KV	2.50
D .002	2500	.45	C .002	6 KV	2.90
E .005	2500	.55	B .007	5 KV	2.75
C .025	2500	1.25	B .0005	8 KV	2.90
			B .002	8 KV	4.50



MOSSMAN SWITCHES
4 Pole Single Throw....$1.10
3 PDT, plus 6 PST..... 1.75

WESTINGHOUSE SELENIUM RECTIFIER
Hermetically sealed, Oil Immersed Full Wave Bridge. 30 Volts AC Input. 24 Volts at 2 Amps Output.
Size ....$3.75 ea.

GUARDIAN LATCHING RELAY
Type RC 100. 110 volt 60 cycle coil. S.P.D.T. each impulse reverses the position of the contacts. Locks automatically. Contacts rated 1500 watts at 110V 60 cycles. Size 3" long, 2⅛" wide, 1½" high. Only.................................$1.95 ea.

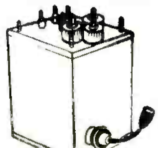


MINIATURE HEADPHONES
250 ohms imp. Can be used for sound power Telephones, etc.
Type HS 30............. .69 ea.
HS 30 with Trans....... .89 ea.
Hi Imp. Transf. .... .45

THORDARSON PLATE TRANS.
Pri 115/230 V. 60 cy. 625 Watts. Sec. 2000, 2500, 3000, 3500 Volts Center Tapped. Type T15P22 $22.50

30 WATT WIRE WOUND RESISTORS
Ohms: 100-2500-3k-4k-4500-5k-5300
12k-18k .15 ea. 8 for .99

SCOPE AND FIL. TRANSFORMER



Pri. 115 volts, 60 cycles. Sec. 4400 volts RMS 4.5 MA., 5 volts, CT 3 amps. Fil. Ins. 15 KV. RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon. 4½ x 5 x 5½ ....Only $3.95

MIDGET VARIABLE CONDENSERS
Steatite Insulation
15 MMF (HF 15).......................... .39
Dual 15 MMF (HF 15 D)................... .69
250 MMF (MC 250 S)...................... .69

50 megohm 35 watt Resistor with mount..$1.49 each ; 10 for $9.90
10 Meg 10 Watts... .49: 2 Meg 5 Watt........ .35

OIL CONDENSERS

2 mfd 600 vdc— .39	10 mfd 2000 vdc—5.95
4 mfd 600 vdc— .59	2 mfd 4000 vdc—4.95
6 mfd 600 vdc— .79	1 mfd 5000 vdc—4.50
3/3 mfd 600 vdc— .79	.1/.1 mfd 7000 vdc—2.25
10 mfd 600 vdc— .89	2 mfd 6000 vdc—9.95
4 mfd 1000 vdc— .95	1 mfd 7500 vdc—6.50
10 mfd 1000 vdc—1.99	.01/.01 mfd 12 kv dc—5.75
2 mfd 1500 vdc—1.25	
6 mfd 1500 vdc—2.95	.65 mfd 12,500 vdc—12.95
1 mfd 2000 vdc—1.45	2 mfd 18 kv dc—49.55
2 mfd 2000 vdc—2.25	61 mfd 15 kv dc—15.95
8 mfd 2000 vdc—4.95	

WIRE WOUND RESISTORS
5 Watt type AA, 20-25-50-200-470-2500-400 ohms..............................$.09 ea.
10 watt type AB. 25-40-84-400-470-1325-1000-2000-4000 ohms .... .15 ea.
20 watt type DG. 50-70-100-150-300-750-1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms .... .20 ea.

ADJUSTABLE RESISTORS
20 Watt: 1, 5, 50 Ohms...................... .25
50 Watt: 80, 100, 500 Ohms.................. .35
75 Watt: 40, 80, 100, 150, 200 Ohms......... .39
100 Watt: 20, 50, 75, 120, 180 Ohms......... .49
150 Watt: 50, 100 Ohms...................... .59

W. W. POWER RHEOSTATS
25 Ohms 25 Watt .... .39
250 Ohms 50 Watt .... .59
300 Ohms 50 Watt .... .59
Dual 200 Ohms 50 Watt...................... .79
100 ohm 100 watt........................... .99
200 ohm 100 watt........................... .99

MISCELLANEOUS BARGAINS
.02 400 volt dc tubulars..................15 for .99
2mfd 250 volts ac oil cond............... 6 for .99
10 meg 10 watt resistor.................. 2 for .99
Heinoman 25 amp 110 volt ac ckt breaker.. 1.19
Ceramicon .0005 mfd ....20 for .99
.01 600 volt dc pigtail micas............10 for .99
.001 600 volt dc pigtail micas...........15 for .99
.006 600 volt, pigtail micas.............12 for .99
Butterfly cond. 2 to 11 mmf ball brngs... 3 for .99
CD type 4 micas .001 600vdc..............10 for .99
250 mmf variable cond. (mc250s)........ .59
10,000 ohm potentiometers .... 6 for .99
500 ohm 100 watt non-induct. Resistor.... .99
250 ohm 100 watt non-induct. Resistor.... .99
16 mfd 450 volt electrolytic (EB9160).... 3 for .99
Var. cond. 150 mmf .07 spacing.......... 2 for .99
Variable ceramicon 20 to 125 mmf type 823 5 for .99
Western Electric silver varble .5 to 2.5 mmf 8 for .99
50 K 1% W. W. Resistors, Precision.......... .14
.35 at 16 KV plus .75 at 8 KV Oil Cond........ 3.95
.1 MFD 7500 VDC Oil Cond.................. .89
.05 MFD 7500 VDC Oil Cond................. .75
7 MFD 330 VAC Oil Cond.................... .69
Meter Multiplier 2 MEG. ½ of 1% 2KV........ 1.49

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N.Y.

Phone Co 7—6486 —6443
DEPARTMENT EA

Reliance Specials

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MFD
8.2	62	370	900	.0047
10	68	390	910	.005
15	75	400		.006
20	72	430	MFD	.007
22	90	500	.001	.0068
24	100	510	.0012	.0075
25	110	560	.0013	.0082
39	150	600	.00136	.009
40	160	620	.0015	.01
47	200	650	.002	
50	240	680	.0026	
51	250	700	.0027	
56	300	800	.003	
60	330	820	.0033	

Price Schedule

8.2 MMF to .001 MFD.....5¢
.0012 MFD to .002 MFD.....7¢
.0026 MFD to .009 MFD.....12¢
.01 MFD..................18¢

SILVER MICA

MMF	MMF	MMF	MMF	MFD
10	85	260	488	.0023
24	100	270	500	.0024
30	110	300	510	.0027
39	115	325	525	.003
40	120	330	560	.0033
45	125	360	680	.0039
50	150	370	700	.004
51	180	390	750	.0047
60	200	400	820	.005
62	208	430	MFD	.0051
66	225	450	.001	.006
68	240	466	.0013	.0082
75	250	470	.0022	.01

Price Schedule

10 MMF to .001 MFD...10¢
.0012 MFD to .0027 MFD...20¢
.003 MFD to .0082 MFD...50¢
.01 MFD..............65¢

OIL FILLED

MFD	V.D.C.	Price
.25	20,000	$16.75
.4	10,000	4.75
.03	16,000	1.95
.1	7,500	1.55
.1-.1	7,000	1.55
.02-.02	7,000	1.25
1	6,000	5.25
3	4,000	4.35
2	4,000	2.25
.25	3,000	1.10
8	2,000	5.75
4	2,000	3.95
1	2,000	.95
3	1,000	.80
2	1,000	.65
10	600	1.00
4	600	.69
2	600	.39

