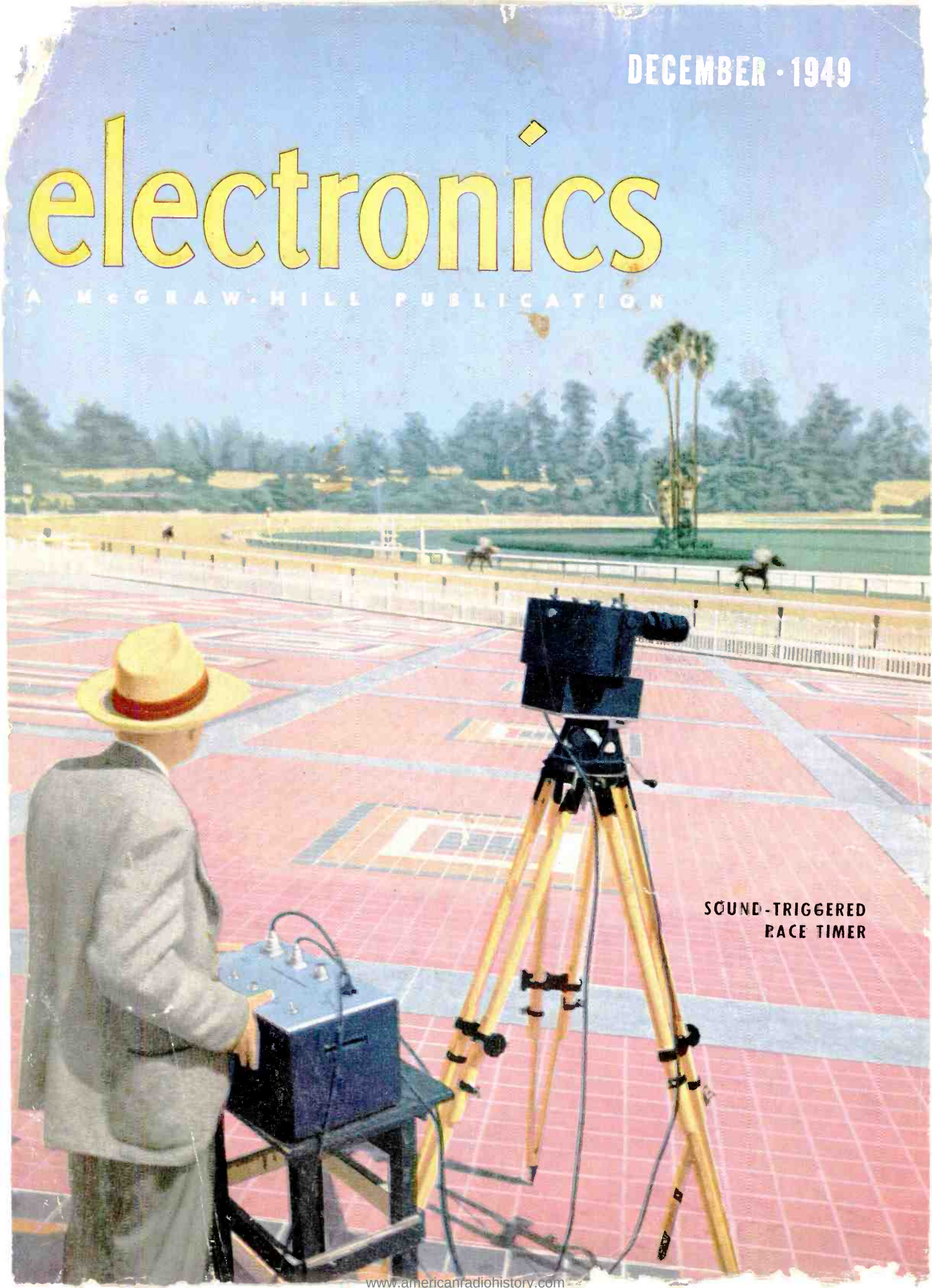
DECEMBER · 1949

electronics

A McGRAW-HILL PUBLICATION



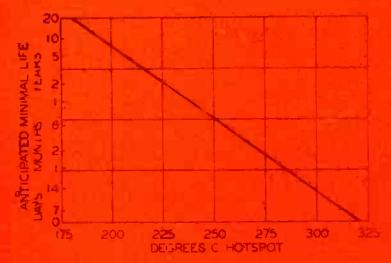
SOUND-TRIGGERED
RACE TIMER

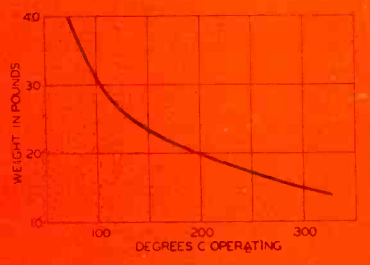
FOR SPECIALTIES

The fields of frequency control, Servomechanisms, etc., are developing rapidly with increasing complexity. UTC is playing a principal role in the development of special components for these and allied fields. A few typical special products are illustrated below:

SMALLER POWER COMPONENTS

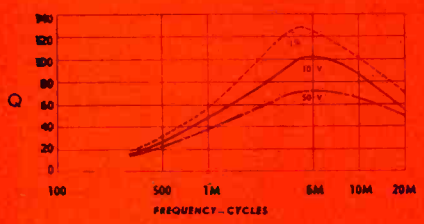
High temperature (class H) insulation, and, in many instances, short life requirements, can effect considerable weight and size reduction where these are important. The curve at the left indicates anticipated life versus temperature rise, using Class "H" insulating materials. The curve at the right illustrates on one typical type the variation in weight with permissible continuous operating temperature.

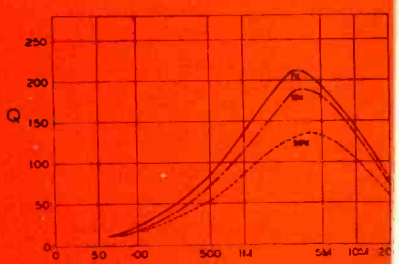




TOROID DUST HIGH Q COILS

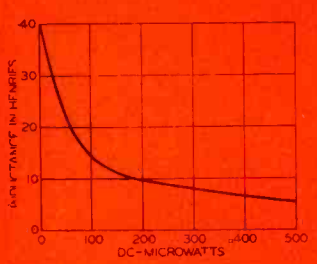
UTC type HQ (permalloy dust) coils have found wide application because of their high Q, stable inductance, and dependability. Four standardized groups of stock coils cover virtually any high Q coil application from 300 cycles to 300 Kc.

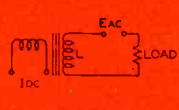


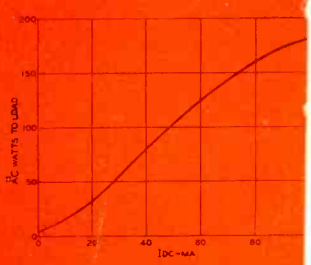


MAGNETIC AMPLIFIERS

Magnetic amplifiers are used extensively for both power control and phase control. The left curve shown is that of a sensitive saturable reactor structure controllable with powers below .5 milliwatt. The right curve is that of a moderate size power control reactor indicating power to the load with saturating DC.

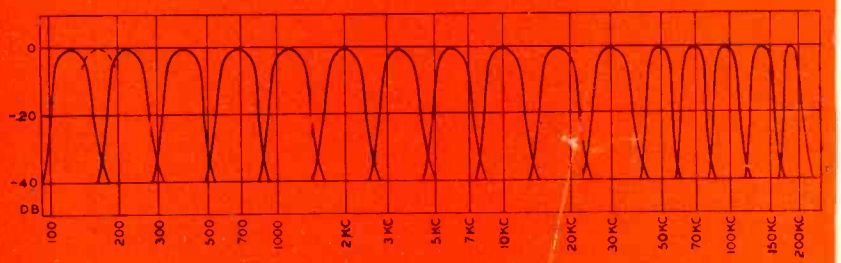






AUDIO FILTERS

The curve illustrated shows a group of filters affording sixteen separate bands in the audio and supersonic region with 35 DB attenuation at the cross-over points. These have also been supplied spaced further apart (40 DB cross-over), with intermediate bands, permitting flat top band pass action for any selected range from 100 cycles to 200 KC.



May we design a unit for your application problem.

United Transformer Co.

150 VARICK STREET • NEW YORK 13, N. Y.

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

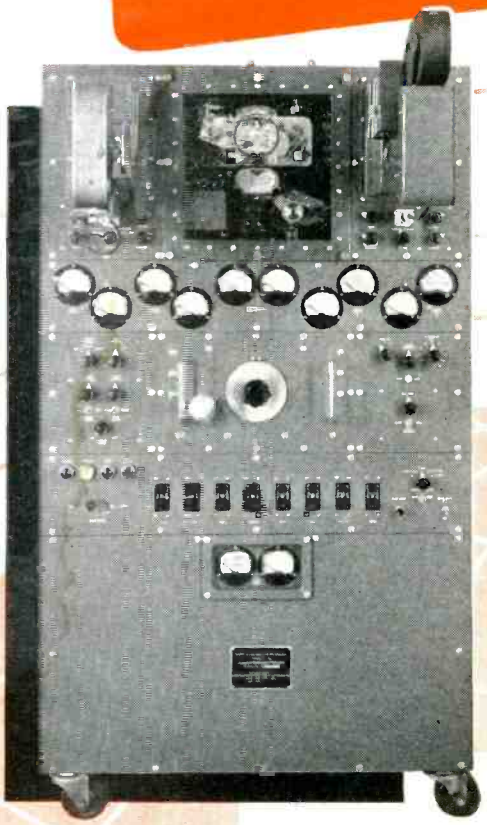
electronics

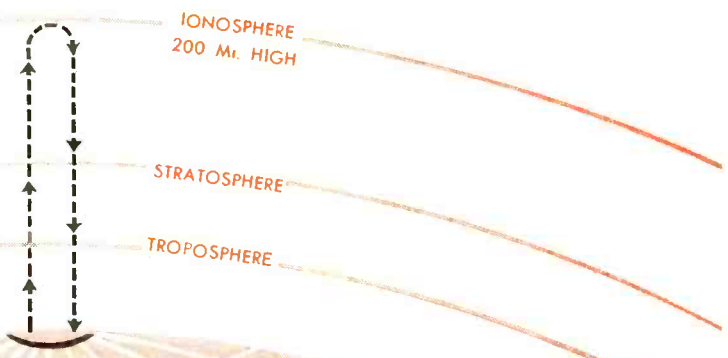
A McGRAW-HILL PUBLICATION

DECEMBER • 1949

ELECTRONICS, December, 1949, Vol. 22; No. 12. Published monthly, with an additional issue in June, price 75c a copy for U. S. and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 for two years, $12.00 for three years; Canada (Canadian funds accepted), $10.00 a year, $16.00 for two years, $20.00 for three years. Latin American countries $15.00 for one year, $25.00 for two years, $30.00 for three years. All other countries $20.00 for one year, $30.00 for two years, $40.00 for three years. Please indicate position and company connections on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

MARION ...helps Communication Measurements Laboratory





. . . explore the ionosphere

Type C-2 Ionosphere Recorder by C.M.L. is the first Commercial automatic recorder used by the Bureau of Standards to determine and record the height of the Ionosphere on a continuous basis. It is now in operation in many locations throughout the world. Study of the Ionosphere is important to the behavior of guided missiles and long distance radio frequency transmissions. It is also of interest to astronomers, meteorologists, navigators and other scientists.

During development, CML Type C-2 and its improved version, C-3, called for 12 troublefree, highly sensitive, critically accurate meters with special characteristics. Because Marion has long been recognized as the specialist in such meters, the Marion HM3 Type was selected. All were hermetically sealed. All were of different ranges and each one was individually produced to meet rigid CML specifications.

When you need meters or other electrical instruments to help explore the Ionosphere or perform any other special or standard function — we would like to have you see us *first*. We have solved innumerable problems in electronic and electrical measuring. We think we can help solve yours too.

MANUFACTURERS OF HERMETICALLY SEALED METERS SINCE 1944

The name MARION means the MOST in meters.

M·E·I

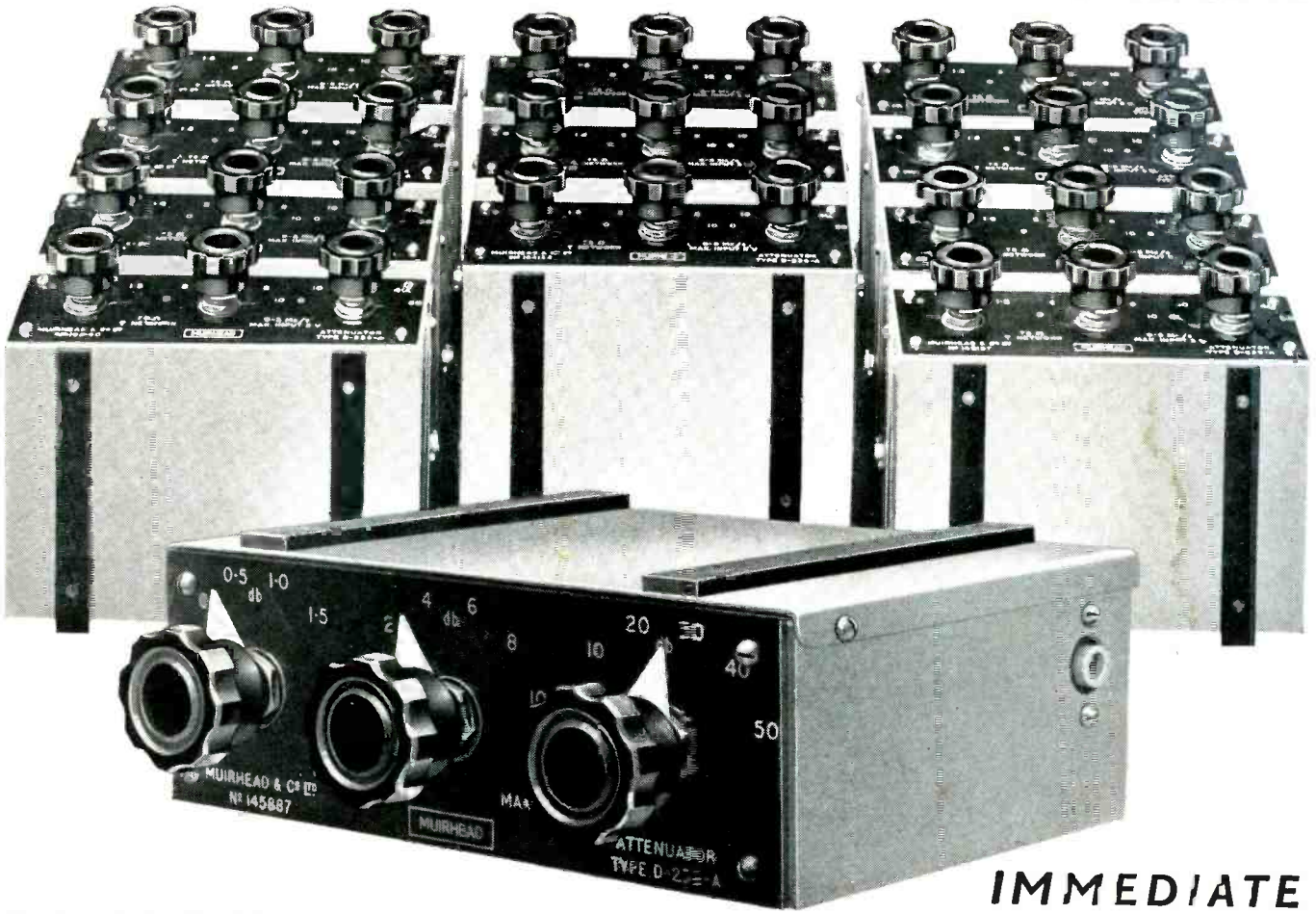
MARION ELECTRICAL INSTRUMENT COMPANY

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

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

WHY NOT HAVE A DOZEN



R. F. ATTENUATOR TYPE D—239

IMMEDIATE DELIVERY

DESIGNED for work on coaxial cables and for testing at video frequencies — arranged to work between finite impedances — conventional gain and loss measuring technique may be used up to 20 Mc.

UNLIKE MOST PRECISION INSTRUMENTS, IF YOU WANT A DOZEN, THE COST NEED NOT DETER YOU

SPECIFICATION

NETWORK:	"T" Section	**MAXIMUM INPUT:**	3 volts
ATTENUATION RANGE:	D-239-A 61·5 db in 0·5 db steps D-239-B 80 db in 1 db steps	**DIMENSIONS:**	6½" × 2⅜" × 5¼" (16·5 cm × 6 cm × 13·5 cm)
TERMINAL IMPEDANCE:	Both Types 75 ohms	**WEIGHT:**	2½ lbs. (1·13 kg)
TERMINATIONS:	Coaxial Connectors	**MOUNTING:**	Equally suitable for bench or panel use
ACCURACY:	Better than 0·5 db at 10 Mc	**PRICE:**	**$35 Postpaid**

ORDER BY CABLE—PAY BY YOUR OWN DOLLAR CHECK

MUIRHEAD & Co. LTD.

PRECISION ELECTRICAL INSTRUMENT MAKERS

BECKENHAM · KENT · ENGLAND

Telegrams and Cables: MUIRHEADS ELMERS-END

PRECISION **MUIRHEAD** ELECTRICAL INSTRUMENTS

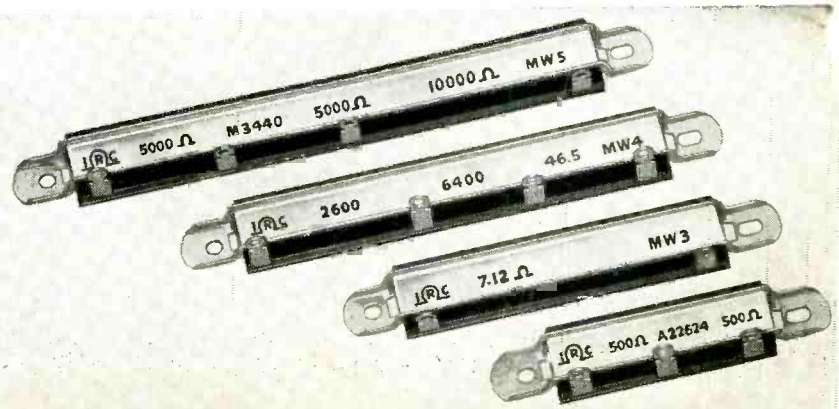
M.U.

Power problems can

for resistors too!

. . . But the most stubborn problems of power and resistance find an answer in IRC resistors. Where crowded chassis demand miniaturization—where portable units call for maximum lightness—where critical applications require complete insulation, unusual heat dissipation, or ability to handle exceptionally high voltages—there's an IRC power resistor for the specific job. Manufacturing the widest line of resistance products in the industry, IRC can specify *without bias!* This is your warranty of efficient, economical resistor performance in virtually any application.

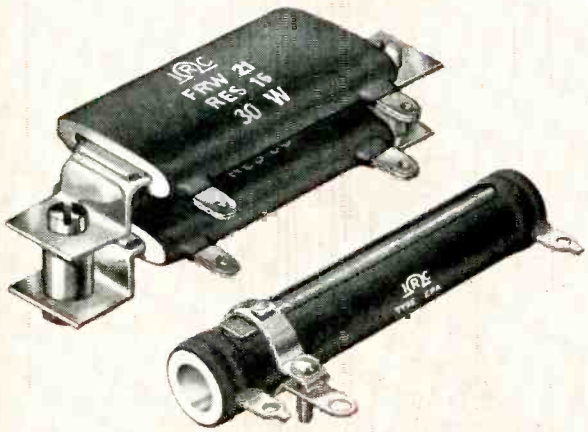
UNSURPASSED FOR ADAPTABILITY to an extremely wide variety of design requirements, IRC Type MW Wire Wound Resistors also give more watts per dollar than conventional types. Initial cost and mounting cost are low. Flexibility in providing taps and savings in space suit flat Type MW's to a host of difficult applications. Mounting bracket of unique design actually transfers heat from inside resistor to mounting surface. MW's may be operated at full "on plate" rating, whether enclosed or not, without exceeding their rated temperature of 100° C. (Thus, an MW 5 can be used at 20 watts where a 60 watt tubular resistor would normally be required.) Use the convenient coupon to obtain full characteristic and specification data.



be tough

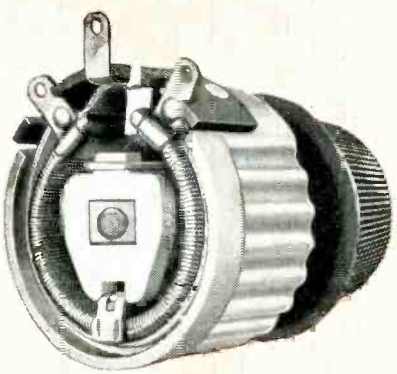
EXCEPTIONAL STABILITY even in very high resistance values assures the dependability of IRC Type MV Resistors in high voltage applications. Unique application of IRC's famous filament coating in helical turns on a ceramic tube provides a conducting path of long effective length, and permits the use of high voltage on the resistor while keeping the voltage per unit length of path comparatively low. Bulletin G-1 gives complete characteristics; use handy coupon.

LENGTH OF RESISTANCE PATH IN INCHES—FOR MV TYPES			
MVF	10	MVS	20
MVG	25	MVT	30
MVJ	50	MVB	70
MVP	80	MVD	95
MVA	190	MVZ	185
MVO	330	MVE	265
MVR	1,100		



HIGHER SPACE-POWER RATIO than tubular power resistors makes IRC Type FRW Flat WireWounds ideal for voltage dropping applications in limited space. FRW's can be mounted vertically or horizontally, singly or in stacks—and are available in fixed or adjustable types. Bulletin C-1 gives all the performance facts.

UNEXCELLED IN EXACTING, HEAVY-DUTY REQUIREMENTS, IRC Power Wire Wounds are designed to give balanced performance in every characteristic. Special dark, rough coating assures ability to combat humidity and moisture corrosion, dissipate high heat rapidly, withstand reasonable overloads without opens or breakdowns. Available in a broad range of ratings, sizes and terminal styles in fixed and adjustable types. Send for Bulletin C-2.



VARIABLE POWER requirements within 25 and 50 watt ratings are well handled by IRC Type PR Power Rheostats. All-metal corrugated construction gives maximum heat dissipation. PR Rheostats can be operated at full power in as little as 25% of rotation without appreciable temperature rise. Direct contact between housing and mounting panel increases ability to disperse heat. Bulletin E-2 details specifications; send for your copy.

When you're being "powered" for fast service on small order resistor requirements for experimental work, pilot runs, or maintenance, call your nearest IRC Distributor. IRC's Industrial Service Plan enables him to save you time and worry by giving you 'round-the-corner service on standard types right from his local stocks. He's a handy man to know. May we send you his name and address?

IRC

Wherever the Circuit Says

INTERNATIONAL RESISTANCE COMPANY

401 N. Broad Street, Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto Licensee

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

INTERNATIONAL RESISTANCE COMPANY
403 N. BROAD ST., PHILADELPHIA 8, PA.

Send me additional data on the items checked below:

- ☐ MW Insulated Wire Wounds
- ☐ MV High Voltage Resistors
- ☐ PR Power Rheostats
- ☐ FRW Flat Wire Wounds
- ☐ Power Wire Wounds
- ☐ Name and address of local IRC Distributor

NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

.....

ANNOUNCING...Television's greatest picture tube improvement!

The New Rauland Luxide Screen

1. Greatly diminishes tube face halation
2. Reduces reflection of ambient light

New Tube Vastly Increases Contrast!

Here is a scientific advance in picture tube technique which offers a marked, visible picture improvement already widely acclaimed by Television buyers.

In this newest Rauland development, the tube face is a new, practically colorless glass containing a metallic oxide which produces uniform light attenuation throughout the visible range. This light-absorbing characteristic acts in two ways to increase picture contrast, clarity and detail.

In ordinary tubes, light from bright picture areas of the screen striking the exterior tube face surface in angles greater than 48 degrees is completely reflected onto dark screen areas, reducing the apparent blackness. This halation is greatly reduced with the new Rauland "Luxide" screen, because such reflected light is attenuated by passing three times through the glass before it can reach the eye.

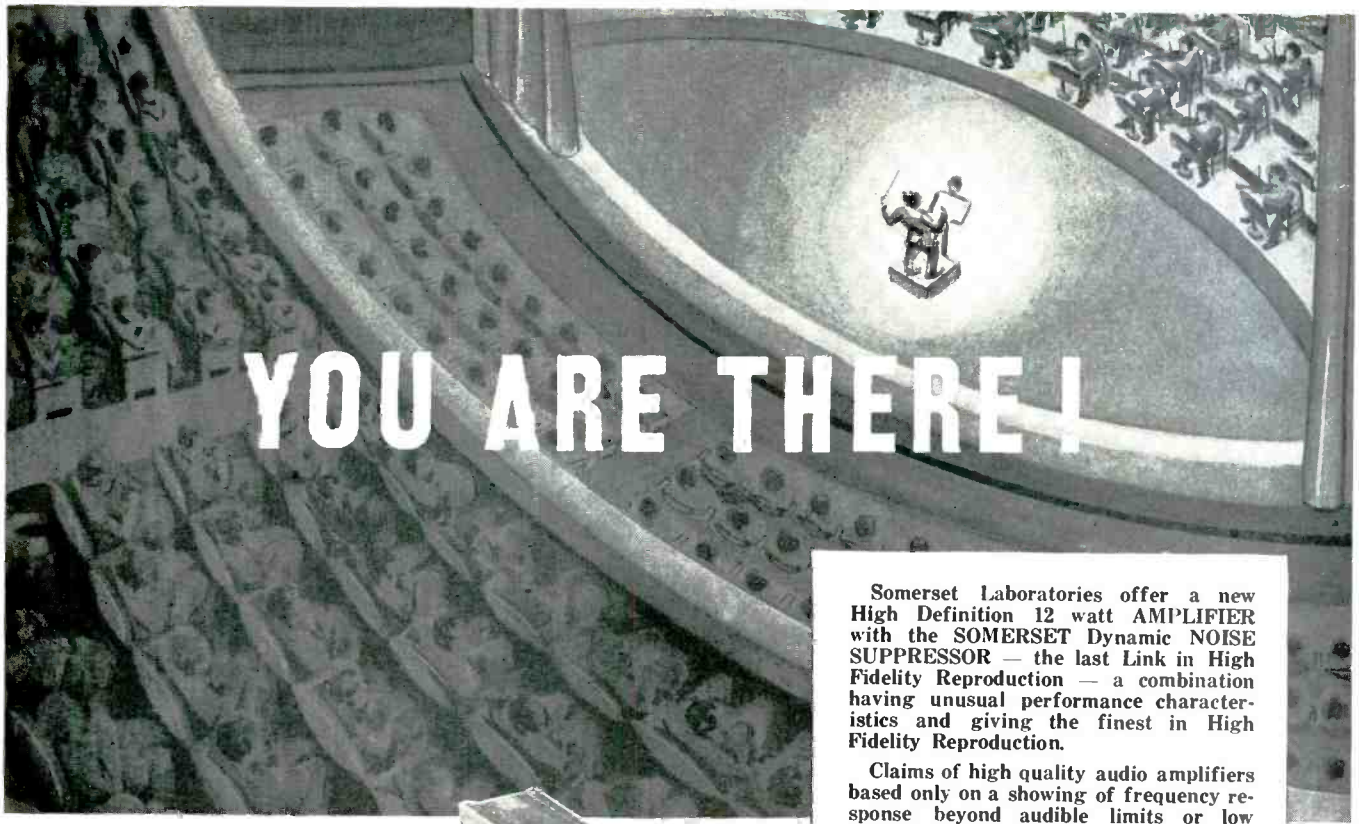
Similarly, under normal conditions, clear glass picture tubes can have their maximum contrast only when operated in an otherwise dark room. Ambient light passing through the tube face to the phosphor causes the dark picture area to appear light in tone and causes the picture to "wash out." With the "Luxide" screen, such ambient light must pass twice through the attenuating glass while light originating in the phosphor passes through the glass only once. The result is a picture with far greater contrast when viewed in lighted rooms, and since several more steps in the grey scale are available in forming the picture, better detail as well as greater contrast results.

Write for Technical Bulletins. The Luxide screen is available in metal-cone types 16AP4-A, 16EP4-A and 12UP4-A, and in the all-glass 12LP4-A.

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE · CHICAGO 41, ILLINOIS



A New 12 Watt
HIGH QUALITY AMPLIFIER
Including
The SOMERSET DYNAMIC NOISE SUPPRESSOR

Somerset Laboratories offer a new High Definition 12 watt AMPLIFIER with the SOMERSET Dynamic NOISE SUPPRESSOR — the last Link in High Fidelity Reproduction — a combination having unusual performance characteristics and giving the finest in High Fidelity Reproduction.

Claims of high quality audio amplifiers based only on a showing of frequency response beyond audible limits or low distortion and noise percentages evidence engineering skill, but do not guarantee High quality Reproduction.

Such an Amplifier may accentuate defects of the program source or distortions originating within the loudspeaker. The use of tone controls to offset these effects may degenerate performance and the High Fidelity characteristics are virtually unuseable.

The SOMERSET FEEDBACK AMPLIFIER was designed not as a laboratory exhibit but as the controlling unit in the reproducing system. Its performance with respect to frequency response, and distortion is superb. In addition it has the ability.

First—To reject unwanted portions of the input signal,
Second—to subject the loudspeaker to a rigid discipline the consequence of which is Reproduction with perfect definition.

These outstanding qualities are produced by the SOMERSET DYNAMIC NOISE SUPPRESSOR and a UNIQUE MULTIPLE FEEDBACK CIRCUIT whereby the Amplifier acquires a more perfect control of the movements of the loudspeaker diaphram throughout the audible range.

In this CIRCUIT beam power tetrodes are used in a manner which greatly reduces output impedance. Extraordinarily effective loudspeaker damping and substantial improvement in bass tone response are obtained without distortion or intermodulation. Thus, even inexpensive loudspeakers become capable of high quality reproduction rarely equalled by the most costly equipment.

Somerset **LABORATORIES, INC.**
1701 PALISADE AVENUE, UNION CITY, N. J.

Now A BROAD, NEW LINE OF

and we're developing still more instruments to bring you hp speed, convenience and accuracy —throughout the microwave field!

-hp- 616A Microwave Signal Generator

MICROWAVE SIGNAL GENERATORS

Easy operation, direct reading without calibration, one-dial frequency control, high stability, a wide choice of pulsing, triggering and modulation...those are but few of the important advantages of -*hp*- microwave signal generators.

-hp- 616A Microwave Signal Generator. For frequencies 1,800 to 4,000 mc. Reads carrier frequency and voltage output direct without calibration or charts. Accurate within ± 1%, stable within .005% per degree centigrade change in ambient temperature. Output .223 v. to 0.1 μv. Output impedance 50 ohms; internal or external pulse modulation, or FM. Repetition rate variable from 40 to 4,000 pps. Pulse length variable from 1 to 10 μsec. Trigger pulses out simultaneous with rf pulse, or in advance of rf pulse from 3 to 300 μsec. .5 μsec rise time. Synchronizes with external pulse or with sine wave.

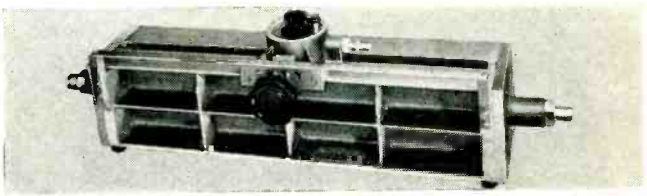
-hp- 614A Microwave Signal Generator. Covers frequencies 800 to 2,100 mc. Extremely fast rise time (0.1 μsec). Directly calibrated, accurate within ± 1%. Output .223 v. to 0.1 μv. Output accuracy ± 1 db. Output impedance 50 ohms, SWR 3 db. External modulation .5 μsec pulses to square waves. Internal pulsing, FM modulation and delays same as Model 616A.

-hp- 610B Microwave Signal Generator. General purpose UHF generator for standard measurements between 450 and 1,200 mc. Accuracy ± 1%. Accurately known output from 0.1 v. to 0.1 μv. Internal impedance 50 ohms. Modulation by internal or external pulse, external sine or square wave. Internal pulse length variable 2 to 50 μsec, repetition rate variable 60 to 3,000 cps. 3 to 300 μsec delay circuit.

Other -*hp*- signal generators, now in the development stage, will operate in frequency ranges above 4,000 mc and below 450 mc. They will be announced soon.

IMPEDANCE MEASURING DEVICES

Two new instruments, introduced this year, have established new standards for ease and accuracy of microwave impedance measurements. (Soon -*hp*- will announce still newer impedance measuring devices for frequencies above 4,000 mc and below 500 mc.)



-hp- 805 Slotted Line. Incorporates a radically different structural design employing rigid parallel planes and central conductor. This design is inherently superior in terms of electrical accuracy, stability, negligible slope and minimum leakage. VSWR of the basic section is less than 1.02. Frequency range 500 to 4,000 mc. Model 805A impedance 50 ohms for Type N connector and flexible cables. Model 805B impedance 46.3 ohms for ⅞" rigid transmission lines.

-hp- 415A Standing Wave Indicator. Designed for use with -*hp*- 805 Slotted Lines. Consists of high gain amplifier with low noise level, operating at fixed frequencies between 300 and 2,000 cps. (Normal frequency 1,000 cps. Plug-ins for others available.) Reads direct in VSWR and db without computation. Input circuits for use with crystal rectifier or bolometer. 75,000 ohm null indicator input circuit.

Look to -hp- for complete instrumentation in the microwave field

HEWLETT hp PACKARD

hp MICROWAVE EQUIPMENT!

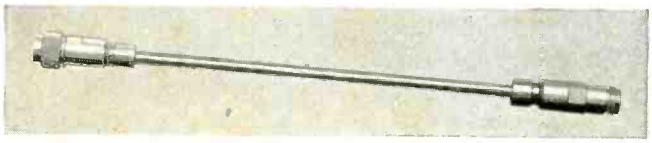
-hp- 430A Microwave Power Meter

-hp- 475 Tunable Bolometer Mount

MICROWAVE POWER MEASURING EQUIPMENT

-hp- 430A Microwave Power Meter. Offers direct, instantaneous power readings in mw or dbm. No tedious calculations, no troublesome adjustment. For use at *any* microwave frequency. Just connect to the 200-ohm bolometer in your system, and after initial balancing this instrument does the rest! Read power in mw from .02 to 10 mw or dbm from −20 to ±10. Measure higher powers by adding attenuators or directional couplers to the system. 5 ranges give full-scale readings of .1, .3, 1, 3 and 10 mw. Accuracy ±5% of full scale reading.

-hp- 475 Tunable Bolometer Mounts. New, wide-band matching systems for measuring microwave power directly. Tunable between 300 and 1,000 mc (Model 475A) or 800 to 4,000 mc (Model 475B) for universal applicability. Both models are double-stub tuners, coupling energy from 50 ohm coaxial system into a 200 ohm bolometer. Swift, sure direct readings are available when mounts are used with *-hp-* 430A Meter. Power sensitive element can be 1/100 amp. instrument fuse, or barretter.



-hp- 360 Low Pass Filters. Facilitate microwave measurements by eliminating harmonics from microwave systems and permitting passage of energy at a single known frequency. Cut-off frequencies of 700, 1,200, 2,200 and 4,100 mc are available. Insertion loss not over 3 db throughout pass band. Rejection characteristic assures at least 50 db attenuation at 1.4 x cutoff frequency. Nominal impedance 50 ohms. Uses Type N fittings.

FREE BROCHURE gives details of these new *-hp-* microwave instruments.

WRITE TODAY FOR YOUR COPY, OR SEE THE *-hp-* REPRESENTATIVE IN YOUR LOCALITY.

HEWLETT-PACKARD COMPANY

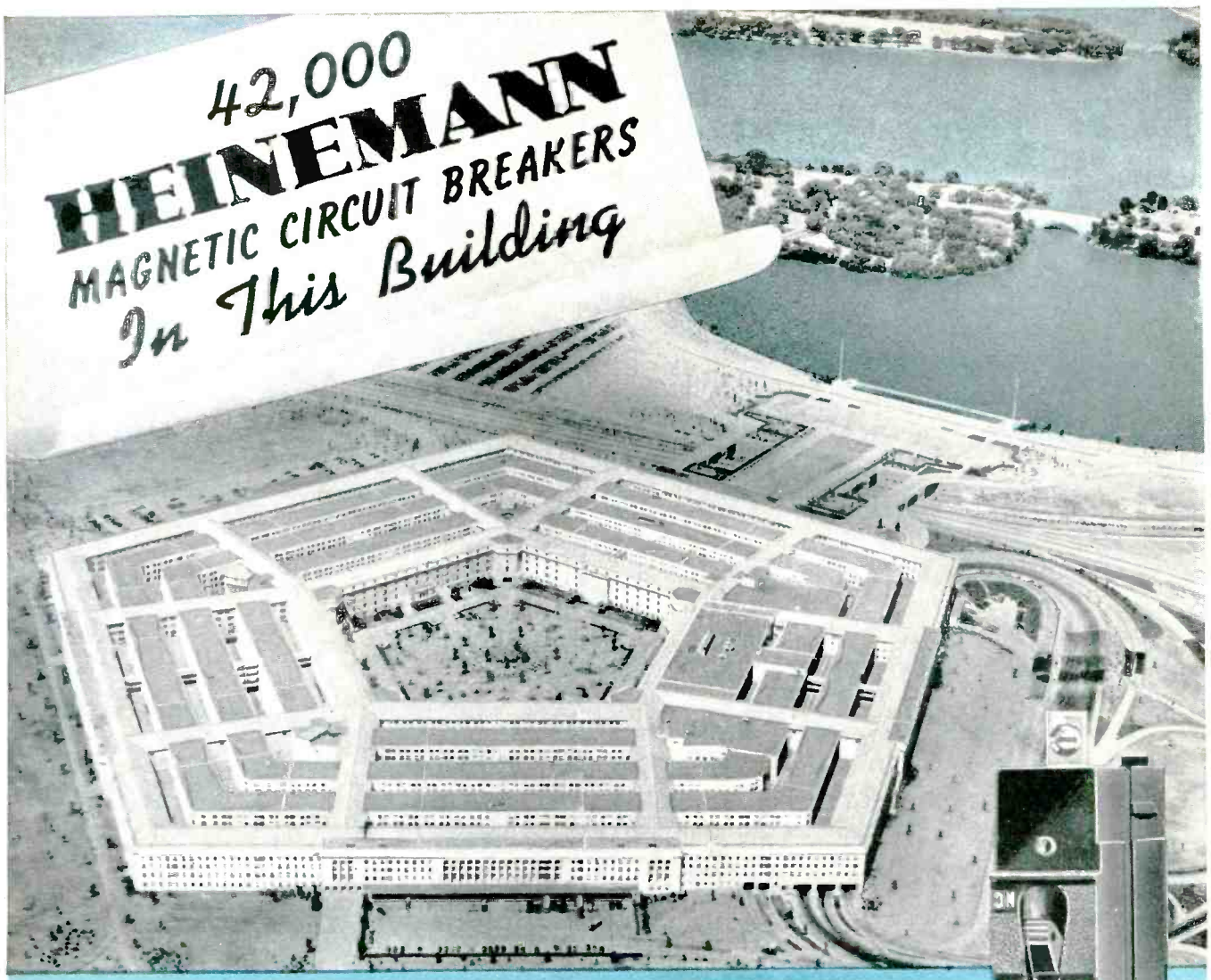
2000 Page Mill Road • Palo Alto, California

Export: FRAZAR & HANSEN, Ltd., 301 Clay St., San Francisco, Calif., U. S. A. Offices: New York, N.Y. and Los Angeles, Calif.

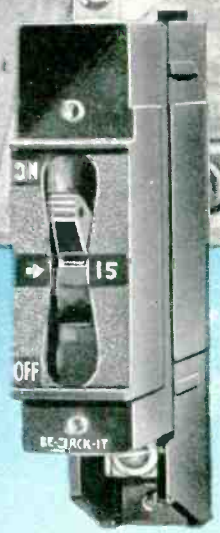
Look to -hp- for complete instrumentation in the microwave field

HEWLETT hp PACKARD

42,000 HEINEMANN MAGNETIC CIRCUIT BREAKERS In This Building



THE PENTAGON BUILDING, WASHINGTON, D. C. FAIRCHILD PHOTO



The heading of this advertisement speaks volumes. We do not think it necessary to say more. But we would like to have you know why the Heinemann Magnetic Circuit Breaker is so highly regarded in the electrical industry.

In the first place, it is *entirely magnetic*. In case of short circuit, the breaker trips INSTANTLY, before the wire has a chance to heat. It can be re-closed at once, provided the "short" no longer exists. Also since NO HEAT is generated, it always carries 100% of rated capacity. No "de-rating" factor is needed.

In the second place, it is extremely flexible. A magnetic-hydraulic time-delay unit adapts the breaker to current conditions so that it will not trip on minor overload or starting surge. A pre-determined safe amount of time will elapse before tripping.

It would be well worth your while to write us for further information

EST. 1888

HEINEMANN ELECTRIC COMPANY

97 PLUM STREET **TRENTON, NEW JERSEY**

ADVENTURES IN ELECTRONIC DESIGN

'Twas The Night Before Christmas

Christmas, 1949 will find more breathless youngsters thrilling to the timeless story of Santa Claus than ever before. It will also find more grown-ups enjoying the beautiful carols and dramatic programs that are so much a part of the Yuletide Season There's no doubt about it Christmas, 1949, will be the merriest ever for millions of people everywhere . . . And a good share of the credit belongs to you . . . America's great radio and television industry Yes, by producing more and finer radio and television receivers than ever before and making these sets available at prices practically every family can afford, you are playing a vital role in making the world a better place in which to live. For this great accomplishment Centralab supplier of quality parts to the radio and television industry for more than 25 years salutes you and wishes you a very merry Christmas!

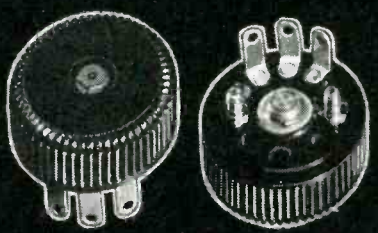
Centralab — DEVELOPMENTS THAT HAVE HELPED YOU SINCE 1922!

Division of GLOBE-UNION INC. • Milwaukee

Centralab reports to

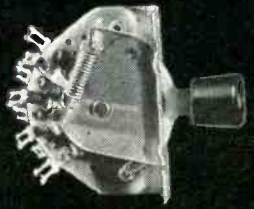
DECEMBER, 1949
How Centralab's "Famous Firsts" have helped You since 1922!

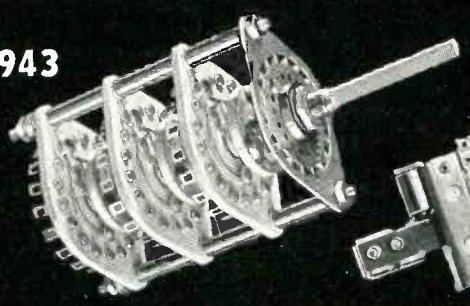
CONTROLS

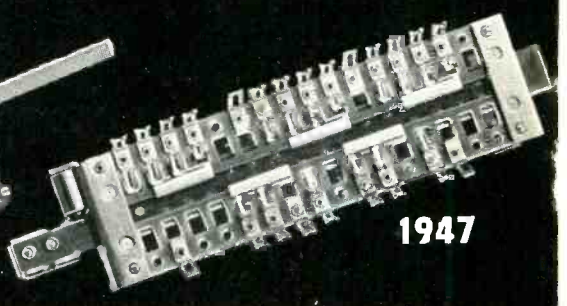


Centralab has come to be known in the electronics industry as "first" in the majority of the products it manufactures and sells. Originator of the Composition Type Volume Control, in 1922. The first Barnacle Type Line Switch attached to a volume control, in 1929. Model 1, smallest switch type hearing aid control, 1946. Now, 1949, Model 2 Radiohm, the most modern high quality variable resistor.

SWITCHES

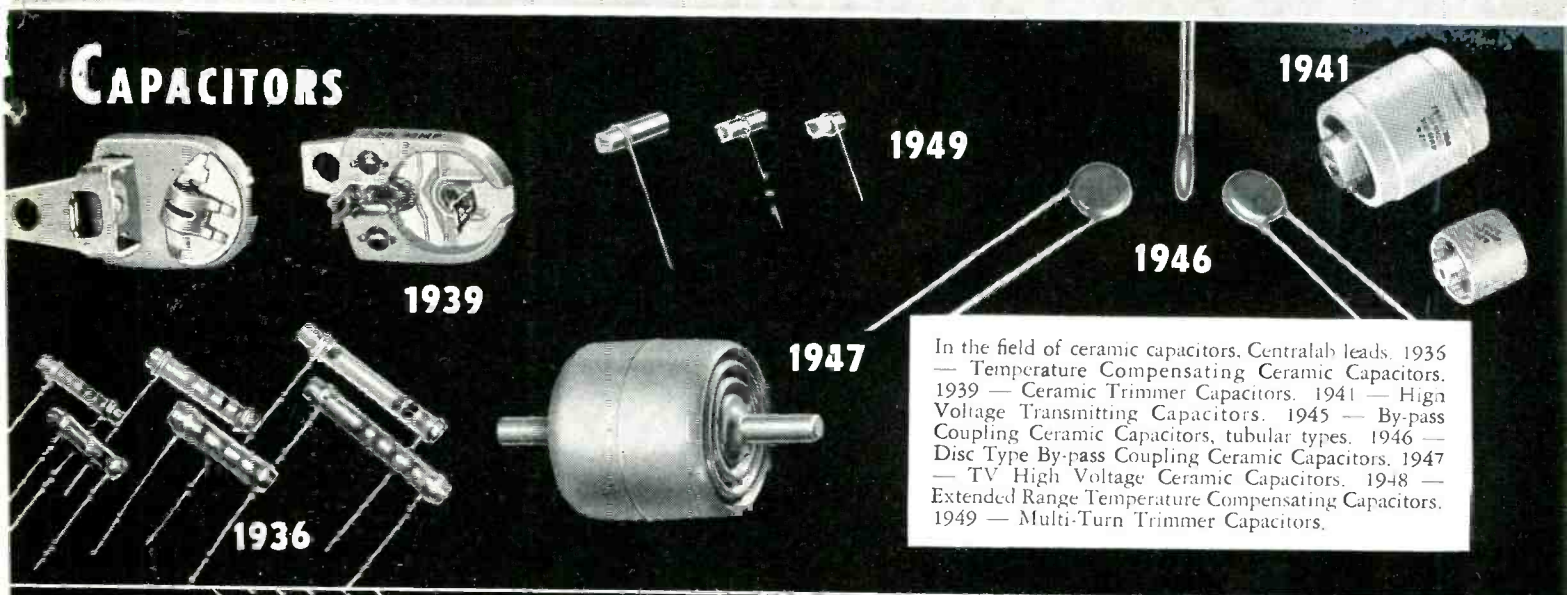




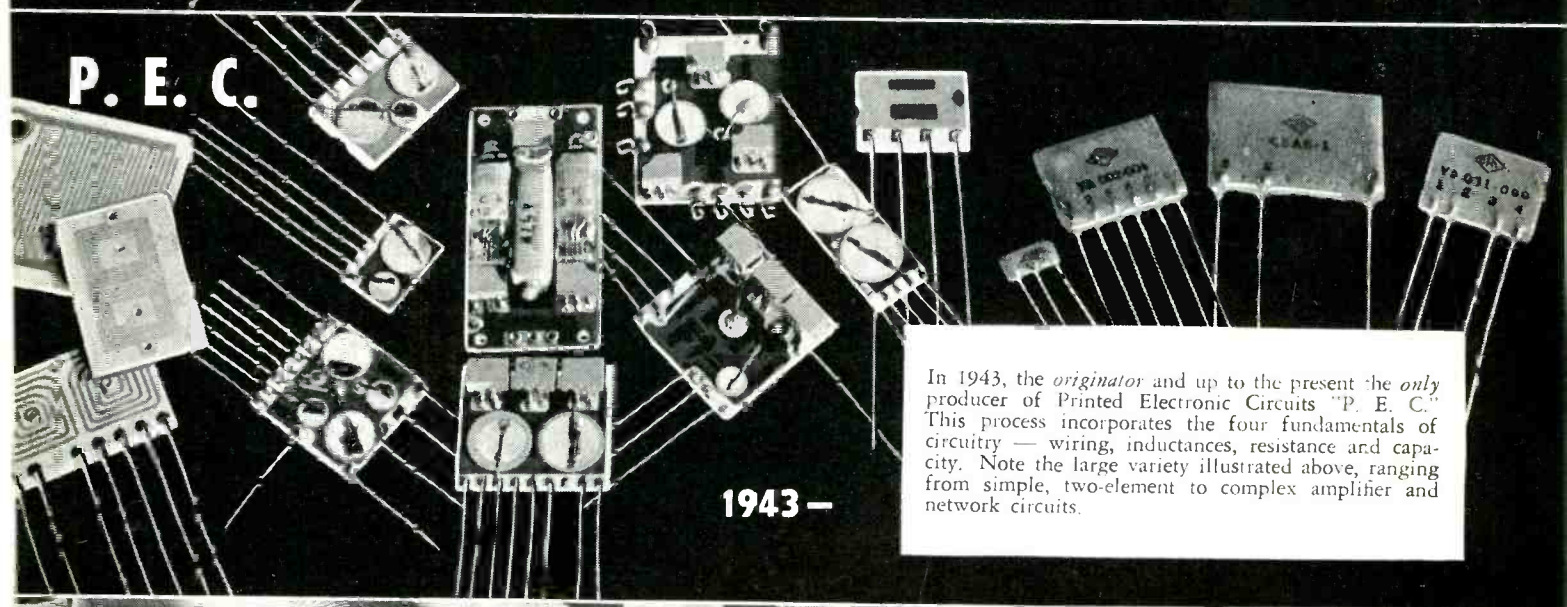


In 1936, Centralab introduced a complete line of wave band and tone switches. First in switch development. A 24 contact per single section switch in 1938. Lever Action Switch in 1939. Low-loss, high-frequency, medium-duty Power Switch, 1943. FM and TV Slide Switch, 1947.

Electronic Industry



In the field of ceramic capacitors, Centralab leads. 1936 — Temperature Compensating Ceramic Capacitors. 1939 — Ceramic Trimmer Capacitors. 1941 — High Voltage Transmitting Capacitors. 1945 — By-pass Coupling Ceramic Capacitors, tubular types. 1946 — Disc Type By-pass Coupling Ceramic Capacitors. 1947 — TV High Voltage Ceramic Capacitors. 1948 — Extended Range Temperature Compensating Capacitors. 1949 — Multi-Turn Trimmer Capacitors.



In 1943, the *originator* and up to the present the *only* producer of Printed Electronic Circuits "P. E. C." This process incorporates the four fundamentals of circuitry — wiring, inductances, resistance and capacity. Note the large variety illustrated above, ranging from simple, two-element to complex amplifier and network circuits.

In 1942 Centralab developed a grade L-5 Steatite Ceramic superior to the then existing navy grade "G" specification. In 1944 a grade L-6 was introduced. In 1945, Cordierite and Zirconite bodies with grade L-4 rating were developed. Since 1943, Centralab has led in the metalizing of ceramic bodies for special purposes.

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42-9 — FILPEC — Printed Electronic Circuit filter.

Centralab Capacitors

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42-4 — BC DISC HI-KAPS — miniature ceramic BC capacitors.
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695 — CERAMIC TRIMMERS — CRL trimmer catalog.
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814 — CAPACITORS — high-voltage capacitors.
975 — FT HI-KAPS — feed-thru capacitors.

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970 — LEVER SWITCH — shows indexing combinat ons.
995 — ROTARY SWITCH — schematic application diagrams.
722 — SWITCH CATALOG — facts on CRL's complete line of switches.

Centralab Controls

42-7 — MODEL "1" RADIOHM — world's smallest commercially produced control.
697 — VARIABLE RESISTORS — full facts on CRL Variable Resistors.

Centralab Ceramics

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

General

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

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

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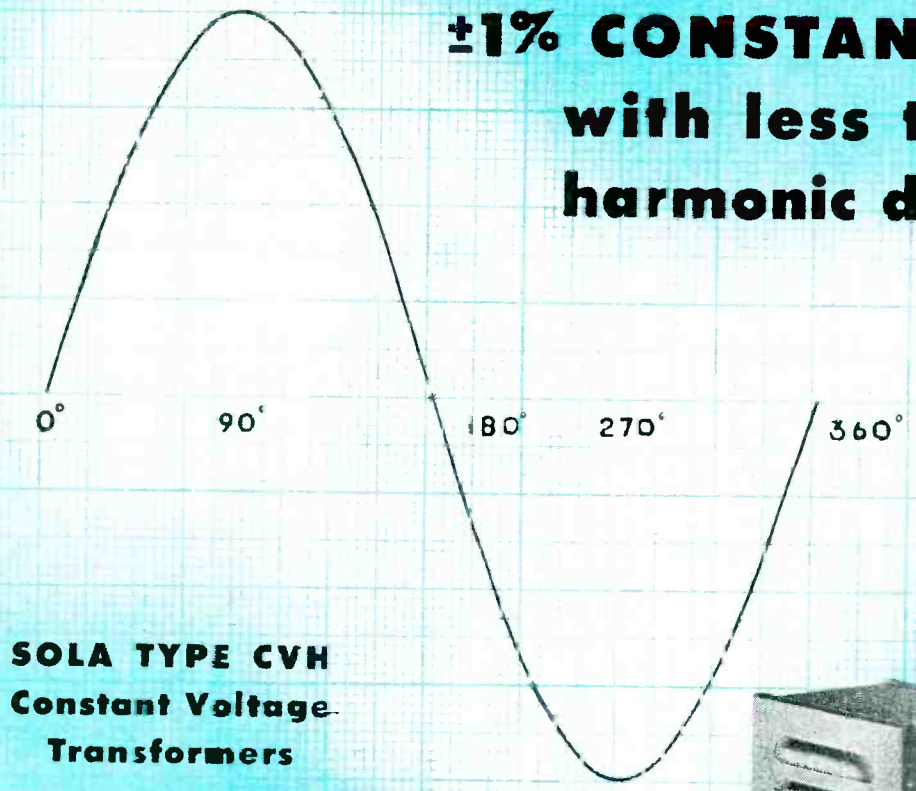
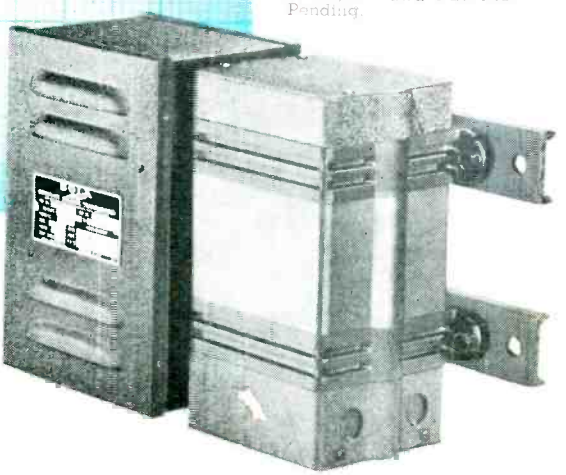
±1% CONSTANT VOLTAGE with less than 3% harmonic distortion



SOLA TYPE CVH Constant Voltage Transformers

Made under one or more of the following Patent Nos.: 2,143,745; 2,212,198; 2,346,821 and Patents Pending.



Type CVH, SOLA Constant Voltage Transformers are designed for use with equipment that requires a source of constant, undistorted voltage. They provide all of the voltage stabilizing characteristics of the standard SOLA Constant Voltage Transformer (±1% regulation) with less than 3% harmonic distortion of the sinusoidal output voltage wave

Type CVH Transformers may be used for the most exacting applications such as general laboratory work, instrument calibration, precision VHF and microwave testing or other operations involving elements which are sensitive to power frequencies harmonically related to the fundamental.

As in all SOLA Constant Voltage Transformers, the regulation is automatic and instantaneous. There are no moving parts, no manual adjustments and every unit is self-protecting against short circuit.

Type CVH SOLA Constant Voltage Transformers are available from your electronics distributor in the following capacities: 60 V.A., 120 V.A., 250 V.A., 500 V.A., 1000 V.A., 2000 V.A.

WRITE FOR THESE BULLETINS

DCVH-136—complete electrical and mechanical characteristics of type CVH Constant Voltage Transformers.

DCV-102—complete engineering handbook and catalog of standard Constant Voltage Transformers available for remedial or built-in applications.

SOLA *Constant Voltage* **TRANSFORMERS**

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

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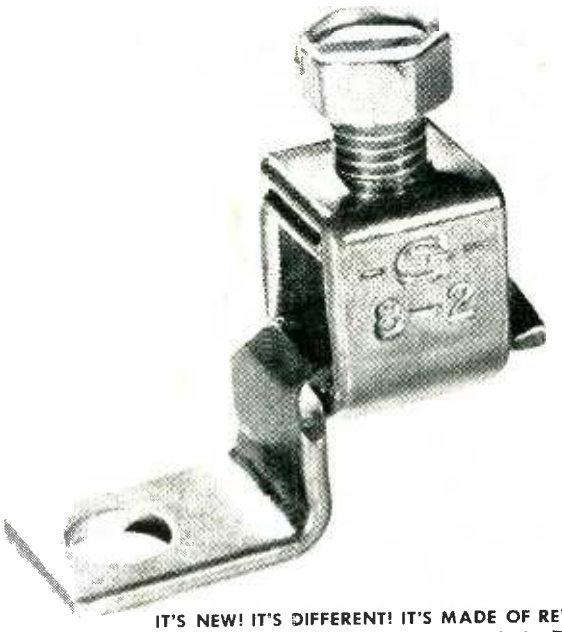

What a Cold, Calculating Beating this Lug takes!

IT'S NEW! IT'S DIFFERENT! IT'S MADE OF REVERE COPPER —The "Double G" Solderless Lug made by THE GREGORY MANUFACTURING CO., INC., New Haven, Conn., for the electrical field, comes in 6 sizes to accommodate from 14 ga wire to 1,000,000 CM cables. Pressure screws are steel.

HOLD 'EM TIGHT—These sharp, deep-cut serrations on inside of both tubular sections and projection tang help to make firm, non-slip joints possible. They also increase the rigidity and conductivity of the connection. Note that these serrations were made cold, and without any distortion of the Revere Copper used. Lugs shown are twice actual size and are unretouched.

...and not a Scar to show for it!

Improved solderless lug of hard drawn Revere Copper, cold worked over and over without distortion, cracking, pitting or scarring.

Pierced, formed at short 45 degree and 90 degree angles and deeply serrated, this "Double G" solderless lug really gets a working over . . . and cold, too, no annealing. Yet, with all this, the surface remains absolutely smooth, the lug is not in any way weakened and there is no twisting, pitting, cracking or scarring of any kind. And, in addition, its dimensions are held.

When the Gregory Manufacturing Co., Inc., was developing this solderless lug, with its unusual features, it had a problem on its hands.

Their design called for copper strip that could stand a lot of cold working and when finally fabricated into a product of uniform quality, would not have a lot of twist, cracks, pitted or scarred surface. In their efforts to secure such a product their engineers had frequent consultations with Revere's Technical Advisory Service. The result was the product shown and described above, with production time and money saved and rejects held to the vanishing point. The material used was Revere hard drawn copper strip with a temper of 36 to 46 Rockwell B Scale. This company feels that they could not have developed such a successful product if the quality of the copper was not of the best and did not possess the inherent working characteristics needed.

Perhaps Revere Copper or some other Revere Metal can be of help in developing or improving your product—cutting your production costs. Why not tell Revere's Technical Advisory Service about your metal problems? Call the Revere Sales Office nearest you today.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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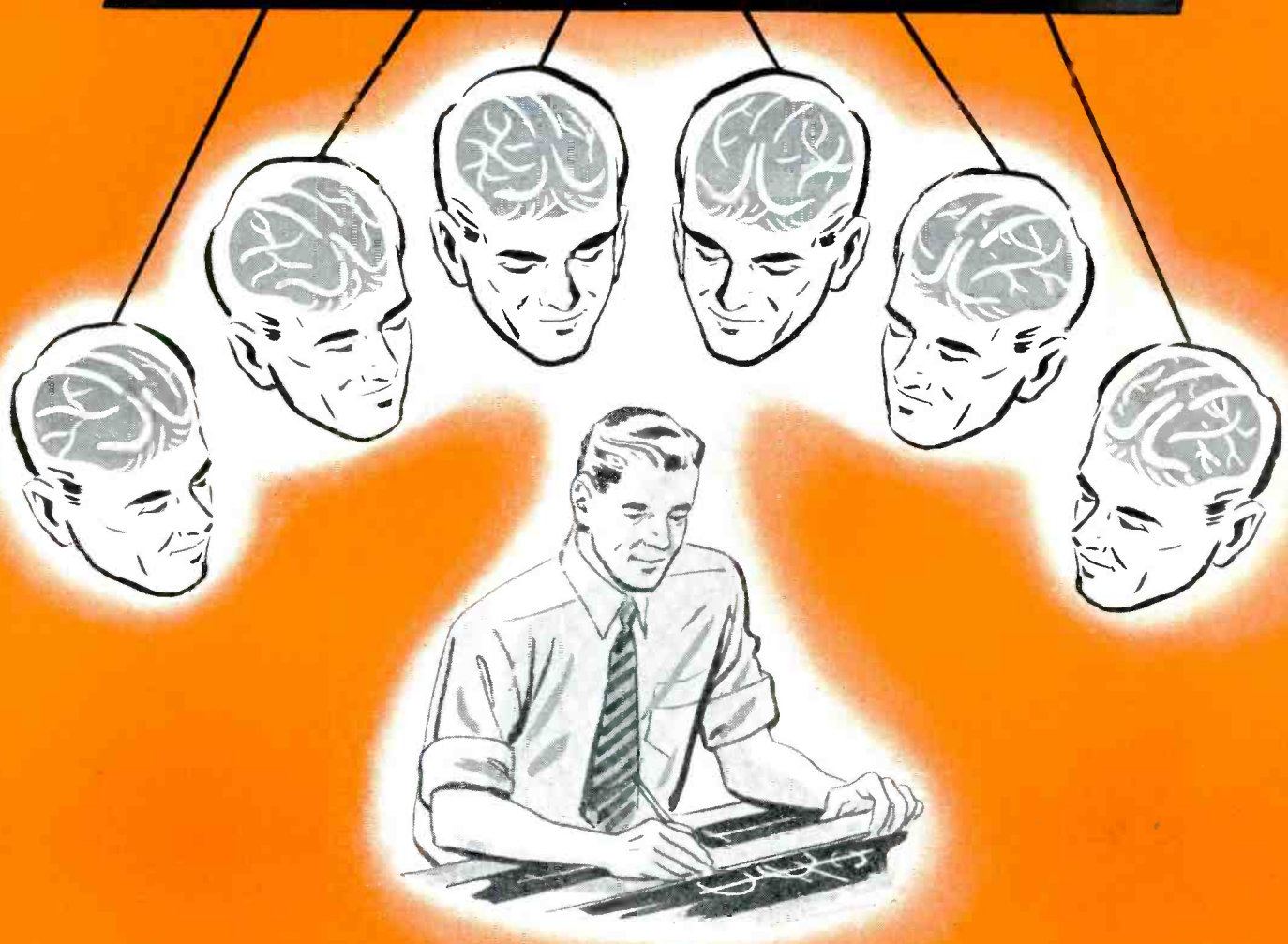
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

OHMITE Resistance "Know-How"



HERE'S A VALUABLE SOURCE OF DESIGN INFORMATION

IF YOU have a design problem involving rheostats or resistors, call on Ohmite for assistance. The accumulated experience of the entire Ohmite engineering staff . . the combined thinking of its many resistance specialists . . . are all available to you for the asking. Ohmite engineers are well qualified to help analyze your requirements and select the correct units to fit your specific application. Years of experience in building dependable rheostats and resistors, in helping others solve specialized resistance problems, is your assurance that Ohmite "know-how" can help you. We invite you to submit your problems to us.

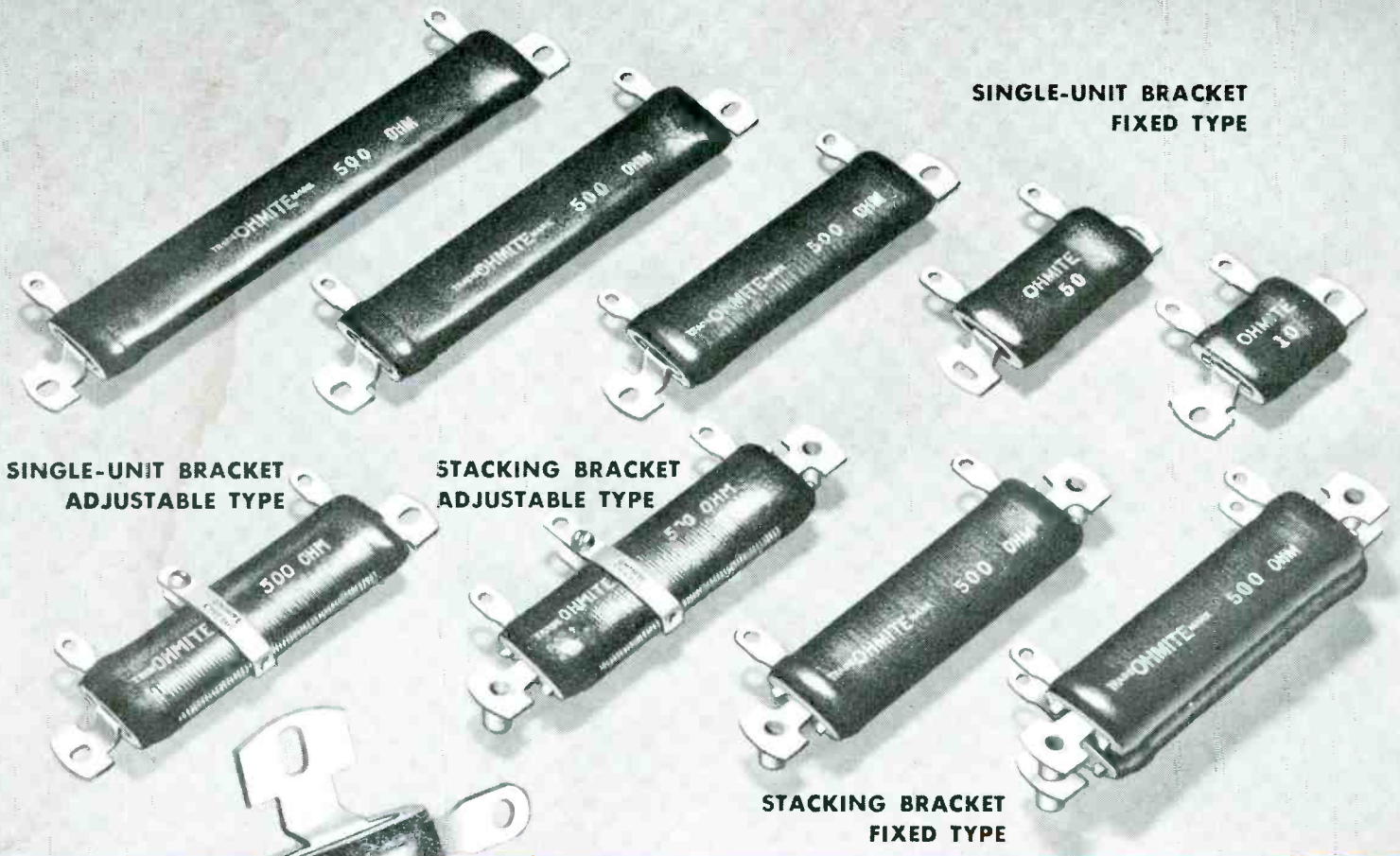
RHEOSTATS

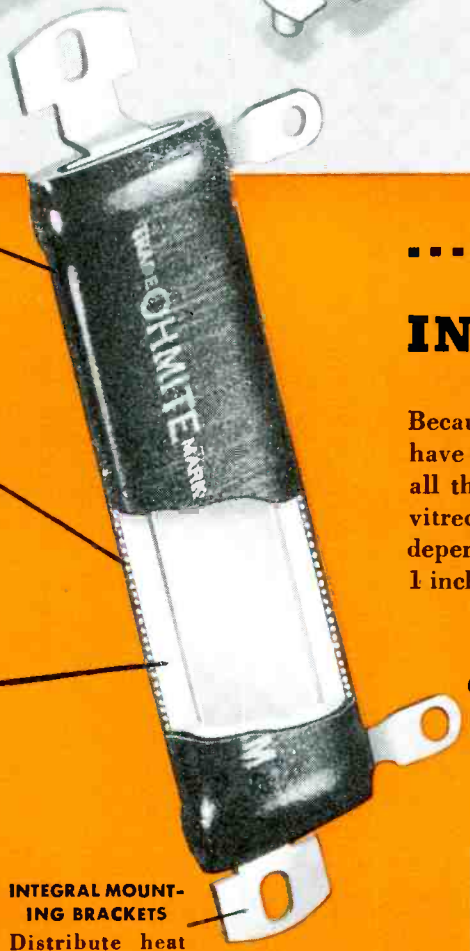
RESISTORS

TAP SWITCHES

Be Right with OHMITE

OHMITE THIN RESISTORS





VITREOUS-ENAMEL COVERING
Winding is rigidly held in place and protected from damage by Ohmite special vitreous enamel.

EVEN, UNIFORM WINDING
"Hot spots" and resultant failures are prevented by the resistance winding's unsurpassed uniformity.

STRONG, CERAMIC CORE
Unaffected by cold, heat, fumes, or high humidity, its core provides a strong base for winding.

FIVE WATTAGE SIZES
Lengths range from 1¼ inch to 6 inches, corresponding to ratings of 30 to 75 watts.

INTEGRAL MOUNTING BRACKETS
Distribute heat more evenly throughout resistor and conduct heat away quickly.

...PACK HIGHER WATTAGE INTO LESS SPACE

Because of their compact design, Ohmite Thin Type Resistors have a higher wattage rating per unit of space. They provide all the time-proven superiority of conventional Ohmite vitreous-enamel resistors—giving you a compact unit you can depend upon. Available in four types—all only ¼ inch thick by 1 inch wide—in five lengths and a wide range of resistance values.

Send for Bulletin No. 138

OHMITE MANUFACTURING CO.
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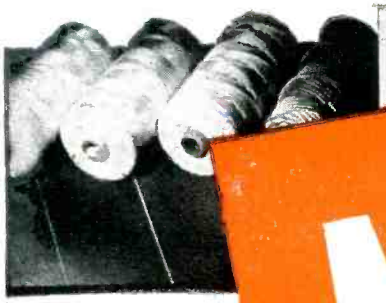
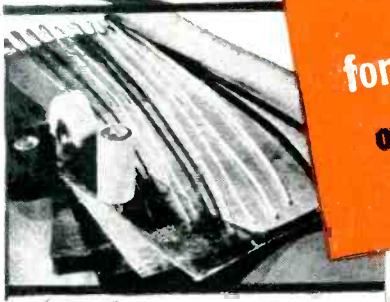
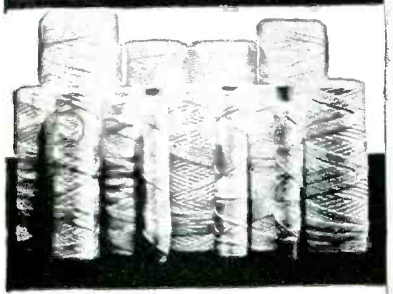
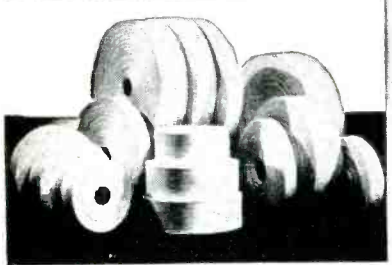
Be Right with

OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES









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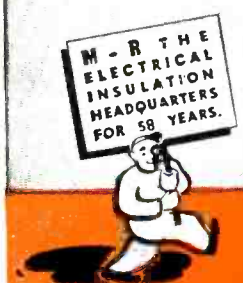
for woven TAPES, TUBINGS, SLEEVINGS, CORDS, CLOTHS, of fiberglas yarn for every electrical insulation requirement

MITCHELL-RAND, using Owens Corning fiberglas yarn, processes and fabricates TAPES, TUBINGS, SLEEVINGS, CORDS and CLOTHS that are the optimum in electrical insulation . . . marketed under the trade name **MIRAGLAS,** they protect electrical equipment from the destructive forces that play havoc with ordinary electrical insulations; overloading, extreme high or low temperatures, moisture, corrosive acids, fumes or vapors, oils, grease, dust and dirt.

MIRAGLAS fiberglas INSULATIONS have an amazing background of use throughout industry—wherever used they feature fewer breakdowns, less maintenance, elimination of waste, savings in labor and materials and prove their standing as the optimum in electrical insulation protection.

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.



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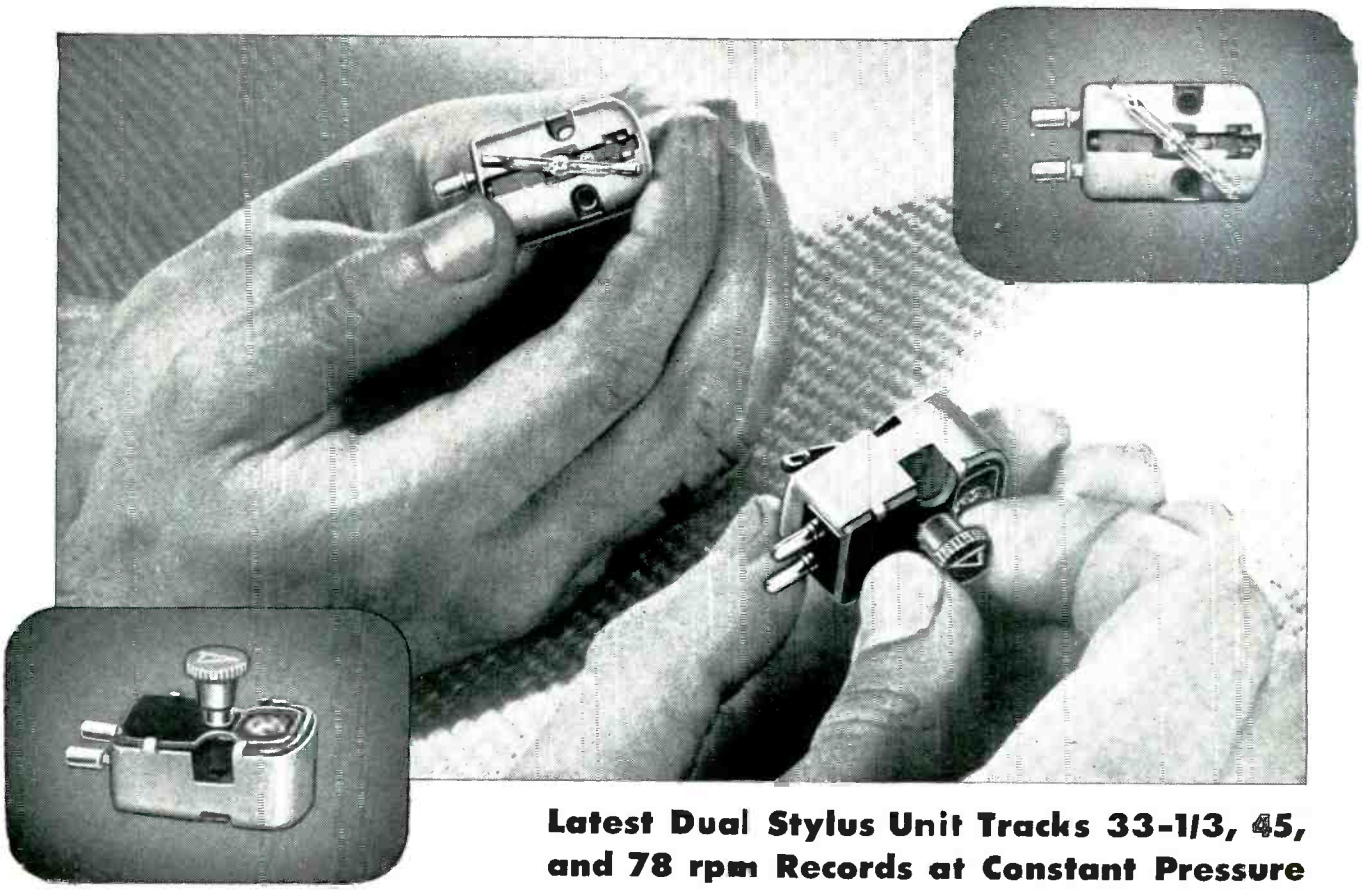
NEW G-E *Triple-Play* CARTRIDGE PLAYS ALL 3 SPEEDS



Latest Dual Stylus Unit Tracks 33-1/3, 45, and 78 rpm Records at Constant Pressure

Costs 25% less than Pickups it Replaces

A new General Electric "Triple Play" Cartridge that tracks any commercial record is now available to manufacturers, distributors, and dealers.

Simplicity is the key feature of this notable electronic advancement. Once installed in a tone arm, the cartridge will play all types of popular narrow groove and standard groove records *without replacement or even a change in position!*

ONLY ONE PRESSURE

The new cartridge retains the unsurpassed frequency response characteristics of the famous G-E Variable Reluctance unit and in addition, tracks the three types of records at 6 to 8 grams. Thus the pressure is constant regardless of the stylus you're using. The special design of the "Triple Play" permits precise adjustment of tone arm pressure. Weight changing and pressure compromise problems are eliminated. High compliance and low moving mass reduce record wear to a minimum.

TWO STYLI IN ONE CARTRIDGE

A single twist of a built-in knob turns either end of a dual stylus to playing position. A 1-mil stylus, mounted at one end, plays 33⅓ and 45 rpm records, and a 3-mil stylus, at the opposite end, tracks standard 78 rpm records.

MANUFACTURERS NOTE LOW COST

Although it plays records that formerly required the use of two cartridges, the price of the "Triple Play" is 25% *less* than the price of two individual cartridges. It is adaptable to many types of tone arms and *its use as an initial component will effectively reduce set manufacturing costs.*

UNAFFECTED BY TEMPERATURE

The G-E "Triple Play" is unaffected by normal climatic changes in humidity and extreme variations in temperature. Needle talk and needle scratch are reduced to a minimum. Record reproduction—as always with G-E Cartridges—is superb. Mail coupon below for complete information.

You can put your confidence in
GENERAL ELECTRIC

General Electric Company, Parts Section 1E
Electronics Park, Syracuse, New York
Send me full particulars on the new G-E "Triple Play" Cartridge.

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If it's a problem calling for PRECISION POTENTIOMETERS

Bring it to Helipot

For many years The HELIPOT Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the *helical* potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL*—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring *precision potentiometers* your best bet is to bring it to The HELIPOT Corporation. A call or letter outlining your problem will receive immediate attention!

*Trade Marks Registered

In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.

A B C

MODELS A, B, & C HELIPOTS
A—10 turns, 46" coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B—15 turns, 140" coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2" coil, 1-13/16" dia., 3 watts—resistances from 5 to 50,000 ohms.
—Ask for Bulletin 104—

D E

MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234" coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373" coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.
—Ask for Bulletin 104—

F G

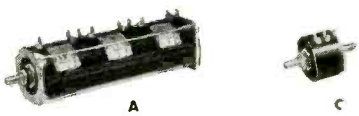
MODELS F AND G PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16" dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16" dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.
—Ask for Bulletin 105—

LABORATORY MODEL HELIPOT
The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.
—Ask for Bulletin 106—

R W

MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2" diameter, exclusive of index.
W—4-3/4" diameter, exclusive of index. Features finger hole in knob to speed rotation.
—Ask for Bulletins 104 and 114—

The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.



A C

3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL C HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

B F

MULTITAPPED MODEL B HELIPOT AND 4-GANGED TAPPED MODEL F
This Model B HELIPOT contains 28 taps, placed as required at specified points on coil. The Four-Gang Model F Potentiometer contains 10 taps on each section. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

Q. Why is "dag" Colloidal Graphite best for CRT Exterior Wall Coating?

A. It's cheaper ...Has better adhesion ...Requires no baking ...Resists scratching

"dag" Dispersion #194 is a lacquer-base dispersion of microscopically small graphite particles. It is easily applied to CRT surfaces by spraying, and dries very rapidly, enabling tubes to be handled in 2 or 3 minutes. Maximum adhesion is obtained by drying at room temperature for 24 hours, or by forced infra-red drying for ½ hour.

"dag" Dispersion #194 forms a smooth, uniform, conductive black coating on any type glass. Its adhesive properties are so good that it will resist scratching by a thumb nail or soaking in water.

Prominent CRT manufacturers have found **"dag"** colloidal graphite dispersions satisfactory and usually cheaper for wall coatings . . . for other electronics work, too. Let Acheson Colloids engineers show YOU how these versatile dispersions can solve many and varied electronics problems. Send the coupon NOW for more information.

dag REG. U.S. PAT. OFF. COLLOIDS

ACHESON COLLOIDS CORPORATION
Port Huron, Michigan

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M-5

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DU MONT TYPES 250-A and 250-AH

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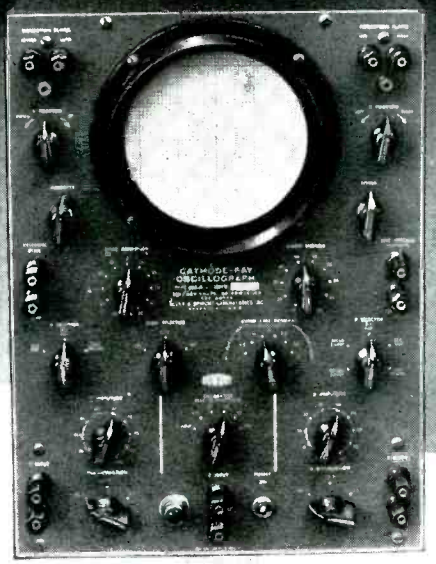


◗ For *research* where utility and precision work demand high-quality performance and steadfast dependability.

◗ In *industry* where a wide range of application and adverse operating conditions demand general-purpose versatility and rugged endurance.

Equipped for both INDUSTRY and RESEARCH with...

Amplification of both a-c and d-c input signals.
Sweep durations as long as 5 seconds.
Recurrent, single, or driven sweeps; spot rests at beginning of forward sweep, virtually eliminating sweep-starting time.
Automatic beam-blanking and provision for intensity modulation.
Photography of oscillograms with either Du Mont Type 271-A or 314-A Oscillograph-record Cameras.
Additional accelerating potential in the Type 250-AH, by using Type 5RP-A Cathode-ray Tube and Type 263-B High Voltage Power Supply Unit.
Projection of Oscillograms with Du Mont Type 2542 Projection Lens.
Built-in Voltage Calibrator.
High-impedance input probe.

◗ ***Literature or demonstration on request, without obligation.***

SPECIFICATIONS...

Cathode-ray Tube: For Type 250-A, Type 5CP-A; for Type 250-AH, 5RP-A.

Accelerating Potentials: Type 250-A, 3200 volts; Type 250-AH, 13,500 volts.

Y-Axis: Deflection factor, 0.015 rms volt/in. maximum through amplifier at full gain; 0.15 through probe and amplifier; 0.9 d-c volts maximum through d-c amplifier at full gain; 21 rms volts/in. ±20% direct to deflection plates. Sinusoidal frequency response of a-c amplifiers uniform within 10% from 5 to 200,000 cps; within 60% to 500,000 cps. Response of d-c amplifier uniform within 10% from 0 to 200,000 cps.

X-Axis: Deflection factor, 0.4 rms volt/in. maximum through a-c amplifier at full gain; 1.2 d-c volts/in. maximum through d-c amplifier at full gain; 23 rms volts/in. ±20% direct to deflection plates. Sinusoidal frequency response of a-c amplifier uniform within 10% from 5 to 200,000 cps; within 60% to 500,000 cps. Response of d-c amplifier uniform within 10% from 0 to 200,000 cps.

Linear Time Base: Both driven and recurrent sweep-time intervals continuously variable from 5 seconds to 10 microseconds.

Intensity Modulation: 5 volts peak for adequate modulation.

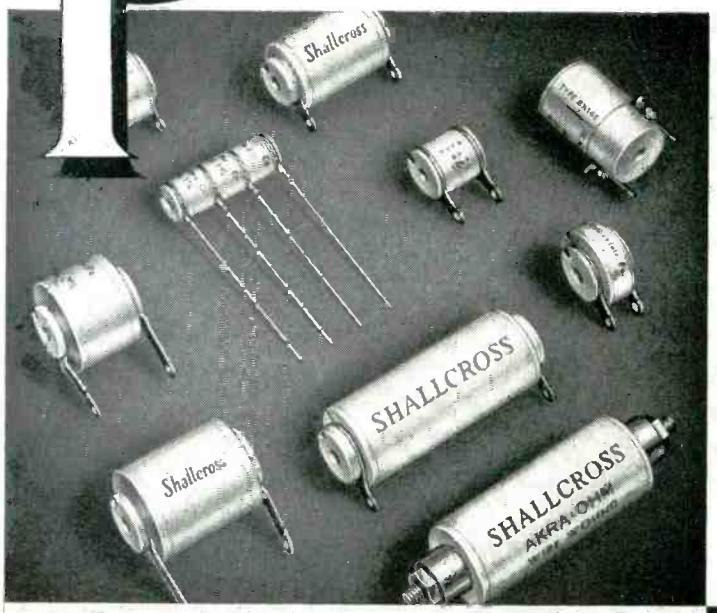
Primary Power: 115/230 volts, 50-60 cycles, 250 watts.

Dimensions: 15" h., 11" w., 19" d., *Weight:* 68 lbs.

DUMONT *for Oscillography*

ALLEN B. DUMONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

Precision products



◀ CLOSE TOLERANCE RESISTORS

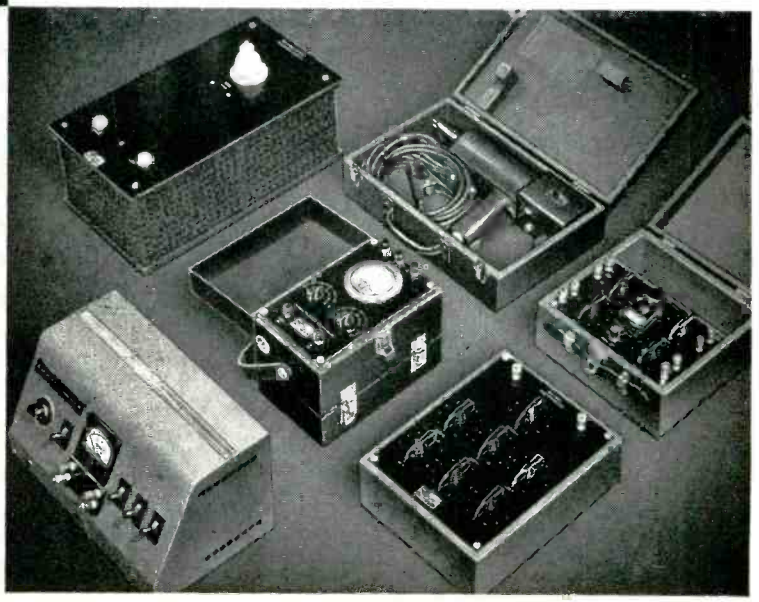
(JAN and standard types)

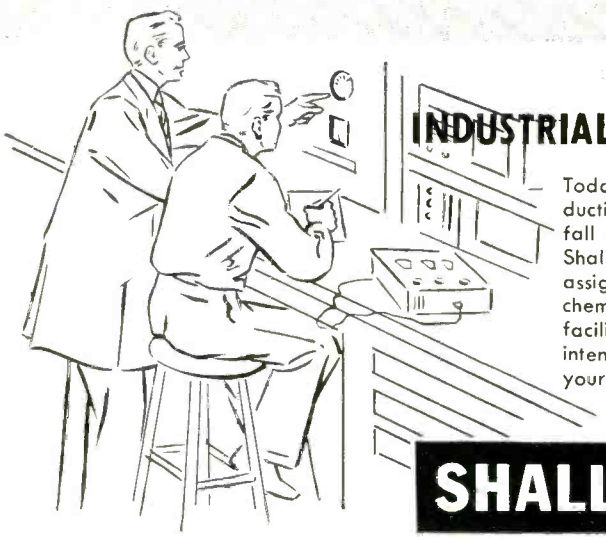
Wire-wound precision resistors have characteristics suitable for many exacting modern circuits. Shallcross Akra-Ohm resistors meet these requirements and are available in several types, shapes, and mounting styles. They are noted for high stability, low temperature coefficients, low noise levels, uniformity,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

PRECISE ELECTRICAL ▶ MEASURING INSTRUMENTS

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

Write for Catalog No. 10.



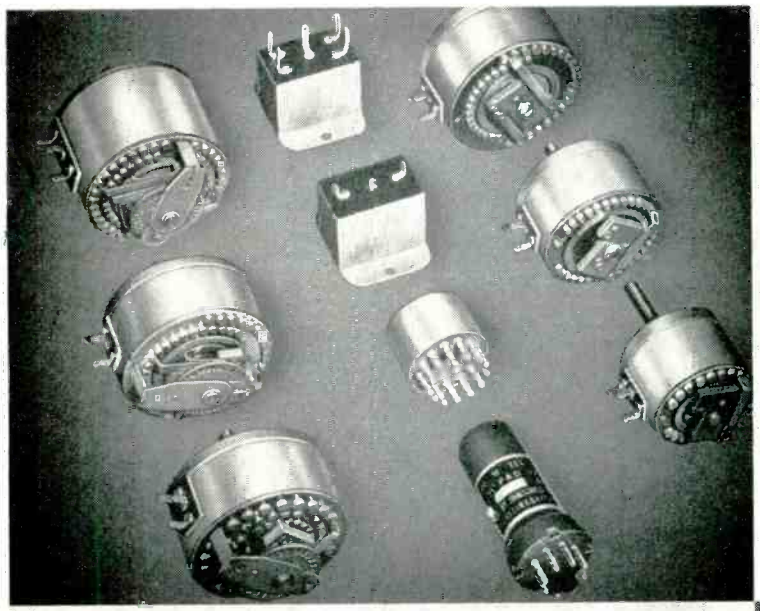


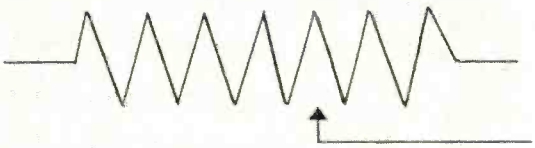
INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICE

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

SHALLCROSS MANUFACTURING

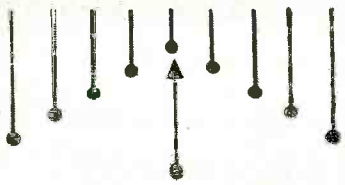
by SHALLCROSS





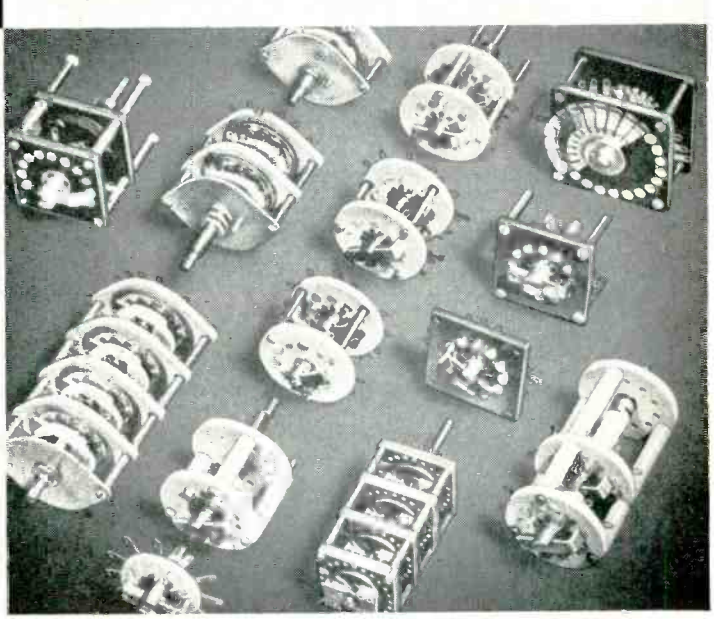
◀ HIGH QUALITY ATTENUATORS

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



CUSTOM-BUILT SELECTOR SWITCHES ▶

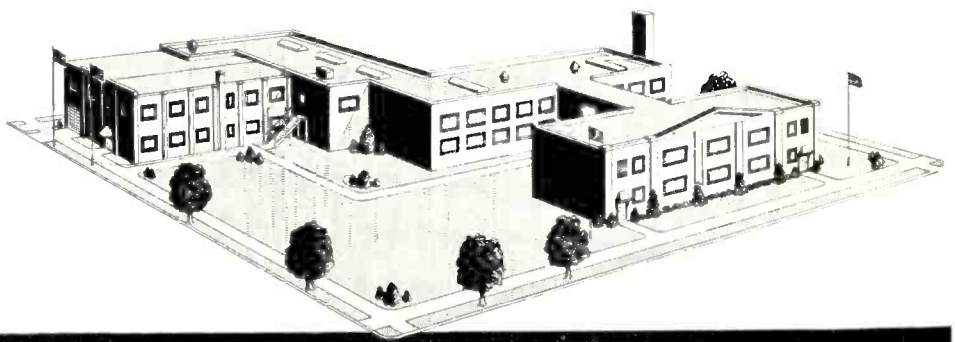
Shallcross builds single or multiple deck selector switches having up to 180 positions. Test units have given satisfactory performance at 250 volts 10 amperes and at 2500 volts 1 ampere A.C. Contact resistance ranges from a low of 0.0005 ohms to a maximum of 0.005 ohms depending upon the size and material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



HIGH-VOLTAGE

Test and Measuring Equipment

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



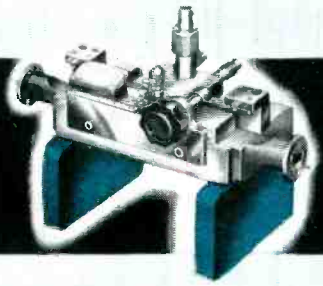
COMPANY Dept. E-129 **Collingdale, Pennsylvania**

PRD

PRECISION MICROWAVE MEASUREMENT COMPONENTS

TYPE 211—PRECISION WAVEGUIDE SLOTTED SECTION
(½" x ¼" Waveguide)

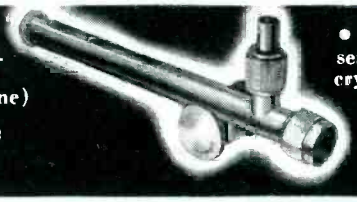
Broadband Operation; Crystal and Bolometer Detection; Ball Bearing Carriage Support



• Similar slotted sections and probes in standard rectangular waveguide and coaxial line sizes make possible precise impedance measurements over the microwave spectrum from 1000 to 40,000 megacycles per second.

TYPE 612—TUNABLE CRYSTAL AND BOLOMETER MOUNT
(Type N—⅜" Coaxial Line)

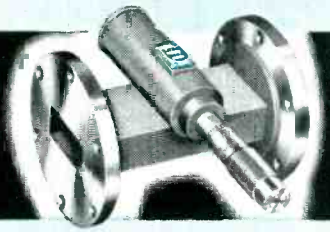
Broadband Operation; Accurate Square-Law Detection



• The instrument illustrated serves both as a general purpose crystal or bolometer detector and as an harmonic generator for the multiplication of crystal-controlled u-h-f signals into the microwave region.

TYPE 575—REACTION TYPE FREQUENCY METER
(1½" x ¾" Waveguide)

Micrometer Precision; Full Waveguide Frequency Coverage; Ease of Operation



• Currently available in three waveguide sizes to provide coverage from 3950 to 10,000 megacycles per second, these frequency meters combine simplicity of operation, precision, and reliability.

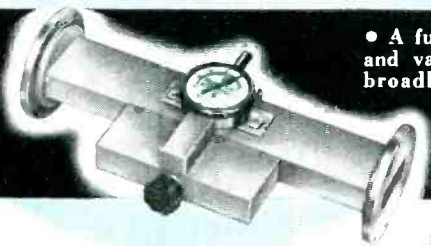
TYPE 559-A—PRECISION FREQUENCY METER
(1" x ½" Waveguide)

Direct Reading Dial; Linear Drive; Hermetic Sealing; Temperature Compensation

• This unit is representative of a complete new line of precision frequency meters available with reaction or transmission coupling, and providing maximum accuracy even when exposed to extremes of temperature and humidity.

TYPE 170—PRECISION CALIBRATED VARIABLE ATTENUATOR
(2" x 1" Waveguide)

Metallized-glass Attenuating Element; Precise and Permanent Calibration; Negligible Insertion Loss



• A full complement of fixed and variable attenuators and broadband terminations in standard waveguide sizes provides coverage from 2600 to 40,000 megacycles per second.

The instruments illustrated above are the result of the continuing efforts of PRD's skilled staff to provide the microwave research engineer with test equipment of ultimate accuracy and reliability over broader and broader frequency bands. Techniques of novel character are used to give the many outstanding features available in the complete PRD line of precision microwave measurement and test equipment. An illustrated catalog may be obtained by writing on company letterhead to Dept. E-1.

Polytechnic **RESEARCH and DEVELOPMENT COMPANY • Inc**

202 TILLARY ST., BROOKLYN 1, NEW YORK

Good Listening! for EVERYONE!

with the NEW Genuine JENSEN WIDE-RANGE LOUDSPEAKERS

16 COMPLETELY NEW MODELS
Three 15-inch Coaxials, one 12-inch Coaxial
Eleven 5-inch to 15-inch Single-Radiator Models

● No longer is truly *good* listening ruled out by cost or size restrictions. Now music can come to life for everyone, for Genuine JENSEN Wide-Range Loudspeakers include *small sizes* as well as large . . . *low cost units* as well as more expensive models.

● Not alone in frequency range but also in smooth response, wide-angle distribution, low distortion, good efficiency and power handling capacity . . . in all 7 Performance Points Genuine JENSEN Wide-Range loudspeakers establish new standards of reproduction quality.

● So whether you choose a 5" single-unit direct-radiator type loudspeaker at $8.00 list, a 12" Coaxial at $33.40 list, or a 15" Coaxial with the new JENSEN Wide-Angle Acoustic Lens, you get superior performance all the way . . . in every attribute that makes for enhanced listening pleasure.

New WIDE-ANGLE ACOUSTIC LENS

Typical of JENSEN leadership in loudspeakers engineering is the Acoustic diverging Lens used on Model H-510 illustrated at the left. Adapting optical principles to acoustics, this lens acts in conjunction with the h-f horn to distribute h-f radiation uniformly over a wide angle...insures constant balance and high quality reproduction throughout the whole room.

Write now for Data Sheet No. 152 describing all the new loudspeakers in the new Genuine JENSEN Wide-Range series, and booklet, "Let Music Come to Life."

GENUINE Jensen WIDE RANGE

This trademark identifies an advanced-design loudspeaker . . . with performance to meet today's exacting requirements for faithful music reproduction . . . achieved through the most modern applications of acoustics.

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Division of the Muter Company
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In Canada: Copper Wire Products, Ltd., 351 Carlaw Avenue, Toronto

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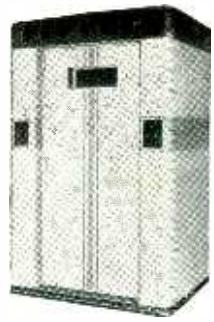
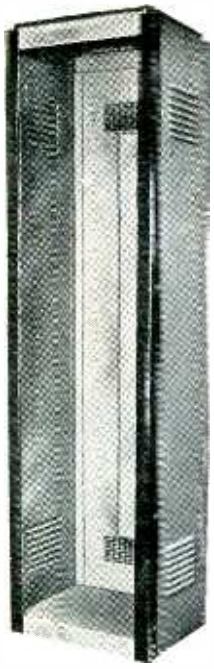
Intricate Jobs...





We Give Them All "High Hat" Quality

Whether you come to us for simple stamped-out chassis, ordinary metal boxes or the most intricate electronic apparatus housing, your job will receive the same Karp quality treatment, plus every possible economy.

The same long-experienced principals of our staff will give you intimate, personalized service, from planning and design to delivery. Your work will be done by highly skilled specialists, in a plant which is without an equal in its field for up-to-date machinery and modern facilities. Welding, when needed, will be done under precise timing controls . . . painting and finishing with the most modern equipment and conditions.

In most cases, our vast variety of dies will save you the cost of special dies and jigs. We will give your work accuracy and uniformity that will make your final assembly easy, time-saving and hence economical.

Try us for the plain or the precise . . . the everyday or the elaborate and de luxe . . . in modest or substantial quantity. Whatever your needs in sheet metal fabrication, it pays to get our estimate.

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KARP METAL PRODUCTS CO., INC.

215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

HEAVY-DUTY RELAYS THAT MOUNT 3 WAYS

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

ACCURATE BUT RUGGED

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

SNAP-SWITCH INSTALLATION TIME CUT TO SECONDS

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

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

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

A SMALL PACKAGE OF WELL-REGULATED HIGH VOLTAGE

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

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

General Electric Company, Section D667-3
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

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

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NEXT BEST THING TO A "SKY-HOOK!"

"Sky-hooks" being expensive and somewhat impractical, why not start from the ground up with a Blaw-Knox tower to obtain support for your high-riding FM and TV antennas?

Blaw-Knox, having built towers since spark-gap days, makes available to electronic engineers a degree of practical experience unequalled in this field. So, when you want the next best thing to a sky-hook, call Blaw-Knox.

[Shown here is a Blaw-Knox special 417 ft. Type H-40 Heavy Duty tower for Station WHIO, Dayton, Ohio. This tower was designed to support an RCA combination 4-section pylon, plus a 6-section TV antenna and station call letters.]

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OF BLAW-KNOX COMPANY
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BLAW-KNOX ANTENNA TOWERS

The Labor Union Monopoly Bites *ALL* Workers

What kind of government is it which:

. . . Prosecutes the Great Atlantic & Pacific Tea Company which it asserts handles about 6½% of the retail food distributing business as an illegal monopoly in restraint of trade, and

. . . Seeks to break up four big meat packing companies and make them into 14 companies, charging the four with being a monopoly in restraint of trade, but

. . . Makes no move whatsoever to apply the federal anti-trust laws to the exercise of virtually 100 percent monopoly control of labor in the coal industry, and the only slightly less complete monopoly control of labor in the steel industry?

The answer to that question is simple. It is class government of the most flagrant type, a government by which special privileges are dispensed without justice and to the great injury of all workers. It is the kind of government which will lead to the early sacking of the American enterprise system and the personal freedoms of workers.

In legal terms the explanation of this flagrant affront to good government is also simple. In 1932 labor union activities were given virtually complete exemption from the application of the federal anti-trust laws by passage of the Norris-LaGuardia Act.

continued on next page

When the Norris-LaGuardia Act was passed labor unions were relatively weak. Only about 16% of the nation's industrial workers were organized, only about 12% of the steel workers. About two-thirds of the coal miners were union members, but only half that number were paying dues. The country was in the depth of its worst depression. The unemployment of about one-fourth of the labor force made monopoly control by labor seem so remote as to be almost fanciful.

But after only seventeen years devoted to the promotion of labor union organization by the federal government, we have labor monopoly with us. In its power and scope it makes the alleged business monopolies being prosecuted under the federal anti-trust laws seem positively piddling. In its manners it makes the old-time business monopolists look like Lord Fauntleroys.

What is lacking, grievously lacking, is action by Congress; action to shape our federal anti-trust laws to take account of the labor monopoly that has become the dominant national force in our country today—a force that is leading to the loss of freedom of all workers.

Before labor monopoly is broken up, as it must be broken up if our economy is not to be permanently wrecked, other steps will no doubt be required. But one test more than any other will be the touchstone of the nation's determination to keep its economic and personal freedom. It is what it does to see that labor monopoly receives the same treatment under the federal anti-trust laws as any other kind of economic monopoly.

The purpose of the federal anti-trust laws is to break up monopoly and preserve fair competition in the United States. It is a fine purpose. The wisdom and fairness of its application in particular cases is often open to challenge. But in spite of bad administration every farsighted business man I know is a staunch defender of our national anti-trust policy.

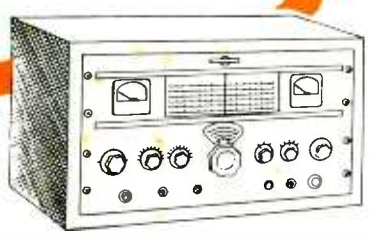
At present, in the exemption of labor monopoly, we have a breach in that policy which, if not closed, will soon become fatal both to the policy and the enterprise system it is designed to foster and protect.

The main thing wrong today with Great Britain and indeed all Europe is that no effective anti-trust laws are in existence to protect the public from business and labor monopolies, to guarantee personal freedoms. No free economy in Europe or America can prosper as long as protected monopolies remain and flourish.

While your representatives in Congress are home with you talk to them about the special privileges now granted to labor union monopoly. You would serve your country well by finding out what they intend to do about it before it is too late.

President, McGraw-Hill Publishing Company, Inc.

What Collins is doing about amateur radio TVI



The widespread and eager acceptance of television has imposed on the radio amateur fraternity a new problem of major proportions. Elimination of television interference is very difficult due to the harmonic relationship of amateur and television frequencies, poor selectivity and spurious responses prevalent in many TV receivers and, generally, to the enormous power ratio which must be achieved between desired and undesired output frequencies in an amateur transmitter.

The Collins Radio Company, in keeping with its policy of building fine amateur gear, has modified the design of the Collins 32V amateur transmitter to meet the TVI problem. Extensive laboratory development, tests conducted cooperatively with one of the leading TV receiver manufacturers, and field checks in a large number of actual ham installations have shown that the new model (the 32V-2) is an effective answer to the TVI problem.

At the present time, due to occasional unusual field conditions, we are unable to make a flat statement that the 32V-2 is TVI proof, yet our field tests have shown no TVI in over 97% of the cases. Therefore, we are authorizing our dealers to offer full refund of the purchase price of the 32V-2 returned in new condition, transportation prepaid, within 30 days if the amateur is not satisfied with its freedom from television interference.

The following methods of avoiding TVI have been provided in the design of the 32V-2 and accessory units:

(a) Reduction of spurious signals in the transmitter output.

(b) Filtering of transmitter output at the antenna terminal.

(c) Shielding of transmitter.

(a) In the 32V-2 series added tuned circuits in the exciter and an added L section in the unbalanced pi output network reduce unwanted signals. This output network is designed primarily to feed into a 52 ohm coaxial transmission line, such as RG-8/U. It will also match unbalanced impedances of approximately 26 to 300 ohms and will tune out reactances normally encountered.

(b) A coaxial fitting is provided at the rear of the 32V-2 cabinet. This permits the use of a well shielded transmission line in which the Collins 35C-1 Low Pass Filter may be inserted. The 35C-1 is a 50 ohm three-section filter which, with approximately 0.2 db insertion loss below 29.7 mc, provides approximately 75 db attenuation of harmonic emissions at the television frequencies. This high attenuation is added to that provided in the transmitter. The unbalanced output permits grounding of the outer conductor of the line and the case of the filter. The price of the 35C-1 is $40.00 at your Collins dealer's.

(c) For reducing TVI from sources other than the antenna, the Collins 49S-1 Shielded Cabinet for the 32V-2 is available at extra cost. It includes well filtered control wires and leads to terminals, and forced air ventilation. Provision is made for mounting the 35C-1 filter on the rear. The 49S-1 Cabinet is required in only the most difficult TVI installations. If wanted, your new 32V-2 can be delivered in the 49S-1 by your dealer. Or, if you already own a 32V-2, you can order from him a 49S-1 cabinet only, and install it yourself.

For best operation, the 35C-1 filter should feed a properly terminated 52 ohm line. Coupling to a balanced antenna may be accomplished by an antenna tuner or by the Collins 315E-1 Balun Transformer, which is a wide band low loss transmission line for coupling from a 52 ohm unbalanced line to a 300 ohm balanced load without tuning controls. It consists of a transmission line connected to transfer from balanced to unbalanced conditions ("balun") and a step-tapered impedance matching line. Over the frequency range 7 to 30 mc, a standing wave ratio of less than 2 to 1 is possible. The efficiency of the system is good even beyond the specified limits. The 315E-1 is supplied in kit form with coaxial cables completely made up, and aluminum tubing and spacers fabricated ready to assemble.

FOR SUCCESS IN AMATEUR RADIO, IT'S...

COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

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BURBANK

M & W Tower
DALLAS 1

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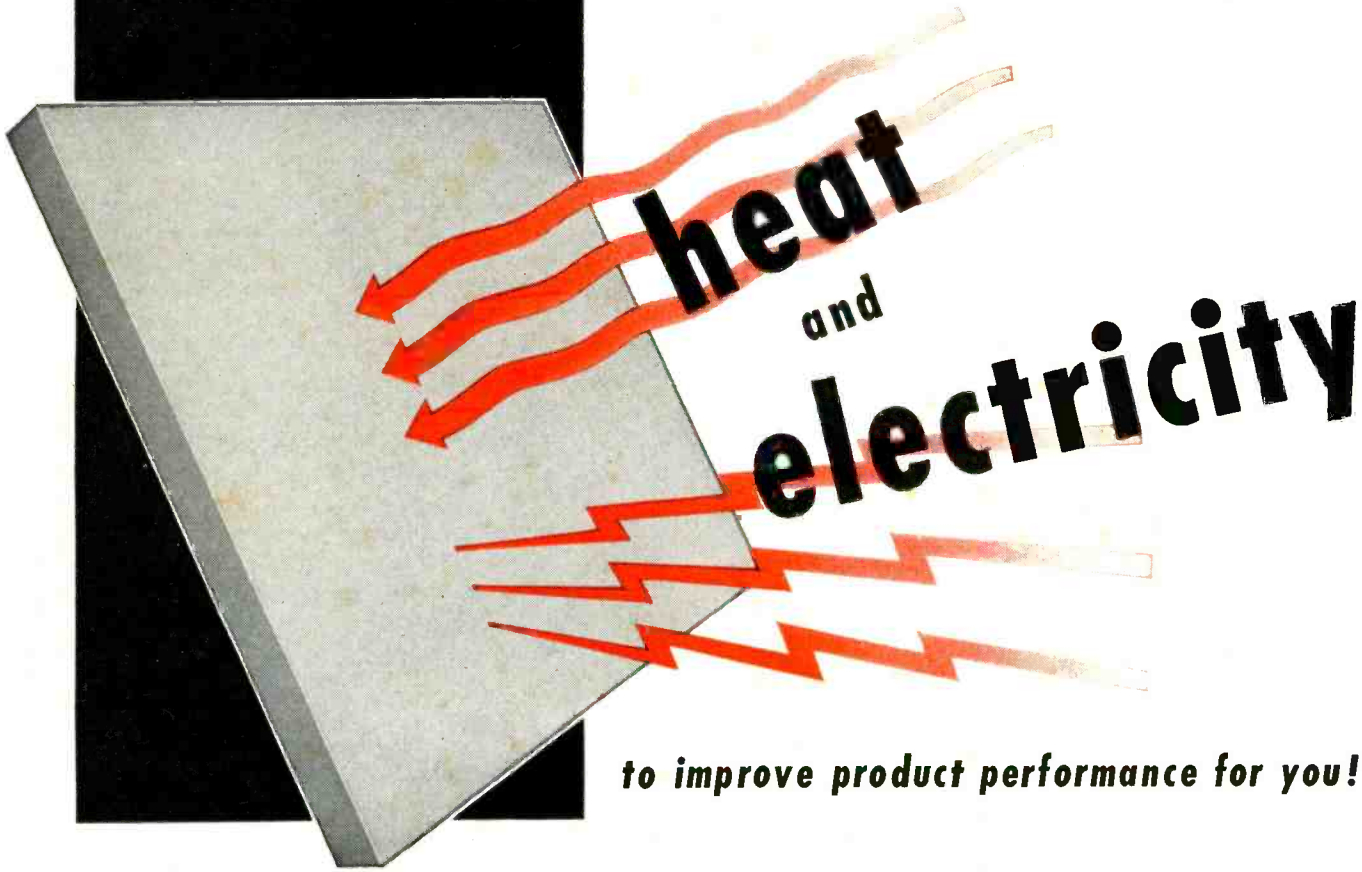
NEW C-D Silicone Dilecto withstands an inferno of heat and electricity



to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

DE-2-49

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PROVEN DEPENDABILITY

Carefully consider the Eimac 4X150A for your applications, in its power category, for service anywhere in the r-f spectrum up to 1000-Mc. The 4X150A's universal acceptance is your assurance of dependable performance.

These extremely compact, forced air-cooled tetrodes are characterized by their high degree of stability at high power-gain and high ratio of transconductance to capacitance.

Emission is derived from a unipotential cathode having a 6 volt heater. Grid structures are permanently positioned in precise alignment for optimum beam action. Special processing of the grid wire eliminates primary and controls secondary grid emission. The forced air-cooled anode is conservatively rated at 150 watts dissipation and is adequately cooled with less than 6 cubic feet of air per minute.

Wide application of the Eimac 4X150A tetrodes as video amplifiers, TV sound amplifiers, FM and TV r-f amplifiers, UHF communications, and in STL and dielectric heating service is firm evidence of their outstanding dependability and performance.

Complete characteristics and operational data are available at no obligation.

FULL RATINGS INTO UHF

•

HIGH POWER-GAIN

•

LOW LEAD INDUCTANCE

•

COMPACT SIZE

•

HIGH TRANSCONDUCTANCE CAPACITANCE RATIO

•

GOOD STABILITY

•

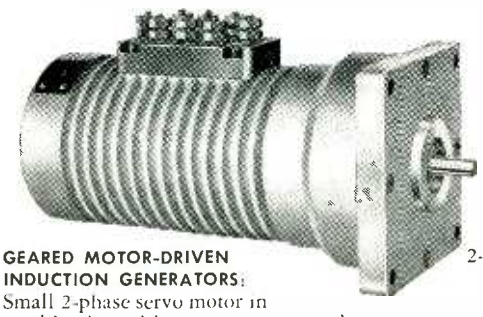
RUGGED ELECTRICALLY AND PHYSICALLY

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

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.

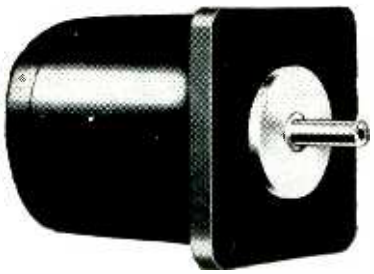
CIRCUTROL UNITS: rotary electro-magnetic devices for use as control components in electronic circuits and related equipment. Single and polyphase rotor and stator windings are available in several frame sizes. Deviation from sine accuracy of resolver shown is ±0.3% of maximum output.

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

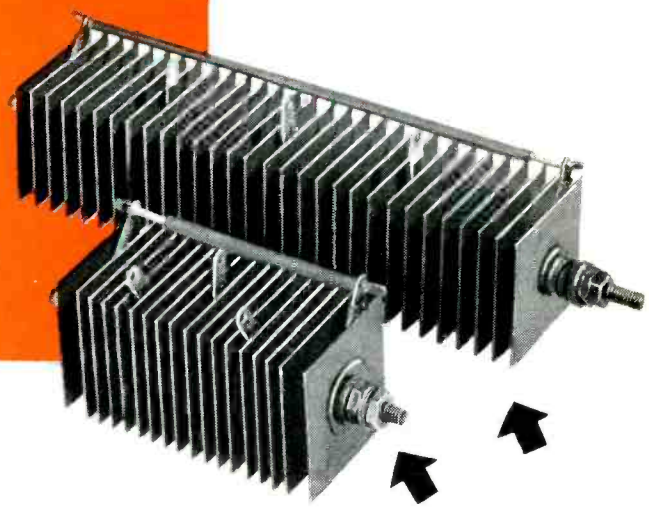
SQUARE D COMPANY

ELMHURST, NEW YORK · GLENDALE, CALIFORNIA

THIS IS NOT NEWS to most designers and engineers. But it is a REMINDER to all!

FEDERAL'S 26-VOLTS RMS PER CELL

High Voltage Selenium Rectifiers



COMPARE! The size of a Federal 26-Volt RMS per cell Selenium Rectifier (front) with an equivalent low voltage type.

Tried and Proved by Industry in hundreds of thousands of installations for MORE THAN 3 YEARS

The Federal 26-Volt Selenium Rectifier was the *first* power stack to operate at such high voltage, the *first* to be accepted by industry, the *first* to prove itself. No other manufacturer can match this record of performance.

Here's what Federal's 26-Volt RMS per cell Selenium Rectifier means to you:

- **LOWER COST**... A smaller rectifier with fewer cells does a better job... at lower first cost and at lower operating cost—in addition to the important reduction in cost of components.
- **HIGHER EFFICIENCY**... Fewer cells per stack mean lower losses.
- **SPACE SAVING**... More design freedom resulting from greatly reduced size of the rectifier unit.
- **GREATER VERSATILITY**... New fields of application are opened through the inherent advantages of lower cost, efficiency and compactness.

Every Federal Selenium Rectifier, for every power conversion requirement, is backed by the engineering and production skill of America's oldest and largest manufacturer of Selenium Rectifiers. Write Federal today for information on your rectifier requirements.

Get the facts on 26-Volt RMS Per Cell Selenium Rectifiers. Send for your free copies of Federal's new 32-page book, "Federal Selenium Rectifiers From Milliwatts to Kilowatts," and Federal's "Packaged Power Data Sheet." Address Department F-713.

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

Federal Telephone and Radio Corporation

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

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

FEDERAL TELEPHONE & RADIO — FTR — AN IT&T ASSOCIATE

The H-2-P

A NEW PURIFYING JET OIL DIFFUSION PUMP,

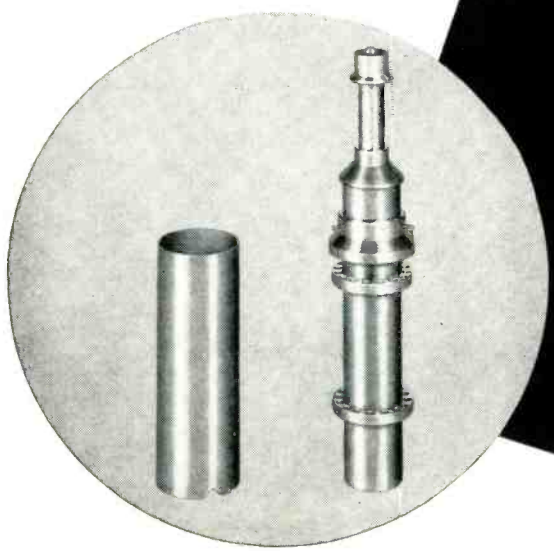
for electronic tubes and general laboratory use.

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

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

High Vacuum mm Hg. is maintained when the pressure is increased to 0.34 *mm Hg.*

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



INDUSTRIAL RESEARCH PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING & EQUIPMENT
Metallurgy — Dehydration — Distillation — Coating — Applied Physics

NATIONAL RESEARCH CORPORATION

SEVENTY MEMORIAL DRIVE CAMBRIDGE, MASSACHUSETTS

In the United Kingdom, BRITISH-AMERICAN RESEARCH, LTD., London S.W. 7, England—Glasgow S.W. 2, Scotland

THE REDSKINS ARE HERE!

SANGAMO'S *NEW* MOLDED PAPER TUBULARS

Sangamo presents the REDSKIN . . . a new molded paper tubular capacitor that gives *long life* under severe operating conditions. The REDSKIN is an 85° C tubular that is easy to work with, on production line or bench, because the flexible leads resist breakage and can't pull out! It offers greater mechanical strength because of its plastic construction. It is molded under *low* pressure, assuring elements undamaged in fabrication, greater dependability, and the absence of "hot spots."

A trial of these new molded tubulars will convince you! See your jobber—if he can't supply you, write us.

Big Chief Sangamo Says:

PLENTY PROUD OF NEW PAPOOSES!
REDSKINS HEAP TOUGH...STAND TESTS
THAT MAKE OTHER BRAVES FLINCH.
REDSKINS LIVE LONG TIME...WORK
HARD...HELP YOU MAKE WAMPUM TOO!

IMMERSION and HUMIDITY RESISTANCE
Test Result: ***EXCELLENT!***
Far surpasses normal specification requirements . . . Insulation resistance practically unchanged under severe conditions of immersion or humidity.

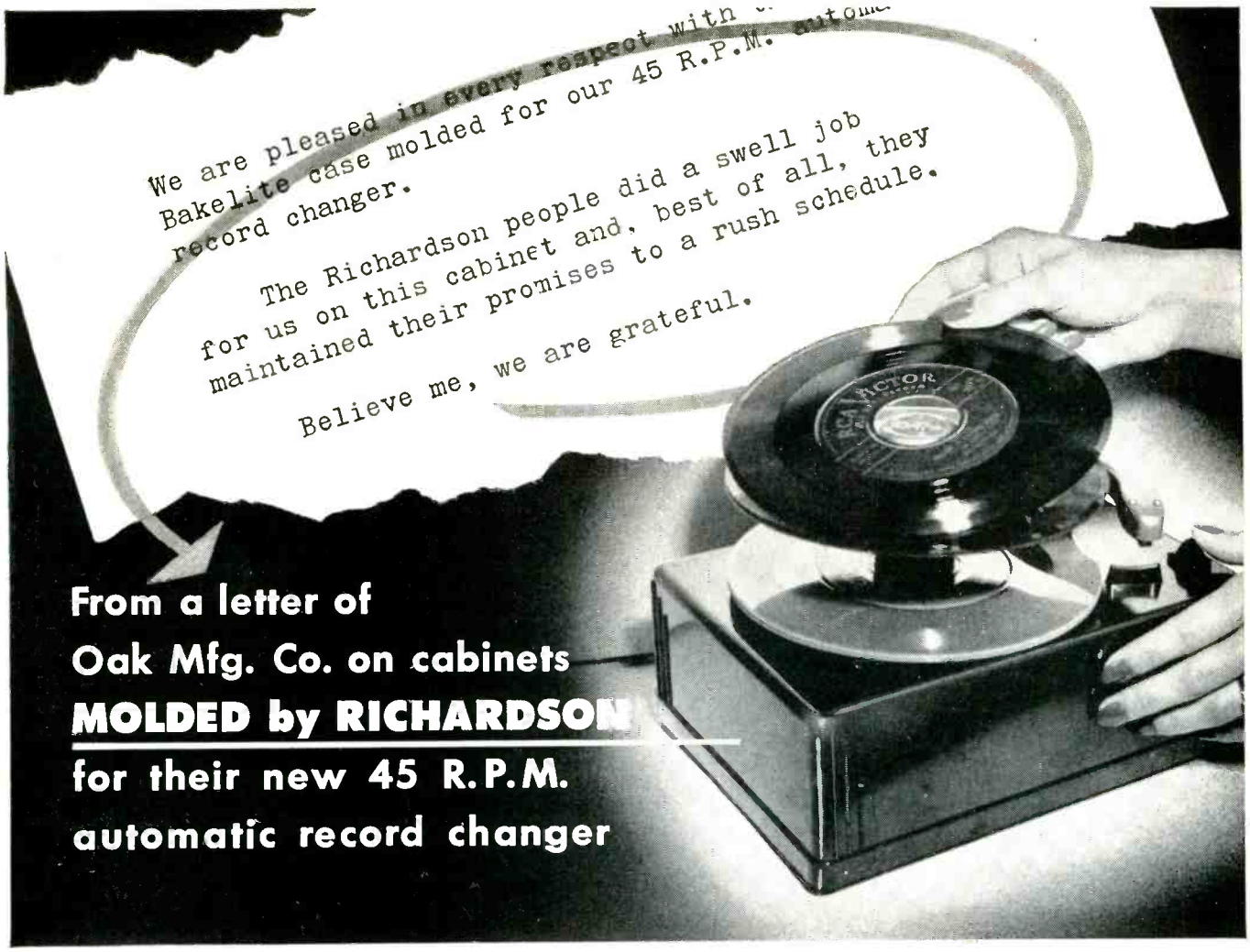
85° C PERFORMANCE
Test Result: ***EXCELLENT!***
Long life operation under high temperature conditions make it a "natural" for applications where high temperatures cause trouble.

MECHANICAL STRENGTH
Test Result: ***EXCELLENT!***
Especially designed flexible leads resist breaking or pulling out even when handling is extremely rough.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS
In Canada: Sangamo Electric Company Limited, Leaside, Ont.

50TH ANNIVERSARY SANGAMO 1899 - 1949

8C4914A



RICHARDSON MOLDING SERVICES

This sturdy record changer cabinet, molded by Richardson for Oak Mfg. Co., is only one of thousands of parts Richardson has molded efficiently, economically and on time for scores of manufacturers.

These cabinets come from the molds with a smooth, attractive finish that makes further finishing operations unnecessary.

Richardson experience in molding plastics produced this cabinet with tapped machine screw holes accurately spaced for quick, easy assembly. Also, Richardson experience pointed the way to produce the job at minimum cost.

Hundreds of manufacturers have found that Richardson's extra experience, extra facilities and extra know-how have paid important dividends. May we discuss with you your next plastic molding job?

INSUROK *by* RICHARDSON
Dependable names in plastics

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

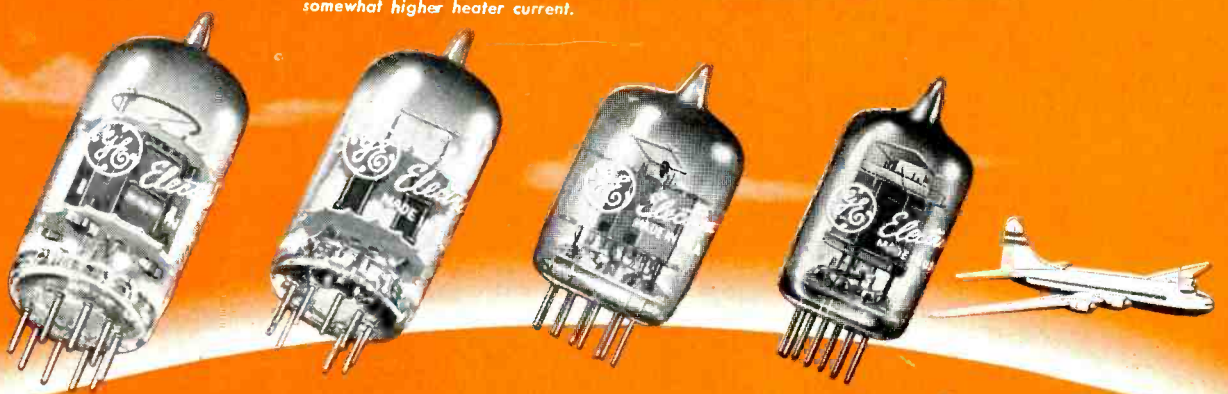
CLEVELAND • DETROIT • INDIANAPOLIS • MILWAUKEE • NEW BRUNSWICK, (N. J.) • NEW YORK • PHILADELPHIA • ROCHESTER • ST. LOUIS

GL-5814
This tube is similar to the 12AU7. Improved heater design with a somewhat higher heater current.

GL-5751
Similar to the 12AX7, except that amplification factor is 70. Improved heater design with somewhat higher heater current.

GL-5670
Similar to the 2C51 except for improved heater design and a somewhat higher heater current.

GL-5654
7-pin miniature high-frequency pentode. Electrically the same as the 6AK5.



Pinpoint-designed for Specific Needs!

GENERAL ELECTRIC CUSTOM MINIATURES ON THE JOB FOR AVIATION— STANDING BY TO WORK FOR YOU!

RELIABILITY is the one big feature common to the four tubes shown here. First of a growing family of General Electric miniatures designed and built to order for specific jobs, these tubes now are at work for commercial airlines in altimeters, radio compasses, radio control equipment, and high-frequency aircraft radio receivers.

Each tube receives 50 hours of operation under Class A conditions. As an added control, samples regularly are selected and subjected to a life test in which the tube is operated normally but intermittently by turning the heaters on and off at one-minute intervals. These unusually exacting tests are made to avoid early life failures, and to assure that tube performance will be in line with ratings consistently.

Aviation is but one of many industries to which G-E Custom Miniatures are adapted, and for which General Electric special design and production facilities are available. Why not use these tubes for superior performance in *your* next design? Wire or write *General Electric Company, Electronics Department, Schenectady 5, New York.*

CHARACTERISTICS

TYPE GL-5814

Heater voltage, a-c or d-c series	12.6 v
Heater current	0.175 amp
or	
Heater voltage, a-c or d-c parallel	6.3 v
Heater current	0.350 amp
Max ratings, design center values, each triode section:	
plate voltage	300 v
plate dissipation	2.75 w
Typical operation, each section:	
plate voltage	250 v
grid-bias voltage	−8.5 v
amplification factor	17
plate resistance	7,700 ohms
transconductance	2,200 micromhos
plate current	10.5 ma

TYPE GL-5751

Heater voltage, a-c or d-c series	12.6 v
Heater current	0.175 amp
or	
Heater voltage, a-c or d-c parallel	6.3 v
Heater current	0.350 amp
Max ratings, design center values, each triode section:	
plate voltage	300 v
grid-bias voltage	never positive
plate dissipation	1.0 w
Typical operation, each section:	
plate voltage	250 v
grid-bias voltage	−3 v
amplification factor	70
plate resistance	58,000 ohms
transconductance	1,200 micromhos
plate current	1.1 ma

TYPE GL-5670

Heater voltage, a-c or d-c	6.3 v
Heater current	0.350 amp
Max ratings, design center values, each triode section:	
plate voltage	300 v
plate dissipation	1.5 w
Typical operation, Class A1:	
plate voltage	150 v
cathode resistor, per section	240 ohms
plate current, per section	8.2 ma
transconductance, per section	5,550 micromhos
amplification factor	35

TYPE GL-5654

Heater voltage, a-c or d-c	6.3 v
Heater current	0.175 amp
Max ratings, design center values:	
plate voltage	180 v
grid No. 2 voltage	140 v
plate dissipation	1.7 w
grid No. 2 dissipation	0.5 w
Typical operation:	
plate voltage	120 v
grid No. 2 voltage	120 v
cathode-bias resistor	200 ohms
plate resistance (approx)	0.34 megohms
transconductance	5,000 micromhos
plate current	7.5 ma
grid No. 2 current	2.5 ma

GENERAL ELECTRIC

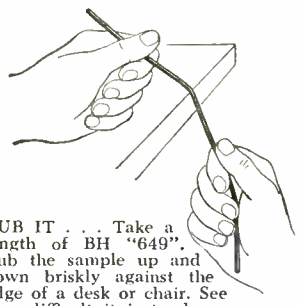
180-H7

FIRST AND GREATEST NAME IN ELECTRONICS

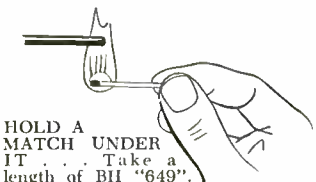
AMAZING BH "649"

. . . cuts insulation costs 2 ways

KNOT IT . . . Take a length of BH "649". Knot it. Pull it as tight as you can. Twist it. Then loosen the knot. There is no cracking. No change in the dielectric strength.



RUB IT . . . Take a length of BH "649". Rub the sample up and down briskly against the edge of a desk or chair. See how difficult it is to damage the coating.



HOLD A MATCH UNDER IT . . . Take a length of BH "649". Hold a lighted match under it. BH "649" will not support combustion.

See how BH "649" cuts insulation costs two ways.

First, it gives you a superior Fiberglas insulation at the price of ordinary cotton-base or rayon-base insulation.

Second, it retains rated dielectric strength even after rough handling, making it possible in many cases to drop one insulation grade and still meet full voltage requirements.

With BH "649" there is little or no loss of dielectric strength in assembly or product use. It stays supple after baking 12 hours at 300°F.

BH "649" is made in Grades A-1, B-1, C-1 and C-2—in all sizes from No. 24 to 5/8" inclusive. Write for production samples.

BENTLEY, HARRIS MANUFACTURING CO., CONSHOHOCKEN, PA.

BH Fiberglas* SLEEVINGS

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

COUPON

Bentley, Harris Mfg. Co., Dept. E-38, Conshohocken, Pa.

I am interested in BH "649" Fiberglas Tubing and Sleeving. Send samples for production testing of Grade_____in sizes as follows_____(size or I.D.) for_____(product) operating at temperatures of_____°F. at_____volts.

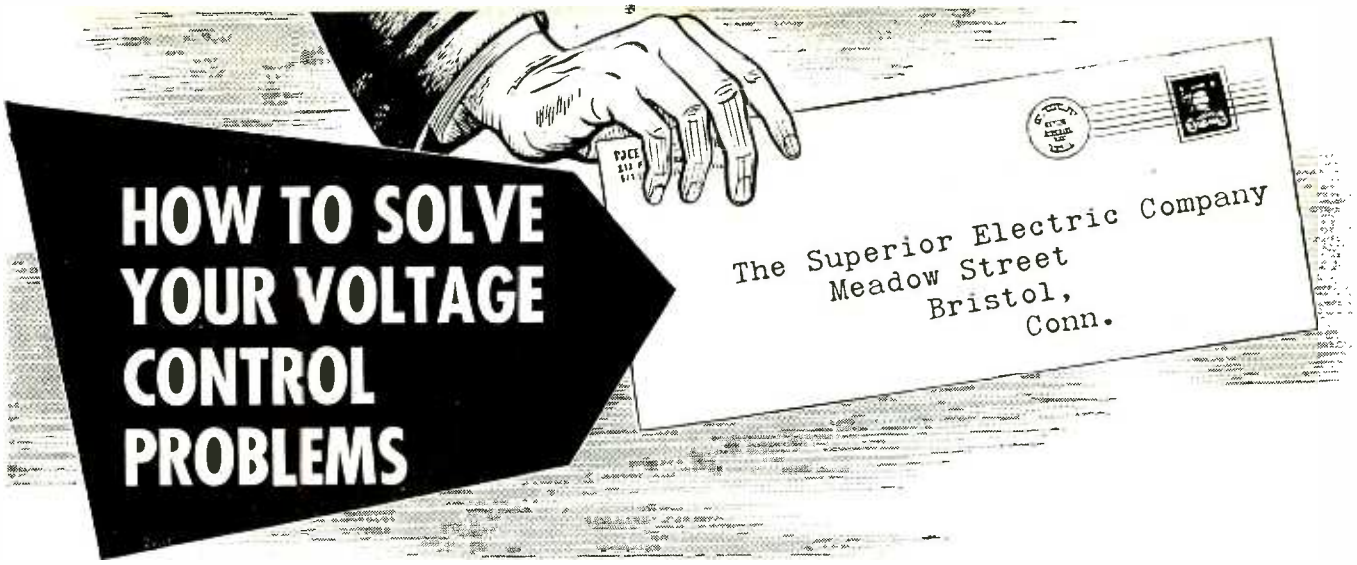
NAME _____

ADDRESS _____

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

☐ BH non-fraying Fiberglas Sleeving

☐ Cotton or Rayon-base Sleeving and Tubing



Every day we help someone solve their voltage control difficulties — someone who has written or called us, given us the details of their problem and asked us to recommend a solution. Because we're known as manufacturers of superior voltage control equipment, engineers rely on our judgment — and on our voltage control equipment. Next time you have a problem, we'll be glad to work with you on it. The following are examples of just a few units which have led to a quick solution for others.

HAND-OPERATED FOR MANUAL CONTROL

These POWERSTAT Variable Transformers give you a variable output voltage from a-c lines. They're suitable for 115, 230, 440 volt, single and polyphase duty, 25, 50/60 or 400/800 cycles; in ratings from 400VA to 75KVA.

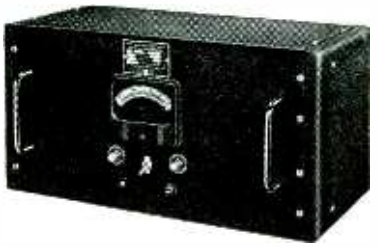
POWERSTAT Line Correctors, below, are best used to hold a varying line to a nominal value, or to vary a constant line voltage over a limited range at large current capacities. Numerous models are offered, in capacities up to 100KVA.

MOTOR-DRIVEN FOR PUSHBUTTON CONTROL

Available in the same wide range of capacities as manually-operated units. Recommended for remote pushbutton or automatic controller operation. Special 3-wire synchronous motor drives the POWERSTAT Variable Transformer. By using appropriate gearing combinations

various speeds of travel from zero to maximum output can be had to suit each need. Motor operates from a 115V single phase source max. current requirement is 0.4A. Rotor shaft is ball-bearing mounted for long, quiet operation. Rapid starting and instantaneous stopping are features.

ELECTROMECHANICAL OR INSTANTANEOUS

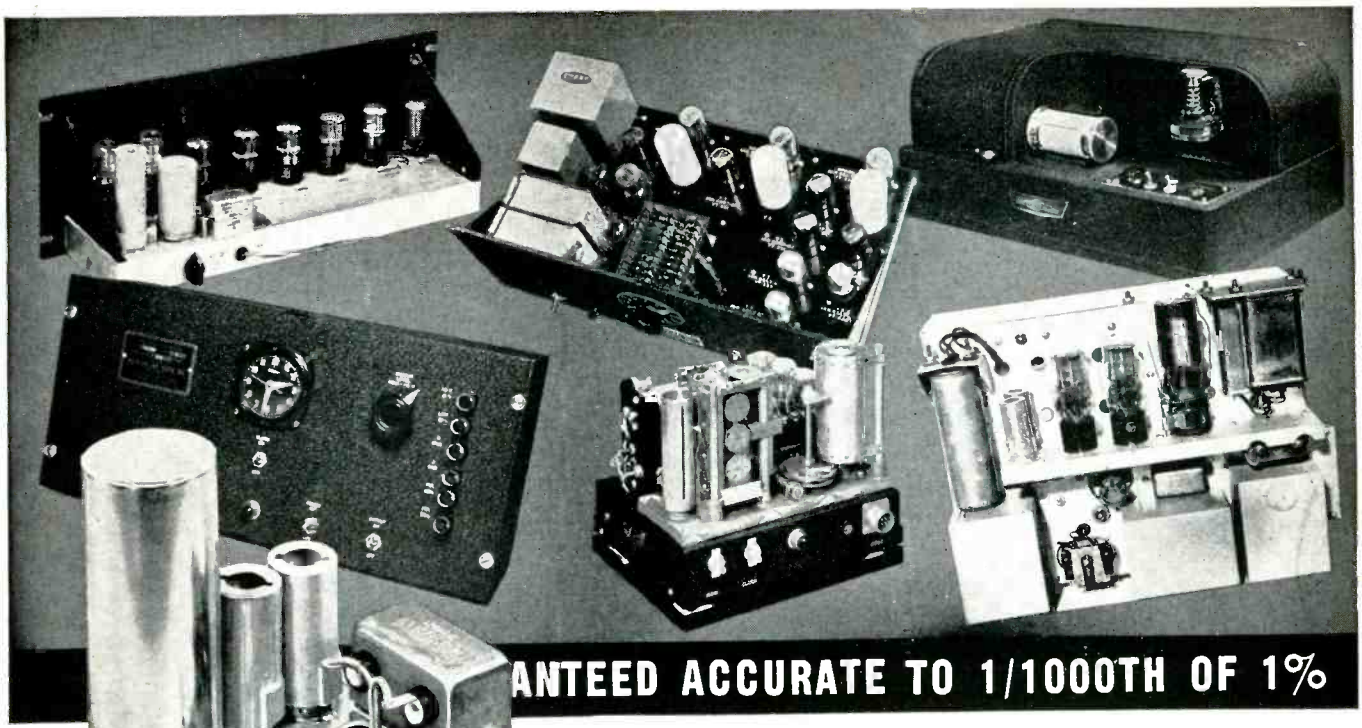


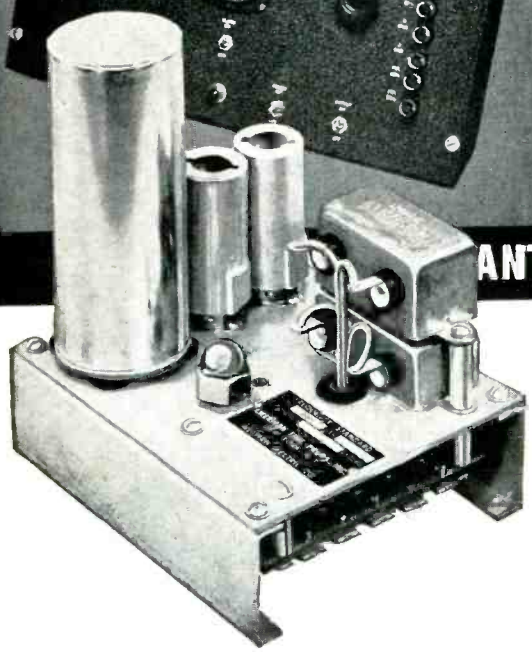
STABILINE Automatic Voltage Regulators maintain a constant output voltage, regardless of variations in input voltage or load current; require no attention for continuous operation. Type EM (Electro-mechanical), above, is recommended where long-term stability for 24-hour line correction is required. Type IE (Instantaneous Electronic), below, performs electronically, instantaneously. Line stabilization is 0.1%; regulation is 0.15%. Waveform distortion *never* exceeds 3%.

WRITE TODAY FOR BULLETIN 547
The Full SECO Line
4129 MEADOW STREET

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

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





Any Frequency from 40 to 10,000 in fractions or otherwise

ELECTRONIC FREQUENCY STANDARDS AND GENERATORS

The basic unit of the frequency standards and generators presented here is an electrically driven tuning fork,—temperature-compensated and hermetically sealed against changes of humidity and barometric pressure. Through its use any frequency or multi-frequencies between 40 and 10,000, fractional or otherwise, are obtainable.

FOR plant operations, for product development, for timing studies, wherever frequency generation or interval measurement is required, these instruments provide accuracy to 1 part in 100,000.

Their reliability and stability have been proven through the years here and abroad in Government Departments, aviation, industry and laboratories where precision is imperative.

The instruments with which the basic frequency standard unit is integrated are adaptable to an infinite number of uses. If you have a precision timing or frequency problem, we will be pleased to suggest a solution.

American Time Products, Inc.

580 Fifth Avenue **New York 19, N. Y.**

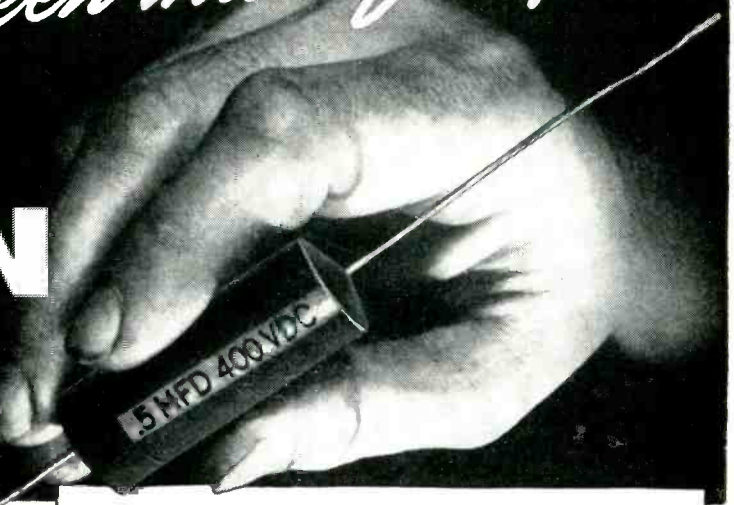
OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

You haven't seen this before!

AEROVOX TYPE '87

AEROCON

SELF-MOLDED PLASTIC TUBULAR



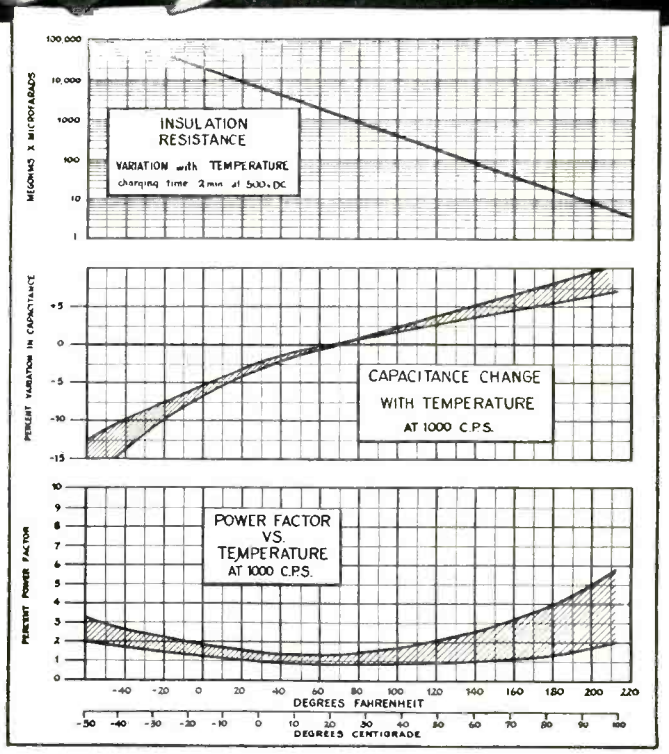
Brand *new!* Looks like a paper tubular yet is *entirely different.* This plastic tubular is *molded in its own paper tube.* That means a tubular approaching the performance of the molded-plastic capacitor yet available at a price closer to the conventional paper tubular.

For example: In a typical TV receiver using some 30 molded-plastic capacitors, the Type '87 Aerocon scores a saving of 50 cents! And without sacrificing top performance!

It's all due to another exclusive Aerovox development—Aerolene—the combination impregnating-sealing material already featured in Aerovox Duranite tubulars in general use.

So here's real *performance insurance* for those TV, auto-radio, oscillograph and other severe-service requirements. And at irresistible price, too.

Samples, ratings, quotations available on request



AEROCON CHECK LIST

- Paper-tube tubular but with ends sealed with rock-hard Duranite.
- Aerolene impregnant eliminates stocking and using of both wax and oil capacitors. One impregnant does work of both.
- Absence of impregnating oils and waxes eliminates dripping or cracking of wax coating which interaction might cause.
- Equal to or even smaller than molded units.
- Heat- and humidity-resistant qualities of the order of the best plastic tubulars.
- Can be used without drips at 212°F.
- Dielectric strength maintained at elevated temperatures. Rated voltages based on 212°F. operation.
- No softening of dip wax to become gummy, tacky, dirty or dark.
- Unimpaired by sub-zero operation. Capacitance increases slightly with temperature rise.
- Extremely high initial insulation resistance. Units recover insulation resistance upon heating.

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th St., New York 16, N. Y.

Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

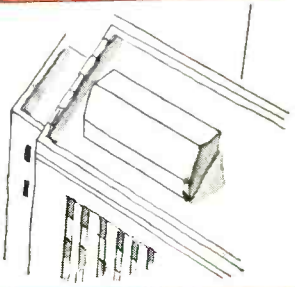
High wire artist praises...

H. I. Walker says, "I no longer get shocked when lightning strikes my high wire. G-E Textolite shoe soles give me complete protection."

GENERAL ELECTRIC
TEXTOLITE* LAMINATED
Plastics
*REG. U. S. PAT. OFF.

● If you haven't as yet used nonmetallic G-E Textolite laminated plastics in your products, you should give it a try. Versatile General Electric Textolite may be your solution to lower costs and product improvement . . . it has excellent electrical properties. Then too, its mechanical, thermal, and chemical characteristics are outstanding.

Although the story about the aerial artist may be a slight exaggeration, it does point up an important fact—G-E Textolite is continually solving difficult problems. Why not fully investigate this proven material. You'll profit. Plastics Division, Chemical Department, General Electric Company, One Plastics Avenue, Pittsfield, Mass.



It's the excellent electrical properties that enable G-E Textolite to perform this insulating feat. If it weren't for General Electric Textolite, high-wire artistry would be mighty uncomfortable . . . even deadly during electrical storms.

G-E TEXTOLITE LAMINATED PLASTICS IS SUPPLIED IN:

LOW-PRESSURE MOLDED PARTS

MOLDED-LAMINATED PARTS

FABRICATED PARTS

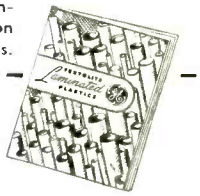
SHEETS, TUBES RODS

GENERAL ELECTRIC

CD49-J3

SEND FOR THIS HELPFUL BULLETIN TODAY— IT'S FREE

Write for your copy of "G-E Textolite Laminated Plastics." It lists grades, properties, fabricating instructions, and detailed information about Textolite industrial laminates.



General Electric Company
Chemical Department (9-12)
One Plastics Ave.,
Pittsfield, Mass.

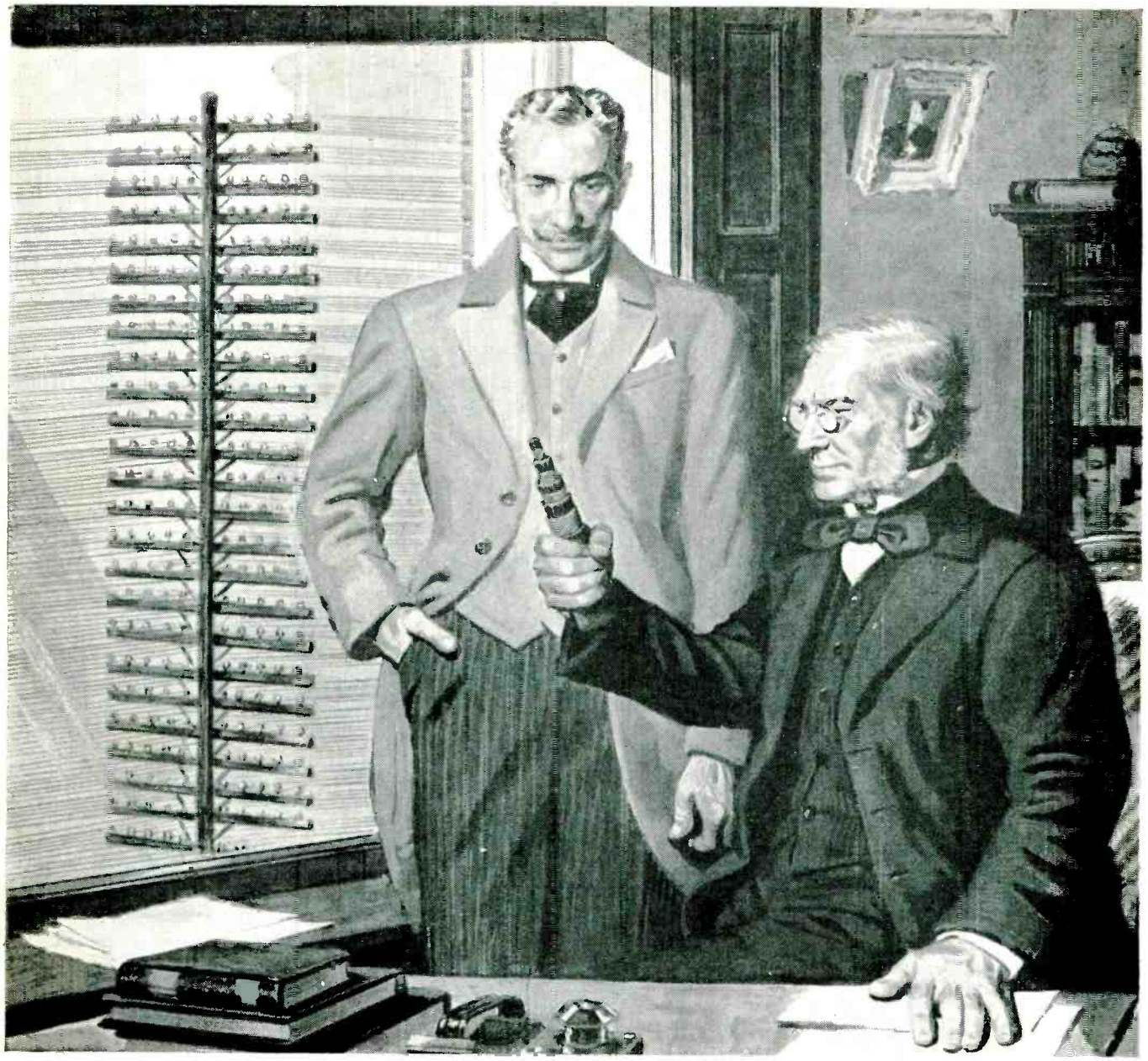
Please send me the new G-E Textolite laminated plastics bulletin

Name .....

Firm .....

Address .....

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



They Packed a Pole Line Into a Pipe

Back in the eighties, telephone executives faced a dilemma. The public demanded more telephone service. But too often, overloaded telephone poles just couldn't carry the extra wires needed, and in cities there was no room for extra poles. Could wires be packed away in cables underground?

Yes, but in those days wires in cables were only fair conductors of voice vibrations, good only for very short distances. Gradually cables were improved; soon every city call could travel underground; by the early 1900's even cities far apart could be linked by cable.

Then Bell scientists went on to devise ways to get more service out of the wires. They evolved carrier systems which transmit 3, 12, or even 15 voices over a pair of long distance wires. A coaxial cable can carry 1800 conversations or six television pictures. This is another product of the centralized research that means still better service for you in the future.

BELL TELEPHONE LABORATORIES *EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE*

YOUR COPY of the MOST COMPLETE CATALOG EVER PRODUCED on Free! Hermetic SEALS

GLASS-METAL HEADERS ★ SINGLE • MULTIPLE ★

SEALED IN by HERMETIC HEADERS

Do you manufacture or utilize relays, filters, transformers, condensers—as a matter of fact, any vital components in which the right kind of Hermetic Seals should be employed to provide maximum protection against every adverse element? Whether in your planning you require standard hermetic seals or unique custom-designed seals, this new brochure should prove to be not only a revelation but a source of inestimable assistance.

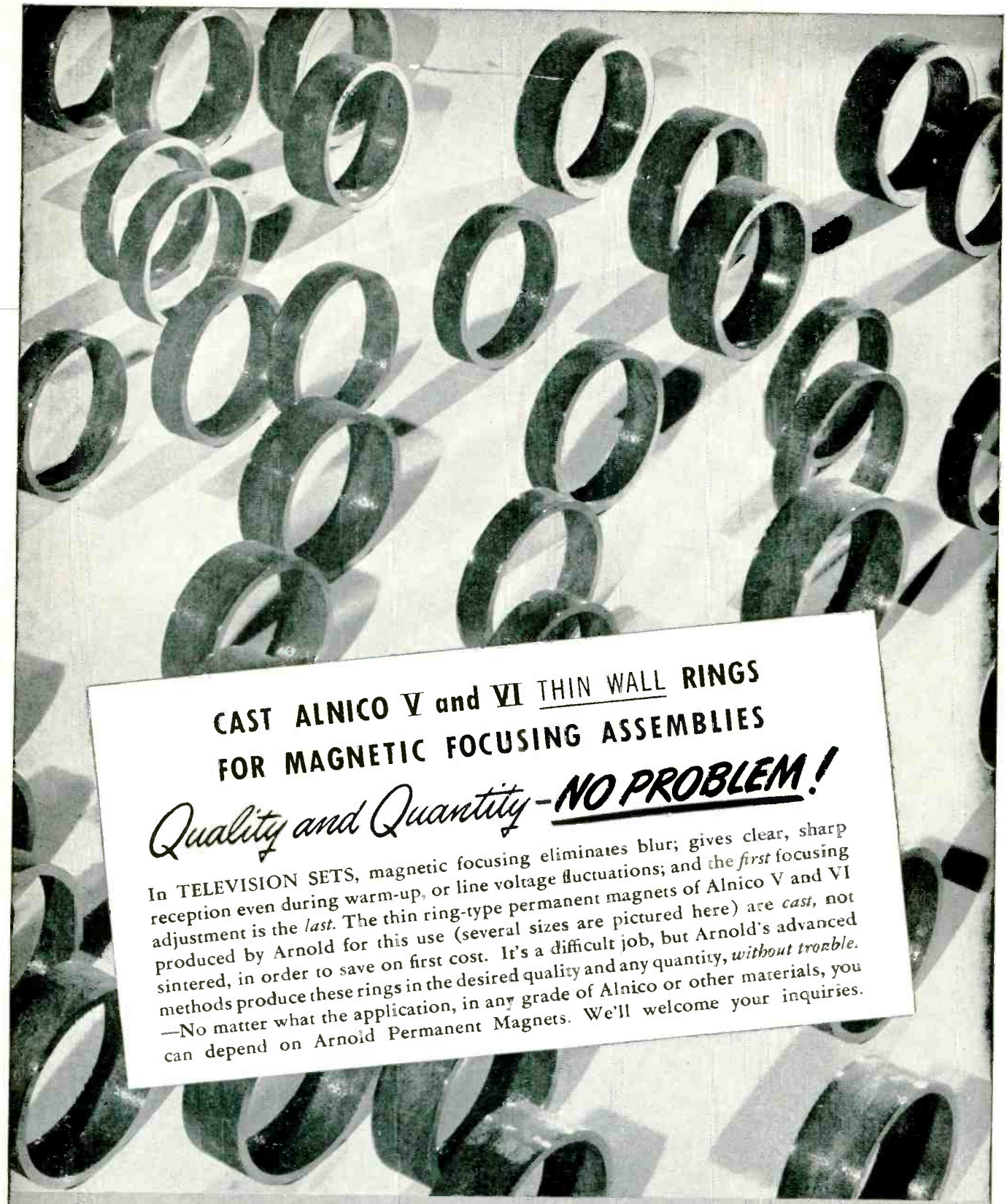
The book is replete with engineering drawings and photographic illustrations. It thoroughly covers our own exclusive multi-terminal headers, polarized plugs, problems in miniaturization, multi-point plugs, high voltage terminals, and it presents additional data that will spark your thinking and undoubtedly give you many new ideas.

Here, in sixteen data-laden pages, is the ultimate achievement in the presentation of factual material on Hermetic Seals—produced by the one organization in the field which has made an outstanding reputation.

Send for your copy of our new catalog today.

HERMETIC SEAL PRODUCTS COMPANY 29-37 South 6th St., Newark 7, N. J.

The Header Seal Guaranteed Impervious to Every Element!



CAST ALNICO V and VI THIN WALL RINGS FOR MAGNETIC FOCUSING ASSEMBLIES

Quality and Quantity — **NO PROBLEM!**

In TELEVISION SETS, magnetic focusing eliminates blur; gives clear, sharp reception even during warm-up, or line voltage fluctuations; and the *first* focusing adjustment is the *last*. The thin ring-type permanent magnets of Alnico V and VI produced by Arnold for this use (several sizes are pictured here) are *cast*, not sintered, in order to save on first cost. It's a difficult job, but Arnold's advanced methods produce these rings in the desired quality and any quantity, *without trouble.* —No matter what the application, in any grade of Alnico or other materials, you can depend on Arnold Permanent Magnets. We'll welcome your inquiries.

THE ARNOLD ENGINEERING COMPANY

Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

C-D CAPACITORS MAY *LOOK* LIKE OTHERS, BUT...

SUPERFICIALLY, they may LOOK alike. But men like yourself don't judge performance by looks. You want to know how well they're *made*. And, equally important, *who* makes them.

The Cornell-Dubilier name on a capacitor does *more* than identify the product's maker. It identifies the capacitor as a product of 40 years' *specialized* capacitor experience, and a product which is *world famous*.

You are safe in joining the leading engineers who specify C-D.

C-D PAPER CAPACITORS

Typical of the line of C-D capacitors is the complete listing of capacitors made in accordance with joint Army and Navy specification JAN-C-25. These are completely covered in Cornell-Dubilier catalog #400 which is now available.

Cornell-Dubilier engineers will welcome the opportunity of assisting you with your capacitor problems.

Cornell-Dubilier Electric Corporation, Dept. KL-9 South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, Rhode Island; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

1910 1949
Reg. U. S. Pat. Off.

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

C-D Best by Field Test!

RAYTHEON **AM–FM & TV**

TRANSMITTERS

are equipped with

Adlake Relays

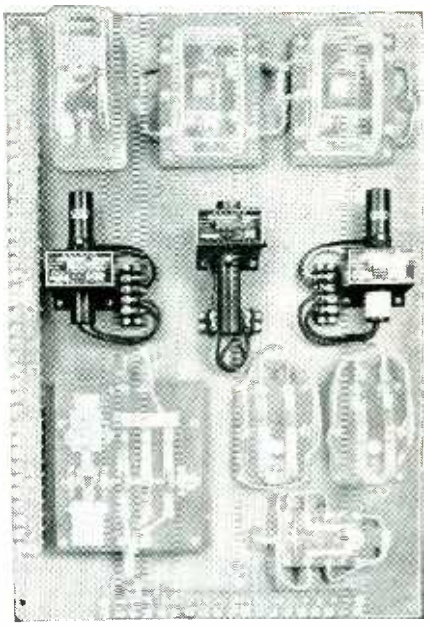
RAYTHEON Manufacturing Company's AM, FM and TV transmitters, including the famous "RF-3" 3-KW FM, "RA-5" 5-KW AM and the new "RTV-500" 500 watt TV and "RTV-5" 5000 watt TV equipment, employ Adlake Relays for CONTROL.

Silent and chatterless, Adlake Mercury Plunger Type Relays are an integral part of these streamlined transmitters which produce high fidelity modulation with a low noise level.

Besides silent operation, Adlake Relays bring these advantages to *any* job where relays are used:

- **Hermetically sealed contact mechanism is impervious to dust, dirt and moisture.**
- **Liquid mercury-to-mercury contact prevents burning, pitting and sticking.**
- **Adlake design armors relays against outside vibration or impact; they are usable on either stationary or fixed equipment.**

Whatever your relay needs are, there's an Adlake Relay to do the job. You'll like our free, illustrated folder giving full details. Write for it today to: The Adams & Westlake Company, 1107 N. Michigan, ELKHART, Indiana.



(Above) Relay panel in Raytheon's RF-3A 3-KW FM AMPLIFIER (shown below)

THE

Adams & Westlake

COMPANY

Est. 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

These Stackpole Specialties

SIMPLIFY DESIGN *and* CONSTRUCTION

TINY "GA" CAPACITORS

...that cost no more than "gimmicks"

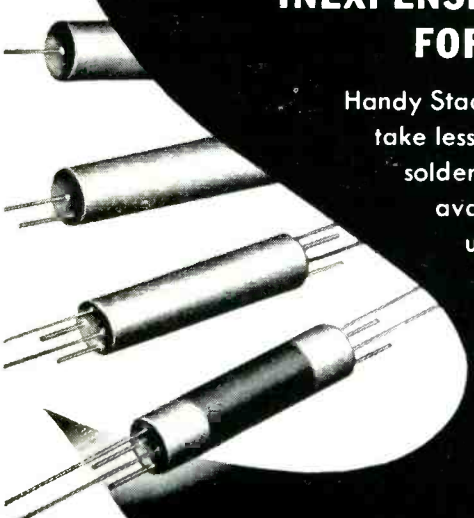
These sturdy little capacitors cost no more than flimsy, twisted wire "gimmicks," are non-inductive and assure greater stability, higher Q, better insulation resistance and higher breakdown voltage. Standard capacities include .5—.68—1.0—1.5—2.2—3.3 and 4.7mmfd. types.

WRITE FOR CATALOG RC7

Stackpole fixed and variable resistors—Iron cores for practically any need—Inexpensive line and slide switches.

INEXPENSIVE SUPPORTS FOR WINDINGS

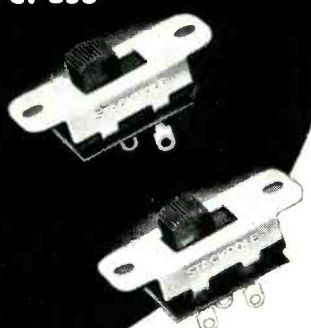
Handy Stackpole molded Bakelite coil forms take less space and require one-third fewer soldered connections. Standard forms are available for universal, solenoid, tapped universal and multiple windings. Molded iron center sections can also be provided.



DEPENDABLE, LOW COST SLIDE SWITCHES

for 3 ampere, 125V. A. C. use

The new Stackpole Type SS-26 Switch is just the thing for electrical appliances and equipment of all sorts! Construction is exceptionally durable and the switches are readily adaptable to various mounting arrangements. Underwriters approved and conservatively rated for 3 amperes at 125 volts A.C. (or 1 ampere at 125 volts D.C.). Single-pole single-throw and single-pole double-throw types available.



The Stackpole Minute Man—your assurance of prompt, dependable service

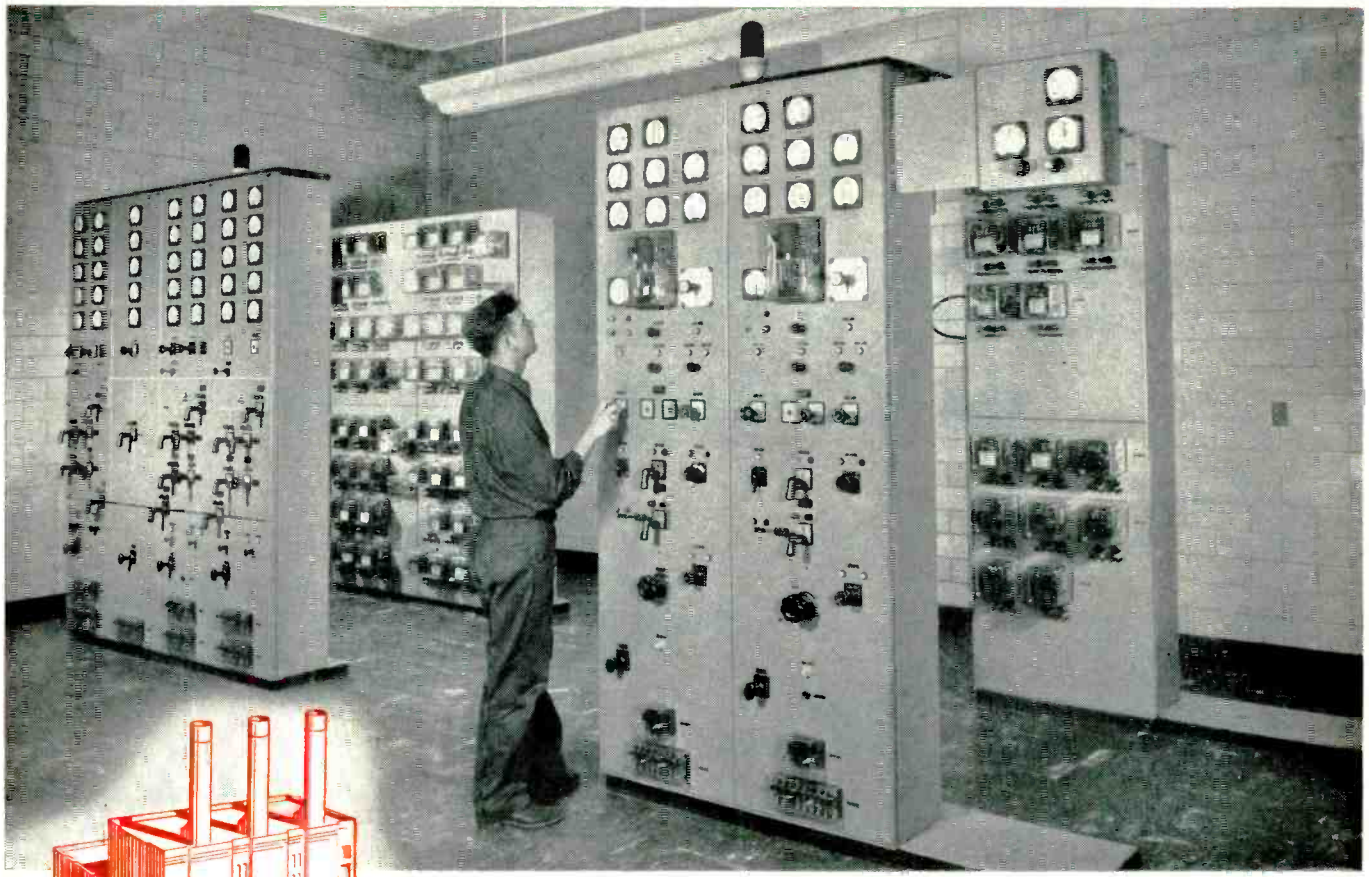
STACKPOLE

Electronic Components Division

STACKPOLE CARBON COMPANY • ST. MARYS, PENNA.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



Instruments "Check-Rein" 240,000 Horsepower!

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

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

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

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

Westinghouse
INSTRUMENTS

Beat the Heat

specify

"NOFLAME-COR"

the TELEVISION hookup wire

APPROVED BY UNDERWRITERS LABORATORIES AT

90° CENTIGRADE —— **600** VOLTS

by

Preferred more and more by particular manufacturers of television, F-M, quality radio and all exacting electronic equipment. Available in all sizes, solid and stranded; over 200 color combinations.

PRODUCTION ENGINEERS: Specify "NOFLAME-COR" for maximum output and minimum rejects. This is not an extruded plastic and therefore losses from "blobbing" under heat of soldering iron are avoided.

✓ Flame Resistant ✓ High Insulation Resistance ✓ Heat Resistant
✓ High Dielectric ✓ Facilitates Positive Soldering ✓ Easy Stripping

✓ Also unaffected by the heat of impregnation— therefore, ideal for coil and transformer leads

RUBBER	75°
PLASTIC	80°
"NOFLAME-COR"	90°

"made by engineers for engineers"

CORNISH WIRE COMPANY, Inc.

605 North Michigan Avenue, Chicago 11 — 15 Park Row, New York 7, N. Y. — 1237 Public Ledger Bldg., Philadelphia 6

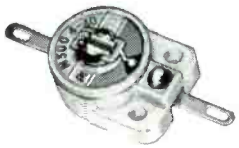
MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

Type 557 Ceramicon Trimmer

1.5-7 MMF
3-12 MMF
5-25 MMF
5-30 MMF
8-50 MMF

Type 554 Ceramicon Trimmer

Type 531 and 532 Tubular Trimmers
0.5-5 MMF
1-8 MMF



Type TS2A Ceramicon Trimmer
1.5-7 MMF 3-13 MMF 4-30 MMF
3-12 MMF 5-20 MMF 7-45 MMF

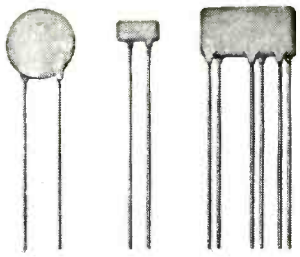
ERIE RESISTOR COMPONENTS

for better electronic products

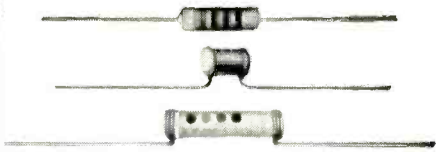
THE dependability and accuracy to close tolerances required for Television and Broadcast applications are combined in Erie Ceramicons with compact design, tubular in form, for easy installation on the assembly line.

Erie manufactures a complete line of Ceramic and Button Mica Condensers for transmitter and receiver applications: Carbon Suppressors, Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates and Coil Forms. Complete technical information on request.

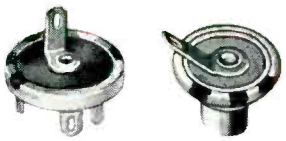
*Ceramicon, HiK, GP, Button and Plexicon are registered trade names of Erie Resistor Corporation.



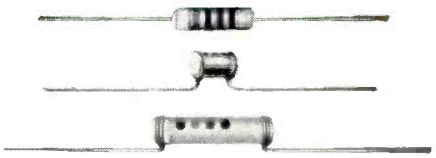
Erie Disc Ceramicons
Up to .01 MFD



Temperature Compensating Molded Insulated Ceramicons*
0.5 MMF—550 MMF
Temperature Compensating Dipped Insulated Ceramicons
0.5 MMF—1,770 MMF
Temperature Compensating Non-Insulated Ceramicons
0.5 MMF—1,770 MMF



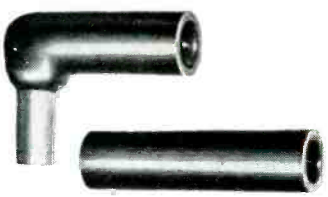
Button* Mica Condensers
15 MMF—6,000 MMF



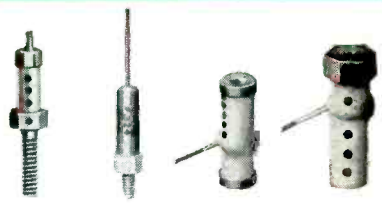
Erie "GP"* Molded Insulated Ceramicons
5 MMF—5,000 MMF
Erie "GP" Dipped Insulated Ceramicons
5 MMF—10,000 MMF
Erie "GP" Non-Insulated Ceramicons
5 MMF—10,000 MMF

Cinch-Erie Plexicon* Tube Sockets with 1,000 MMF built in by-pass condensers

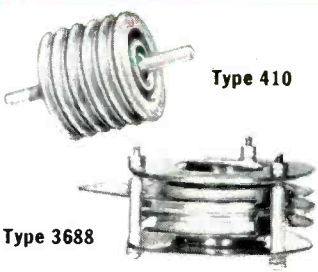
Feed-Thru Ceramicons
5 MMF—1,000 MMF
5 MMF—1,500 MMF



Types L-4, L-7, S-5 Suppressors for Spark Plugs and Distributors



Erie Stand-Off Ceramicons
5 MMF—5,000 MMF



High Voltage Double Cup and plate Condensers
Up to 15,000 VOLTS WORKING

Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates, Coilforms, etc.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND TORONTO, CANADA

It PAYS to work with an MB Vibration Exciter

You can save time, eliminate tedious calculations, and improve your product with the help of an MB electromagnetic shaker. Note how these benefits add up in the following typical applications – just three of many uses for this quality-control and research "tool."

MODEL SA VIBRATION EXCITER Delivers 5 pounds force from 20 to 1,000 c.p.s., usable to 20,000 c.p.s.

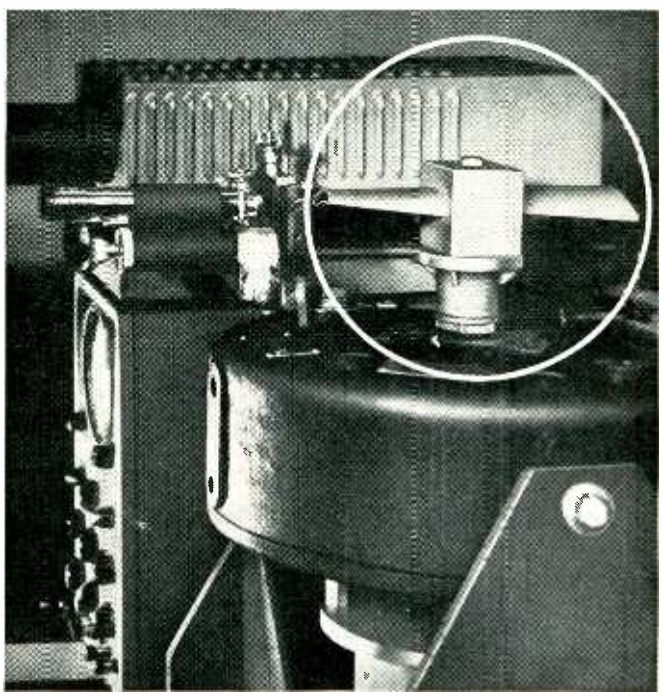
INDEFATIGABLE FATIGUE TESTER – Here is the endurance tester to show up *quickly* those faults which often result in failures under dynamic stresses. Why risk trouble reports? You can shake such parts as axles, brackets, complete assemblies, housings, castings and make improvements *before* full scale production – *before* the remedy becomes costly.

NOISE LOCATER – Operating silently, the MB Exciter reveals sources of noise in equipment of all types. Because you can "scan" a product's operating frequency range, you can put your finger right on resonant trouble areas. Less noise means more customer satisfaction.

SHAKE OUT THE "BUGS" – Electrical and sensitive components can be checked for ability to withstand severe vibratory service conditions. Reproduce the effect of years of vibration on your product within *hours!*

You'll find MB Vibration Exciters at work for many leading companies recognized for the quality of their engineering. Would you like to know how to apply one to your *own* problems? An MB engineer will be glad to show you—without obligation.

MODEL S3 VIBRATION EXCITER Delivers controlled force up to 200 pounds, in frequency range of 3 to 500 c.p.s.



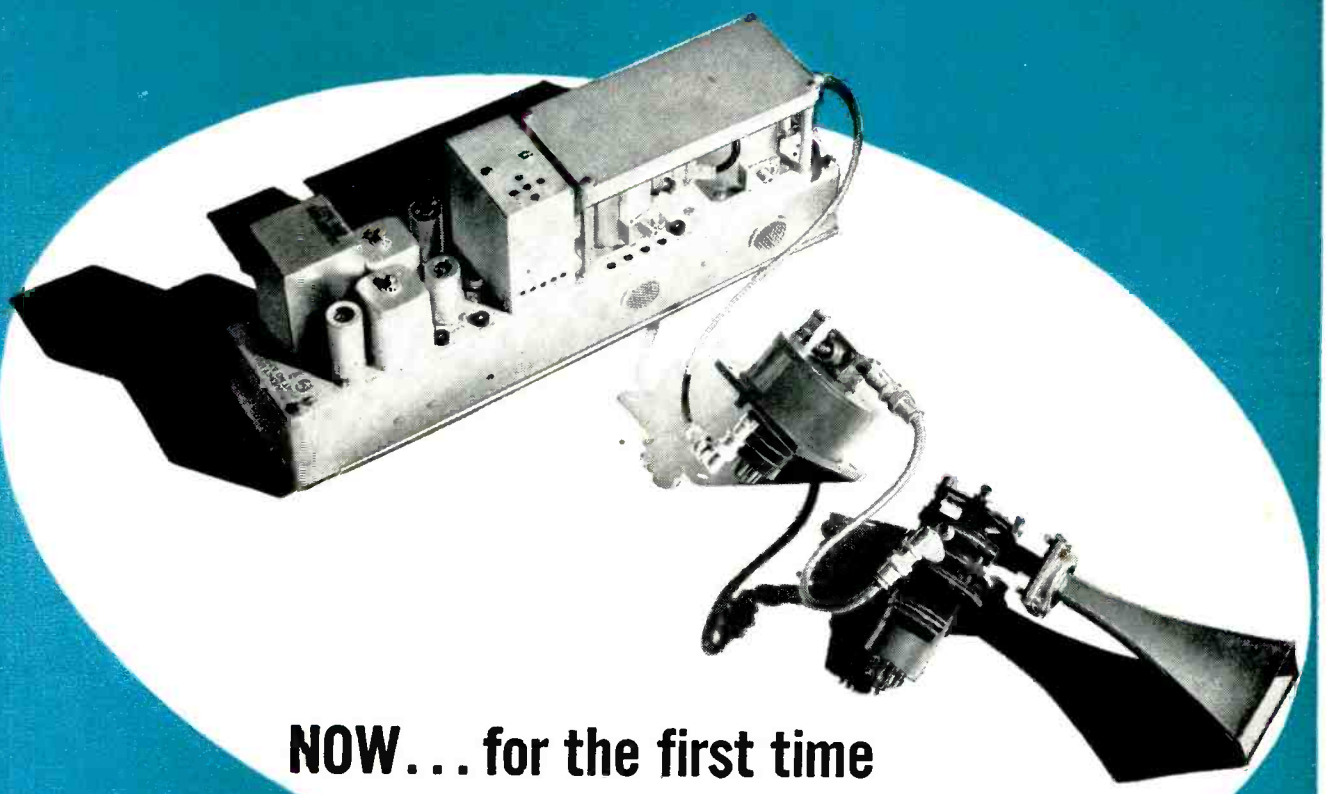
Testing of small turbine blades (encircled) mounted on an MB Model C-1 Exciter which delivers 25 pounds force in range of 4 to 500 c.p.s. (and higher). Using stroboscopic lighting, resonances and deflections are studied *visually* — and any need for corrections determined quickly. A stronger, stiffer blade is sure to result.

DO YOU HAVE OUR NEW BULLETIN ON FILE?

It contains helpful design data on vibration control, plus more information on the line of MB Exciters. Write for your copy today. Ask for bulletin No. 410-G5.

THE MB MANUFACTURING COMPANY, Inc.

1060 State St., New Haven 11, Conn.



NOW... for the first time

SUBSTANTIAL POWER

At Microwave Frequencies with Direct Crystal Control

Now, with two new Sperry Klystron tubes, stabilized frequency control is possible at 10,000 mc. with 1 watt continuous wave power output. These multiplier tubes, the SMC-11 and the SMX-32, permit direct crystal control at microwave frequencies with this power level.

Starting with a 5 mc. crystal, the frequency is multiplied to 830 mc. by use of an *Exciter*. The SMC-11 Klystron multiplies the 830 mc. to a frequency of 5,000 mc. The SMX-32 then multiplies this frequency to 10,000 mc. with the same accuracy which exists in the control crystal (±0.0005%).

This practical achievement of 1 watt power output with continuous accuracy of frequency control at 10,000 mc. exists only through the use of these two Sperry Klystrons.