WW PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	10,000
11.74	14.98		366.6	59,148

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	65,000Ω
2.58	10.9	3,300	18,000	70,000
3.39	270	7,000	55,000	

½ WATT—25c

.250Ω	1.53Ω	75Ω	270Ω	4,000Ω	8,000Ω
.334	2.04	97.8	298.3	4,451	8,500
.502	11.1	125	400	5,000	14,825
.557	13.15	180	723.1	5,900	15,000
.627	46	210	2,500	6,500	15,750
.76	52	235	2,850	7,000	17,000
1.01	55.1	260	3,427	7,500	30,000
					100,000

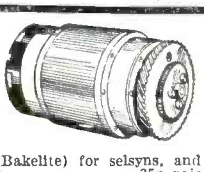
1 WATT—40c

120,000	128,000Ω	320,000	522,000Ω
125,000	130,000	470,000	600,000
	160,000		700,000

1 Megohm—1 Watt 1%—65c; 5%—40c

100 pieces—10% off; 1,000 pieces—20% off

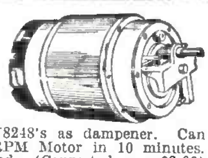
SELSYNS



115 V., 60 Cyc.
#C78248
3⅜" dia. x 5⅝" long
$7.95 pair

Mounting Brackets — (Bakelite) for selsyns, and differentials shown above...............35¢ pair

DIFFERENTIAL



115 V., 60 Cyc.
#C78249
3⅜" dia. x 5⅜" long
$2.25 ea.

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted......$3.00)

TAIL END RADAR

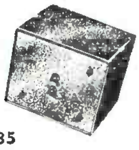
APS-13—like new, complete with tubes..........$14.95

CERAMICONS

2 MMF	30 MMF
5.6	39
10	45
12	82
15	150
20	680

$4.50 per hundred

CHOKE



400 MA
12 Hy.
90 OHM
HIGH VOLT TEST
$3.85
10 for $34.00

ALLEN SET SCREWS

4-40 x ⅛ | 8-32 x ⅛ | 8-32 x 5/16
4-40 x 3/16 | 8-32 x 3/16 | 8-32 x ⅜
ALL SIZES...........................$1.50 per 100

GLYPTAL CEMENT 1 qt.........................75¢

SELENIUM RECTIFIERS HALF WAVE

117 V.A.C. IN. 110 V.D.C. OUT @ 75 Ma.........$ .49
117 V.A.C. IN. 110 V.D.C. OUT @ 100 Ma........ .72
117 V.A.C. IN. 110 V.D.C. OUT @ 400 Ma........ 1.51

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A. • Holds ON as long as power is applied • Fully cased •
ONLY $6.50

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay................85¢
T 114—Approx. 2.2 micro sec. delay................85¢
T 115—Similar to T 114 with tap brought out........85¢

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1½	$2.50	5	$2.50
¼	4.00	2	2.50	10	3.00
¾	4.00	3	2.50	15	3.00
1	2.50				

Fuse Holder—for 3AG Fuse..........................18¢

4AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
1/10	$4.00	2	$2.00	10	$2.50
1/4	3.50	3	2.00	15	2.50
1/2	3.50	3.2	2.00	20	2.50
1	2.00	5	2.00	25	2.50
				30	2.50

Fuse Holder—Little fuse for 4AG Fuse.............18¢

MICRO AMMETER 0-500

2" round Basic move. 500 micro-amps. NEW—Guaranteed. Original box...............$3.85 ea.—10 for $35

UNIVERSAL JOINT
3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	.25
N.D.38	5/16	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
SKF170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16	11/32"	25¢

SOUND POWERED HANDSET

Brand New! TS-10

Includes 6 ft. cord & spring clips
$8.92 ea. — $17.60

POWER RHEOSTATS
STANDARD BRANDS

25 WATT

Resist.	Shaft	
10Ω	7/16"	49¢
145	½" with switch	49
250	7/16"	59
370	½"	59

25 WATT

5,000	⅛"*	69¢
123Ω	½"	79¢
1,250	½"	89
2,000	⅛"	89

50 WATT

8Ω	⅛"*	79
20	7/16"	79
90	½"	79

150 WATT

8Ω	½"	$1.99

*S.D. Screw Driver Slot

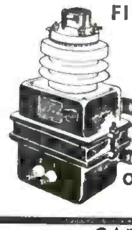
2J1G1 SELSYNS (Brand New)

400 Cyc. Use on 24V. or 110 VAC...............$1.65 each

FILAMENT TRANSFORMER

Pri., 115 V., 60 Cyc.—Sec. 5V., 115 A. 6000 volt insulation ....$9.95 each

FILAMENT TRANSFORMER



Amertran Type WS

For High Voltage Rectifiers. PRI. 115V., 50/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

NEW OVERSEAS PACKED $10.95

872-A Tube..... $1.88

CARBON RESISTORS

Large stock on hand. Send list of your requirements.

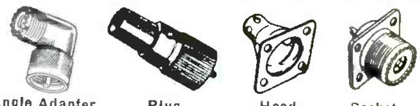
Write for Monthly Bulletin

COAXIAL CABLE
RG 8/U 52 OHM
$55.00 per 1,000 feet

	Ohm	Price per 1,000 ft.		Ohm	Price per 1,000 ft.
RG 5/U	53.5	$70.00	RG 27/U	48	$290.00
RG 7/U	97.5	60.00	RG 29/U	53.5	50.00
RG 8/U	52	55.00	RG 34/U	71	175.00
RG 9/U	51	135.00	RG 39/U	72.5	180.00
RG 10/U	52	125.00	RG 41/U	67.5	575.00
RG 11/U	75	100.00	RG 54/U	58	65.00
RG 12/U	75	190.00	RG 54/AU	58	75.00
RG 13/U	74	125.00	RG 55/AU	53.5	60.00
RG 18/U	52	450.00	RG 57/U	95	100.00
RG 20/U	52	450.00	RG 58/U	53.5	50.00
RG 22/U	95	110.00	RG 59/U	73	40.00
RG 24/U	125	240.00	RG 62/U	93	50.00
RG 25/U	48	575.00	RG 74/U	52	250.00
			RG 77/U	48	100.00

Less than 1,000 ft. add 25%

COAXIAL CABLE CONNECTORS



Angle Adapter 15¢ M-359 83-1AP | Plug 28¢ PL-259A 93-1SPN | Hood 9¢ 83-1H | Socket 28¢ SO-239 83-1R

Adapter for PL-259 A for use on small coax. 12¢ each ....$10.00 per 100

83-1SP	$.28	83-22R	.48	UG27/U	.60
83-1J	.80	83-22SP	.60	UG59/U	.60
83-1RTY	.45	UG13/U	.60	UG61/U	.60
83-1T	1.12	UG21/U	.60	UG85/U	.62
83-1F	1.12	UG22/U	.80	UG87/U	.68
83-22AP	.85	UG24/U	.60	UG167/U	2.00
83-22F	.88	UG25/U	.60	UG281/U	.60