Write our Industrial Department for further information.

SPERRY

GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

NEW YORK • CLEVELAND • NEW ORLEANS
LOS ANGELES • SAN FRANCISCO • SEATTLE

BUSINESS BRIEFS

By W. W. MacDONALD

Tube Life continues to be the subject of many letters we receive from users of industrial electronic equipment. They are not nearly so concerned about mere extension of life as some manufacturers think. Rather, they want tubes that *can be depended upon to last some specific length of time, whatever that time may be.* Many are willing and, in fact, anxious to replace tubes before they fail.

This very fine distinction may very well be the key to better industrial tube business. Given careful thought by engineers, sales and advertising people, it could lead to different designs, guarantees and promotion. Meanwhile, designers of industrial electronic equipment are using every means of meeting market requirements halfway. At least one is designing new equipment in which tubes are deliberately used in parallel, so that if a tube fails the machine will keep working until a maintenance man comes along and makes a replacement.

NEC Predictions, based upon personal observation and conversation around Chicago's Edgewater Beach Hotel, are laid on the line as follows:

(1) There will be more papers about industrial electronics in next year's program, and sessions devoted to industrial electronics will be more prominently placed in the program.

(2) There will be fewer exhibitors, but they will cover a wider variety of electronic equipment than they did at this year's show.

So Far As We Know, the FCC has to date granted type approval on just two citizens-band radio units designed for commercial sale. One meets class-A requirements and the other class-B. Both were engineered by one company, but this company has recently been acquired by and become a department of another firm.

Neither unit is available in the open market at this writing but we are told that production plans are well along. The class-A unit turns out three watts of r-f, has a superhet receiver, incorporates crystal switching, is adaptable to fixed-station or mobile use. The class-B unit turns out 3/10 watt, employs a superregen receiver, incorporates a switch which permits either class-A or class-B signals to be received.

One other company is rumored to be about ready to apply for type approval but we have not, so far, been able to verify the rumor.

Taxi Radio Figures, supplied by George E. Sterling of the FCC, are very impressive. There are, he says. . . .

Over 80,000 taxicabs in the United States.

Two thirds of these have been authorized to use two-way equipment (2,700 systems, 55,000 cabs).

The total investment is nearing $30,000,000.

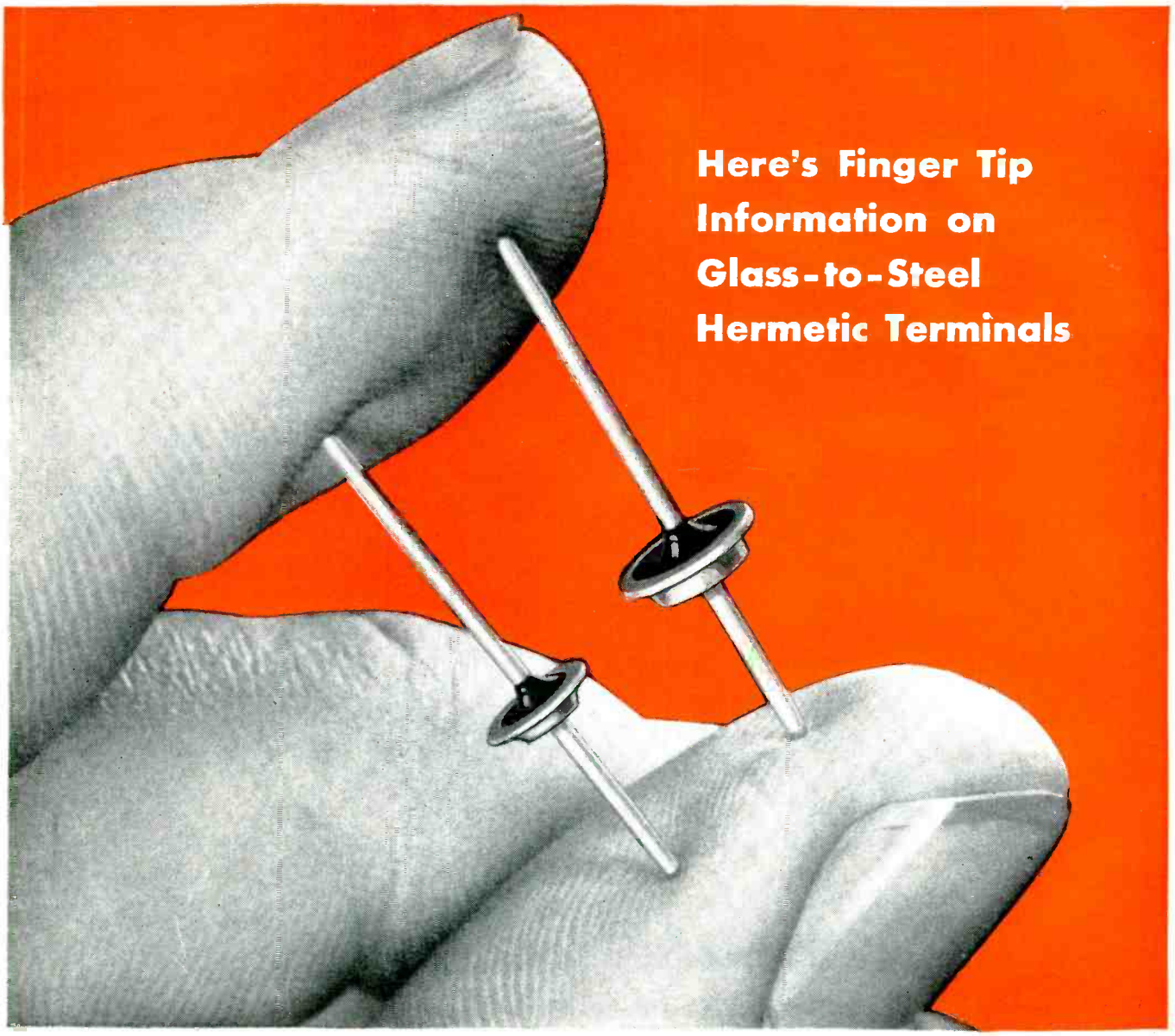
More than 90 percent of all cabs should be equipped with radio in from three to five years.

There are already more radio-equipped taxis than radio-equipped police cars.

Printed Circuit Techniques have until now stubbed their toe on most curved and rounded surfaces. Use of the decalcomania principle may solve this problem. In effect, you print the circuit flat and then transfer it to the rounded surface. The National Bureau of Standards is working on it.

Incidentally the Bureau tells us that one of the major problems in the miniaturization program, particularly where potting compounds or plastics are used, is developing component parts that will withstand temperatures as high as 175 centigrade.

Fish, it seems, can be caused to wiggle their tails against their will and thus propel themselves into traps. This, at any rate, is



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

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

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

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

INSULATE ELECTRICALLY
GLASS TO METAL
FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

THE FUSITE CORPORATION

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

the basis of a German invention involving a positive electrode, a negative electrode and a periodically varying potential.

SMPE Board will decide by December 15 whether or not to change the Society's 33-year old name to embrace television as well as motion-picture engineers. Predicted in *Business Briefs* (June 1949), the move hinges upon replies to a questionnaire just mailed to the organization's 3,000 members.

TV C-R Tube Sales totalled 777,054 valued at $23,123,698 in the second quarter of 1949, as against 686,620 valued at $21,971,869 in the first quarter, according to RMA.

Breakdown of the second quarter figures indicates that set manufacturers took 730,148, dealers and distributors 42,299, export 4,577 and the Government 30.

Saucepans are being used as the chassis of radio sets now made in South Africa for the natives of Northern Rhodesia. It just happens that a saucepan plant is next door to the radio plant. The sets, incidentally, are all blue in color. That, it seems, is the only color about which the natives are not superstitious.

TV Transformer Makers, and manufacturers of other television receiver components, experienced a sudden, welcome, but temporarily embarrassing rush of orders last month. Dealer price cutting apparently scared set makers off production schedules during the summer, and they let the pipelines dry up.

Abercrombie & Fitch has been one of the Nuclear Instrument & Chemical Corporation's best retail outlets for $50 portable Geiger counters designed for uranium prospectors. Macy's heard about it and ordered some, didn't do so well.

Experimental Parachutes are now equipped with radio telemetering apparatus that signals characteristics of their performance to the ground. This should

further reduce the number of instances in which men who jump demand a new chute when the old one fails to open.

Frequency Calibrations over the range from 10 kilocycles to 300 megacycles have for some time been available from the National Bureau of Standards. We understand the high-frequency limit will be extended to 10,000 megacycles within a year and that a further extension to 40,000 megacycles is planned as soon as tubes and components are available.

X-Ray Equipment represents one of the oldest applications of electronics. It is so old, in fact, that many engineers in our field are inclined to forget it, and just the other day we had a potential author ask as if *we* were interested. The answer is definitely yes, particularly from an equipment design standpoint.

Once Again we have shifted our eye from things strictly editorial to the ads in one of our own recent issues. We learned, among other things, that. . . .

Better permanent-magnet materials, and better magnetic-core materials, are out of the lab and into the market.

An English company is attempting to sell r-f attenuators by the dozen, like rolls.

An induction-soldering unit originally developed by a manufacturer for his own production use is now being offered for sale.

A fat melter can also be used to melt insulating waxes and other compounds.

"Yoke Spitting" has to do with c-r tubes; "Tuffernell" is actually the trade-name of an insulating material; a "Thyrode" is a tube and not a gland; one of our advertisers ("Multum in Parvo") understands Latin.

Such are the things that catch even our jaundiced editorial eye.

To Billy Rose we are indebted for the following phrase, which might apply to the current economic situation: *"Things being what they are, if a man can break even he should consider himself a howling success."*

In Refrigerators, too

MALLORY SILVER CONTACTS

Play a vital role in that "taken-for-granted" service

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CROSS TALK

► **PHOTICON** . . . Dr. V. K. Zworykin of RCA announced last month a new type of television camera tube, the photicon, which equals the human eye in sensitivity to light. This marks the latest milestone on the steady march of improvement in the iconoscope family.

It was news, not many years ago, that the image orthicon had surpassed the sensitivity of the fastest photographic film. But the eye remained the most sensitive continuously-registering photo-optical device known.

The photicon uses no electron multipliers, is less than an inch in diameter and about six inches long.

More later.

► **ANTI-REDUNDANT** . . . Two events of importance occurred in the communications world last month. One was the paper presented by Professor J. B. Wiesner at the National Electronics Conference, which described the MIT Autocorrelator. The other was the demonstration before the FCC of a color television system using synchronized time-multiplex transmission. Both are auguries of great new things to come, practical embodiments of raw theory. Some thirty years elapsed between Maxwell and Hertz. Today things move apace. It is less than five years between Wiener and Shannon, the theoreticians, and Wiesner, Kell and their colleagues, who built the above-mentioned apparatus.

Wiener and Shannon pointed out, independently, that the information carried by a communications system must be measured by the degree to which the message cannot be predicted at the receiving end. Parts of a message known with certainty before its receipt are not information; they simply waste energy and spectrum space. Moral: if we wish to make communications systems more efficient we must recognize and weed out the redundant parts of messages, concentrate on the unpredictable elements. Several dozen savants have probed into this concept and have verified its remarkable implication that information can be crowded into a channel without limit, provided noise is rigorously excluded.

The picture on this page shows a device designed to examine the signal waveform of a communications system and to reveal the predictable (repetitious and redundant) portions of it. The autocorrelator is limited in its range of application at present. But we venture to predict that the progeny of this machine will find use in a hundred fields, probing everything from the theory of games to the treatment of anxiety states, from television systems to the indexing of libraries. (It may even put editors out of jobs by putting order into repetitious and redundant manuscripts!)

In this issue of ELECTRONICS, p 69, is described the time-multiplex color-tv system, an example of a technique which eliminates redundant information. A single sinewave is made to carry information on three interspersed color signals. We were taught that a single sinewave can carry just one signal. But that was before Wiener. The color-tv system throws away the redundant data about the sequence of selecting the colors and their timing. This data is reinserted at the receiver through the agency of the synchronizing pulses, pulses provided for a purpose quite apart from painting the colors of the scene.

The MIT Autocorrelator. Left to right, Dr. Norbert Wiener, Prof. J. B. Wiesner and Dr. Y. W. Lee

New Directions

The search for a color system to fit the 6-mc channel of the black-and-white service has led to the field-sequential, line-sequential and dot-sequential methods of transmission. Principles of CBS, CTI and RCA systems are described and compared

THE DEVELOPMENT of color television during the past decade has undergone a remarkable reversal.

In 1940, when Peter C. Goldmark first demonstrated the CBS color system[1], the scanning standards were 343 lines and 120 fields per second. These values were chosen to permit operation on a 6-mc channel, and color images were transmitted from the CBS black-and-white transmitter then operating on 50-56 mc.

In 1946, when work on color was resumed by CBS, the 6-mc channel was abandoned in favor of a 16-mc channel in the uhf region from 480 to 496 mc. The scanning standards were changed to 525 lines and 144 fields to secure more detail in the images and greater freedom from flicker[2,3]. Later, the number of lines was reduced to 441 and the channel width to 12 mc. In 1946 the RCA Laboratories announced their work on a simultaneous system[4] which employed 525 lines, 60 fields per second, and a channel approximately 14 mc wide.

When the question was reviewed by the television panel of the Radio Technical Planning Board, before the FCC Hearing of November 1946, it was the unanimous opinion of all the engineers participating, including those from CBS and RCA, that a channel width narrower than 12 mc was not capable of carrying a satisfactory color service.

Today, only three years later, the state of affairs has reverted to that of 1940. CBS and RCA have both urged in the hearing before the FCC which began September 26th, that color tv be instituted on 6-mc channels and have demonstrated systems designed for this bandwidth. A third organization, Color Television, Inc. (CTI), has developed another system for a 6-mc channel and plans to demonstrate it to the FCC before the year ends.

While opinion is not unanimous that a 6-mc channel can be successfully used for a color service (the DuMont Laboratories strongly oppose the present proposals) the possibility of a 6-mc system seems to many observers to be, in one system or another, a practical possibility for the future.

Chairman Coy of FCC and Adrian Murphy of CBS inspect CBS color receiver. Disk within cabinet is viewed through magnifier. This equipment was built by Zenith for medical demonstrations at Atlantic City

Why 6-Mc Color?

The reason for the shift of interest to 6-mc color systems is not hard to find. A large portion of the uhf region from 475 to 890 mc, formerly reserved for color service, is about to be allocated to black-and-white service to fill the pressing public demand for more television stations. The remaining portion of the uhf band (not more than 100 mc according to present estimates) is not adequate to support a nationwide color service of any type, let alone a service which employs 12-mc channels. The possibility of setting up color service on still higher frequencies exists, but is not attractive in view of the expected poor performance of such frequencies in broadcast service and the lack of experience with practical equipment. If color must go above 1,000 mc its advent is many years off.

But if color television can be made to work satisfactorily on 6-

in COLOR TELEVISION

The CBS mechanical-disk color converter. For color reception the converter slides in front of a standard monochrome receiver whose scanning circuits have been modified for 144-cps field frequency and 29,160-cps line frequency

mc channels a very attractive course of action is available: the black-and-white service can be expanded at once, in terms of present demands, without regard to the color question. The color service could then be instituted, when and as ready, on the same channels. This superposition of monochrome and color service on identical channels not only offers badly needed economy in the use of the spectrum, but provides an orderly transition from one type of service to the other. Each broadcaster could offer monochrome and color programs, either simultaneously or alternatively, and the proportion of time devoted to each would follow the public demand. In this way the monochrome service could provide the initial economic support for the introduction of color. In the opinion of many, the monochrome service would never be supplanted.

An important question is whether owners of black and white sets could utilize the 6-mc color transmissions, and if so, at what additional cost? Two types of reception are of interest: reception of a monochrome version of the color transmissions, and reception in color. Engineers are agreed that existing receivers can be converted to either type of reception, but the three systems proposed by CBS, CTI and RCA differ markedly in the cost of conversion. They differ, also in their fundamental performance as determined by the scanning standards adopted and the terminal equipment (camera and viewing mechanism) used. On the basis of cost estimates for converting existing receivers and producing new receivers, and on the actual and potential performance of the systems, the FCC is currently endeavoring to determine which system, if any, is ready for public use.

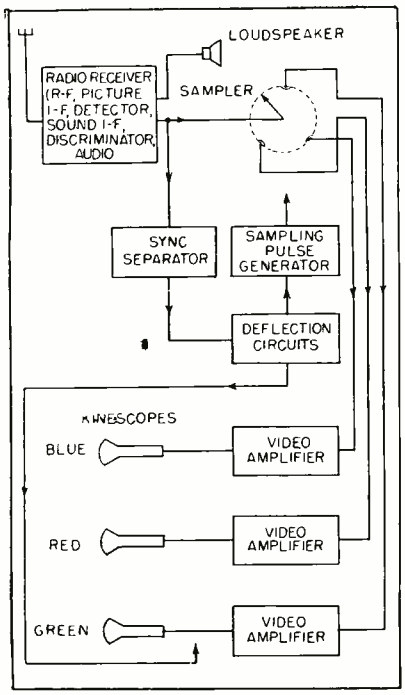
The three systems currently proposed are all of the sequential type, that is, they employ one signal which takes on, in time sequence, the three primary color values inherent in a scene. All three are quite different from the simultaneous system[4], in which three carriers are devoted individually to the three primary colors. A simultaneous system could be set up in a 6-mc channel. But its reception on existing receivers, in monochrome or color, would be rendered almost impossible by the difficulty of separating the three carriers, all of which would lie within the passband of the receiver. The simultaneous system of transmission is, at least for the present, in a state of eclipse, although the cameras and viewing devices originally developed for it are used in the RCA 6-mc system.

CBS Field-Sequential System

The three 6-mc sequential systems differ fundamentally in the rate at which the color sequence occurs. In the CBS system, each field of the scanning pattern is scanned as a whole in one primary color, successive fields being scanned in the sequence red, green, blue. This is the so-called "field-sequential" system and is unchanged in its fundamentals from the first CBS system of 1940.

The scanning fields in this system are laid down at 144 fields per second. This rate is slow enough to permit the color sequence to be introduced by positioning in front of a direct-view picture tube a succession of optical filter segments carried on a filter disk rotating at several thousand rpm. The CBS system thus permits the use of a mechanical color sequence device. At present it appears that the mechanical type is substantially cheaper to construct than the electronic sequence devices required in the other two systems. The CBS system also permits the electronic type of sequence device to be used, and the electronic type is in fact required for pictures whose diagonal is larger than 12 inches. For such pictures, the rotating filter disk becomes so large (its diameter must be twice the diameter of the picture tube screen) that it cannot be rotated safely at the high speed required.

The advantage of the slow color-sequence rate, which permits



RCA receiver. Sampler rotates in exact phase with similar device in transmitter, separating color pulses from composite color sinewave. Synchronism between samplers is maintained by sync pulses

cheaper receivers and converters, is balanced by the tendency of the images to flicker. In the field-sequential system the whole area of the image takes on one color at once. Since flicker is most prominent in large areas, the field-sequential system suffers from flicker unless the field rate is high, much higher then the 60-per-second rate of the black-and-white system. Even at 144 fields per second, flicker is evident if the highlight picture brightness is greater than about 25 foot-lamberts. In comparison, the black-and-white standard image remains free of flicker at brightnesses in excess of 100 foot-lamberts.

The high field rate required in the field-sequential system to avoid flicker has two important effects. First it requires the scanning circuits of existing receivers to be modified to receive color transmissions, whether the reception is to be in monochrome or in color. In existing black-and-white receivers the field scanning rate is 60 cps and the line scanning rate is 15,750 cps. In the CBS 6-mc color system, the field rate is 144 cps, the line rate 29,160 cps.

The second effect of the high field rate, the more fundamental of the two, is reduction in the geometric resolution of the image. In the 525-line black-and-white image, the horizontal resolution is about 330 lines, the vertical resolution about 350 lines and the total number of picture elements per frame about 150,000. In the CBS 6-mc, system, using the same maximum video frequency as the black-and-white system, the number of picture elements per frame is reduced in the ratio of the field rates, or $60/144 = 0.42$. Thus the number of picture elements per frame in the CBS image is about 60,000, less than half the value of the black-and-white system.

In the CBS system the number of lines per frame is 405. This value produces a vertical resolution of about 250 lines, and with a 4.25-mc maximum video frequency a horizontal resolution of about 190 lines. While it is not essential that these two values be the same, if they were equalized the resolution in both directions would be about 220 lines and the corresponding number of lines per frame would be about 350 lines. This compares with 525 lines in the black-and-white system.

The low value of resolution in the CBS system has been compensated in part by peaking circuits which use the video bandwidth to the fullest degree. The presence of color, through the mechanism of color contrast, also compensates for the loss of detail. These compensations are, of course, equally available in any other color system having equally good resolving power in the camera and receiver.

An important advantage of the CBS system is the fact that but one scanning pattern is used in the camera and one in the direct-view receiver. This avoids the problems of optical and electrical registration between the color images, which must be dealt with in the other two systems. For images larger than 12-inches, however, the registration problem appears at the receiver in the CBS system, since three images must be projected in register in this case.

In demonstrations thus far viewed, the CBS images display excellent fidelity of color reproduction, due no doubt to the fact that the color values are introduced solely by optical filters which have been brought to a high state of perfection in the photographic art. In the RCA system, the colors are produced by colored phosphors, and the color balance, over a range of brightness values, appears to be inferior. The generally expressed opinion is, however, that there is no fundamental difference in the ability of the three systems to render color values accurately.

CTI Line-Sequential System

The second of the three 6-mc color system was developed by George E. Sleeper, Jr. of CTI. In this system, the change in color is introduced between successive lines in the scanning fields, that is, the system is in the "line-sequential" class. The scanning standards are the same as in the black-and-white system (525 lines and 60 fields). This choice permits a monochrome version of the color transmissions to be received on existing receivers without modification.

The CTI color sequence rate (the line scanning rate, 15,750 cps) is more than 100 times as great as the 144-per-second rate of the CBS system. For this reason, there is no known mechanical method of introducing the color sequence. In the camera, three separate lens systems, each containing a primary color filter, project three identical images of the scene on the mosaic of an image-orthicon tube. These images lie side by side and appear in the three primary colors. The scanning beam in the tube traces across all three images from left to right. The line scanning rate is one third the normal (5,250 cps), so each passage of the beam across the three images produces a sequence of lines at the normal rate of 15,750 cps, in the sequence red, green, blue.

At the receiver a similar set of three images is formed, side by side, on the face of the picture tube, the scanning sequence being identical to that in the camera. Three separate optical systems project the images one on top of the other in precise register, on a viewing screen. The colors are introduced either by using three different colored phosphors in the respective

areas of the picture tube screen, or by filters in the projection systems.

Since the number of lines in the image (525) is exactly divisible by three, it follows that a particular line in the pattern is always scanned in the same color. This is disadvantageous, since areas of the scene approximating the primary colors would appear on every third line only, and the image structure would be correspondingly coarse.

To minimize this effect and to avoid the tendency of the color lines to "crawl", the color sequence is commutated, so that a given line in the scanning pattern is scanned in each of the three colors in successive alternate fields. The color commutation is introduced by a "slot" which appears in every third horizontal sync pulse and which may be displaced by one or two lines during vertical blanking. This slot is used to actuate a control circuit which shifts the scanning beam so that the red image is scanned immediately following the appearance of the slot, followed by green and blue. In this manner every point on the image is scanned in all three primary colors during the scanning of six successive fields. Since the field rate is 60 per second, the entire color sequence is repeated at a rate (the "color picture rate") of 10 per second. In comparison, the color picture rate of the CBS system is one sixth the field rate of 144 per second, or 24 complete color pictures per second.

It thus appears that the CTI system uses the 525-line 60-field scanning pattern at the expense of introducing a low color picture rate. This low rate emphasizes interline flicker and line crawl, particularly when areas of solid color approximating the primaries are transmitted. These effects also appear when viewing a monochrome version of the color transmission. Since the CTI system had not been demonstrated to the press, at the time of writing, it has not been possible to form any estimate of the actual extent of these difficulties in practice. The principal advantages of the CTI system, compared to the CBS system, are higher resolution (equal to that of the black-and-white system or nearly so), and the fact that it permits a monochrome version of the color transmission to be reproduced (subject to the defects just mentioned) on existing receivers without modification. The disadvantages are the fact that the three color images in camera and picture tube must be very precisely aligned, both electrically and optically, to secure accurate registration. Without such accurate registration, the potential increase in resolution would not be realized, either in monochrome or color, and color fringes would be visible in the color reproduction. Finally, the high color sequence rate precludes the use of the inexpensive mechanical filter disk. Color converters and color receivers for the CTI system are, at least for the present, restricted to the more expensive projection types. For pictures larger than 12 inches, the cost of the receiving equipment should be approximately the same in the CBS and CTI systems.

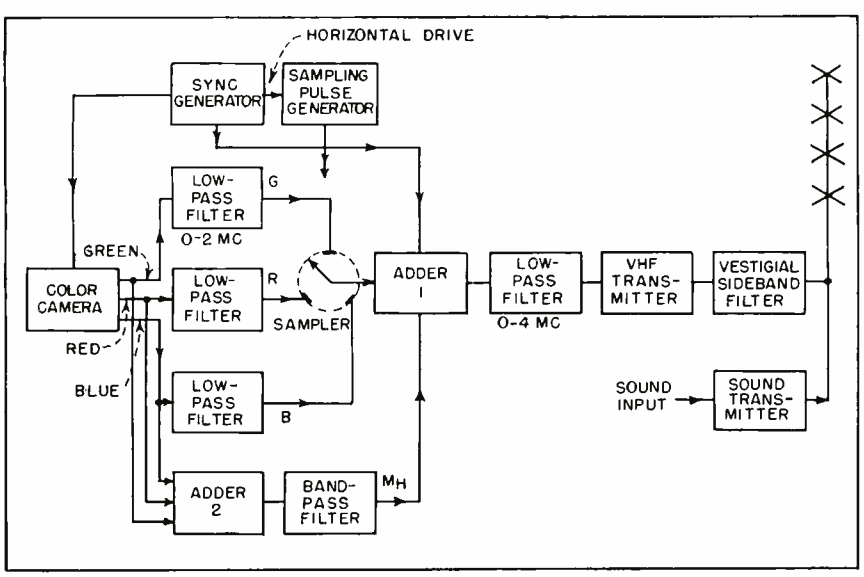
RCA camera with cover removed. Dichroic mirror system passes images in primary colors to three image orthicons. Optical and scanning systems must be precisely adjusted to preserve registration of images

RCA Dot-Sequential System

The third 6-mc system, developed at the RCA Laboratories in Princeton under the direction of Ray D. Kell, was announced late in August[5]. This system, like the CTI system, is designed around the 525-line, 60-field black-and-white scanning standards, the objective being to permit the color transmissions to be viewed in monochrome on existing receivers without modification. The color change is introduced, not between fields or scanning lines, but between successive picture elements. That is, a succession of dots in the primary colors appears along each scanning line. The system is therefore of the "dot-sequential" type.

The rate of producing picture elements in any one color is near the upper limit of the video frequency range, 3.8 mc. Three sets of dots in the primary colors are interspersed in sequence along each line, so the color sequence rate is three times 3.8 mc or 11,400,000 cps. This rate is so high that mechanical methods of introducing the color sequence are wholly out of the question.

The purpose of the dot-sequential



RCA dot-interlace transmitter. Sampler at center is an electronic switch which "rotates" 3,800,000 cps

Arrangement of three 10-inch picture tubes with dichroic mirrors to produce direct-view image in RCA system. Mirrors reflect light of one primary color, pass other two

system is twofold. First, it permits color information to be sent by time-multiplex pulse transmission, which makes more efficient use of the video bandwidth than does the conventional method of continuous modulation. Second, it permits the use of a second form of interlace ("dot interlace") which permits the effective picture rate to be halved without incurring the flicker problem. Conventional interlacing of the scanning lines permits a field rate of 60 per second to be used at a picture rate of 30. Dot interlace, added to line interlace, permits the field rate of 60 to be retained, while the color picture rate is lowered to 15 per second. The low color picture rate permits a high degree of resolution to be retained in the color images, while the field rate of 60 insures that the large-area flicker performance will be identical to that of the black-and-white system.

Dot interlace and time-multiplex transmission thus circumvent the principal shortcomings of the CBS field-sequential system, i.e., low resolution and the tendency to flicker at high brightness levels. But the dot interlace and time multiplex are provided at considerable cost in complexity of terminal equipment.

Accompanying block diagrams show the transmitter and receiver of the RCA system. The camera consists of three separate image orthicons, with lens systems and optical filters. The camera tubes provide, continuously and simultaneously, three complete signals corresponding to the three primary color values of the scene. The optical system and scanning circuits must be precisely aligned to preserve register between the three images. The camera arrangement is identical in principle to that developed for the RCA simultaneous system.

The output of each camera tube contains video frequencies up to 4 mc. The components above 2 mc of all three outputs are combined at once (in Adder 2 and the band-pass filter following it). This combined signal represents the finest detail of the image in tones of gray, in the manner of the mixed-highs technique developed for the simultaneous system. The components below 2 mc retain separate identities and provide the color information. These latter components are commutated sequentially in a sampler circuit which is essentially a three-pole electronic switch rotating at a rate of 3.8 mc.

As the electronic switch connects with one of the camera tube outputs, it produces a very narrow pulse whose amplitude is proportional to brightness of the colored picture element then being scanned by that camera tube. As the switch rotates, it produces a succession of such narrow pulses ("color pulses"), in the sequence red, green, blue. These pulses are passed through a 4-mc low-pass filter.

The color pulses are so short that they contain no frequency components below 4 mc except the 3.8-mc fundamental (the sampling rate for each of the primary colors considered separately). Passage through the 4-mc low-pass filter removes the harmonics and converts the color pulses into 3.8-mc sinewaves whose amplitudes follow the changes in the respective color signals as the scanning proceeds. Moreover, the three sinewaves, one for each primary color, are in three-phase relationship, that is, the peak of one wave is reached while the other two waves are passing through zero amplitude. Thus, the three sinewaves may be combined vectorially into a single 3.8-mc sinewave, and this single wave carries the information on the three color signals, in separable form.

The combined 3.8-mc signal, the mixed-highs signal and sync pulses become a composite video signal. This signal is not unlike that of the black-and-white system except that it contains a strong component at 3.8 mc, which carries the color information including the d-c components and video components up to 2 mc. The composite signal modulates the transmitter and is transmitted and recovered at the output of the second detector of the receiver in the conventional manner.

At the receiver, the second-detector output feeds a sampler circuit, an electronic switch identical to and operated in precise phase with that at the transmitter. The synchronization is derived from the horizontal sync pulses. The sampler measures the amplitude of the video signal and produces therefrom short color pulses at the same instants that the respective color pulses are generated at the transmitter. As a result, the receiver color pulses follow in the same color sequence, and have the same successive amplitudes, as the transmitter color pulses. The information in each primary color is thus separated in time sequence from the composite 3.8-mc wave. The mixed-highs signal, passed by the sampler switch, does not contribute to the color information, but does reproduce fine detail.

The separated color pulses, plus the mixed-highs signal, are passed by the switch to three separate video amplifiers, which pass all components up to 4 mc but cut off sharply at 7.6 mc (the second harmonic of the 3.8-mc signal). Consequently, the pulses are converted by the video amplifiers into 3.8-mc sinewaves. Each sinewave is applied to a separate picture tube, whose phosphor produces a primary color corresponding to that present in the corresponding camera tube.

The positive half-cycles of each sinewave produce colored dots on the screen of the respective picture tube, whereas the negative half-cycles produce dark spots. For example, on the green picture tube

each scanning line consists of a succession of green dots separated by spaces of approximately equal size. Between successive scannings of a particular line, the position of the green dots is shifted so that in the second scanning of that line, the dots fall in the spaces left in the first. The same shift occurs on all the other lines in the green image, and the process as a whole occurs simultaneously in the red and blue images.

Since a particular scanning line is rescanned 30 times per second, the line is filled up with the two sets of dots at a rate half as great, and this rate applies equally to all three images. Consequently, all points on the combined image are scanned in red, green, and blue at a color picture rate of 15 per second.

The three color images may be combined by projecting them in register on a viewing screen through reflective or refractive optics. Alternatively, a direct-view image may be formed by viewing the picture tubes through three dichroic mirrors. These mirrors are coated with a semi-transparent color surface which reflects light of one primary color and passes, without reflection, light of the other two primaries. A similar arrangement of mirrors is used in the camera.

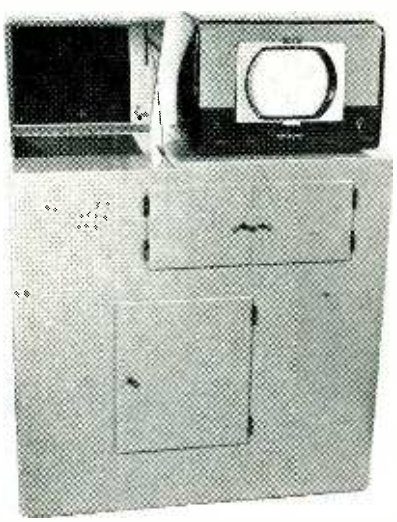
For picture detail corresponding to video frequencies lower than 1.9 mc (half the sinewave frequency) the amplitude of one primary sinewave is, or in theory can be made to be, completely independent of the amplitudes of the other two sinewaves. But for detail corresponding to frequencies higher than 1.9 mc crosstalk occurs, that is, one sinewave varies slightly in response to changes in the others. This dilutes the colors (renders them grayish) in areas of fine detail and at the edges of sharp vertical boundaries between areas of different colors. The effect is subjectively not different from the rendition of detail in gray by the mixed-highs component of the signal

An important aspect of the RCA system of transmission is the fact that the signal contains a strong, and highly important, component at 3.8 mc. This component must be transmitted at full amplitude to permit true rendition of the colors. If it is eliminated (as by passage through a coaxial cable cutting off below 3.8 mc) the color aspect of the signal is removed altogether and a monochrome image results.

The 3.8-mc component appears as a mesh of fine dots (not unlike the interference pattern produced on a black-and-white image by an interfering c-w carrier separated 3.8 mc from the picture carrier). The picture appears, on close inspection, to have a vertical line structure, due to the dots, as well as the usual horizontal line structure. The combination of the two sets of lines gives the appearance of the halftone screen used in printed engravings. At normal viewing distances (roughly that at which the line structure disappears) the dot structure is not visible.

The advantages of the RCA system are higher resolution and greater freedom from flicker than the CBS, and greater freedom from interline effects and flicker than the CTI. The RCA and CTI systems are alike in that they will operate existing receivers without change. In theory the RCA system should have higher resolution than the CTI (both in color and in monochrome) due to the use of time-multiplex and dot interlace.

The disadvantage of the RCA system is the fact that its terminal equipment (camera and viewing devices) is more complex, by a substantial degree, than the CBS and by a lesser degree than the CTI. Three separate images must be formed in separate camera tubes and picture tubes. The registration problem is, therefore, more critical than in the CTI system, which uses one scanning pattern composed of three images side by side. The CBS system, in contrast, has no registration problem at all (other than that due to beam defocussing) under the same circumstances. A version of the RCA system using but one camera tube and one picture tube is possible in theory, but would require three scanning beams in each tube.



RCA direct-view converter and standard black-and-white table-model set to which it may be connected, illustrating complexity of terminal equipment in dot-interlace system

Summary

It appears that the three systems discussed have advantages and disadvantages which are in many respects complementary.

The CBS system is the simplest from the apparatus standpoint, but has important fundamental restrictions imposed on it by the scanning standards which must be adopted to avoid flicker. The RCA system has no such fundamental scanning limitations, but it requires much more complicated and expensive terminal equipment. The position of the CTI system appears to be intermediate to the CBS and RCA in both respects. The choice between them would then appear to devolve upon the relative importance placed on scanning limitations and apparatus complexity. Finally, it is possible that the good points of the systems might be combined with advantage. Dot-interlace might conceivably be used in a field-sequential system, for example, with consequent improved resolution while retaining simple terminal apparatus.—D. G. F.

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By ROLF K. HANSEN
Chief Engineer

and WILLIAM EISNER
Associate Engineer

Leru Laboratories, Inc.
New York, New York

Synchronizing pulse transmitter mounted behind pilot in control plane sends signals to six other planes

SKYTYPING

IN THE ART OF SKYWRITING by means of a single plane, there are several serious drawbacks which impair both the efficiency and overall effectiveness of the method as an advertising medium.

Only 40 percent (approximately) of the total flying time is spent actually writing; the rest of the time is devoted to maneuvering into position to make a given stroke. Due to the low hold-together time of the smoke letters, the first characters of the message often become fuzzy and illegible while the last letters are still being made. Thus, the sign is not always seen by a ground observer as a complete unit.

Using the conventional system, a great deal of skill is required on the part of the pilot. The novelty and spectacular quality of acrobatic skywriting seems to have worn off somewhat. Something different is required to renew interest and make people look up.

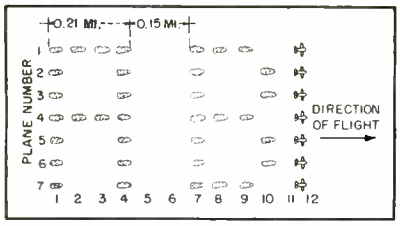


FIG. 1—Seven-plane smoke pulse system used in skytyping

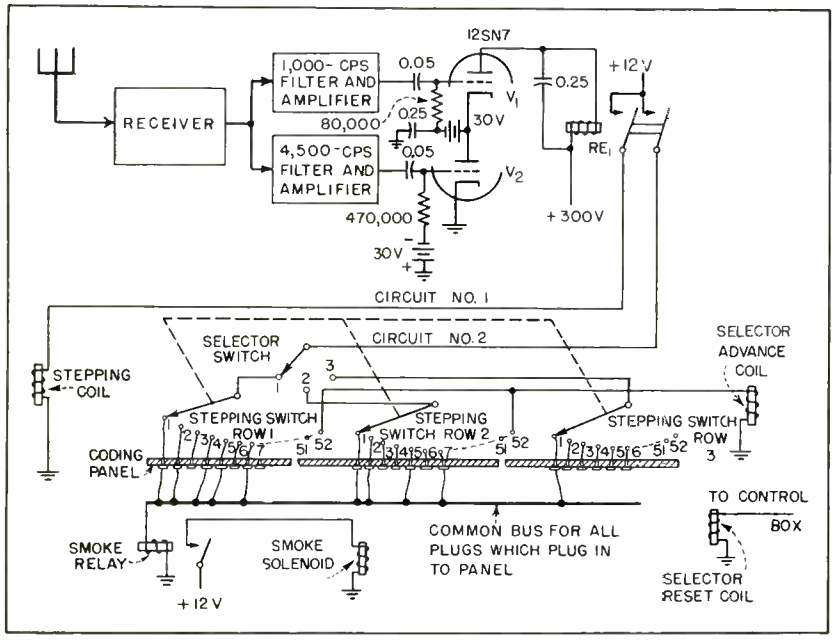
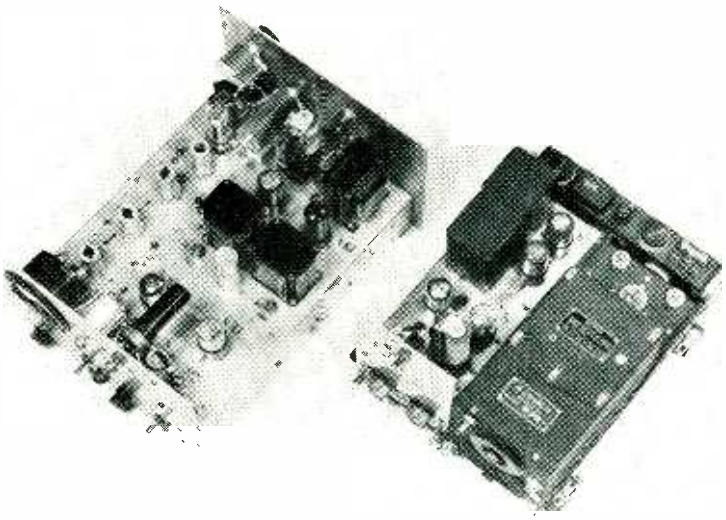


FIG. 2—Schematic diagram of receiving equipment used in all but the control plane which is keyed directly from timing circuit

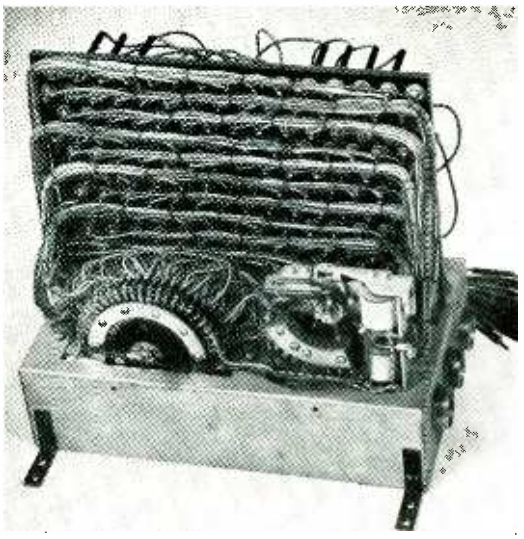
Skytyping

To improve skywriting technique a new approach was undertaken and the following scheme devised. Instead of a single plane, seven planes are used, all flying in a straight line and equally spaced from one another, as shown in Fig. 1. When position 1 is reached, all seven planes simultaneously emit a short dash of smoke. At positions 2 and 3, only planes 1 and 4 emit. At position 4 all planes emit smoke. In this way the letter A is written in block form.

In skytyping, the seven airplanes thus fly along in a straight line, emitting smoke at the proper intervals and writing the message in the length of time it takes them to traverse the distance. For the type airplane used (AT-6's, cruising



Synchronizing pulse transmitter and a typical receiver



Stepping relay panel for a receiver

Letters are formed by electronically synchronized pulses of smoke which are released from seven airplanes flying in straight-line formation. Center plane transmits modulated r-f timing pulses which are received in the other six planes and used to actuate stepping-relay circuits and smoke valves

speed 180 mph), a ten-letter message five miles long is written in about a minute and a half.

It is virtually impossible for the pilots to cut smoke on and off in synchronism and at the proper moment by manual control. Some automatic control had to be found and an electronic solution seemed logical.

Electronic Synchronization

The actual emission of smoke from the airplanes is accomplished by means of a solenoid-controlled, quick-acting valve which injects under pressure and in spray form an oil-base chemical into the exhaust of the airplane. On meeting the hot exhaust gases, the oil burns, giving off thick white smoke, which is then swept out with the exhaust gases.

The heart of the electronic apparatus is a telephone stepping switch operating in conjunction with a selector switch to determine the message. A simplified schematic is shown in Fig. 2. One of these units is placed in every plane. An r-f signal, the character of which will be discussed later, is transmitted by the center, or control airplane. This signal is received by the other planes through a conventional superhet receiver, demodulated, suitably amplified, and used to drive the two series tubes V_1 and V_2 to conduction. As long as V_1 and V_2 conduct, which is as long as the impulse from the center plane acts, there will be current through RE_1 which is the d-c plate load for the series tubes.

The closing of RE_1 applies +12 volts to two circuits. Circuit 1 is the coil of the stepping switch. Circuit 2 determines whether or not the plane containing the switch will emit smoke on the reception of this signal. Circuit 2 energizes the smoke relay (which closes the smoke solenoid) through the selector switch and through the stepping switch. Each contact on the stepping switch is connected to a switchboard which acts as a coding panel. Depending on whether or not the plugs are plugged in at a given contact, the plane will either smoke or not smoke when that contact is reached.

When the impulse being received ceases, RE_1 opens, the smoke relay is de-energized, and the stepping-coil armature opens, advancing the wipers of the stepping switch to the next contact.

The purpose of the selector switch is to select first one row and then the next, on the stepping switch. Thus, when the series of impulses has caused the stepping switch to advance through 51 contacts (52 contacts to a row), at the 52nd contact the coil of the selector is energized, causing the selector wiper to advance to its second position and thus bring in the second row of the stepping switch. In this way all the rows of the stepping switch are effectively in series thereby giving 150 useful contacts, or a maximum message length of 20 letters.

It is essential to the successful operation of the scheme that all the

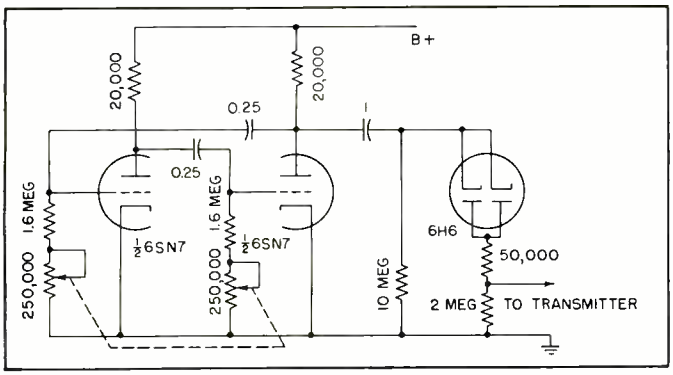


FIG. 3—Multivibrator timing circuit produces 0.6-second negative pulses of sufficient amplitude for cutting off modulation between synchronizing pulses

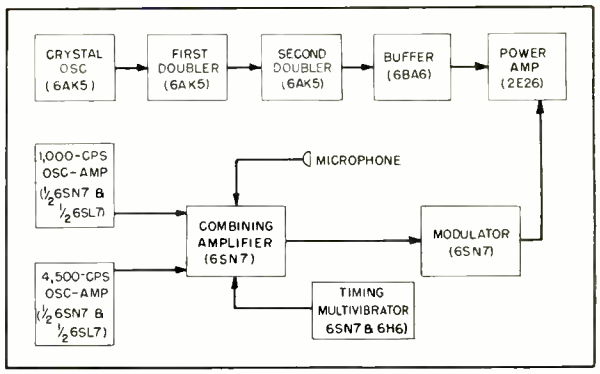


FIG. 4—Block diagram of transmitter unit which is carried in the control plane. Carrier frequency is 27 mc with 3 watts radiated power with two-tone audio modulation

stepping switches (one in each plane) remain in synchronism. Impulses from the transmitting plane are sent out at intervals of 0.6 second on and 0.6 second off. At the end of each impulse all stepping switches advance simultaneously to the next position and await the next impulse.

If, in the interim between signals, a noise pulse of sufficient magnitude should come along to drive the series tubes of one of the planes to conduction, that plane's stepping switch would advance, and for the remainder of the message would be one step ahead of the other planes and thereby ruin the appearance of the message.

It was found that the seven closely grouped airplanes gave rise to an extremely high noise level. Since signal strength could not be increased, due to FCC allocation, some means of negating the effect of noise pulses had to be devised. The following system was developed.

The center plane contains a conventional transmitter consisting of a crystal oscillator followed by two frequency-multiplier stages and a buffer amplifier used to drive a power amplifier giving three watts of r-f power at 27 mc in the antenna. The signal or impulse previously referred to is a combination of two audio frequencies—a 1,000-cycle tone and 4,500-cycle tone. The signals are derived from two audio oscillators of the Wien bridge type. The outputs of the audio oscillators are combined in a voltage amplifier, pass through a push-pull stage, and then plate-modulate the power amplifier.

In the receiving planes, surplus ARC-5 receivers are used with the coils converted for reception at 27 mc. The demodulated and amplified output contains the two audio frequencies plus noise. The audio signal is passed through two filter networks each of which consists of a two-stage amplifier with a sharply tuned circuit as a plate load. One filter passes 1,000 cycles and the other 4,500 cycles. The 1,000-cycle signal is applied to the first of the series tubes and the 4,500-cycle signal to the second, driving them both to conduction and closing RE_1.

In order for current to flow through RE_1, it is necessary for both tubes simultaneously to have strong enough signals on the grid to drive them to conduction. It was found that the noise voltages encountered did not have modulating components of sufficient amplitude at both 1,000 and 4,500 cycles simultaneously to drive both series tubes to conduction. The same effect was found to be true of voice signals; therefore, between messages voice is transmitted on the same carrier and the center plane pilot can communicate with six other planes.

Timing Circuit

The synchronizing pulses sent out by the middle plane originate in the multivibrator oscillator shown in Fig. 3. Its output consists of a symmetrical square wave with a period of 1.2 seconds. This square-wave output is fed through a clipper circuit which removes the positive half of the cycle, leaving only negative pulses of 0.6-second duration and sufficient amplitude to cut off the voltage amplifiers in the audio tone-producing circuits in the modulator. The modulation is thus applied periodically for 0.6 second and then turned off for a like interval. A block diagram of the transmitter is shown in Fig. 4.

To insure that all stepping switches are at the initial position before starting the message, each plane contains a control box with a reset switch and two pilot lights. The reset switch serves two functions. It energizes the reset coil of the selector switch, causing the selector switch to fall back to zero. Secondly, the reset switch applies 12 volts to a self-stepping circuit causing the stepping switch to rotate at about 50 steps per second and stop at the initial position. A light on the control box tells the pilot when the initial position is reached. A second light indicates when the smoke relay is energized.

The center plane or control plane is keyed directly from the timing multivibrator. The pulse which is used to key the transmitter is also fed to a tube which is alternately turned on and off and has a sensitive relay in its plate circuit. This relay controls a stepping-switch network like those in the other planes.

The antenna system used is an array of three parallel half-wave antennas strung between the rudder and a mast in front of the cockpit. This gives a radiation pattern directive to either side.

Direct-Reading Electronic Clock

Used to measure time intervals between two operations or as a predetermined clock-counter, this intervalometer gives readings accurate to 0.01 second over a 24-hour period. It can be started by the seconds tick from WWV

By A. E. WOLFE, Jr. and F. G. STEELE

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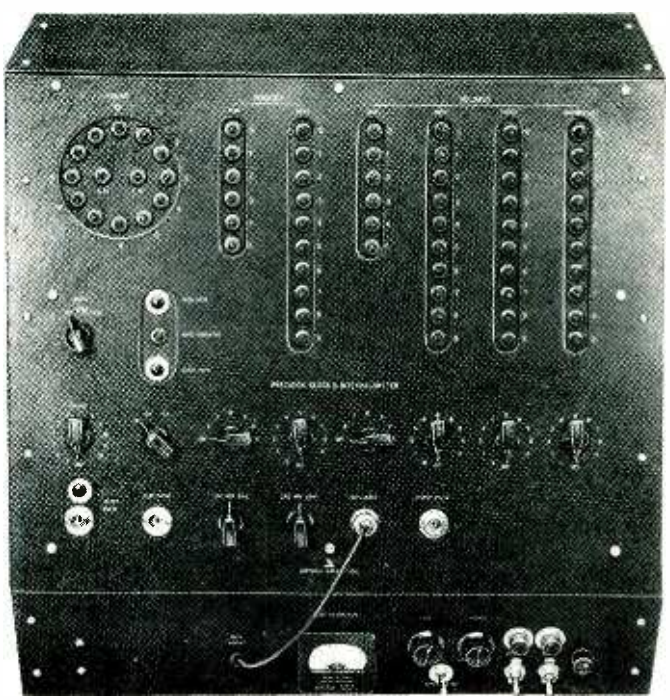
ACCURATE timing and interval-measuring devices employing stable crystal oscillators and frequency-dividing circuits are becoming increasingly useful for essentially nonelectronic manufacturing processes as well as more directly in nucleonic instrumentation. One of the latest types combines the functions of a direct-reading clock and predetermined interval meter.

Basis of the circuit is a temperature-controlled quartz-crystal frequency standard operating at 102.4 kc. The rather unusual frequency was chosen because it is an even power of two and therefore allows simple scale-of-two dividing circuits to be used. It was felt that such circuits had a reliability considerably superior to other types of circuits that could have been used for the same purpose. The divider assembly consists of 10 double-triode tubes and provides an input pulse rate to the clock of 100 pulses per second. A simplified block diagram is shown in Fig. 1.

The face of the clock, illustrated, consists of six vertical rows of neon bulbs indicating 0.01, 0.1, 1 and 10 seconds and 1 and 10 minutes. The circular display at the left shows 12 hours, while in the center of the circle are two neon tubes showing morning and night. Reading from the right, each of the first three rows of 10 tubes is connected to a 10-position scaler unit. Each 10-position unit consists of four double triodes connected in the special feedback circuit shown in Fig. 2. The output of each scaler unit (Fig. 1) is fed to the succeeding unit. The output of the third scaler unit, which represents seconds, is fed to a six-position counter consisting of three double triodes. This scaler unit represents tens of seconds and feeds the minute unit. This is another scaler unit feeding a second six-position counter representing tens of minutes. This counter in turn feeds the hour counter which feeds the AM-PM indicator which is a single flip-flop.

Below each of the above-mentioned scaler units on the clock panel is a multiposition switch which scans each unit and detects the number it contains. The outputs of all the switches are mixed, and the output of the mixer detects the total number contained in the clock. Depending on how the clock is used, this number could represent either a time interval or some absolute time.

The unit below the face of the clock proper consists of a power



Front-panel view of clock and intervalometer. Power supply and controls are on vertical panel below

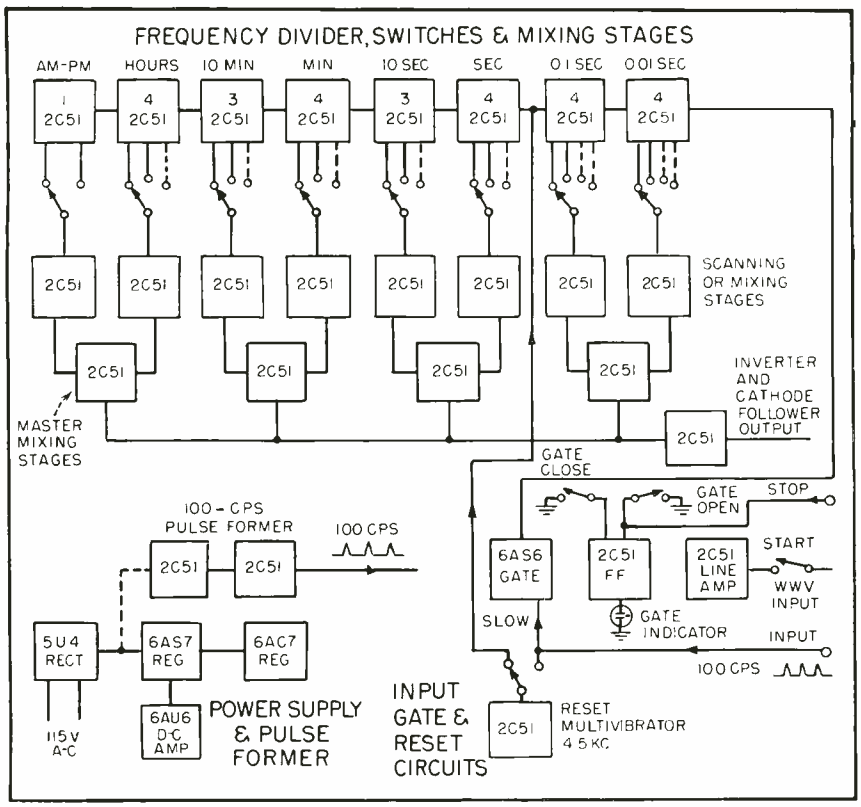


FIG. 1—Block diagram of electronic intervalometer and clock

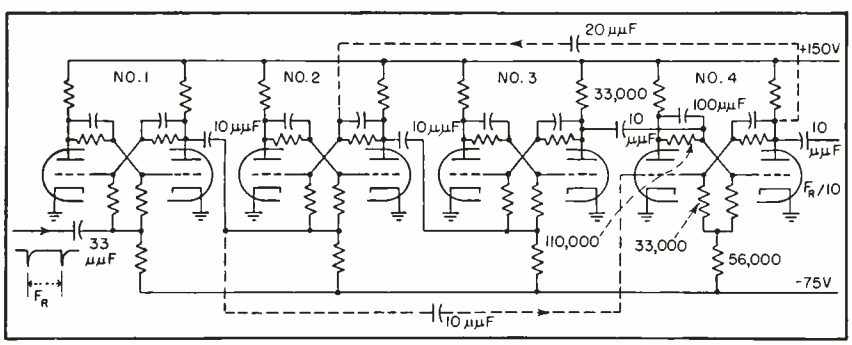


FIG. 2—Typical binary-10 counter with double feedback

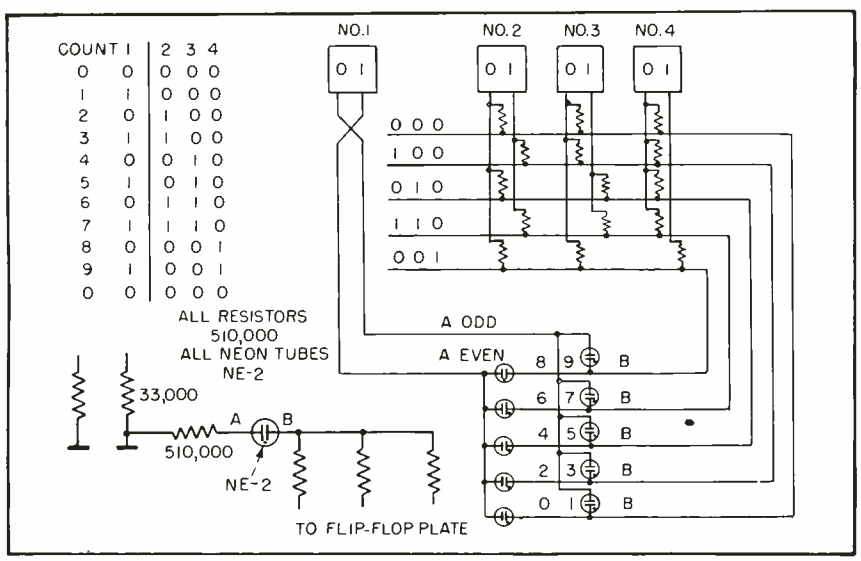


FIG. 3—Matrix development for typical binary-10 circuit

supply and a built-in 100-cycle pulse source which can be substituted for the frequency standard if accuracy desired is not greater than variations in line frequency. Figure 1 shows also the reset circuits, the input gate and associated flip-flop controlling the gate, and the start-pulse line amplifier.

Scaler Circuits

Referring to Fig. 2, this typical binary-10 scaler unit consists of modified Eccles-Jordan circuits with a normal capacity of 16 pulses before recycling. The unit is held to a capacity of 10 by utilizing two feedback paths. The other types of scaler units utilize the same principle to reduce their normal capacity of eight pulses to a capacity of six pulses. The block diagram in Fig. 1 shows that four units with a capacity of 10 are used; that is, 0.01 sec, 0.1 sec, seconds and minutes. Two scaler units with a capacity of six—tens of seconds, minutes and tens of minutes, are employed. One unit with a capacity of 12 is used for the hours. This latter unit is made up of a counter of six preceded by a flip-flop.

The development of a matrix (Table I) to scan the four tubes through their 10 positions is as follows: First, if a stage be in the 01 condition, let that equal 0, and if a stage be in the 10 condition, let this equal 1 in the table shown with Fig. 3.

The actual connections of the matrix appear at the right-hand side of the figure. The table in this figure shows five combinations of the last three stages which, when combined with the even-odd configuration of the first stage, gives 10 possible outputs.

In the operation of the matrix, the NE-2 bulb will only light when side *B* is high and side *A* is low. Side *B* is high only when all flip-flop plates connected to it are high.

Operation of Matrix

Considering the counter with 0 pulses (0 configuration using the abbreviated sequence), each stage is therefore in the 0 condition, which means that all left-hand plates are high. Since the left-hand plates in all stages are high, we must use the right-hand plate in

stage 1 and left-hand plates in stages 2, 3, and 4 to light the 0 bulb. If we feed one pulse into the counter, the first stage is the only one to be affected, going from the 0 to the 1 condition; that is, the left-hand plate is now low. Therefore, to light the 1 bulb, we use the same high connection, but for the low side of 1 we use the left-hand plate of stage 1.

Consider the counter when another pulse is fed into it. From the table, both the first and second stages are affected, the first stage going back to the 0 condition and the second stage going to the 1 condition. The even branch from stage 1 now becomes low. In a similar manner, all subsequent positions up to 9 are carried out and the 10th pulse returns the system to zero.

It has been shown that the neon bulbs indicate the number of pulses fed into the counter. Associated with each scaler unit is a two-deck wafer switch. Figure 4A shows their connection to the NE-2 bulbs. The rotors of these switches, therefore, will be able to detect when a given number appears in the counter. These rotors are connected to the scanning or mixing stages.

Coincidence Mixer

Briefly, a mixing stage consists of a double-triode d-c amplifier connected as shown in Fig. 4B. An input is applied to each grid of the double triode and coincidence is detected in the plate circuit. The wave shapes are shown, and the 100,000-ohm pot in the cathode circuit is used to detect only the most positive part of the wave on grid 2. Eight of these scanning or mixing stages are used—one to each scaler unit. Coincidence of all the outputs of all the scanning or mixing stages is detected in the master mixing stages. These consist of four double-triode tubes with a common plate load resistance and separate inputs on each of the eight grids which are derived from the eight outputs of the eight scanning or mixing stages. There is an output from the master mixing stages when and only when inputs to all eight grids are present as shown in Fig. 4C.

The output from the master mixing stages is fed into the inverter and cathode follower output stage of Fig. 4D. This circuit consists of a 2C51 double triode. The input to the inverter stage is a rectangular wave of about 100 v amplitude and 0.01 second (10,000 μsec) width. This wave is differentiated in the input circuit to the inverter, and only the leading edge is used. The output of the inverter is a negative-going pulse approximately 50 μsec wide and approximately 100 v in height. This signal is fed into the cathode follower and this negative-going pulse appears on the output jack.

Input Gate and Reset Circuits

The input gate is a 6AS6 tube controlled by a flip-flop (Fig. 5). The 100-cycle timing pulses are applied to grid 1 and the controlled voltage for the gate which is derived from the flip-flop is applied to grid 3. The gated output appears in the plate circuit. The clock was designed to be started by WWV time pulses and therefore a pulse-shaping amplifier was included. This pulse-shaping amplifier merely develops a series of five sharp pulses from the five 1,000-cycle sine waves which make up a WWV one-second pulse as broadcast by the National Bureau of Standards.

In addition to the electronic means of controlling the gate, two pushbuttons are associated with the flip-flop, allowing manual operation of the gate if desired. An NE-2 tube connected to the proper plate of the flip-flop serves as a gate indicator showing either open or closed condition.

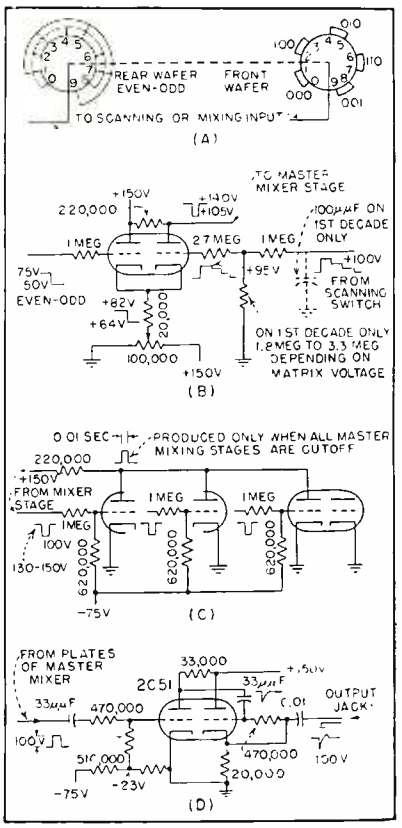


FIG. 4—Method of collecting scanning or mixing signals (A), mixing tube (B), master mixing stage (C), inverter and cathode follower for output pulse (D)

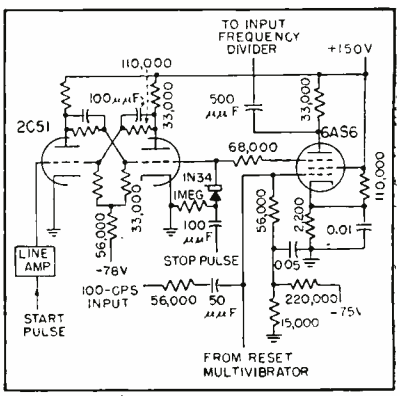


FIG. 5—Input gate driven from flip-flop circuit

Table I—Matrix for Scanning Four Tubes Through 10 Positions

PULSE	No. 1	No. 2	No. 3	No. 4
0	01	01	01	01
1	10	01	01	01
2	01	10	01	01
3	10	10	01	01
4	01	01	10	01
5	10	01	10	01
6	01	10	10	01
7	10	10	10	01
8	01	01	01	10
9	10	01	01	10
0	01	10 (overridden) 01	01	01

Stage in 01 means plate of left-hand section is high, right-hand low. Carry (indicated by horizontal lines) from 0 to 1 only

Duplicating Magnetic

Description: By MARVIN CAMRAS
Research Physicist
Armour Research Foundation
Illinois Institute of Technology
Chicago, Illinois

Analysis: By ROBERT HERR
Physicist
Minnesota Mining & Mfg. Co.
St. Paul, Minnesota

Recorded master and tape to be printed are run through controlled alternating field at high speed with magnetic surfaces in direct contact, for almost perfect transfer of recorded material without demagnetization of master. New process, announced independently by two research groups, offers promise of low-cost pre-recorded reels

Description

LACK OF A HIGH-SPEED duplicating process has been considered a limitation of magnetic recording for home entertainment. With proper equipment an excellent job can be done by re-recording, at a cost that makes mass production of tapes commercially practical.[1] However, a more economical process is still desirable. This paper describes a new method for making duplicates of magnetic records by a printing process that is even simpler than the analogous duplication of phonograph records and of optical sound tracks on film.

Tape Duplication

The fundamental process for copying magnetic tapes is illustrated in Fig. 1A. A program is recorded originally in the usual way on a high-quality tape recorder. This program is then arranged and edited to give the most pleasing results. One possibility is to make a stereophonic or multichannel recording, and to mix or select the various channels to produce the best single-channel effect. From this original, one or more working masters are made. For some work, the first step may be omitted, and the masters made directly from the program.

The working master is a magnetic tape of durable material, since it may have to last for thousands of copies. Some of the most durable tapes are of solid magnetic alloy, or of a nonmagnetic metal coated or plated with suitable magnetic material. The master is not changed physically during recording or copying, and may be erased and re-used at any time.

As shown in Fig. 1A, the beginning and end of the master tape are spliced together to form an endless tape. A long master tape may be handled by winding back and forth over drums, or by any one of several other well-known arrangements. The master tape comes off the storage drums, over an idler, and over a support where it contacts the blank tape which is drawn from a supply reel. While the master tape is in contact with the copy tape, the two are subjected to a high-frequency magnetic field. This field is called the transfer field and may be in the order of 100 kc,

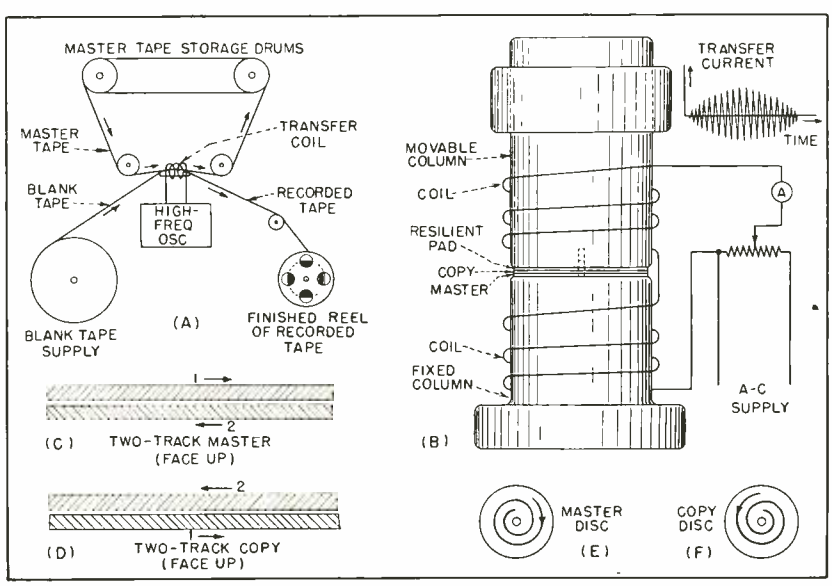
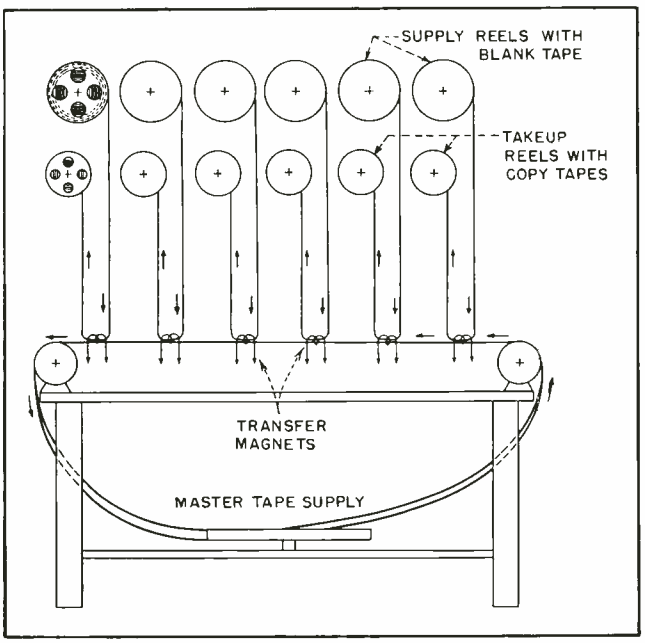


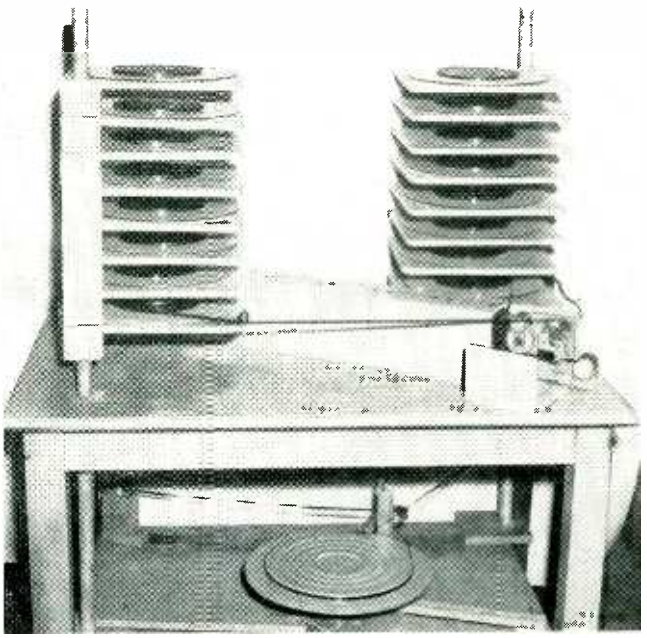
FIG. 1—Basic arrangements for copying magnetic tapes (A) and magnetic disc records (B) by contact printing, using a-c supply to produce almost perfect transfer without demagnetizing the master. Magnetic surfaces of master and blank must be in contact, so mirror image of master is obtained, as indicated by small diagrams at (C), (D), (E) and (F). Movement of tapes out of transfer coil while magnetic surfaces are still in contact gives required time variation of transfer field

This article is based on papers presented individually by the two authors at the 1949 National Electronics Conference in Chicago. The Conference papers will appear in the N.E.C. Proceedings.

Tape by Contact Printing



Experimental arrangement for multiple contact printing of magnetic tapes. With eight contact printing heads, machine running 10 ft per sec turns out 240 hours recording per hour



Multiple duplicator. Master tape, below, runs through all eight printing boxes on table. Each tape being copied runs through its own box, as illustrated by opened box at right

although frequencies ranging from 60 cycles to the megacycle range may be used successfully. The action of the transfer field is to produce a distortionless magnetization of the copy tape in accordance with the magnetic pattern on the master tape being duplicated.

ADVANTAGES OF PROCESS

- Simple all-mechanical construction, except for a-c source for signal-transferring electromagnet
- No critically adjusted recording heads
- No low-noise, high-gain amplifiers to build and maintain
- May be operated by untrained personnel
- Speed need not be constant
- Speed of duplication is almost unlimited
- Mechanical problems are minimized, the only stringent requirement being that tapes be in contact without slipping while in alternating field that transfers the recording

Magnetic disc records can be duplicated by the arrangement shown in Fig. 1B. The master record is fastened to the table of the press, and the disc of copy material is placed over it. The movable arm of the press is then brought down with enough pressure to insure good contact of the copy with the master. A resilient pad is mounted on the movable arm to help iron out any irregularities. While the press is closed, an alternating current is sent through the transfer coils mounted on the columns. The current is increased from zero to a maximum value, and then decreased to zero again by means of a rheostat. This gives a time variation of current similar to that shown in the upper right-hand corner of Fig. 1B.

Current of power frequency can be used in the coils of the disc duplicator. There are advantages in using a higher frequency, however. If an electronic source of transfer field current is used, the required time-vs-output curve can be obtained by switching in the input side of a well-filtered power supply. The columns on which the coils are mounted can be made of molded powdered iron, with a yoke at the back to complete the magnetic circuit.

Reversal During Copying

It is interesting to observe that the copy record is the mirror image of the master. When we were copying single-channel records, centered on the tape, no unusual effects were noted, except that when the gap in the recording head was not perpendicular to the tape, the error doubled rather than cancelled when the copy was played back on the same head. Complications arose when we tried to play back copies of double-track and stereophonic records on the same machine that made the masters. No matter how we threaded the copy, it always played backwards.

Examination of Fig. 1C and 1D shows that in order to make copies of double-track tapes that will play on a standard machine, a master recorder has to run in a backward direction. Also, the lateral posi-

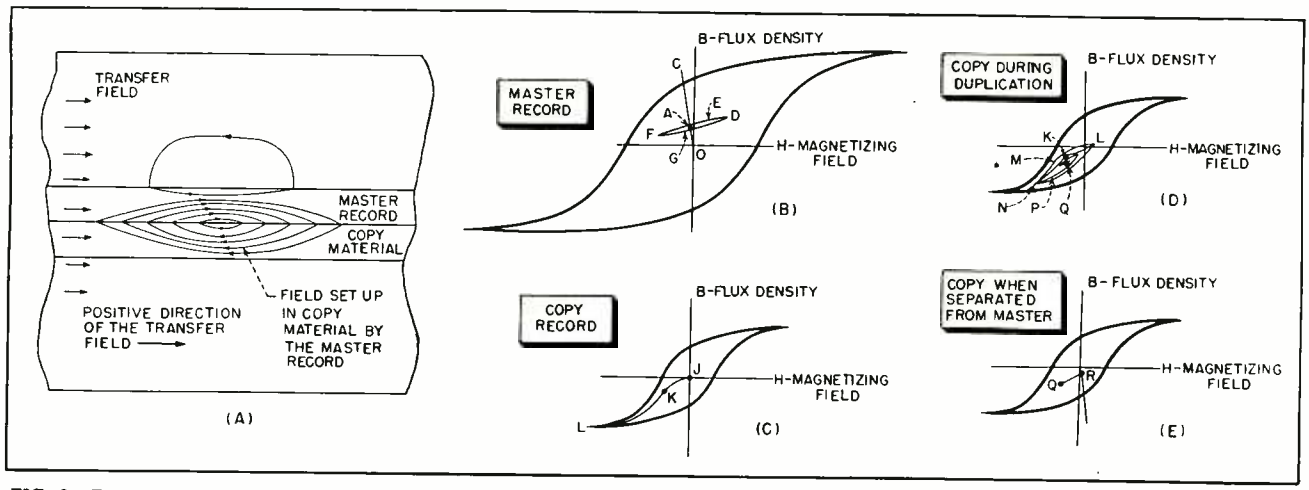


FIG. 2—Fields acting on copy material during duplicating process, and B-H curves showing steps in magnetization of copy material

tions of the channels are in reverse order.

Similarly, Fig. 1E and 1F show that master disc records must be made with a turn-table that turns counterclockwise, so that copies will play back correctly on a standard turntable.

Even when the individual magnetic wavelengths are examined it will be found that they are of opposite phase compared to corresponding wavelengths on the master. It can be seen in Fig. 2A that when the field in the master is to the right, it will set up a copy field in the left-hand direction.

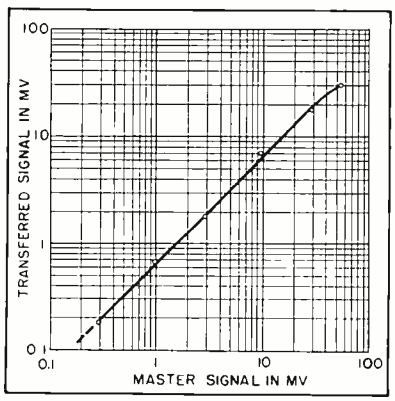


FIG. 3—Plot of measured values shows linearity of relationship between master and copy signals over wide range of signal strengths

Duplicating Process

The magnetic changes that take place during the duplicating process may be analyzed by reference to Fig. 2. Figure 2A shows the physical relations between the master and copy tapes, the field set up in the copy by the master, and the transfer field. Figure 2B gives the magnetic characteristics of the master record material, and Fig. 2C gives the magnetic characteristics of the copy record material.

On the master record, the magnetization will vary from point to point according to the recorded program. Let us arbitrarily select a spot on the master record that is magnetized an amount A on the curves of Fig. 2B. Note that this point is not on the B axis, but because of demagnetization, lies on line OC which makes an angle with the B axis.

From Fig. 2B, let us trace what happens in the master during the transfer process. When the copy is brought into contact with the master, the magnetization of the master will move slightly in a direction AD. When the transfer field is applied, the magnetization follows a loop such as $EFGDE$ while in the field. As the transfer field decays to zero over several cycles, the magnetization again ends up at a point slightly to the right of A. Finally, when the copy separates from the master, the magnetization moves toward A again. Thus the master is unchanged by the transfer process.

Next we use Fig. 2C to consider what takes place in the copy blank at the same time. Initially the demagnetized copy record is represented by point J. When it first contacts the master record, the copy magnetization follows the initial magnetization curve JL to point K. Now we apply the transfer field, and the action shown in Fig. 2D takes place. The combined influence of the transfer field plus the master field causes the copy magnetization to move from point K to a path along the minor hysteresis loop $LMNPL$. When the transfer field decays to zero the magnetization decreases along a zigzag path to point Q. Figure 2E shows that when the copy is finally separated from the master, its magnetization decreases from Q to R.

As a result of this process, points such as R which represent the copy magnetization are linearly proportional to points such as A which represent the master magnetization, within wide limits. This is shown by the output-input curve of Fig. 3. Here a series of test signals were recorded on a master record, and a copy was made from the master. The output from the copy was linear with respect to the master record over a range of more than 40 db.

Test recordings have been made of different kinds of programs and copies were played for judgment by various listeners. It was agreed that the quality of the copies was comparable to directly-recorded tapes made on similar instruments.

Experimental Duplicating Machine

What are the production capabilities of a contact type of duplicating machine for magnetic tapes? To explore the possibilities, we designed an experimental duplicating machine for making copies of a single master tape onto as many as eight tapes at once. The entire apparatus is built up on a small table of standard height, measuring

4 feet long by 2½ feet wide. A lower shelf holds the master tape. The master tape runs over pulleys on the top surface and contacts each of the copy tapes in succession. At each station where contact takes place, a transfer field is applied.

When a complete record has been copied, the machine may be stopped and the takeup reels changed. Better still, the machine can be kept running and a number of complete copies made on each reel with a hole or similar cue mark impressed at the end of every record. The tape is then re-reeled on to smaller spools as a separate operation, and at the same time it may be inspected and test-monitored.

Using double-track tapes ¼ inch wide and running the duplicator at a speed of ten feet per second, we can produce eight one-hour reels every two minutes. Allowing a net running time of four hours per day, one machine of this type has an output of 960 hours of recording per day. This is equivalent to 9,600 standard ten-inch disc records, and one machine thus produces as much as a fair-sized battery of disc presses. These calculations are based on tapes which will be played at a speed of 7½ inches per second.

The main advantages of the contact printing process are low cost and high speed. The apparatus is simple; close control of the drive speed is not essential; heat or wet processing is not required. All the tracks on multichannel records are copied at once, allowing further economy, and making possible the wide use of stereophonic tape recordings.

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Analysis

WHEN A RECORDED magnetic medium is placed adjacent to another section of the medium, as occurs in a reel of wire or tape, there is a tendency for one layer to magnetize the other by virtue of the field surrounding it. This effect is very small because the fields existing are small. In the case of coated tape, these fields are further attenuated by the separation afforded by the nonmagnetic backing which acts as a spacing layer. Furthermore, the attenuation caused by this spacing is frequency-dependent, the fields of shorter wavelength being more attenuated than those of longer wavelength, as is to be expected on the basis of simple dipole theory. The level of a signal impressed on adjacent tape in this manner does not vary linearly with the level of the signal recorded on the tape causing the effect, because of the highly nonlinear remanent magnetization characteristic of all magnetic record media. This characteristic is depicted graphically by the solid-line curve in Fig. 4. The numerical values differ somewhat among various tapes in use, but the value shown for an iron oxide of coercive force 240 oersteds may be considered typical in nature. This curve shows on an arbitrary vertical scale the induction remaining in the material after a sample has been demagnetized and then subjected to unidirectional fields of various strengths.

Since the fields existing in the neighborhood of recorded tapes are of the order of magnitude of 50 oersteds (differing among various tapes) the degree of magnetization resulting from placing a demagnetized tape next to a recorded tape will be small and also nonlinear. However, this magnetization may be enhanced and made linear by the so-called idealization process. The shaking or idealizing influence may be almost anything which introduces strains into the crystal lattices of the magnetic material. Elevated temperatures, magnetic fields, and mechanical stresses may all be used with varying degrees of effectiveness.

Idealization Process

Magnetic fields seem to offer the simplest and most easily controlled form of idealizing influence. An alternating field from an electromagnet is superimposed on the direct field of the recorded magnetic tape. This alternating idealizing field preferably will have maximum values sufficient to magnetize the magnetic material of the previously demagnetized tape nearly to positive and negative saturation for a few cycles, and then gradually reduce over the course of many cycles to zero.

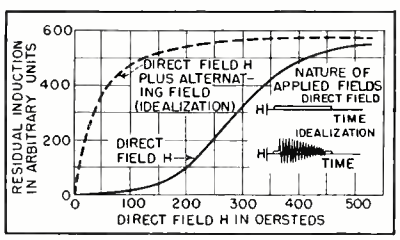
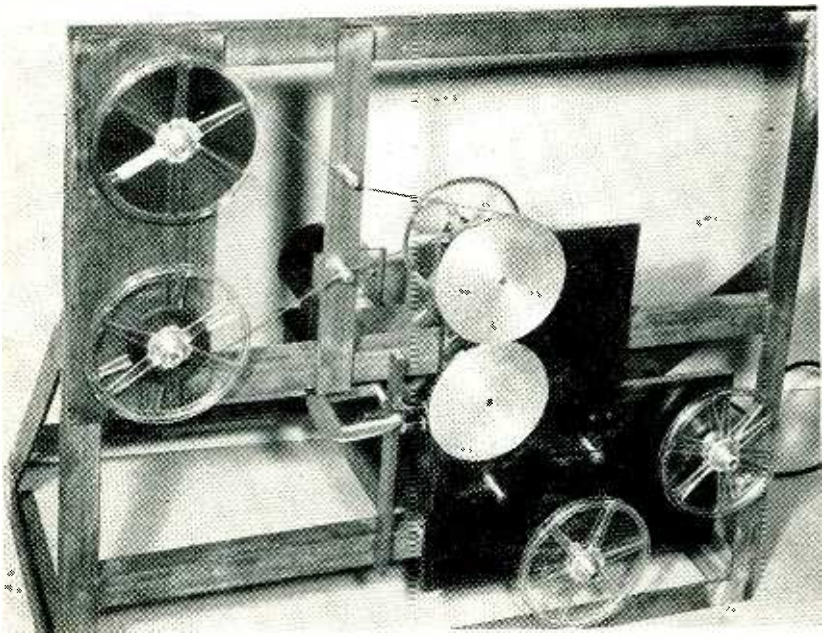


FIG. 4—Solid-line curve shows how much induction remains in demagnetized tape when exposed to unidirectional magnetic field *H*. Dashed curve shows how much more induction remains when exposure is made in presence of an alternating field for idealization

For idealization by magnetic fields, the characteristic of remanent induction as a function of the direct field is shown in Fig. 4 by the dashed curve. To make the idealizing process clear, the history of the sample in terms of applied field vs time is shown in the inset of Fig. 4 for both the d-c and the idealized case. The curve for idealization may be generalized considerably; it is shown with the alternating component beginning abruptly at maximum strength, whereas it may increase gradually to maximum strength and will in practice do so. The alternating component may have any orientation in space relative to the direct field.

Field Strength

The alternating field for idealization of a sample of the tape shown in Fig. 4 should have maximum values of the order of at least 250 oersteds and preferably more. The curve shown is for 500-oersted maximum idealizing field. The use of smaller idealizing fields will result in characteristics lying be-



Experimental contact printing machine made by Minnesota Mining and Mfg. Co. for making a single tape duplicate at 10 in. per sec, using 600-cps idealizing current. Supply reels are at left, with master at top. Slipping-clutch takeup reels are at right. Idealizing magnet is at left of lower of two solid aluminum drive wheels. Peak idealizing field is about 300 oersteds and drops off slowly so no 600-cps magnetization can be detected in tapes

tween the two curves shown.

The idealizing field may increase the residual induction caused by a given direct field by a factor, depending on the strength of the direct field, of as much as 40 to 60 db. Thus, although ordinarily signals produced in a demagnetized tape by face-to-face contact with a recorded tape are inaudible or at the most at about the noise level, this process is capable of increasing such signals to approximately full modulation of the magnetic medium. The residual induction is very nearly proportional to the direct field over the region of small fields, so that the recorded signal on one tape may be reproduced on the adjacent tape without appreciable nonlinear distortion.

High-Frequency Loss

In order to prevent severe high-frequency discrimination, it is necessary to place the two coated magnetic tapes with their magnetic surfaces in good contact. In this way, and provided there is no relative slippage of the tapes during the printing process, high frequencies of wavelengths as short as 0.001 in. (7,500 cps at 7.5 in. per sec tape speed) may be duplicated with only about 3-db loss relative to the duplication of a medium-wavelength signal. There is also a loss, depending upon the tape used and idealizing field strength, of several db at very long wavelengths.

Figure 5 shows the level of printed tones relative to the level of the master record as a function of frequency. These data were taken using the medium described by Fig. 4 with an idealizing field of about 300 oersteds maximum. (Slightly better results may be obtained using still larger idealizing fields.)

The drop in efficiencies at low frequencies is apparently inherent in the process, but that at high frequencies (short wavelengths) is largely controlled by such factors as intimacy of contact, freedom from relative tape slippage, and head alignment. Still better machines than the one on which data for Fig. 5 were taken may show even less loss at high frequencies.

The loss involved in printing in this way is small but definitely significant. Duplicates made without any special recording of the master will be easily intelligible and fairly satisfactory, but will never be the equal of the master record. The frequency selectivity of the process may be compensated by appropriate equalization in recording the master or in playing the print, but only at some sacrifice of signal-to-noise ratio.

However, another step may be taken which increases the quality of the print considerably. It is not necessary that the tape used as a master be identical with the tape used to run off duplicates. Tapes differ in their inherent signal level. Without going to a tape superior in signal-to-noise ratio it is possible to select one which has higher absolute levels. In this way the print tape, although modulated to a lower absolute level than the master, may be fully modulated to its own distortion point. The only loss then remaining is that occasioned by the frequency selectivity, assuming the master and print media have similar frequency responses. Furthermore, some control may be exercised over the relative frequency responses of the media.

Special Master Tapes

While it is possible to use either special master or special print media or both, we have so far been avoiding special print media so that a pre-recorded reel of tape could be satisfactorily erased and re-used on existing recording machines. On the other hand, a special type of tape for masters would not be impractical. For example, a tape with a very heavy coating of magnetic material may be utilized to obtain a better low-frequency response with very little or no increase in noise, which still further reduces need for bass equalization.

In general, it is possible with existing media to obtain a print with no frequency distortion at a level about 5 db below that obtainable by direct recording. Alternatively, some compromise between higher level and flat frequency response may be struck. With media which can be foreseen, no sacrifice in level or frequency response is necessary.

Noise Levels

Not only is the signal level of a print the same or nearly the same as that which can be obtained by direct recording, but the noise is, if anything, less. In direct recording there is always some contribution to noise by the imperfect demagnetization achieved by the erase head or the modulation noise created by the bias field. In printing,

the roll of tape may be initially demagnetized very carefully by large external demagnetizing fields. The only noise will then be the actual modulation noise of the recorded audio signals, which is inevitable.

While in theory, and in some laboratory equipment, the noise caused by imperfect erasure and biasing may be made vanishingly small, in practice the background noise level of a truly demagnetized roll of tape is usually at least several db lower than that of tape erased and biased by a recording machine. In any event, it is a great deal easier to demagnetize rolls of tape by a large solenoid or electromagnet than to maintain nearly perfect recording heads and bias supplies.

Erasure of Master

There is another reason why the selection of proper media is important. The above discussion of idealization was based upon idealizing fields added to a d-c field which is invariable. In printing, this d-c field is the field of the recorded master tape and it is not necessarily invariable. In duplication, the idealizing field is only wanted in the region of the print, but with the print and master in contact, the master recording necessarily is subjected to some alternating field as well. This alternating field, if large enough, may partially erase the master recording, which is of course undesirable.

On the other hand, if the idealizing field is too small, the print will be low in level, especially at low frequencies, and suffer nonlinear distortion. Thus, in duplicating a recording on another tape of the same magnetic material, a compromise level of idealizing field is sought which gives the best overall results. If some erasure of the master results, it occurs only once, in making the first duplicate; subsequent applications of the same idealizing field do not attenuate the master further.

To serve as a master, a medium should be difficult to erase. To serve as a print, it should be capable of idealization with a relatively low alternating field. These two conditions are in rather essential conflict. It seems reasonable that printing from one tape to another identical tape will never be wholly satisfactory. This is indeed the case; while easily intelligible duplicates can be made this way, the duplicate can never have as high a signal-to-noise ratio as the original, or it will be distorted to some degree, or both disadvantages will be present.

For some applications it is not necessary that the two recordings be on the same medium. Magnetic materials of widely different magnetic properties are available and it is possible to select two media, one of them designed for use as master and one for use as print. At the present time, a very good print medium exists and fairly satisfactory master media have been used. As research proceeds with definite objectives in view, undoubtedly still superior media will be uncovered for both purposes.

Harmonic Distortion

Regarding harmonic distortion, the process is excellent provided sufficiently high idealizing fields are used. In general, we have not detected harmonic distortion caused by the reproducing process. To the extent that there is slight frequency selectivity, particularly in the low frequencies, the harmonic content of a master recording will be reproduced at a slight increase with respect to the fundamentals. For example, Fig. 5 shows the transfer efficiency at 1,200 cps to be about 2.5 db higher than at 400 cps, so that a 400-cps signal recorded with 1-percent third harmonic distortion will be reproduced with about 1½-percent third harmonic distortion, assuming the same playback equalization. If the frequency response differences between master and print are compensated by post-equalization of the print rather than pre-equalization of the master, this effect is nullified.

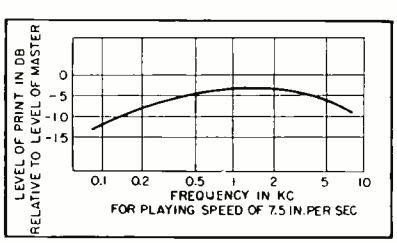


FIG. 5—Efficiency of contact printing process at various audio frequencies. Curve can be made flat either by pre-emphasis incorporated in master tape or by equalization during playback

Printing Speed

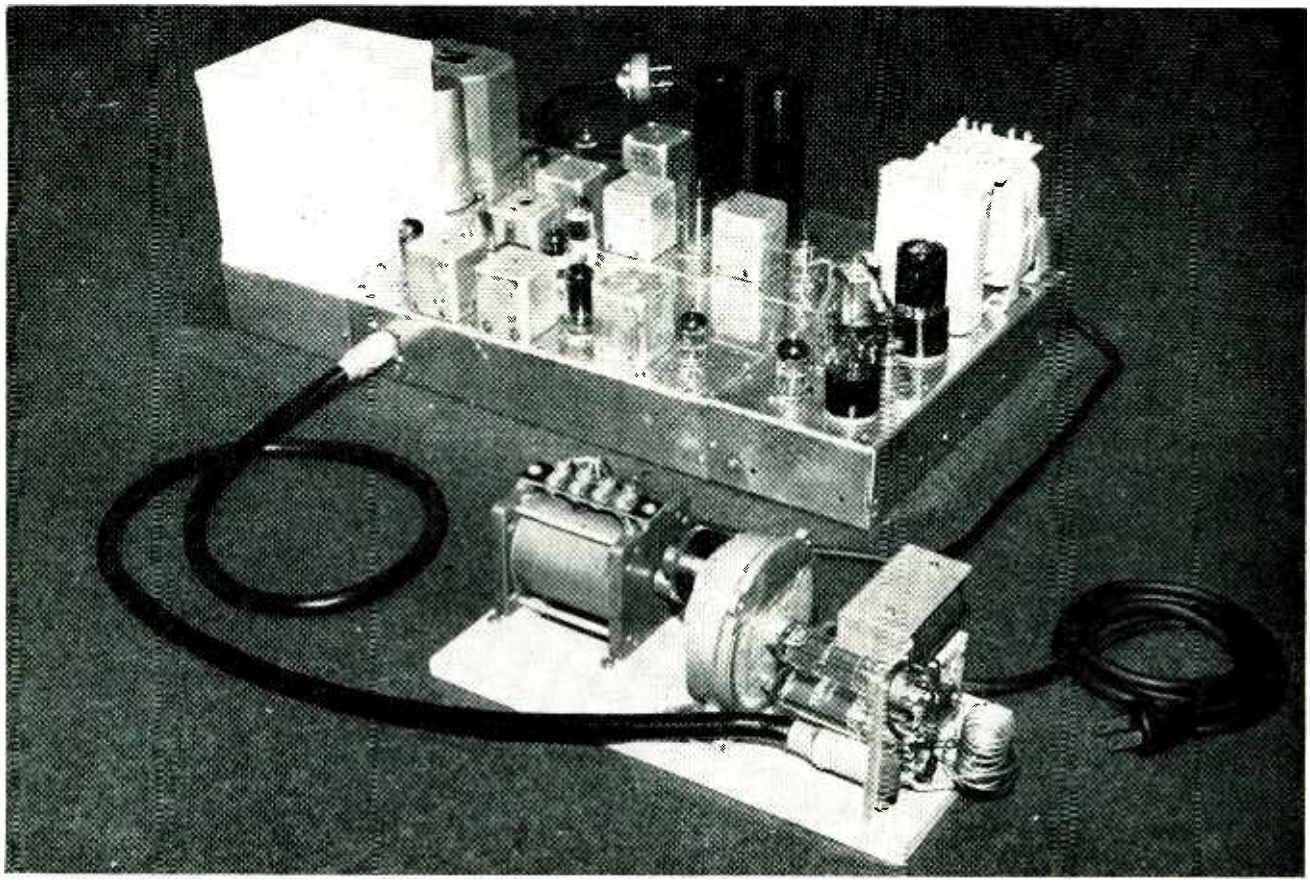
The factor of tape speed deserves attention. The basic requirement of the process is that the tapes in contact be in the idealizing field for a few cycles at maximum strength plus many, preferably a hundred or more, cycles of gradually decreasing strength. This decrease is, of course, effected by allowing the tapes to move out of the field of the magnet while they are still in contact. The tape speed may, therefore, be increased by increasing the frequency of the idealizing field, or by increasing its physical dimensions, or by a combination of the two. It seems preferable to keep the dimensions small so as to minimize the distance over which the tapes must not slip, and increase the frequency as necessary for the speed desired.

Experience to date indicates there is no reasonable limit to the speed which might be used, but it will probably be easier to produce a large number of duplicates simultaneously at slower speed than by using very high speeds and fewer tapes.

Other Applications

The process seems most extensively useful in the large-scale production of tape recordings, but is not limited to tape as a medium. Recordings on discs, drums, sheets and the like can also be duplicated in this manner. It does not as yet seem applicable to the duplication of magnetic recordings on wire.

Pulse recordings or magnetic recordings of various types such as are used in sorting machines and electronic computers may also be duplicated. While some use may be made of the process in small-scale reproduction, as in making carbon copies of magnetically recorded letters, conferences and miscellaneous program material, the major use visualized is in the large-scale production of reels of pre-recorded music. In this field the inherent speed, simplicity and economy of the process should help to make pre-recorded reels of magnetic tape a reality at an early date.



Test setup in which pulse-controlled servomechanism on large chassis corrects output frequency of miniaturized self-excited power oscillator in foreground. Actual correction of tuning capacitor setting in oscillator is done by reversible servo motor

Industrial Oscillator

By JACK W. LOWER

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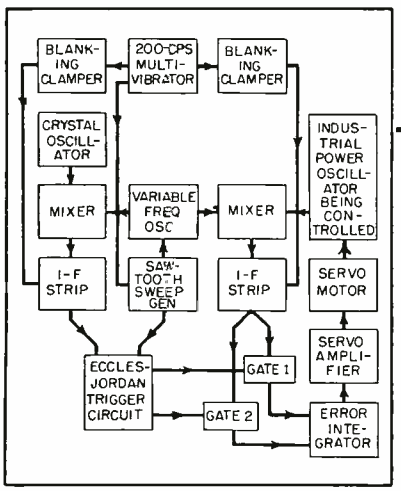

FIG. 1—Operating principle of pulse-controlled frequency-stabilization servomechanism that retunes self-excited industrial power oscillators continually to keep them within assigned band

IN THE PAST SEVERAL YEARS the FCC has placed increasing emphasis upon tightening tolerances in the frequency control of industrial-type power oscillators. Existing frequency control systems use filter networks or discriminators with associated electronic circuits, but possess inherent difficulties in range of control, stability, and practicability.

The system described here is sensitive to frequency errors only, and is stabilized by a crystal-controlled reference oscillator. It has an exceptionally wide range of control and employs integral control features to greatly minimize error. This is accomplished with the application of somewhat unusual frequency modulation and pulse gating techniques.

The basic system is shown in the block diagram of Fig. 1. The technique is to regularly scan through a range of frequencies, sampling

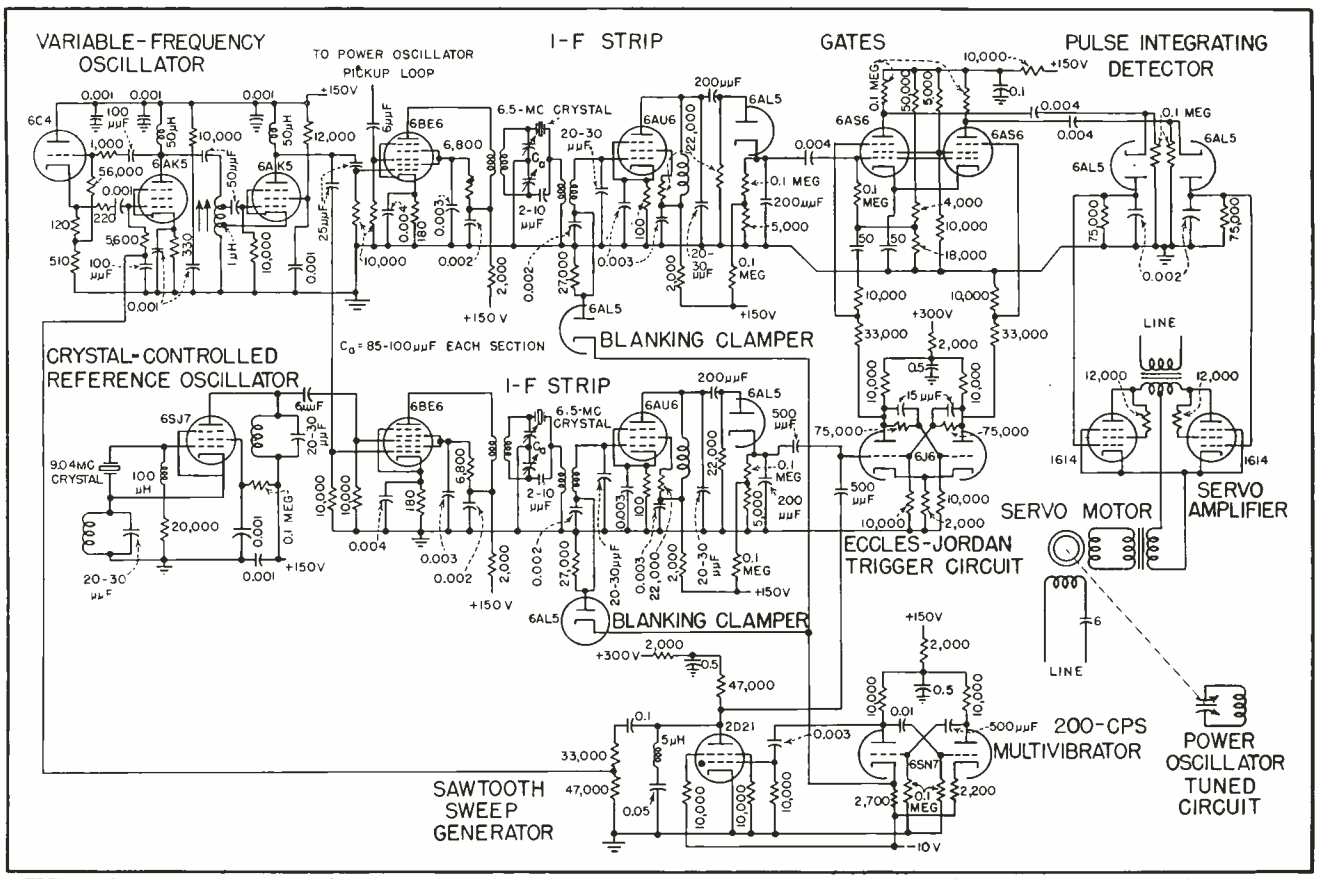

FIG. 2—Circuit action starts with 200-cps multivibrator at lower right, which governs rate at which system compares power oscillator frequency with that of crystal-controlled reference oscillator at left center. Servo motor is reversible

Frequency Control

Pulse-controlled frequency-stabilizing servomechanism for dielectric heating and diathermy equipment holds self-excited power oscillator within 0.01 percent of 27.12-mc crystal reference standard, using gate circuits to control servo amplifier and tuning motor

the power oscillator frequency for comparison with that of the crystal-controlled reference oscillator. The standard oscillator causes a gating operation to reverse action at the proper instant along the sweep in order that the power oscillator will operate one gate if its frequency is too low but another gate if its frequency is too high. Gate outputs control a servo amplifier and motor to mechanically retune a reactive element at the power oscillator. The complete circuit is given in Fig. 2.

Everything starts at a 200-cps free-running asymmetric multivibrator having an unbalance ratio of 7:1. The leading edge of the shorter period of the multivibrator is delayed slightly to synchronize a sawtooth sweep generator, in order to use the entire shorter period as an i-f blanking pulse during sweep retrace. The sweep generator modulates a variable-frequency oscillator to develop an approximately linear sweep of frequency covering a 20-percent range, elevated above the allocated operating frequency by an appropriate i-f value.

Pulse Circuits

A pulse secured by differentiating the sweep retrace triggers the Eccles-Jordan flip-flop circuit to the same mode of operation at the start of each sweep. Another pulse is developed along the sweep at the instant the variable-frequency os-

cillator differs in frequency from the crystal reference oscillator by the i-f. Suitably amplified and rectified in the left i-f strip, this pulse triggers the Eccles-Jordan circuit to the opposite mode of operation. The resulting square waves constitute gating signals which switch over at an instant of time along the sweep corresponding to crystal oscillator frequency. Typical waveforms obtained are shown in Fig. 3.

In a similar channel the variable-frequency oscillator is also mixed with the power oscillator to develop an i-f beat at an instant along the sweep corresponding to power oscillator frequency. This signal is suitably amplified in a crystal-controlled i-f stage and rectified into a pulse which is directed to both gates.

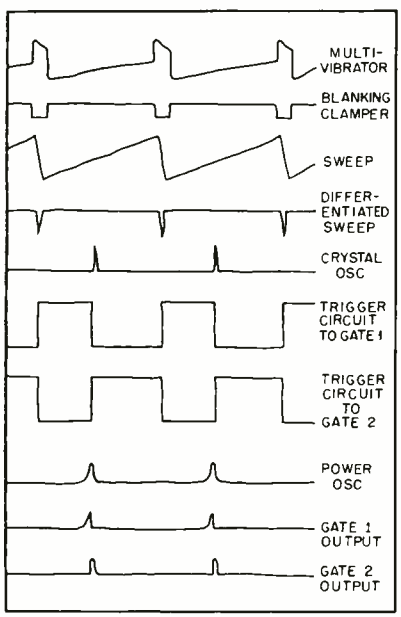

FIG. 3—Voltage waveforms at various stages in control system, as traced from oscillograms. Gate outputs feed servo amplifier through pulse integrating detector to provide required tuning correction of power oscillator

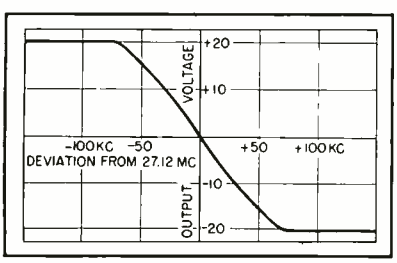

FIG. 4—Net transducer characteristic for all pulse circuits, showing error-correcting voltage fed to servo system

Table I—FCC Regulations for High-Frequency Generators

The Federal Communications Commission provides the following bands for operation of industrial, scientific and medical equipment:

Assigned Band	Center Frequency of Channel	Tolerance from Center Frequency
13,553.22–13,566.78 kc	13,560 kc	6.78 kc
26,960.00–27,280.00 kc	27,120 kc	160.00 kc
40,660.00–40,700.00 kc	40,680 kc	20.00 kc

There is no limitation on radiated power provided operation is within one of the assigned bands, but radiation outside the assigned bands must be kept at whatever minimum is necessary to eliminate interference with existing authorized radio services

Operation of a gate requires a combination of a positive gating signal from the Eccles-Jordan circuit and the pulse from the right i-f strip, a process called coincidence mixing. Depending on whether this pulse occurs before or after the crystal oscillator has reversed the gating action along the sweep, either one gate or the other will amplify the pulse, with a narrow region of overlap existing at the switchover point. To prevent improper alignment, identical crystal filters have been included in each of the i-f strips. In addition to securing stabilized operation, the crystal filters also reduce the i-f bandwidth to improve accuracy.

Error Signal

Pulses which pass through the gates are converted into a continuous voltage in diode integrating circuits to develop an error signal, as shown in Fig. 4. This error signal is coupled through suitable stabilizing networks to the servo amplifier which in turn controls a small two-phase induction motor to retune the reactive element at the power oscillator until the operating frequency is corrected to that of the crystal reference oscillator.

Using the system described here it is possible to maintain the frequency of a self-excited power oscillator conservatively within 0.01 percent of a 27.12-mc crystal reference standard.

Step functions of error were corrected at the rate of 1 mc per second with no oscillatory overshoot exceeding the FCC tolerance for the band. Dead spot width was in the region of 1 to 2 kc, thanks to the integral control feature, with the system positioning the power oscillator control capacitor as little as 0.05 degree to retune. Operation proved to be quite stable from a control adjustment standpoint. No special power supply design precautions were necessary since the key circuits were effectively decoupled. Variation in operating parameters cannot affect accuracy since crystal control is maintained at the reference oscillator and i-f amplifiers.

Other Applications

Although the initial applications lie in frequency stabilization of dielectric heating and diathermy equipments in the high-frequency bands, modified techniques could extend the control range down into the audio region or up into the microwave region. Other possible applications lie in the rapid switching of communications equipment between several crystal standards.

The system described here formed the basis of a Master's degree thesis by the author at Purdue University.

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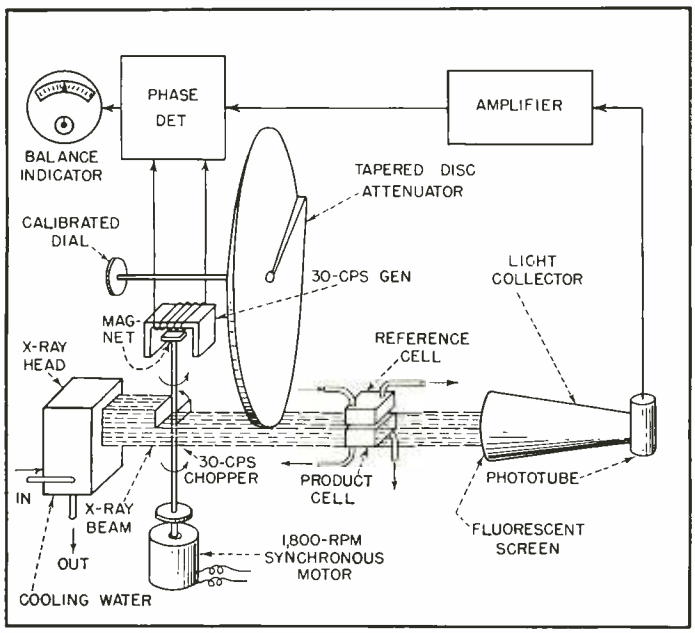

FIG. 1—Photometer setup for comparing X-ray absorption characteristics of materials

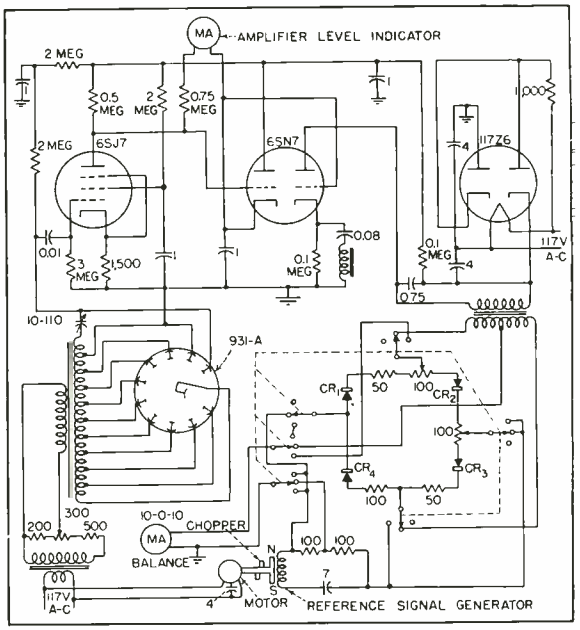

FIG. 2—Amplifier and phase detector of photometer. X-ray tube circuit not shown

Chemical Analysis by X-RAY PHOTOMETRY

Method permits determination of the concentration of one element in mixtures or compounds. Equipment specifically designed to control blending of tetraethyl lead and gasoline can be adapted to other mixing processes

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X-RAY CHEMICAL ANALYSIS provides a means by which industrial mixing processes may be monitored continuously and accurately without interrupting the flow of materials. Such a system has recently been applied in the petroleum industry and enables tetraethyl lead to be blended with raw gasoline in a fixed predetermined ratio by a completely automatic operation. The basic system is shown in Fig. 1.

The x-rays are produced by a water-cooled wolfram (tungsten)-target tube and beamed through a motor-driven 30-cps chopper arrangement which divides the rays into two pulsed beams which pass alternately through a specimen of the material being tested and through a sample of known composition and a calibrated attenuator. These pulsating beams fall on a common fluorescent screen which is viewed by a multiplier phototube. The output of the phototube consists of electrical pulses, the amplitude of every other pulse being determined by the x-ray absorption characteristics of either the reference cell and the attenuator, or the product cell. The tapered-disc aluminum attenuator thickness that must be placed in the reference-cell beam to effect balance between the two beams when they reach the fluorescent screen indicates the difference between the concentration of the material in the two cells.

The Circuit

The instrument is of the null-balance type, as shown in the circuit diagram of Fig. 2. The multiplier phototube signal is amplified by a two-stage amplifier (the gain of which is indicated by the amplifier level indicator) and compared in phase to a reference voltage which is generated by a rotating-magnet-coil arrangement on the beam-chopper shaft. The attenuator dial is then rotated, until the balance indicator needle is centered.

The attenuator may be used with or without the reference cell and may, in either case, be calibrated directly in percentages.

This system has the advantage of being almost instantaneous in operation and nondestructive to the specimen, which may be in either the solid, liquid or gaseous state.

The x-ray photometer is well shielded against x-radiation, and door interlocks provide protection to operating personnel. The high voltage can be varied from 15 to 45 kilovolts peak, providing a range of effective wavelengths from 0.35 to 1.07 angstrom units.

Dot Systems of COLOR

Recent advances involve the application of new sampling and multiplexing techniques for efficient transmission of information through systems having a limited frequency band. These have important implications for the television industry, especially in connection with color television systems

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THE CHANNEL BANDWIDTH to be used for color transmissions should be as narrow as is practical for good performance and if possible should not exceed that of a monochrome channel, a 6-mc channel accommodating an approximately 4.25-mc modulation bandwidth.

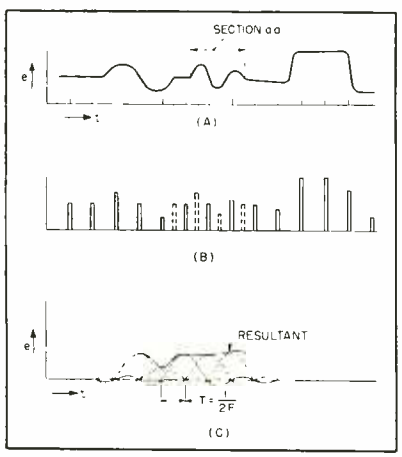

FIG. 1—The sampling process

The many reasons for this premise are beyond this paper but are associated with the need for providing a maximum of broadcasting service in a minimum of total frequency spectrum. Since color systems require the transmission of three video signals, new techniques must be used if a 6-mc channel is to provide for color signals of a quality comparable to present monochrome signals.

The recent progress in transmission system engineering applicable to television broadcasting is the result of research in the more general fields of information and sampling theory as well as in the direct science of television. Hence, some understanding of these fields becomes a fundamental requirement for a working knowledge of the new techniques now being proposed for television transmission.

One method of transmitting a signal waveform is by pulse amplitude modulation wherein the amplitude of each pulse of the output signal corresponds to an instantaneous value of the modulating signal. Figure 1A shows a representative waveform including representations of low- and high-frequency modulations. If this signal be sampled at the intervals shown (that is, at a sampling rate of $1/(2T)$ samples per second) a pulse train of the form of Fig. 1B may be formed. If it be permitted that the precise pulse waveform be ignored so long as the peak amplitude of each pulse (at a time corresponding to the original sampling time) corresponds to the original amplitude, then the transmission bandwidth required may be minimized in accordance with the following:

It is noted that the spectrum of a very narrow single pulse is uniform, consisting of all frequencies, all of equal amplitude and so phased as to maximize at the instant of the pulse, $g\ (\omega) =$ a constant. If this energy spectrum is applied to a transmission system of linear phase and constant amplitude up to a frequency F beyond which there is no transmission, then the output wave form as a function of time would be sin $2\pi Ft/$

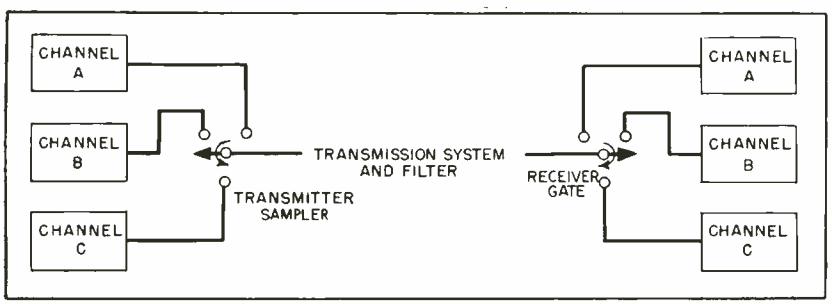

FIG. 2—Three-channel multiplex system

TELEVISION

Part I

of a two-part paper

FIG. 3—Presentation on picture tube of noninterlaced monochrome subject

$2\pi Ft$. This familiar curve has the form $(\sin X)/X$ and is characterized by having zero value at intervals spaced from the maximum of the principal output by $1/(2F)$ seconds.

Because of these zeros of output, it is possible to insert additional similar pulse signals into the transmission system input at time intervals equal to the zero spacing of the transient. This is indicated in Fig. 1C, wherein it will be observed that at the original pulse intervals all pulse signal amplitudes except that corresponding to the appropriate sample are zero. The composite signal resulting from the insertion of a series of properly spaced pulses is the linear sum of the signals.

If a receiving demodulator is time gated so as to receive information only at times corresponding to the original sampling instants, the original pulse train may be effectively reconstructed at the receiver. The individual samples are each independent of all others, hence it can be said that interpulse crosstalk is zero, provided the resulting signal is properly handled by the demodulating equipment.

Since the sampling interval is $1/(2F)$, it follows that $2F$ independent pulses may be transmitted through a bandwidth of F cycles. If the input pulses each correspond to the ordinates of a video waveform, the information specified by these ordinates may be regained by a suitable receiver. This is a restatement of the well-known Hartley Law. The pulse rate may be less than $2F$ without affecting the independence of the pulses. That is, control of the transient response of a system makes possible the adjustment of the time separation of the response zeros to any interval which is equal to or greater than the interval $1/(2F)$. However, the pulse rate can exceed $2F$ only if non-independence of the pulses (crosstalk) is accepted.

Sampling for Video

The above sampling principles have been successfully employed in many applications and appear particularly well adapted for time division multiplex systems. Sampling principles are also directly applicable to television transmission. The waveform of Fig. 1A may be the voltage output of a television camera system, voltage corresponding to shades of grey across a picture line. The signal ordinates derived by sampling may be transmitted and recovered and applied to a viewing device such as a cathode-ray tube so as to modulate its light output. Thus the pulse train might be translated into a series of intensity-modulated dots in a picture.

If the sampling rate is sufficiently high that the individual dots on the viewing device can not be resolved optically by a viewer at normal viewing distance, then it is unnecessary to fill in any information between the dots. Specifically, if it is desired to have a system capable of resolving changes of shading occurring in 1/8 microsecond, then the sampling rate must be 8 mc per second and the required transmission bandwidth is 4 mc.

It is to be noted from Fig. 1A and 1B that low-frequency modulations in the input signal resulted in corresponding amplitude modulations of the pulse train but that a high-frequency signal occurring in section *a-a* does not properly appear in the pulse train. This is the result of too long a sampling inter-

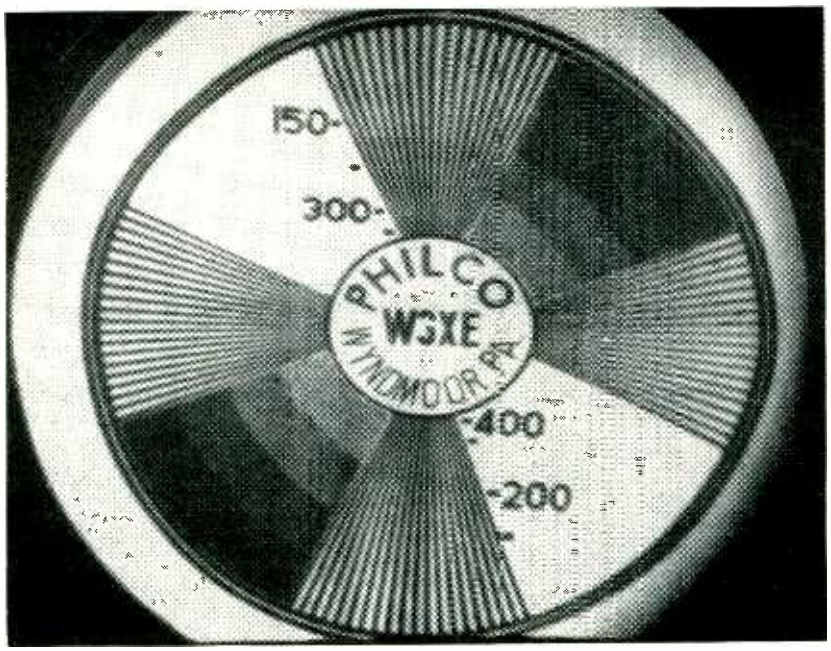

FIG. 4—Noninterlaced monochrome test chart

val. If additional samples are taken at a higher rate, indicated by dotted pulses in 1B, then higher-frequency modulations can be resolved. To determine the highest modulating frequency which can be resolved by a sampling system, we may study the following analysis:

A set of unmodulated rectangular pulses having a width d and period T can be defined by a Fourier series such as

$$f(t) = \frac{d}{T}\left(1 + 2\sum_{1}^{\infty} a_n \cos n\omega_0 t\right) \qquad (1)$$

where

$$a_n = \frac{\sin \frac{\pi n d}{T}}{\frac{\pi n d}{T}} \qquad \omega_0 = \frac{2\pi}{T}$$

Now suppose that a signal consisting of d-c and sinusoidal terms is sampled by this set of pulses. Let this signal be $A(1 + m\cos\omega_a t)$. Then the modulated set of sampling pulses can be expressed as $A(1 + m\cos\omega_a t)\, f(t)$. A Fourier analysis of the spectrum of the pulse train, valid provided the width of the pulses d is small compared to their period T, shows it to consist of the original modulation plus a group of carriers at the frequency of the sampling operation and harmonics thereof, each with an upper and lower sideband. This is expressed by the equation

$$A(1 + m\cos\omega_a t)\, f(t) = A\, f(t) + A\, m\, \frac{d}{T}\left\{\cos\omega_a t + \sum_{1}^{\infty} a_n\left[\cos(n\omega_0 + \omega_a)t + \cos(n\omega_0 - \omega_a)t\right]\right\} \qquad (2)$$

Therefore, original modulation can be recovered by applying the pulse energy to a low-pass filter having a linear phase characteristic with a passband equal to the modulation bandwidth. This can be seen from the last equation by noting that the filter will remove all terms except the original modulation, provided that the sampling frequency is greater than twice the highest modulating frequency so that the lower sideband of the fundamental sampling frequency $(\omega_0 - \omega_a)$ does not fall in the range of modulation frequencies.

Basic System

If the modulating frequency exceeds one half the sampling frequency, or if the modulation recovery filter does not suppress frequencies above one-half the sampling frequency, the lower sideband of the fundamental sampling frequency also will be passed by the filter and this will prevent the undisturbed recovery of the original modulation. From the above it is seen that if it is desired to recover only the original modulation from a sampled signal, certain sampling rate and filter requirements must be met.

A single-channel sampling system such as was just considered is of little practical value since it has been shown that the output of the transmission system is the original modulation, and this modulation could have been passed without sampling. However, the single-channel system serves as the basic building block from which more complex systems can be designed.

The discussion has been concerned only with transmission systems having no appreciable storage capability and is applicable, for example, to the transmission of a television video signal in which the information from one scan of the image is nearly instantaneously reproduced at the receiver. However, television transmission is based upon the principle of sequential scanning of an image area and offers an ideal situation for sampling of relatively high-frequency information over a time interval and for the subsequent reproduction of the original information by means of a storage device operable over a similar time interval. For example, the high-frequency modulation of Fig. 1 could be transmitted by increasing the sampling rate and transmission bandwidth.

Interlaced System

However, this can not be done in practice and, therefore, a different technique is required. This has been found in interlaced sampling. In one specific form of interlaced sampling applicable to television each line signal of a video raster is sampled twice, with the points of the two sampling sequences occurring in alternate fields, and with the points of each sequence falling on the same signal midway in time between the points of the previous sampling (as indicated in Fig. 1B). Since the interlaced sampling now requires a time of two normal scanning fields it is necessary to note that for purposes of calculation it is assumed there has been no motion of the image during the dual field interval and that the video signals derived in these fields are

identical. However, this limitation is non-essential to the practical application of interlacing techniques.

To study the performance of an interlaced system with high-frequency modulation consider a modulating signal ω_a of a frequency between F and $2F$ cycles sampled at the rate of $2F$ cycles per second and the resulting pulse train being transmitted through a system of bandwidth F cycles.

Then Eq. 2 is the expression for the pulse train spectrum and after transmission with the resultant filtering the output is

$$\frac{A\,d}{T} + \frac{m\,A\,d}{T} a_1 \cos(\omega_0 - \omega_a)\,t \quad (3)$$

The output consists of a d-c term plus only the lower sideband of the fundamental sampling frequency. If the same modulation is re-sampled at a subsequent time, such as during the next field at intervals translated with respect to the modulation by the interval $T/2$ the transmission system output is

$$\frac{A\,d}{T} + m\,\frac{A\,d}{T} a_1 \cos(\omega_0 - \omega_a + \pi)\,t \quad (4)$$

If at the receiver each of the signals represented by Eq. 3 and 4 are sampled by a gate at a rate and at a phase corresponding to the initial sampling of each signal, a new pulse train is formed and one has from Eq. 3 and 1,

$$A\left(\frac{d}{T}\right)^2 [1 + 2\sum_1^\infty a_n \cos n\,\omega_0 t] + m\,a_1$$

$$A\left(\frac{d}{T}\right)^2 \left[\cos(\omega_0 - \omega_a)\,t + \sum_1^\infty a_n \left\{\cos(n\omega_0 + \omega_0 - \omega_a)\,t + \cos(n\,\omega_0 - \omega_0 + \omega_a)\,t\right\}\right] \quad (5)$$

and from Eq. 4 and 1

$$A\left(\frac{d}{T}\right)^2 \left[1 + 2\sum_1^\infty (-1)^n a_n \cos n\,\omega_0 t\right] -$$

$$m\,a_1 A\left(\frac{d}{T}\right)^2 \left[\cos(\omega_0 - \omega_a)\,t + \sum_1^\infty (-1)^n a_n \left\{\cos(n\,\omega_0 + \omega_0 - \omega_a)\,t + \cos(n\,\omega_0 - \omega_0 + \omega_a)\,t\right\}\right] \quad (6)$$

If each of these signals from the receiver gate as expressed by Eq. 5 and 6 is passed through a filter of bandwidth sufficient to pass the modulation frequency spectrum only (frequencies between 0 and $2F$) the filtered output for each input signal will be for Eq. 5

$$A\left(\frac{d}{T}\right)^2 \left[1 + m\,a_1 \cos(\omega_0 - \omega_a)\,t + m\,a_1^2 \cos\omega_a t\right] \quad (7)$$

and for Eq. 6,

$$A\left(\frac{d}{T}\right)^2 \left[1 - m\,a_1 \cos(\omega_0 - \omega_a)\,t + m\,a_1^2 \cos\omega_a t\right] \quad (8)$$

Each of these signals may now be presented in time sequence to an adding device which will sum the signals in accordance with their original relative orientation in time and the result of the addition will be a signal of the form

$$A\left(\frac{d}{T}\right)^2 [2 + 2\,m\,a_1^2 \cos\omega_a t] \quad (9)$$

This signal contains no output other than the original modulation, which has now been recovered. For signals of modulation frequency less than F, the output waveform after passing through the receiver gate can be found by multiplying together Eq. 1 and the modulation terms of Eq. 2 and eliminating all terms which are out of the system passband. From this it is observed that the depth of modulation is the same for both input signals above and below the frequency F (but less than $2F$) and that all terms other than the modulation cancel in the adding process. Hence transmission without distortion is possible in the full modulation bandwidth 0 to $2F$ cycles per second in this interlaced sampling system of bandwidth F cycles. This is not inconsistent with the Hartley Law since a longer time of transmission (by a factor of 2) has been used.

In the foregoing discussion we have not specified the means by which the two sequential signals may be added. One method is to present each signal to a cathode-ray tube having a phosphor of moderately long persistence or to a similar storage device in which the two successive signals may be overlaid. To obtain a replica of the original signal waveform the storage device may be scanned and its signal be converted to voltage waveform. For television receiver applications, the resulting modulated light pattern of the cathode-ray tube may be the final desired signal. In practical television, very long time storage devices can not be used due to requirements of motion in the subject, but medium storage devices comprising phosphors of single or double field persistence are satisfactory.

Multiplex Techniques

The preceding discussion has been limited to some considerations in which a single-channel input signal has been sampled into a pulse train before transmission. This same sampling technique may be extended to the sampling in sequence of a number of input signals.

Consider a three-channel time-division multiplexing system as shown in Fig. 2. Let the modulation bandwidth of all three channels be equal. It was shown above that the sampling rate per channel must be twice the highest modulating frequency F_m. Therefore, the combined three-channel pulse rate of $2F$, where F is again the transmission system bandwidth, must be six times the frequency F_m, or $3F_m = F$. Further, in order to obtain at the receiver pulses whose amplitudes correspond to pulse output of the transmitter samples it is necessary to use a synchronized receiver gate (or resampler).

By simple arrangement, the receiver gate can also conveniently pass the proper pulses into separate channels so that the pulses delivered to each channel at the receiver correspond to the sampled signal of that channel at the transmitter. Each channel now becomes the equivalent of the single-channel case which was previously considered, and hence the original modulation in each channel can be recovered by filtering if desired. The three-channel example is applicable to a color television system.

In the application to television of the sampling and multiplexing techniques which have been described the general systems have become known as Dot Transmission Systems, since the presentation of the final picture may be in the form of an orderly arrangement of intensity-modulated dots of light.

Non-Interlaced Monochrome Television

The simplest application of sampling might be in a conventional monochrome television system wherein the video output of the camera chain is sampled at a rate

of approximately 8 mc. The pulse train is then filtered to a bandwidth of 4 mc for transmission and reception in conventional manner. At the receiver, the video detector output signal may be gated to reform pulses (identical to the original samples) and the pulses may directly gate and modulate the cathode-ray tube beam.

Figure 3 is a typical photograph of a subject viewed on a dotted picture tube. The photograph shows the grain structure of the picture although at normal viewing distance this could not be resolved by the observer.

Figure 4 is a similar photograph of a test signal which includes input modulation frequencies in excess of half the sampling rate. These frequencies are present in the region of the vertical wedges where the line structure is finer than the dot structure of the reproduced picture. Hence as predicted, the resulting pattern shows the presence of the lower sideband of the fundamental sampling rate, which is resolved as a relatively low-frequency component. This same effect is actually present in Fig. 3 but is not detectable since the subject does not include sufficiently large regions of abnormally high-frequency information.

Interlaced Monochrome Television

This application is similar to the non-interlaced case except that the interlace technique described previously is applicable. That is, the transmitter and receiver sampling systems are effectively modulated at a 15-cycle rate so that on alternate frames of a normal 60-field 30-frame vertically interlaced video signal, samples are taken at the midpoints of the previous frame samples. Effectively, therefore, the sampling is accomplished at a 15-frame rate and double normal resolution may thus be obtained in the resulting picture.

This resolution is shown in Fig. 5 which shows the test signal as reproduced by an interlaced sampling system. The vertical wedge pattern is faithfully reproduced to patterns corresponding to modulating frequencies of 5 mc (corresponding to the pattern at the center circle). In similar tests made in the early spring of this year, resolution wedges on test signals were fully resolved with patterns corresponding to modulating frequencies of 7.5 mc when the transmission bandwidth was limited to 4 mc.

It was previously mentioned that in systems of interlacing, it is necessary for the receiving device to integrate two successively presented signals into one pattern. This requirement presents an interesting problem of flicker when interlaced signals are used for tele-

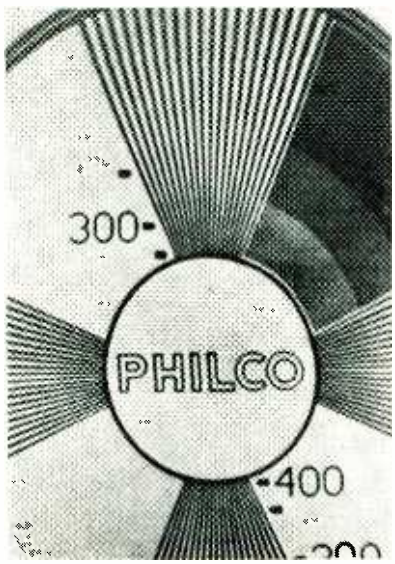

FIG. 5 — Interlaced monochrome test chart

vision displays. Obviously, very long decay phosphors cannot be used due to the requirements of motion in the picture since a long decay time would add smearing trails to moving subjects. On the other hand the failure of a short decay phosphor fully to integrate the signal over a fifteenth of a second presents some unusual types of flicker. For instance, with modulating frequencies which are under half the sampling rate, it has been shown that interlacing is unnecessary. Hence, in areas of the picture having only low-frequency modulations, interlacing serves only to increase the frequency of certain carrier terms to effect a finer grain dot pattern, provided the video bandwidth beyond the receiver gate is effectively unlimited.

Wide bandwidth at this point can be accomplished very conveniently by applying the receiver gating carrier directly to the cathode-ray tube so as to gate the electron beam. In this case it would be observed that for each line the interdot flicker rate is the line repetition rate of 30 cycles. However, if the bandwidth beyond the receiver gate is limited to just below the carrier frequency ($2F$) the above situation does not obtain and the signal presented on each sampling will include, in addition to the desired modulation, the lower sideband of the gating carrier. The expressions for each signal are:

$$A\left(\frac{d}{T}\right)^2 [1 + m\, a_1^2 \cos \omega_a t + m\, a_1 \cos (\omega_0 - \omega_a)\, t] \quad (10)$$

$$A\left(\frac{d}{T}\right)^2 [1 + m\, a_1^2 \cos \omega_a t - m\, a_1 \cos (\omega_0 - \omega_a)\, t] \quad (11)$$

The lower sideband will cancel if the addition is complete, but the viewed signal will include 15-cycle components which may flicker if storage is inadequate. Of course, Eq. 5 and 6 indicate that the picture will include 15-cycle components in regions of high-frequency modulation (between F and $2F$ cycles) regardless of the choice of the bandwidth of circuits beyond the receiver gates.

A wideband video system following the receiver gate apparently is to be preferred, although subjective tests are necessary fully to evaluate the effect of flicker on picture quality in cases of general usage where the system may be flickerless to low-frequency modulation but may possess flicker in regions of high-frequency modulation. Tests to date using a cathode-ray tube having a phosphor with a relatively short decay time appear to show that even at high luminosity levels, areas of low-modulation-frequency signals have only slight sparkle when wideband gate circuits are used as compared to pronounced flicker when a narrowband gate circuit is used.

Tests with dot interlace systems have shown no tendency for interlace crawl, interlace breakup or other picture deterioration beyond that normally present in a conventional vertically interlaced television picture.

Warbler for Beat-Frequency Oscillator

A reactance-tube modulator for use with heterodyne audio oscillator produces frequency deviations of plus and minus ten percent with inputs from 2 to 1,000 cycles. Designed for a flutter generator the circuit has other audio applications

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ACOUSTICIANS and psychologists are often faced with the problem of providing, for experimental purposes, a frequency-modulated or warbled audio tone having negligible inherent amplitude modulation and a variable frequency and degree of modulation.

Common Systems

Experimenters have, in general, met the problem by resorting to mechanical means; probably the most popular method is the use of a mechanically-driven variable capacitor in the tuned circuit of one oscillator of a beat-frequency type audio oscillator.[1] This method is not only cumbersome, but is also subject to restrictions imposed by mechanical tolerances on the accuracy of calibration. The solution to be described lies in an electronic means of producing the frequency-modulated tone.

There are several methods of frequency modulating R-C phase shift oscillators and obtaining, with the proper design, negligible amplitude modulation.[2,3] Circuits of this nature are employed in subcarrier facsimile transmission. Here, however, we are chiefly interested in the heterodyne-type audio oscillator

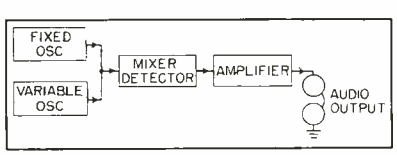
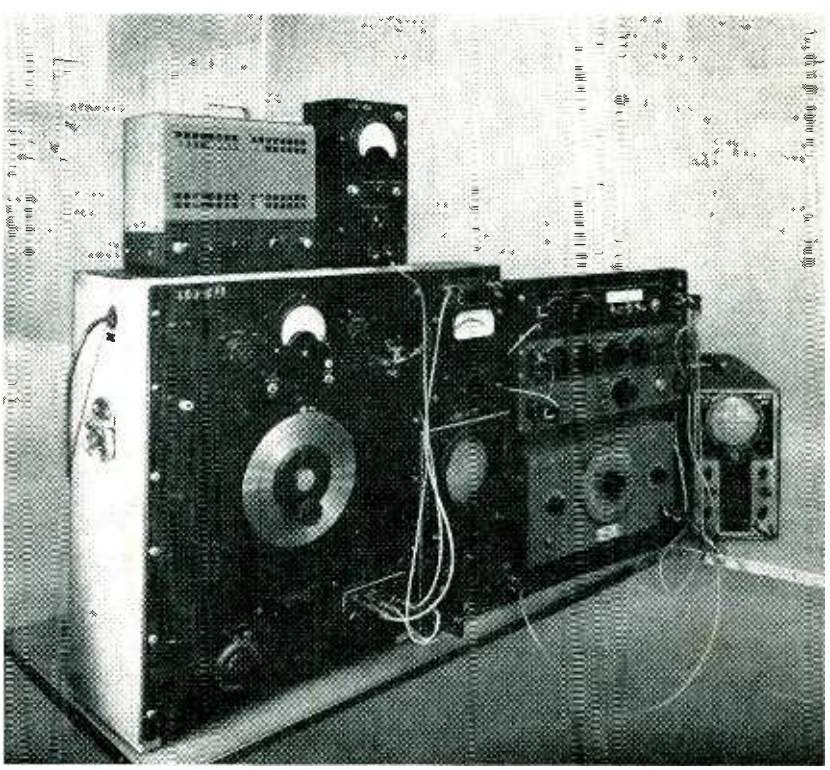


FIG. 1—Simplified arrangement of heterodyne type audio oscillator



Equipment setup for subjective determination of flutter threshold. The reactance modulator is mounted on a sub-chassis in the type 713 oscillator

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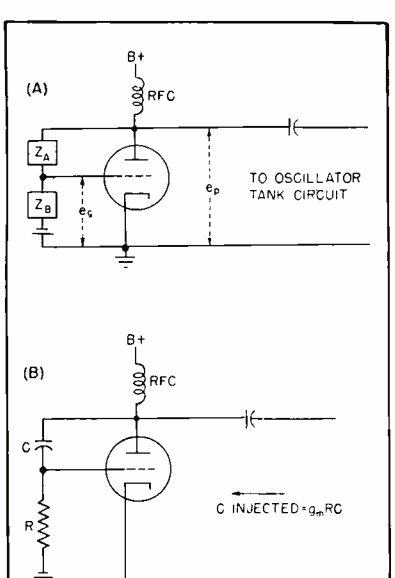

FIG. 2—Basic reactance-tube circuit (A) in which Z_A and Z_B provide 90-deg shift, and capacitive form (B)

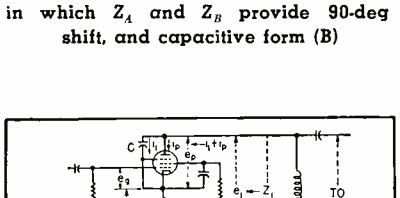

FIG. 3—A type of reactance modulator requiring no avc with little amplitude modulation

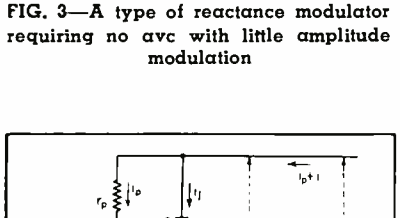

FIG. 4—The linear equivalent circuit derived from the practical modulator shown in Fig. 3

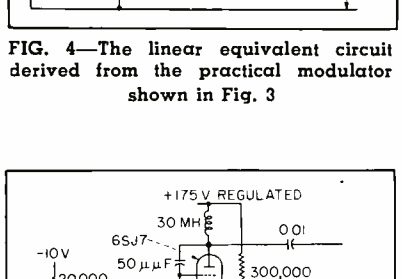

FIG. 5—Final degenerative-type modulator circuit that was built into commercial beat-frequency oscillator

and shall confine this discussion to it alone.

Electronic Frequency Modulator

The reactance-tube modulator offers itself at once for the electrical performance of the task accomplished by the mechanically-driven rotating capacitor. The basic set-up of a heterodyne type oscillator is shown in Fig. 1. The frequencies of the beating oscillators are usually in the neighborhood of 200 kc in most commercial types.

By placing a reactance-tube modulator across the tuned circuit of the fixed oscillator and feeding into it the desired modulating signal, a frequency-modulated or warbled audio output is produced. In order that no amplitude modulation be present in the output, the amplitude of the modulated high-frequency oscillator must not vary with the modulating signal. Therefore the a-c component of the plate current in the reactance tube that is in phase with the tank circuit voltage must be kept very small, and must be essentially independent of the modulating signal, in order to give negligible resistive shunting of the tuned circuit.

In considering specific requirements, it should be noted that a normal ear is capable of detecting a difference limen of as low as 2 cps on a 1,000-cps base, under certain conditions of low flutter rates. Thus the modulator must be capable of producing accurately a warbler frequency deviation of as low as ±0.1 percent. In terms of the frequency deviation of the high-frequency oscillator that is modulated by the reactance tube, this frequency deviation is much smaller (±0.0005 percent on a 200-kc base). The problem then reduces to one of using a modulator that will provide a warbler frequency deviation that may be accurately controlled, measured, and reproduced in the range of ±0.1 to approximately ±10 percent, and which produces less than one-percent amplitude modulation.

Selecting the Modulator

The basic reactance-tube circuit takes the form shown in Fig. 2A, where the elements Z_A and Z_B provide a phase shift of approximately 90 degrees between e_p and e_g.

The nature of the elements Z_A and Z_B is dependent upon whether the tube is to appear capacitive or inductive. In the simplest capacitive form the circuit would appear as in Fig. 2B, where the injected capacitance is approximately equal to $g_m RC$ for high plate-resistance tubes (such as pentodes) as is shown in most any basic electronics text.[4,5]

Actually, taking into account the phase-shift circuit, the injected impedance seen by the tank circuit is equal to

$$\frac{R + 1/j\omega C}{1 + g_m R}$$, where in general,

$$\frac{R}{1 + g_m R} << \frac{1}{j\omega C\,(1 + g_m R)}$$ and the modulator appears mainly reactive.

In the course of the investigation several modifications of this basic circuit were employed to frequency modulate a heterodyne oscillator (a General Radio type 713AS9 and also a type 913). Low-plate-resistance triodes were ruled out at the outset on the basis that a variation in plate voltage, as produced by the oscillator tank circuit, would cause a relatively large in-phase compon-

Table I — Comparison of Measured and Calculated Capacitance Injected for Different Voltage Combinations

E_{cn} volts	E_c volts	E_{c2} volts	g_m μmhos	C_{in} measured μμf	C_{in} calculated μμf
0	1.7	62	913	23.0	26.2
2	3.2	85	670	25.5	30.0
4	4.8	110	553	28.3	32.2
6	6.5	130	393	31.4	36.0
8	8.2	150	270	35.2	39.3
10	10.0	170	170	40.2	42.7

ent of plate current and, consequently, an objectionable amount of amplitude modulation. It was found that for the desired application this type of circuit produced in general an overly sufficient amount of frequency modulation and an intolerable amount of amplitude modulation. Using elements of practical size, the sensitivity of the injected capacitance of this type modulator to variations in g_m (or to the modulating signal) was too great for accurate control and measurement of the low deviations. Also, since the resistive component of the injected impedance is a function of g_m, amplitude modulation could not be avoided without resorting to intricate avc circuits.

A modulator circuit, devised by P. Dippolito of Harvard Psycho-Acoustics Lab, that eliminates these objectionable features is shown in Fig. 3. A simple linear analysis of this modulator follows and the impedance relations are derived.

From the above circuit the following relations are evident, where the quantities are complex a-c values.

$$e_g = -R\,(i_1 + i_p)$$
$$e_p = X_c\, i_1$$
$$e_1 = X_c\, i_1 + R\,(i_1 + i_p)$$
$$= e_p - e_g$$

The linear equivalent circuit is shown in Fig. 4, from which follows

$$Z \text{ (injected)} = Z_1 = e_1/(i_p + i_1)$$

$$Z_1 = \frac{X_c\, i_1 + R\,(i_1 + i_p)}{i_p + i_1}$$

$$Z_1 = R + X_c\left(\frac{i_1}{i_p + i_1}\right)$$

$$i_p = i_1\left[\frac{X_c - \mu R}{r_p + \mu R}\right]$$

$$i_p = i_1\left[\frac{X_c/r_p - g_m R}{1 + g_m R}\right]$$

$$Z_1 = R + X_c\left[\frac{1}{1 + \dfrac{X_c/r_p - g_m R}{1 + g_m R}}\right]$$

$$Z_1 = R + X_c\left[\frac{1 + g_m R}{1 + X_c/r_p}\right]$$

*If $r_p >> X_c$ (as would be the case for pentodes)

$$Z_1 = R + X_c\,(1 + g_m R)$$

$$Z_1 = R + \frac{1}{j\omega\left(\dfrac{C}{1 + g_m R}\right)}$$

In comparing this modulator with the basic circuit first discussed we note that for the basic circuit

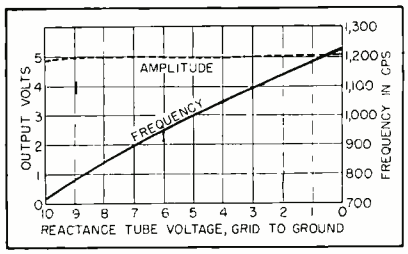

FIG. 6—Static calibration of warbler for 1,000-cps base frequency. Amplitude is essentially constant

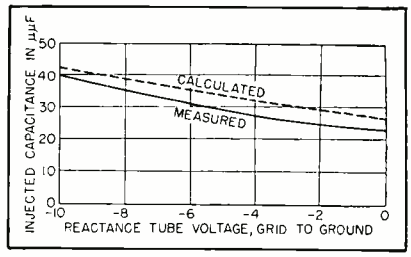

FIG. 7—Graphical comparison of measured and calculated values of injected capacitance

$$Z_{\text{inject}} = \frac{R}{1 + g_m R} - j\,\frac{1}{\omega\, C\,(1 + g_m R)}$$

For the degenerative circuit

$$Z_{\text{inject}} = R - j\,\frac{1}{\omega\left(\dfrac{C}{1 + g_m R}\right)}$$

The resistive component injected by the latter circuit is therefore constant for linear operation, and will produce little amplitude modulation. Thus the necessity of complicating the apparatus with avc circuits to obtain the desired amplitude characteristics is foregone. Defining the sensitivity of the injected capacitance to variations in g_m as $\partial C_{\text{inject}}/\partial g_m$, we obtain for the respective sensitivities of the basic circuit $C_{\text{inject}}/\partial g_m = RC$ and of the degenerative circuit $\partial C_{\text{inject}}/\partial g_m = -RC/(1 + g_m R)^2$. The degenerative circuit is considerably less sensitive for given values of R and C, and provides for more accurate reproduction of a given frequency deviation with less accurate measurement of the modulating signal. It should also be noted that the latter circuit has the advantage that the output impedance of the modulating signal source has no effect upon the phase-shift circuit, as might be the case in driving the former modulator.

Warbler Equipment

A degenerative type modulator stage with the circuit elements shown in Fig. 5 was built into a General Radio type 713 beat frequency oscillator, and found to perform exceedingly well. With sinusoidal modulator inputs of 2 to 1,000 cps, a frequency deviation of approximately ±10 percent was obtained with negligible amplitude modulation. This instrument is currently being employed as a flutter generator for subjective flutter threshold measurements. It will be noted from the circuit that the screen grid is bypassed only for the r-f oscillator frequency, and not the audio modulating frequency. The purpose in this arrangement was to obtain a variation in g_m with grid voltage which would produce a linear overall frequency variation of the warbler with the input signal. Static calibration curves of this warbler for a 1,000-cps base frequency are shown in Fig. 6.

The injected capacitance of this modulator was measured on a General Radio capacitance bridge Type 716-C, by the substitution method, at a frequency of 200 kc. The injected capacitance was also calculated from the expression obtained in the foregoing derivation. Sample data are shown in the accompanying table and results are plotted in Fig. 7 comparing the measured and calculated values.

Although the circuit has, so far, been used only for producing a sinusoidally frequency - modulated audio tone for subjective flutter measurements, the modulating signal waveform is certainly not limited to sinusoids. The ability of the circuit arrangement to modulate the audio tone with any desired type of wave is counted as a prime advantage.

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Ultrasonic Control

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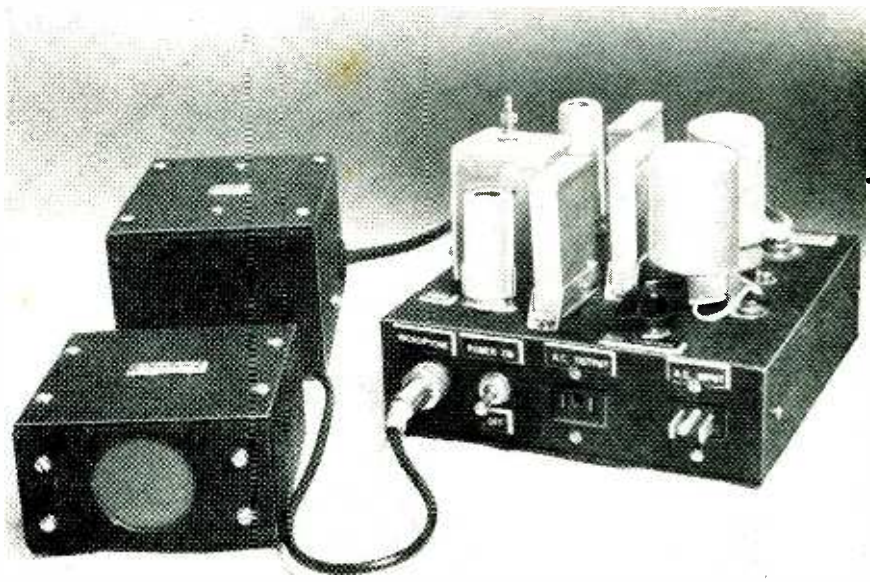

Microphone and amplifier chassis for converting ultrasonic signal into projector operation

THE operation of lantern slide projectors always has been a problem in classrooms. The lecturer has had either to secure the services of an assistant or operate the projector himself. Since the introduction of automatic pushbutton-actuated equipment it has not been necessary for the lecturer to remain behind the projector, but the long control cable has still impeded his freedom of movement. The desirability of a control system that allowed unrestricted movement, and with which an unattended projector apparently operated by mental telepathy, resulted in the ultrasonic control system*.

Galton whistle actuated by atomizer bulb gives 25-kc signal

Tripping mechanism of standard slide projector is triggered by a hidden whistle

In searching for a form of synthetic mental telepathy the electrical engineer instinctively thinks first of radio, induction or capacitance control schemes. Radio and induction control were discarded because they would burden the lecturer with batteries and other bulky equipment. Capacitance control would require visible motion and might be uncertain, However, these and other objections have been overcome by the use of a control circuit that the lecturer actuates by a miniature whistle on a rubber bulb concealed in his pocket.

The whistle is the heart of any such system and, from the viewpoint of an electrical engineer, is its most mysterious and troublesome component. It was contemplated that one of the extensively advertised inaudible dog whistles could be used, but all of the models tested became inoperative or too erratic at frequencies above 12 to 15 kc. This frequency range can be heard plainly by youthful ears.

Tests with a laboratory model Galton whistle showed that satisfactory operation at 25 kc could be obtained from the air pressure of a home atomizer bulb, but the whistle was too large to be concealed in the pocket. Since the jet and cavity account for a negligible part of the volume from the laboratory whistle, a miniature whistle was developed. Constructional details are shown in Fig. 1. The 25-kc cavity has a diameter of 5/32 inch and a depth of approximately 5/64 inch, or only half its diameter. This ratio of depth to diameter might be inefficient for an organ pipe or audible whistle but the Galton type whistle employs a very thin circular jet of the same diameter as the cavity. In this miniature whistle the circular jet is obtained by centering a plug in the orifice with 0.003-in. shims.

A block schematic of the control circuit is shown in Fig. 2. The very weak energy from the crystal microphone is amplified by a moderately selective two-stage 25-kc amplifier, after which it is rectified, amplified and applied to a relay circuit controlling the projector.

The microphone contains a stack of six ammonium dihydrogen phosphate (ADP) crystals cemented to

* The work described here is based on a thesis leading toward the degree of Master of Electrical Engineering.

# of a Slide Projector

An atomizer bulb in the lecturer's pocket operates a modified Galton whistle at 25 kc. Frequency-sensitive microphone picks up signal, which is amplified to operate solenoid in conventional slide changer. Antijamming circuits are built in

a 0.010-in. Bakelite diaphragm. The individual crystals are 2.5 in. long, 1.2 in. wide and 0.24 in. deep, and the stack is housed in a metal box packed with a cork-neoprene compound called Corprene, which has an acoustic impedance approximating that of air. The resonant impedance of the microphone is 42,900 ohms at minus 70 degrees.

The schematic diagram of the amplifier, Fig. 3, shows the microphone capacitively coupled to the first 6BA6 tube, which has a single-tuned plate circuit and feeds a second 6BA6 stage. No effort was made to achieve high selectivity because the whistle frequency may change slightly and interference is unimportant. These two 25-kc stages are operated at zero bias and their gain drops from 17,000 for a 1-millivolt signal to 7,500 for 4 millivolts. A type 1N34 crystal is used as the detector, followed by a 6AQ5 d-c amplifier, with a sensitive relay in its plate circuit. The power supply for all plates is a transformerless voltage doubler using selenium rectifiers.

The contacts of the sensitive relay were inadequate for the 115-v motor control circuit of the projector, so this first relay is used to actuate a more rugged relay powered by a single flashlight cell. This second relay could either be eliminated or powered from a-c. Operation of the sensitive relay is monitored by a small red pilot lamp. An unusual but very important feature of the control circuit is the use of a Cramer timer as a ¾-second slow-release circuit. With improper whistle action, or when operating at extreme ranges, the relays may chatter and cause the slide-changing mechanism to operate more than once. The timer forms a hold circuit with a holding time longer than the whistle blast and thus contributes greatly to reliability.

In classroom use the projector is housed in a box on the rear wall and is connected by concealed wiring to the amplifier and control circuit beneath the lecture table. The microphone is placed in an unobstructed position pointing toward the area of the platform that the lecturer may occupy.

Cloth offers considerable attenuation at ultrasonic frequencies. The attenuation at 25 kc through two layers of cloth of an empty pocket amounts to approximately 20 db, and may be very much higher if the lecturer forgets to remove his handkerchief from that pocket. Operation with the whistle concealed in the pocket is reliable within 20 feet. Much greater distances can be obtained by removing the whistle from the pocket.

In any classroom full of veterans there inevitably is at least one ex-countermeasure technician who cannot resist trying to jam an ultrasonic control circuit by excessive applause, by jangling a bunch of keys, or by even more ingenious methods. Such noises can produce false operation only if they occur in front of the microphone and within about three feet of it. The only successful means of producing false operation from the audience, and thus speeding up a dry lecture, would be to use a powerful ultrasonic whistle of the correct frequency. Even then, the lecturer's counter-countermeasure would be to cut back the gain control and remain closer to the microphone!

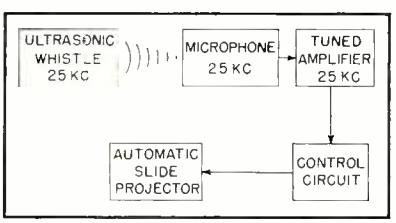

FIG. 2—Ultrasonic projector system

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

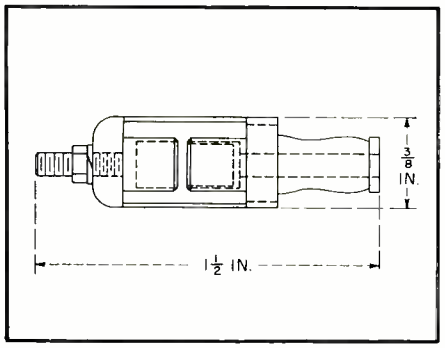

FIG. 1—Modified Galton whistle for 25-kc ultrasonic signal

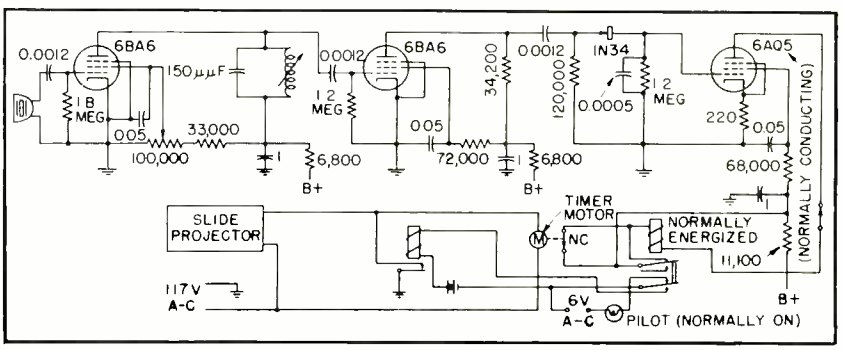

FIG. 3—Projector control, showing time-delay circuit to insure against false sequential operation

Race Finish Recorder

By JOHN C. BECKMAN and ERNEST M. WHITLEY

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IN DETERMINING the winners of races, particularly horse races, the slit camera has been widely applied for a number of years.

The slit camera contains an always-open vertical slit in place of a shutter and a mechanism for advancing a continuous strip of film behind the slit at a speed proportional to the motion of the horses across the finish line of the track. The slit is aligned with the finish line.

As the race nears completion the camera motor is started and all entries are photographed during the period in which they approach and cross the finish line. Processed prints reveal the detailed relationships with an accuracy far beyond the capabilities of human observers.

The objective in the development of the equipment to be described, illustrated herewith as well as on the cover of this issue of ELECTRONICS, has been to add to the basic slit-camera concept an integral and precisely synchronized record of time elapsed from the firing of the starter's gun to the finish of the race. That this has been accomplished is illustrated in the actual finish photograph of runners. The figures across the top of the picture indicate seconds from the start. Any runner's time can be determined by dropping a vertical to his chest and reading directly from the scale, interpolating as necessary.

In the conventional slit-camera technique, a revolving drum at the edge of the track opposite the camera and on the finish line inserts marks on the film as the images of vertical lines spaced around the periphery of the drum. These serve as convenient spacing references but provide no measure of absolute elapsed time.

Since the Phototimer was developed for Bulova Watch Company to use primarily in timing track events, the particular problems associated with track events had to be taken into consideration. In horse and dog races, the nose comes first, even though it may be preceded by a paw or hoof. In the trackman's rulebook, the winner is the one whose torso first hits the tape, and the problem of judging finishes is complicated by final lunges which throw arms or shoulders against the tape.

Other problems in track judging are created by closely-bunched finishes and by the obscuring of farside runners by those in the closer lanes of eight-lane fields. In track judging it is common to assign definite placings to specific

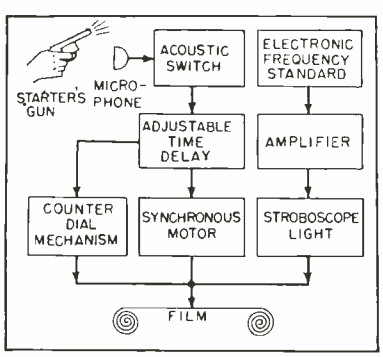
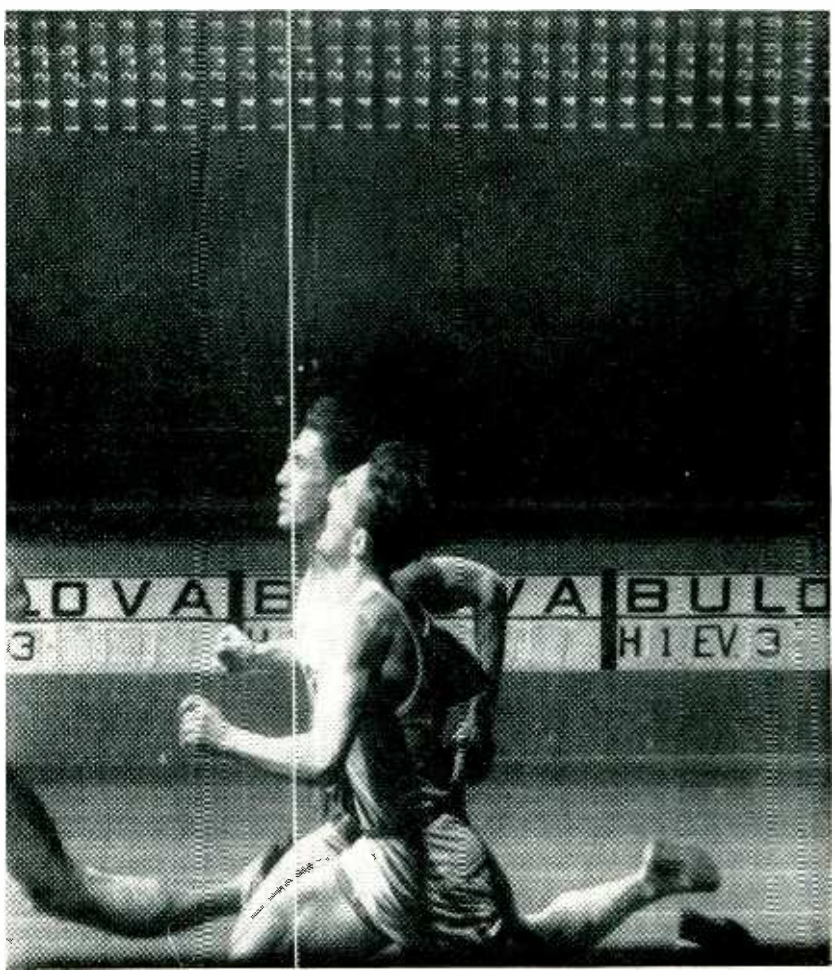


FIG. 1—Functions of stages of the complete system



Finish photo with time figures for each contestant, as taken with race finish recorder described here and shown on front cover

Starter's gun triggers acoustic switch. This starts timing mechanism which is driven by synchronous motor powered from tuning-fork oscillator-amplifier. Synchronized light prints time on moving film on which winners are photographed

judges. Since the second-place judge, for instance, cannot be certain who will finish second until it has happened, he may have his eye on the third-place man at the actual finish. There is a reported tendency for runners who finish well forward to be picked by no judge—with resulting complications.

Equipment

An accompanying photograph shows a closeup of the camera and associated electronic equipment as set up for operation. The block diagram of Fig. 1 shows the functional interrelation of the units illustrated. The microphone and acoustic switch form a remote unit.

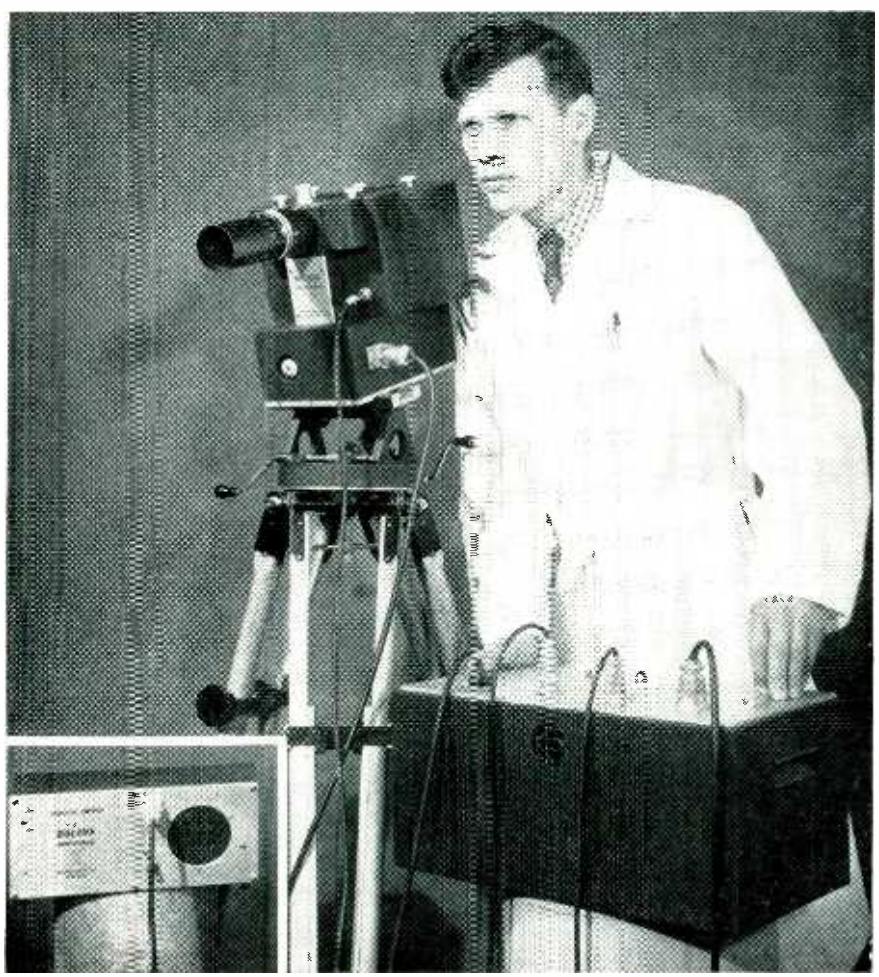
In operation, the sound of the starter's gun is picked up by a microphone in the acoustic switch unit at the operator's right in the illustration. This unit is placed within 20 feet of the starter. Its actuation triggers off the counter dials, visible to the film in the camera. These rotate continuously throughout the race. Alternative arrangements permit starting the timing mechanism by a photocell switch, from a greyhound starting-box switch in the case of dog racing, or radio or lightbeam link from any desired location. Time lag in this step is measured beforehand and compensated within the adjustable time lag device.

The counter dials, continuously advancing, are driven by the same synchronous motor that drives the stroboscope light through a commutator. Power for this motor comes from a tuning-fork frequency standard whose vibrations are picked up magnetically and amplified electronically to an adequate power level.

The dials are illuminated once every 0.01 second by the stroboscope light source. The two elements are thus synchronized by a mechanical link through the synchronous motor. Flashes of light have a duration of 0.00001 second. Each of the figures visible along the upper edge of the film, therefore, represents a single exposure of the counter dials which advance 0.01 second between each exposure.

Film speed, it can be seen, has nothing to do with synchronization but is free to be controlled in accordance with the speed of movement of the images, thus making them as sharply-defined as possible. If the film is slowed down, the time marks are simply brought closer together.

Figure 2 is the circuit of the acoustic switch. It utilizes a small loudspeaker as a microphone. A



Complete setup of timing equipment and slit camera. The acoustic switch at left picks up the sound of the starter's gun

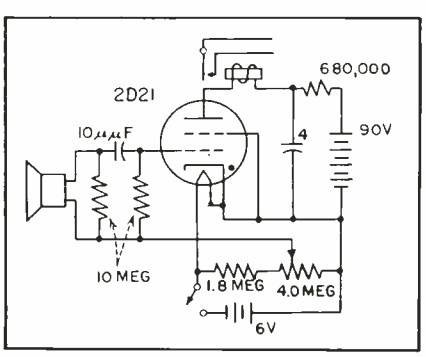


FIG. 2—Circuit of portable acoustic switch which is placed by the starter

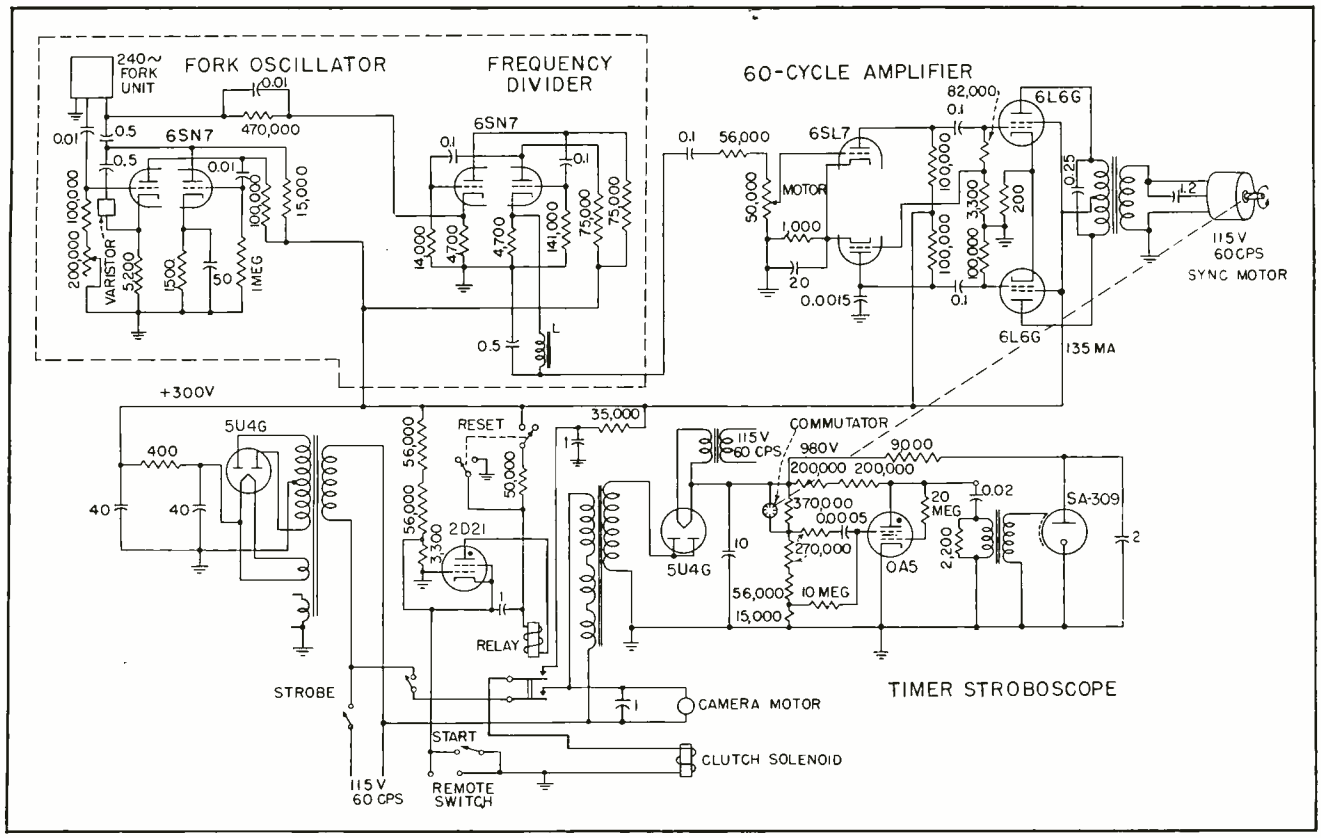


FIG. 3—Complete circuit of equipment mounted at camera. Switches other than acoustic may be used to initiate the timing

type 2D21 thyratron is fired by the pulse caused by the sound of the starting gun. This circuit is powered by batteries because the unit is required to be portable so it can be placed within the required 20 feet of the starter. The time lag represented by this distance is the extreme range of the adjustable time lag in the counter unit.

Twisted-pair line is run from the acoustic switch to the location of the camera unit at the finish line.

The frequency standard is the initial section of the unit located at the finish line. It is shown in the general schematic diagram of Fig. 3. The fork oscillator utilizes a type 6SN7 driven from a magnetic pickup sealed inside a hermetically-housed and rubber-shock-mounted fork unit operating at 240 cps. It is temperature compensated through a varistor located in a feedback loop between the two sections of the double triode.

This is followed by a 4-to-1 frequency-divider circuit consisting of another 6SN7 in a multivibrator connection. These two units, enclosed in dashed lines on the schematic, are a standard device supplied by American Time Products Inc., under Western Electric license.

The low-impedance cathode-follower output of the frequency standard is fed to a 6SL7 in a phase-rotating circuit. This tube drives a pair of 6L6's in push-pull, and their output drives the synchronous motor which turns the counter dials and the commutator controlling the firing time of the stroboscope light. Motor voltage is controlled in the setting of the 50,000-ohm potentiometer in the 6SL7 grid circuit.

Stroboscope

The acoustic switch input connects to the finish-line equipment at the terminals marked *remote switch*. Various other triggering arrangements can be substituted as the occasion may suggest. Any momentary contact device is adequate to fire the 2D21 thyratron in the stroboscope unit. Firing of this tube closes the relay in its plate circuit. This engages the camera-motor clutch and holds it in operation until the reset button is pressed to remove the plate supply voltage from the 2D21 and ground the plate.

Closing of the relay in the 2D21 plate circuit also energizes the stroboscope power supply, a 5U4 whose high-voltage d-c output supplies plate voltage to the following 0A5 and anode voltage for the type SA309 Sylvania blue-white light source. This 980-volt supply is also commutated and fed through a resistor-capacitor network to the grid of the 0A5. The resulting pulsed output energizes a transformer whose secondary feeds the firing electrode of the SA-309.

In early experiments, the illumination provided by the 0A5 upon firing was used directly to illuminate the counter dials. This operation required the use of high-speed film in the camera, which was not the general practice. The type SA-1309 lamp provided a solution to the problem of a high-intensity flash with the correct spectral distribution of blue-white light to obtain satisfactory images of the counter wheels on the film ordinarily used.

The Bulova Company, which has sponsored the development of the Phototimer described above, is making the recording service available to various major track-meet events.

Sky-Wave F-M Receiver

Multipath reception, generally considered more troublesome for f-m than a-m, is explained and a receiver capable of such reception described. Simulated cochannel tests indicate that transatlantic f-m broadcasting is possible with a 150-kc bandwidth

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AT THE PRESENT TIME there are two main technical obstacles to completely reliable transatlantic communication, noise and multipath fading. In a sense these difficulties are merely two aspects of the same problem, that of trying to receive a desired signal in the presence of unwanted disturbances. The disturbances may consist of atmospheric noise, signals from other transmitters or signals from the desired transmitter that arrive from subsidiary transmission paths and interfere with the main signal.

A-M Interference

It has been known for a long time that with amplitude modulation the signal-to-noise ratio is not essentially modified by the detection process. Thus if we wish to suppress interference by 40 decibels in the output of a receiver we must make sure that there is a similar difference in level between the radio-frequency signals. In the case of multipath interference the situation is not quite so serious because in practice the interference from a delayed version of the same audio signal is not usually so bothersome as a totally new signal. However, when the desired and undesired signals are of comparable magnitude, the envelope distortion becomes intolerable.

By the use of proper frequency-modulation equipment and present standards it is possible to reduce the effect of interference by thirty-odd decibels. These facts might lead one to feel that frequency modulation could be substituted for amplitude modulation under multipath conditions with great advantage.

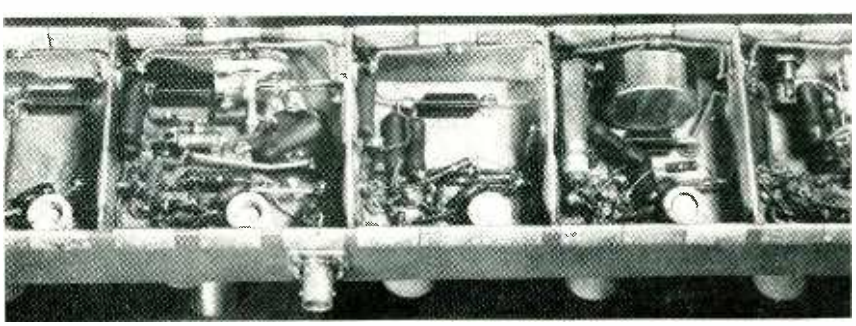
Early experiments[1, 2] indicated that the contrary is true, that frequency modulation is more highly susceptible to multipath interference than is amplitude modulation. The results were very bad when the signals from the various paths became of comparable magnitude.

This result was not surprising because it has usually been assumed that the advantages of frequency modulation only apply when the signal exceeds the interference by a considerable amount, perhaps by two or three to one. This idea of a threshold perhaps arose from the difficulties of computing the interference from ratios near unity and from the fact that with heavy interference receivers depart from our idealized notions of what they should do.

In the case of multipath transmission, or deep selective fading, the desired signal and the interference are likely to be of comparable magnitude. It is not safe, therefore, to assume a two- or three-to-one voltage ratio.

Average vs. Instantaneous Frequency

It has been shown by the writers[3, 4, 5, 6] that no such threshold or necessity for difference in level actually exists if a receiver is carefully designed. The reasons for this can be summarized briefly. If two signals of constant but different frequency and of nearly equal amplitude are superposed their sum has an average frequency which is exactly the frequency of the larger signal. However, the instantaneous frequency varies widely. Most of the time the frequency is very nearly the average frequency of the two signals. However, when the two signals are near phase opposition the phase of their sum jumps by approximately 180 degrees in a very short time interval. This gives rise to a frequency spike or impulse. The nature of the frequency variations has been studied carefully by several writers.[7, 8, 9] If two signals of frequencies f_1 and f_2 differ in amplitude by a small frac-



Portion of the receiver built into a 10-cm waveguide for good shielding

* This work has been supported in part by the Signal Corps, the Air Materiel Command, and ONR.

tion, $1-a$, then the instantaneous frequency may vary over a bandwidth of approximately 2 $\left(\frac{f_1 - f_2}{1 - a}\right)$ For example, if the two signals differ in frequency by 150 kilocycles and in amplitude by 5 percent a band of around 6 megacycles may be covered.

Of course the frequency spectrum of two superposed signals is merely the sum of the spectra of the two signals and is not widened by linear superposition. However, the amplitude of the combined signal varies from the sum of the two amplitudes to the difference. Our 5-percent example corresponds to an amplitude variation of 39 to 1. If this amplitude variation is removed the resultant constant-amplitude signal has a spectrum corresponding to the variation of instantaneous frequency and in our numerical case covers at least a six-megacycle band.

In order to receive a desired signal in the presence of deep fading or interference we may make a receiver that gives a rectified output which varies linearly with frequency over the widened band regardless of input amplitude. This should be followed by a de-emphasis circuit and a filter arranged to remove the ultrasonic components generated by the interference.

The Receiver

In order to illustrate the principles involved it may be useful to describe the special features of a receiver designed to separate a signal and noise differing by only a half decibel (5 percent in voltage). In order to give a very good check on the theory, the receiver design has been kept ultraconservative. No effort has been made to use one vacuum tube where three will work as well. The receiver was built in 10-centimeter waveguide, not because this was necessary but because it eliminated shielding problems. The general scheme of the receiver is indicated in Fig. 1.

There is little unconventional in the early portions up to the limiter. This part must supply a signal of fair peak amplitude to the limiter. Furthermore it must have adequate selectivity but must have a very nearly constant response over its 150-kilocycle pass band. This requirement prevents the relative amplitudes of the signal and interference from changing while their frequencies vary. Failure to use due care at this point may cause the signal and interference to interchange during the audio cycle. In the particular receiver under discussion the response was kept within one percent over this range.

The limiter section consists of four stages, one of which is shown in Fig. 2. It is capable of removing the 39-to-1 variations in amplitude corresponding to the 5-percent margin even when these occur at a 150-kilocycle rate. In fact, such amplitude variations are reduced to something like one percent, a total 70-decibel reduction of amplitude variations. The limiter has a flat response over a bandwidth of 6 megacycles centered at 13.