HAYLON TIMING MOTOR

4 R.P.M., 115V., 60 Cycle..........$1.79

VOLTMETER—0—300 VDC

2" Round: basic movement, 1 ma. New—Guaranteed. Original Box.................$3.50 ea.—10 for $32.50

#18 SHIELDED WIRE—STRANDED

Single Conductor—100 ft....$1.95 1,000 ft....$12.50
Two Conductor —100 ft....$2.95 1,000 ft....$19.50

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, 9340. small gray case. Ratio 1:1:1:, hypersil core..........................$1.50
D161310. 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms.......................... $1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.00
D-166638 W. E. Permalloy core, Semi-toridal windings $1.25
KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50
D106173, W.E. Freq. resp. 10KC to 2 MC....... $9.80
800 KVA G.E. K2731, 28000 Volt pk. output: Bifilar: one microsecond pulse width.............$28.50

CARBON MIKE

T-17—Slightly used, guaranteed, 5 ft. cord & PL 68..69¢

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	5-141	$.20	15-141Y	$.77
2-140¾W	.10	5-141Y	.27	17-141Y	.87
3-140¾W	.13	5-141¾W	.27	3-142	.15
4-140	.13	6-141¾W	.32	5-142	.24
8-140W	.33	7-141	.27	5-142¾W	.34
10-140¾W	.40	7-141¾W	.37	6-142	.28
13-140	.37	7-141Y	.37	6-142¾W	.40
2-141	.60	8-141¾W	.42	6-142¾W	.40
3-141¾W	.17	9-141¾W	.47	10-142¾W	.64
3-141W	.17	9-141Y	.47	2-150	.28
4-141W	.22	10-141Y	.52	3-150	.40
4-141¾W	.22	13-141	.47	4-150	.52
4-141Y	.22	13-141¾W	.67	6-150	.75

Gear Assortment..........................$6.50
Experimenters dream, 100 pieces, many stainless steel.

PRECISION CONTROLS

6 WATT

20,000	Muter	314A	*1.70
20,000Ω	GR	314A	2.50
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	260	1.70

25 WATT

100K	GR	433A	$4.95

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
12	GR	301	1.10

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00

7 Terminal Bakelite tie point...............35 for $1.00

VERNIER DIAL (From BC-221)

2 ⅝" Dia. 0-100 in 360". Black with silver marks. Has thumblock ....85¢

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1N21B	1.39
1N22	.98
1N23	.79
1N23A	.79
1N23B	1.89
1N27	1.29
1N34	.82
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1P24	.59
1P36	2.85
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2C26A	.15
2C34/RK34	.22
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2C44	.98
2C46	6.95
2C51	5.95
2D21	.89
2D29	1.39
2E22	1.19
2E26	3.39
2E30	2.39
2J21A	7.95
2J22	7.95
2J26	6.95
2J27	12.75
2J30	49.50
2J31	8.49
2J32	12.95
2J33	18.75
2J34	18.95
2J36	97.50
2J37	12.95
2J38	11.95
2J39	19.95
2J40	24.50
2J46	49.50
2J48	12.75
2J49	39.50
2J50	22.50
2J54B	22.50
2J55	69.50
2J61	34.50
2J62	34.50
2K25	22.50
2K28	24.95
2K29	24.50
3AP1	4.59
3B22	1.98
3B24	1.49
3B25	4.87
3B26	1.49
3B27	1.95
3B28	7.95
3BP1	2.39

3C22	$39.50
3C23	2.19
3C24/24G	.35
3C30/809	1.89
3C31/C1B	2.98
3C45	12.95
3CP1	1.39
3DP1	1.79
3DP1-S2A	2.79
3D21A	.98
3EP1	2.59
3E29	8.95
3FP7	.97
3GP1	5.95
3HP7	3.95
4-65A	14.21
4-125A	26.05
4-250A	36.25
4AP10	1.98
4B22	9.98
4B24	1.98
4B25	7.95
4B26	4.49
4B28	2.47
4B32	9.95
4C35	19.38
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5AP1	2.95
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5BP4	2.39
5CP1	1.29
5CP7	2.95
5D21	24.45
5FP7	1.19
5GP1	2.98
5JP1	39.50
5JP2	8.95
5JP4	39.50
5J23	12.95
5J29	12.95
5J30	47.50
5LP1	12.95
5MP1	9.95
5NP1	4.98
6C21	19.69
6F4	5.59
6J4	4.49
7BP7	9.95
9GP7	8.95
9JP1	6.95
9LP1	19.95
9LP7	1.98
10BP4	19.69
10Y	.19
12DP7	14.95
12GP7	12.75
12HP7	13.95
12LP4	24.95
15E	1.19
15R	.49
16AP4	49.50
19T8	.89
23D4	.29
28D7	.29
30SP	.19
35TG	5.95
45SP	.19
53A	5.95
75TL	5.95
100R	.97
100TH	9.95
100TS	2.25
211	.25
217C	9.95

227A/5C27	$2.69
249C	1.49
250R	5.95
250TH	18.95
250TL	18.95
274B	2.69
293A	2.98
294A	2.95
300B	9.95
304TH	3.49
304TL	1.29
305A	24.95
307A	3.69
316A	.29
327A/5C37	2.75
331A	12.95
350A	1.98
350B	1.39
368A/S	4.98
371B	.49
388A	.47
393A	3.69
394A	3.69
417A	9.95
446A	1.25
446B	1.79
450TH	19.95
450TL	44.50
527	5.95
559	.98
575A	11.95
631P1	3.75
700A	19.95
700B	19.95
700C	19.95
700D	19.95
701A	3.95
702A	2.69
703A	1.89
704A	1.49
705A	.69
706B	18.95
706CY	18.75
706FY	47.50
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707B	14.95
708A	3.59
713A	.79
714AY	3.59
715A	5.49
715B	6.59
715C	19.95
717A	.49
721A	1.98
723A/B	12.95
724A/B	2.95
725A	6.45
726A	6.75
726B	29.50
726C	49.50
730A	9.95
750TL	69.50
800	1.49
801A	.19
802	4.19
803	2.95
804	7.95
805	3.65
807	1.09
808	.99
809/3C30	1.89
810	7.95
811	1.98
812	2.45
812H	6.86
813	6.85
814	1.98
815	1.59

816	.99
826	.39
828	10.95
829	7.45
830B	3.19
832A	4.89
833A	33.95
836A	1.97
837	1.19
838	1.98
841	.29
843	.29
845	4.25
851	12.95
860	14.95
861	9.95
864	.29
865	.79
866A	1.05
866JR	1.05
869B	26.50
872A	1.12
874	.39
876	.29
878	1.98
884	1.19
885	1.19
902	3.39
905	2.49
908	4.95
918	1.49
919	1.95
923	.79
927	1.25
930	.98
931A	2.98
954	.16
955	.25
956	.25
957	.22
958	.22
959	.35
991/NE16	.24
1613	.49
1614	1.35
1616	.49
1619	.17
1624	.67
1625	.19
1626	.25
1629	.19
1630	.49
1631	.98
1632	.69
1633	.79
1634	.98
1635	1.09
1636	1.98
1638	.65
1644	.98
1654	2.45
1665	1.10
1851	.69
1960	.89
2050	1.19
2051	.39
8005	4.75
8011	.25
8012	1.39
8013	1.39
8014	22.50
8020	.89
8025	3.69
9001	.32
9002	.25
9003	.33
9004	.24
9005	1.35