The discriminator circuit is shown in Fig. 3. This rather unconventional arrangement was used in preference to the more usual Foster-Seeley circuit. Its chief relative advantage is that it is much less subject to diagonal clipping by the detectors. The single radio-frequency bypass capacitor, C, is alternately charged and discharged

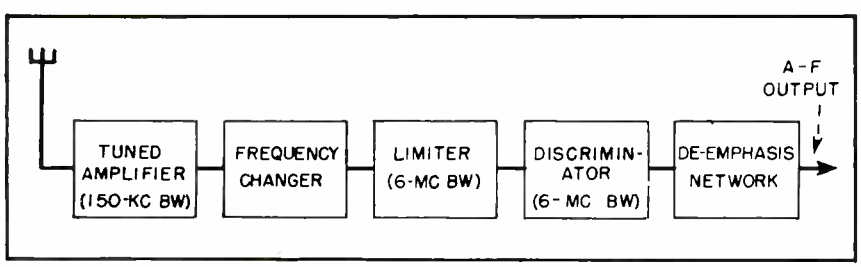


FIG. 1—Block diagram of long-distance f-m receiver showing the main circuit elements and bandwidths required

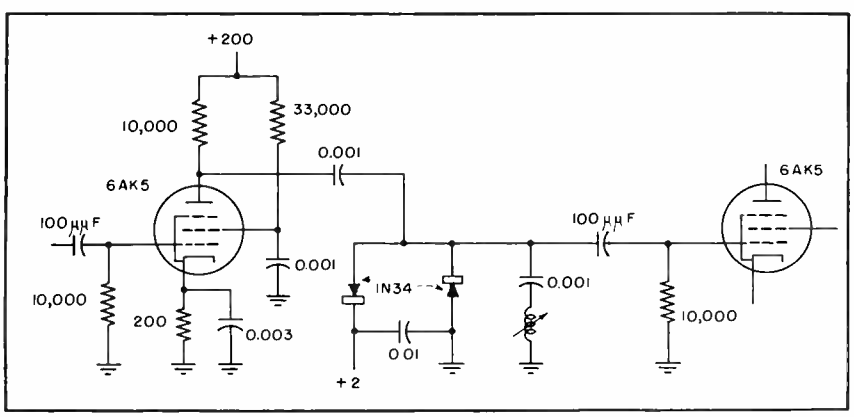


FIG. 2—Representative limiter stage. There are four similar stages used in the prototype receiver to reduce amplitude variations

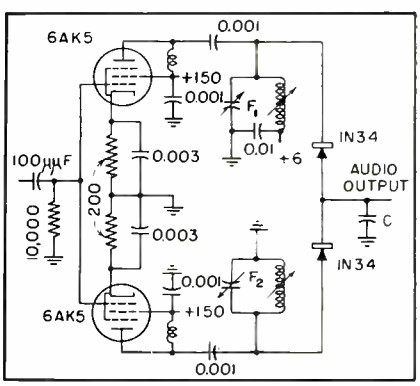


FIG. 3—Discriminator with no resistors in active circuits

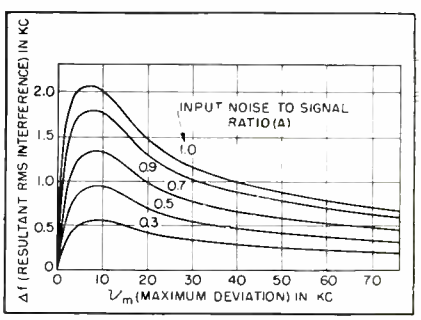


FIG. 4—Interference as a function of transmitter deviation

by the crystal diodes as they take turns in conducting. The rates of charging and discharging the capacitor are alike. It must be remembered that diagonal clipping is a serious problem in the present receiver, since its output must follow faithfully the extremely rapid fluctuations of instantaneous frequency.

It will be noticed that no resistors are indicated in the active part of the detector circuit, either in the two tank circuits or shunting the bypass capacitor, C. Under these loss-free conditions the output varies linearly with frequency between f_1 and f_2, the resonant frequencies of the two tank circuits. The alignment procedure consists simply of tuning the two tuned circuits so that $f_2 - f_1$ is the desired bandwidth, and $\frac{1}{2}(f_2 + f_1)$ is the desired center frequency.

A necessary condition for proper operation is that both diodes conduct during each radio-frequency cycle. If this condition is fulfilled, the output at a particular frequency is proportional to the bias (6 volts in this circuit). The output is not proportional to the instantaneous signal amplitude. Thus it is seen that a limiter stage is incorporated in the discriminator.

RMS Interference

In the foregoing paragraphs we have indicated that with an ideal receiver, interference can be kept very small. It is not difficult to show that the signal-to-noise ratio at the output of the receiver is increased relative to that at the input by a factor very roughly equal to the ratio of peak frequency deviation to de-emphasis frequency, as long as the signal is greater than the interference.

A somewhat more careful analysis gives the results shown in Fig. 4. These curves were computed for the case in which a sinusoidally modulated signal is interfering with an unmodulated signal. The abscissas show the peak deviation of the interfering signal and the ordinates show the equivalent peak frequency deviation of the resultant root-mean-square interference. Notice that the largest interference is about 2 kc, a value which should be compared with the peak swing of 75 kc. Notice that the ratio corresponds to a suppression of 36-to-1 or about 31 decibels.

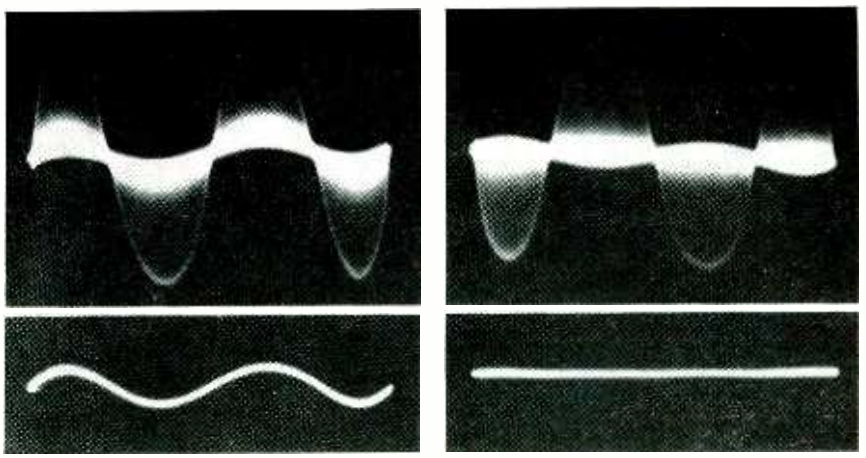


FIG. 5—Simulated transatlantic reception showing unfiltered (above) and filtered (below) signals with input noise-to-signal ratio 0.9 (left) and 1.1 (right)

Although these results were computed for cochannel interference with only the interference modulated, they are directly applicable to multipath conditions provided the abscissas are found by multiplying the peak signal deviation by twice the sine of half the audio delay angle between the paths. In the worst case this means that the abscissas are doubled without change in the ordinates.

In order to simulate a transatlantic link an ultrasonic mercury delay line[10] corresponding to about 100 miles of space or a half millisecond was paralleled with a capacitive attenuator. When it was tried out with amplitude-modulated signals the combination gave the selective fading that is so characteristic of transatlantic reception.

Under frequency-modulation conditions the results given by Fig. 4 checked fairly closely. Listening tests showed that reception comparable to local broadcast quality is possible as long as the level difference between the paths is less than a half decibel. The chief interference observable is a relatively high-pitched swishing noise, the audible residue of the frequency spikes.

When more than two paths are present the results are similar unless the peak value of the interference exceeds the strongest path. Even in this case the resultant interference is not very bad unless the total interference exceeds the largest signal by something like fifty percent. A small excess is tolerable.

Although the receiver was primarily designed to suppress selective fading it is of course applicable to the common-channel conditions of interference between two different stations. Figure 5 shows the output of the receiver during such a test, before and after passing the detected output through the de-emphasis and filter circuits.

The results described indicate that technically it should be possible to establish a high-fidelity transatlantic link for relaying speech and music with a freedom from interference comparable to that associated with local reception. The question of the desirability of doing this depends upon whether or not the 150-kc channel width can be spared in the short-wave band.

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Arc-Back Indicator

Current supplied to transmitting tubes passes through a toroidal coil. When an arc back occurs, the current flow in the reverse direction generates a voltage in the coil which triggers a thyratron that extinguishes a neon panel lamp

IN THE OPERATION of high-power rectifiers, one type of failure which is particularly exasperating to the operating engineer is arc-back.

Since this failure cannot usually be located by metering or by observation, the engineer is never certain that the tube which is replaced in an effort to correct the trouble is the one which is failing.

Many devices are available to indicate the passage of inverse current through each tube but, until recently, none has been found to indicate only the failing tube. This is explained by the fact that, when an arc-back occurs in a rectifier tube, the overload on other tubes in the rectifier may cause them to pass inverse current thereby resulting in the indication of such current in several tubes simultaneously. The equipment to be described herein does not have this fault inasmuch as it will indicate only the first tube to pass inverse current.

A schematic diagram of the instrument is shown in Fig. 1. This diagram shows only the first two and last stages of the unit but it is normally supplied with six identical stages. The dashed lines on the schematic indicate the two major assemblies of the arc-back indicator, the upper block containing the electronic assembly and the lower block the indicator. A third assembly consists of the toroidal coupling coils.

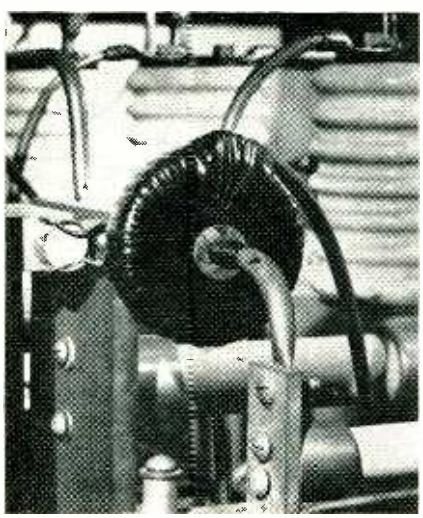
System Components

The electronic assembly is housed in an aluminum cabinet which is suitable for mounting in any position. The indicating unit mounts an indicating lamp for each position, a test switch for each circuit and a reset switch. The coupling coil is toroidal in shape and designed to be mounted over the existing bus structure in a rectifier. This is the only component to be mounted in the rectifier unit, and modification of the rectifier circuit is not required.

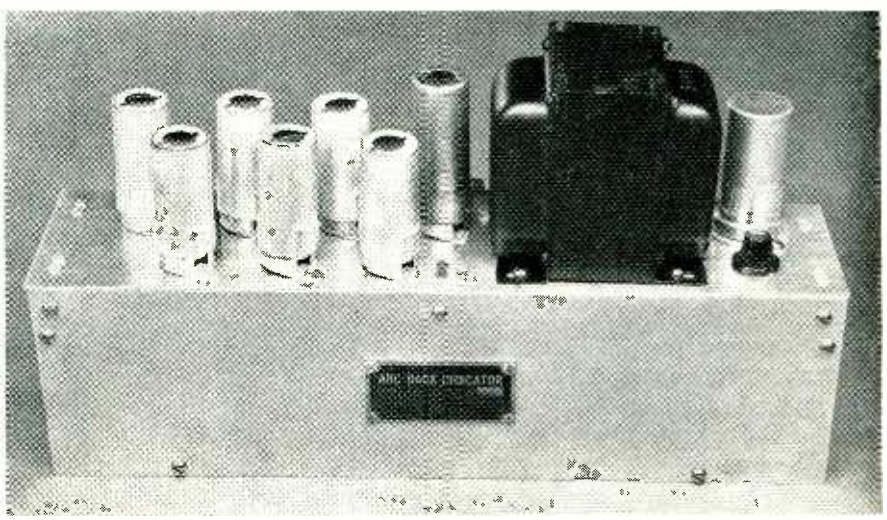
The electronic circuit for each stage is identical and comprises a type 2D21 thyratron, V_1, a type NE-2 gas discharge tube, V_3, an input divider consisting of resistors R_2 and R_3, and an r-f filter consisting of resistor R_1 and capacitor C_1. The cathodes of all stages are connected together and return to ground through the reset switch, S_2, and resistor R_6. Positive potential is applied to the cathodes through resistor R_5 which maintains an initial bias so that the thyratrons are normally non-conducting.

When a positive pulse of sufficient amplitude is applied to the input circuit of any thyratron by its associated coupling coil, the thyratron is triggered and conducts current. The thyratron current, passing through resistor R_6, increases the bias on all the tubes so that a similar input voltage applied to any other tube will not be of sufficient magnitude to trigger the associated thyratron.

The voltage limiter, V_3, assures that the blocking bias cannot be exceeded irrespective of the magnitude or direction of the current



Toroidal coupling coil mounted on a rectifier bus



Chassis of the electronic assembly holds the power supply and six thyratrons that are connected to the toroidal coils

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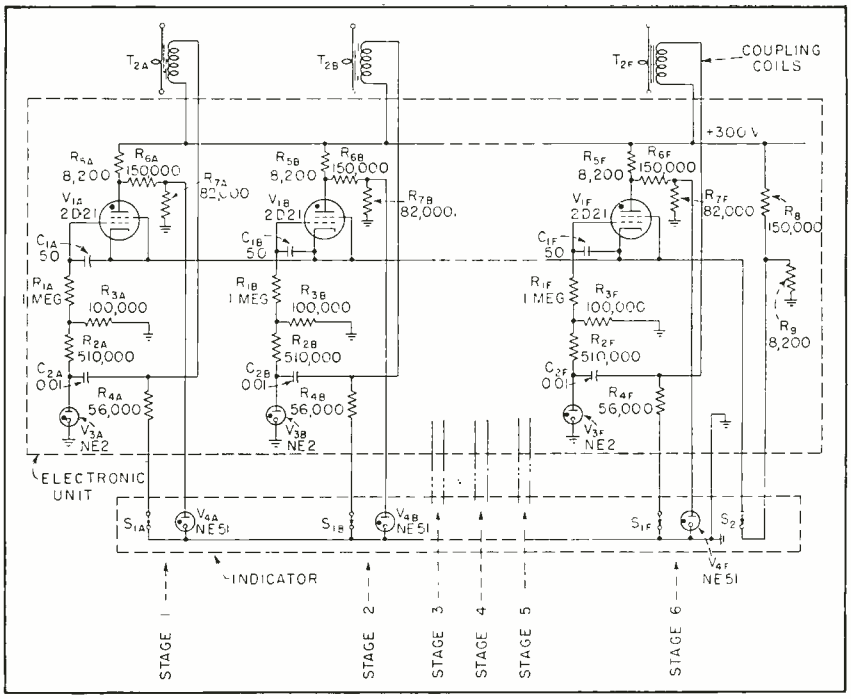

FIG. 1—Circuit of the first two and last stages of the electronic unit and indicator

Panel lamps and test switches are on the indicating unit

flowing through the bus in the center of the coupling coil and thereby prevents indication of sympathetic arc-back in other tubes of the rectifier. The operation of the type thyratron used is of sufficiently high speed compared to the time separation of pulses from other tubes passing inverse current to insure indication of only the first tube to arc-back.

The indicating circuit comprises resistors R_5, R_6, and R_7, and pilot lamp V_4. Under initial conditions, the plate supply voltage is applied through resistor R_5 to the voltage divider consisting of resistors R_6 and R_7. These resistors permit the pilot lamp to be illuminated when the associated thyratron is non-conducting. When the thyratron is triggered, the current passing through resistor R_5 decreases the voltage applied to the pilot lamp and it is extinguished, thereby indicating the associated thyratron is conducting.

The coupling coil, T_2, has many turns of wire around a core of high-permeability transformer alloy. Its core is saturated by current from the plate supply passing through the coil, resistor R_4, and test switch S_1, to ground. Capacitor C_2 connects the coupling coil to the voltage limiter and the input circuit of the associated thyratron. The coupling coil operates on the principle that unidirectional current passing through the bus in the center of the toroid, when properly poled, will act to increase the saturation and, because of the magnetic properties of the core, will fail to generate any voltage in the coil.

Current passing in the reverse direction, however, will act to decrease the saturation and, when the effects of the two currents are such that the saturation approaches zero, a voltage is generated in the coupling coil. This voltage is used to trigger the associated thyratron.

The test switch, S_1, is a normally closed, momentarily operated switch which is used to open the circuit carrying the saturation current through the coupling coil. The sudden cessation of current resulting from operation of the test switch causes the magnetic field in the coupling coil to collapse thereby generating an induced voltage which is applied to the thyratron as an equivalent to an arc-back signal. Operation of this switch tests the coupling coil circuit establishing that current is flowing and shows that the thyratron and associated indicating lamp are functioning normally.

The reset switch, S_2, is a normally closed, momentarily operated switch which is used to open the cathode circuit of the thyratrons. When operated, it opens this circuit thereby stopping the flow of current through any conducting thyratron. When released the circuit is restored but, as the thyratrons are now nonconducting, the circuits are ready to indicate the reception of another signal.

The use of an arc-back indicator results in the saving of "down" time in the event of this type of trouble as it permits instant location of the defective tube. Replacement of a good tube, erroneously believed to be the source of arc-back failure, is eliminated, permitting the operation of rectifier tubes to the end of their useful life.

200-MC Traveling-Wave

An aperiodic traveling-wave amplifier with a bandwidth from 10 kc to 200 mc uses standard pentodes, six per stage, and provides a gain of 10 db. Stages may be cascaded where greater gains are required. Uses Percival delay-line coupling, or distribution

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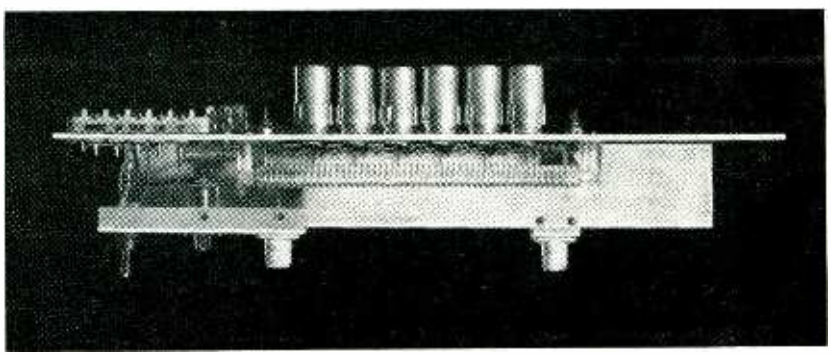

The connections to the delay line are visible in the above photograph

THE CHAIN AMPLIFIER represents a high-frequency circuit using an additive principle which circumvents the limits restricting single-tube wide-band amplifiers which have been described by Wheeler and others. Figure 1 presents a schematic comparison of the classes of circuits normally used for high-frequency amplifiers, and the further development into a full chain. For purposes of comparison, only the interstage coupling networks are shown. Figure 2 shows the experimental circuit and response of an early form of such an amplifier.

The circuit utilizes a chain of vacuum tubes, the grids of which are connected to the various nodes of one delay line and the plates of the tubes to the corresponding nodes of a second line of similar time delay. These lines can be lumped-constant low-pass filters, having series inductances separating the shunt capacitances which include those of the tube electrodes and wiring. Traveling waves impressed on the grid line at one end of the chain emerge at the opposite end of the chain on the plate line, amplified by the tubes which essentially operate in parallel. Stages are cascaded by connecting to the plate line of the first chain the matched grid line of another amplifier chain through appropriate coupling networks.

Primarily the improved performance of the Percival circuit is due to the separation of the interelectrode capacitances of adjacent tubes. Thus, the impedances and limiting frequencies of the delay lines are a function of the electrode and stray capacitances of only one tube.

The overall transconductance is determined by the additive effect of the transconductances of all the tubes in the chain, because their plates are conductively connected together in the load circuit. Thus we obtain the paradoxical result of added transconductances and separated tube capacitances.

Traveling-Wave Tube Comparison

The traveling-wave or helix tube of Kompfner and its later development by Pierce, Field and others is much more recent than the chain circuit. Its operating principles are quite different from those of the pentodes used in the chain amplifiers, being more analogous to the operation of a klystron. Basically, the traveling-wave tube is characterized by a completely distributed helix coaxial with an electron beam. Electromagnetic waves traveling on the helix from the cathode end toward the collector (Fig. 3) continuously interact with the electron beam and travel down the tube with approximately the same velocity as the electrons.

In the simpler forms of these tubes the amplified wave is taken off from the output end of the helix. This contrasts markedly with the chain amplifier which consists of a number of pentodes linking two lumped-constant delay lines. Here the electrons flow from the grid line to the plate line within each tube. They only flow down the plate line after leaving the tubes.

These differences of operation result in considerable differences of characteristic. The standard tubes of the Percival chain circuit are used with a conventional power supply of several hundred volts. The Kompfner helix-type traveling-wave tube is commonly operated at several thousand volts.

The fact that several wave lengths of a high-frequency wave on the helix are necessary to ensure proper space charge bunching and wave amplification means that such a tube will operate at high

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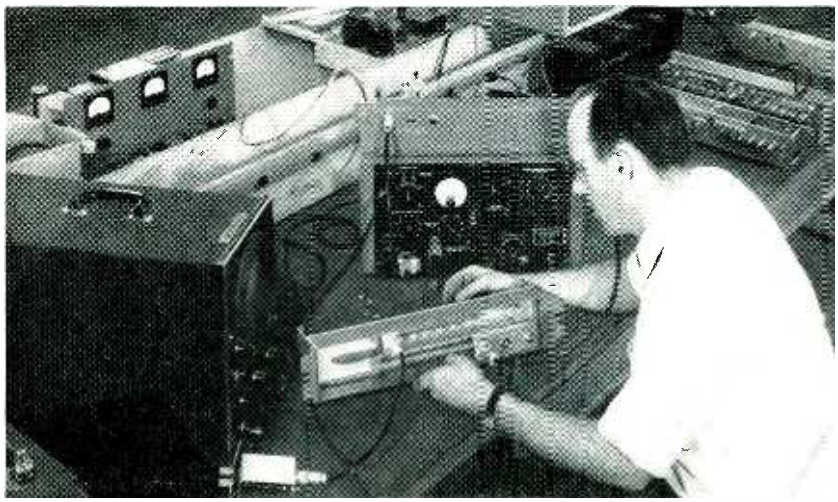
Chain Amplifier



The chain amplifier consis's of a series of pentodes, the grids of which are connected to the various nodes of one delay line and the plates connected to corresponding nodes of a similar delay line. The two delay lines are visible in the photograph

frequencies, usually several hundred or thousand megacycles. In fact, no longitudinal-velocity-modulated tube will operate at very low frequencies. Furthermore, the conductively common input and output circuit of the helix tube would only lead to regeneration at low frequencies. In addition, the requirement of a definite constant electron beam velocity makes the tube quite critical in regard to beam voltage.

On the other hand, the chain amplifier circuit, with proper coupling networks, can perform at low frequencies and, in principal, at d-c. The plate and grid circuits, although delay lines, are physically separate from each other and should have no coupling other than that provided by the electron streams of the many tubes. Thus, although the upper frequency limit of the chain, as limited by most pentodes, is near 300 megacycles, this bandwidth represents many decades of the spectrum. On the other hand, a bandwidth of 1,000 megacycles at 3,000 megacycles, a representative traveling-wave tube operating point, is not even one octave of relative bandwidth.

In order to calculate the performance of a chain amplifier we must first examine its operation in more detail. The plate current of each tube divides, one half traveling forward and the other half backward along the anode line to its termination or load. Consequently, at the output end of the plate line, Fig. 4, the currents traveling forward from all the anodes will add, provided that their phases are synchronous. This condition is achieved with lines having equal delays.

The parallel operation of the tubes is most easily visualized by noting that the contributions to the output from all tubes have traveled, either on the grid or on the plate line, through the same number of delay-line sections. The currents traveling backward on the plate line are, except at the lowest and highest frequencies, out of phase with each other and nearly cancel. They are absorbed by the plate resistor which should be chosen to prevent reflections. This also applies to the grid terminating resistor.

Operation and Design

Figure 5 lists the theoretical and design equations which can be derived from a combination of well-known tube and delay-line formulas. For a simple line all the standard delay-line design equations are applicable. Two important design factors should be considered. The first is optimum gain per chain. Cascading of stages with gains less than unity is useless. However, in stages with large gains additive connections of tubes increase the gain more slowly than multiplicative connections.

The optimum balance occurs when enough tubes are added to a chain to achieve a gain of $E = 2.718$ (8.7 db) and then such chains are cascaded. Such a design is most economical of tubes. As a gain of

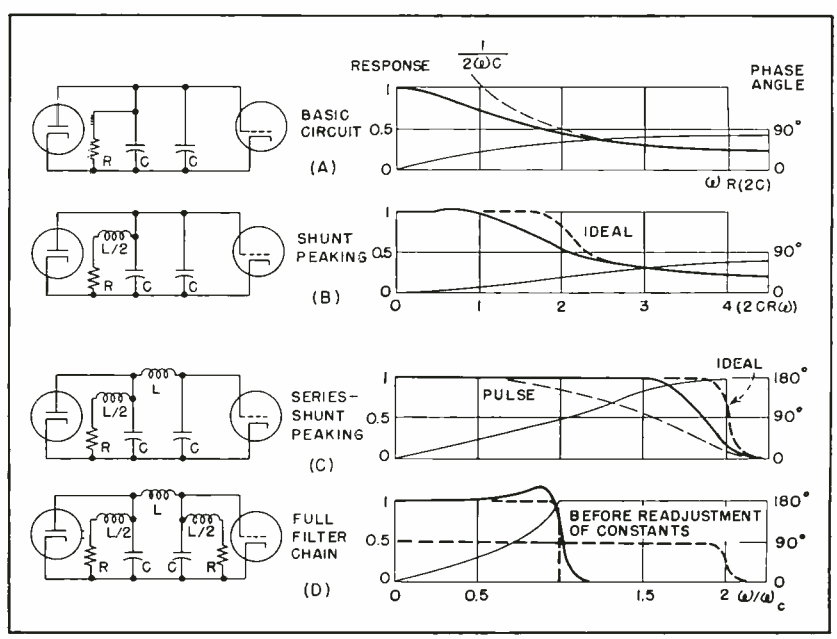


FIG. 1—Schematic comparison of several circuits normally used for high-frequency amplifiers and the further development into a full chain amplifier

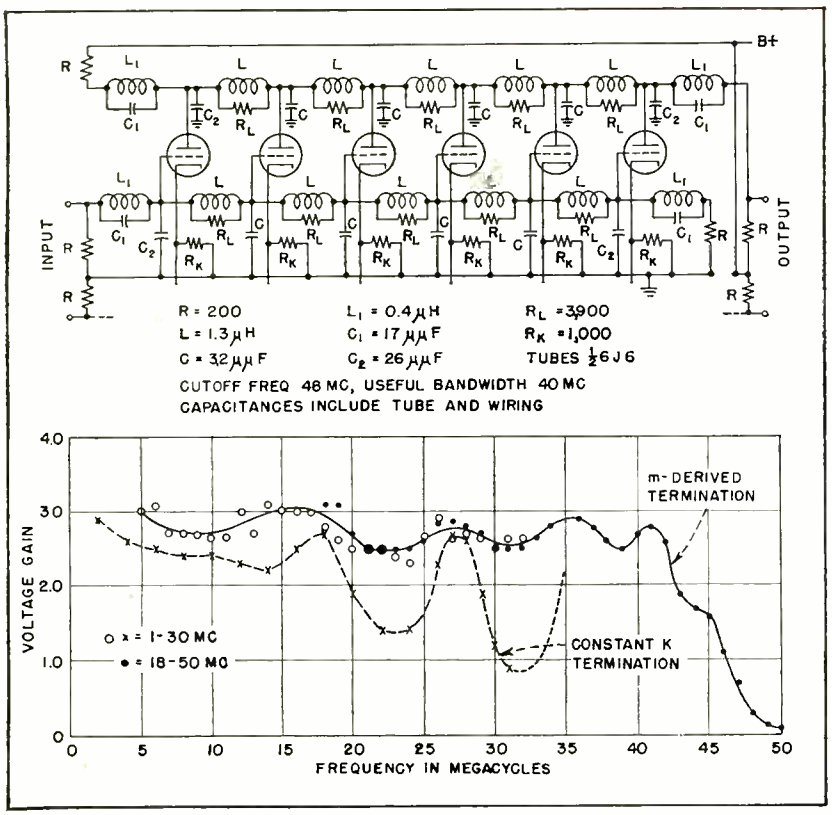


FIG. 2—Experimental full chain circuit used to check design equations. One half of a push-pull amplifier circuit is shown. The graph shows the gain of the delay-line-coupled traveling-wave amplifier. The improvement obtained through the use of m-derived terminating sections over a constant-coupling termination is obvious

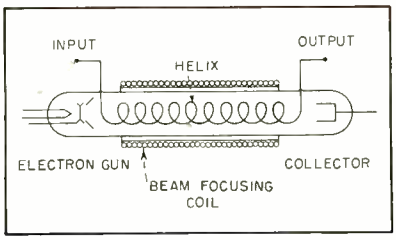


FIG. 3—The chain amplifier, which is not to be confused with the traveling-wave tube

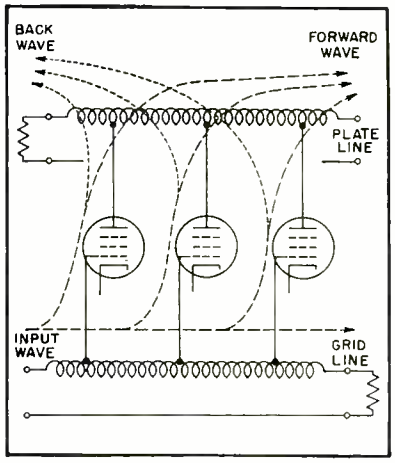


FIG. 4—The plate current of each tube of a chain amplifier divides, one half traveling forward, and adding with that of other tubes, and the other half traveling backwards and canceling with backward currents from other tubes

E is nearly 10 db, this value was used in the design of a commercial amplifier circuit (Fig. 6).

Secondly, the adverse effects on the frequency response of both the back wave of the amplifier and the standing waves on the lines must be avoided by matching the delay lines to their terminating resistors. This required the use of m-derived terminating sections.

Linear phase and impedance characteristics are two other important considerations in chain amplifier design. Mutual inductance between adjacent sections of the delay-line coils improves these characteristics considerably. Equality of both the impedance and the delay of the grid and plate lines is achieved by padding the plate circuits with small capacitors.

Practical Considerations

In the actual design and construction of a chain amplifier the first consideration is the type of delay line to be used. The low-pass filter with separate coils can be considerably improved by using mutual-inductance coupling between adjacent sections. This is illustrated in Fig. 7. The continuous coil, as illustrated in the photograph, is the simplest from a mechanical viewpoint. Furthermore, owing to the construction, a large coefficient of coupling is achieved between adjacent sections of the line. This has the beneficial effect of a more linear phase response.

A more elaborate configuration is the bridged-tee or all-pass line. This combination of mutual-induc-

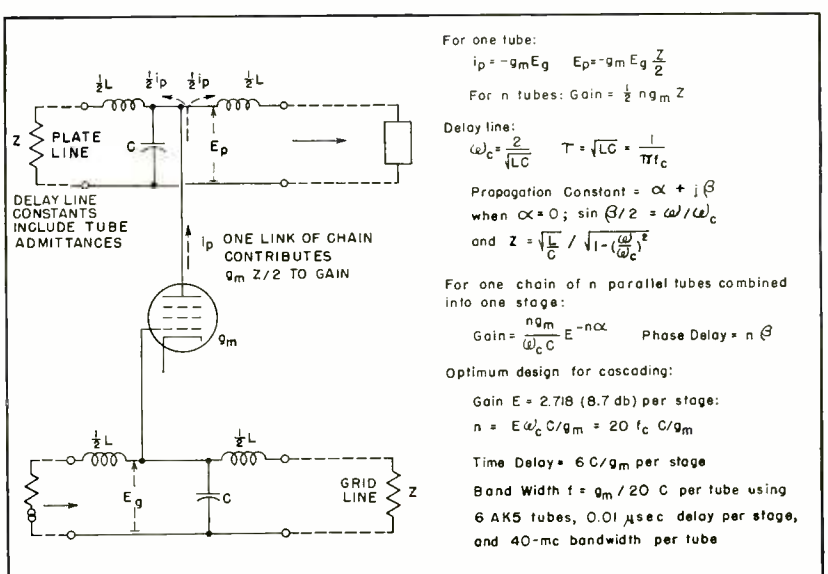


FIG. 5—Theoretical and design equations derived from a combination of well-known tube and delay-line formulas

tance coupled coils and bridging capacitors has the advantages of constant impedance and good delay response. These are characteristic of the lattice-type filter from which this configuration is derived.

As mentioned previously, the delay lines are critical as to terminating impedances. The impedance of a low-pass filter or a continuous-coil type of line changes with frequency, and so matching sections are required to match the load resistors. A mismatch results in standing waves, the amplitudes of which are proportional to the products of the reflection coefficients from the two ends of the mismatched lines. In the case of the lines shown in Fig. 2 and 6, matching half-sections have been used for terminations. The variable capacitors at the ends of the section provide some adjustment for stray capacitance, as well as for the connecting capacitance at the input and output coaxial cable connectors.

Equality of impedance of the two lines may be achieved by adding a small capacitance at each section of the plate delay line. This also has the effect of equalizing the delay in the plate and grid lines although it produces a slight reduction of voltage gain. The equality of line impedances also facilitates the matching of the plate line to the grid line of a following chain or stage when two are cascaded.

Some low-pass compensation is desirable if an extended low-frequency response is required. This can be achieved by placing a compensating capacitor in series with the resistor terminating the grid line. With careful choice of components the amplifier shown in Fig. 6 can have a cutoff as low as 10 kc.

Of considerable importance in the practical construction of all very-wide-band amplifiers is the shielding between adjacent components of the grid and plate circuits. Similarly, it is important that there is no coupling between stages due to common ground currents.

High-Frequency Limitation

The ultimate high-frequency limit of the chain amplifier is set by the large grid input admittance of most tubes at high frequencies. At 200 megacycles the input conductance of a 6AK5 pentode is in the neighborhood of 2,000 ohms. Thus, a chain of such tubes introduces considerable damping into the grid delay line at the highest frequencies. Some reduction of grid loading is possible by controlling the screen lead inductances. For further extension of the frequency range, tubes should be used in which the cathode inductance does not cause such large grid loading.

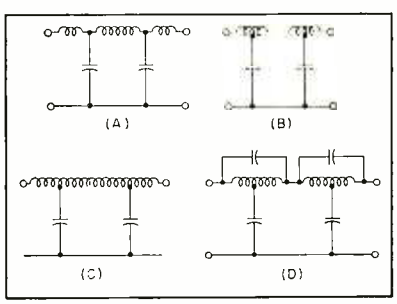


FIG. 7—Steps in the development of the best type of delay line to use in a chain amplifier

Acknowledgment

Considerable work has recently been performed at many laboratories on the chain amplifiers. We wish to acknowledge the continued interest of E. L. Chaffee who directed the work while one of the authors held an NRC-RCA Fellowship in Electronics at Harvard University. The basic experiments at Harvard University were assisted by ONR contract N5ori-76 T.O.I. Further development was performed at Spencer-Kennedy Laboratories, Inc.

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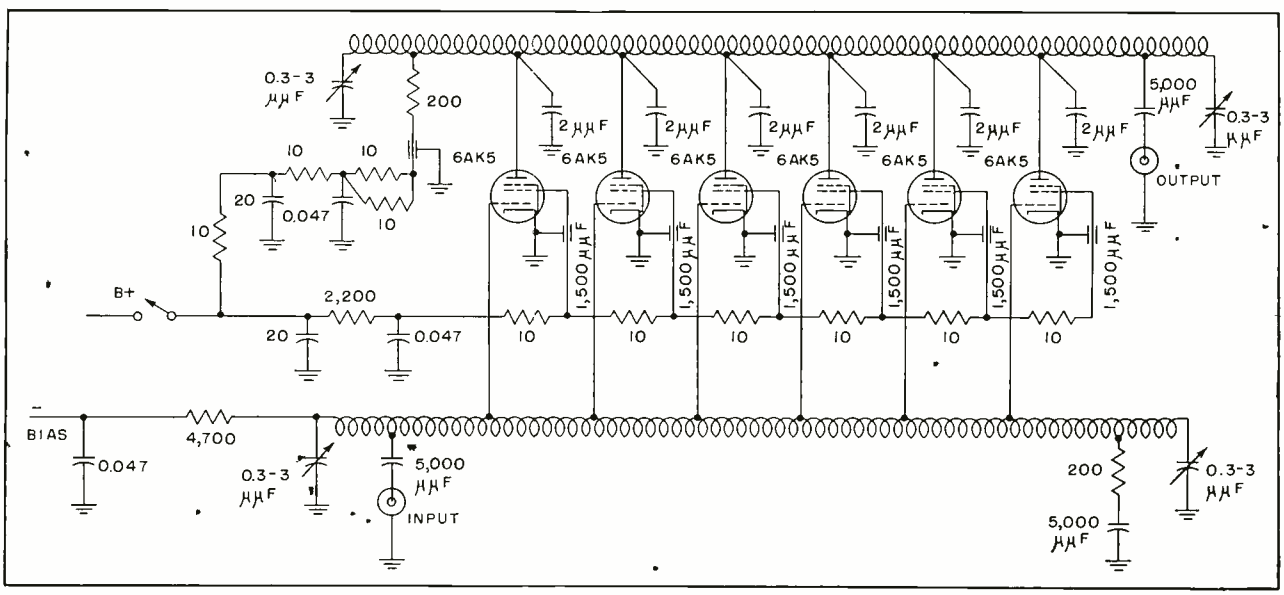

FIG. 6—The gain of the amplifier whose circuit is shown above is about 10 db to 200 mc

Corona-Tube Regulators

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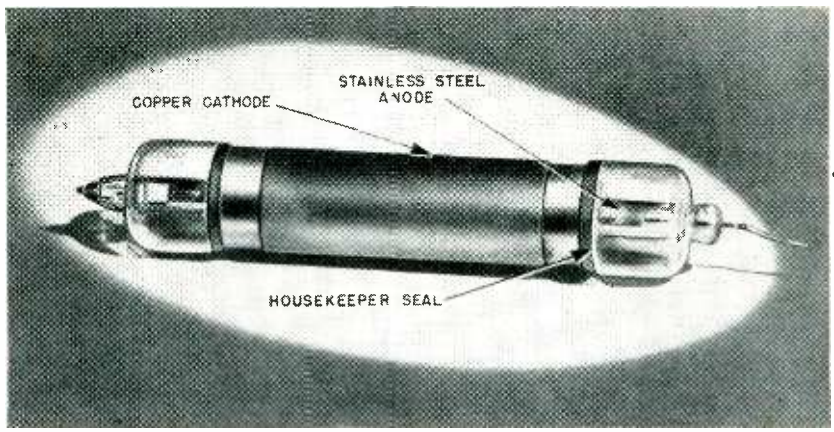
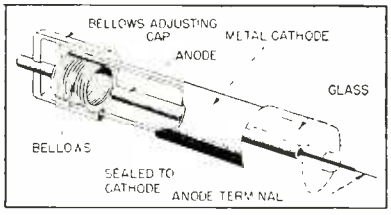
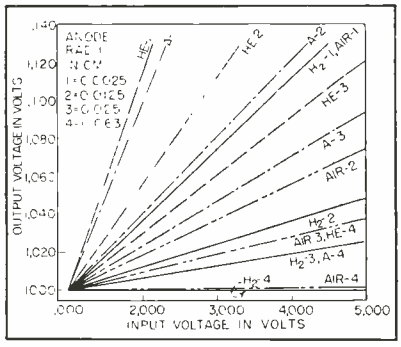


Rugged corona-regulator tube having 10-cm-long copper cathode. With hydrogen, pressure may be selected to give any starting voltage between 360 and 9,000 volts. No aging is observed when tubes are properly cleaned and outgassed

FOR stabilization of d-c voltages appreciably higher than the 150-volt limit of conventional voltage-regulator tubes, new corona-discharge tubes employing coaxial cylinders in an atmosphere of hydrogen, nitrogen, or dry air have been developed at the Naval Research Laboratory[1]. For voltages up to 10,000 volts the tubes need be no larger than ordinary receiving tubes and can be equally rugged in construction. Larger sizes enable regulation of voltages of the order of 40 kv or higher. Current available is of the order of 1 ma, so that the tubes may be used with power supplies for G-M tubes, photomultipliers, television picture tubes and similar devices needing high-voltage low-current power.



Variable voltage-regulator tube in which pressure of gas can be increased by turning screw cap so as to compress the sylphon bellows sealed to one end of cathode



Regulation characteristics of corona tubes at given stabilized voltage, for 0.5-cm cathode radius, four different gases and four different anode radius values. Series resistance is 10 megohms and load resistance is zero

Several of the new tubes may be used in series for stabilizing even greater voltages. If higher currents are required, the tube may be used as a reference potential for the simplest type of electronic regulator, such as a single-tube degenerative triode circuit. This method can provide over-all stabilization sufficient for x-ray and electron-diffraction instruments and electron microscopes.

Operating Principle

The starting voltage of the corona discharge in a tube comprising two coaxial cylinders and filled with a monatomic or diatomic gas is quite sharply defined.

If the voltage supply is connected directly across the electrodes without including a series quenching resistor, a corona characteristic similar to Fig. 1A is observed. Between V_{min} and a slightly lower voltage V_s the discharge is not self-sustaining and breaks off after a mean lifetime that approaches zero as V approaches V_s. If ionizing radiation is supplied from an external source, or if the cathode is illuminated by ultraviolet light, the unstable corona can be stabilized down to V_s. Below V_s no corona discharge is possible. The slope of the corona characteristic has the dimensions of a resistance, equal to about 1 megohm for hydrogen-filled tubes.

If a resistance R_s is included in series with the tube and voltage supply, as in Fig. 1B, the corona-discharge tube behaves like a voltage stabilizer.

With a series resistance of 100 megohms, a stabilization ratio (ratio of the change in voltage across the corona discharge to the change in applied voltage) of about one percent can be obtained. The regulation can be improved by increasing R_s.

Figure 1C shows the stabilization obtained with a particular tube for various values of R_s. But there are disadvantages to making R_s very large. For a given load resistance R_L, a large overvoltage is required to fire the tube if R_s is large compared to R_L. By the proper choice of tube dimensions, however, the corona resistance can easily be reduced to 100,000 ohms or less, with a corresponding reduction in the required size of R_s.

Choice of Gas

Corona-regulator tubes for operation in the low-voltage range, down to about 250 volts, must be filled with a major proportion of helium. At the lower voltages, and correspondingly lower pressures, the corona-discharge region in pure helium is contracted to the extent that the transition to glow discharge takes place at a small over-voltage.

for High Voltages

Coaxial cylinders in hydrogen or other gas utilize corona discharge around anode to stabilize voltages up to 40,000 volts and higher for G-M, x-ray and television picture tubes

The impurity admixture generally increases the starting voltage, decreases the degree of stabilization and increases the maximum current that can be drawn before the transition from corona to glow discharge. One percent of hydrogen in helium is effective in extending the usable current range for miniature low-voltage corona-regulator tubes to about 50 microamperes. Such tubes have application in circuits where the current drawn by the regulator must be less than is required to support the discharge in present types of glow-discharge regulator tubes.

An example of the possibilities of applying the corona-tube regulator in portable Geiger-counter power supplies is given in Fig. 2, where 5,000 volts output at 100μa was obtained from a three-volt flashlight-battery supply.[2] The primary circuit was tuned to produce an effective peak primary voltage ten to twenty times the battery voltage. A corona-discharge regulator tube stabilized the output sufficiently for operation of a G-M counter. Although the input to the regulator fell from 5,000 to 1,200 volts as the batteries ran down, the stabilized output dropped only ten volts, from 1,000 to 990 volts.

The corona stabilization method can be applied to much higher voltage ranges than have been mentioned thus far, as indicated in Fig. 3A. A stabilization ratio of less than one percent was obtained at current loads of 10 μa in this case.

If the corona discharge is used as the reference potential for a degenerative triode voltage regulator[2] as shown in Fig. 3B, the stabilization ratio is given very nearly by the reciprocal of the amplification factor of the triode. The current limitations of such a stabilizer are determined only by the plate dissipation of the triode.

A number of triodes in parallel may be combined to increase the current capacity. To regulate the high voltage for an x-ray tube at 40,000 volts when the input varied in the range from 40,000 to 50,000 volts, a combination of three type 811 tubes was used. The stabilization ratio was about 0.5 percent at a current drain of 10 ma. By using a saturable-reactor regulation transformer in the input to the high-voltage transformer, an overall stability of about 0.01 percent was achieved. The constancy of the output voltage was determined entirely by the stability of the reference potential of the corona tube, and was virtually independent of load.

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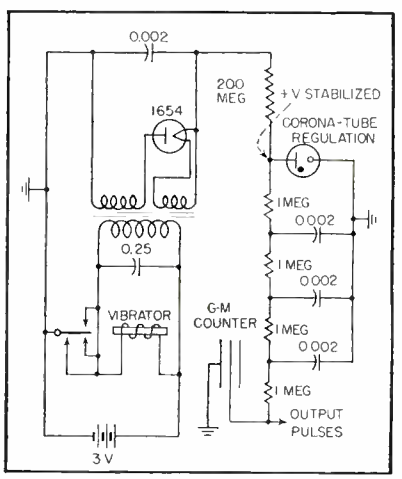

FIG. 2—Circuit of portable power supply for G-M counter, operating from single 3-volt battery. Corona tube holds output within 10 volts of 1,000 volts while input to regulator drops from 5,000 volts to 1,200 volts as battery ages

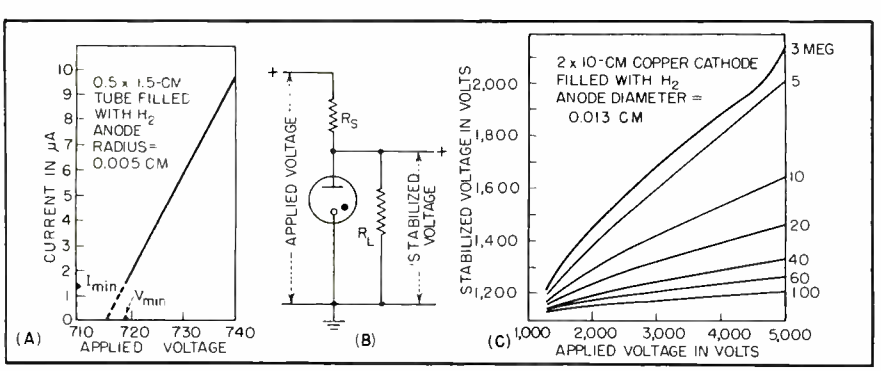

FIG. 1—Corona-discharge characteristic of monatomic or diatomic gas circuit for corona-discharge tube, and effect of series-resistor value on stabilizing characteristics

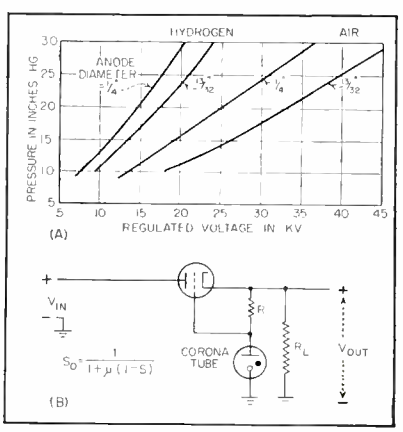

FIG. 3—Pressure dependence of starting voltage for corona tube having cathode 20 inches long and 3 inches in diameter, with 13/32-inch rod in center as anode. Circuit shows use of corona tube as reference potential for triode voltage-regulator

Transference Nomographs

for Low-Pass Iterative Filters

Figures for attenuation at the prescribed frequency allow r-c constant to be read off. Phase angle for this and for other frequencies between 10 and 1,000 cycles is quickly determined as a second step

By E. W. TSCHUDI

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Pilotless Plane Division
Fairchild Engine and Airplane Corp.
Farmingdale, N. Y.

THE USE of low-pass iterative filters requires the proper choice of r-c time constant and number of iterative stages to attain a specified attenuation at a selected noise frequency while at the same time attenuation throughout the pass band is held within a prescribed maximum. A knowledge of the amount of lagging phase angle at several input frequencies for any selected iterative filter is also of vital importance. To determine these several quantities from the transfer function of one or more iterative filters can be a laborious procedure. For example, the transfer function of a four-stage filter is

$$\frac{E_o}{E_i} = \frac{1}{1 + 10Tp + 15T^2p^2 + 7T^3p^3 + T^4p^4} \quad (1)$$

where T = RC and $p = j\omega = j2\pi f$. The attenuation resulting from such a filter is given by

$$A_{db} = 20 \log \times \left[\frac{1}{(1 - 15T^2\omega^2 + T^4\omega^4)^2 + (10T\omega - 7T^3\omega^3)^2}\right]^{\frac{1}{2}} \quad (2)$$

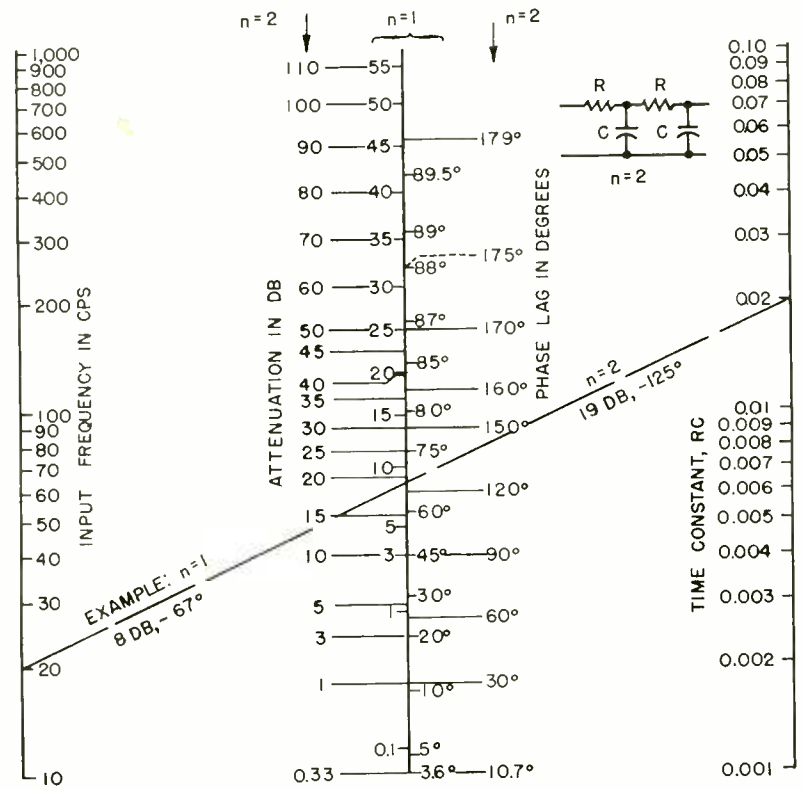
and the phase angle by

$$\phi = \tan^{-1} \frac{10T\omega - 7T^3\omega^3}{1 - 15T^2\omega^2 + T^4\omega^4} \quad (3)$$

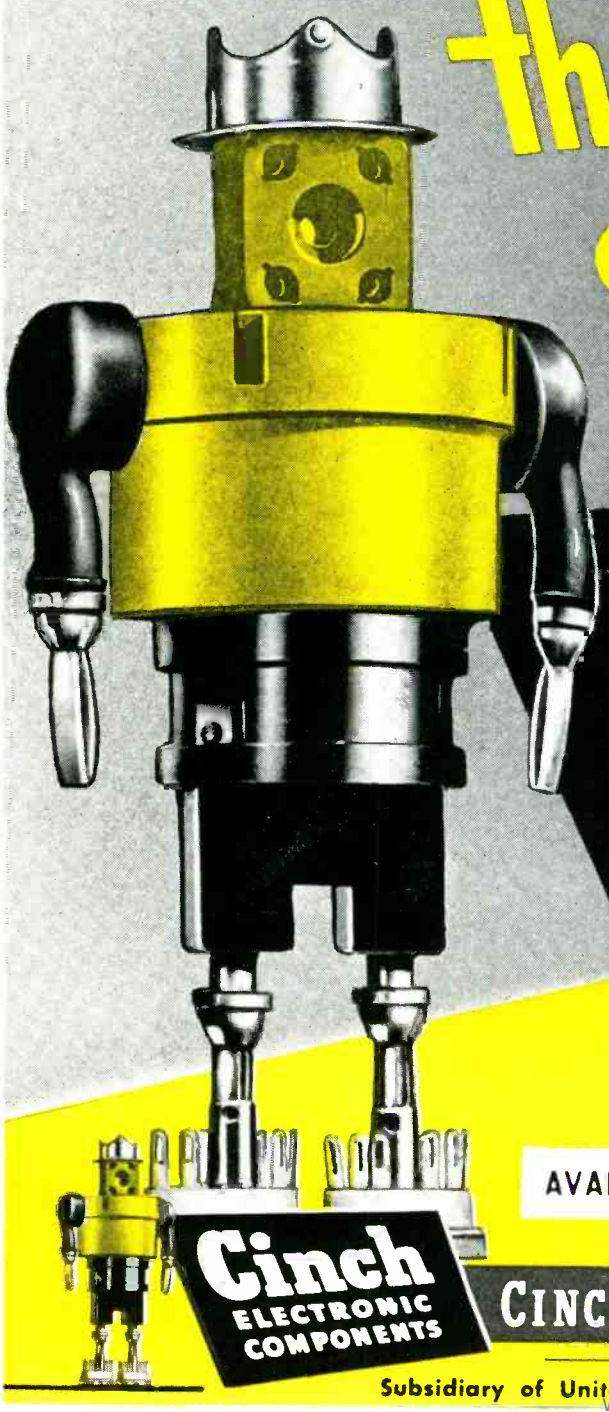
If by the aid of Eq. 2 a value of the time constant T is found that will result in satisfactory attenuation at a noise frequency ω_n, one still would not know if a three-stage filter might not be more desirable when considering all of the factors involved. Transference nomographs furnish information as to output attenuation and lagging phase angle when input frequency and time constant are selected.

Usually, the development of a nomograph is based directly upon an algebraic expression relating the dependent and independent qualities involved. How-

(continued on page 114)



throughout the electronics industry



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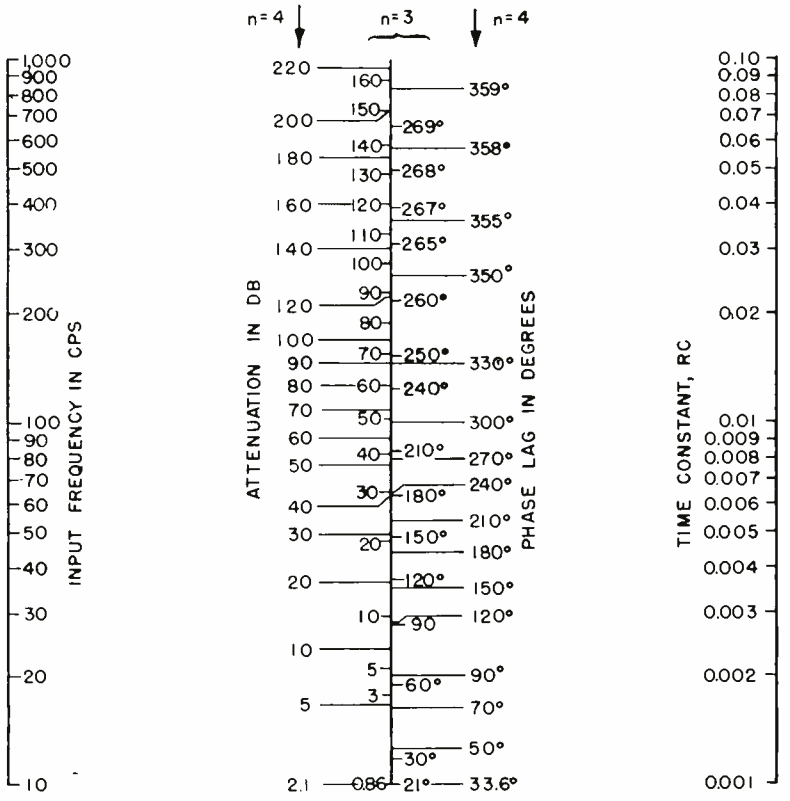
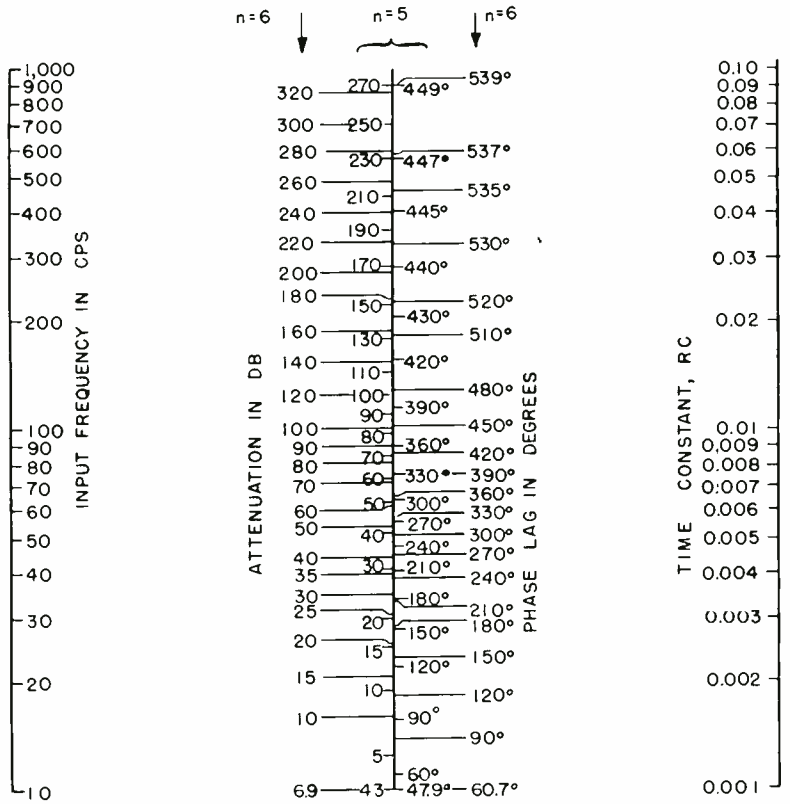
Transference Nomographs for Low Pass-Iterative Filters

(Continued from page 112)





ever, in the present instance expressions such as Eq. 1 and 2 are not readily adaptable to such a procedure. In order to develop the accompanying transference nomographs it was necessary to rely upon an empirical method of procedure, the results of which are presented here.

As an extended example of the use of these transference nomographs, suppose it is desired to obtain an attenuation of 60 db at an input frequency of 400 cycles. With a two-stage filter an r-c value of 0.01 is indicated. The associated phase lag would be 173 degrees. This filter would then produce an attenuation of about 6 db at a frequency of 10 cycles with an associated phase lag of about 73 degrees.

With a three-stage filter, an r-c value of 0.004 is indicated to produce 60 db at 400 cycles with an associated phase lag of 241 degrees. This time constant will produce between 4 db and 5 db at 10 cycles with an associated phase lag of 65 degrees. With a four-stage filter, an r-c value of 0.002 is indicated for 60 db down and would result in a phase lag of 285 degrees at 400 cycles. At 10 cycles the attenuation would be about 4 db with a phase lag of about 60 degrees. The final choice of the number of stages to be used would be dictated by circuit performance requirements.

Since the output of a filter, as given by its transfer function, is applicable only when the filter is isolated, values taken from the nomographs should be applied in an actual circuit including the filter only when that filter is separated from the balance of the circuit by an isolation amplifier, or by a transducer if the filter is part of a servo loop. In all other cases the balance of a circuit loads the filter and thereby alters its transfer characteristics.

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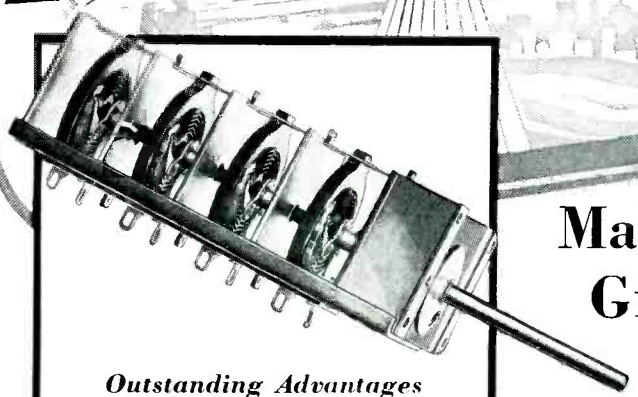

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Edited by VIN ZELUFF

Drift-Cancellation Circuit

BY FREDERICK A. SCHANER

Project Engineer
Air Associates, Incorporated
Teterboro, New Jersey

IN THE DEVELOPMENT of communication receivers in the frequency range of 0.5 mc to 56 mc, especially those for the Armed Services, there are generally three common requirements: Extremely high image and spurious response rejection ratios across the entire tuning range, a high order of oscillator stability, and symmetry of the skirts of the i-f pass band around the center frequency in the order of ± 2 percent. The first requirement can be most readily dealt with through the application of the principle of double conversion throughout the frequency range above 8 mc.

In the case of oscillator stability, it is possible to develop a local oscillator with excellent frequency stability through the use of the so-called Clapp oscillator circuit. Frequency multipliers may be used in cases of high tuning ratio per band where the Clapp oscillator itself is unsatisfactory.

Considering the difficulties in maintaining almost perfect symmetry of the i-f pass band skirts around the center frequency, the first step is to maintain a fixed center frequency. The problem of asymmetry becomes greater as the bandwidth of the pass band decreases and is most acute in the cases where crystal filters are employed to set up the pass band. In the hypothetical case of a 455-kc i-f crystal filter with a bandwidth 100 cycles wide at the 6-db points, a shift in center frequency of a few cycles ahead of the crystal filter will result in an asymmetrical selectivity curve at the output of the filter. Another important step in the solution of this problem is to eliminate regeneration in the entire i-f system so that any change in coupling in the case of a variable bandwidth i-f system will not affect the center frequency.

Figure 1 shows a block diagram of the drift cancellation circuit. This circuit employs triple conversion and hence solves the image rejection problem.

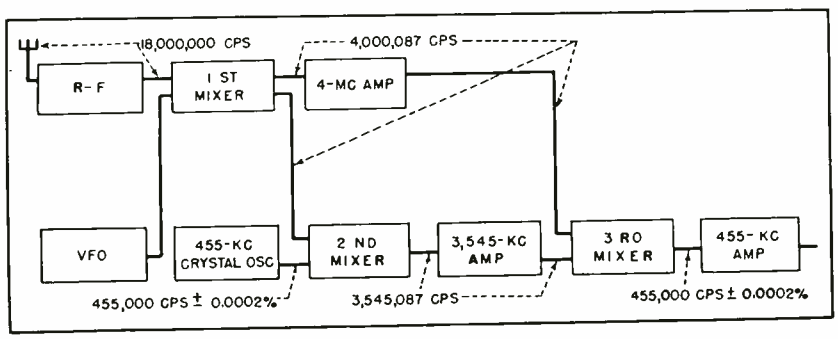

FIG. 1—Arrangement of mixers and oscillators to provide triple conversion

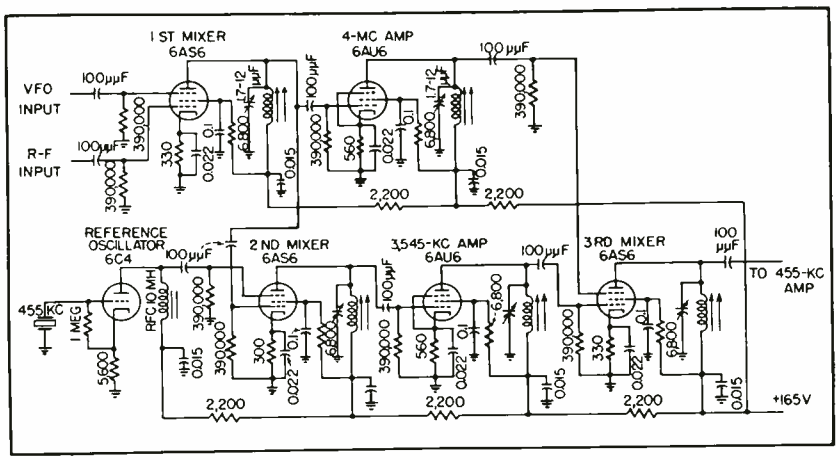

FIG. 2—Complete circuit forms a unit that may be added to a conventional communication receiver

Constant-Frequency Output

The figures superimposed on the connections between the various blocks of the diagram show a simple arithmetical analysis of the principle of drift cancellation. These figures represent a case where the r-f system of the receiver is connected to a primary standard adjusted to 18 mc. The local oscillator is assumed to be operating 4 mc above the r-f and has drifted 87 cycles. This signal is fed into the broad-band i-f amplifier and also into the second mixer. A signal generated by the 455-kc crystal oscillator which employs a crystal of the CR-26/U type is also fed into the second mixer.

The output of the second mixer,

SOLDERING TIPS

Previous to the late war, many of the largest users of solder maintained schools to teach their employees the art of soldering. Due to the great need of materials during the war and the great rush to be first on the market in the post-war years, much of this educational work has been pushed into the background. As a result, on many production soldering lines, many different techniques have been developed. The lack of a thorough understanding of making an efficient soldered joint has resulted in the waste of high-priced time and valuable materials. Most solder users understand the correct method of making a solder joint, but perhaps a brief resume of the essential points may bring to mind some forgotten technique and further the cause of a well-made, efficient soldering operation.

1. A SOLDERING IRON OF SUFFICIENT HEAT CAPACITY to rapidly heat the metal being soldered to a temperature sufficient to melt the solder.
2. A CLEAN IRON TIP, WELL TINNED. Keep a rag handy to the soldering operation so that the iron may frequently be wiped clean of the burnt particles of the soldering flux.
3. USE THE FULL FACE OF THE IRON TIP, not just the point. This will assist in transmitting the heat more rapidly.
4. ROTATE THE IRON TIP. Soldering irons have many sides. Use them. This will increase the life of your tip between dressings.
5. USE THE PROPER AMOUNT OF FLUX FOR YOUR OPERATION. Too much flux results in spreading solder and flux over the adjacent area and makes a bad-looking joint. Too little flux will result in an inefficient, poorly-soldered joint.
6. FLUX-CORE SOLDER should always be applied to the exact junction of the metal and the soldering iron. Flux-core solder applied high up on the iron will result in the dissipation of all or part of the flux before it reaches the metal to be soldered.

Finally, an efficient solder operation requires CLEANLINESS — HEAT — THE PROPER SOLDER—THE PROPER FLUX

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which is now 3,545,087 cycles, is fed into a narrow-band amplifier. The output of the i-f amplifier, 4,000,087 cycles, and the output of the narrow-band amplifier, 3,545,087 cycles, are fed into the third mixer with a resultant output of 455,000 cycles. Thus each cycle of local oscillator drift results in a change of one cycle in the frequency of the signal passing through each of the two amplifiers feeding the third mixer and the difference remains at 455-kc. The output of the third mixer feeds the regular 455-kc amplifier.

The crystal of the reference oscillator is capable of maintaining an accuracy of 0.0002 percent per megacycle or slightly less than one cycle in 455 kc. Hence the drift cancellation circuit eliminates the effect of local oscillator drift on the intermediate frequency and provides an accurate i-f center frequency. A diagram of the complete circuit is shown in Fig. 2.

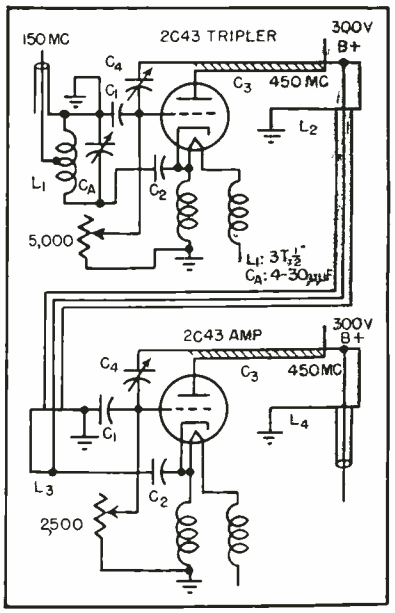

FIG. 2—Schematic diagram of tripler and final amplifier for 450 mc. Construction of C_1 and C_3 is shown in Fig. 1. Capacitors C_3 are internal to G-E 2C43 tubes and capacitors C_4 are the floating rotors

Citizens Band Transmitter

By ARTHUR R. KOCH

Project Engineer
General Electric Co.
Schenectady, N. Y.

ENGINEERS interested in developing equipment for the citizens band and the mobile service could use to advantage tank circuits formed of parallel-plate transmission lines. Such lines are easy to handle and are readily adapted for use with lighthouse tubes.

To explore the possibilities of the parallel-plate construction, a transmitter was constructed. To provide the frequency stability required, a 25-mc quartz crystal oscillator was employed. This was followed by a frequency doubler, a tripler, and a power amplifier to provide output at 150 megacycles. Since conventional lumped constants were used, the circuit of these preliminary stages is not shown.

To reach final frequency of 450 mc, a tripler using a lighthouse 2C43 is employed. This is followed by an additional 2C43 as a power amplifier. Both stages are operated with grounded grids. Figure 1 shows the construction of the two stages.

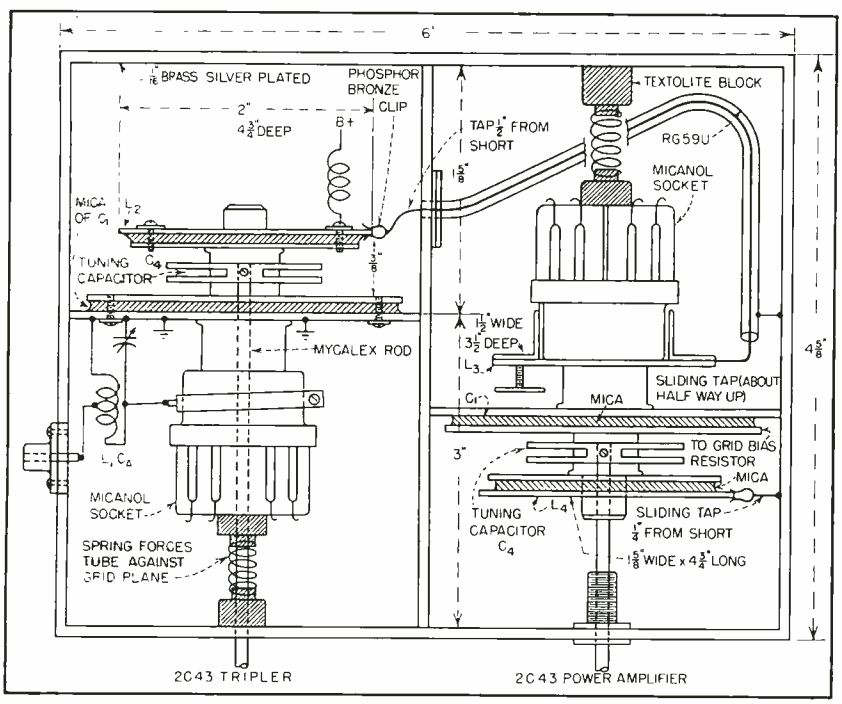

FIG. 1—Top view of box containing two lighthouse tubes and parallel-plate tank circuits

Calculation shows that a parallel flat-plate circuit would need to be slightly under 5 inches long to resonate at 460 mc with the grid-anode capacitance of a 2C43. For the higher grid-cathode capacitance it would need to be slightly shorter than the grid-anode line.

Since the distance between the anode cap and the grid plane is approximately 3/8 inch, the spacing between the anode plate and the grid plane is also approximately equal to 3/8 inch. This permits utilizing a half-circular rotor as a tuning capacitor to resonate the plate and cathode tanks. By using simple 180-degree rotation, it is possible to utilize existing tuning dials.

The tripler-power amplifier circuits using parallel flat plates thereby eliminate the use of costly concentric-type cavities, and it is possible to obtain excellent efficiencies using the 2C43 as triplers and power amplifiers. The apparent plate efficiency of the tripler is between 25 and 30 percent and the

(continued on page 132)

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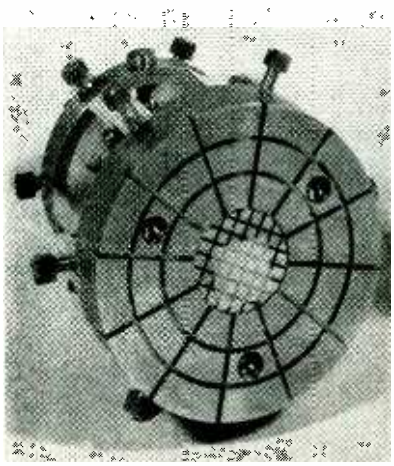
THE ELECTRON ART

Edited by JOHN MARKUS

Lapping 100-Mc Crystals

MODIFICATIONS of conventional techniques for grinding quartz crystals between abrasive-charged lapping plates now make possible the production of 0.001-inch thick crystals with a high degree of parallelism and flatness, permitting fundamental crystal frequencies of 100 mc and higher. Breakage is almost nonexistent during grinding, but difficulties in handling and properly measuring such thin crystals have so far prevented determination of the limiting thickness for the equipment.



Lapping plate of tall plunger apparatus developed at National Bureau of Standards for grinding quartz crystals as thin as a thousandth of an inch

The lapping method evolved is an improved form of the square block and cell method and exists in two slightly different models—the inkwell and the tall plunger. The inkwell type has a conical exterior and is essentially a keyed and closely fitting plunger and cylinder. The crystal is attached to the plunger by means of a drop of oil; the unit is then inverted and placed on the lapping plate. The crystal is thus confined between the piston and plate by the cylinder walls. A nest drives a number of such units over the lapping plate. The tall plunger model differs mainly in having a taller piston sliding on bearing screws by which the amount of wobble can be precisely controlled.

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Pulse-Controlled Thyratron

By J. G. SKALNIK
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Yale University
New Haven, Conn.

MANY circuits have been developed for the purpose of controlling the conduction period of a thyratron that has an alternating voltage applied to its plate circuit. The simplest of these methods is to place a variable direct-voltage bias on the thyratron grid. The magnitude of this bias voltage will control the instant during the half-cycle of positive plate voltage at which conduction starts.

A different approach is to utilize firing pulses, with the same repetition frequency as the frequency of the plate voltage. If a pulse time-delay circuit, controlled by a direct voltage, is provided, the firing instant may be varied over the complete positive half-cycle of thyratron plate voltage.

Circuit Details

The circuit shown in Fig. 1 will perform these functions. A 60-cycle sawtooth voltage is used as the signal for a cathode-coupled clipper circuit[1]. The output of this circuit is a rectangular pulse with a prf of 60, and a width that is controlled by the magnitude of the control voltage E_c. The width of the pulse may be varied, without difficulty, from 5 to 95 percent of the fundamental period of a 60-cycle sine wave. This pulse is then differentiated and fed to the thyratron grid through a cathode-follower stage. Waveforms throughout the

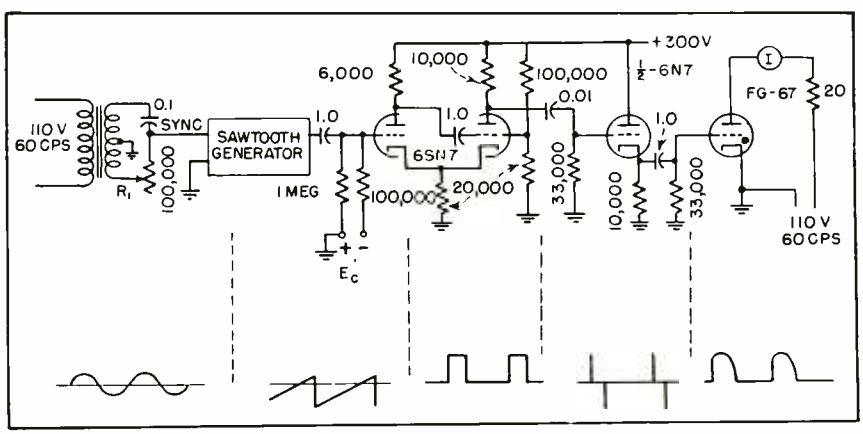

FIG. 1—Circuit diagram of pulse-controlled thyratron with which the firing instant may be varied over the complete positive half-cycle of the thyratron plate voltage

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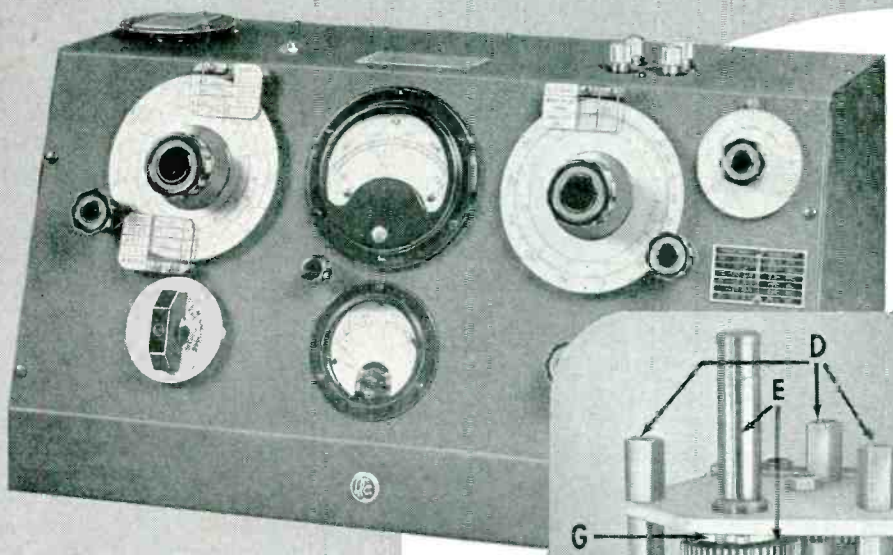

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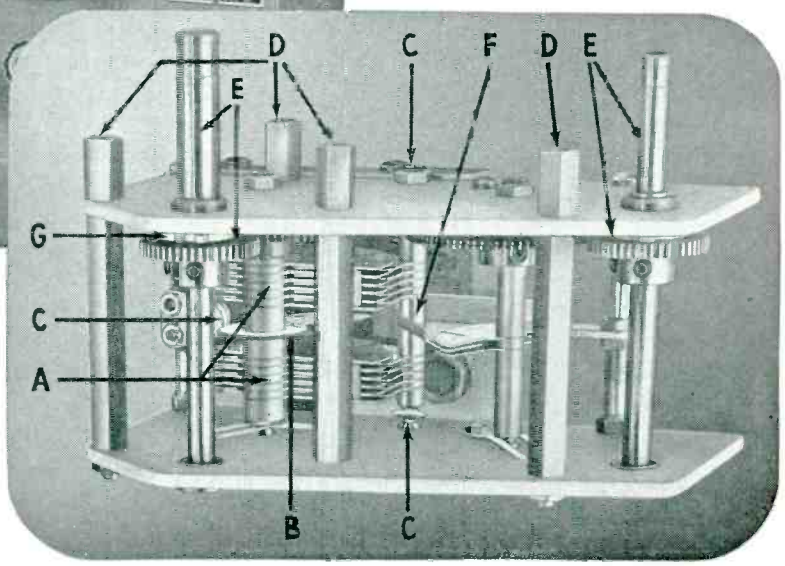
50 KC. to 75 MC.



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Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached only after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

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Shown above is the Q tuning capacitator assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Parallel connection of dual rotor and stator assemblies minimizes internal inductance and resistance.
B. Spring silver fingers contact both sides of silver disc to provide low series resistance.
C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.
D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.
E. Precision-cut brass spur gears and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.
F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.
G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.
Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.
Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.
Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
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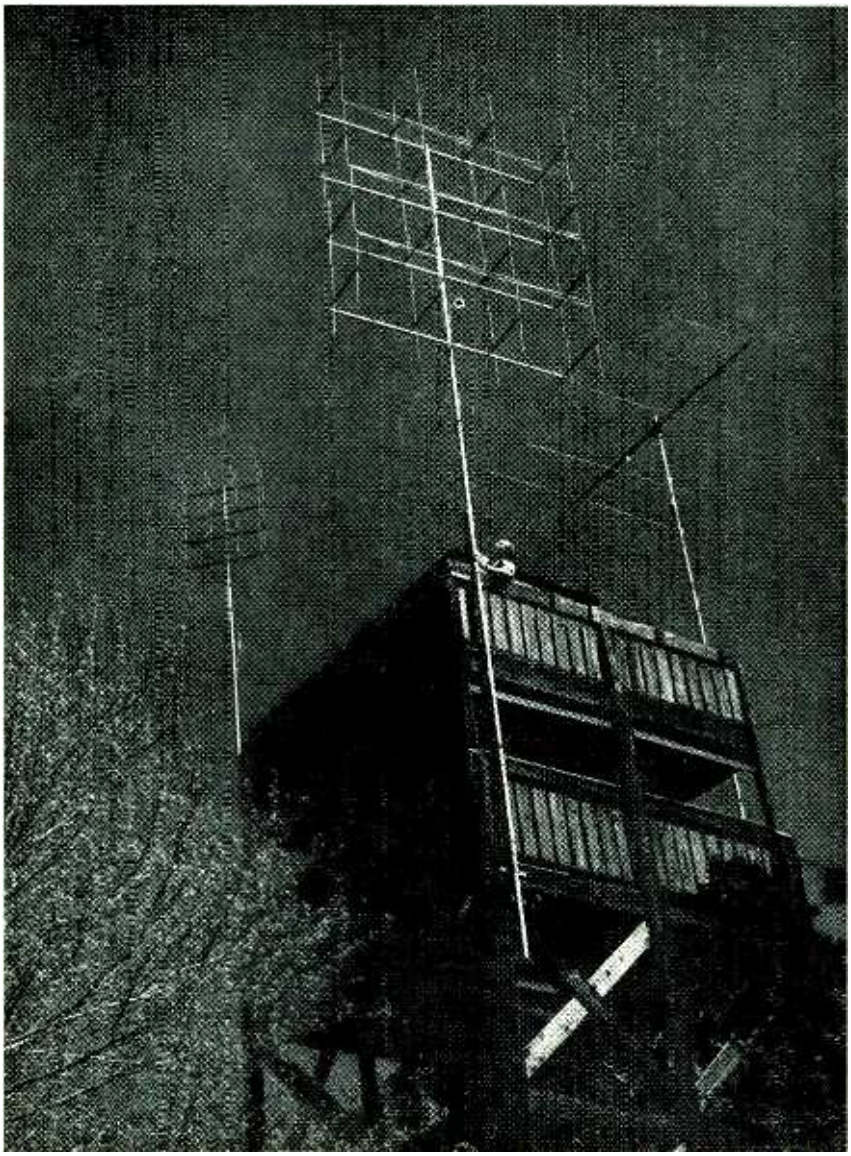
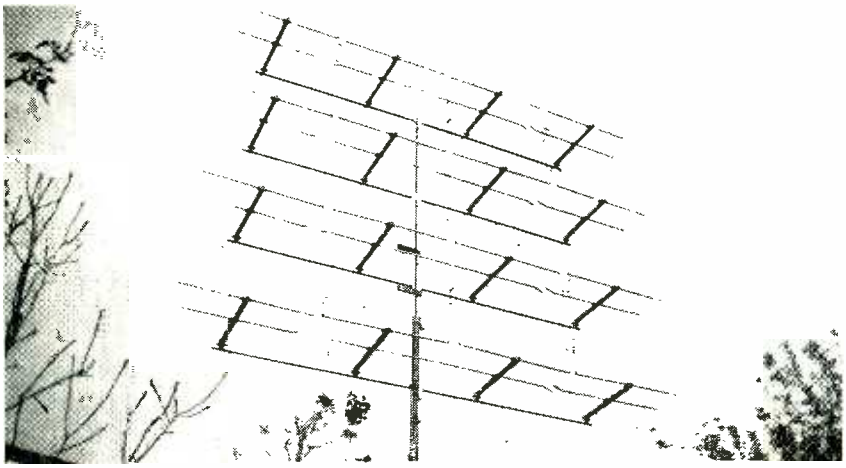


Gains up to 127 times the power of a folded dipole are obtained from special multi-element beams during tests on this Rye, New York research tower built by W. F. Hoisington. At left corners of tower are two 32-element special beams using vertical polarization, intended for mobile communication use. At right corner is four-element television beam peaked for one particular channel. Tower construction permits easy mounting and adjusting of any size vhf array. Photo below shows corresponding horizontally polarized 32-element beam for television or f-m reception far beyond normal service range of a station



circuit are shown on the circuit diagram.

Phase Control

The phase of the sawtooth-generator synchronizing voltage, controlled by the setting of the potentiometer R_1, will determine the magnitude of E_c at which control will start. Figure 2 shows the two limits obtainable with the constants shown in the circuit diagram. The data for these curves were taken with a sawtooth voltage of approximately 60 volts peak amplitude. When a 30-volt sawtooth voltage

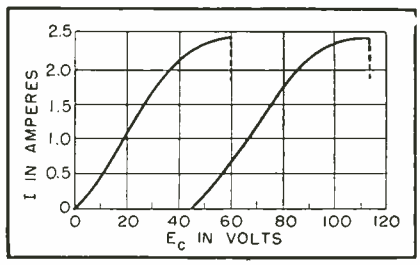


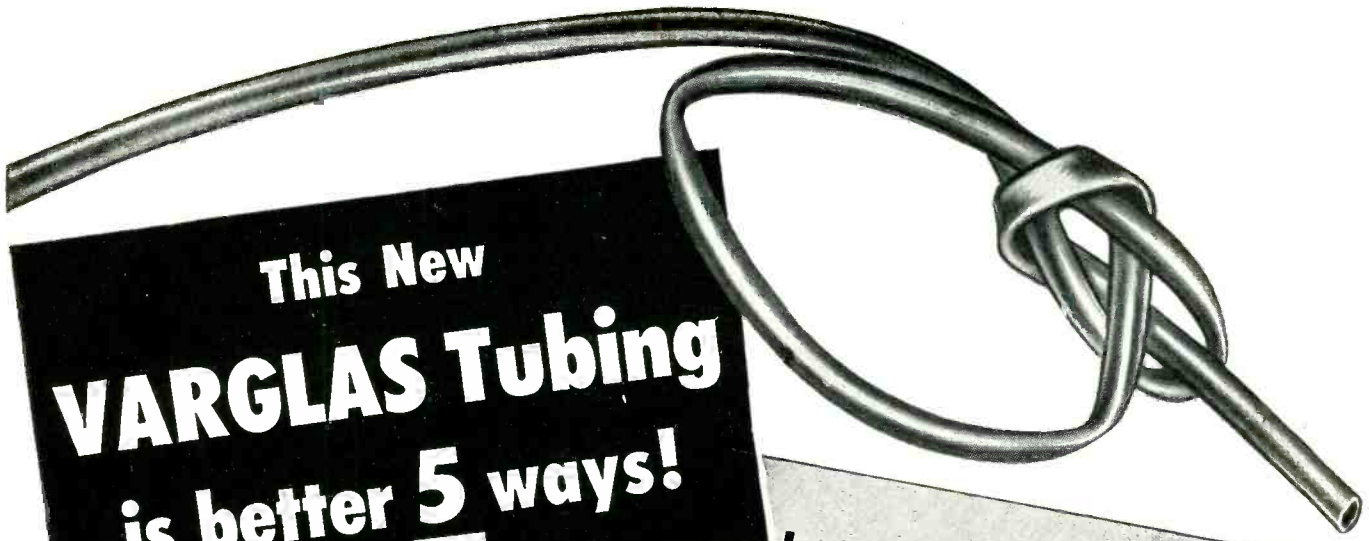
FIG. 2—Curves showing limits obtainable with constants shown in pulse-controlled thyratron circuit

was used, essentially the same curves were obtained except that only about half as much variation in E_c was needed to cause the average thyratron plate current to increase from zero to 2.5 amperes. In other words, if greater sensitivity is required, a smaller magnitude of sawtooth voltage may be used. If a different shape of control curve is desired, the sawtooth voltage may be distorted until the desired shape is achieved.

A maximum of 100 microamperes of direct current was supplied by the control voltage E_c under the conditions for the curve starting from the origin of Fig. 2. If this is objectionable, the common cathode resistor in the cathode-coupled stages may be increased or the control voltage may be inserted into the circuit through a cathode-follower.

The thyratron used throughout was an FG-67 which requires a positive grid voltage for firing when the plate voltage is only 110 volts. For applications using higher alternating plate voltages or a negative-grid thyratron, a fixed

Continued on page 168



This New VARGLAS Tubing is better 5 ways!

Impregnated with General Electric's PERMAFIL for superior insulation...

Varglas Permafil Tubing excels oleoresinous and other synthetic coated tubing in several important performance characteristics. Outstanding among these are:

1 TOUGHNESS

Remains pliable even after severe flexing. This new tubing can be twisted, bent or tied in knots with no loss in its dielectric value (7,000 volts).

2 SOLVENT RESISTANCE

Is relatively immune to alcohol. Petroleum and aromatic hydrocarbons have only slight effect after long exposure.

3 HEAT AGING

Withstands more than 2,000 hours at 105° to 110° C., 1,000 hours at 125° C. and extensive periods at 150° C.

4 BAKING

Can be after-treated in baking and varnishing operations—reacts better than most oleoresinous materials.

5 AVAILABLE IN COILS

—in standard colors and wide range of sizes. Meets or exceeds all requirements of A.S.T.M. specifications.

Send for FREE SAMPLE and complete data.

Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

VARFLEX Corporation, 308 Jay St., Rome, N. Y.

Please send me full information as well as a free sample of your new Varglas Tubing impregnated with G.E. Permafil. I am particularly interested in samples suitable for.....

Name.....

Company.....

Street.....

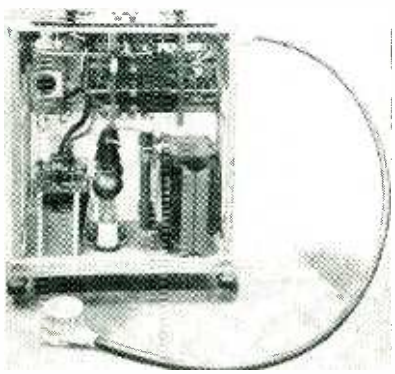
City.....Zone.....State.....

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Ultrasonic Generator

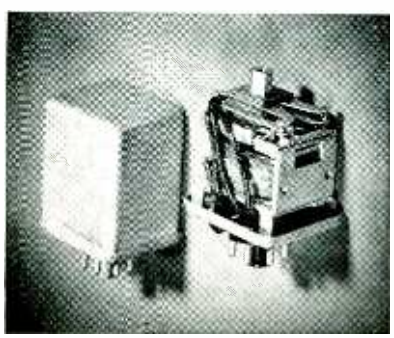
MULLARD ELECTRONIC PRODUCTS LTD., Century House, Shaftesbury Ave., London WC2, England, has introduced the type E.7562 ultrasonic generator. The r-f output is generated directly by a silica triode capable of producing 1 kw of r-f power. Four plug-in, rapidly interchangeable coil assemblies are provided for operation around nominal frequencies of 0.25, 0.5, 1 and 2 mc.



The oscillator is housed in the upper portion of the frame with the control panel immediately above. On the lower deck is the power supply comprising two grid-controlled mercury vapor rectifiers, the filament transformer and the high-voltage transformer.

Miniature Relay

STRUTHERS-DUNN, INC., 150 N. 13th St., Philadelphia 7, Pa. Frame 181 miniature relay for low-voltage d-c operation offers resistance to the shock and vibration encountered in portable, mobile, aircraft and military applications. Any contact arrangement up to 4-pole, double-throw can be furnished as a standard open-type relay or with plug-in base and removable or hermetically sealed metal cover.



Universal Bridge

FREED TRANSFORMER CO., 1718-36 Weirfield St., Brooklyn 27, N. Y. The No. 1150 universal bridge is a laboratory instrument designed for measurements of inductors, capaci-

tors, and determination of resistive and reactive components of impedances. Frequency range is 20 to 20,000 cycles. Accuracy is 1.0 percent.

Voltage Regulators

SORENSEN & CO., INC., 375 Fairfield Ave., Stamford, Conn., is producing a group of a-c line electronic voltage regulators and d-c supplies. Input voltage range is from 95 to 215 volts a-c, 400 to 800 cycles; output voltage is adjustable between 100 and 120 volts a-c; and regulation accuracy is 0.5 percent. One regulated d-c supply working from a 400-cycle line is now ready, rated at 28 volts d-c output with a load range of 2.5 to 10 amperes.

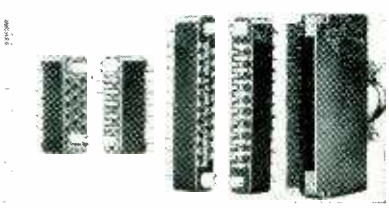
Bridge and Amplifier

ELLIS ASSOCIATES, Box 77, Pelham 65, N. Y. Model BA-1 bridge and amplifier, designed for complete control of all SR-4 gages and similar instrumentation, drives any standard c-r oscilloscope. The unit comprises bridge elements, signal chopper, calibration system, ampli-

fier and power supply. Bridge input is 50 to 2,000 ohm resistive elements; signal chopper frequency, 180 cps. For calibration ten resistors (10,000 to 10,000,000 ohms) are used. Amplifier input is 0.5 μf, 2 mc. Power supply is self-contained batteries.

Rectangular Connectors

WINCHESTER ELECTRONICS CO., 6 E. 46th St., New York 17, N. Y. Miniature lightweight rectangular connectors are now available in 14, 21 and 34 contacts. They are well-suited for instrumentation, such as

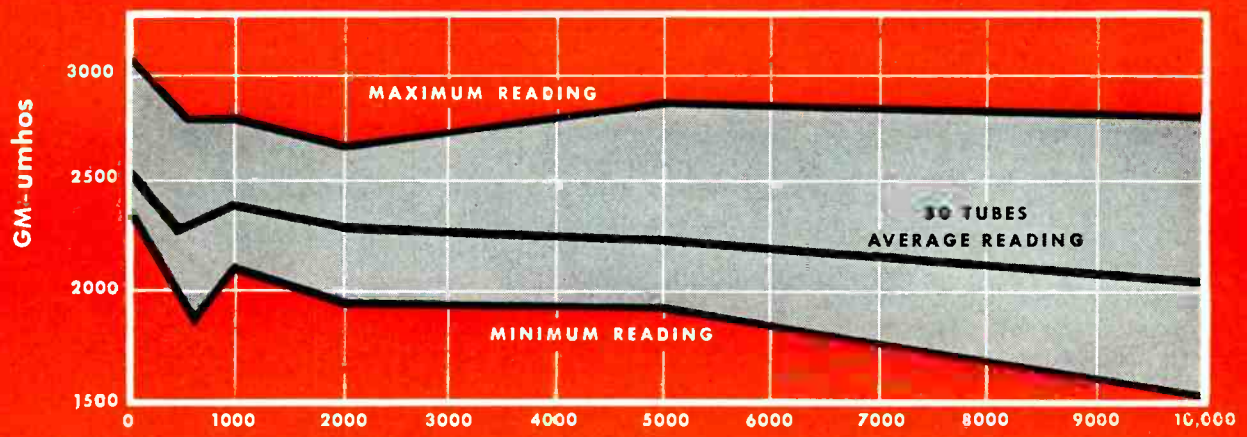


strain gage, telemetering and pressure pickup installation. Breakdown voltage is 5,200 volts d-c, 3,600 volts a-c.

Aircraft Thyratron

CONTINENTAL ELECTRIC CO., Geneva, Ill. Type CE-330 thyratron

RAYTHEON RUGGEDIZED 6SN7W* TUBES RATE TEN THOUSAND HOUR LIFE



Here's the test chart, obtained as part of a long life development contract from the National Bureau of Standards for a computer project.

TEST CONDITIONS
Ef = 6.3 Vac
Ec = −8 Vdc
Eb = 250 Vdc

LIFE TEST OPERATIONS
Ef = 6.3 Vac.
Eb = 175 Vdc
Pp/p = 1.4 Watts

THESE RAYTHEON RUGGEDIZED TUBES ARE NOW AVAILABLE...REASONABLY PRICED

Type	Description	Typical Service	Prototype	Construction	Heater Volts	Heater Amps.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Factor	Mut. Cond.
2C50	Dual Power Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	300	12.5	−24	—	—	9.5	1750
2C52	Dual Amplifier Triode	Aircraft Control Equip.	—	Bantal	12.6	0.3	250	1.3	−2	—	—	100	1900
6AK5W	Pentode RF Amplifier	Military Ruggedized	6AK5	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
6AL5W	Dual Diode	Military Ruggedized	6AL5	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma. dc.			
6AS6W	Pentode RF Mixer	Military Ruggedized	6AS6	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
6C4W†	RF Power Triode	Military Ruggedized	6C4	7 pin miniature	6.3	0.15	250	10.5	−8.5	—	—	17	2200
6J5WGT	General Purpose Triode	Military Ruggedized	6J5GT	Standard glass	6.3	0.3	250	9	−8	—	—	20	2600
6J6W†	Dual AF-RF Triode	Military Ruggedized	6J6	7 pin miniature	6.3	0.45	100	8.5	Rk 50	—	—	38	5300
6SA7WGT†	Pentagrid Converter	Military Ruggedized	6SA7GT	Standard glass	6.3	0.3	250	3.5	Rg 20000	100	8.5	—	450 Conv. Cond.
6SJ7WGT	Pentode RF Amplifier	Military Ruggedized	6SJ7GT	Standard glass	6.3	0.3	250	3.0	−3	100	0.8	—	1650
6SN7W*	Dual Triode	Military Ruggedized	6SN7GT	Standard glass	6.3	0.6	250	9.0	−8	—	—	20	2600
6X4W	Fullwave Rectifier	Military Ruggedized	6X4	7 pin miniature	6.3	0.6	Max. Peak Inv. 1250 Volts Max.			Io 70 ma. dc.			
12J5WGT	General Purpose Triode	Military Ruggedized	12J5GT	Standard glass	12.6	0.15	250	9	−8	—	—	20	2600
CK5654	Pentode RF Amplifier	Commercial Aircraft Ruggedized	6AK5W	7 pin miniature	6.3	0.175	120	7.5	Rk 200	120	2.5	—	5000
CK5670	Dual Triode	Commercial Aircraft Ruggedized	2C51	9 pin miniature	6.3	0.35	150	8.2	Rk 240	—	—	35	5500
CK5686	AF-RF Output Pentode	Commercial Aircraft Ruggedized	—	9 pin miniature	6.3	0.35	250	27	−12.5 per sect.	250	5	—	3100**
CK5694	Dual Power Triode	Industrial AF-RF Amp.	6N7G	Standard glass	6.3	0.8	294	7	−6	—	—	35	3200
CK5725	Pentode RF Mixer	Commercial Aircraft Ruggedized	6AS6W	7 pin miniature	6.3	0.175	120	5.2	−2	120	3.5	—	3200
CK5726	Dual Diode	Commercial Aircraft Ruggedized	6AL5W	7 pin miniature	6.3	0.3	Max. Peak Inv. 330 Volts Max.			Io 9 ma. dc.			

†Available during the early part of 1950. * *2.7 watts Class A output. 10 watts Class C input power to 160 mc.

*6SN7W is the military designation for 6SN7WGT

Note: All dual section tube ratings are for each section.

ASK US if you don't find just the tube you need in the above chart. Raytheon engineers stand ready to develop additional types for your tough service applications.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

was designed especially for the aviation industry. Its maximum height, excluding leads, is 6 inches, and maximum diameter, 2⅛ inches. Filament voltage is 14 v and filament current, 2.4 ±0.4 amperes. Heating time is 180 sec and deionization time, 200 μ sec. Minimum ambient temperature is −54 C and maximum, +100 C.

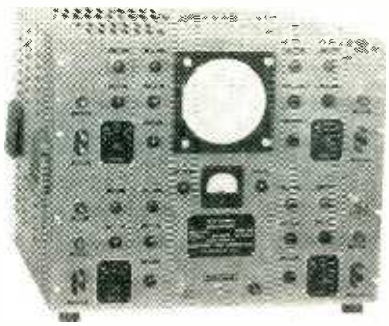
Powdered Iron Cores

STACKPOLE CARBON CO., St. Marys, Pa. Molded of a new powdered material, Ceramag II iron cores are designed for television horizontal image deflection circuits. In screen areas where there is a sudden voltage drop, the cores give ratios of

from 1 to 8 or more. The units are of standard screw type construction and are available in a complete range of frequencies for modern television applications.

Four-Channel Oscilloscope

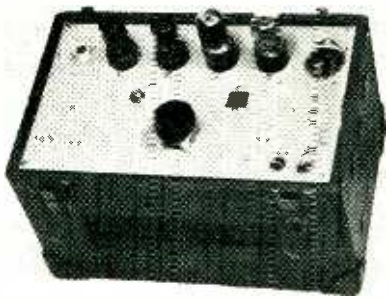
ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa. Model H-43 four-channel oscilloscope, designed primarily for use with a continuous film type of recording camera, can indicate as



many as four variables on a single 5-in. flat-face tube. It uses a type 54SW c-r tube which operates at 4,500 volts overall acceleration. Separate focus, intensity and positioning controls are provided in each of the four channels, and positioning in both horizontal and vertical directions is possible. The four signal amplifiers have a frequency range from 0 to 200 kc ± 3 db.

Calibrated Preamplifier

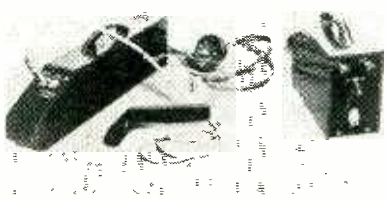
SOUND APPARATUS CO., Stirling, N. J. Model PR calibrated preamplifier is an all-purpose self-contained laboratory instrument,



equally suitable for portable applications. A flat response from 40 to 40,000 cps, a dynamic range in excess of 60 db, and a calibrated gain control in 5-db steps from 0 to 50 db, give a calibrated amplification into a low output impedance.

Tracing Device

SPECIAL PRODUCTS CO., Silver Spring, Md. The Electracer is an electronic tracing device capable of locating a defective point in wire,



cable, metal pipe or other conductor in any type of electrical installation or apparatus. No technical knowledge is necessary to operate the instrument. It consists of a signal generator, portable probe, receiver and headphones. A generated signal is followed with the probe and, amplified by the receiver, it is heard in the headphones. Thus the route of the conductor (whether it be imbedded in a wall or lost in a maze of other pipes and wires), point of defect or end of the conductor is quickly and positively determined.

Carrier-Current Tube

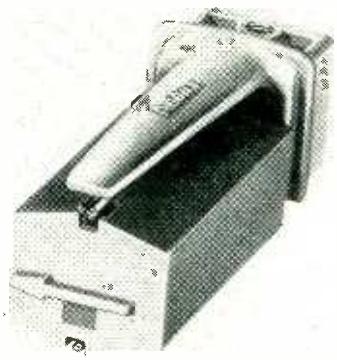
GENERAL ELECTRIC CO., Schenectady 5, N. Y. Type GL-5824, a new tube for carrier-current application, is designed to provide high power out-

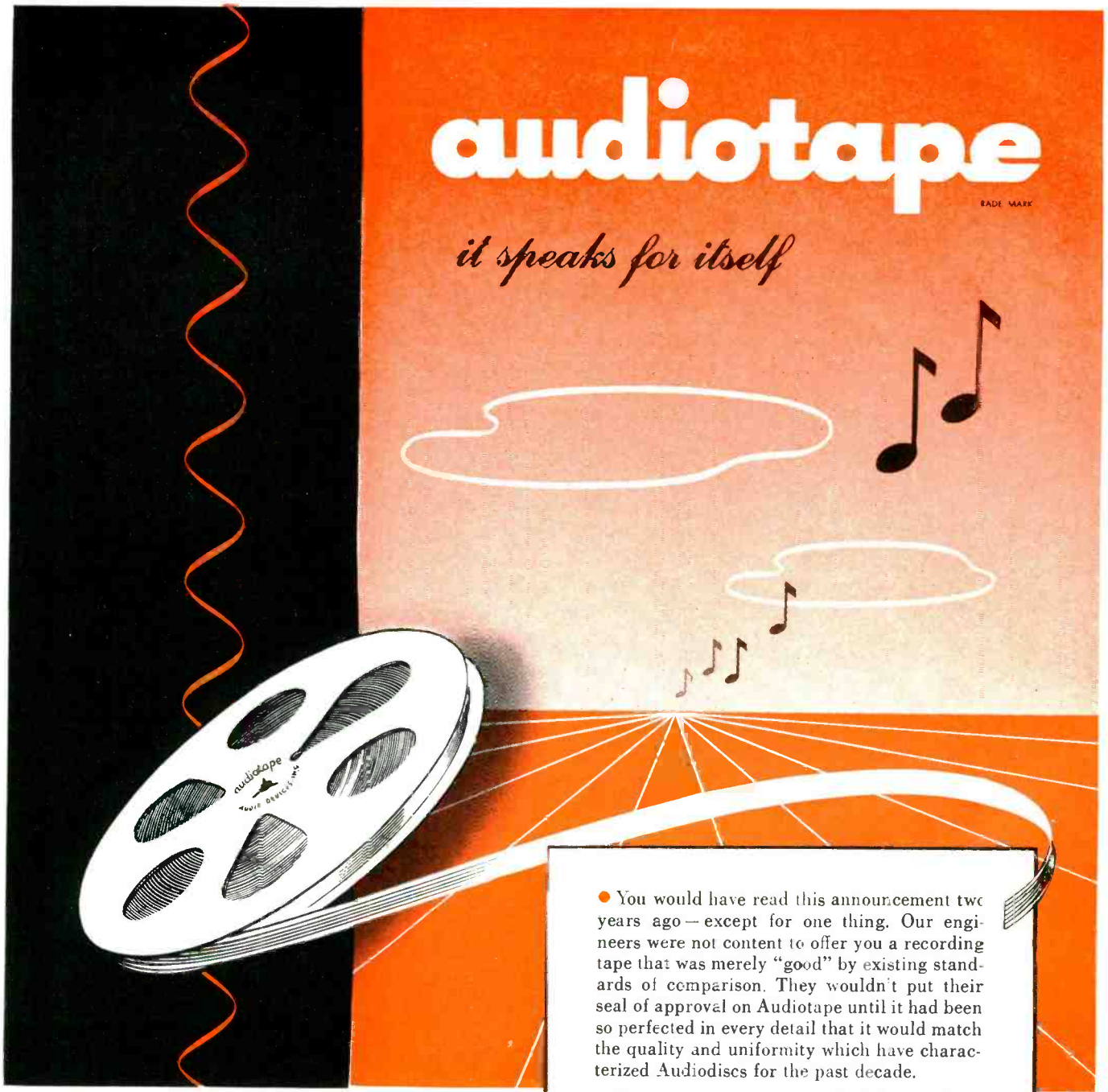
put at relatively low plate and screen voltages in applications requiring long life and reliability. The power amplifier pentode has beam characteristics and has plate dissipation of 12.5 watts with plate voltage at 200 volts. Heater voltage is 25 volts at 0.3 ampere.

Reproducing Unit

AUDAK CO., 500 Fifth Ave., New York 18, N. Y. The new Polyphase reproducer is a high-quality magnetic unit which plays the various types of disks without shifting ap-

(Continued on p 194)





NOW AVAILABLE

on plastic or paper base with red or black oxide

Audio Devices now offers you a complete line of highest quality magnetic recording tape — designed for matched performance in any tape recorder.

● You would have read this announcement two years ago — except for one thing. Our engineers were not content to offer you a recording tape that was merely "good" by existing standards of comparison. They wouldn't put their seal of approval on Audiotape until it had been so perfected in every detail that it would match the quality and uniformity which have characterized Audiodiscs for the past decade.

Paper base Audiotape reached that goal last May, after more than 2½ years of research and development. And now plastic base Audiotape has also graduated from the laboratory — with a degree of engineering excellence which is an unqualified recommendation to all professional recordists. Try it yourself — and note particularly the *uniformity of output* for the full length of the tape. A request on your business letterhead will bring you a free 200-foot sample reel of the new plastic-base Audiotape, or two 200-foot reels of paper-base Audiotape, one with red oxide and the other with black oxide coating.

THEY SPEAK FOR THEMSELVES

AUDIO DEVICES, INC.
444 Madison Ave., N. Y. 22, N. Y.

Export Dept.: ROCKE INTERNATIONAL
13 East 40th St., New York 16, N. Y.

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Amended I-F Pickup Rules

THE FCC has amended Part 18 of its rules and regulations, effective Dec. 1, 1949, to relieve operators of type-approved or certified diathermy and other non-broadcast equipment from being required to eliminate interference to television and other receivers arising from direct intermediate-frequency pickup of emissions from apparatus operating on prescribed frequencies and otherwise adhering to Commission requirements.

This rule-making concerns television reception primarily. The broad band required by tv signals tends to increase the receiver's susceptibility to interference. Also, intermediate frequency amplifiers for tv receivers are, for economic reasons, made less selective than those in a-m and f-m receivers. The problem is not one of interference caused by operation of diathermy or other devices in the television channels, but rather of interference resulting from direct i-f pickup by tv receivers of radiation from devices operating on other frequencies.

The new rules have the effect of putting the initial responsibility of correcting tv receivers on their manufacturers. Interference to tv reception from direct i-f pickup could be eliminated by the use of traps, shields or filters in tv sets, or retuning the i-f system on a locally satisfactory basis.

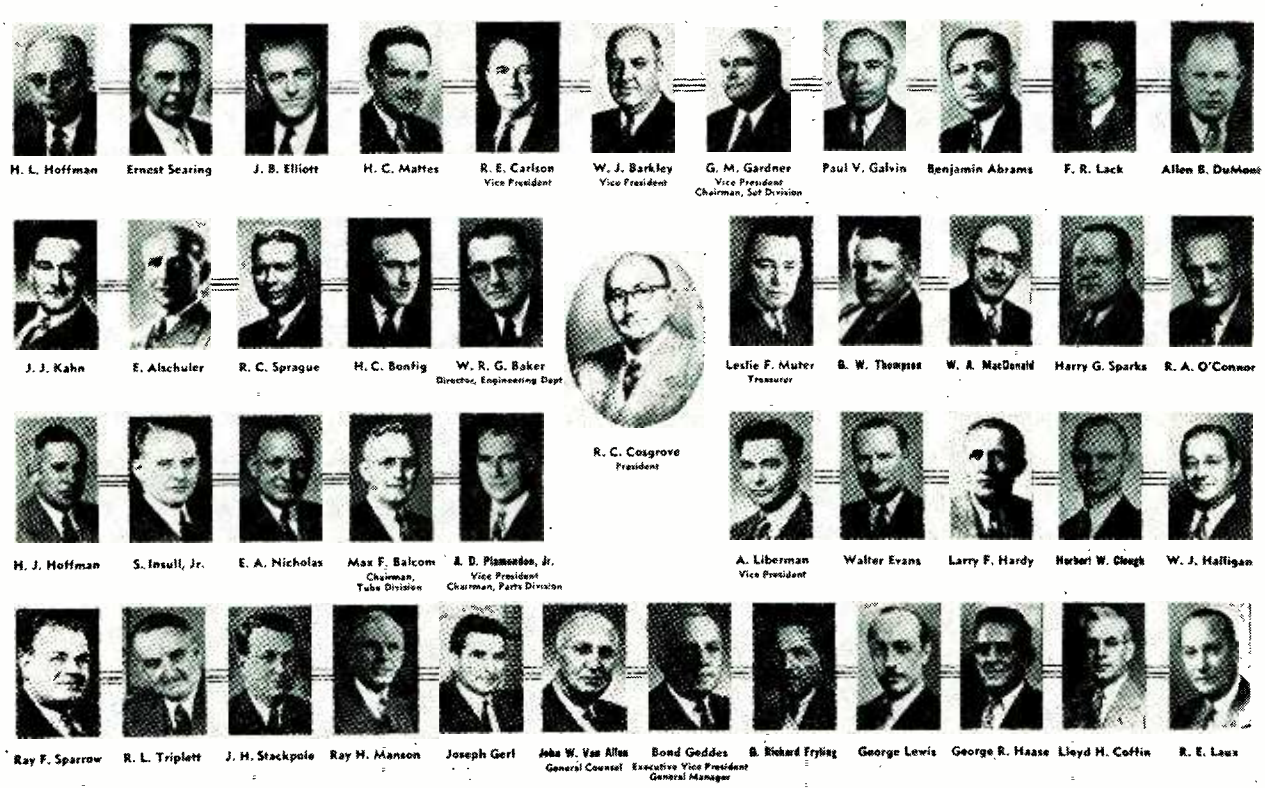
Radio Propagation Notice

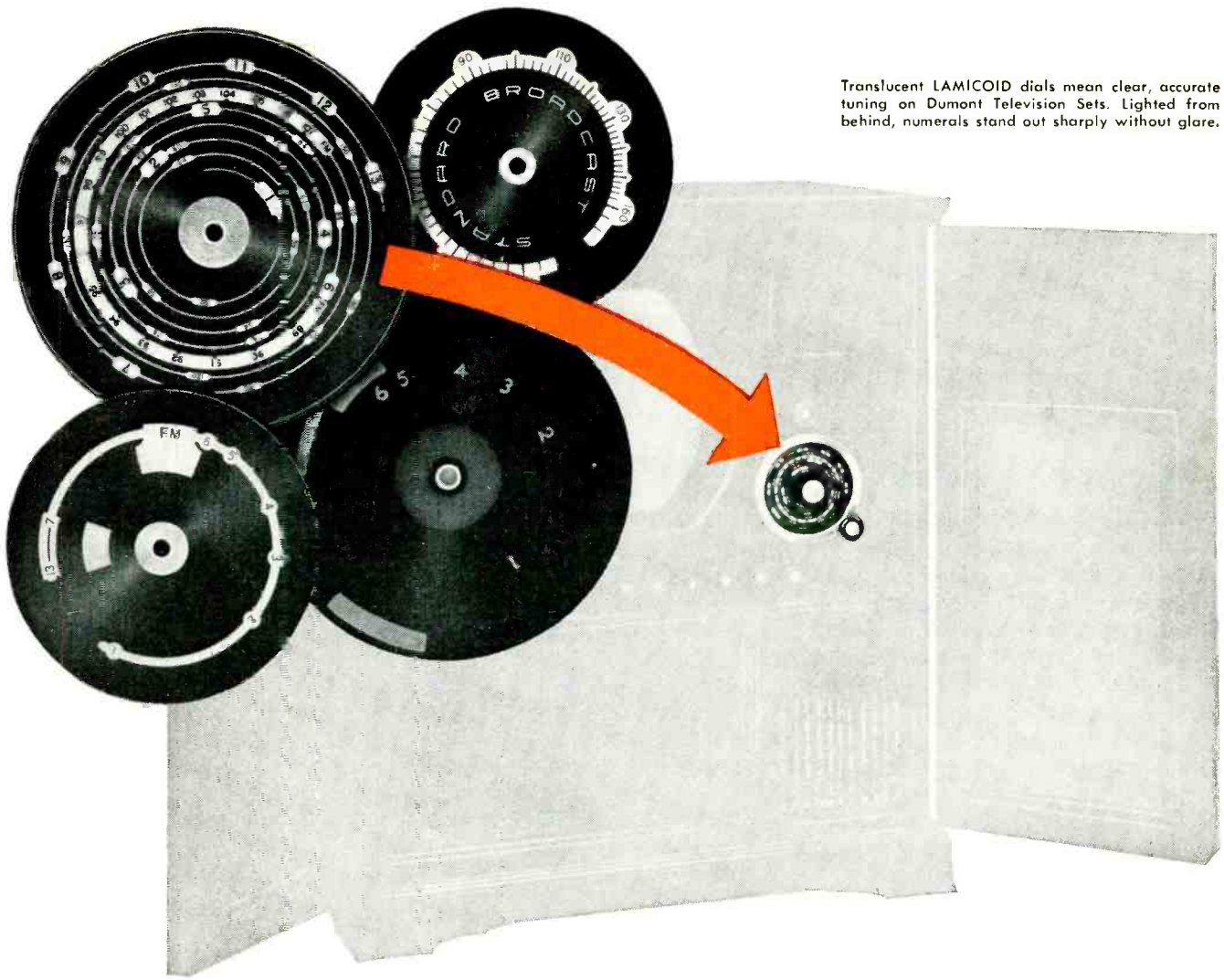
EFFECTIVE November 1, 1949, a new broadcast signal of the National Bureau of Standards radio station WWV has improved one of the technical radio broadcast services of the Bureau's Central Radio Propagation Laboratory. This signal, a warning of unstable conditions in the ionosphere, provides additional data on ionospheric disturbances—information of vital significance to the Armed Services and the communications industry in maintaining uninterrupted long-distance radio communications.

Heretofore two grades of propagation conditions have been recognized in the notices given at 19 and 49 minutes past each hour by station WWV, which continuously broadcasts standard radio frequencies, time announcements, and the standard musical pitch in addition to the radio propagation disturbance notices. The letter N (in International Morse Code) repeated several times has signified normal conditions, while the letter W has constituted a warning that disturbed conditions were present or expected within 12 hours.

A third category, indicating unstable conditions and denoted by the letter U, is now being used when the forecasters expect satisfactory reception of short-wave communication or broadcast services employing high-power trans-

RMA Board of Directors for 1949-1950





Translucent LAMICOID dials mean clear, accurate tuning on Dumont Television Sets. Lighted from behind, numerals stand out sharply without glare.

ON *Translucent Lamicoid** DIALS
all channels are clear!

The tuning "channel" on Translucent LAMICOID dials for TV is always highly legible. Lighted from behind, its printed numerals stand out bright and clear without glare.

Translucent LAMICOID won't "brown out" or warp. This thermosetting laminated plastic is tough, stable, moisture-resistant, attractive, colorful, easy to clean, economical to fabricate—all the things you want in a material for dials, signs, charts, nameplates or similar products.

For visual devices of all kinds, you have a choice of three different grades of Decorative LAMICOID —Graphic, Translucent or Engraving. In addition, we offer a complete line of electrical insulating materials—perfected through our experience of more than a half century. Contact our nearest branch office or fabricator for further information.

*Registered Trade Mark

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

mitting equipment operating on the recommended frequency, but poor results on less well equipped services. Such conditions often occur as major disturbances subside. Although point-to-point communication links are able to resume reliable operation, mobile services and short-wave broadcasts continue to experience difficulty. The propagation disturbance notices, broadcast in International Morse Code, primarily refer to the North Atlantic radio circuits.

MEETINGS

DEC. 9-10: Second Southwestern IRE Conference, Baker Hotel, Dallas, Texas.

JAN. 30-FEB. 3: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

FEB. 27- MARCH 3: ASTM Committee Week and Spring Meeting, Hotel William Penn, Pittsburgh, Pa.

MARCH 6-9: IRE Convention and Radio Engineering Show, Hotel Commodore and Grand Central Palace, New York City.

APRIL 26-28: Fourth annual meeting of the Armed Forces Communications Association, Astoria, New York City, and Fort Monmouth, N. J.

JUNE 26-30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

Frequency Nomenclature Revision

IN VIEW of numerous inquiries concerning various abbreviations and symbols used to designate frequency bands or regions in the r-f spectrum, the FCC recently revised its Rules and Regulations to include the internationally adopted system of frequency-band abbreviations.

The system of abbreviations, applicable to all U. S. non-government radio services, was set forth as follows: vlf (very low frequency), below 30 kc; l-f (low frequency), 30 to 300 kc; m-f (medium frequency), 300 to 3,000 kc; h-f (high frequency), 3,000 to 30,000 kc; vhf (very high frequency), 30,000 kc to 300 mc; uhf (ultrahigh frequency), 300 mc to 3,000 mc; shf superhigh frequency), 3,000 mc to 30,000 mc; ehf (extremely high frequency), 30,000 mc to 300,000 mc.

In order to promote a standard system of frequency band symbols, recognized nationally and internationally, the Commission encourages the use of this abbreviation system and suggests the discontinuance of the use of the following wartime military symbols in civil fields:

P	200 mc Region
L	1,000 mc Region
S	3,000 mc Region
X	10,000 mc Region
K	30,000 mc Region
V	50,000 mc Region

The above abbreviations were evolved primarily for security reasons but also served as a brevity device which came to be widely used in the field of radio and radar for nomenclature and documentation purposes by the military services and, primarily because of the brevity feature, by the non-military as well. Following the war, these abbreviations were closely identified with large amounts of surplus electronic equipment.

RADIOLYMPIA 1949

General view of the main-hall booths at Radiolympia (National Radio Exhibition), held in London, England, between Sept. 28 and Oct. 8, 1949, gives a good impression of the number of firms exhibiting. Although the accent was on television at the show, a wide variety of improved and more economical radio receivers were also exhibited

New Elements Officially Named

THE OFFICIAL nomenclature for eight man-made chemical elements was recently announced by the International Union in Chemistry in Amsterdam, Holland. In addition to the official naming of the elements, which include the atomic bomb element plutonium, six of the older elements on the periodic table, known under different names in different countries, will now be known officially under one name in all lands.

The four transuranium elements (those beyond uranium, the ninety-second on the periodic table) made in America's atomic ovens, received the names proposed by their makers: neptunium for element 93, plutonium for 94, Americium for 95 and curium for 96. The four other man-made elements were named as follows: element 43, technetium; element 61, promethium; element

(continued on page 226)

SYLVANIA GERMANIUM DIODES assure accuracy in top-quality test instruments

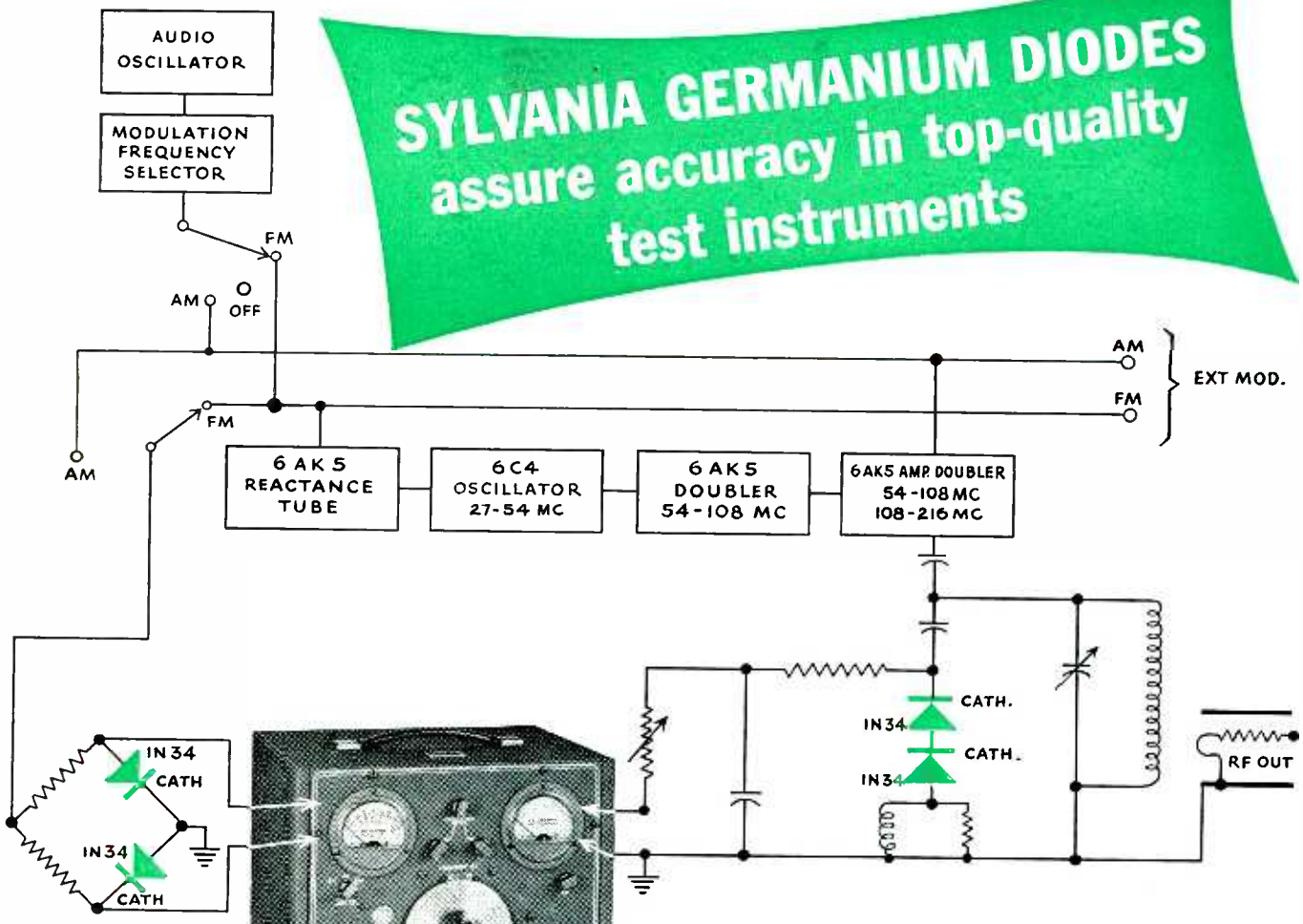


Diagram shows the four 1N34's used as meter rectifiers in Boonton's Type 202-B Frequency Modulated Signal Generator. The diodes help assure accurate operation over a frequency range of 54 to 216 mc.

Boonton Radio Corporation uses four 1N34's to maintain accurate calibration of FM Signal Generator over wide frequency range

Boonton Radio Corporation instruments using Sylvania Germanium Diodes include—in addition to the Type 202-B Frequency Modulated Signal Generator—a VHF Signal Generator, a Univerter and a Glide Slope Test Set. And Boonton is just one of the many manufacturers who have found Sylvania Germanium Diodes ideal for assuring dependable product performance—or of making equipment designs more compact. You'll want the full story on these small, light, rugged diodes that require no heater supplies. Mail the coupon for information on the Sylvania line—including ceramic and new sealed-in-glass types.

SYLVANIA ELECTRIC

Electronics Division, 500 Fifth Avenue, New York 18, N. Y.

ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; PHOTOLAMPS; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS

Sylvania Electric Products Inc.
Electronics Division, Dept. E-2912
500 Fifth Avenue, New York 18, N. Y.

Please send me information on the complete line of Sylvania Germanium Diodes, including glass types.

Name_____

Position_____

Company_____

Street Address_____

City_____ State_____

TUBES AT WORK
(continued from p 118)

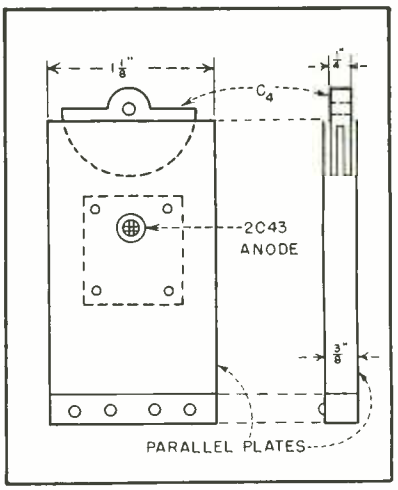


FIG. 3—Inductors L_2, L_3 and L_4 are parallel-plate tanks. Floating rotors C_3 tune L_2 and L_1 as shown above. Dimensions of plates are given in Fig. 1

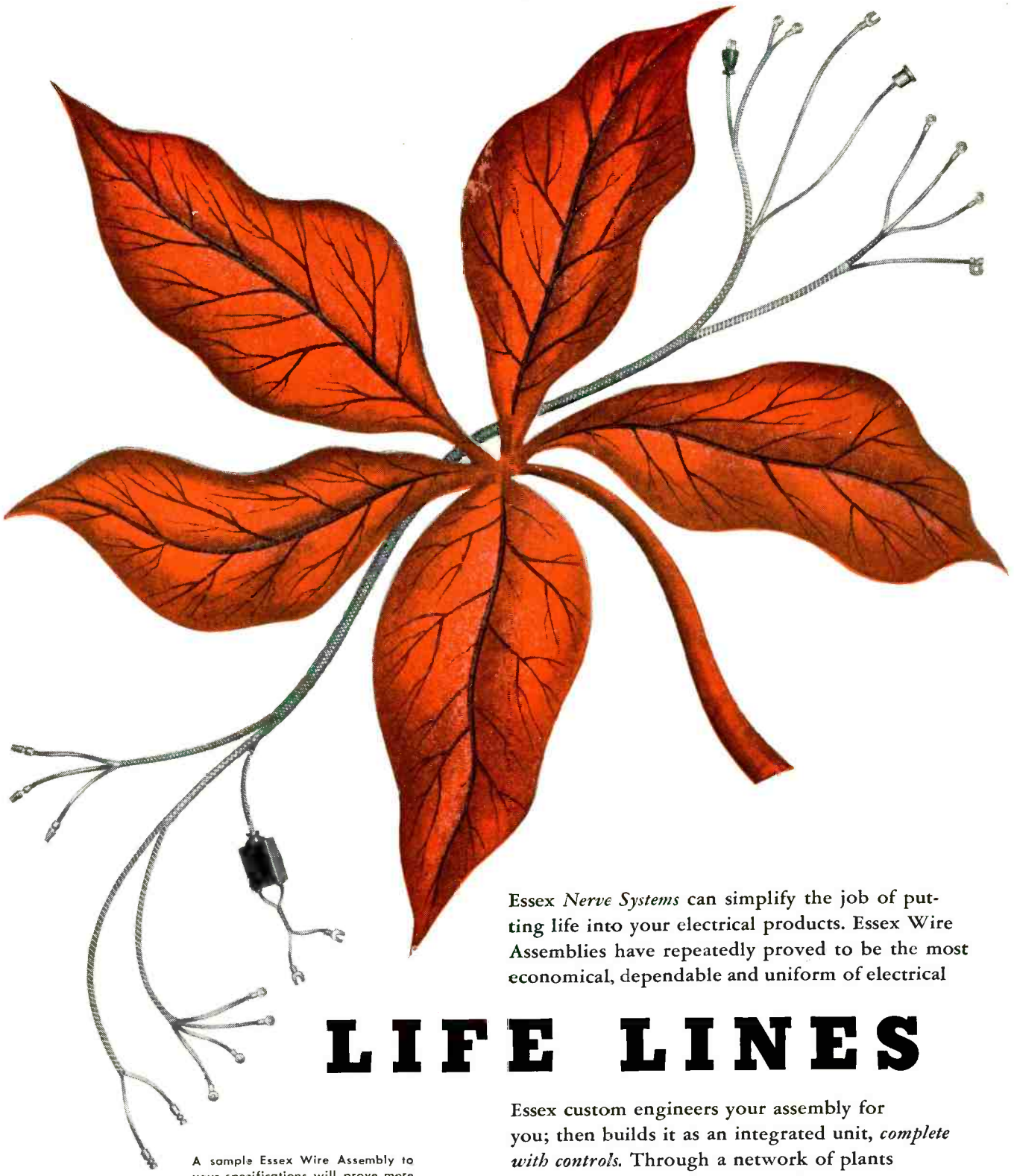
power amplifier between 55 and 70 percent. Power gain through the power amplifier was approximately 4 to 1 at 300 plate volts.

Coupling from the tripler plate to the power-amplifier cathode line is done by tapping down on the line with a sliding piece of phosphor bronze on the center conductor of RG59U coaxial cable. On the tripler plate and amplifier plate, the tap is very close to the shorted end, while it is nearly half way up the line on the cathode tank line of the power amplifier. It is necessary to add a small padder in the cathode tank to compensate for various tube grid-cathode capacitances. This is absolutely essential to realize maximum performance from the power amplifier.

Power drive to the tripler is about 3½ watts at 150 mc. Power output at 450 mc is 7 watts. This is accomplished by staying within cathode current ratings and plate dissipation ratings of the 2C43.

TV Interference From Incandescent Lamps

INTERFERENCE to tv reception caused by incandescent lamps has recently been identified by several service and utility groups. Lamps on the point of burnout have long been known as sources of interference to radio and tv, the cause being sparking across a small gap in the filament wire. But interference from a lamp in good working order



Essex *Nerve Systems* can simplify the job of putting life into your electrical products. Essex Wire Assemblies have repeatedly proved to be the most economical, dependable and uniform of electrical

LIFE LINES

Essex custom engineers your assembly for you; then builds it as an integrated unit, *complete with controls.* Through a network of plants Essex controls the whole operation from copper bar to your product.

A sample Essex Wire Assembly to your specifications will prove more than words. Call an Essex representative, or send your specifications to Service Engineering at the factory.

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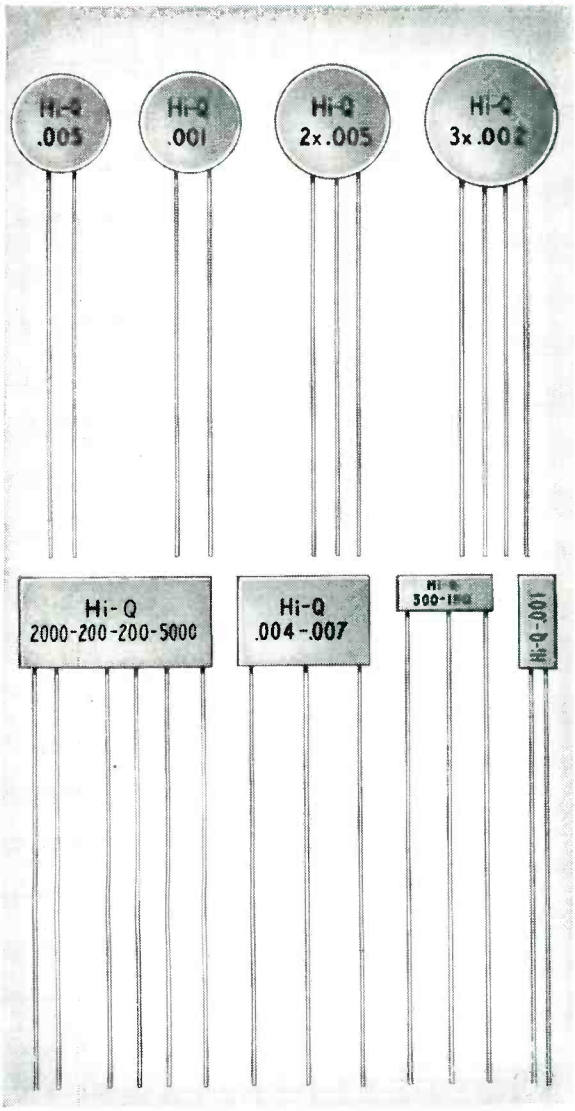

ILLUSTRATIONS APPROXIMATELY ACTUAL SIZE

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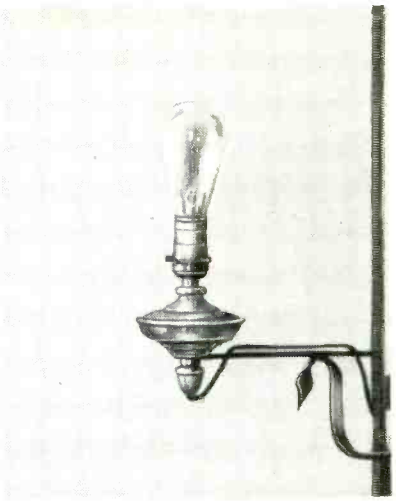


FIG. 1—Straight-filament type of lamp used in the tests

had not been suspected. One of the first to track down such a source was the Communications Committee of the Pennsylvania Electric Association. This group found that the Mazda A lamp (Fig. 1), an old type containing a straight-wire filament in the form of a cage supported on a glass post, was a notable offender. Television service organizations have detected similar interference from modern inside-frosted bulbs.

To study the effect at first hand, the editors of ELECTRONICS requested the Pennsylvania Electric Association to provide a lamp known to cause the interference. The lamp was installed (Fig. 2) in an open holder about two feet away from a model 630TS television chassis. The lamp and receiver were fed from the same convenience outlet.

The interference observed in the test takes the form of one or more horizontal bars, covering from 3 to 50 lines of the image (corresponding to interference pulses of

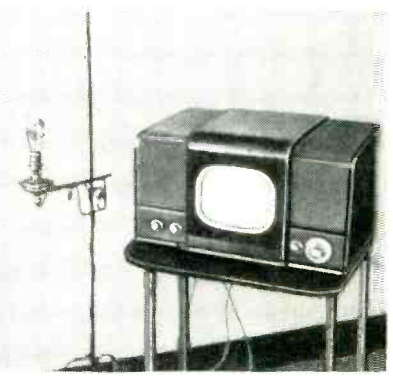
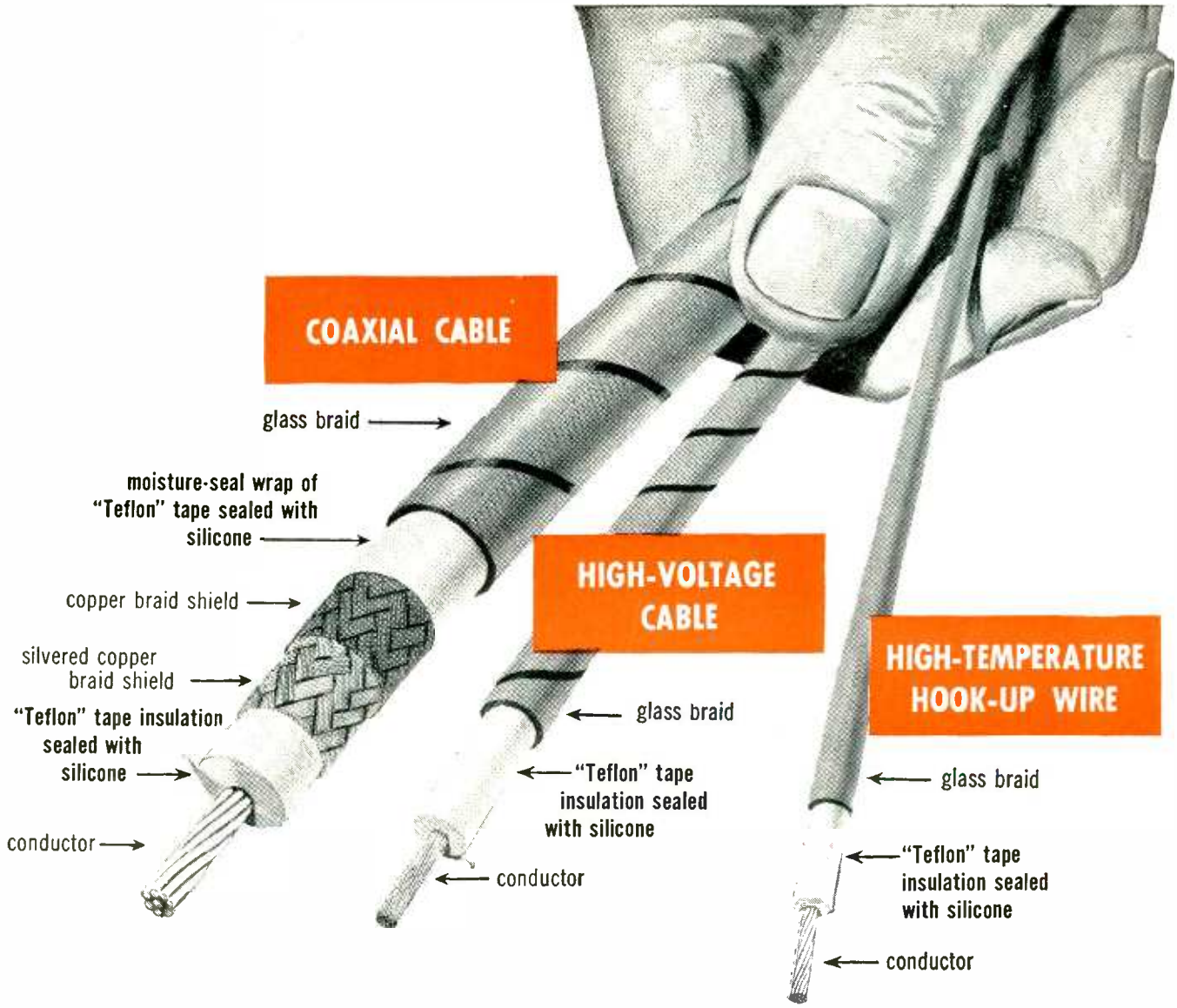


FIG. 2—Test setup of lamp and receiver



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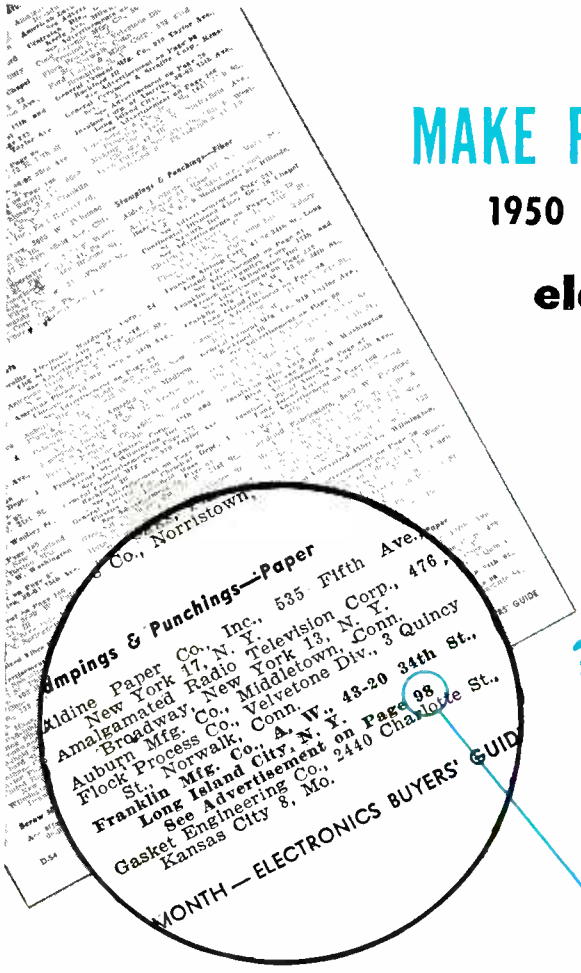

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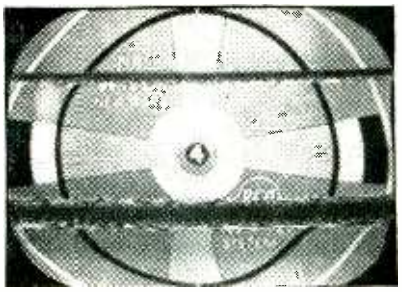

FIG. 3—Interference on channel 4 consisted of two bars

200 to 3,000 microseconds duration). The wider bars display beat-pattern striations having from 50 to 150 black and white segments in the width of the picture. The beat pattern indicates that each pulse of interference has a frequency in the vicinity of the picture carrier, and is frequency modulated over a range of 1 to 2 mc. The possibility that the interference occurs at intermediate frequencies is ruled out by the radical change in its character as the receiver is tuned from one channel to another. The pulses of interference are synchronous, as is to be expected, with the frequency of the local power system.

With the particular lamp tested, the strongest interference was experienced on channel 4 (66-72 mc), and took the form of two bars (Fig. 3). When the lamp bulb was partially shielded by placing one's hand over it, the intensity was reduced markedly, but otherwise retained its character, as shown in Fig. 4.

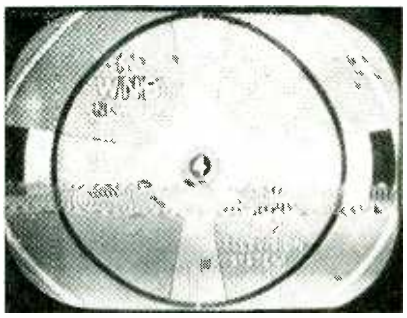

FIG. 4—Partial shielding of bulb reduces the intensity of the bars

On channel 2 (54-60 mc) the interference was less intense and appeared in three bars (Fig. 5). On channel 5 (76-82 mc) only one bar appeared, likewise of low intensity (Fig. 6). On channels 7 to 13 (174-216 mc) very little interference was noted, although one small bar, too faint to be photographed, was seen on channel 13 (210-216 mc).

When the lamp was removed

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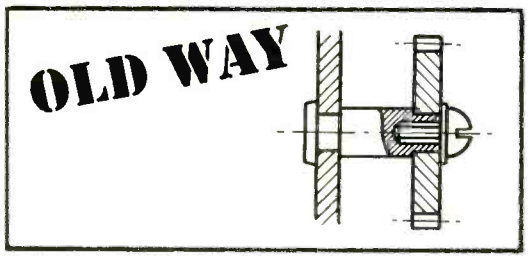
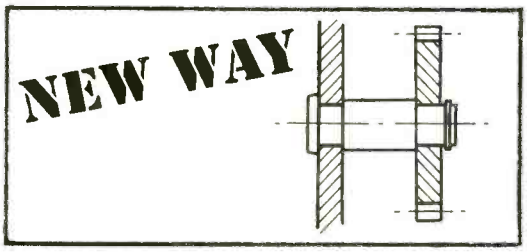


SCREW AND WASHER HOLD FLOATING GEAR IN PLACE in old model newspaper facsimile recorder. Gear stud may rotate at pivoted end, making removal of screw difficult. Screw head takes up valuable space.



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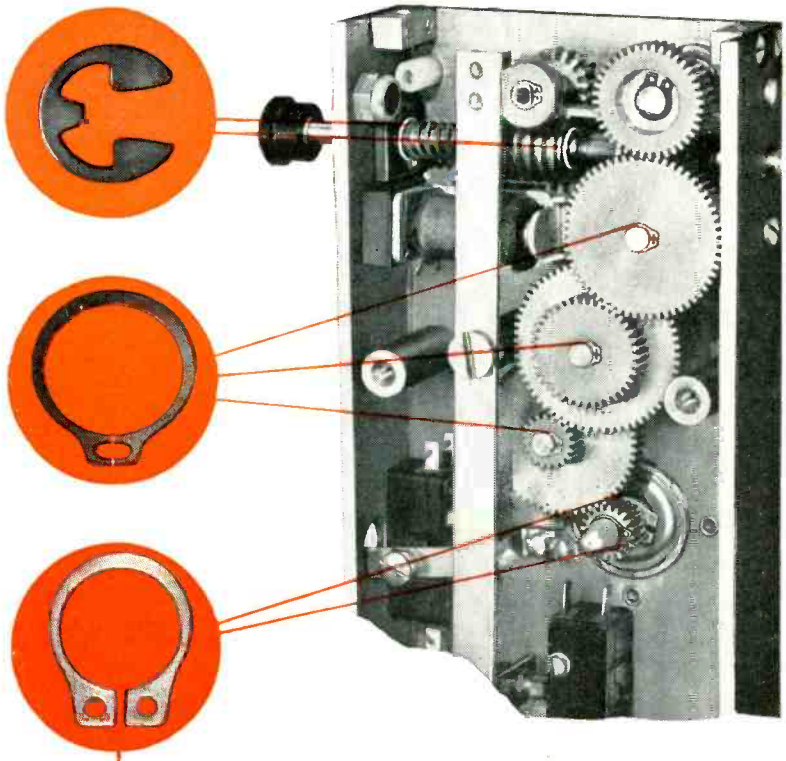

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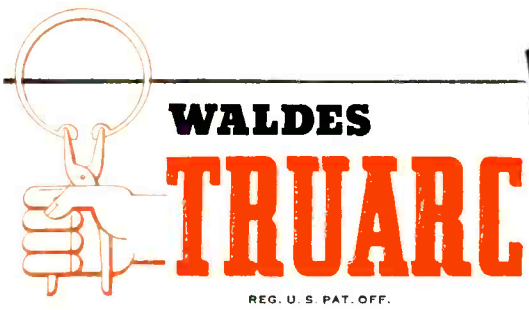

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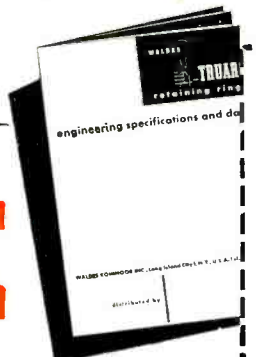

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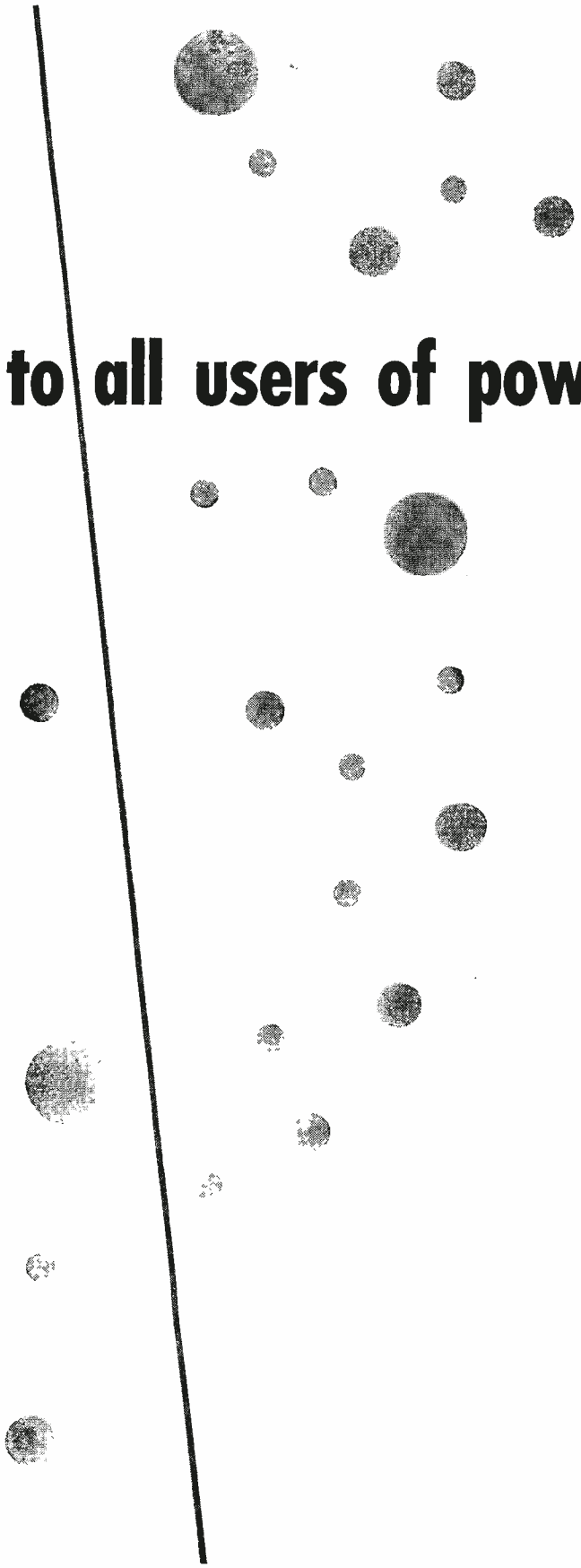

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FIG. 5—Three bars appeared on channel 2

about 20 feet from the receiver and connected to a separate outlet (joining the receiver outlet through the fuse box over 40 feet of BX cable), the interference disappeared on all channels except channel 4, and then only one bar was of sufficient strength to be visible.

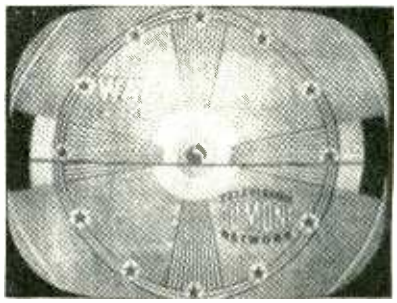

FIG. 6—Channel 5 interference consisted of one bar

These observations indicate that the source of the interference is shock excitation of one or more tuned circuits whose natural resonances are in the 50- to 100-mc band. One possible explanation is thermal vibration, causing the filament wire to make intermittent contact with its supports. This would cause the natural period of the filament wire, considered as a resonant system made up of its own self inductance and distributed capacitance, to change synchronously with the alternation in voltage drop along the wire. If the duration of the intermittent contact is brief, the resonant circuit formed by the wire receives a brief pulse of excitation from the power line once each cycle.

Lamps of the type shown are still in use, particularly in rural districts, and are most often found in attics and cellars. Instances of this type of interference which come to the attention of readers should be

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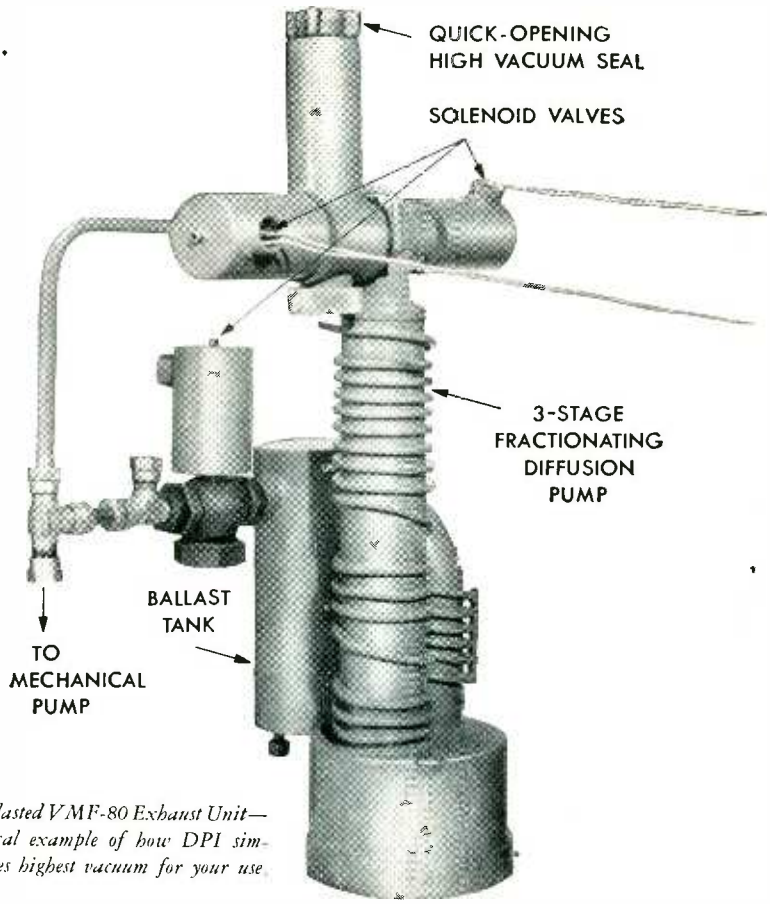

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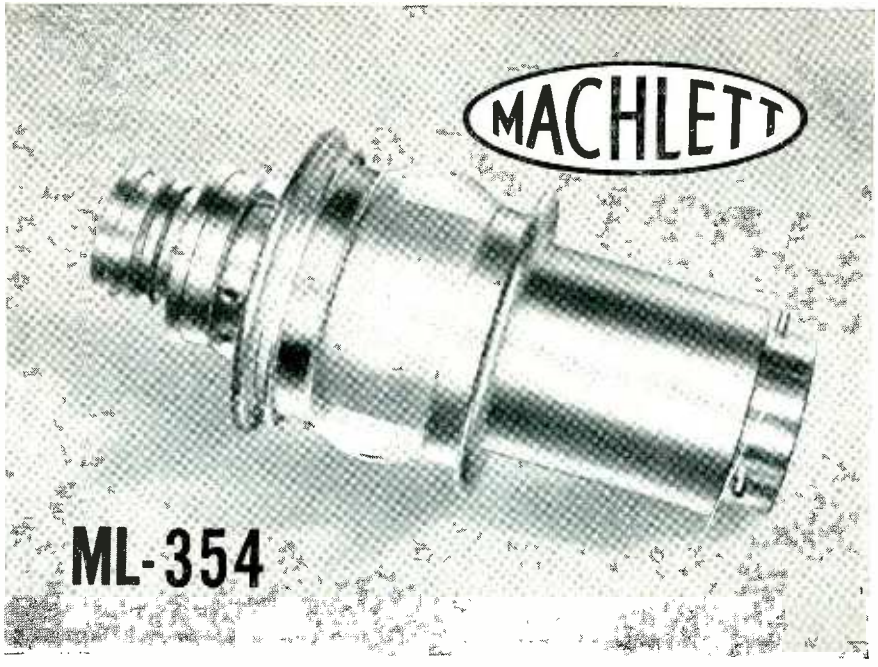
Superior Design Features

Developed to satisfy the need for higher-power electron tubes in broadcast, communications, research, and industrial services, this all-ring-seal triode is of a balanced electrical and mechanical design. Its low plate impedance makes it ideally suitable for broad band applications. All electrodes mount directly from heavy copper cylinders, resulting in a structure which is far superior, electrically and mechanically, to conventional water-cooled electron tube design; all glass-to-metal seals are of Kovar, and the large diameter seals give increased strength and freedom from excessive heating at electrode contacts. The tube incorporates a high-conductivity, heavy-wall copper anode. The integral anode water jacket and quick change water-coupling, contribute to easy and rapid tube replacement. The cathode is a 16 strand self-supporting thoriated-tungsten filament, completely balanced and stress-free throughout life. The rigidly supported grid and cathode are designed to give uniform anode heating. The grid is capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

Wide Application

The foregoing design features and characteristics are incorporated in the ML-354 triode, developed by Machlett Laboratories, Inc., Springdale, Conn. The ML-354, having basic design features usable over a wider range of power and frequencies than has been heretofore available in triodes, finds applications, among others, in high-power AM, FM and TV broadcasting, cyclotron and synchrotron oscillators and in induction and dielectric heating. *(advertisement)*



DESCRIPTION

The **ML-354** is a compact, general purpose, high power electron tube designed for operation at full power up to 110 mcs/sec. It is an all-ring-seal water and forced-air-cooled triode capable of giving in excess of 50 kilowatts output power at 108 mcs/sec. in grounded grid circuits with 10 kilowatts driving power. Considerably higher power is available at lower frequencies. This tube is ideally suited for cavity operation, and its low plate impedance is advantageous for broad band applications. Features include Kovar glass-to-metal seals, sturdy electrode structures, integral anode water jacket, and quick change water coupling. The cathode is a stress-free self-supporting thoriated-tungsten filament.

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DC Grid Current	2.5	2.5	Adc
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Plate Dissipation	75	50	kW

For complete technical data on the ML-354 high power, all-ring-seal triode, write to Engineering Department,

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reported to the editors with a brief description of the character of the interference, the type of lamp causing it, the location of lamp and receiver, and the channels on which it is observed.—D. G. F.

Signal Circuit for Model Railroads

By Willard W. Van Allen
Washington, D. C.

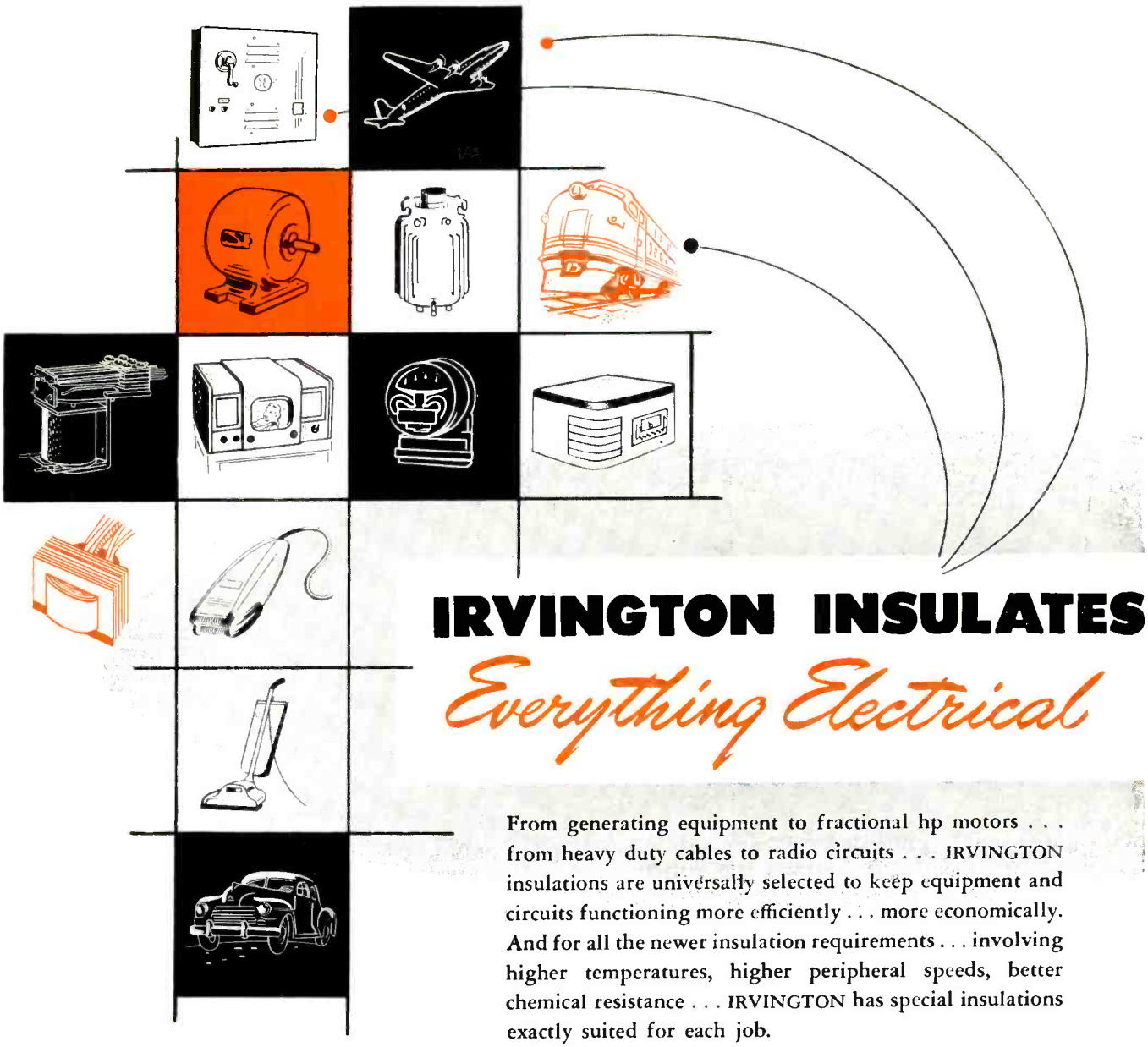
Model railroad enthusiasts who use the so-called two-rail system, whereby direct-current power is supplied to the locomotives through the two running rails, are faced with a problem in signal-circuit design, since the same two rails must provide both running power and signal control. Many circuits have been proposed and are in use, but all offer one or more serious faults.

An ideal signal system should provide indication of the presence of a train or single car in any or all blocks regardless of whether running power is supplied and of the polarity of this power. If the signal system is also operated on direct current, it is obvious that when running power is supplied to two or more blocks simultaneously from a common source, the gap in the rails intended to isolate one block from another is effectively shunted by the power feeders and the individuality of the blocks is lost.

Any direct-current signal system, therefore, requires a separate source of running power for each block. Separate power for each block unquestionably simplifies the signal control problem, but offers the serious objection of high cost and complex control panels, since independent speed controls are also required for each block.

The necessity for isolating each block for signal purposes while allowing power distribution from a common source immediately suggests the use of alternating current for signal control. The blocks can then be isolated from each other by choke coils and from the power supply by capacitors, as shown in the lower half of Fig. 1.

For effective isolation, the ratio



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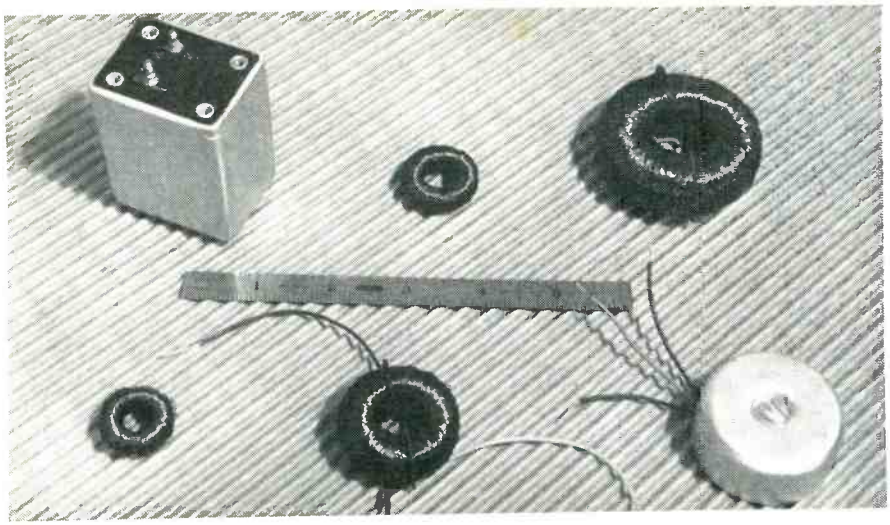

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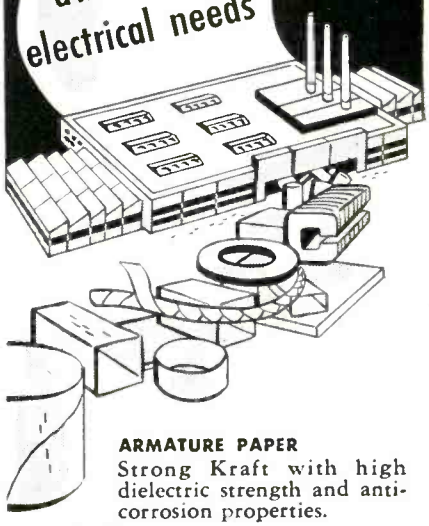

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REG. U. S. PAT. OFF.

CENTRAL PAPER COMPANY
INCORPORATED

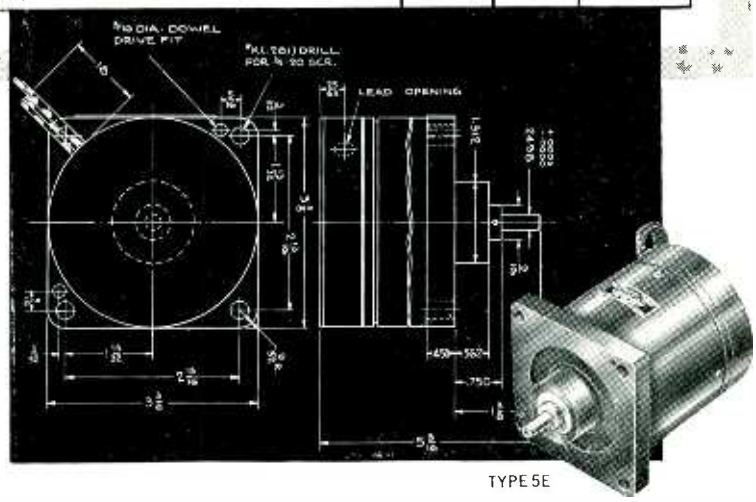
2442 LAKESHORE DRIVE, MUSKEGON, MICH.

To Top Flight Development, Design and Instrumentation Engineers

This table gives the essential characteristics of Arma Induction Generators. The information may suggest applications of these components to your designs.

TYPE	FREQ.	INPUT VOLTS	INPUT AMPS.	INPUT WATTS	OUTPUT Volts per 100 R.P.M.	OUTPUT Specified R.P.M.	OUTPUT Phase	RESIDUAL AT 0 SPEED (m.v.) In-Phase	RESIDUAL AT 0 SPEED (m.v.) Quadrature	RESIDUAL AT 0 SPEED (m.v.) Harmonic	ROTOR INERTIA Oz. in.^{2}	WEIGHT (lbs.)	ALLOW. MAX. STATIC FRIC. Oz. In.
1A60	60	24	0.18	2.0	0.33±5%	900	0°±1.5°	10	10	10	0.22	1.5	0.2
5E	60	90	0.15	5.0	1.0 ±1%	600	0°±0.5°	5	5	15	2.60	6.3	0.75
03ADC	DC	24	0.15	3.5	0.070 V.D.C. (approx.) for an acceleration of 1400 Radians/Sec.^{2}						0.019	0.54	0.1
3	DC	38-46	0.12	5	0.1 V.D.C. (approx.) for an acceleration of 1400 Radians/Sec.^{2}						0.25	3.0	1.0

Induction Generators that serve importantly in ARMA'S Post-War Technique of electrical "BRAIN BLOCK" instrumentation



TYPE 5E

"Brain Block" instrumentation quickly describes any custom arrangement of light, small, accurate standard Arma components to make precision instruments and controls.

Wide Use for Tachometer Type

Arma's 1A60 and 5E Generators are of the tachometer type. They generate an A.C. voltage equal to the product of excitation voltage and rotor speed with minimum introduction of phase shift, harmonics or quadrature voltage. The linear voltage-speed characteristics of these units over wide speed ranges and the low level of quadrature and harmonics at very low or zero speed indicate their selection where a voltage proportional to speed is required. The units are designed to minimize sensitivity to temperature changes and each is calibrated and standardized for complete interchangeability. Advantages include: linearity deviations extremely small over wide speed range; minimum phase shift; and low residual voltage.

Where to Use Acceleration Type

The Arma 3 and 03ADC Generators are of the acceleration type. This type is D.C. excited and its output is a D.C. voltage proportional to acceleration of the rotor. It is extremely useful in servo systems having severe damping requirements and in systems where it is necessary to measure or limit the acceleration.

Features of Arma Ind. Generators

1. *Rugged construction and high mechanical accuracy.*
2. *Low friction and inertia.*
3. *High output to inertia ratio.*
4. *Engineered precision.*

New Opportunities in Other Arma Components, too

While you re-examine, in the light of these Generators, designs once limited by available components, it may pay you to have up to date information on: Arma Synchro Units for remote control and indicating purposes; two-phase Induction Motors for servo-mechanisms and control devices; Electrical Resolvers* for solving problems involving triangles, coordinates and vectors; high-precision Mechanical Differentials for instrument applications; D.C. Step Motors for remote control purposes; and, Induction Potentiometers for the smooth, stepless rotation required in modern "Brain Block" instrumentation.

Entering its 32nd year, Arma Corporation is so fully committed on urgent defense projects as to preclude its presently undertaking industrial instrumentation. However, you are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N. Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* ARMA SYNCHROS ARMA INDUCTION MOTORS ARMA INDUCTION GENERATORS ARMA MECHANICAL DIFFERENTIALS ARMA ALTERNATING VOLTAGE COMPARATOR COMPUTING MECHANISMS INDUSTRIAL CONTROLS STABILIZATION DEVICES NAVIGATIONAL EQUIPMENT LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,624 and 2,467,646. License information available.

QUALITY ARMA INSTRUMENT PRECISION

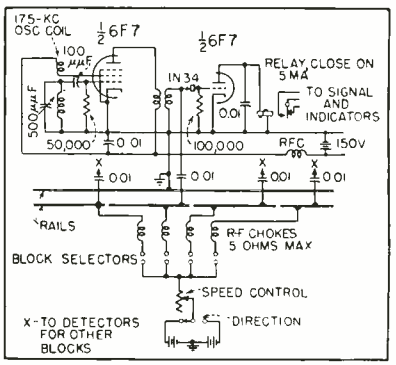


FIG. 1—Circuit diagram of tuned-circuit signal and power distribution system for model railroads

of impedances between the choke coils and capacitors must be at least 10 to 1. The choke coils must carry the full running current of at least one ampere and have low resistance to avoid objectionable voltage drop. If low-frequency alternating current for signal control circuits is to be used, therefore, large and expensive chokes and capacitors are required. At higher frequencies, however, this difficulty is avoided.

R-F Signaling

It has been proposed to use a source of radio-frequency power for signal indication, using the above outlined method of block isolation. In this system the presence of a train in a block would complete an r-f circuit from one rail to the other through suitable capacitors mounted between the wheels of the rolling stock.

The r-f signal current flowing in this circuit would then operate an electronic relay of suitable design. However, it has been found that the leakage of high-frequency currents through the roadbed and switches is so high that reliable operation is very difficult to obtain.

This difficulty is overcome by using the rails as part of a tuned circuit in a modified form of capacitance relay. Thus the condition of the block, that is, occupied or free, effectively controls the signal circuit, while no signal current in the usual sense is required to flow between the rails. This also greatly simplifies the problem of altering the rolling stock to obtain signal operation.

A schematic diagram of such a tuned-circuit signal system is

CLARE New Type "J" Relay Provides Sure, Positive Action with Exclusive Twin-Contact Design

● Here, at last, is a twin-contact design in which the chance of contact failure is actually reduced to the practical limit.

Exclusive design of the CLARE Type "J" d.c. Relay allows the twin contacts to operate independently of each other so that one contact is sure to close even when the other may be blocked by presence of dirt or grit.

This sensational new relay combines the best features of the conventional telephone-type relay with the small size and light weight developed during the war for military aircraft use.

Weighing little more than two ounces, slightly over two inches in length, it has the sturdy construction, large contact spring capacity, extreme sensitivity, and adaptability to a wide range of specifications for which CLARE Relays are noted.

Modern designers, working to develop close-coupled, compact equipment to meet today's streamlined standards, welcome this highly efficient combination of capacity and small size.

CLARE Relays are especially designed for jobs where ordinary relays won't do. If you have such a relay problem, Clare Sales Engineers are located in principal cities to help you work out a Clare "Custom-Built" Relay that will just fit your needs. Write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable Address: CLARELAY. *In Canada: Canadian Line Materials, Ltd., Toronto 13, Ontario.*

All These Features . . . and More . . . Provided By CLARE Type "J" Relay

Independent Spring Contacts. Dome shaped contacts on movable springs; flat discs on fixed springs.

High Current-Carrying Capacity. Twin contact points of palladium. Rated current-carrying capacity: 4 amperes, 150 watts.

New Design Large Armature Bearing Area. Hinge type armature has new design bearing providing largest possible bearing surface. Pivot pin turns in cylinder of different metal which is full width of heelpiece.

Sensitive, Efficient Magnetic Structure. Heelpiece and other magnetic iron parts are exceptionally heavy for size of relay . . . provide highly sensitive and efficient magnetic path.

High Operating Speed. Designed for extremely fast operation . . . a minimum of one to two milliseconds.

Permits Handling Large Spring Loads. Power and sensitivity permit handling of large spring loads. Both single and double-arm relays available. Maximum of 10 springs on single-arm relay . . . 20 springs (10 in each pileup) on double-arm relay.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical and Industrial Use

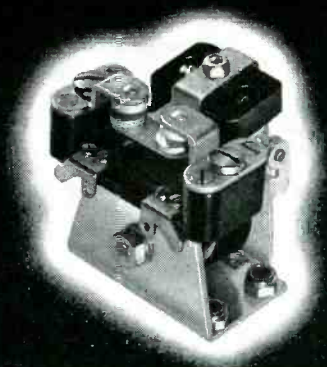
shown in Fig. 1. Each block control circuit consists of an electron-coupled oscillator transformer-coupled to a detector circuit. The secondary of the coupling transformer and the capacitance of the rails constitute a tuned circuit whose output is rectified, conveniently by a 1N34 crystal diode, and applied to the grid of a triode having a relay in its plate circuit. For simplicity a single 6F7 may be employed, using the pentode section as the oscillator and the triode section as detector. The diode-triode type cannot be used unless separate power is supplied for each block signal circuit.

With no train in the block, the frequency of the oscillator is adjusted by means of C_1 until the input to the detector is at or near resonance. Sufficient voltage is then developed across the grid resistor of the triode to cause cutoff and the relay is relaxed. Any change in the impedance of the rails then detunes the circuit and causes relay operation. This impedance change is effected by the presence in the block of a locomotive whether running or idle without any additional capacitance or resistance. Hence no alteration of the locomotive is required.

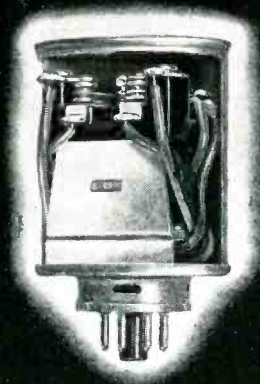
Wheel Bridging

To secure signal operation by a single car, it is necessary, as in other systems, to provide a bridge between the insulated wheels. This may be a small capacitor of 10 $\mu\mu$f or more, or a high resistance. However, since the required capacitance is very small, it may be obtained simply and effectively by building a capacitor on the axle of the truck with a conductive paint. The axle and insulating bushing are first coated with a dielectric material such as rubber cement, care being taken to insure complete coverage. When thoroughly dry, a layer of conductive silver is applied over the insulation so that it is continuous with the insulated wheel. In this manner a cylindrical capacitor of ample capacitance to operate the signal circuit is formed without the necessity of mounting a capacitor in the car and providing flexible contacts with the wheels. It should be pointed out that in choosing the

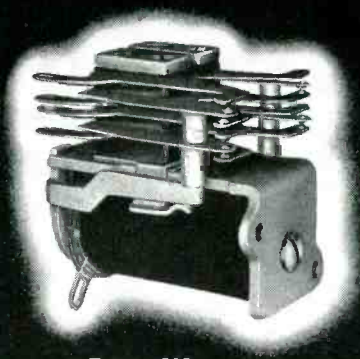
RELAYS OF ADAPTABILITY



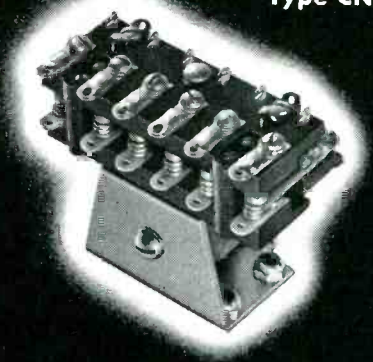
Type CN



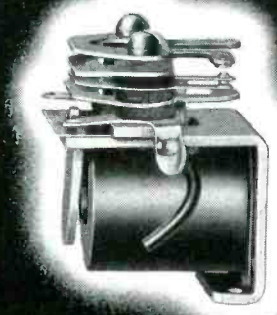
Type BOHO



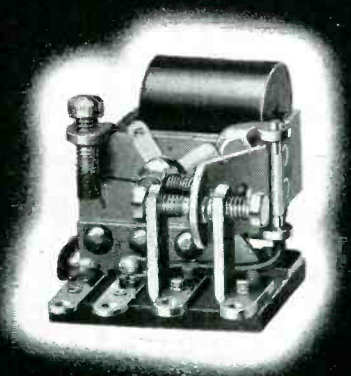
Type SK



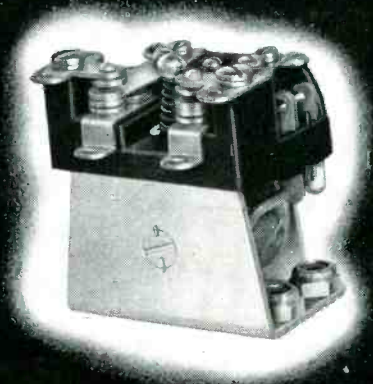
Type BN



Type F



Type BG



Type BO

Thousands of specifications are filled by the complete line of Allied Relays—seven of which are grouped around the Allied emblem of engineering leadership.

Allied Control engineers pioneered the design of relays from signal circuits to 75 ampere contacts, coils from 12 milliwatts to 3½ watts to give the smallest mounting area and accessible wiring facilities.

*Type "BOHO" is D.P.D.T. relay sealed with standard octal plug. Contact rating of 5 to 10 amperes and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

*Type "CN" is S.P.S.T. double break relay with 50 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts and 220 volts; 60 cycles at 10.5 volt-amperes.

*Type "BN" is 6 P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts (not available in A.C.).

*Type "BG" is S.P.D.T. relay with 2 ampere contacts and coil capacity of 25 v. D.C. at 50 milliwatts (not available in A.C.)

*Type "BO" is D.P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

*Type "F" is S.P.D.T. with 2 ampere contacts and coil capacity of 85 v. D. C. at 1.5 watts (not available in A.C.).

*Type "SK" from S.P.S.T. up to 4 P.D.T. with 1 ampere contacts and coil capacity of 60 v. D.C. at 750 milliwatts (for 4 P.D.T. relay) not available in A.C.

Allied Control representatives are located throughout the United States. A short note to our home office will give you the name of our nearest representative.

AL-119

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

insulating material something must be used which will not be redissolved by the vehicle of the conductive paint. For this purpose a latex material was found most satisfactory.

The signal system described offers an indication and control device which is free from the objections and difficulties of other two-rail circuits. It is not unduly complicated and need not be expensive. If indication only is required, the plate-circuit relay may be replaced by a ¼ or ½-watt neon pilot light, thus further simplifying the circuit.

Radio-Controlled Airport Lighting

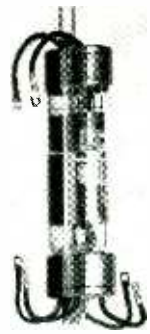
THE NIGHT-FLYING PILOT is constantly plagued by the thought that when he arrives at his destination the landing field lights will not be turned on. A Bellflower, California, airport manager and a local electronics consultant have what they consider to be the solution for small airports which may be unattended at night.

Since most night-flying planes are equipped with radio transmitters, they struck on the idea of having a system by which the pilot approaching the field could turn on the field's lights and have them remain on long enough for him to

By switching the carrier of his transmitter on and off seven times in rapid succession, the pilot turns on the airport's landing lights as he approaches the field

"EL" XENON GAS-FILLED TUBES

RECTIFIERS



FULL WAVE RECTIFIER
EL 1C

D.C. Output (Amps.)	1.0
Peak Anode Current	4.0
Peak Inverse Volts	725
Filament Volts	2.5
Filament Amperes	6.0
Overall Length	5½"

FULL WAVE RECTIFIER
EL 3C

D.C. Output (Amps.)	2.5
Peak Anode Current	10.0
Peak Inverse Volts	725
Filament Volts	2.5
Filament Amperes	11.5
Overall Length	7"

FULL WAVE RECTIFIER
EL 6C

D.C. Output (Amps.)	6.4
Peak Anode Current	25.6
Peak Inverse Volts	725
Filament Volts	2.5
Filament Amperes	17.0
Overall Length	7½"

HALF WAVE RECTIFIER
EL 6B

D.C. Output (Amps.)	6.4
Peak Anode Current	40.0
Peak Inverse Volts	920
Filament Volts	2.5
Filament Amperes	21
Overall Length	9½"

HALF WAVE RECTIFIER
EL 16F

D.C. Output (Amps.)	16.0
Peak Anode Current	96.0
Peak Inverse Volts	620
Filament Volts	2.5
Filament Amperes	36
Overall Length	15⅝"

GRID CONTROL RECTIFIERS (THYRATRONS)

EL C1J

D.C. Output (Amps.)	1.0
Peak Anode Current	8.0
Peak Forward Volts	450
Peak Inverse Volts	700
Filament Volts	2.5
Filament Amperes	6.3
Overall Length	4¼"

EL C3J

D.C. Output (Amps.)	2.5
Peak Anode Current	30.0
Peak Forward Volts	750
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	9.0
Overall Length	6⅛"

EL C6J

D.C. Output (Amps.)	6.4
Peak Anode Current	77.0
Peak Forward Volts	750
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	21.0
Overall Length	9"

EL C16J

D.C. Output (Amps.)	16.0
Peak Anode Current	160.0
Peak Forward Volts	1000
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	31.0
Overall Length	10"

EL C6C

D.C. Output (Amps.)	6.4
Peak Anode Current	77.0
Peak Forward Volts	2000
Peak Inverse Volts	4000
Filament Volts	2.5
Filament Amperes	24.0
Overall Length	11"

EL C1J/A

D.C. Output (Amps.)	1.0
Peak Anode Current	8.0
Peak Forward Volts	750
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	6.3
Overall Length	4¼"

EL C3J/A

D.C. Output (Amps.)	2.5
Peak Anode Current	30.0
Peak Forward Volts	1000
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	9.0
Overall Length	6⅛"

EL C6J/A

D.C. Output (Amps.)	6.4
Peak Anode Current	77.0
Peak Forward Volts	1000
Peak Inverse Volts	1250
Filament Volts	2.5
Filament Amperes	21.0
Overall Length	9"

SEND FOR DESCRIPTIVE CATALOG

ELECTRONS, INCORPORATED
127 SUSSEX AVENUE
NEWARK, N. J.

make his approach, land, and taxi up to the hangar.