9006	.15
C1JA	9.95
C5B	6.95
C6A	7.95
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C100D	.98
CK502AX	2.25
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CK507AX	1.95
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CK1005	.09
CK1006	.85
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E1148	.29
EF50	.39
F123A	7.95
F127A	15.95
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HY114B	.69
HY115	.59
HY615	.19
KU610	6.95
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KC4/ML100	37.50
ML101	49.50
MX408U	.39
REL21	.98
RK59	1.69
RK60	.42
RK65	24.50
RK72	.59
RK73	.59
RX21	2.39
RX120	8.95
V70D	7.35
VCR138	5.95
VR53	.19
VR78	.29
VT127A	2.19
VT158	14.95
VU111	.49
WL468	5.95
WL530	12.75
WL531	4.75
WL532	1.89
WL616	37.50
WL619	18.95
WL677	34.50
WL681/686	22.50
WL710A	.25
OA2	1.29
OA4G	.89

0B2	$1.67
0Z4	.57
01A	.39
1A3	.44
1A4	1.09
1A4P	.97
1A5GT	.49
1A6	.79
1A7GT	.67
1AB5	.59
1B3/8016	1.15
1B4	1.19
1B5/25S	.89
1C5GT	.59
1C6	.89
1C7G	.89
1D5GP	.97
1D7G	.89
1D8GT	.95
1F4	.75
1F5G	.75
1G4GT	.69
1G6GT	.65
1E7G	1.15
1H4G	.55
1H5GT	.54
1H6GT	.87
1J6G	.75
1L4	.48
1LA4	.79
1LA6	.89
1LB4	.89
1LC5	.69
1LC6	.79
1LD5	.79
1LE3	.69
1L5	.79
1LH4	.79
1LN5	.67
1N5GT	.59
1P5GT	.67
1Q5GT	.67
1R4	.59
1R5	.69
1S4	.59
1S5	.49
1T4	.53
1T5GT	.69
1U4	.59
1V	.57
2A3	.87
2A4G	1.07
2A5	.69
2A6	.79
2A7	.79
2V3G	.69
2X2	.37
2X2A	.65
3A4	.34
3A5	.79
3A8	1.59
3B7/1291	.29
3D6/1299	.29
3LF4	.79
3Q4	.47
3Q5GT	.67
3S4	.57
3V4	.67
5R4GY	1.09
5T4	.87
5U4G	.49
5V4G	.87
5W4	.67
5X4G	.57
5Y3GT	.39
5Y4G	.49
5Z3	.52

5Z4	.77
6A3	.92
6A4LA	1.09
6A6	.79
6A7	.69
6A8	.75
6AB7	.79
6AC7	.74
6AD7G	1.09
6AF6G	.79
6AG5	.69
6AG7	.98
6AH6	1.29
6AJ5	.79
6AK5	.85
6AK6	.79
6AL5	.59
6AQ5	.49
6AQ6	.59
6AR5	.52
6AT6	.44
6AU6	.59
6AV6	.47
6B4G	.89
6B6G	.79
6B7	.87
6B8G	.69
6BA6	.55
6BE6	.52
6BF6	.57
6BG6G	1.47
6BH6	.59
6BJ6	.57
6C4	.19
6C5	.47
6C6	.57
6C8G	.69
6D6	.44
6D8G	.79
6E5	.69
6F5	.47
6F6	.57
6F6GT	.57
6F7	.69
6F8G	.87
6G6G	.69
6H6	.39
6H6GT	.37
6J5	.47
6J5GT	.39
6J6	.77
6J7	.67
6J7GT	.65
6K5GT	.79
6K6GT	.44
6K7	.49
6K8	.79
6L5GT	.79
6L6	1.05
6L6G	.99
6L6GA	.85
6L7	.79
6L7G	.87
6N7	.75
6Q7	.64
6R7	.79
6S7G	.79
6S8GT	.77
6SA7	.44
6SC7	.59
6SD7GT	.44
6SF5	.49
6SF7	.59
6SG7	.59
6SH7	.37
6SJ7	.47
6SK7GT	.44
6SL7GT	.59

6SN6GT	.97
6SN7GT	.54
6SQ7	.45
6SR7GT	.52
6SS7	.49
6ST7	.72
6SU7GTY	1.25
6SV7	.79
6T7G	.89
6U5G	.65
6U6GT	.63
6U7G	.49
6V6	.89
6V6GT	.57
6W4	.63
6W7G	.77
6X4	.57
6X5GT	.47
6Y6G	.67
6C7G	.98
6ZY5G	.59
7A4/XXL	.49
7A6	.59
7A7	.53
7AG7	.72
7B4	.53
7B5	.67
7B6	.56
7B7	.59
7C4	.34
7C5	.48
7C7	.59
7E5	.67
7E6	.54
7E7	.62
7F7	.59
7H7	.59
7K7	.89
7L7	.69
7N7	.67
7Q7	.59
7R7	.69
7V7	.87
7W7	.79
7X7	.79
7Y4	.47
7Z4	.57
12A	.57
12A6	.17
12A7	.89
12A8GT	.49
12AH7GT	.80
12AT6	.44
12AT7	.79
12AU6	.57
12AU7	.67
12AV6	.54
12BA6	.55
12BE6	.49
12C8	.34
12F5GT	.58
12H6	.27
12J5GT	.34
12J7GT	.67
12K7GT	.52
12K8	.59
12Q7	.49
12SA7	.57
12SC7	.54
12SF5	.59
12SF7	.54
12SG7	.52
12SH7	.35
12SJ7	.47
12SK7	.57
12SL7	.59
12SN7	.52
12SQ7	.49

12SR7	.49
12Z3	.69
14A4	.79
14A7	.52
14B6	.67
14F7	.69
14F8	.79
14H7	.59
14J7	.87
14N7	.85
14Q7	.53
14R7	.67
19	.69
24A	.49
25L6GT	.53
25Z5	.44
25Z6GT	.43
26	.49
27	.42
28D7	.35
30	.37
31	.59
32	.85
32L7GT	.89
33	.69
34	.37
35/51	.57
35A5	.63
35B5	.55
35C5	.59
35L6	.52
35W4	.39
35Y4	.49
35Z3	.57
35Z4	.44
35Z5	.39
36	.67
37	.35
38	.37
39/44	.27
41	.49
42	.49
43	.49
45	.52
45Z3	.57
45Z5	.55
46	.62
47	.69
49	.85
50	1.39
50A5	.69
50B5	.53
50L6GT	.52
50Y6	.57
53	.87
56	.45
57	.45
58	.49
59	.89
70L7	.99
71A	.59
75	.53
76	.44
77	.43
78	.44
80	.37
81	1.25
82	.84
83	.75
83V	.89
84/6Z4	.56
85	.69
89Y	.35
117L7/M7	1.19
117N7	1.19
117P7	1.19
117Z3	.49
117Z6	.65

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189 GREENWICH STREET . NEW YORK, N. Y.