In the system finally adopted, the pilot simply flips his transmitter on and off seven times in rapid succession, and a receiver and relay system in the airport's flight tower turn on the lights for an interval of about 30 minutes—long enough for any normal approach and landing. If the pilot requires additional time, he may turn the lights on for another 30-minute period by repeating his original transmitter keying.

The photograph shows the plane which was used in initial tests on the equipment.

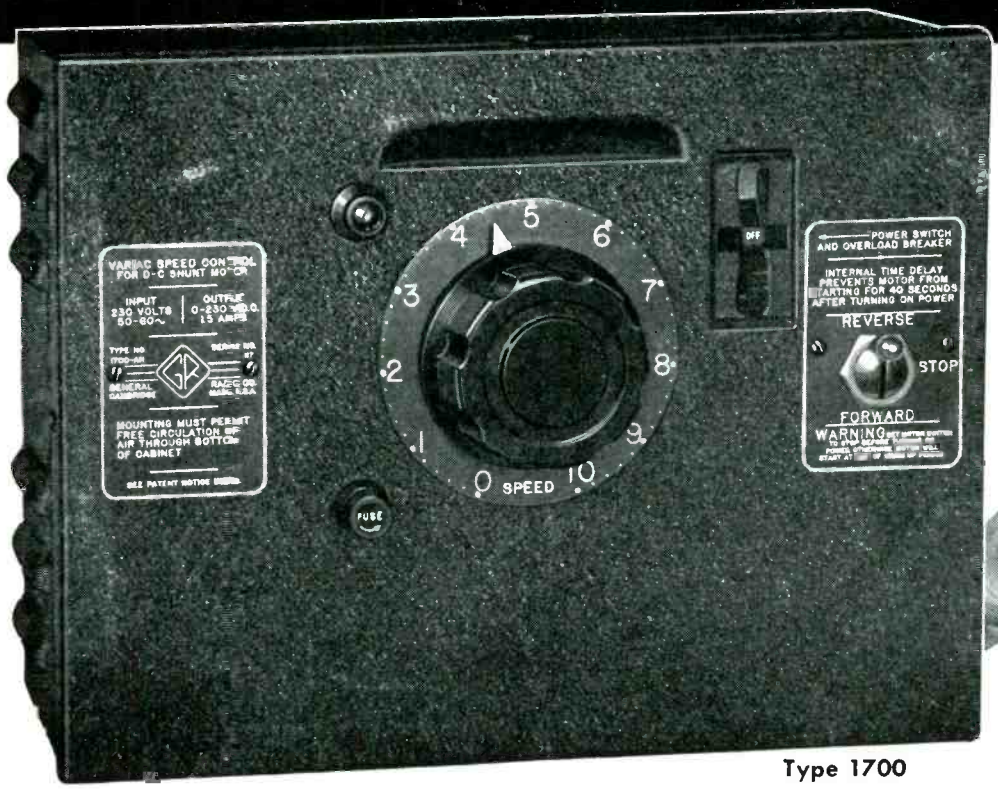
Typesetter

EXPERTS are predicting sad things for the present-day line-casting machines since the introduction, several months ago, of an electronic type-setting machine which does the same job with increased speed and efficiency and much more versatility.

The machine was developed by the Graphic Arts Research Foundation. It consists of a typewriter-type keyboard on which the letters are selected, and a system which actually photographs a line of type after a certain number of characters have been set. The electronic system stores the letters until the whole line has been set, and then

Electronic type-composing machine. A line of characters is stored in electronic circuits, automatically justified, and transferred to a photographic plate which can be used to make a printing plate in about five minutes

NEW Motor Speed Controls for D-C Motors from A-C Lines



Type 1700

Type 1701

These New General Radio *VARIAC** *Speed Controls Feature*

- Operation of 1/3 and 1/4 h.p. d-c shunt or compound, 1/20 h.p. d-c shunt and 1/20 h.p. universal motors, from A-C LINES
- Continuously-variable Speed Ranges of Over 15 to 1
- Extremely fast Starting — Large Overload Capacity
- Fast Stopping — Dynamic Braking (on 1/3 and 1/4 h.p. units)
- Extremely Fast Reversing
- Good Speed Regulation
- Smooth Operation — Less Torque Pulsation
- Straightforward Circuit
- All Controls and Circuits in One Small, Easily Mounted Box
- For Use with STANDARD D-C Motors, No Derating Necessary

*Trade Name VARIAC is Registered at the U. S. Patent Office

Variac Speed Controls

TYPE	FOR USE WITH D-C MOTOR OF	A-C LINE	PRICE
1700-AL	1/3 or 1/4 h.p. shunt or compound wound	105-125 volts (50-60 cycles)	$175.00
1700-AH	ditto	210-250 volts (50-60 cycles)	175.00
1701-AK	1/20 h.p. shunt wound	105-125 volts (60 cycles)	65.00
1701-AU	1/20 h.p. Universal	105-125 volts (60 cycles)	65.00

For complete data write for:
VARIAC MOTOR CONTROL BULLETIN

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

applies appropriate spaces between words to make the letters in any line extend from the left to the right-hand margin.

The text set in this manner resembles a photographic negative which may then be used to make a printing plate. This process takes about five minutes and saves much in time and trouble over the present conventional system. Any competent stenographer or typist can operate the machine, since it is controlled from a standard typewriter keyboard.

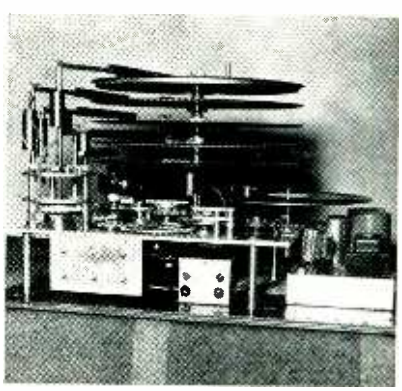
The machine is capable of setting twenty lines a minute, which is about three times as fast as methods now used.

Automatic Time Announcer

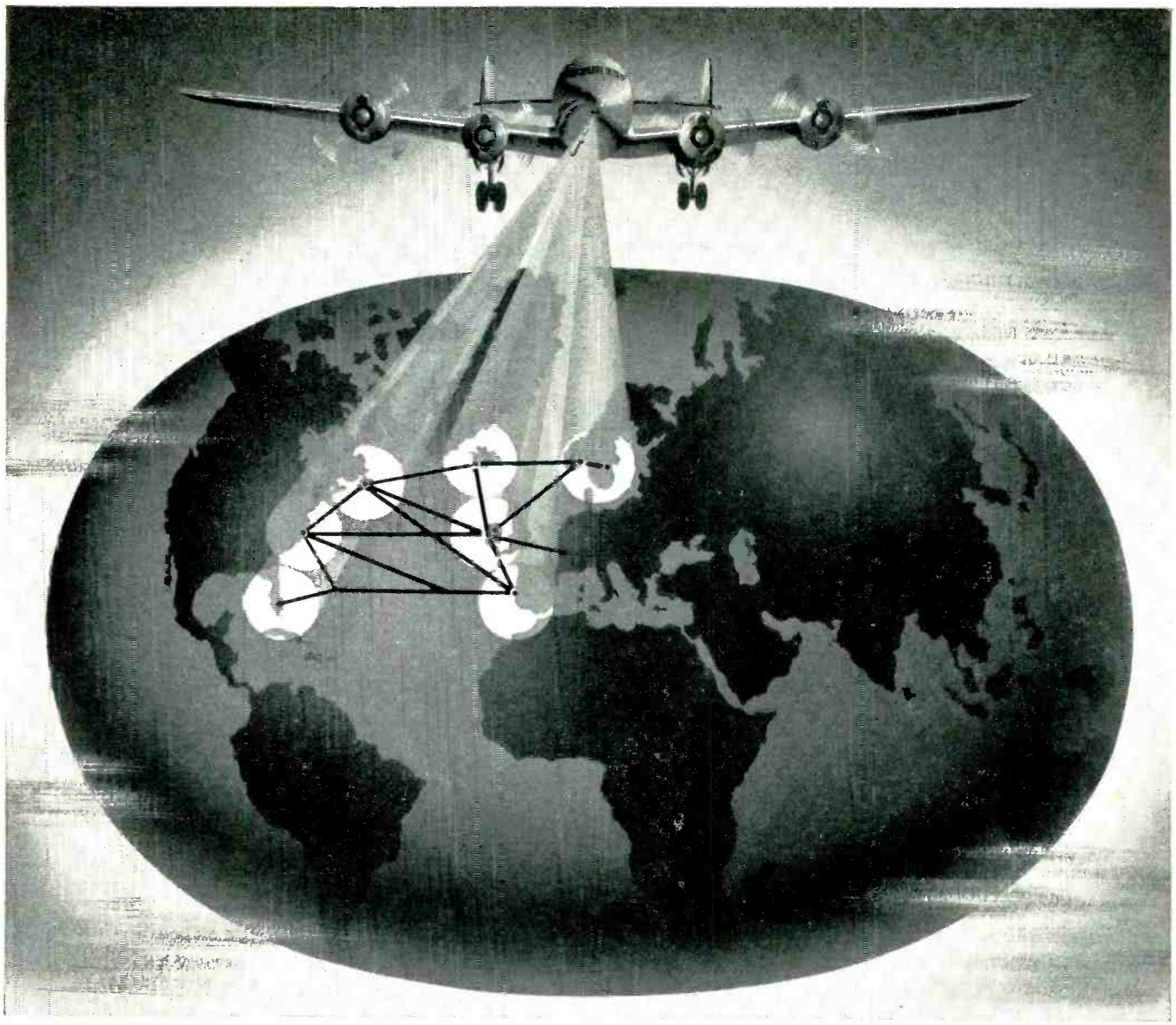
By Harry G. Lundgren and Eric H. Lundgren
Amco Inc., Oakland, California

Error-free service is assured by the newly developed time-announcing machine pictured below with the cover removed. The unit is self-supervising and operates continuously. It uses five 16-inch 18-rpm disk transcriptions to supply 5,760 voice announcements (one every 15 seconds) of the time of day during each 24-hour period. Provisions are included for inserting recorded advertisements, or other spoken material, between the time announcements and signals.

The turntables are driven by a synchronous gear-motor through a special intermittent gear mechanism. A cam on the driving gear is so designed that the turntables accelerate gradually for the first ½ revolution, turn at 18 rpm for the



Automatic time announcer with cover removed. Record at right is for inserting advertising between time signals



WILCOX ...First Choice for Transatlantic Airline Communication

The whirling propellers of the international air lines make daily mockery of the vast space of the Atlantic Ocean. Intercontinental passengers and cargo come and go hourly at New York, Miami, Gander, Shannon, Ireland, and Lisbon, Portugal. These European and American airports are equipped with modern long-range, multichannel WILCOX Transmitters.

Oslo, Norway, and Stockholm, Sweden, use WILCOX Transmitters as basic communications equipment, and radio beacon service is provided at Reykjavik, Iceland, by WILCOX Type 96-200 Transmitters.

Thus, the giant airliners of the world's major airways are protected in flight and guided safely to the runways of Europe's and America's principal ports of entry.

WRITE TODAY...for complete information on air-borne, ground station, point-to-point, or shore-to-ship communications equipment.

WILCOX ELECTRIC COMPANY
KANSAS CITY MISSOURI

next ¾ revolution, and decelerate gradually for the next ¼ revolution. The voice announcement of the time in minutes and seconds is contained in the 18-rpm constant-speed ¾ revolution.

Five separate pickups play the five time transcriptions. They track outward from the center and setscrews are provided (visible between the turntables in the photograph) to give accurate adjustment in the positioning of each pickup to the starting groove of each transcription. Two hours and 24 minutes are covered by each disk operating with announcements on a 15-second interval. Vinylite pressings for this use are made commercially from acetate originals and last from six to eight months in continuous service.

A sixth turntable, to the right in the photograph, is used for playing a 12-in. transcription which provides for an advertising or other type of message preceding each time announcement.

The tone which follows the preliminary time announcement is derived from a 6SJ7 r-c oscillator which is ordinarily tuned to 900 cps and is keyed by a momentary-contact switch actuated by a cam. The oscillator output is attenuated to proper level, and fed to the grid of a 6SJ7 tube in a conventional amplifier whose final output is combined with voice and tone signals.

X-Rays Identify Flocked Fabric

NORZON, a suede-like fabric, is used principally in the manufacture of shoes. Behr-Manning Corp. of Troy, N. Y. sells it through a national distributor to shoe manufacturers. The company claims that their material is being substituted by some manufacturers for an inferior material resembling the fabric in appearance but being less durable.

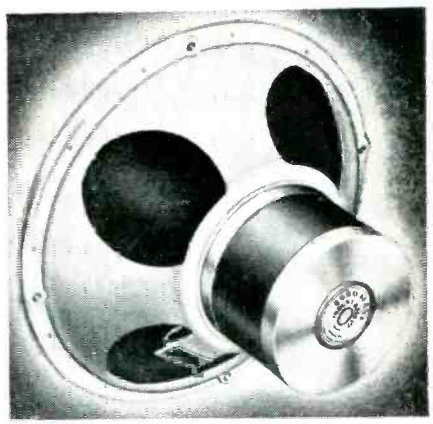
To combat this practice, the fabric is stamped on the reverse side with a pigmented ink that is sensitized by x-ray. When the fabric is made into a shoe and placed under x-ray, the trademark appears on the inside as a red glow.

E'ectronics also plays a major

High Fidelity + Power brings *new realism* to sound reproduction

A High Fidelity Loudspeaker that brings within reach of all the means of achieving a degree of fidelity usually obtained only from the most expensvie and elaborate equipment. From the rich pulsation of the organ's pedal register to the delicate whisper of the E-string of the violin, the whole complement of the orchestra is strikingly re-created, and all the varied inflections of the human voice are so naturally rendered that this may truly be called "Living Reproduction".

The loudspeaker for the discriminating music lover.



A TRADITION OF EXCELLENCE
FIDELITY
G
EFFICIENCY

GOODMANS

AXIOM 22-20 Watt
12" P.M. LOUDSPEAKER

Fully Dustproof

SPECIFICATION

Axiom 22

Frequency Coverage	40 to 15,000 c.p.s.
Overall Diameter	12 5/16"
Overall Depth	7"
Fundamental Resonance	55 c.p.s.
Voice Coil Diameter	1¾"
Voice Coil Impedance	15 ohms at 400 c.p.s.
Maximum Power Capacity	20 watts peak A.C.
Total Flux	195,000 lines
Nett Weight	18 lbs. 4 ozs.

GOODMANS INDUSTRIES LTD. Lancelot Road, WEMBLEY. Middlesex. England.

role in the manufacturing of Norzon. Here's how the fabric is made:

A base fabric is coated with durable, wet-proof adhesive. Then, fine rayon filaments, known as Behrlon Fibers are dyed and cut to uniform length.

A potential difference of sixty-thousand volts is maintained between the fibers and the base fabric as they enter between electrodes. The base fabric receives a negative electrical charge while the fibers are positively charged. Since opposite charges attract, the fibers jump toward the adhesive surface backing, and are embedded permanently in on-end position. Because every fiber has the same charge, they repel each other an darrange themselves automatically with great density and uniformity.

The patented process produces a densely-flocked surface of approximately 550,000 fibers per square inch of fabric.

Tone Source for Tuning Musical Instruments

By Earl L. Kent
Division Manager
C. G. Conn, Ltd.
Elkhart, Indiana

The simple and accurate tone-producing device shown in the accompanying photograph was designed to fill a need in the rapid tuning of the musical instruments in bands and orchestras.

The tuner produces a continuous tone with adjustable tone intensity, frequency and timbre. A frequency

Tone producer for use in tuning musical instruments

Federated ROSIN CORE SOLDER

Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes *every* commercial solder . . . Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world's leading supplier of solder.

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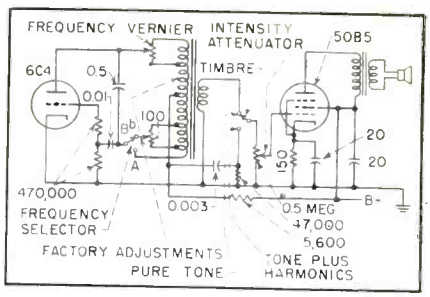
120 Broadway, New York 5, N. Y.
OFFICES IN PRINCIPAL CITIES ACROSS THE NATION

Federated first in the non ferrous field FMD



Circuit diagram of electronic tuning tone source

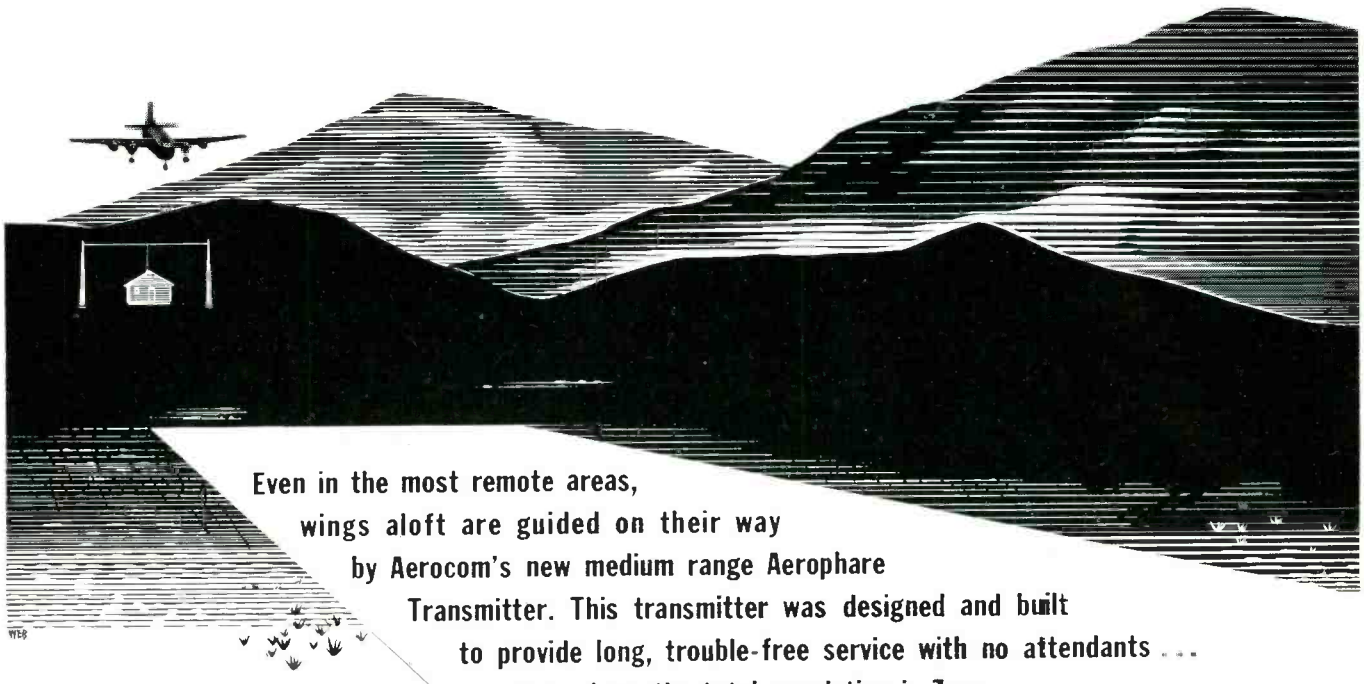
vernier is provided on the back of the instrument so the director may select his frequency standard anywhere between 435 and 445 cps. Two tones are selectable by the frequency selector on the front panel giving either A or $B_\flat$. The semitone relationship is retained irrespective of the setting of the frequency vernier. In other words, when the desired frequency is selected for A, the switch for changing the output note to $B_\flat$ automatically sets in the proper interval or half note.

A timbre switch enables the director to select either a flute-like tone or a reed-like voice that is rich in harmonics, depending upon which tonal character is better for the musicians tuning to it. This switch makes it possible to take the signal from the tank circuit by way of the secondary winding in a relatively pure form, or from the plate current circuit in a pulse form that contains high harmonic content. The tank circuit is tuned to the fundamental frequency of the oscillator so the voltage produced across it is approximately sinusoidal.

The volume control provides adjustment of the sound level to suit the room and ambient sound conditions. Sufficient volume is available for use with a large group of musicians.

In designing the instrument special care has been taken to provide the extreme stability required of tuning devices with changes in temperature, line voltage and tube life. The instrument drifts about 0.06 percent after 5 minutes warm-up, and after 15 minutes returns to its original frequency. A 5-percent fluctuation of line voltage will cause about 0.09-percent change in frequency. A 0.06-percent change in frequency is about 1/100 of a half tone.

POPULATION - 0



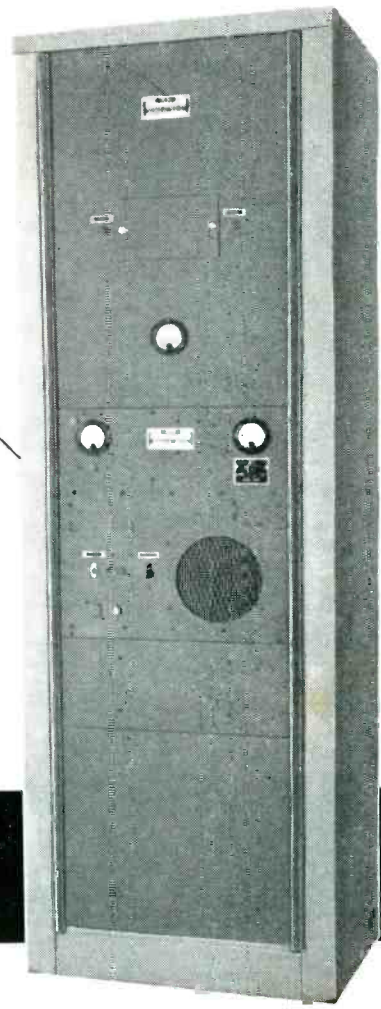
Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

AEROPHARE

The 100 Watt Aerophare illustrated consists of the following units--AK-3 automatic keyer; Model 100XL transmitter, (100 Watt carrier power, minimum of 30%-high level tone modulation for identification but with no provision for voice modulation); and antenna matching unit.

The smaller unit is similiar, except transmitter is of 50 Watts carrier power with 90% high level tone modulation for identification, or, 90% high level voice modulation. Microphone P-T-Switch, when depressed interrupts tone, permitting voice operation. This feature makes this unit ideal for airport operation where both aerophare and traffic control are needed.

Both units are completely "tropicalized" to allow operation under unusual climatic conditions. Each unit is ruggedly constructed and conservatively rated, providing low operating and maintainence costs. Engineering data on both units upon request.



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(continued from p 122)

negative bias would have to be provided in the grid circuit.

None of the circuit constants is extremely critical. Most of them can be changed over a two-to-one range without affecting the ability to control the thyratron firing angle. The voltage that is used to synchronize the sawtooth generator may, in many cases, be obtained from the filament transformer.

The circuit presented herein has the disadvantage of requiring a B supply, but eliminates the need for coupling transformers and audio chokes frequently used. It is also immediately adaptable to different values of control voltage magnitude.

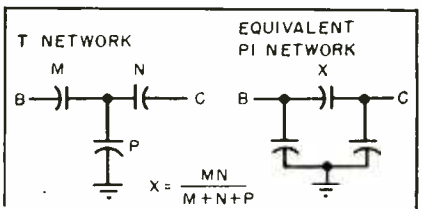
REFERENCE

(1) L. A. Goldmuntz and H. L. Krauss, The Cathode-Coupled Clipper Circuit, *Proc. IRE*, Sept. 1948.

Standard Test Capacitors

DURING the war, Bell Telephone Laboratories developed a capacitance bridge capable of measuring the interelectrode capacitances normally found in small electron tubes to within an accuracy of approximately 2 percent. This bridge measured direct capacitance of a three-terminal network and made use of a step-down calibration principle, hence there was no absolute need for standard small-value calibrating capacitors at the time.

As time went on and bridges were scattered over the country, as well as over the world via lend lease, it became necessary to check



When M = N = 3 μμf		When M = N = 40 μμf	
X (μμf)	P (μμf)	X (μμf)	P (μμf)
*0.001	8,995	0.10	15,920
0.0025	3,594	0.25	6,320
0.005	1,794	0.50	3,120
*0.0075	1,194	*0.75	2,053
0.01	894	1.00	1,520
0.025	354	2.50	560
0.05	174	5.00	240
*0.075	114	*7.50	133.3
0.10	84	10.00	80.0

FIG. 1—Method of using ordinary mica capacitors to obtain very small capacitance values for use as secondary standards

these devices accurately and more frequently than the cumbersome step-down method would allow.

This report describes a set of secondary standard calibrating capacitors designed and constructed at Evans Signal Laboratory and later calibrated by the Bureau of Standards for use in checking the Western Electric type D160936 and Sylvania type 125 capacitance-measuring devices used by electron tube manufacturers in United States and Canada.

Very low values of X may be obtained by using readily obtainable values for M, N and P in Fig. 1. The capacitance X conforms to the definition of direct capacitance between terminals B and C; therefore, when the capacitance between B and C is measured by the bridges, the equivalent capacitance X will be indicated.

The computed values in the table adequately cover the range of the bridges. The starred values, selected for the Evans Signal Laboratory standards, can be used to check the Western Electric and Sylvania capacitance bridges at the three-quarters mark on every range on which the bridges operate. For a complete scale calibration of any

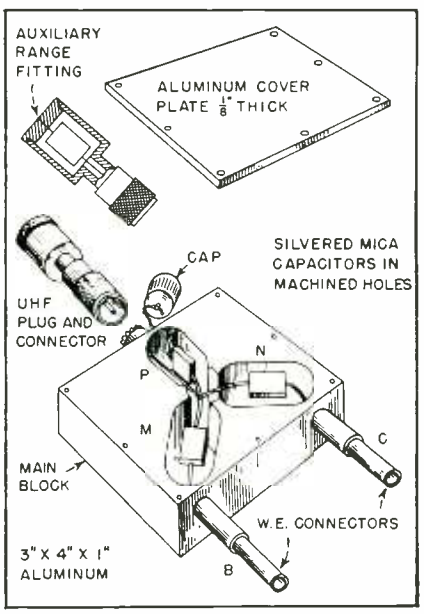


FIG. 2—Details of machined aluminum block and fittings used in assembling set of capacitance substandards for checking and calibrating precision bridges used for measuring interelectrode capacitances of vacuum tubes

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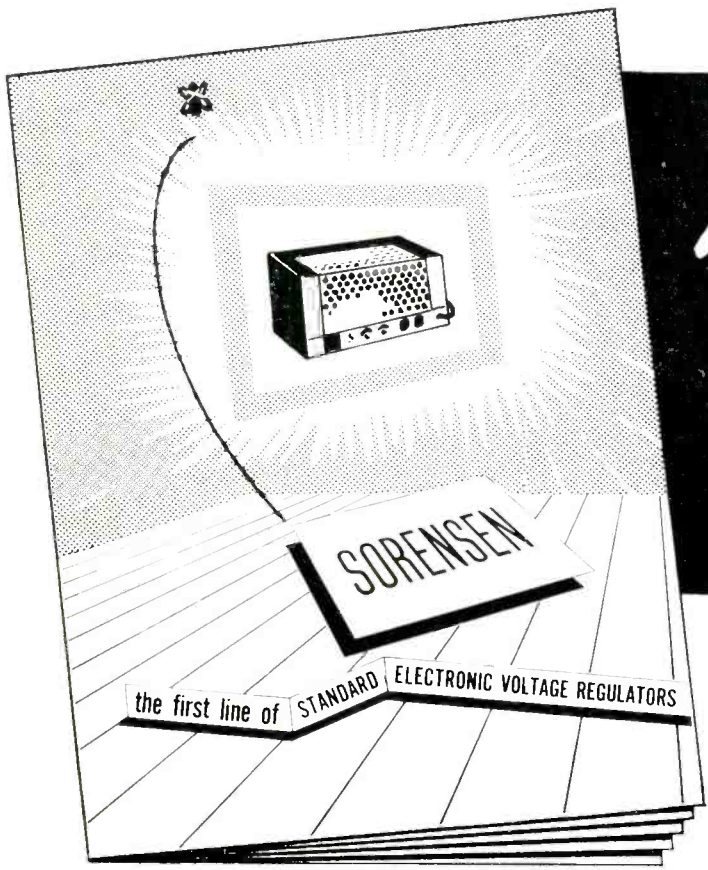
OF ELECTRONIC VOLTAGE REGULATORS

Gives you



more for less!

MORE, because there's

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- Less Distortion
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LESS, because . . .

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

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

NEW SORENSEN CATALOG

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

Sorensen stays out front!

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

bridge, it is only necessary to add additional end plug capacitors so that a number of points on each scale are obtained.

Constructional Details

In order to fabricate the standard capacitors in a form which would be mechanically rugged, insure stability, and also provide as little capacitance to ground in the leads (bridge sensitivity falls off with additional shunt capacitance in the leads), the block form of construction shown in Fig. 2 was employed. Plug spacings were matched to the various bridges available at Evans Signal Laboratory.

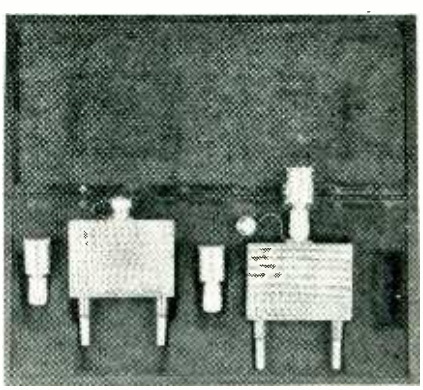
If a more flexible setup is required, any uhf connector to which a short length of cable and plug can be attached can be used.

Complete ranges are covered with two basic blocks, with $M=N=3\mu\mu f$ and $M=N=40\ \mu\mu f$ respectively. The various values of P were obtained by inserting the basic P value and then adding a parallel capacitor-to-ground through the uhf connector at the top of the unit. The added units are merely small cups to hold the capacitors.

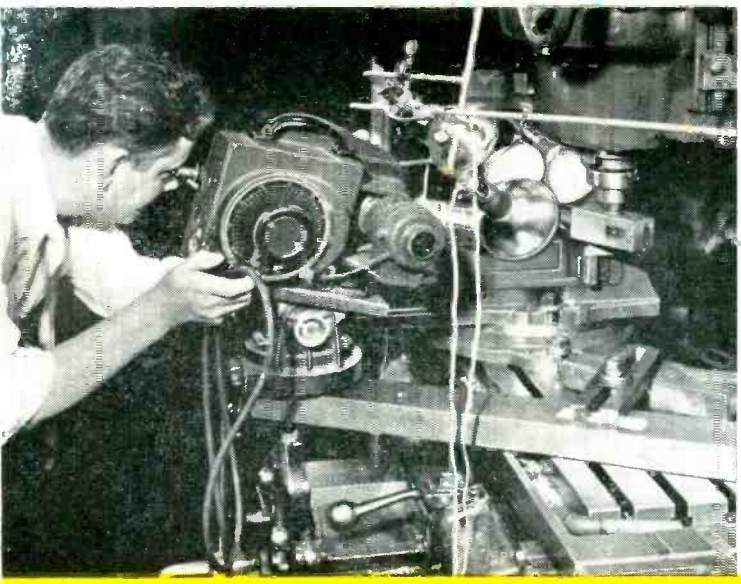
The capacitors used are silvered mica postage stamp type and selected for nominal values by means of a General Radio impedance bridge. A cap is provided for the uhf connector so that in its basic form the extra lead will be shielded at all times. To avoid possible error and confusion the units are marked with the corresponding jack letters so that insertion in the bridge will be the same each time.

Calibration

The units were assembled, potted with acrowax, and shipped to the



Completed capacitance standards as constructed for use at Evans Signal Laboratory



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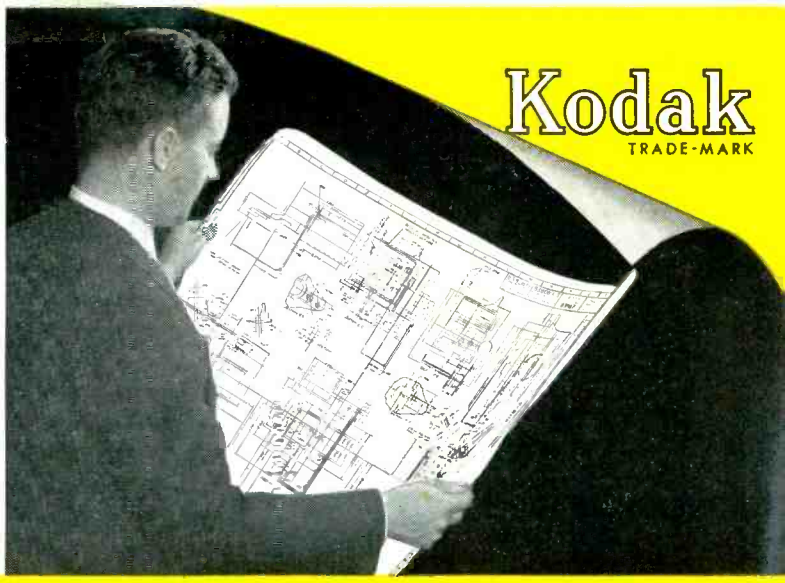

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HERE YOU SEE a few examples of how the speed of photography serves industry. In addition, its accuracy is used in copying drawings, documents, and data of all kinds. Its ability to reduce can put records on microfilm and save 98% of filing space.

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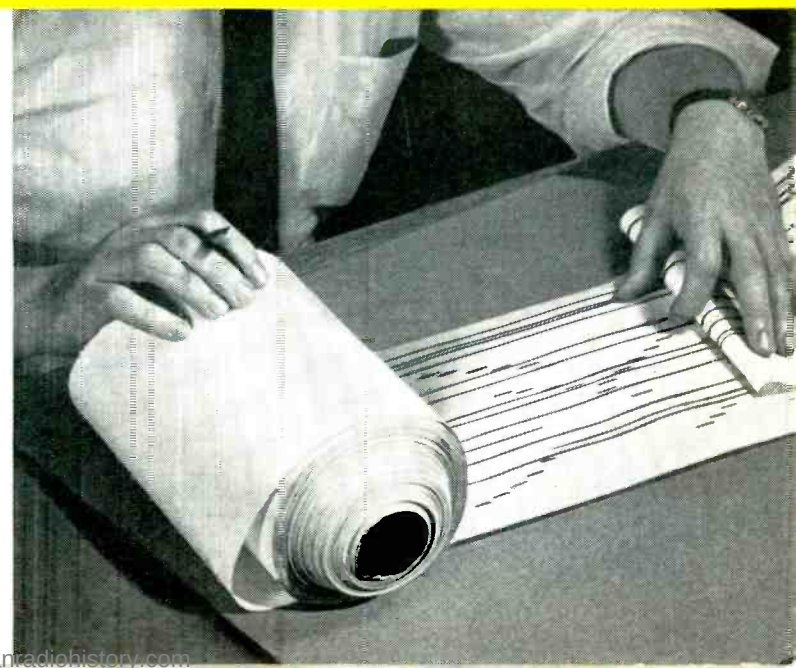
IT RECORDS THE FLICK OF INSTRUMENTS—The swift swing of the galvanometer mirror or cathode-ray tube beam is not too fast for photography. Readings of these instruments are quickly recorded on Kodak Linagraph Films and Papers so that they can be studied and full advantage taken of the facts that they reveal.



National Bureau of Standards for calibration. The NBS certificate returned with the capacitors indicated that the capacitances were measured to $\pm$ (0.3 percent + 0.00005 $\mu\mu$f).

Topographic Radar

BY MODULATING the X-axis of the conventional ppi radar cathode-ray tube in such a way that intensity on the scope represents height on the ground, topographic presentation radar aboard an airplane gives a three-dimensional picture of the terrain below. Details of this system were given by W. J. Hirschberg of California Institute of Technology at the AIEE Pacific General Meeting in San Francisco Aug. 23-26, 1949.

To obtain intensity modulation, a special wave form, called the contrast saw-tooth wave form, is generated in the radar receiver. The saw-tooth rises from its minimum to its maximum value in a fraction of the pulse period of the radar and is automatically positioned (in time) with respect to the transmitter pulse in such a way that an average-altitude echo pulse will return when the saw-tooth has reached half its maximum. All echo pulses are superimposed on this saw-tooth, so that the peak value of the resultant wave form changes with the instantaneous position of the echo pulse. This peak value then modulates the grid of the cathode-ray tube.

The monitor scope should have a persistency high enough to allow a complete picture to be formed, but not high enough to interfere with the following picture.

For producing an accurate record of the terrain a continuously moving photographic film is used. Since the average altitude of the airplane over the terrain will show up as grey in the picture, all other altitude values will be relative to the average. The radar furnishes separately the value of this average altitude at any instant. This combined with the absolute altitude above sea level, obtained from barometric instruments, furnishes the absolute altitude of those points on

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The space-saving design of I-T-E Oval Resistors didn't just happen. I-T-E engineers realized that complex aviation, radio, TV, and other electronics applications call for maximum resistance in minimum space. With that thought in mind, I-T-E Oval Resistors were developed.

These modern, compact resistors are distinguished by their high, unit-area wattage ratios. An oval resistor, or assembly of oval units, has a much higher wattage rating than that of a conventional round resistor of comparable size.

No matter what you look for in resistors — compactness, dependability, long life, or exact tolerances — be sure to investigate I-T-E Oval Resistor Assemblies, the *modern* wire-wound Power Resistors!

Oval Resistor Assemblies are part of I-T-E's complete line of wire-wound Power Resistors. Technical information, including valuable application data, is contained in the I-T-E Resistor Catalog. Send for it today.

I-T-E OVAL RESISTORS

Type	Watts	Length	Maximum Recommended Resistance	Mounting Centers
108 Oval	30	1¼″	10000	2″
200 Oval	40	2″	15000	2¾″
316 Oval	55	3½″	25000	4¼″
424 Oval	65	4¾″	35000	5½″
600 Oval	75	6″	50000	6¾″

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the map which are halfway between black and white. This reference level can be continuously recorded together with the map itself.

Special circuits are included which provide for a constant scale factor in the x and y directions no matter what the altitude of the airplane is. Maps thus could be made directly from the photographic record.

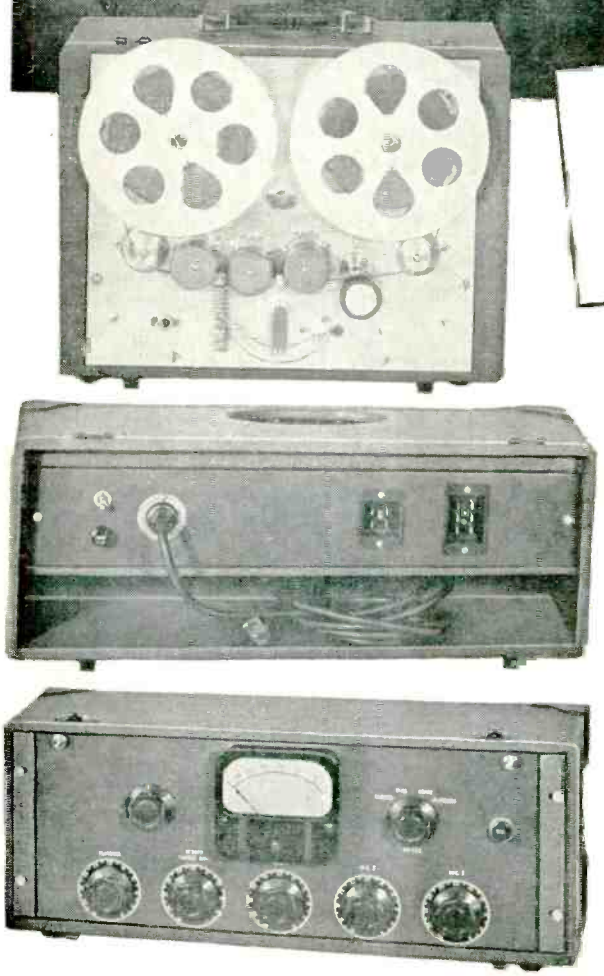
Timer Correction

DIFFERENCE in speed of rotation of two 60-cycle synchronous motors, one driven by the power line and the other by a standard crystal-controlled frequency, is utilized in a power-line frequency monitoring system developed by the National Bureau of Standards for giving the correction to be applied to a commercial interval timer driven by the power line. Accuracy of 0.01 second is thereby obtained, extending the usefulness of interval timers to the realm of precise timing in connection with radiation counters, fluid flow, viscosity measurements, chemical reactions, ballistics experiments and high-speed photography.

The two motors are connected

Frequency monitoring system devised by R. E. Gould and H. A. Bowman of NBS for determining correction to be applied to commercial interval timer when power line frequency drifts during period of observation. Power amplifier amplifies Bureau's crystal-controlled standard frequency to drive one of small black motors behind differential gears, and other motor runs directly off power line. Transmitter selsyn at upper right transmits angular motion of differential gear shaft to receiver selsyn on remotely located automatic recorder

"Top Fidelity...the most dependable Tape Recorder yet!" says WOR's STAN LOMAX



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PRESTO'S PT-900 is the answer for delayed sports broadcasts—field recording—wherever there is a need for a portable recorder of complete broadcast quality. Look at these outstanding engineering features:

- Three separate heads for superior performance (and for monitoring direct from tape). One head each to erase, record and play back. • 3 microphone channels with master gain control in recording amplifier. • Large V.U. meter with illuminated dial to indicate recording level, playback output level, bias current and erase current, and level for telephone line. • 2-speed, single motor drive system. Toggle switch to change tape speeds from 7½" to 15" per second.

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WORLD'S GREATEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

to a differential gear system. The position of the differential gear shaft at any instant depends upon the total integrated frequency error of the power line at that instant. This shaft is connected to indicating dials which are calibrated to give the cumulative error in seconds and hundredths of a second rather than in cycles.

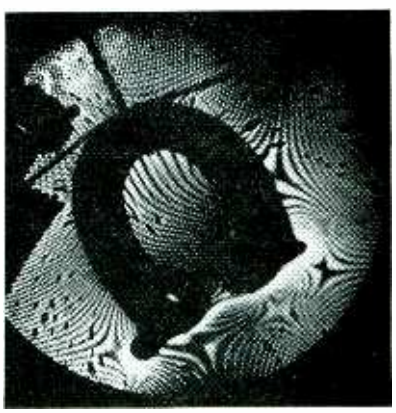
Electron Shadows of Small Magnetic Fields

USE OF the electron as a probe to explore electric and magnetic fields of extremely small dimensions has been announced by the National Bureau of Standards. The results take the form of a photograph which shows, for the magnetic studies, the direction and strength of the magnetic forces about any small magnetized object.

Description of Method

In the shadow method, the electron microscope is first used to form an ordinary image of the magnetic object—say a small horseshoe magnet. A fine wire netting of nonmagnetic material is then placed slightly beyond the focus of the magnetic lens system of the electron microscope in just the right position so that the mesh casts a magnified but rather sharp electron shadow on the screen. The shadow network is thus superimposed on the image of the magnetized object.

Some of the electrons which form



Electrons passing through magnetic field of small horseshoe magnet (about one-fourth inch wide) produced this distortion of the electron shadow of a fine wire mesh in an electron microscope

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because Wheeler is a leader in the field of EM Focus coil suppliers; has research, engineering, production facilities — and personnel long skilled in precision manufacturing.

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because Wheeler is geared — inventory-wise — to carry sufficient stocks of high grade components to maintain vital production schedules and to insure prompt deliveries.

because Wheeler precision methods insure uniformity in its EM and PM-EM coils — whether your requirement is for 500 or 500,000 units.

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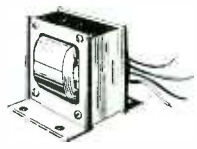

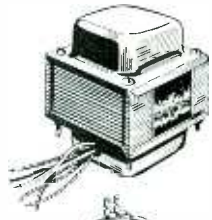

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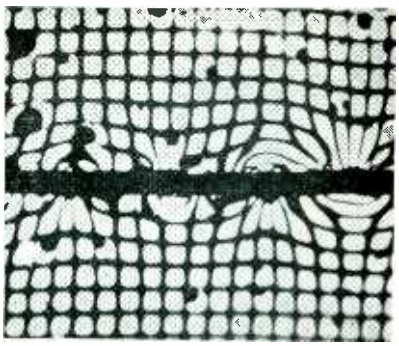


Electron-optical shadow photograph of magnetic recording wire that is magnetized in evenly spaced short pulses. Shadow of screen shows maximum distortion at points of maximum magnetization

the shadow image of the wire netting must pass through the field of the magnet. In doing so, the electrons are deflected from their usual straight-line path by the magnetic forces. This causes distortion and change in magnification in the shadow image of the network. The effect is most noticeable in the parts of the fluorescent screen which correspond to regions of strong magnetic force in the magnetic field. Thus a visual representation of the strength of the magnetic field at various points is obtained and may be photographed.

Calculations

Formulas have been worked out which permit calculation of numerical values of the absolute field strength in the magnetic field being studied. As a result measurements can be made on extremely small or weak fields without altering or disturbing the field under study.

Though similar in some respects to the electron-optical Schlieren method previously developed at the Bureau, the shadow method is much better adapted to precise determinations of field intensity.

Applications

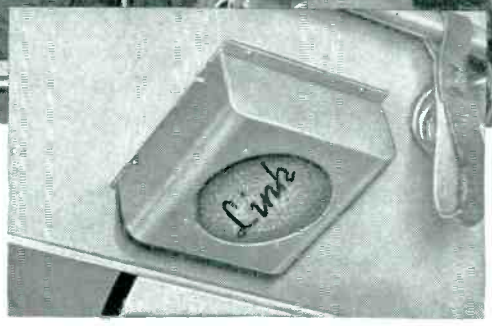
The shadow method is well adapted to investigation of the fundamental nature of ferromagnetism. Experiments now under way include a study of the ferromagnetic domains using a single crystal of cobalt with very large domains, and study of space-charge fields in several types of electron-beam apparatus used in atomic physics.

Another suggested application is

FM RADIO ON DULUTH-SUPERIOR BUSES MADE POSSIBLE THROUGH

LINK EQUIPMENT... SYLVANIA TUBES!

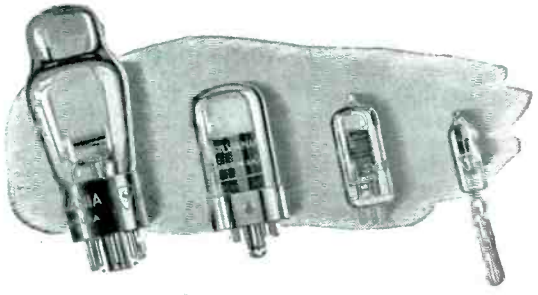
In Duluth, Minnesota, passengers on Dulu-h-Superior Transit Co. buses listen to radio entertainment, weather forecasts and local where-to-buy-it information as they ride. Link Radio equipment with Sylvania Radio Tubes takes on the rugged broadcasting job.



Close-up of Link speaker. These units are attached to ceiling of bus at regular intervals for even distribution of sound.

The success of transitcasting was assured with the development by Link Radio of an ultra-sensitive, fixed-frequency, crystal-controlled mobile FM receiver with high-fidelity characteristics. 35 of these receivers—complete with Sylvania Radio Tubes—have been riding through ice-furrowed streets, extremes of noise and temperature, and up and down steep hills in Duluth for over a year . . . and maintenance has been so low that one man can easily service all of them!

Sylvania tubes have a long record of superlative performance under rugged conditions—having been in use in autos, trains, and aircraft from coast to coast. For full details about the entire line address Radio Tube Division, Advertising Dept. R-1112, Emporium, Pa.



The Sylvania line of high quality tubes includes every variety for a multitude of applications—from the standard glass tubes to the tiny subminiatures.

SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES, SIGN TUBING; LIGHT BULBS; PHOTOLAMPS

L. L. Marton of NBS at control panel of horizontal experimental electron microscope used with his electron-optical shadow method of exploring and measuring small-dimension magnetic fields. Image appears on circular fluorescent screen above and to right of control panel

in connection with waveguides, which often become so complicated that no geometry can be used to calculate radio energy distribution in the system. Through suitable auxiliary electron shadow techniques, it is now thought possible that energy distribution (or field strength) at critical points—such as elbows—in these waveguide systems can be explored.

An engineer, having in many cases only an intuitive picture of the field distribution at junctions and elbows of the guide, must rely on empirical methods in designing waveguide techniques and equipment. By the use of suitable auxiliary techniques, it is hoped that the shadow method may be adapted to the calculation of field intensities in regions of a guide that are not at present susceptible to analytical treatment.

Spherical aberration in electron lenses can also be studied. When a fine wire mesh is placed in the focal region of a lens having spherical aberration, the shadow image of the network is enlarged either centrally or at the periphery, depending on the position of the mesh and the nature of the lens error.

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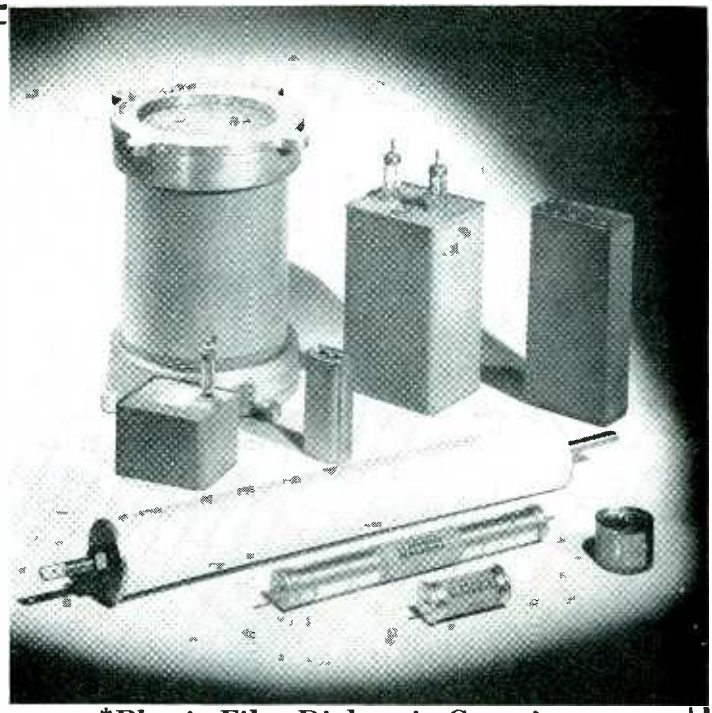
L. Marton and S. H. Lachenbruch, Electron Optical Observation of Magnetic Fields, *Journal of Research, NBS*, Oct. 1949 : RP2033.

L. Marton and S. H. Lachenbruch, Electron Optical Mapping of Electromagnetic Fields, *Jrl. Appl. Phys.*, Nov. 1949.

Electron-Optical Schlieren Effect, *NBS*

Special PLASTICON* Capacitors



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We manufacture capacitors to specifications for many unusual applications. *A few examples are:*

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- Ultra high resistance capacitors for radiation counters
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Technical News Bulletin 32, p 82, 1948. In the Schlieren method a magnetic lens forms an image of a source of electrons on a small copper stop that intercepts all direct rays. If in the space between the electron source and the lens there is a variation of the index of refraction for electrons an image of that electric or magnetic field inhomogeneity will be produced in a conjugate plane beyond the stop. This gives a dark-field image of the field on a fluorescent screen or photographic plate.

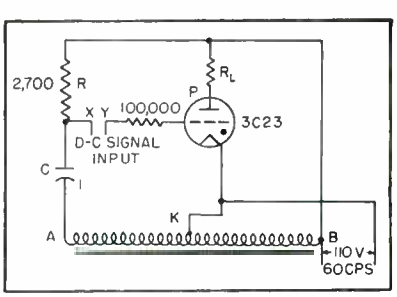
Linear Thyratron Control Circuit

By NORMAN ALPERT
Edo Corporation
New York, New York

NUMEROUS OCCASIONS arise where it is desirable for the average or d-c plate current in a thyratron to vary linearly with an applied d-c grid voltage. In the standard circuit, which is the same as that shown in the accompanying diagram with the d-c input shorted out, the d-c plate current follows the relationship $I_{d\text{-}c} = E_m(1 + \cos\phi)/2\pi R_L$, where E_m is the peak voltage of the a-c plate supply, R_L is the d-c load resistance, and ϕ is the angle at which the thyratron fires $(0 \leqq \phi \leqq \pi)$.

It should be emphasized the above equation is valid provided the tube drop during conduction is negligible compared to E_m, and also the critical grid curve corresponding to the a-c plate supply voltage is assumed to coincide with the zero voltage axis. These conditions are easily satisfied in practice.

It is seen from the equation that $I_{d\text{-}c}$ does not vary linearly with grid voltage but as some cosine function of the phase angle. The circuit may be modified, however, by inserting a d-c voltage, E_c, between X and Y, and making $R = X_c$ so that the a-c grid voltage lags the a-c plate voltage by 90 degrees or ϕ will be 90 degrees when E_c is 0. Hence the d-c plate current will follow the re-



Circuit diagram of linear thyratron control circuit

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- A 12 Channel Crystal Controlled Generator for TV Receiver Tests.
- Panel Controls Select Carriers: Adjust Internal FM Tone Modulation for Sound and Video Modulation Obtained from External Source.
- Carrier Frequency Accuracy .01% for Picture—Separation between Picture and Sound Carriers 4.5 mc ± 500 cps.
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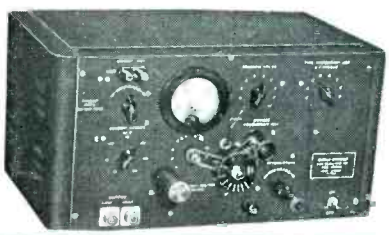
- Price: $990.00 F.O.B. Factory.

THE MEGA-NODE SR.

- A UHF and Microwave Random Noise Source.
- Frequency Range 100 to 3000 mc.
- Output Impedance 50 ohms Unbalanced.
- Low Output VSWR over Frequency Range.
- Noise Figures 0 to 20 db.
- Price: $895.00 F.O.B. Factory.



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- Single Control Tuning and Dial Indication of Sweep Center Frequency (100 kc. to 1000 mc.)
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- Sweep Width Adjustable up to 30 mc., 100 mv. Output, Continuously Variable Attenuator.
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- Frequency Range 8500-9700 mc.
- Includes Calibrated Wavemeter.
- Sawtooth Frequency Modulated to 100 mc Band Width.
- When Used with MEGALYZER Jr. Provides X-Band Spectrum. Analyzer.
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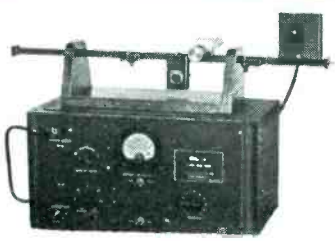

Also Manufacturers of Mega-Sweep, Mega-Match, Microwave Mega-Match, Megalyzer, Mega-Pulser, Micro-Pulser, Mega-Marker, Megaligner, Mega-Pipper, Mega-Node, Megalyzer Jr., Mega-Marker Sr., Sona-Graph and Sonalator.

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the next digit. It will operate reliably to at least 250 kc, and numbers have been circulated through six stages at frequencies as high as 600 kc.

Figure 1A shows a basic trigger circuit in which V_1 conducts to store a 1 and V_2 conducts to store a 0.

Figure 1B shows the coupling circuit between stages. This includes a voltage divider from each plate to ground. The grids of stage $N + 1$ are connected to taps on the dividers of stage N through crystal rectifiers and the taps are also connected to the shift bus through capacitors. A shift pulse will pass the rectifiers to trigger a stage if the condition of the preceding stage is different. Voltage levels as actually measured are given in Fig. 1B to show how the rectifiers gate the shift pulses, and Fig. 1C shows how these voltages vary during operation.

For example, the cathode-to-anode voltage of rectifier D_1 is 47 volts so that no pulse less than 47

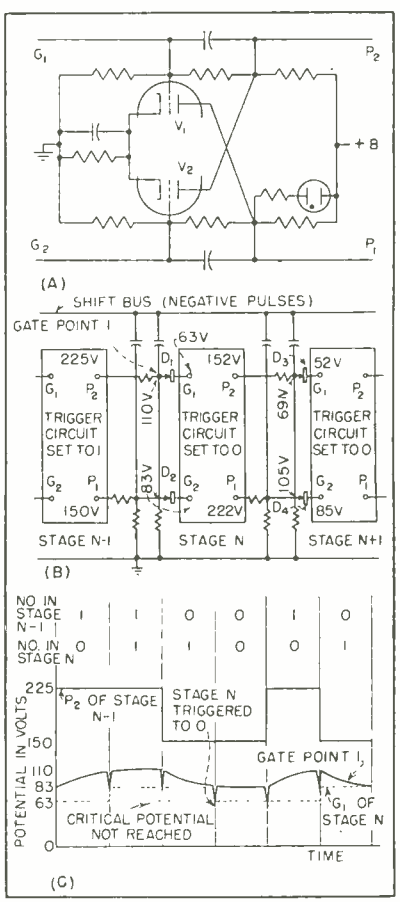

FIG. 1—Basic circuit (A), interconnections (B) and voltage waveforms (C) for gate-type shifting register

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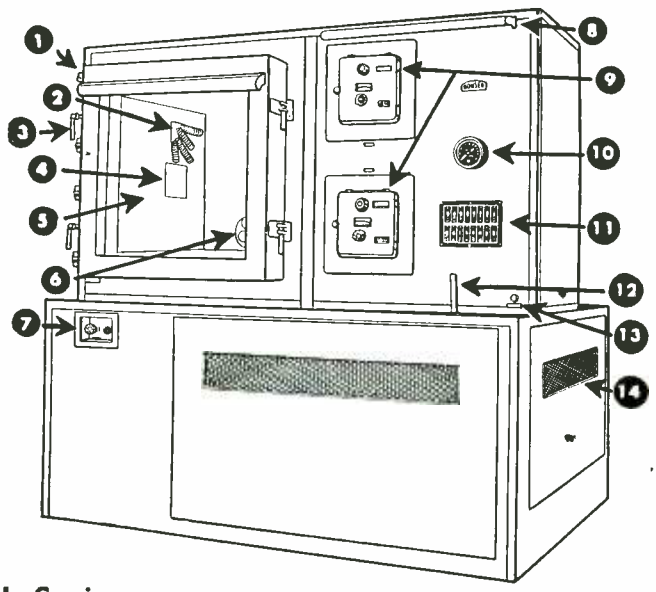
Designed by Bowser, Inc., to meet the most rigid requirements for testing electronic components or equipment in relation to temperature, humidity or altitude. Used widely by government and industry in laboratories for research and development work and on the production line.



1. Door Light
2. Internal Terminal Pad
3. Cam Latch
4. Access Port
5. Inspection Window
6. Air Mover
7. Hand Regulating Water Valves
8. Instrument Panel Light
9. Indicating Potentiometer, Controller (Wet and Dry Bulb)
10. Altitude Gauge
11. Control Panel
12. Climb-Dive Valve
13. Manometer Connection
14. Condensing Unit Compartment

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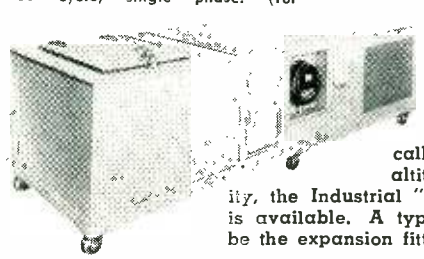
MODEL NO.	SIZE H	SIZE W	SIZE D	LOW TEMP. POINT F.	PULL DOWN FROM AMB. MIN.	DISSIPATION AT LOW OPERATING POINT AT SEA LEVEL	MASS LOAD OF STEEL	8 POST 4 THERMOCOUPLE TERMINAL PAD	CUT OUT AND REMOVABLE INSULATION BATT
L1-50 VH	12"	12"	12"	—50°F.	70	100 watts	25#	Available in all 3 L1 Units installed on left side wall, only if "cut out" not required	Available in all 3 L1 Units installed on left side wall, only if Terminal Pad is not required
L1-76 VH	(1 cu. ft.)			—76°F.	105	100 watts	25#		
L1-100 VH				—100°F.	170	50 watts	25#		
L5-50 VH	18"	30"	15½"	—50°F.	70	200 watts	50#	Installed in left side wall	Installed in left side wall
L5-76 VH	(5 cu. ft.)			—76°F.	110	200 watts	50#		
L5-100 VH				—100°F.	200	100 watts	50#		
L8-50 VH	24"	24"	24"	—50°F.	70	200 watts	50#	Installed in left side wall	Installed in left side wall
L8-76 VH	(8 cu. ft.)			—76°F.	110	200 watts	50#		
L8-100 VH				—100°F.	200	100 watts	50#		
L18-50 VH	30"	30"	36"	—50°F.	70	200 watts	25#	Installed in left side wall	Installed in left side wall
L18-76 VH	(18 cu. ft.)			—76°F.	110	200 watts	25#		
L18-100 VH				—100°F.	210	100 watts	25#		
L27-50 VH	36"	36"	36"	—50°F.	75	200 watts	100#	Installed in left side wall	Installed in left side wall
L27-76 VH	(27 cu. ft.)			—76°F.	110	200 watts	100#		
L27-100 VH				—100°F.	210	100 watts	100#		

THE FOLLOWING SPECIFICATIONS ARE STANDARD FOR ALL MODELS:

1. Reheat time from ambient to +180°F. is 70 minutes.
2. Thermocouple Type Indicating Controller; installed in instrument panel to right of free-working space. Range: —150°F. to +200°F.
3. Altitude Simulation Equipment: Laboratory Type, Oil Sealed Vacuum Pump and Hand Operated Climb-Neutral-Dive Valve.
4. Current (for control): 110 volt, 60 cycle, single phase. (for power): 220 volt, 60 cycle, three phase.
5. Average Climb Rate: 3,000 feet per minute to 50,000 feet.
6. Maximum Vacuum: 1" mercury absolute.
7. Vacuum Gauge: 4½" Dial Type, 0' to 80,000'.
8. ⅜" I.D. Low Pressure Pipe: 50 psi, installed in left side wall.
9. Special instrumentation can be supplied at customer's request.

CONSTRUCTION

Cabinet mounted on rigid steel base of welded channel irons to prevent warpage or distortion. Refrigeration equipment and vacuum pump, etc., mounted on separate inner frame to minimize vibration. Work being tested checked during processing through inspection window mounted in door of chamber. Interior illuminated by means of a light mounted on door outside the chamber. Instrument panel is also supplied with a light mounted over it.



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For the user whose requirements do not call for conditions of high altitude or relative humidity, the Industrial "low temperature" Unit is available. A typical application might be the expansion fitting of bushings.

OTHER BOWSER UNITS

Some of the many Bowser units are shown and briefly described on this page. They have a wide scope of application throughout industry. Complete details regarding any of them are available upon request.

UTILITY UNITS

Designed for rapid, dependable production testing and processing. It is also capable of being used for limited amounts of research and development work. Adaptable to a wide range of applications from production processing of radio crystals to testing of cameras and camera lenses. Provided with temperature control from +158°F. to —80°F., with a tolerance of control of ±3°F. over the range.

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volts would be transmitted to G_1. The two elements of D_2, however, are at the same potential, so the negative shift pulse will be transmitted to G_2, thereby triggering stage N to the 1 condition as required for correct shifting. Stage $N + 1$ should not trigger, and an examination of the voltage levels shows that the shift pulse appears at both grids. This prevents triggering by holding G_1 below cutoff until the pulse has disappeared from G_2. No trouble has ever been encountered from plate triggering.

The input stage shown in Fig. 2

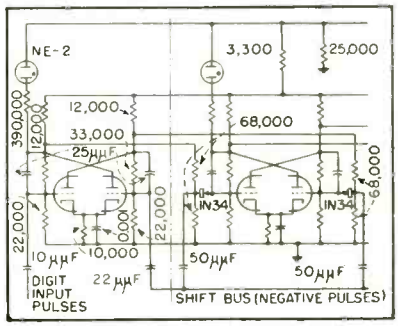


FIG. 2—Circuit diagram showing two stages. Ordinarily many more would be used. For example, 41 stages could store ten decimal digits and a sign. Subsequent stages are identical to second stage

works differently from the other stages; it is designed for a single-wire input. Whenever it holds a 1 it is reset by the next shift pulse and then set again if a new 1 is to be inserted. The digit-input pulses must be delayed slightly from the shift pulses to allow the first stage, if just reset, to recover and be ready for setting again. The trigger circuit has a resolving time of about 1 microsecond so a delay of about 2 microseconds is recommended. This special input stage can be avoided if the signal source provides pulses for 1's and 0's on separate wires instead of pulses to represent 1's and blanks to represent 0's, all on the same wire. It can also be avoided if necessary by squelching the shift pulse to the first stage with the digit input pulse.

The circuit shown in Fig. 2 will operate reliably on negative shift pulses between 30 and 100 volts in amplitude and negative digit-input pulses between 60 and 110 volts when the plate supply is set at 300

volts, and on smaller pulses with lower supply voltages. Pulse duration should be about 1 microsecond. The capacitor which applies the shift pulse to reset the first stage was chosen to obtain a sufficient resetting pulse from the shift bus without at the same time interfering with normal trigger action in the first stage. The digit-input capacitor, similarly, was made as small as possible to avoid decreasing the resolving time of the first stage.

The development of this shifting register was part of a research program supported by the Office of Naval Research. The writers wish to thank David R. Brown, E. E. Bolles and Professor Paul L. Norton for their assistance.

SURVEY OF NEW TECHNIQUES

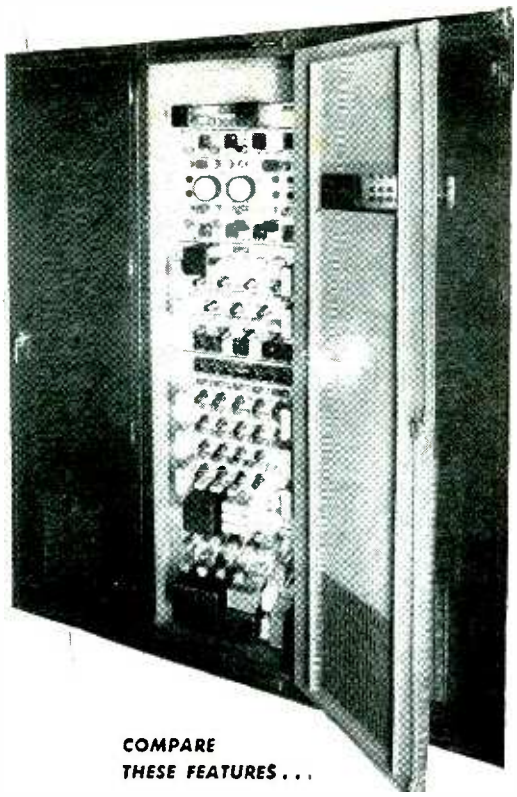
ATOM-SPLITTING QUALITIES of the neutron are utilized in a new neutron counter developed by Westinghouse. A small amount of uranium 235 is mixed with a special light-producing phosphor coated on the surface of a photo-electronic tube. The whole device fits in a metal cylinder lined with a two-inch thick wall of paraffin to slow down fast-moving neutrons. An arriving neutron splits a uranium atom and resulting nuclear fragments strike the phosphors, producing light rays that act on the phototube. Output pulses are fed to electronic circuits that give an accurate count of the atomic explosions taking place.

Tiny atom-smashing neutron counter being inspected by Kuan-Han Sun, who developed it jointly with W. E. Shoupp of Westinghouse Research Laboratories

For that steady pulse of dependable, day-in and day-out telecasting service . . .

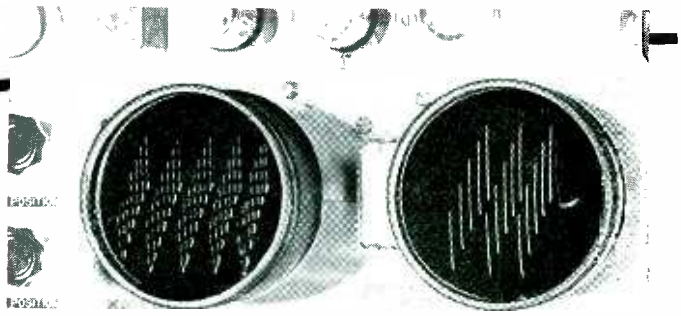
DU MONT MODEL TA-107 A/B

Synchronizing SIGNAL GENERATOR

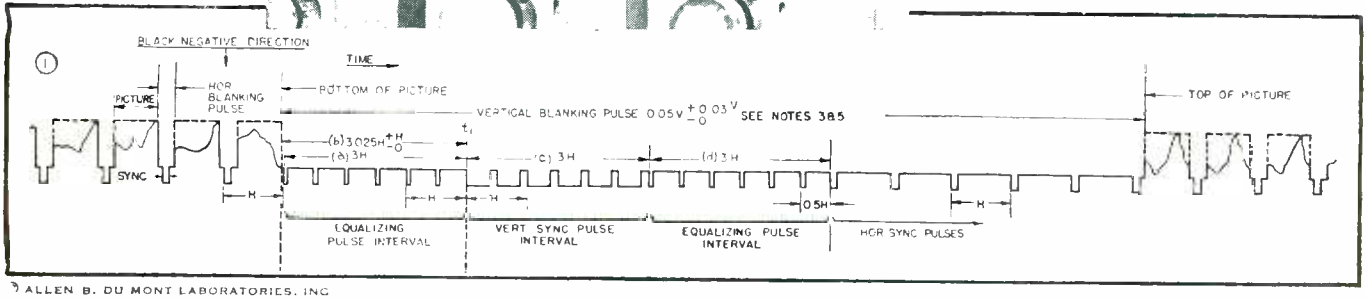


Basically a set of tried-tested-proven units packaged in one cabinet for use in furnishing the horizontal and vertical driving pulses; the blanking signals; and the composite synchronizing signals required by studio and film cameras, camera control units, monitors and other telecasting station equipment. May also be used with a source of television picture signal in the preliminary and the final testing of television receivers in production. Likewise in the development laboratory, in schools and wherever video circuits are critically analyzed.

Further details on request



Close-up of the two 3" cathode-ray tube monitors indicating all frequencies within sync generator. Below, the composite signal provided by Model TA-107 A/B.



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COMPARE THESE FEATURES . . .

✔ Conforms to all RMA and FCC specs for standard output signals, horizontal and vertical driving signals, composite video blanking and synchronizing signals.

✔ Linearity test signals at 900 cycles providing 15 horizontal bars, and 157.5 kc providing 10 vertical bars mixed with blanking, by means of switch, for use in checking scanning linearity of picture monitors and television receivers.

✔ Provision of two 3" c-r tubes for use in *simultaneous monitoring* (without switching) of all frequencies in the sync generator. Thus frequency counts may be checked or adjusted without use of external oscillographs.

✔ Leading edges of equalizing pulses are also leading edges of horizontal and vertical sync pulses . . . for perfect interlacing.

✔ A crystal oscillator at 157.5 kc or a highly stable self-excited oscillator at 157.5 kc may be selected by a switch for use as master oscillator. The self-excited MO is useful in synchronizing the generator, by means of provided lock-in circuit, to 60 cycle power line or to a remotely generated sync signal.

✔ Very short signal lead lengths. Operation of all tubes well within manufacturer's rating. Dimensions, mounted in cabinets: 83¼" x 22" x 18¼", 680 watts.

Plus many other outstanding features.

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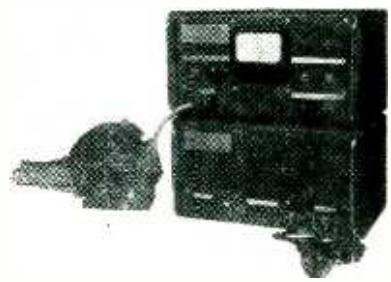
paratus. It permits ten different combinations of styli and can be mounted on most arms. Point pressure is about 7 grams and output, about 30 mv. Needle radiation is very low.

Cable Eccentricity Gage

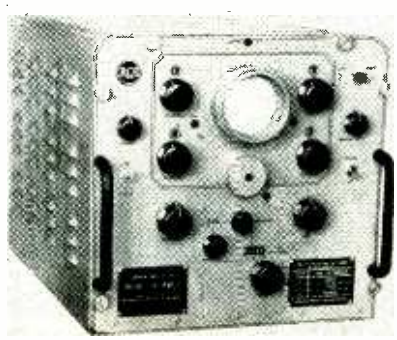
THE ADDISON ELECTRIC CO., LTD., 163 Holland Park Ave., London, W.11, England. A new type of gage for continuous process control in the manufacture of extruded cables and wires employs a low-frequency current of 90 ma and an induction



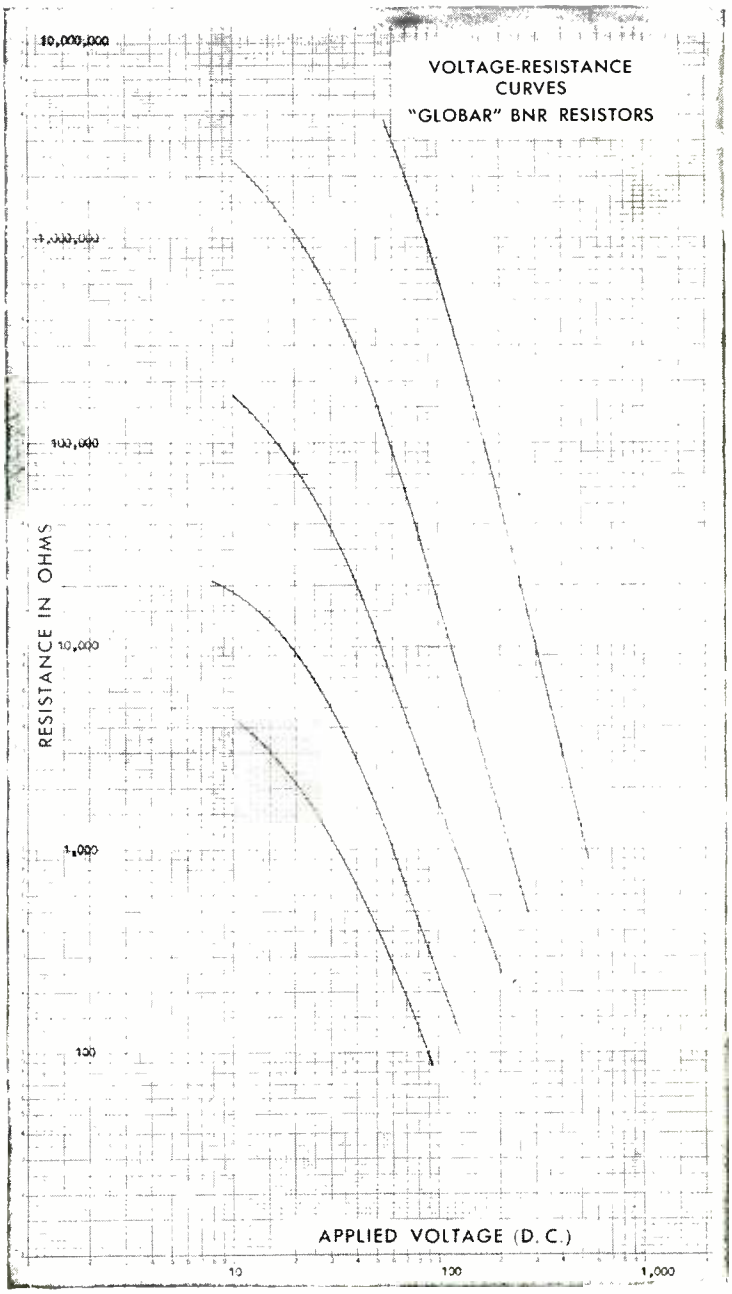
pickup. The device shows any deviation of the center conductor. Three eccentricity ranges, −0.5 to +0.5 mm, −1.5 to +1.5 mm, and −5 to +5 mm, are available at a selector switch. Four electron tubes are used. Equipment is powered from 110-volt, 50-cycle lines.

Loran Indicator

RADIOMARINE CORP. OF AMERICA, 75 Varick St., New York 13, N. Y. Model LR-8802 direct-reading indicator is designed to provide shipboard reception of loran signals. A special self-check display on the c-r tube permits instant verification of proper instrument operation. With auxiliary power conversion equipment the unit may be operated from either 32, 115 or 230 volts d-c. In such cases the regular front panel ON-OFF switch con-



GLOBAR Voltage Sensitive Resistors reduce Arcing at Electrical Contacts



Many electrical devices, in which breaking of contacts is accompanied by arcing, require surge absorption to maintain acceptable contact life.

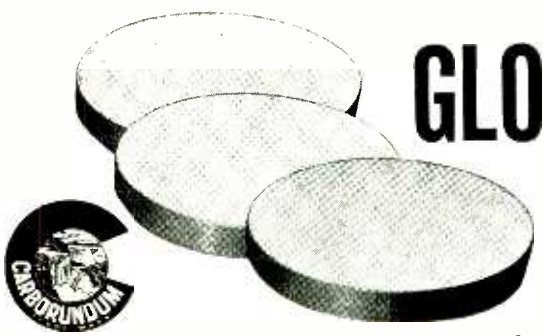
The GLOBAR type BNR resistor can be designed to bypass only an insignificant amount of current across open contacts. As the contacts open, the rising voltage surge causes a sharp decrease in resistance and surge energy is dissipated.

The arc is extinguished much earlier. Addition of GLOBAR type BNR resistors to some unprotected circuits has produced a 95% reduction in duration of arcing.

Material reduction in radiation of interference harmful to radio and televison reception also results.

Complete application data is available. Write Dept. V-129 for Bulletin GE-R1-B.

The Carborundum Company, GLOBAR Division, Niagara Falls, New York.



GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

trols the motor generator or inverter. Major units besides the indicator are an external power supply unit and an antenna loading coil unit.

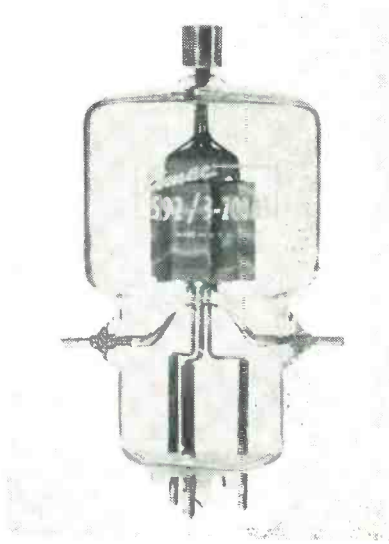
Heavy-Duty Soldering Guns

WELLER MFG. CO., 806 Packer St., Easton, Pa., announces a new model soldering gun capable of handling 250 watts. The Model WD250 gun

is suited to all electrical, telephone, commercial and industrial soldering. It features five-second dual heat, prefocused spotlight and the new rigid tip for heavy-duty soldering. Redesigned terminals give greater accessibility to tight spots.

VHF Triode

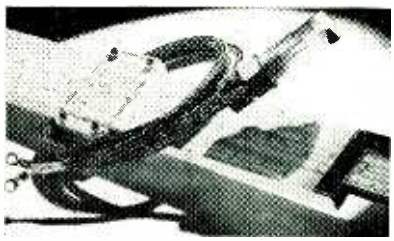
EITEL-MCCULLOUGH, INC., 237 San Mateo Ave., San Bruno, Calif. Type 592/3-200A3 general purpose vhf triode is suitable for both oscillator and power amplifier service. As an oscillator it lends itself to develop-



ing medium vhf power for industrial purposes. The construction is also designed for power amplifier service at frequencies as high as 125 mc.

Temperature Pickup

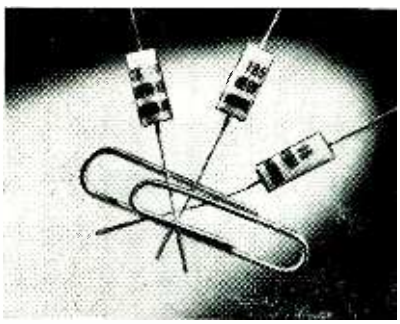
TRANS-SONICS, INC., Bedford Airport, Bedford, Mass. Type 17-2 air and gas temperature telemetering pickup is a platinum resistance thermometer, the resistance of which varies linearly from 8 to 14



ohms over the temperature range 0 to 600 F (0 to 315 C). When inserted in air moving at 5 feet per second, its thermal time constant is less than 0.5 second. Balancing bridges are available so as to provide zero output at zero deg C and 5 mv per volt applied at 600 F.

Germanium Diodes

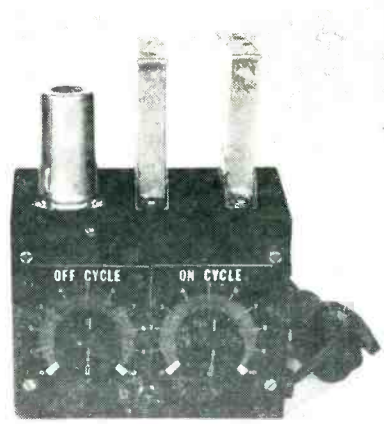
RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Types CK705, 706, 707 and 708 germanium diodes feature small size (0.390 inch long and 0.160 inch in diameter) and



high ambient operating temperature rating of 100 deg C. High temperature rating is obtained by using only glass and metal in the basic assembly, thus eliminating the necessity for a wax filler.

Timing Device

G. C. WILSON & Co., 2 N. Passaic Ave., Chatham, N. J. The Cyclo-Flex timer is an electronic device



which may be operated either single interval with manual initiation or as a repeat cycle timer with two adjustable intervals which occur successively without any external operation. Each interval is accompanied by relay contact closure and is obtained by the charging of a resistance-capacitance network. Power supply is 110-125 volts, 60 cycles. Time intervals for the ON cycle are 0.5 to 3 seconds; for the OFF cycle, 9 to 20 seconds. The relay is spdt. Contacts are rated at 3 amperes, 115 volts a-c.

Universal Amplifier

MILLIVAC INSTRUMENTS, P.O. Box 3027, New Haven, Conn. Type DCA-3 universal amplifier for d-c can be used as a self-contained, complete vacuum-tube millivoltmeter or as an amplifier for external meters and recording instruments. It has an input impedance selector (100 ohms to 4 megohms),

a multiplier range switch covering a total measuring range between 1 mv and 1,000 volts d-c, and a built-in 10-mv calibrator. Output varies between a few microamperes and 5 ma.

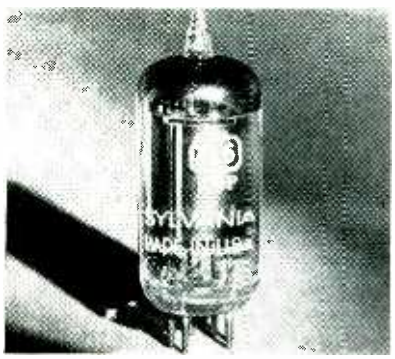
Survey Meter

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland, Ohio. Model 263B survey meter, designed

for semi-quantitative work and highly sensitive to beta and gamma-ray radiation, uses a 1B85 thyrode and two 5828 medium-mu triodes. Full scale sensitivity on three ranges is 130, 1,300 and 13,000 counts per sec. A microammeter calibrated in milliroentgens per hour, measures the average intensity of the radiation.

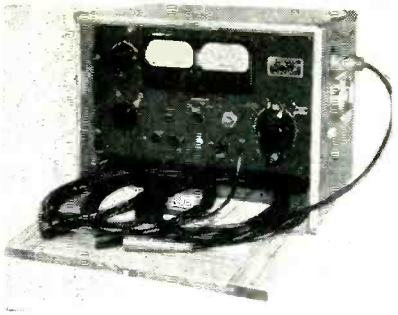
Miniature Pentagrid Converter

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 1L6 miniature pentagrid converter tube is designed for use in portable radio receivers. It is supplied with a 1.4-volt d-c filament cathode rated at 50 ma. Operated from a 90-volt B supply, its plate current is 0.5 ma.



Insulation Tester

RADIO FREQUENCY LABORATORIES, INC., Boonton, N. J Model 184C insulation tester, designed for preventive maintenance field testing and general purpose production and laboratory use, has four voltage ranges providing continuously variable d-c voltages up to 10 kv. Resistances ranging from 0.1 to 50,000 megohms may be read di-



rectly on a megohmmeter scale or may be calculated in ranges from 0.3 to 20,000 megohms from the readings of a voltmeter and microammeter. The unit operates from a 115-volt, 60-cycle line and consumes a maximum of 65 watts.

Sweep Calibrator

BROWNING LABORATORIES, INC., 751 Main St., Winchester, Mass. Model GL-22A sweep calibrator is designed to provide markers for accurate time calibration of synchroscopic sweeps. Markers at intervals of 0.1, 1.0, 10 and 100 microsec-

onds are provided and are suitable for deflection indicating or beam blanking presentation. A self-contained trigger generator with positive or negative output can be used to drive the calibrator and associated equipment or it may be triggered externally up to approximately 100 kc.

Wave Generator

ALFRED W. BARBER LABORATORIES, 34-04 Francis Lewis Blvd., Flush-

ing, N. Y. The Complex Wave Generator is a new electronic laboratory instrument which will provide a fundamental and 2nd, 3rd, 4th and 5th harmonics in any percentage and any relative phase. The frequency of the fundamental may be varied from 50 to 3,000 cycles. Output is 1 volt into 500 ohms at fundamental or any harmonic. Tubes used in the instrument are 22 6SJ7's, five 6L7's, four 6SN7's and one 5U4G.

R-F Wattmeter

M. C. JONES ELECTRONICS Co., 96 North Main St., Bristol, Conn. Model MM620 series absorption-type wattmeter accurately measures r-f power from 10 milliwatts to 4 watts over the frequency range from 1 to 1,000 mc. It will also accurately terminate any 51.5-ohm coaxial line. Other uses are measurement of r-f power output of low-power transmitters and exciters, measuring oscillator excitation in superhet receivers and checking signal generators. Absolute accuracy is ± 10 percent of full scale.

Versatile Counter

ROBERT HETHERINGTON & SON, INC., 1216 Elmwood Ave., Sharon Hill, Pa., has developed an electronic counter for industrial and research

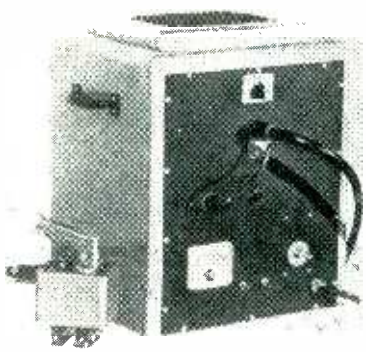
applications requiring up to 1,000 counts per second. It features the preselection of any number to be counted by setting the four decade knobs to the number desired. Automatic recycling is provided. Accuracy of the counter is unaffected by line voltage variations from 95 to 135 volts. A built-in relay provides both normally open and normally closed contacts capable of handling 5 amperes at 125 volts.

Thermostatic Bimetal

H. A. WILSON Co., Newark, N. J. A new thermostatic bimetal Wilco R-16 has an electrical resistance of 16 ohms per square mil foot at 70 F, flexivity ASTM B 106-40, useful deflection minus 100 to 500 F, modulus of elasticity 19,500,000. A fuller table of properties can be obtained from the manufacturer.

Glue Curing Machine

PAN-AMERICAN ELECTRONICS, INC., 5816 So. Santa Fe Ave., Los Angeles 11, Calif. The R1-A portable electronic high-frequency wood bonding machine can reduce the time consumed in wood fabrication operations by as much as 70 percent.



Completely cured permanent bonds are produced within a few seconds. The hand gun can be fitted with electrodes for veneering, banding, mitered corners of all angles and penetration, making it adaptable to a wide variety of jobs.

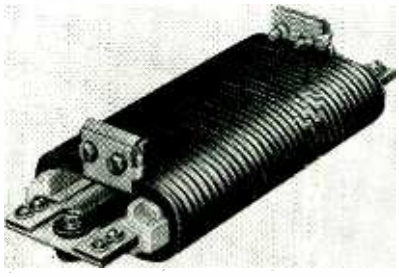
Miniature Tubes

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y., has announced two new miniature electron tubes, a T 5½ pentode

power amplifier type 1W4 and a T 5½ triode amplifier or oscillator type 1C3. Both are designed for battery operation and have 1.4 volt d-c filaments requiring only 50 ma. Rated power output of the 1W4 pentode is 35 mw with 45 volts on the plate and 200 mw with 90 volts. The 1C3 triode is designed for 90 volt operation. It has an amplification factor of 14.5.

High-Current Resistors

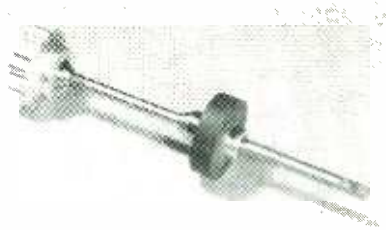
WARD LEONARD ELECTRIC CO., Mount Vernon, N. Y. Bulletin 35 Edgeohm high-current resistors are now available in four shorter lengths than the 19-in. size previously listed. The new sizes: 6, 9¼, 12½ and 15¾ inches, extend the minimum resistance value per unit



from 0.35 to 0.05 ohm. Continuous current capacities range from 21 to 79 amperes for all sizes. Maximum continuous duty ratings are approximately 2,200 watts for 19-in. units to 320 watts for 6-in. resistors.