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STANDARD DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-153	12V	200	SPDT-SPST (NO)	$1.25
R-154	12V	200	SPST (NO)	1.20
R-155	12V	100	SPST (4ND4NC)	1.15
R-158	6V	50	4PST (NO)	1.10
R-159	6V	50	DPST (NO)	1.10
R-160	6V	12	3PDT-3PST (NO)	1.05
R-161	6V	10	3PST (2NC-1NO)	.90
R-121	150V	5000	2PST (NO) SPDT	1.65
R-517	12V	250	DPST (NO)	1.20
R-520	250V	14000	DPDT	2.10
R-166	24V	Dual 200	DPDT-SPST (NO)	1.59
R-168	24V	Dual 200	4PST (NO)	1.20
R-725	100-300V DC	6500	3PST (INC-2NO)	1.95
R-726	115AC	——	5PDT	2.25
R-735	48V DC	600	3PDT	1.10
R-777	12-24 VDC	70	DPST (1NO-1NC)	1.20

TYPE 18 DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-109	24-48V	4000	SPDT	1.50
R-110	24-32V	3500	SPDT	1.50
R-114	24V	500	4PST (NO)	1.30
R-115	24V DC	500	SPDT	1.35
R-750	24V DC	400	SPST (NO)	1.30
R-764	48V DC	1000	DPDT DPST (NO)	1.50
R-770	24V DC	150	DPST (NO) 10 amp.	1.15
R-771	24V DC	200	SPST (NO) 10 amp.	1.15
R-799	24V DC	500	None	.75
R-800	12V DC	150	DPDT-SPST (NO)	1.25
R-801	115AC		None	1.15
H-238	24V	150	DPDT-SPST (NC)	1.25
H-239	24V	180	DPST (NO)	1.25

SEALED DC TELEPHONE RELAYS

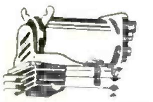
Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-125	24V	300	DPDT	$2.75

E TYPE DC TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-164	24-32V	1000	SPST (NO)	1.20
R-526	6V	35	DPDT-SPST (1NC-1NO)	1.05

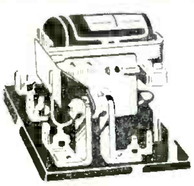
AC—STANDARD TELEPHONE RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-213	5-8V	——	DPST (NO)	1.50
R-605	24V	——	3PST (NO)	.95
R-606	24V	——	DPST (1NO-1NC)	.95
R-607	24V	——	SPST (NO)	.95



DIRECT CURRENT MIDGET RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-132	24V	300	DPDT	$1.20
R-133	24V	300	None	.60
R-135	24V	300	SPST (NC)	1.15
R-137	24V	300	SPDT	1.15
R-138	24V	300	4PST (NO)	1.15
R-139	24V	200	4PDT	1.15
R-140	24V	280	SPDT	1.15
R-141	24V	280	3PST (NO)	1.15
R-142	24V	400	DPDT	1.20
R-143	24V	280	SPST (NO)	1.15
R-144	24V	250	SPST (NO)	1.15
R-145	24V	300	DPST (NO)	1.15
R-146	12V	126	DPST (1 NO) (1NC)	1.10
R-148	12V	100	SPST DPDT-(NC)	1.10
R-149	6-8V	45	SPST (NC)	1.00
R-150	6V	30	SPST (NO)	.95
R-523	90-125V	6500	DPDT	1.90
R-222	12V	100	DPST (NO)	.95
R-696	24V DC	200	SPST (NO) 8 amp.	1.50
R-728	6V DC	30	SPST (NO)	1.00
R-731	24V DC	300	DPDT	1.25
R-733	12V DC	120	DPDT	1.00
R-738	12V DC	60	3PST (NO)	.95
R-743	110V DC	5000	4PST (1NO) (3NC)	1.65
R-755	24V DC	300	SPST (NO)	1.15
R-781	24V DC	250	DPST (1NO-1NC)	1.20
R-782	100V DC	6500	4PDT-SPST (NO)	1.95
R-732	12V DC	120	SPST (NO)	1.15
R-783	100V DC	6500	SPDT Micalex	1.85
R-785	60V DC	1300	DPDT	1.50
R-786	24V DC	200	DPDT-10 amp.	1.50
H-242	24-32V	300	DPDT	1.20
H-243	24-32V	300	4PDT	1.20



SENSITIVE DC RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-177	24V	300	4PDT	$1.65
R-218	4-6V	1800	SPDT	1.95
R-220	75V	5000	SPDT	1.20
R-221	18-24V	5000	SPST (NO)	1.15

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-600	8-12V	5000	SPDT	$2.10
R-716	24V	70	DPST (NO) 5 amp.	1.45
R-778	8V DC	4500	SPDT 5 amp.	2.10
R-798	24V DC	Dual 500	Each SPDT-5 amp.	1.85
R-693	2-6V DC	125	SPDT-3 amp.	.95
R-692	-6 to 24V DC	1280	SPDT-3 amp.	1.10
R-695	12V DC	70	DPDT-3 amp.	1.05
R-694	24V DC	300	SPST (NO) 5 amp.	1.20
R-706	24V DC	150	4PDT 10 amp.	1.95
R-705	12-24V DC	70	SPST (NO) 10 amp.	1.25

TYPE BO DC RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-169	24V	250	SPST (NO)	1.95
R-171	24V	230	DPDT	2.15
R-173	2-6V	5	SPST (NO)	1.25
R-529	24-48V	1000	DPDT	2.00

TYPE BJ DC RELAYS

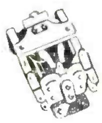
Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-204	12V	65	DPST	1.15
R-205	24V	260	DPDT	1.25
R-224	12V	75	SPST(NO)	1.15
H-237	27V	230	DPDT	1.25

HEAVY DUTY KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-248	28V DC	150	SPST (NO) 10 amp.	1.05
R-244	75V AC	265	SPST (NO) 20 amp.	1.75
R-206	24V DC	150	5PDT-3 amp.	1.20
R-207	24V DC	210	4PDT-3 amp.	1.10
R-219	50V DC	1500	DPST (NO) 15 amp.	1.25
R-508	110 AC	600	SPDT-6 amp.	1.95
R-506	24V DC	300	DPST (NO) 6 amp.	.95
R-604	24V DC	200	SPST (NO) 30 amp.	1.25
R-223	28V DC	150	SPST (NO) 40 amp.	1.35
H-230	12-24V DC	80	DPST (NO) 10 amp.	1.20
H-231	24V	230	DPST (NO) 5 amp.	1.15

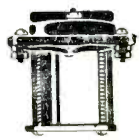
DC-TYPE 76 ROTARY RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-197	9-16V	70	DPDT	1.65
R-198	9-16V	125	6PST (3 NO) (3NC) SPDT	1.65
R-200	24-32V	275	SPDT-SPST (NC)	1.65
R-201	24-32V	250	DPST (NO) SPDT (NC) DPDT	1.65



KEYING RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-191	28V DC	125	DPDT 10 amp.	$1.20
R-192	12V DC	44	3PDT 10 amp.	1.35
R-193	5-8V DC	11	DPDT 10 amp. SPST (NO)	1.05
R-196	12V DC	50	DPDT 10 amp. SPST (NC)	1.15
R-242	24V DC	170	SPDT 2 amp.	1.25
R-734	24V DC	150	3PDT-10 amp.	1.05
R-752	24V DC	150	DPDT-3 amp.	1.15
R-757	12V DC	44	DPDT SPST (NO)	1.15
R-758	24V DC	160	DPDT-10 amp.	1.25
R-744	24V DC	265	SPST (NO) 20 amp.	1.20
R-720	24V DC	50	DPDT-Ceramic	1.35
R-724	75V DC	2200	DPST (NC) 3 amp	1.85
R-715	24V AC		DPDT-Ceramic	2.95
R-503	24V DC	Dual 50	MICALEX INS. 5PST (3NO) (2NC)	2.25
R-508	110 AC		SPDT 6 amps.	2.25
R-768	24V DC	175	DPST (NO) 5 amps.	1.15
R-772	12V DC	70	SPST (NO) 15 amps.	1.15
R-773	24V DC	280	3PDT-10 amp.	1.30
R-775	28V DC	180	DPDT	1.25
R-776	28V DC	265	DPST (NO)	1.25
R-779	12V AC		SPST (NC) 10 amp.	1.35
R-791	24V DC	375	DPDT-10 amp.	1.25
R-792	24V DC	Dual 200	SPST (NO) 15 amp.	1.05
R-793	12V DC	42	DPDT-10 amp.	1.25
R-794	3 coils 12V DC	3 coils 16 Ea.	SPST (NO) 15 amp. SPST (NC) 15 amp.	2.65
R-795	24V DC	160	DPST (NO) 10 amp.	1.25
R-796	24V DC	160 Dual	DPST (NO) 15 amp	2.25
R-797	24V DC	160	8PST (NO) 8 amp.	2.25
R-699	24V DC	200	3PDT-5 amp.	1.25
R-697	12-24V DC	100	SPST-10 amp.	1.15
R-708	6-12V DC	15	5PDT-5 amp.	1.00
R-700	24V DC	200	DPDT-8 amp.	1.25
R-691	12V DC	50	DPDT-6 amp.	1.10
R-701	22-28V DC	425	DPST (NC) 10 amp.	1.35



HEAVY DUTY CONTACTORS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-178	24V DC	100	SPST (NO) 100 amp.	$3.85
R-179	6V DC	6.5	SPST (NO) 50 amp.	3.00
R-180	12V DC	25	SPST (NO) 50 amp.	3.25
R-739	24V DC	200	SPST	1.10
R-742	20V AC, DC	70	SPST (NO) 25 amp.	2.45
R-748	24V DC	60	SPST (NO) 30 amp.	1.95
R-762	115V AC		DPST (NO) 30 amp.	3.45
R-719	24V DC	10	SPST (NO) 200 amp.	3.95
R-717	24V DC	200	SPST (NO) 50 amp.	2.75
R-727	10V DC	20	SPST (NO) 20 amp.	1.50
R-767	24V AC	20	DPST (NO) 10 amp.	2.95
R-788	110 AC		5PST(3NC-2NO) 10A	4.35
R-703	12V DC	20	DPST (NO) 25 amp.	2.25
H-232	24V	55	SPST (NO) 50 amp.	3.25
H-235	24V	70	SPST (NO) 100 amp.	3.85

DIRECT CURRENT AIRCRAFT CONTACTORS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-182	28V	80	SPST (NO) 25 amp.	1.85
R-183	24V	60	SPST (NO) 50 amp.	2.75
R-184	28V	50	SPST (NO) 100 amp.	2.95
R-185	24V	100	SPST (NO) 50 amp.	2.75
R-186	24V	132	SPST (NO) 50 amp.	3.50
R-187	24V	100	SPST (NO) 50 amp.	2.95
R-188	24V	200	SPST (NO) 75 amp.	2.95
H-234	14V	45	SPST (NO) 30 amp.	1.65

ANTENNA CHANGEOVER RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-192	6-12V DC	44	2PDT 10 amp.	1.35
R-503	12-32V DC	100	SPDT-SPST	1.95

COMBINATION PUSH BUTTON AND REMOTE RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
H-244	12-24V DC	Dual 60	SPDT	1.65

ADJUSTABLE TIME DELAY RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-246	115 AC		SPST (NO) or (NC) 10 amp.	8.95

DC MECHANICAL ACTION RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-245	12V	25	4" Lever	0.95
R-527	6-12V	200	2" Lever	.95

TYPE C.M.S. RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-511	24V DC	200	MICRO-SW SPST (NO)	2.45

DC CURRENT REGULATOR

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-509	6-12V DC	40	SPST (NC)	0.85

LATCH AND RESET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-500	12V DC	10	DPDT-10 amp	2.85

DC-ROTARY STEP RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-711	24V DC	200	2 position DPDT-SPST (NC)	1.65
R-712	24V DC	200	2 position DPST (NC)	1.65
R-713	9-14V DC	125	2 position SPDT-SPST (NO)	1.65
R-766	24V DC	230	12 position 8 deck	3.95

DC-RACHET RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-230	5-SV	2	SPDT-DPST (NO)	2.15

VOLTAGE REGULATOR RELAYS

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-745	6V	2	SPST (NO) amp.	.85
R-780	24V DC	350	SPDT-6 amp.	.85

MAGNETIC OVERLOAD RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-749	600V DC 28 amp.-Oil Dashpot Type			5.95

DC TIME DELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-525	12-24V DC	200	DPDT 10 amp.	1.25

OVERLOAD CURRENT RELAY

Stock No.	Operating Voltage	Coil Resistance	Contacts	Net Each
R-250	115 AC 60 Cycle		SPST (NC)	12.95

ORDER DIRECTLY FROM THIS AD OR THROUGH YOUR LOCAL PARTS JOBBER

Manufacturers: *Write for Quantity Prices*
Distributors: *Write For The New Wells Jobber Manual*

WELLS SALES, INC. 320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
2	225	$4.95	150	150	$3.50
3	100	2.90	200	25	.98
3	225	4.95	200	150	3.50
4	225	4.95	225	50	1.24
5	50	1.24	250	25	.98
5	100	2.90	350	25	.98
5	150	3.50	350	100	2.70
6	25	.98	378	150	3.50
6	50	1.24	400	25	.98
7	25	.98	500	25	.98
8	50	1.24	500	75	2.49
10	25	.98	585	150	3.50
10	100	2.70	750	25	.98
12	25	.98	750	150	3.50
15	25	.98	1000	25	.98
16	50	1.24	1200	225	4.95
22	50	1.24	1250	50	1.24
25	25	.98	1250	150	3.50
32	300	5.25	1500	50	1.24
50	25	.98	2000	25	.98
50	50	1.24	2000	50	1.24
50	750	14.95	2500	100	2.90
60	25	.98	3000	25	.98
75	150	3.50	3000	100	2.90
80	50	1.24	3500	50	1.24
80	500	7.60	5000	25	.98
100	25	.98	5000	50	1.49
100	50	1.24	7500	50	1.63
100	225	4.95	7500	100	3.30
125	25	.98	10000	50	1.63
125	500	7.60	10000	100	3.50
150	50	1.24	20000	150	5.26

Specify whether shaft required is KNOB or SCREWDRIVER type (Discount to Quantity Users.)

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	6	1	bak-shtg	.31
1	11	1	bak-n/shtg	.50
1	12	1	Cer-n/shtg	.55
1	21	3	bak-n/shtg	.69
1	24	2	bak-n/shtg	.79
2	2	1	cer-shtg	.39
2	6	2	bak-n/shtg	.49
2	8	2	bak-shtg	.54
2	11	2	bak-shtg	.60
4	4	2	cer-n/shtg	.54
4	11	4	bak-shtg	1.20
5	3	2	cer-n shtg	.56
6	11	6	bak-n shtg	1.98
10	5	5	cer-shtg	1.49
12	2	3	bak-shtg	.75
16	2	4	bak-n/shtg	.98

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

OIL CONDENSERS

Mfd	VDCW	Each
.1	3000	.75
.1	6000	1.89
.1	20,000	18.95
.25	3000	1.10
.5	1500	.89
1	600	.35
1	2000	1.95
2	400	.35
2	600	.39
2	1000	.79
4	600	.69
6	400	.75
6	600	.79
10	600	.98
14	600	1.75
15	600	1.98
15	1000	3.25
2 x .1	7000	3.95
2 x .5	9000	14.95

BATHTUBS

mfd	vdcw	each
.033	400	.17
.05	200	.17
.05	400	.19
.05	600	.21
.1	400	.20
.1	600	.22
.1	1000	.32
.15	600	.22
.25	200	.19
.25	600	.23
.35	400	.22
.5	400	.23
.5	600	.25
.5	1000	.35
1	200	.29
1	600	.35
2	600	.59
4	50	.25
8	500	.59
25	50	.28
25	75	.30
50	25	.28
200	12	.35
300	6	.39
.05-.05	600	.29
.05-.05	1500	.45
.1-.1	400	.26
.1-.1	600	.28
.25-.25	600	.30
.5-.5	600	.35
1.0-.1	300	.29
200-200	9	.49
3 x .05	600	.40
3x.1	400	.42
3x.1	600	.45
3x.25	600	.50
3x1.0	100	.40

Specify Top, Side or Bottom Lugs.

TYPE "J" POTENTIOMETERS

TYPE "J" 50¢

ohms	ohms	ohms
60	1000	25K
100	1500	30K
150	2000	50K
200	4000	75K
300	5000	100K
400	10K	200K
500	15K	250K
600	20K	1 meg

TYPE "JJ"

$1.25 ohms	$1.50 ohms
100-100	100K-100K
200-200	150K-150K
500-500	250K-250K
2000-2000	350K-5000
2200-24K	350K-25K
20K-2000	500K-500K
25K-10K	800K-75K
35K-5000	1meg-1meg
50K-50K	2meg-2meg
	4meg-4meg
	5meg-5meg

Specify type shaft needed — For S.D. or knob.

TYPE "JJJ" $2.25

ohms	ohms
20K-200K-20K	750K-750K-750K
45K-27K-2500	800K-800K-800K
700K-700K-700K	1meg-1meg-1meg

TRANSMITTING MICAS

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.00051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

Other sizes available

"UHF" CONNECTORS

Cat. No.	Army No.	Each	Per/C
83-1AC		.42	.39
83-1AP	M-359	.35	.28
83-1D	PL-271	1.25	1.00
83-1F	PL-274	1.10	.90
83-1R	SO-239	.35	.28
83-1SPN	PL-259A	.35	.28
83-22R	SO-264	.50	.40
83-22SP	UG-102/U	.68	.60

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ALEXANDER MOGULL CO., INC.
161 Washington St., N. Y. 6, N. Y. WOrth 4-0865

EDUCATIONAL FREQUENCY MODULATION TRANSMITTER

GENERAL ELECTRIC TYPE BT-10-B MODEL 4BT10B1

SPECIFICATIONS

Carrier power output—2½ watts.

Carrier frequency range—88 to 108 M.C. Tuned to 100 M.C.

Carrier frequency stability—±1000 cycles.

F.M. carrier noise level—65 db below ±75 kc swing, unweighted.

R.F. load—51.5 ohm line.

Modulation capability—±100 kc. swing, 50 to 15000 cycles with less than 3% distortion.

A.F. input level—10 db ±2 db for 100% modulation at 400 cycles.

600 or 150 ohm input impedance balanced or unbalanced.

A.F. response—± db from FCC pre-emphasis standard 50—15000 cycles.

Power supply—115 to 2300 V. 50 to 60 cycles single phase.

The G.E. transmitter is completely self contained in a modern Hammerlin grey lacquered steel cabinet with stainless steel trim. The cabinet provides radio frequency shielding as well as protection to station personnel. Access to the front is through two doors. There is no power or high voltage accessible from the front and all tuning controls, on-off switches and metering facilities are located there; also all tubes may be replaced from the front. The cabinet is 42½" high, 30" wide and 18" deep and is furnished with an enclosed stand to raise it to rack height (67½") if desired. Access to the rear for service is through a removable panel which has an interlock to remove power when panel is removed.

For further information write:

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION
BALTIMORE 4, MARYLAND
Attention: Mr. R. L. Grotefend

TELEVISION TUBE MACHINERY

8-HEAD MACHINE, for button stems.
TUBE STEM MACHINES Mfd. by Kahle Eng. Co. 4-5-6-7-8 positions with Geneva movements.
HYDROGEN FURNACES Complete with automatic controls, 20" x 7" x 4". Brick-lined, with two Bristol automatic controllers, Brown pyrometers.
EXHAUST MACHINE 32 head, capacity 60 tubes per hour, 60 W. type B174 Sealiex chassis.
VACUUM FIRING EQUIPMENT Mfg. by GE.
SEALING & STEM MACHINE 16 head, mfd. by GE.
EXHAUST MACHINE 16 head, mfd. by GE, can be converted to standard tube production.

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Plainfield, New Jersey

ELECTRONIC TUBE-MAKING MACHINERY

For manufacturing radio tubes, electronic tubes, cathode-ray tubes, lamps. New and used. Reasonably priced, satisfaction guaranteed.

AMERICAN ELECTRICAL SALES CO.
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0-200 ua 3" sq. G.E. DO 50.......... $ 8.00
0-100 ua 3" sq. G.E. DO 50.......... 10.00
0-50 ua 3" sq. G.E. DO 50.......... 12.00

R.F. MILLIAMMETERS

0-115 Ma 3¼" Weston 425.......... $12.00
0-100 Ma 3½" Weston 425.......... 12.00

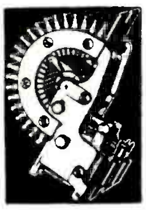
PRECISION PORTABLE INSTRUMENTS

Single or multi-range

D.C. Microammeters, from 5 ua full scale. Thermo-couple Milliammeters, from 1.5 Ma. Thermo-couple voltmeters.

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

STEPPING SWITCHES



EXCESS INVENTORY LIQUIDATION

This Low Price in Effect Only As Long as This Excess Stock Lasts

Clare Type SD-14
20 Steps, 6 Levels, 120 Contacts Total, Coil 12V. D.C.

CLEARANCE PRICE **$13.00**
(Immediate Delivery)
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METER MULTIPLIER

Westinghouse R5, 1 meg., w.w., noninductive ½% tol. $.90 each, 10 for $7.50 or 10 multipliers plus a Weston or Westinghouse 3", 1 ma. meter....................$10.00

RECTIFIER

Copper Sulphide, F.W.B., 3.5 v. a-c in, 1.8 v. d-c @ 1 amp out. (Fine for 1.5 v. d-c filaments). New, boxed. $.60 each, 10 for $5.00, 100 for $40.00.

TUBES:

Discount 20% on orders over $50.00

1B22	$4.25	714AY	3.75
1N21	.40	715A	7.50
1N23	.50	715B	6.50
2J62	37.50	721A	2.75
3B22	2.50	722A	7.50
250TL	19.50	724B	2.50
316A	.35	725A	8.50
388A	2.75	730A	10.50
700A	9.75	846	47.50
701A	3.50	872A	1.75
702A	2.75	C5B	7.75
703A	2.75	C6A	8.25
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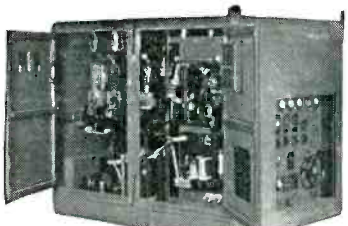

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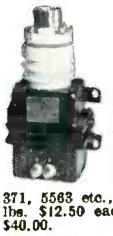

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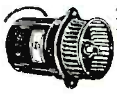

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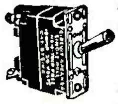

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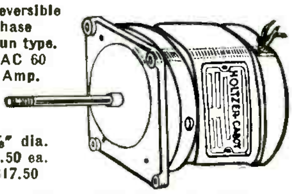

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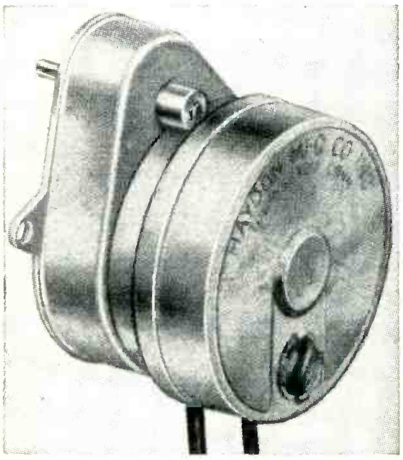

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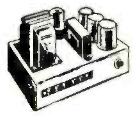

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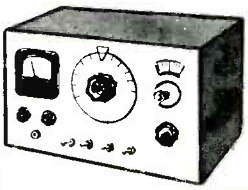

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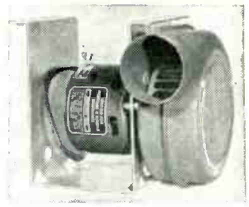

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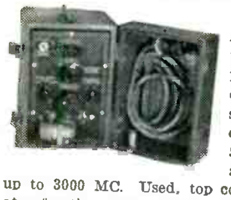

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WESTERN ELECTRIC COMPUTER POTENTIOMETERS D170545, 6, 7 and D170561 each $8.50

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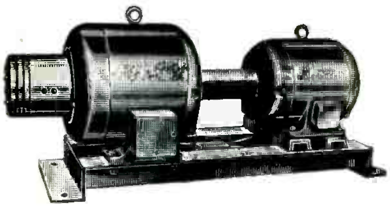

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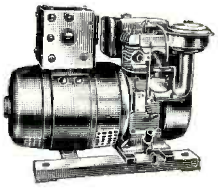

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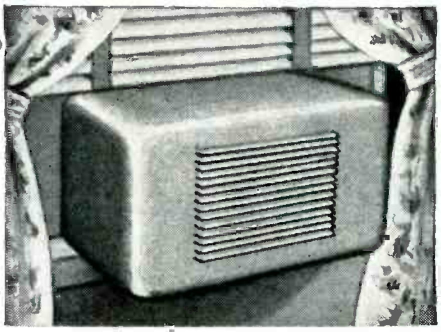

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6AH6 .89
6AJ5 .73
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6AS5 .59
6AS6 2.89
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6B7 .85
6B8G .65
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6BA7 .79
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6BH6 .52
6BJ6 .55
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6D7 .98
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6J8GT .95
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6K7 .48
6K8 .75
6L5 .78
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6L7 .77
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6N7GT .75
6P5G .81
6Q7 .57
6R7 .77
6R8 .79
6S4 .79
6S7 .85
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6SA7GT .43
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6SC7 .57
6SD7GT .43
6SF5 .43
6SF7 .58
6SG7 .57
6SH7 .35
6SJ7GT .45
6SK7GT .40
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6SQ7GT .43
6SR7 .51
6SS7 .48
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6T7G .84
6T8 .89
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6U5/6G5 .63
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6U7G .48
6V6GT .52
6V6GTY .90
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6W4GT .59
6W7G .75
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6X5GT .42
6Y5 1.85
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7A5 .65
7A6 .58
7A7 .52
7A8 .69
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7AG7 .69
7AH7 .87
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7B5 .55
7B6 .55
7B7 .55
7B8 .70
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7C7 .52
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7F7 .58

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7N7 .65
7Q7 .57
7R7 .63
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7W7 .77
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12A7 .86
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12AU7 .62
12AV6 .50
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12BA7 .75
12BD6 .59
12BE6 .45
12BF6 .54
12BH7 1.11
12C8 .32
12E5 .98
12F5 .55
12H6 .27
12J5GT .33
12J7GT .52
12K7GT .50
12K8 .59
12L8GT 1.59
12Q7GT .48
12S8GT .79
12SA7GT .55
12SC7 .54
12SF5GT .54
12SF7GT .50
12SG7 .52
12SH7 .34
12SJ7GT .45
12SK7GT .51
12SK7M .52
12SL7GT .54
12SN7GT .47
12SQ7GT .45
12SR7 .48
12X3 .90
12Z3 .68
14A4 .99
14A7/12B7 .51
14AF7 .86
14B6 .65
14B8 .77
14C5 .87
14C7 .86
14E6 .71
14E7 .87
14F7 .69
14F8 .75
14H7 .57
14J7 .80
14N7 .83
14Q7 .51
14R7 .65
14S7 1.05
14W7 1.05
14X7 .52
14Y4 1.05
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19J6 1.89
19T8 .89
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24A .45
24G/3C24 .45
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25AC5GT 1.08
25B5 1.39
25B6 2.49
25BQ6GT .89
25C6 1.18
25L6GT .49
25N6 1.69
25W4GT .70
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25Z5 .42
25Z6GT .42
26 .42
27 .41
FG27A 6.89
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30 .35
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32 .85
FG32 4.89
32L7GT .85
33 .63
FG33 7.89
34 .33
35/51 .55
35A5 .61
35B5 .54
35C5 .49
35L6GT .51
35W4 .38
35Y4 .48
35Z3 .56
35Z4GT .43
35Z5GT .39
REL36/6J4 .54
36 .39
37 .34
38 .27
39/44 .25
CRC40 .54
41 .49
42 .47
43 .49
45S/VT52 .18
45Z3 .54
45Z5 .48
46 .48
47 .68
49 .75
50 1.37
EF50 .37
50A5 .67
50B5 .51
50C5 .59
50C6 1.18
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77 .41
78 .43
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"Williamson" 10-Watt Hi-Fi. Kit

10cyc to 20kc with case! Internationally Famous. Simplicity of design. Extraordinary linearity & lack of distortion. To 1 Mc. for experimenters.
RCA Chassis. Less Output Xformer $19.95
Same withPreAmp-ToneControlKit 29.95
"Wmson" 32 page brochure........98¢

Super Wide-Range Hi-Fi Amp Kit 20cyc to 20kc. 10W. Max harmonic distortion 1¾%/full outpt; 0.5%/5W outpt. PreAmp, Tone Cont, RCA chassis. Less Outpt Xfmr $24.95

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.75	MVG	4	5Kv	1.29	9.98
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5	MVP	10	15Kv	1.69	13.49
10	MVG	4	5Kv	1.29	9.98
10	MVP	10	15Kv	1.69	13.49
15	MVA	20	25Kv	1.98	
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