Coil Winder Supply Spindle

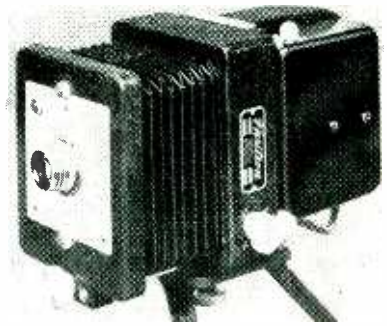
UNIVERSAL WINDING CO., Providence, R. I., has developed a new supply spindle to be used in conjunction with the strap type un-



rolling tension on the No. 84, 96, 102, 104 and 105 coil winding machines. The new spindle features a solid shaft, a firmly anchored brake wheel and a latch nut equipped with a double thread which can be quickly spun on or off to compensate for difference in length of wire spools.

Data Recording Camera

PHOTOGRAPHIC PRODUCTS INC., 955 N. Mansfield Ave., Hollywood 38, Calif. The Varitron camera, containing a recording chamber mounted in its side, is basically an industrial control designed for technical, scientific and industrial applications, especially where remote control and automatic operation are demanded, and where it is necessary to correlate information from two or more points at one time.



The camera will record any quantitative or qualitative measurement process. In operation it is controlled by closing an electrical contact, either manually or by sequence time clock, intervalometer, radio signal, sound or any phenomena that can be converted into a mechanical or electrical impulse.

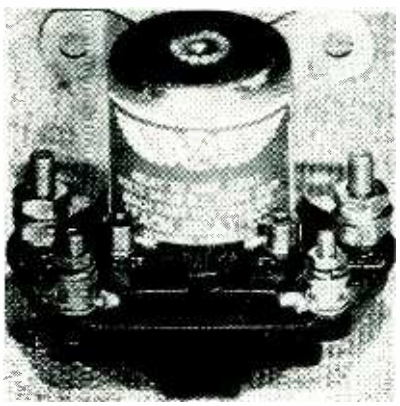
Tele Portable Power Supply

RADIO CORP. OF AMERICA, Camden, N. J., has announced a well-regulated source of d-c at loads from 200 to 300 ma. Type-25A portable tv power supply is adjustable be-

tween 260 and 290 volts, with variations of less than 0.5 percent from minimum to maximum load. Its a-c ripple is less than 0.01 percent from peak-to-peak. Power requirement is 120 volts, 60 cycles, 300 watts. The unit is suitable for laboratory, broadcast, industrial and communications applications requiring a well-filtered source of d-c.

A-C Relay

LEACH RELAY CO., 5915 Avalon Boulevard, Los Angeles 3, Calif. The 7064-919 relay is especially built for handling a-c loads of from 50 to 75 amperes at 115 volts a-c, 400 cycles or 25 amperes at 270 volts a-c, 400 cycles. The relay is provided with a 24-volt d-c continu-



ous duty coil which operates on 157 ma. It pulls in at 18 volts and drops out at 7 volts or less. Contacts are also rated 50 amperes at 24 volts d-c. The contact system is spst, normally open double break.

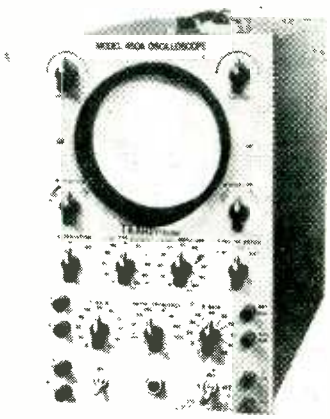
Tuning Fork Resonators

PHILAMON LABORATORIES, 5717 Third Ave., Brooklyn 20, N. Y. Temperature-compensated tuning fork resonators are available in frequencies from 1,000 to 3,000 cps, and in

accuracies from 1 part in 3,000 to 1 part in 100,000. Temperature control is not needed over ambient ranges as wide as 100 deg C; however the 1-part-in-100,000 resonator is obtainable for operation over a 55-deg C range. Units are provided complete with drive and pickup coils mounted in solder-sealed evacuated steel cans.

Five-Inch Oscilloscope

TRANSVISION, INC., New Rochelle, N. Y., announces production of the Model 450A five-inch oscilloscope which features a vertical amplifier response to 1 mc., sensitivity of



0.15 rms volt per inch, and horizontal amplification of 2 cycles to 500 kc. It has a sweep frequency to 50 kc.

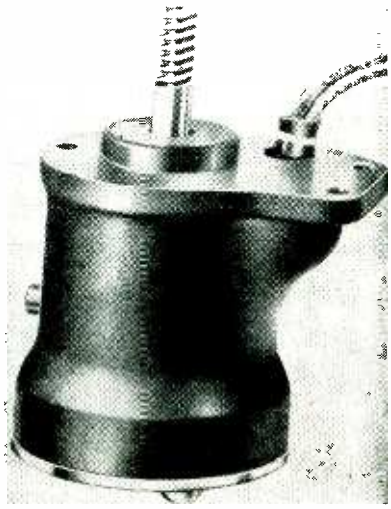
Tele UHF Link

FEDERAL TELECOMMUNICATION LABORATORIES, INC., 500 Washington Ave., Nutley 10, N. J. Illustrated below is the receiver of the FTL-27A crystal-controlled television uhf link. The system was designed

to relay broadcast television programs and can be operated as a studio-to-transmitter link, intercity relay or portable pickup. Single hop program transmission up to 45 miles is possible and long distance tandem operation can be provided. A complete link consists of transmitter, receiver and two parabolic antennas. The system operates in the 1990 to 2110-mc band.

Fractional Horsepower Motor

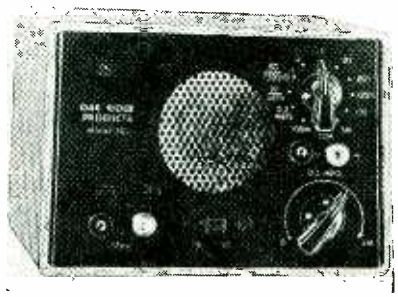
ELECTRO-AIRE, INC., 11439 Vanowen St., North Hollywood, Calif. Model 1201 115-volt, 1/100 h-p, single-phase 400-cycle a-c motor has permanent capacitor. Among its aircraft and industrial applications



are valves, lifts, pumps and actuators. The unit is 2 inches high (excluding worm gear) with a circular pilot 0.875 inch in diameter.

Substitution Tester

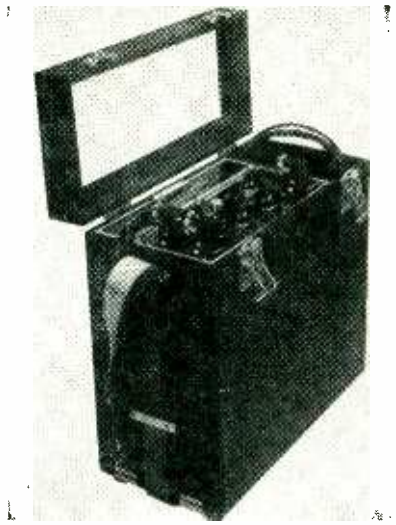
OAK RIDGE ANTENNA, MFG. DIVISION OF VIDEO TELEVISION, INC., 239 E. 127th St., New York 35, N. Y. Model 101 substitution tester contains a range of substitute ca-



pacitors from 0.001 to 0.5 μf, 600 v, 30 μf, 450 v to 150 μf 150 v; resistors from 100 ohms to 100,000 ohms, 2 watts; a variable potentiometer, 0 to 2 meg; and a test speaker with connections to either voice coil or transformer.

Induction Tracer

THE ADDISON ELECTRIC CO., LTD., 163 Holland Park Ave., London, W. 11, England. Type 154 Induction Tracer has recently been improved. This portable instrument used for finding breaks in pipe lines and cables can also tell the depth to which a conductor is buried, by the



induction method. In practice, an alternating current is injected at one end of the wire or pipe and the signal picked up in probe coils, amplified in the portable instrument and identified by headphones.

H-V Rectifier

BRADLEY LABORATORIES, INC., 82 Meadow St., New Haven, Conn., is producing a new high-voltage selenium rectifier, model SE8M, rated at 5 ma. It features a tubular housing ⅜ inch in diameter and has two tinned pigtail leads.

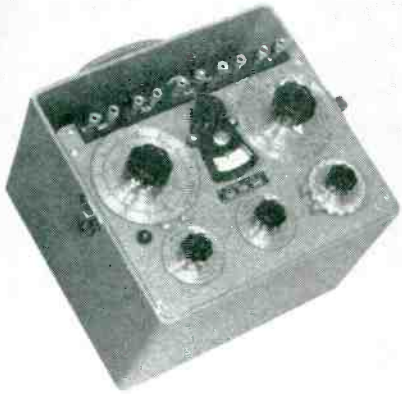
High-Vacuum Rectifier

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. A new high-vacuum rectifier tube, lock-in type 7X6, is supplied with a 6.3-volt heater rated at 1.2 amperes. Maximum rated output of

150 ma and separate cathode leads make it suitable for a wide range of radio, electronic and television power supply circuits.

Universal Impedance Bridge

BROWN ELECTRO - MEASUREMENT CORP. 4635 S. E. Hawthorne Blvd., Portland 15, Oregon. Model 250-A impedance bridge uses 0.1-percent precision wire-wound resistors in the bridge arms and a directly-calibrated slidewire consisting of a 0.1-percent precision decade with a coaxially mounted single-turn rheostat for interpolation within the



decade steps. The unit can measure resistance from 1 milliohm to 1 megohm; capacitance, from 1 $\mu\mu$f to 100 μf; and inductance, from 1 μhenry to 100 henrys.

Industrial Thyratron

NATIONAL ELECTRONICS INC., Geneva, Ill., has announced the NL-740 industrial thyratron designed for use with ignitrons and carrying a 50-ampere peak current rating. The tube is gas and mercury filled for quick-starting and constancy of characteristics within wide temperature limits. Filament

voltage is 2.5 volts; filament current, 16 amperes; peak inverse voltage, 1250 volts; d-c output, 4 amperes.

Literature

Wide-Band Amplifier. Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Volume 1, No. 1 of the Journal is a four-page article giving complete technical information on the model 460A wide-band amplifier which was designed to provide suitable output for operating scalers, coincidence devices, or for direct viewing on a cathode-ray tube.

Telemetering Systems. General Electric Co., Schenectady 5, N. Y. Bulletin GEA 5233 is a 20-page illustrated description of the latest telemetering equipment for electric power distribution and industrial applications. It gives detailed information on frequency type, torque-balance-type and photoelectric-type telemeters. Also included are wiring diagrams of typical installations, as well as dimensions and specifications of telemeters and auxiliary equipment.

Circuit Breakers. Roller-Smith Division, Realty and Industrial Corp., Bethlehem, Pa. Catalog 2550 covers the RS-15, and RS-25 air circuit breakers which were developed to protect feeder circuits and for main breakers on low-voltage systems. The catalog discusses the Arc-Mill arc quencher and the dual magnetic overload and illustrates a cross section of the breaker.

Control Devices. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., has issued a four-page folder describing and illustrating a line of Variacs, the continuously adjustable transformers for all types of voltage, power, speed and heat control. Chief features and specifications for each type are given.

Insulators. Thor Ceramics, Inc., 225 Belleville Ave., Bloomfield, N. J. A recent mailing piece con-

tains descriptive information and illustrations of a wide variety of steatite insulators. Applications for each of the different insulating parts are included.

Relay Catalog. Ward Leonard Electric Co., Mount Vernon, N. Y. Catalog D-20A illustrates and describes a line of relays, gives contact ratings, coil specifications, sizes, current list prices and other helpful data on a-c and d-c units. Different types included are the sensitive, midget metal base, heavy-duty midget, midget magnetic, heavy-duty power, thermal time delay and motor-driven time delay relays.

Tele Signal Generator. Television Projects, Inc., 3660 Coral Way, Miami 35, Florida, has issued a 4-page folder on the Monoscope type 213 television signal generator. General characteristics and the circuit units included are described.

Power Triode. Machlett Laboratories Inc., Springdale, Conn. A recent bulletin gives the characteristics and advantages as well as electrical characteristics and ratings of the ML-5667 electron power triode which was designed for industrial applications, such as induction and dielectric heating, and for broadcast services.

Transformers. Triad Transformer Mfg. Co., 2254 Sepulveda Blvd., Los Angeles 64, Calif., has released a 16-page catalog illustrating, describing and pricing an entire line of transformers for original equipment, radio and television, replacement, and amateur applications. Featured in the publication are the hermetically-sealed series of transformers. Ask for catalog TR-49.

Densitometer. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 270 deals with the Model 500-R radiation-detection densitometer, a photoelectric instrument for measuring density of x-ray film employed in personnel monitoring for protection against radiation in nuclear, radioactive isotope, and x-ray work. Operation

and applications are described and a price list is included.

High-Gain Amplifier. Electro-Mechanical Research, Inc., Ridgefield, Conn. A single-sheet bulletin includes a description and operating characteristics of the Model 33 high-gain narrow-band amplifier designed for operation at or near a frequency of 10 cycles. Prices are also listed.

Peak-Voltage Rectifiers. Rawson Electrical Instrument Co., Inc., 105 Potter St., Cambridge 42, Mass. A single-sheet bulletin covers the types 518P5 and 518P15 peak-voltage rectifiers that measure peak voltages with low current drains. Of the units described, the former is used for 5 kv maximum voltage, and the latter for 15 kv. Prices are included.

Selenium Rectifiers. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa. Booklet DB-19-025 includes efficiency curves for a line of standard (type M) and high-voltage (type H) selenium rectifiers for power supplies and electronic circuits. Life characteristics for various overload conditions or high ambient temperatures are plotted graphically. The booklet concludes with a tabular presentation of schematic diagrams, formulas for calculating rectifier performance, and cell ratings for a wide range of applications.

Relays. Ward Leonard Electric Co., Mount Vernon, N. Y. A new 12-page relay catalog No. D-20A fully illustrates and describes seven standard types of magnetic relays for industrial and general purpose control applications. Complete technical data on relay ratings, dimensions, coil specifications and applications are included.

Microwave Test Equipment. Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y., announces the publication of its new catalog describing microwave test equipment covering the frequency spectrum up to 40,000 mc. Typical of the new

products described is a complete line of hermetically sealed, direct-reading, precision frequency meters.

Hermetically-Sealed Relays. Leach Relay Co., 5915 Avalon Boulevard, Los Angeles 3, Calif., offers a descriptive brochure on a series of small, compact, plug-in, solder terminal and AN-connecting type hermetically-sealed relays. It covers specifications, characteristics, applications and design factors.

Cathode-Ray Oscillographs. Allen B. Du Mont Laboratories, Inc., 1000 Main Avenue, Clifton, N. J. Types 304 and 304-H cathode-ray oscillographs are treated in a recent 12-page folder. Included in the description are the c-r tube circuits and power supplies, sweep circuits, physical layout, amplifier circuits and specifications.

Power Supply and Signal Generator. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. A single-sheet bulletin devotes one page to the type 801 universal klystron power supply developed for research and production engineers in the operation of high-voltage klystrons in the microwave spectrum. The bulletin also describes the TS-602/U broadband microwave signal generator which covers the 4,200 to 10,300-mc range.

Plastic Welding. Electronic Processes Corp., 260 North First St., San Jose 18, Calif. A recent four-page folder describes and illustrates a line of Electrotherm high-frequency generators and presses designed for the bonding of thermoplastic films from 0.002 inch to 0.062 inch in thickness in two seconds or less. With the equipment described it is also possible under certain circumstances to weld plastics to paper or cloth.

Traveling Wave Amplifier. Varian Associates, 99 Washington St., San Carlos, Calif. An eight-page folder on the Model 3001 traveling wave amplifier gives specifications, theory of operation, and adjustments for proper d-c and r-f operation. Auxiliary equipment is also illustrated and described.

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Input Center Frequency.....	455KC	455KC	455KC	5.25MC	10.2MC	30MC	5.25MC	30MC	30MC
Resolution at Maximum Scanning Width.....	2.5KC	3.4KC	4.4KC	11KC	11KC	25KC	11KC	75KC	91KC
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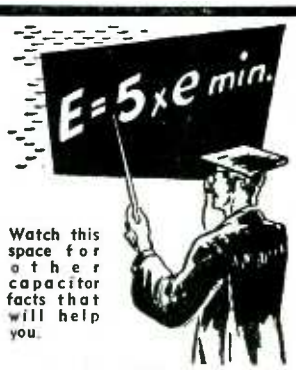

Watch this space for other capacitor facts that will help you.

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(continued from page 130)

85, astatine; and element 87, francium.

Of the six older elements, the name of element 74, formerly known in the U. S. and England as tungsten, will now be known officially as wolfram. Element number 41, known in America as columbium, is now officially recognized as niobium. Other names adopted for older elements are: beryllium, rather than glucinium, for element number 4; hafnium for element 72; lutetium rather than lutecium for number 71; and protactinium, rather than proto-actinium for element 81.

New Research Division

RAYTHEON Manufacturing Co., Waltham, Mass., has established a research division under Carlo L. Calosi as director of research. Members of the new division's staff in charge of its various sections are:

S. Rich—Servo-Sonic Department; P. B. Carwile—Utrasonic Section; W. Roth—Servomechanism Section; C. G. Smith—Gas Tube Section; W. M. Gottschalk and H. G. Rudenberg—Microwave and Tube Section; and R. M. Cudmore—Services Section.

NAB Engineering Handbook

THE FOURTH edition of the engineering handbook of the National Association of Broadcasters was recently mailed to all NAB member stations. The 700-page looseleaf handbook contains FCC rules and regulations, standards of good engineering practice, design data, and information on a-m radio, television, f-m, audio engineering and special articles.

Surplus Equipment Manual

A SIMPLIFIED manual to guide users of the more common types of electronic equipment purchased from Government surplus stocks has been issued by the Office of Technical Services of the U. S. Department of Commerce. The new publication, "Schematic Manual for Surplus

Electronic Equipment", Volume 1, provides prospective purchasers with the basic circuit diagrams, parts, values and voltages of the equipment listed. The more complete manuals published heretofore contained much detail not essential to many surplus equipment buyers, and photostats had to be made of out-of-print volumes. The new manual is the first of a series of similar publications to be issued by OTS.

The following items are included: ARC-4 transmitter-receiver; ARC-5 aircraft radio equipment; BC-191 radio transmitter; BC-222 radio receiver and transmitter; BC-223 radio transmitter; BC-312 receiver; BC-314 radio receiver; BC-610 radio transmitter; BC-614 speech amplifier; SCR-177-B radio set. These equipments include BC-342 receiver; BC-344 radio receiver; DY-8 dynamotor; MD-7 modulator; PE-49 power unit; R-23 and R-24 navigation receivers; R-25, R-26 and R-27 communication receivers; R-28 vhf receiver; RT-19 transmitter receiver; SCR-188-A, SCR-193, SCR-210, SCR-245 and SCR-299 radio sets; T 18, T 19, T 20, T 21 and T 22 transmitters; and T 23 vhf transmitters.

Copies of the 44-page publication, designated as PB 98487, are available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., at $1. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

BUSINESS NEWS

MINNEAPOLIS-HONEYWELL REGULATOR CO. recently purchased a 102,000-sq ft factory building at 1433 Stinson Blvd., Minneapolis, Minn., to provide increased facilities for production of aeronautical control devices.

HOGAN LABORATORIES, INC., New York, N. Y., is the new corporate name of Radio Inventions, Inc., a research and development laboratory specializing in facsimile.

OWENS-ILLINOIS GLASS CO., Columbus, Ohio, recently began production of an all-glass rectangular television bulb at its subsidiary plant,

the American Structural Products Co. The new bulb receives 100 percent of the transmitted picture and makes possible smaller set cabinets.

Examining the new American Structural Products rectangular television bulb are Harvard B. Vincent, director of product development and Kenneth M. Henry, vice-president and chief engineer of the company

EASTMAN KODAK CO., Rochester, N. Y., has been licensed by Armour Research Foundation of Illinois Institute of Technology to manufacture and sell motion picture film with a magnetic sound track.

PERSONNEL

AL FRIEDMAN, formerly chief engineer with J.F.D. Mfg. Co., has been appointed chief engineer and national field service representative of Radio Merchandise Sales, Inc., New York City, manufacturers of television antennas and accessories.

A. E. BENNETT, former electronics consultant with the Air Force and recently chief engineer at Hoffman Radio Corp., Los Angeles, Calif., is now chief engineer and general manager of Audiograph Co., San Carlos, Calif., manufacturer of professional magnetic tape recorders.

A. E. Bennett

W. B. Bergen

WILLIAM B. BERGEN, director of the special weapons department of the Glenn L. Martin Co. Engineering

Division, has been named chief engineer in complete charge of the company's engineering activities.

SAVA JACOBSON, formerly with Garod, Tele-Tone and Tele-King, has been appointed chief television engineer of Air King Products Co., Inc., Brooklyn, N. Y.

ADOLPH E. ROSENTHAL, formerly associated with the British Scophony Corp. and inventor of the Skiatron dark-trace c-r tube, has been named director of physics of Freed Radio Corp., New York City, manufacturer of television consoles.

A. E. Rosenthal

W. W. Davis

WILLIAM W. DAVIS, formerly on the staff of the Naval Ordnance Laboratories, was recently appointed to the Electronics Division of the National Bureau of Standards, where he will engage in research on the high-speed electrostatic memory of the electronic digital computing machines.

JOHN T. WILNER, former engineer-in-charge of CBS television transmitter development, is the new engineering director of WBAL, Baltimore, Md.

C. S. RHOADS, with the Bell Telephone System since 1922, has been named technical director of the Navy Special Devices Center, Port Washington, L. I., N. Y. He will direct the research and development program of the Center, with supervision over its engineering, installation and maintenance and military requirements divisions.

MAURICE APSTEIN, previously chief engineer for the Allen D. Cardwell Mfg. Corp., has joined the staff of the National Bureau of Standards where his duties will include the investigation of new principles and

components of advanced types of electronic ordnance devices.

PERCY L. SPENCER, manager of Raytheon's power tube division, recently received the Navy's Distinguished Public Service Award for his wartime work in microwave magnetron development.

Percy L. Spencer receiving Distinguished Public Service Award from Rear Admiral Hewet Thebaud, U. S. N.

ALAN S. FITZGERALD, electrical research engineer of San Francisco, Calif., and holder of 85 patents granted by the U. S. Patent Office, was recently awarded the Louis Edward Levy Medal of the Franklin Institute for his papers on the design criteria of magnetic amplifiers.

A. S. FitzGerald

O. D. Sledge

OLIVER D. SLEDGE, formerly a professor of electrical engineering at the Georgia School of Technology, has been appointed to the staff of the National Bureau of Standards, where he will do research in the microwave standards section of the Bureau's Central Radio Propagation Laboratories.

C. M. HEIDEN, former head of the radio communication section, has been appointed section engineer of radio communication equipment for the transmitter division of GE at Syracuse.

NEW BOOKS

Reference Data for Radio Engineers

Produced and published by FEDERAL TELEPHONE AND RADIO CORP., *New York*, 1949, *3rd edition*, 669 *pages*, $3.75.

TWICE as large as the second edition, which together with the first edition sold over one hundred thousand copies since 1943, is this latest collective work by engineers of Federal Telecommunication Laboratories and other associate companies of IT&T. Practically all chapters have been revised and expanded, many have been renamed to comply with more advanced terminology or cover increased scope, and new chapters have been added. Among the newcomers are: Frequency Data; Bridges and Impedance Measurements; Modulation; Fourier Waveform Analysis; Radar Fundamentals; Broadcasting; Servomechanisms; Maxwell's Equations. At its price and for its content, this book again becomes one of the best buys in technical publishing.—J.M.

Basic Television

BY BERNARD GROB. *McGraw-Hill Book Co., Inc., New York*, 1949, 596 *pages*, $5.00.

THERE HAS, for some time, been something lacking in the available television literature. For the engineer, information is plentiful; for the straight technician or serviceman, short-cut techniques and highly simplified texts have proved to be completely satisfactory. In "Basic Television," however, Grob has managed to present the entire field of television in a completely understandable and logical way which should appeal to the technician who is sincerely interested in what really goes on behind the picture tube.

Using a sequence formula which has become more or less standard to texts in the field, Grob takes the reader through the various phases of the science in a way that leaves little for the imagination. Nothing is assumed, except, as the author points out, the reader must have a knowledge of basic radio fundamentals. In other words, he should understand vacuum-tube the-

ory, and have a fairly good idea of how a standard superheterodyne receiver works.

The author is an instructor at the RCA Institutes, and his experience in teaching his subject has enabled him to strike a balance unobtainable elsewhere for the particular type of student for whom the book is intended. Where a phase of the subject is usually difficult for the average student to grasp, Grob goes into a little more detail, as he would in addressing a classroom of students whom he knows will be asking questions at the close of the session. The questions have been skillfully anticipated and answered in advance.

It is mildly questionable whether the chapter on video amplifier design should have been included, since at that point the material seems to splash dangerously into the engineering approach. The color television section is, of course, already outdated; but that is entirely understandable since, in these days, our last night's newspapers are seldom abreast of the latest developments in this rapidly-changing phase of the science.

Installation, maintenance and servicing sections are included. While comparatively brief, they are well planned and definitely not superfluous.—J. D. F.

The Mathematics of Circuit Analysis

BY E. A. GUILLEMIN, *Professor of Electrical Engineering, MIT. Published jointly by The Technology Press, Massachusetts Institute of Technology, Cambridge, Mass., and John Wiley & Sons, Inc., New York, N. Y.*, 1949, 590 *pages*, $7.50.

WRITTEN as collateral reading for undergraduates to use with previously published electrical texts by the EE Staff of MIT, the book describes the properties and manipulative techniques of several advanced branches of mathematics that are applicable to circuit analysis, especially in the field of communication.

The content is divided into seven chapters (page lengths given here are approximate): determinants (30 pages), matrices (40 pages), linear transformations (60 pages), quadratic forms (50 pages), vector

analysis (70 pages), functions of a complex variable (180 pages) and Fourier series and integrals (140 pages).

In the first half of the book the author thus presents (in review form to some extent) the usual mathematical tools that are ordinarily a part of communication engineers' underclass training; in the second half he presents (in a form of exposition and example) the two powerful methods of analysis on which recent advances are leaning so heavily. Each of these last two chapters are more complete than the treatments given these subjects in other general texts—practically books in themselves.

By way of orienting the treatment in this book among the several similar books we can compare it with Sokolnikoff "Applied Mathematics for Engineers and Scientists", which is less tutorial than the volume under review, and Reddick and Miller, "Advanced Mathematics for Engineers", which is less specialized. The treatment adhered to in the book under review will appeal to engineers because it is concerned with explaining the utility of the methods more than proving their validity.

The chapter on functions of complex variables occupies nearly a third of the book. Like Guillemin's two volumes on lumped- and distributed-constant networks, the presentation is comprehensive and clear. Topics are introduced when needed. For example, convergency of series, usually treated in such books in a separate chapter on series, is presented briefly before developing the series representations of complex functions. Thus, from a tutorial viewpoint the book is highly coherent. As a reference manual it may not be as useful as the less integrated treatments, but for serious study it is more satisfactory.

The approach in the chapter on complex variables is to build on the reader's familiarity with real variables in presenting their characteristics and relationships. The discussion leads up to their use in evaluating complex functions and in potential theory. The development of method continues to the Schwarz-Christoffel mapping function. The

discussion then turns to stability criteria and Hurwitz polynomials, using determinants (thus joining an earlier chapter to the treatment —one wonders if the first few chapters were incorporated to assure the reader of these background disciplines).

The chapter on Fourier series is equally complete. It begins with harmonic analysis, continues with the integral for treating transients directly, and concludes by relating the discussion to contour integrals. Problems at the ends of chapters offer exercises in demonstrating mastery of the techniques and in applying them.

The author's approach of using "plausibility arguments" instead of rigorous proofs will be appreciated by practicing engineers. Restrictions on the applicability of techniques, usually brought out by mathematicians in their derivations, are pointed out as parts of the developmental discussions. Thus, from the users' viewpoint, rigorous proofs would provide no additional information.

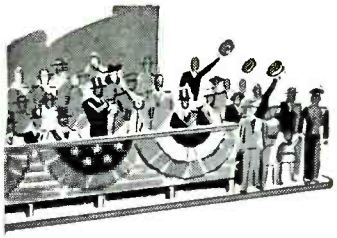
Although illustrative engineering examples are absent, the general treatment is sufficiently practical and the allusions to engineering situations to which the techniques apply are sufficiently frequent to lend concreteness to the abstractions.—F. H. ROCKETT, JR., *Airborne Instruments Laboratory, Mineola, N. Y.*

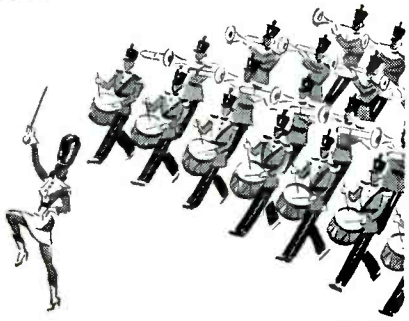
• • •

Books Received for Review

ELECTRICAL ENGINEERS' HANDBOOK: ELECTRIC POWER. Edited by Harold Pender and William A. Del Mar. John Wiley & Sons, Inc., New York. Fourth Edition, 1949, 2 inches thick, $8.50. Companion volume in power field to *Electric Communication and Electronics*, originally published in one volume as Pender's *Handbook for Electrical Engineers*. New fourth edition is entirely rewritten and contains work of 71 specialists in their respective fields. Increased emphasis is placed on circuit stability, electronic rectifiers, servomechanisms, permanent magnets, plastic insulating materials and induction and dielectric heating apparatus.

CONSTRUCTIVE USES OF ATOMIC ENERGY. Edited by S. C. Rothmann. Harper and Brothers, New York. 1949, 258 pages, $3.00. Based on published articles by various authors, each on some nonmilitary aspect of radioactivity and atomic energy. As an example, Chapter IV, Industrial Applications of Radioactivity, is based on an article by M. Blau and J. R. Carlin in the April 1948 issue of ELECTRONICS. Chapter VI, Chemical Process Control with Radioactivity, is from an article by Alan P. Schreiber in *Chemical Engineering* and is similar to an article by the same author, Radioisotopes for Industry, in Jan. 1949 ELECTRONICS.





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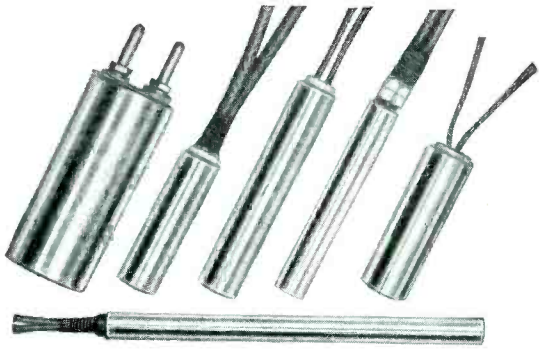

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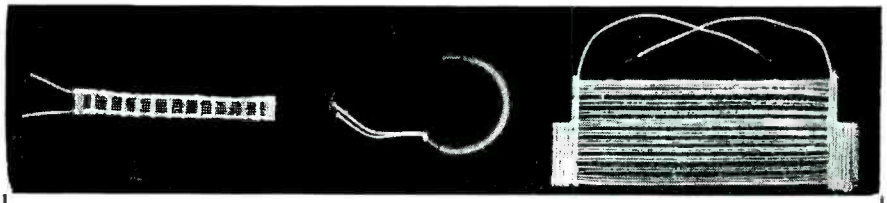

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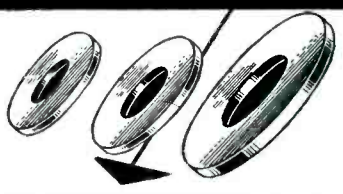

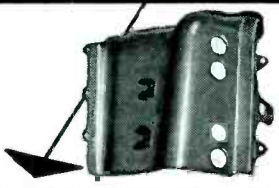

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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

GCA vs CPS-5

DEAR SIRS:

WE HERE AT GILFILLAN have read with interst the article entitled, "What We Learned from the Berlin Airlift" by Mike Chaffee and R. B. Corby in the August issue of ELECTRONICS. With understandable pride, Mike reports that CPS-5, which he helped install at Tempelhof, did an excellent job on the Berlin Airlift. It is true that CPS-5 was invaluable in controlling airlift traffic in the corridors. However, his statements that CPS-5 "assumed direction of the aircraft through an intricate and precise approach pattern", and that "the GCA search radar was not needed for airlift operations" are not only misleading, but contrary to the facts.

Briefly, the CPS-5 antenna has a rotation speed of around 10 rpm. Experience proved that this rotation speed was not sufficient to permit the controller to turn aircraft onto the final approach.

The claim made for CPS-5 is important since there is presently a great deal of discussion in aviation as to the rotation speed required for surveillance radar to handle effectively aircraft in the approach zone. CPS-5 tried and failed in this regard.

The article states that CPS-5 was installed at Tempelhof for operation in December, 1948. During that month, of the 2,796 instrument approaches and landings made by airlift traffic, all search patterns were made by GCA search, with CPS-5 scoring 0. In January 3,061 instrument approaches and landings were effected, all search patterns again being worked by GCA. During February, GCA search radar di-

rected 3,282 airlift planes, with CPS-5 working 707 search patterns, and these were mostly practice approaches during vfr weather. In March the score was GCA search 2,858, and CPS-5 539. In April it was GCA 2,594, CPS-5 only 304. During the final month of the blockade, official Air Force records show that GCA search accomplished 884 approaches, with CPS-5 again working 304 aircraft approaches.

At Tegel, the other U. S. operated air base, CPS-5 operated the search pattern less than 25 times during ifr conditions. On these occasions, the turn-ons accomplished by the CPS-5 controller were so unsatisfactory that the GCA final controller was forced to give dangerously large corrections to the pilot on final approach to enable him to land on the runway.

CPS-5 was extremely effective as a long range navigational aid to space aircraft along the corridor and over the Tempelhof range. Due to the fact that it uses a rotation speed of 8 to 10 rpm, a C-54 aircraft moves nearly ½ mile between sweeps, which does not enable the controller to make an accurate turn-on to final. The GCA with a rotation speed of 30 rpm gives more frequent position reports and enables the operator to give the pilot precise instructions for the critical turn-on to final.

Incidently, you might point out to your caption writer that his description of the antennas on the GCA trailer illustrated on page 78 indicates a lack of radio knowledge. "The three tall whip antennas" provide high-frequency information rather than vhf. The antennas described as "emergency radio antennas" are the primary vhf antennas and are used constantly. The "parabolic rotating search antenna", which the caption states was "not needed for airlift operations" was used during 5,050 hours of airlift operation and controlled 20,068 approaches around the Tempelhof traffic pattern during the blockade of the city of Berlin from June, 1948, to May 15, 1949.

The particular GCA unit shown in your excellent photographs was never intended for operational use. The unit shown is a pre-production

model known as CPN-4 XW2. This equipment was developed and produced by Gilfillan for Watson Laboratories, Air Materiel Command. It is air transportable; that is, it can be disassembled and loaded into two C-54's. It weighs approximately 7 tons instead of the 22 tons of the orignal GCA equipment. It has three completely independent final controller positions, permitting the talk-down of three aircraft simultaneously. A single aircraft can be located and talked down by one operator instead of by a five man crew as required in the MPN-1 GCA units.

Two years ago, the Air Force had a requirement for a GCA unit to be installed at Norman Wells, Canada, above the Arctic Circle. This equipment was to support the pilots on Operation Beetle, who needed a reliable navigation aid while supplying our bases in those uncharted Arctic wastes. It was impossible to reach Norman Wells except by air, and the 22 ton MPN-1 GCA unit was too much for a C-54. We therefore crossed our fingers and loaded the experimental unit into C-54's overnight, and flew this equipment to Norman Wells where it was assembled and operated in 50-degree below zero conditions. This unit proved to be an excellent morale builder for crews flying the Beetle chain.

When the Russians blockaded Berlin, another SOS was dispatched from General Tunner's headquarters for a GCA unit to be flown into Berlin to supplement the MPN-1 unit already there. The CPN-4 at Norman Wells was placed aboard C-54's again and flown halfway around the world to Berlin where it helped the USAF to accomplish the miracle known as Operation Vittles.

Lt. General James K. Cannon, Commanding General of U. S. Air Forces in Europe, on the occasion of the lifting of the blockade, reported to the Pentagon building, "It would not have been possible to have fed the 2½ million people in Berlin without the aid of GCA." Major General Robert Douglas, Chief of Staff of USAF, stated on the same occasion, "Ground Controlled Approach, known as GCA,

CONTACTS

FOR THE FIELD OF ELECTRONICS

deserves a major share of the credit for the success of the Berlin airlift."

LEONARD DAVID CALLAHAN
Director of Public Relations
Gilfillan Bros. Inc.
Los Angeles, Calif.

DEAR SIRS:

RELATIVE to the preceding letter, we would refer readers to two official government reports on the operation of the Berlin Airlift. They are: the U. S. Air Force Air Materiel Command Memorandum report MCREXD-694-23 titled "Human-Engineering Aspects of the Berlin Air Lift" prepared by the Aero Medical Laboratory; and a publication or report by Airways and Air Communication Service Headquarters 1807th AACS Wing titled "Berlin Airlift Air Traffic Control History."

M. A. CHAFFEE
Mineola, New York

Rediscovery

DEAR SIRS:

IT IS with more than casual interest that I read the excellent article on "What We Learned from the Berlin Airlift" in the August 1949 issue of ELECTRONICS. I make particular reference to the chapter on the incorporation of Moving Target Indication (MTI) in the CPS-5 radar unit at Berlin.

Credit for this development was given in the article jointly to MIT and Telecommunications Research Establishment. Actually as far back as early 1942, the undersigned drew up a report outlining these same principles. The report is now in the files of the Radio Material Office of the 12th Naval District, Mare Island, California, where at the time I was employed as an Assistant Radio Engineer. In those days we were not acquainted with the Plan Position Indicator and my application was considered for the "A" scope.

I sometimes wonder if dredging back into early wartime reports might not bring to light ideas which would not necessitate so much time and effort to re-discover.

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SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

ELECTRICAL ENGINEER BEE recent graduate radar repair—in army three years. Desires a start in design or development work in electronics anywhere in U. S. PW-1178, Electronics.

Positions Open for

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

Electronic Engineers

PROJECT ENGINEERS

Five or more years experience in the design and development, for production, of major components in radio and radar equipment.

ASSISTANT PROJECT ENGINEERS

Two or more years experience in the development, for production, of components in radio and radar equipment.

Well equipped laboratories in modern radio plant . . . Excellent opportunity . . . advancement on individual merit.

Baltimore Has Adequate Housing

Send resume to Mr. John Siena:

BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION
Baltimore 4, Maryland

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.

POSITIONS WANTED

ELECTRONICS ENGINEER — specializing in the study of Radio interference. 7 years experience in the measurement, suppression, and design of electrical items to meet government specifications. PW-1348, Electronics.

GOOD ELECTRONIC Engineer — Employed — desires change to small organization. Over seven years experience including servos, all types radar indicators and usual associated circuits. PW-1284, Electronics.

TRANSFORMER AND Coil engineer fully experienced on Television, Radio, Neon and magnetic units. State full details. PW-1346, Electronics.

PHYSICAL DOCTOR, acquainted electronic instruments, seeks occupation by important American Company. Write to Garnero Dante-Giuseppe Verdi 20-Turin (Italy).

RADIO ENGINEER, 30, single, desires position with opportunity in an applied engineering capacity: ass't to executive, technical representative, customer service, etc. Experienced in technical surveys, radio system design and operations, some sales; metal fabrication. Can travel. Relocate. Analytical; reliable. PW-1351, Electronics.

CONTRACT WORK WANTED

WE HAVE increased our capacity and can accept orders for Picture Tubes in 10"-12½" and 16". All guaranteed. CWW1399, Electronics ELECTRNICS—38099—DPT—12-49

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desires difficult work to make full use of capabilities in mathematics, electronics, mechanics, and general engineering ingenuity. B. Chem. E. with considerable training and 5½ years experience in electronics field—research, development, process plant operation and instrumentation, supervision, report writing. Under 30, family, complete resume on request to:

PW-1343, Electronics
330 West 42nd St., New York 18, N. Y.

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Provide an indexing or subject word.

Write it as the first word of your ad.

If it is a Position Wanted or Position Vacant ad, make the first word the kind of position sought or offered.

This will assure proper classification in the column.

The right is reserved to reject, revise or properly classify all Want Advertisements.

Proper Classification increases the possibility of Prompt Returns

Additional Positions Vacant Ads on opposite page

R. F. COMPONENTS—MICROWAVE—TEST EQUIPMENT

1.25 CENTIMETER

"K" BAND DIRECTIONAL COUPLER CU104/APS-34 20 DB.....$49.50 ea.
"K" BAND FEEDBACK TO PARABOLA HORN, with pressurized window.....$30.00
MITRED ELBOW cover to cover.....$4.00
TR/ATR SECTION choke to cover.....$4.00
FLEXIBLE SECTION 1" choke to choke....$5.00
ADAPTER, rd. cover to sq. cover.....$5.00
MITRED ELBOW and S sections choke to cover $4.50
WAVE GUIDE ½ x ¼ per ft.....$1.00
K BAND CIRCULAR FLANGES.....50c
3J31 K BAND MAGNETRON.....$55.00
K BAND MIXER SECTION.....$55.00

3 CENTIMETER

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

723 A/B Klystron mixer section with crystal mount, choke flange and Iris flange output.....$22.50
TR-ATR Section for above with 724 ATR Cavity $8.50
90 degree twist, 6 inches long.....$8.00
723 AB Mixer—Beacon Dual Oscillator Mount with crystal holder.....$12.00
2 Way Wave directional coupler, type N fitting 1⅛ x ⅝" guide 26DB.....$18.50
CG 98B/APG 13, 12" flexible section 1¼" x ⅝ OD.....$10.00
TR-ATR Section, APS 13, for 1B24, with 724 ATR Cavity with 1B24 and 724 tubes. Complete $21.00
Crystal mount in waveguide.....$17.50
SO3 ECHO BOX XMSN type cavity w/bellows $28.50
3 cm. 180° bend with pressurizing nipple.$6.00 ea.
3 cm. 90° bend, 14" long 90° twist with pressurizing nipple.....$6.00 ea.
3 cm. "S" curve 18" long.....$5.50 ea.
3 cm. "S" curve 6" long.....$3.50 ea.
3 cm. right angle bends. "E" plane 18" long cover to cover.....$6.50 ea.
3 cm. Cutler feed dipole. 11" from parabola mount to feed back.....$8.50 ea.
APS-31 mixer section for mounting two 2K25's Beacon, reference cavity 1B24 TR tube. New and complete with attenuating slugs.....$42.50 ea.
DUPLEXER SECTION for 1B24.....$10.00
CIRCULAR CHOKE FLANGES, solid brass. .55
SQ. FLANGES, FLAT BRASS.....ea. .55
FLEX. WAVEGUIDE.....$4.00/Ft.
TRANSITION 1 x ½ to 1¼ x ⅝, 14 in. L..$8.00
"X" BAND PREAMPLIFIER, consisting of 2-723 A/B local oscillator-beacon feeding waveguide and **TR/ATR** Duplexer sect. incl. 30 MC Pre Amp w/Tubes.....$57.50
Random Lengths wavegd, 6" to 18" Lg...$1.10/Ft.
WAVEGUIDE RUN, 1¼" x ½" guide, consisting of 4 ft. section with Rt. angle bend on one end 2" 45 deg. bend other end.....$8.00
12" SECTION 45 deg twist, 90 deg bend....$6.00
11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy Construction, silver plated. $4.50
15 DEG. BEND 10" choke to cover.....$4.50
5 FT. SECTIONS choke to cover. Silver Plated $10.00
18" FLEXIBLE SECTION.....$17.50
"E" and "H" PLANE BENDS.....$12.50
"X" BAND WAVEGUIDE 1¼" x ⅝" OD 1/16" wall Aluminum.....Per Foot $ .75
WAVEGUIDE 1" x ½" I.D.....Per Foot $1.50
TR CAVITY For 724 A TR Tube.....$3.50
3" FLEX SECT. sq. flange to Circ. Flange Adapt.....$7.50
724 TR TUBE (41 TR 1).....$2.50
SWR MEAS. SECTION, & L with 2 type "N" output probes MTD full wave apart. Bell size guide. Silver plated.....$10.00
WAVEGUIDE SECTION, 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend.$4.50
SLUG TUNER/ATTENUATOR, W. E. guide, gold plated.....$6.50
TWIST 90 deg. 5" choke to Cover w/press nipple.....$6.50
WAVEGUIDE SECTIONS 2½ ft. long silver plated with choke flange.....$5.75
ROTARY JOINT choke to choke.....$17.50
ROTARY JOINT choke to choke with deck mounting.....$17.50
3 cm. mitred elbow "E" plane unplated..$6.50 ea.

WAVEGUIDE

½" x ¼" ID.....$1.00 per foot
1" x ½" OD..... 1.50 per foot
⅝" x 1¼" OD..... 1.65 per foot
⅝" x 1 ¼" OD Aluminum..... .75 per foot
1½ " x 3" OD..... 3.00 per foot
2½" x 3" OD..... 3.50 per foot
1" x ½" OD Flexible..... 4.00 per foot
⅞" rigid coax ¼" IC..... 1.20 per foot
(Available in 10 ft. to 15 ft. lengths or smaller.)
UG 65/U 10CM flanges.....$6.75 each
UG 53/U Cover..... 4.00 each
UG 54/U Choke..... 4.50 each

3CM WAVEMETER Coverage 9000-9500 Mcs w/ Calib. Chart Absorb. Type w/Circ. Flange or XMSN. Type w/Sq. Flanges. New.....$75.00

MODEL TS-268/U

Test set designed to provide a means of rapid checking of crystal diodes IN21, IN21A, IN21B, IN23, IN23A, IN23B. Operates on 1½ volt dry cell battery. 3x6x7.

New..... **$35.00**

CRYSTAL DIODES

No.	Each	2 for	10 for
IN21	$1.00	$1.79	$ 8.30
IN22	1.50	2.79	14.00
IN23	1.50	2.79	14.00
IN26	3.00	5.90	27.50

SL WAVEMETER Type Cw60ABM.....$125.00
10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS, direct reading micrometer head. Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10 CM Directional Coupler.....$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
10 cm. cavity type wavemeters 6" deep, 6¼" in diameter. Coax output. Silver plated $64.50 ea.
10 Cm. echo box part of SF radar w/115 volt DC tuning Motor sub sig 1148A.....$47.50
THERMISTER BRIDGE: Power meter I-203-A, 10cm. mfg. W.E. Complete with meter, interpolation chart, portable carrying case.....$72.50
W.E. 1 138. Signal generator, 2700 to 2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter, 115 VAC input reg. Pwr. supply. With circuit diagram.....$75.00
3 cm. stabilizer cavity, transmission type...$20.00
3 CM. HORN AT-48/UP model 710. Type "N" input Hvy. silver plated.....$6.50
AT-68/UP 3 CM Horn with type N fitting...$5.00
TS-89/AP Voltage Divider: Ranges 100; ½ for 200 to 20000V 10; 1 for 200 to 2000v. Input Z 2000 ohm, output Z 4 meg. flat response 150-5 meg. cys. $42.50
10 CM WAVEMETER WE type B-435490 Transmission type. N fittings. Veeder root mic. dial gold plated w/calib chart. P/O WE Freq mtr X66404A New $99.50

R. F. EQUIPMENT

LHTR. LIGHTHOUSE ASSEMBLY, Part of RT-30/APG-5 & APG 15. Receiver and Transmitter Lighthouse Cavities with assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27, Tuneable 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. revr. front end $210.00
Beacon lighthouse cavity 10 cm with miniature 28 volt DC FM motor, Mfg. Bernard Rice $47.50 ea.
T-128-/APN-19 10 cm. radar Beacon transmitter package, used, less tubes.....$59.50 ea.
SO-3 "X" band 3 cm RF package, new complete, including receiver unit as illustrated on Page 337, Volume 23 RAD LAB Series....$375.00 ea.
Pre-Amplifier cavities type "M" 7410590GL, to use 446A lighthouse tube. Completely tunable. Heavy silver plated construction.....$37.50 ea.
RT32/APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR 723 A/B local osc. and beacon mount, pre amplifier. Used but exc. cond.....$97.50
AN/APS-15A "X" Band compl. RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc. & beacon) 1B24, TR, revr ampl. duplexer, HV supply blower, pulse xfmr. Peak Pwr Out: 45 KW apx, Input: 115, 400 cy. Modulator pulse duration .5-2 microsc., apx. 13KV, PK, Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg. $210.00
S BAND AN/APS2. Complete RF head and modulator, including magnetron and magnet, 417A mixer, TR receiver duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00
10 CM RF Package. Consists of: SO Xmtr. receiver using 2—27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer.....$150.00
ASR-500 Megacycles Radar Receiver with two G1 446 lighthouse cavities, new less tubes....$37.50

Rated Concerns Send P.O.

10 CENTIMETER

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED, BROAD BAND. .$37.50 EACH
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABY-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
Crystal Mixer with tunable output TR pick up loop, Type "N" connectors. Type 62ABH.....$14.50
Slotted line probe. Probe depth adjustable, Sperry connector, type CPR-14AAO.....$9.50
Coaxial slotted section, ⅞" rigid coax with carriage and probe.....$25.00
Right Angle Bend 6" radius E or H plain..$15.00
Right Angle Bend 3" radius E or H plain—Circular flanges $15.00
AN/APR5A 10 cm antenna equipment consisting of two 10 CM waveguide sections, each polarized, 45 degrees.....$75.00 per set
APN-7 McNally Cavity for 707B, with tuning slugs .....$5.50 each
"S" BAND XTAL MOUNT, gold plated, with 2 type "N" connectors.....$12.50
PICKUP LOOP, Type "N" Output.....$2.75
TR BOX Pick-up Loop.....$1.25
POWER SPLITTER: 726 Klystron input dual "N" output $5.00
MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated.....$27.50
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. CRP 24AAS. New and complete. .$150.00
"S" BAND Mixer Assembly, with crystal mount, pick-up loop, tunable output.....$3.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50
10 CM. McNALLY CAVITY Type SG.....$3.50
WAVEGUIDE SECTION MC 445A Rt. Angle bend, 5¼ ft. OA. 8" slotted section.....$21.00
10 CM OSC. PICKUP LOOP, with male Homedell output $2.00
10 CM DIPOLE WITH REFLECTOR in lucite ball, with type "N" or Sperry fittings.....$4.50.
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
PHASE SHIFTER. 10 CM WAVEGUIDE, WE TYPE ES-683816. E PLANE TO H PLANE MATCHING SLUGS. MARK & RADAR..$95.00
721A TR cavities. Heavy silver plated....$2.00 ea.
10 cm. horn and rotating joint assembly, gold plated .....$65.00 ea.

⅞" RIGID COAX.—⅜" I.C.

⅞" **rigid coaxial tuning stubs** with vernier stub adjustment. Gold Plated.....$17.50
⅞" **RIGID COAX ROTARY JOINT.** Pressurized. Sperry #810613. Gold Plated.....$27.50
Dipole assembly. Part of SCR-584.....$25.00 ea.
Rotary joint. Part of SCR-584.....$35.00 ea.
RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00
RIGID COAX to flex coax connector.....$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length.....$5.00
RT. ANGLES for above.....$2.50
RT. ANGLE BEND 15" L. OA.....$3.50
FLEXIBLE SECTION: 15" L. Male to female $4.25
MAGNETRON COUPLINGS to ⅞" rigid coax, with TR pickup loop, gold plated.....$7.50
FLEX COAX SECT. Approx. 30 ft.....$16.50

⅞" RIGID ¼ "I.C."

CG 54/U—4 foot flexible section ¼" IC pressurized $15.00
⅞" **RIGID COAX.** Bead Supported per ft.....$1.20
SHORT RIGHT ANGLE BEND.....$2.50
Rotating joint, with deck mounting.....$15.00
RIGID COAX slotted section CU-60/AP.....$5.00

MISCELLANEOUS

Type "N" patching cord UG11/U female to UG9/U using RG5/U cable 12" long...$2.25 ea.
AN/TPS-1B flanged nipple and insert assembly for rotary coupling.....$3.75 ea.
Pulse connector Navy type 49579.....$1.50 ea.
Transmission line pressure gauge, 2" 15 lbs. $1.85 ea.
Pulse cable assembly Western Electric type D163262, 10 feet long.....$4.50 ea.
Holmdell Jack Western Electric BO-12962-1 D. B. #J-102X .....$3.75 ea.
Adapter type "N" RG8/U to RG17/U or 18/U cable .....$4.50 ea.
ADAPTER TYPE "N" TO RG-7i/U CONNECTOR $5.50
F-29/SPR-2 HIGH PASS FILTER P/O A&/APR-SAX, TYPE "N" CONNECTORS...$12.50
Magnetron coupling to ⅝ rigid coax.....$5.00 ea.
MAGNETRON COUPLING 1⅞" to 10 CM Waveguide $84.50

200 MC COAXIAL PLUMBING

Right Angle Bend.....$35.00
T Section $55.00
T Section with Adapter to ⅞" in rigid coax.$65.00

MAGNETRONS – RADAR – PULSE EQUIPMENT

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: 001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715B, 4-829-B, 3-'72's, 1-'73. New $110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Emergy 0.018 Joules.....$49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk); pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes.....$49.50

APS-10 MODULATOR DECK. Complete, less tubes $75.00

BC 1203B Loran pulse modulator.....$125.00

BC 758A Pulse modulator.....$395.00

APS-10 Low voltage power supply less tubes..$18.50

725A magnetron pulse transformers.....$18.50 ea.

DELAY LINES

D-168184: .5 microsec, up to 2000 PPS, 1800 ohm term $4.00

D-170499: .25/.50/.75/, microsec, 8 KV, 50 ohms imp. $16.50

D-165997: 1¼ microsec.....$7.50

WILCOX CS390 CONTROL EQUIPMENT

FOR AIRPORT CONTROL GROUND STATION—Standard relay rack housing, monitor loud speaker, dual channel receiver amplifier. Type 109 A control panel, microphone speech amplifier, etc., spare parts, new and complete .....$750.00 each

Lord #1	#10¢		Lord	#8	20¢
Lord #6	10¢	H	Lord	#35	45¢
Lord #5	10¢	O	Lord	#20	39¢
Lord #15	15¢	C	Lord	#25	45¢
Lord #12	15¢	K	Henrite	#55	49¢
Lord #35	18¢		Lord	#15	35¢
U. S. #5150-C	55¢	M	Barry	#C2070	55¢
Lord #4	35¢	T	Barry	#C2060	55¢
Lord #1	14¢	S	Barry	#C2090H	55¢
Lord #10	25¢				

TELEPHONE EQUIPMENT

F.T. & R. 101-A APPLIQUE

Provides necessary balancing facilities for four wire repeater when used on two wire lines which may be voice-frequency telephone lines of open wire, or non-loaded or loaded cable. Std. 19" channel iron rack mtg. Price, new, complete with tech manual $54.00

400 CYCLE TRANSFORMERS

352-7273: Pri.: 115V, 400 cy. Sect. 6.3V, 2.5 Amp 6.3V, .06 Amp; 6.3V .9 Amp; 5V, 6 amp; 700 VCT. 2-5U4's. For APS-15. T201.....$4.75

352-7176: Pri: 115V, 400 cy. Sec: 6.3V, 20 Amp; 6.3V, .5 Amp; 6.3V, .5 Amp; 320V (2-6x5's) For APS-15. T202 .....$5.25

352-7278: Pri: 115V, 400 cy. Sec: 2.5V, 1.75 Amp. 3500V (2x2). For APS-15. T203 (Anode #2). 5FP7 .....$5.85

352-7070: Pri: 118V, 440 cy. Sec. 2.5V, 2.5 Amp; 2.5V, 2.5 Amp; (2000V, Ins.): 6.3V, 2.25 Amp; 1200V, Tpd at 1000 and 750V, P/O AN/APS 15 .....$4.95

#7469105: Pri: 115V, 400 cy. Sec.: Tpd. to give 742.5V, 50 MA; 709V, .0477 A, 671V, .045 A $2.95

M-747319: Pri: 115V, 400 cy. Sec: 6.3V, 2.7 Amp; 6.3V, 66 Amp; 6.3V, 21 Amp.....$2.95

32332: Pri: 115V, 400-2400 cy. Sec. 400 Vct. 35 MA; 6.4V, 2.5 Amp; 6.4V, 15 Amp.....$2.25

332-7138M: Pri: 115V, 400-2400 cy Sec: 640 V, .5 MA; 2.5V, 1.75 Amp.....$3.85

352-7179: Pri.: 115V, 400-2400 cy. Sec: 6.5V, 12 Amp. Ct, 250V, 100 MA; 5V, 2 Amp.....$3.50

#9069: Pri: 115/80V, 400-2600 cy. Sec: 650 Vct. 50 MA; 6.3 Vct, 2 Amp; 5 Vct, 2 Amp.....$2.45
1.75 Amp, 3 Kv. Ins.; 5V, 3 Amp, 6.5V, 6.5 Amp; 6.3V, 2A; 6.3V 1A. P/O/AN/APQ5.....$5.85

KS 9007: Pri: 115V, 400-2400 cy. Sec: 734 Vct. 177 MA: 1710 Vct, 177 MA.....$5.95

D-160333: Pri: 115V, 400-2400 cy. Sec: 6.3V, 0.9 Amp. 7.7V, 0.365 Amp.....$2.79

G.E. #7471957: Pri: 100/110/120/130V, 400-2400 cy. Sec. 2.5V, 20 Amp. HV ins.....$4.85

D-163254: Pri: 115V, 400 cy. Sec: 6.3V, 12 Amp; 6.3V, 2A; 6.3V 1A. P/O/AN/APQ5.....$5.85

KS-9685: Pri: 115V, 400-2400 cy. Sec: 6.4 Vct, 7.5 Amp; 6.4V, 3.8 Amp; 6.4V, 2.5 Amp.....$4.35

THERMISTORS

D-167332 (tube)	$.95
D-170396 (bead)	$.95
D-167613 (button)	$.95
D-164600 for MTG in "X" band Guide.	$2.50
D-167018 (tube)	$.95

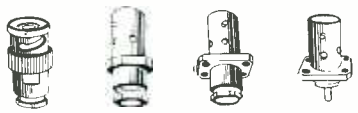
VARISTORS

D-170225	$1.25
D-167176	$.95
D-168687	$.95
D-171812	$.95
D-171528	$.95
D-168549	$.95
D-162482	$3.00
D-163298	$1.25
D-99428	$2.00
D-16187A	$2.85
D-171121	$.95
3A(12-43)	$1.50
D-167020	$3.00
D165593	$2.25

WRITE FOR C.E.C. MICRO-WAVE CATALOG NOW AVAILABLE

3 CM RECEIVER

SO-3 Complete with W.G. Mixer Assy (723 A/B) Reg Fil. Power Supply, 6 Stages IF (6AC7) $99.50



UG TYPE CONNECTORS

AN No.	Price ea.
UG 9U	$ .95
UG10/U	1.56
UG11/U	1.45
UG12/U	.95
UG13/U	1.56
UG14/U	1.45
UG15/U	.95
UG16/U	1.56
UG17/U	1.45
UG18/U	.99
UG18/AU	1.05
UG19/U	1.28
UG19AU	1.38
UG19BU	1.45
UG20/U	1.17
UG20/AU	1.26
UG20BU	1.41
UG21/U	.99
UG21AU	1.05
UG21BU	1.00
UG22/U	1.08
UG22AU	1.38
UG22BU	1.34
UG23/U	.99
T23AU	1.26
UG23BU	1.20
UG27AU	2.25
UG28/U	2.34
UG29/U	1.22
UG29AU	1.56
UG30/U	1.75
UG32/U	20.00
UG33/U	20.00
UG34/U	17.50
UG35AU	16.00
UG36/U	16.00
UG37/U	16.00
UG37AU	16.00
UG57/U	2.25
UG58/U	.65
UG59/U	2.75
UG59AU	1.70
UG60/U	1.90
UG60/AU	1.30
UG61/U	2.05
UG61AU	1.80
UG62/U	28.00
UG83/U	1.50
UG85/U	1.65
UG86/U	1.69
UG87/U	1.40
UG88/U	1.17
UG89/U	.95
UG90/U	1.05
UG91/U	1.25
UG91/AU	1.05
UG92/U	1.10
UG92AU	1.35
UG93/U	1.25
UG93AU	1.45
UG94/U	1.25
UG94AU	1.05
UG95/U	1.10
UG95AU	1.35
UG96/U	1.25

AN No.	Price ea.
UG96AU	$1.45
UG97/U	3.50
UG98/U	1.55
UG100/U	2.34
UG101/U	2.95
UG107/U	2.25
UG108/U	1.75
UG109/U	1.75
UG114/U	1.50
UG115/U	1.33
UG123/U	.45
UG131/U	6.00
UG146/U	2.25
UG154/U	5.35
UG156/U	4.25
UG157/U	4.25
UG160/U	1.90
UG160AU	1.55
UG167 U	2.49
UG173 U	.30
UG174/U	16.00
UG188 U	.95
UG195/U	.75
UG197 U	5.00
UG201 U	2.30
UG202/U	2.75
UG204/U	2.25
UG206 U	1.02
UG212 U	4.50
UG213 U	4.50
UG215 U	3.35
UG216 U	8.70
UG217/U	3.10
UG218/U	6.50
UG222/U	35.00
UG231/U	2.00
UG235/U	28.50
UG236/U	11.75
UG241/U	2.20
UG242/U	2.50
UG243/U	2.75
UG244/U	2.50
UG245/U	1.25
UG246/U	1.45
UG252 U	4.50
UG254/U	1.70
UG255/U	1.85
UG259/U	4.10
UG260 U	.99
UG261/U	.95
UG262 U	1.05
UG269/U	2.60
UG270/U	6.50
UG273/U	1.50
UG274/U	1.98
UG279 U	2.40
UG287/U	5.25
UG290 U	.85
UG291 U	1.05
UG306 U	2.03
UG333/U	4.70
UG334/U	5.75
UG342 U	3.95
UG352 U	6.00

"UHF" COAXIAL CABLE CONNECTORS

No.	AN No.	Description	Price
83-1SPN	PL259	Plug	.35
83-1AP	M359A	Angle adapter	.35
83-1R	SO239	Receptacle	.35

COAX CABLE

RG 9/U 52 ohms.....$.24/Ft.

RG 57/U. Twin Cond. 95 ohms.....$.55/Ft.

RG 18/U. 52 ohm im. armored .....$.51/Ft.

RG 23/U. twin coax. 125 ohm imp. armored .....$.50/Ft.

RG 28/U. 50 ohm imp. imp. pulse cable. Corona min. starting voltage 17 KV.....$.50/Ft.

SUPER SONICS

QCU Magneto striction head RCA type CR 278225—New $75.00

Stainless Steel streamlining housings for above $18.50

QBG Driver Amplifier. New.....$200.00

QCU Magneto striction head, coil plate assembly, new $14.50

QCQ—2/QCB Magneto striction head coil plate assembly $14.50

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT, 1 microsec., 400 PPS, 50 ohms imp.....$42.50

G.E. #6E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance $6.50

G.E. #3E (3-84-810: 8-2-24-405) 50P4T: 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections, .84 Microsec, 810 PPS, 50 ohms imp; Unit 2, 8 Sections, 2.24 Microsec, 405 PPS, 50 ohms imp.$6.50

7.5E3-1-200-67P, 7.5 KV, "E" Circuit, 1 microsec, 200 PPS, 67 ohms impedance, 3 sections...$7.50

7.5E4-16-60-67P, 7.5 KV, "E" Circuit, 4 sections, 16 microsec, 60 PPS, 67 ohms impedance..$15.00

7.5E3-3-200-67PT 7.5 KV, "E" Circuit, 3 microsec, 200 PPS, 67 ohms imp., 3 sections.....$12.50

D171950 .....$9.50

PULSE TRANSFORMERS

G.E.K.-2745 .....$39.50

G.E.K.-2744-A, 115 KV high Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 micro sec. or ¼ microsec. @ 600 PPS.....$39.50

W.E. #D166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc, 2 sections parallel connected, potted in oil.....$36.00

W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core.....$6.00

G.E. #K2731 Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp. 450 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV PK. Peak Output: 800 KW Riflar 2.75 Amp. $64.50

W.E. #D169271 Hi Volt input pulse Transformer $27.50

G.E. K2450A. Will receive 13KV, 4 micro-second pulse on pri. secondary deliveries 14KV. Peak Power out 100KW G.E.....$14.50

G.E. #2748A Pulse Input, line to magnetron $36.00

#9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1"8" 19/32.....$1.50

Raytheon U X 8093 3x32 Turns T.V. 1000 RMS $4.95

G.E. 9318 Pulse Xfmr 1:1:1.....$1.50

UX 1350 .....$5.95

Pulse 132-AWP-L421435 .....$6.00

Pulse 134-BW-2F-L440895 .....$2.25

MAGNETRONS

QK 61 2975-3200 mc. $65.00

QK 60 2800-3025 mc. $65.00

QK 62 3150-3375 mc. $65.00

QK 59 2675-2900 mc. $65.00

QK 915 Raytheon. $150.00 Write for Your Needs

Fil. Trans. for above 115V/60 cy Pri: four 6.3V/4A Sec: 5000VT $27.50

Magnetron Kit of four QK's 2675-3375 mc. w/trans special $250.00

Tube	Freq. Range	Pk. Pwr. Out	
2J31	2820–2860 mc.	265 KW.	
2J21-A	9345–9405 mc.	50 KW.	
2J22	3267–3333 mc.	265 KW.	Brand
2J26	2992–3019 mc.	275 KW.	
2J27	2955–2992 mc.	275 KW.	
2J32	2780–2820 mc.	285 KW.	New
2J34	2700–2740	285 KW.	
2J37			Orig.
2J38 Pkg.	3249–3263 mc.	5 KW.	
2J39 Pkg.	3267–3333 mc.	87 KW.	Pack
2J40	9305–9325 mc.	10 KW.	
2J49	9000–9160 mc.	58 KW.	
2J61	3000–3100 mc.	35 KW.	
2J62	2914–3010 mc.	35 KW.	
3J31	24,000 mc.	50 KW.	
5J30			Fully
714AY, A			
718DY	2720–2890	250	Gtd.
720BY	2800 mc.	1000 KW.	
720CY	2860	1000 KW.	
725-A	9345–9405 mc.	50 KW.	Good
730-A	9345–9405 mc.	50 KW.	
728-AY, BY, CY, DY, EY, FY, GY			
700-A, B, C, D	680–710	50 KW.	
706-AY, BY, DY, EY, FY, GY			

Klystrons: 723A/B 707B W/Cavity 417A 2K41

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	3/4 in.	5 8 in.	$12.50
4200	21/32 in.	3 4 in.	$17.50
1300	1 5/8 in.	1 5/16 in.	$12.50
1860	1 5/8 in.	1 1/2 in.	$14.50

Electromagnets for magnetrons 700A $24.50 ea.

GE Magnet type M7765115. GI distance between pole faces variable from 2 1/16" (1900 gause) to 1 1/2" (2200 gause). Pole dia. 1 5/8 P/o SCR 584. New $34.50

MARINE RADAR

SO-1 AND SO-8 RADAR SETS. Complete, in Used but Excellent Condition. 10 CM Surface Search using 2J26 or 2J27 Magnetron, 707 Mixer, PPI Indicator. Input 115VDC. Used on Merchant Ships throughout the world. FCC Approved. Guaranteed. $1250.00.

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.

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.**

WESTON FREQUENCY METER

Model 637, 350-450 cycle, 115 V.
Price $10.00 each net.

WESTON VOLTMETER

Model 833, 0 to 130 V. 400 cycle.
Price $4.00 each net.

VIBRATOR

Rauland Corp. vibrator non-synchros type Stock No. 3H6694-11; 6, 12 or 24 V.D.C., input frequency 200 cycle.
$3.50 each net.

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle
Price $5.50 each net.

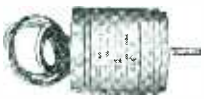
AY14D, 26 V., 400 cycle, new with calibration curve.
Price $15.00 each net.

AY20, 26 V., 400 cycle.
Price $7.50 each net.

AY31, 26 V., 400 cycle. Shaft extends from both ends.
Price $10.00 ea. net.

AY38, 26 V., 400 cycle. Shaft extends from both ends. **Price $10.00 each net.**

PIONEER 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 $30.00 each net.

Type 12604-3-A.
Price $30.00 each net.
Type 12606-1-A. Price $40.00 each net.
Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor.
Price $8.50 each net.

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle.
Price $17.50 each net with tubes.

Type 12077-1-A, single tube Amplifier, outosyn input, 115 V., 400 cycle.
Price $49.50 each net, with tube.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 67000 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m.
Price $12.00 each net.

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase.
Price $14.00 each net.

Weston Tachometer Generator, (aircraft type) model 752-J4 single phase. A.C. output. **Price $17.50 each net.**

SINE-COSINE GENERATORS

(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle.
Price $20.00 each net.

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage.

Price $15.00 each net.

7G Generator, 115 V., 60 cycle.
Price $30.00 each net.

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle.
Price $3.25 each net.

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle.
Price $4.50 each net.

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 each net.**

5SF Repeater, 115/90 V., 400 cycle.
Price $19.00 each net.

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $15.30 each net.**

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HEART OF THE BC-221 FREQ. METER

This VFO Sub-Assembly, used in BC-221 Freq. Meter, is ideally suited for home construction of:

1—Amateur V.F.O.
2—Freq. Mtr. Foundation
3—Portable Transmitter
4—Replacement for BC-221

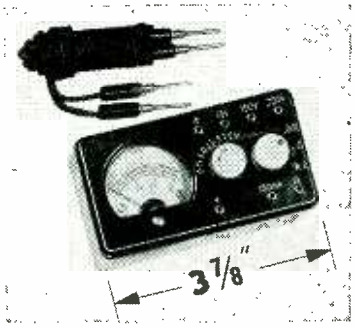
Unit contains two temperature & moisture compensating coils, wafer switch, 3 variable condensers, carbon resistors, & silver mica condensers. FULLY WIRED & mounted on sturdy aluminum sub-chassis, ready for installation. Brand new—in original packing. N-276.

Very special **$6.95**

LORD NO. 1 SHOCK MOUNTS

1½" sq. live rubber shock mounts, in drilled metal flange. Holds 50 lbs. eliminates shock and vibration. Ideal for transmitters, receivers, light experimental equipment. N-277. Your Cost ..... **$.06**
4 for 20¢

TINIEST V.O.M. in the World!

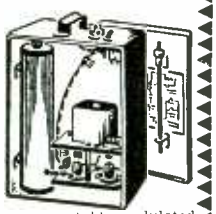


NIAGARA **exclusively** presents the "Universal Baby Tester" measuring 3-7/8" x 2-1/8" x 1-5/16" ! ! ! Contains a sensitive 0-240 microameter with the following ranges. (2400 Ohms-per-Volt Sens.)

- 0- 15V AC or DC
- 0-150V AC or DC
- 0-750V AC or DC
- 0-150 DC MA.
- 0-100,000 ohms

Ohms adjust and DC-AC-OHM switch. Includes 1 pair test leads. Will fit into your watch pocket. Fully guaranteed.
Cat. No. N-258
Special **$8.95**

NIAGARA'S GOLD-PLATED SPECIAL



An ultra-high freq. Gold-plated Cavity Resonator with a range of 234-248 Mcs! Fully wired, including two 955 acorn tubes. Designed by the navy for use as a portable modulated test oscillator. CAN BE USED AS A MODULATED SIGNAL GENERATOR. Battery compartment is large enough to house speech equipment, and power supply, making it a desirable portable UHF Transmitter for Ham use. Complete with tuning wrench, tubes, whip antenna, and circuit diagram on inside cover. Black wrinkle finished cabinet measures 9½ x 6½ x 6¾".

The Buy of a Lifetime!
Cat. No. N-257 SPECIAL..... ... **$3.95**

BARGAINS IN NEW METERS

N-197 2" Rd. G. E. 0-10 D.C. Amps.....$1.96
N-198 3" Rd. G. E. 0-10 D.C. Amps (Adap. Flanged) 2.25
N-200 3" Rd. Asst'd brands 0-4 KV. D.C. * 1.96
N-231 2" Rd. Asst'd brands 0-1 R.F. Amps..... 1.96
N-232 4" Rd. W.F. 50-0-50 Yds. per sec. (0-1 ma.) 2.95
N-233 3" Rd. G. E. 0-30 KV. D.C.....2.65
N-234 3" Rd. —6 to +100 DB. (0-1 ma. basic), illum. 4.95
N-235 3" Rd. McClintock 0-2.5 R.F. Amps..... 1.96
N-236 3" Rd. McClintock 0-1 Ma. D.C..... 3.45
*N-230 Shunt available at $1.00 each

TRANSFORMERS

POWER TRANSFORMERS
ALL 117V. 60 CYCLE PRI.

T-47177	40VDC @ 250 ma. 5V. @ 3A. 1600 V. ins. herm. sealed	$2.49
SP-105	725–0–725V. @ 60. ma., 5V. @ 3A. 6.3V. @ 1.2A.	2.95
511-T2	350V. C.T. @ 150 ma., 6.3V. @ 6A. herm. sealed	2.10
475-T301	245–0–245 @ 70 ma., 6.3V. @ 6.2A., 1600V. ins. herm. sealed	2.75
466-T1R	110–0–110 @ 225 ma. 5V. @ 3A. herm. sealed	3.25
PC-110	600V.C.T. @ 125 ma. 6.3V. @ 3.8A. 5V. @ 3A. 1600V. ins. herm. sealed	2.85

PLATE TRANSFORMERS

T-47168	540–0–540V. @ 650 ma. Herm. sealed	9.95
475-T302	2350–0–2350V. @ 300 ma.	23.50
69125	2100V.C.T. @ 500 ma.	17.95

FILAMENT TRANSFORMERS

T-47164	6.4V. @ 8A. 1600V. Ins. herm. sealed	2.49
T-47167	5V. @ 9A. 3500V. ins. herm. sealed	2.75
SP-100	24V. @ 10A.	4.95
D-161917	6.3V. @ 3A., 2.5V. @ 2A., herm. sealed	1.95
510-T4	6.4V. @ 10A., 6.3V. @ 5A., 1200V. Ins. herm. sealed	2.95
475-T201	5V. C.T. @ 15A., 1600V. ins. herm. sealed	2.75

CHOKES - REACTORS

	Cap.	Current	Res.	Insul.	
L-143	1.72	4A.		10,000V.	$6.95
L-554	20	125ma.	300		*4.95
475-CH301	3.8	75 ma.	160	1600V.	*4.15
475-CH302	10	300ma.	100	7500V.	*5.25
14010	15	200ma.	150	2000V.	*5.25
15406	12	225ma.	200		*5.25
S-16886	2.5–24	50/400ma.	53	10,000V.	8.95
S-16885	.875	400ma.	45	10,000V.	8.95
RC-72	15	125ma.	250	1,600V.	*2.15
T-46256	12	275ma.		10,000V.	*5.25
L-218	45	90			2.75
T-46256A	12	210ma.			5.25

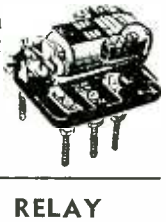
*Herm Sealed

SELENIUM RECTIFIERS

No.	Volts In	Volts Out	Current	Price
N-241	18	14	2 Amps.	$2.49
N-242	18	14	200 Ma.	.89
N-243	10	8	200 Ma.	.89
N-244	25*	117	100 Ma.	.65

*Half wave.
All others, all wave.

WHEELOCK SPDT RELAY



A fine, sturdy, well constructed 110 V. 60 Cy. AC SPDT relay, built to rigid Government Standards. Contacts rated at 5 Amps. Excellent as plate or antenna relay. Extra long mounting screws. Brand new in original packing.
Cat. No. N-181
YOUR COST **$1.45**

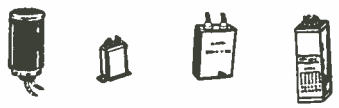
SPST 6 V.D.C. RELAY

Completely encased in compact round can 6 V.D.C. field, SPST contacts will take up to 50 amps.
Cat. No. N-120
YOUR COST ..... **$ .98**

OVERLOAD RELAY

Westinghouse overload relay. Adjustable from 250 m.a. to 1 amp. D.C. Manual reset, heavy construction, coil and contacts fully enclosed in ¼" glass shield. WORTH PLENTY.
Cat. No. N-122
YOUR COST **$12.95**

CONDENSERS



Cat. No.	Cap.	Voltage	Each
N-146	500	12	$ .59
N-147	1000–1000	15	1.95
N-148	1000	25	.98
N-149	6x.3	600	.89
N-150.....	4	450	.79
	8	300	
N-151.....	16–16	150	.49
	10	25	
N-152	3x.25	600	.71
N-153	.1	3500	.98
N-154	2x.6	25	.98
N-155	2	330AC	.69
N-156	1	440AC	.69
N-157	2	440AC	.69
N-158	4	400	.95
N-159	.1	7500	3.95
N-160	2	600	.89
N-161	1	1000	1.19
N-175	4	600	.95
N-162	6	600	.98
N-163	.25	4000	3.95
N-164	6	330AC	.75
N-165	2–4–8	400	.59
N-166	10	400	.98
N-167	2	1000	.98
N-168	4	1000	1.95
N-169	4	1500	2.10
N-170	6	1500	2.89
N-171	1	2500	2.25
N-172	.5	3000	1.75
N-173	1	3500	2.25
N-174	.2	5000	2.95

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Type	Price	Type	Price	Type	Type	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
1B22	$4.95	9JP1	7.95	725A	9.95	1P53	1.06	VU111	1.19	6A3	1.28	6SN7GT	.88	14A7/12B7	.88
1B23	9.50	9LP7	15.00	726A/B/C	23.50	1960	.95	WL460	14.95	6A6	1.06	6SQ7	.60	14AF7/XXD	.88
1B24	4.95	9NP1	7.95	728GY	24.95	2050	1.19	WL468	14.95	6A7	.80	6SQ7GT	.60	14B6	.88
1B25A	4.95	10Y	.69	730A	24.95	2051	.98	WL532A	4.95	6A8	.80	6SR7	.72	14B8	.88
1B26	7.95	10SPEC	.69	750TL	49.50	5514	4.95	WL562	150.00	6A8GT	.80	6SR7GT	.72	14C5	.88
1B27	4.95	10BP4	24.50	800	2.25	5516	5.95	WL616	105.00	6AB5/6N5	.88	6SS7	.66	14C7	.88
1B29	.89	10CP4	29.50	801A	.98	5562	10.00	Z225	1.95	6AB7/1853	1.06	6ST7	.88	14E6	.72
1B32	4.95	12DP7	14.95	802	4.25	7193	.39	ZB120	6.95	6AC5GT	1.16	6SV7	.88	14F7	.88
1B38	49.50	12DP8	14.95	803	8.95	8005	4.95	ZB3200	150.00	6AC7/1852	1.16	6T7G	1.24	14F7	.88
1B40	4.95	12FP7	14.95	804	12.95	8011	2.95	ZP477/12DP	14.95	6AD7G	1.28	6V5 6G5	.72	14F8	1.06
1B59	12.95	12GP7	14.95	805	5.95	8012A	4.95	0A2	1.69	6AF6G	1.25	6U6GT	.72	14H7	.88
1B60	4.95	12HP7	14.95	807	1.25	8013A	2.95	0A3/VR75	.98	6AG5	1.06	6U7G	.72	14J7	1.06
1N21	1.00	12KP4	49.50	808	1.89	8014A	24.95	0A4G	1.06	6AG7	1.28	6V6 6V6G	1.28	14N7	1.06
1N23	1.00	12LP4	49.50	809	2.93	8016	1.49	0B2	2.05	6AH6	1.56	6V6GT	.80	14Q7	.88
1P23	1.95	15E	1.50	810	7.95	8020	3.95	0B3/VR90	.75	6AJ5	.99	6W7G	.88	14R7	.88
2AP1	3.95	15R	.98	811	2.45	8025A	7.95	0C3/VR105	.98	6AK5	1.56	6X4	.60	14S7	1.06
2C4	1.18	23D4	.49	812	2.95	8026	12.95	0D3/VR150	.75	6AK6	.96	6X5GT	.60	14W7	1.06
2C21	.98	24G	.98	812H	6.00	BR	2.50	0Y4	.88	6AL5	.80	6Y6G	.96	14X7	1.06
2C22	.39	35T	4.95	813	8.95	BH	4.95	0Z4	.88	6AL7GT	1.06	6Y7G	.88	19	1.28
2C26A	.28	45SPEC	.49	814	3.95	C1A	4.95	0Z4G	.88	6AQ5	.80	6Z7G	1.28	19T8	1.56
2C34	.59	53A	24.95	815	2.95	C1B	4.95	01A	.50	6AQ6	.72	6ZY5G	.88	22	1.28
2C40	2.98	75TL	3.95	816	1.19	C5B	12.95	1A3	.72	6AQ7GT	.88	7A4 XXL	.72	24A	.88
2C43	9.50	100TH	12.95	826	.69	C6A	9.95	1A4	1.28	6AR5	.66	7A5	.72	25A6	1.06
2C44	1.75	100TS	3.00	829A/B	7.95	C6J	12.95	1A4P	1.56	6AS7G	4.95	7A6	.72	25A6G	1.06
2C46	7.50	101F	4.95	829B/3E29	4.95	CEO72	1.95	1A5GT	.72	6AT6	.60	7A7	.72	25AC5GT	1.16
2C51	6.50	114A	.69	830	2.95	CK1005	.35	1A6	1.28	6AU6	.80	7A8	.72	25L6GT	.66
2D21	1.18	114B	1.25	830B	5.25	CK1006	.69	1A7GT	.80	6AV6	.60	7AD7	1.06	25Y5	1.16
2E22	1.50	120	5.95	832/A	4.95	CK1090	4.95	1B3GT	1.49	6B4G	1.28	7AF7	.72	25Z5	.60
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2E30	2.39	205F	4.50	837	2.50	F123A	12.95	1C5GT	.88	6B8	1.28	7B5	.72	28D7	.39
2J21A	12.95	211	.98	838	3.95	F128A	79.50	1C6	1.28	6B8G	1.28	7B6	.72	30	.39
2J26	8.95	215A	3.00	841	.69	F660	150.00	1C7G	1.28	6BA6	.80	7B7	.72	31	.39
2J27	14.95	218	49.50	843	.69	FG17	3.25	1D5GP	1.55	6BE6	.72	7B8	.72	32	1.28
2J30	19.95	221A	2.95	845/W	4.95	FG27A	9.95	1D7G	1.28	6BF6	.66	7C4 1203A	.39	32L7GT	1.26
2J31	19.95	231D	1.49	849A/H	69.50	FG32	5.95	1D8GT	1.56	6BG6G	1.92	7C5	.72	33	.39
2J32	24.95	249C	3.49	850	22.50	FG33	8.95	1E5GT	1.38	6BH6	.80	7C6	.72	34	.38
2J33	24.95	250R	7.95	851	75.00	FG81A	6.95	1E7G	1.56	6BJ6	.80	7C7	.72	35 51	.80
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2J38	24.95	259A	4.95	864	.69	FG172A	32.50	1F6	1.56	6C5GT	.66	7E7	.88	35L6GT	.66
2J49	24.95	262A/B	3.50	865	2.98	FG235	59.50	1F7G	1.56	6C6	.80	7F7	.88	35W4	.46
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2K25	24.95	283A	10.95	874	2.49	GL502A	1.98	1H5GT	.66	6DSG	1.28	7J7	1.06	35Z5GT	.50
2K28	24.95	286A	10.95	876	2.50	GL530	49.50	1H6G	1.28	6E5	.85	7K7	1.06	36	.39
2X2/879	.39	290A	4.95	878	2.49	GL559	5.35	1H6GT	1.28	6F5	.66	7L7	.88	37	.39
3AP1	4.95	291A	4.95	884	1.49	GL673	11.50	1J6GT	1.28	6F5GT	.66	7N7	.88	38	.39
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4-125A	27.50	393A	7.95	956	.75	RK22	4.95	1T5GT	1.06	6L5G	1.06	12AU7	.96	58	.80
4-250A	37.50	394A	7.50	957	.75	RK23	4.95	1U4	.80	6L6	1.42	12BA6	.72	59	1.06
4A1	.98	399A	2.50	958A	.75	RK31	2.50	1U5	.72	6L6G	1.16	12BE6	.72	70L7GT	1.56
4AP10	4.95	400A	3.25	959	2.95	RK33	.98	1V	.88	6L6GA	1.16	12C8	.69	71A	.80
4C35	19.95	401A	1.95	966A	.99	RK34	.59	2A3	1.28	6L7	.96	12F5GT	.72	75	.66
4J26	110.00	403A/B	1.75	972A	2.95	RK39	1.75	2A5	.88	6L7G	1.16	12H6	.39	76	.66
5AP1	4.95	417A	24.95	975A	14.95	RK51	3.95	2A6	1.06	6N6G	1.56	12J5GT	.39	77	.66
5AP4	4.95	434A	7.95	991	.75	RK52	4.50	2A7	1.06	6N7	.96	12J7G	.80	78	.66
5BP1	2.95	446A/B	1.95	1613	.75	RK59	5.95	2B7	.88	6N7GT	.96	12J7GT	.80	79	.88
5BP4	4.95	450TH	24.95	1614	1.75	RK60	.79	2V3G	1.98	6P5GT	.96	12K7GT	.66	80	.46
5C22	49.50	450TL	45.00	1616	1.39	RK62	1.98	2X2A	1.25	6Q6G 6T7G	1.06	12K8	.88	81	1.56
5CP1	3.95	464A	9.50	1619	.75	RK63	12.95	3A4	.39	6Q7	.80	12K8GT	.96	82	1.06
5CP1A	9.95	527	12.95	1620	4.95	RK65	24.95	3A5	1.49	6Q7GT	.72	12Q7GT	.72	83	1.06
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5GP1	9.95	631P1	4.95	1624	1.75	RX21	3.95	3D6	.36	6S7	1.28	12SC7	.72	85	.88
5HP4	9.95	700R/D	49.50	1625	.49	RX120	10.00	3LF4	1.28	6S7G	1.28	12SK5	.80	89	.72
5J23	100.00	701A	4.95	1626	.49	T20	1.50	3Q4	.88	6S8GT	1.06	12SF5GT	.80	89Y	.39
5J29	100.00	703A	4.95	1628	4.95	T21	1.75	3Q5GT	.96	6SA7	.66	12SF7	.80	117L7GT	1.56
5JP2	11.95	705A	2.95	1629	.69	T55	3.95	3S4	.80	6SA7GT	.66	12SF7GT	.80	117M7GT	1.56
5LP1	11.95	706AY	49.50	1631	1.50	T200	10.95	3V4	.80	6SB7Y	.88	12SG7	.72	117N7GT	1.56
5MP1	4.95	706CY	18.95	1633	.89	T220	1.50	5A74	.60	6SC7	.72	12SH7	.39	117P7GT	1.56
5NP1	1.98	706GY	49.50	1634	.79	T240	2.95	5R4GY	1.15	6SD7GT	.49	12SJ7	.66	117Z3	.60
6AF6G	.88	707A/B	24.95	1636	5.95	UH50	5.95	5T4	1.28	6SF5	.66	12SJ7GT	.66	117Z4GT	1.16
6C21	24.95	708A	7.95	1638	.98	UX200	.75	5U4G	.60	6SF5GT	.72	12SK7	.66	117Z6GT	.96
6F4	5.95	710A	2.95	1641	.79	V70D	6.95	5V4G	.96	6SF7	.80	12SK7GT	.66	FM-1000	1.28
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7BP1	4.95	714AY	6.95	1644	1.49	VR78	.75	5W4GT	.66	6SH7	.39	12SN7GT	.80	UX200	1.28
7BP7	4.95	715A/B	9.95	1645	1.98	VR90	.75	5X4G	.72	6SJ7	.66	12SQ7	.60	9001	.89
7C23	75.00	715C	24.95	1649	1.25	VR91	1.49	5Y3GT	.42	6SJ7GT	.66	12SQ7GT	.60	9002	.39
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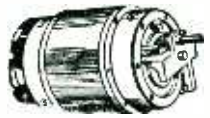
3¼" dia. x 4½" body
#C78248
$7.25 pair

DIFFERENTIAL

115 V., 60 Cyc.
#C78249
$2.25 ea.



Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Mounting Brackets — (Bakelite) for selsyns, and differentials shown above **25¢ pair**

PRECISION CONTROLS

6 WATT				4 WATT			
20,000Ω	Muter	314A	$1.70	500Ω	Centralab	48-501	$.90
20,000	GR	314A	2.50	50	De jur	292	.75
6,000	De jur	260	1.70	50	GR	301	1.10
6,000	Muter	314A	1.70	25	GR	301	1.10
5,000	Muter	314A	2.50	20	De jur	292	.75
5,000	GR	214A	1.40	20	GR	301	1.10
2,000	De jur	260	1.70	12	GR	301	1.10
25 WATT				**12 WATT**			
100K	GR	433A	$4.95	10,000Ω	De jur	271T	$2.00
				5,000	De jur	271T	2.00

METERS

0-7.5 V.A.C. 3½" Westinghouse.....$3.49
0-15 V.A.C. 3½" Westinghouse..... 3.49
0.8 Amps. R.F. 3½" Weston..... 3.29
60-0-60 Amps. 2" G.E..... 1.49

TOGGLE SWITCHES

Bat Handle, S.P.S.T. 6A., 125 V. Off-On plate.....20c
Ball Handle, S.P.D.T. 6A., 125V.....24c
Bat Handle, D.P.S.T., 6A. 125V.....29c
BRASS BINDING POST. Eby, screw down with 832 mounting screw .....Per 100 $3.95

RANGE UNIT

From AN/APS-15. Contains 11 Utah X-124-T2 (9280) Pulse Transformers, 12 Prec. Resistors, 28 V.D.C. Blower, metal cabinet and other useful parts.....**SPECIAL $10.95**
SPAGHETTI SLEEVING — Asst. sizes & colors 3 ft. lengths, 99 ft.....**ONLY $1.00**
POWER TRANSFORMER, Pri. 110/220/440; 60 Cyc., 2 Sec. Windings each 300 V., 4 Amp. **SPECIAL $9.95**

ALLEN SET SCREWS

	6-32 x 1/8	8-32 x 1/4
4-40 x 1/8	8-32 x 1/8	8-32 x 5/16
4-40 x 3/16	8-32 x 3/16	8-32 x 3/8

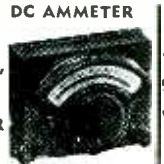
ALL SIZES (Cup Point).....$1.50 per 100

BC-1072-A TRANSMITTER

115V., 60 Cyc.; 150-200mc. Power supply gives 0-5,000 V.D.C. (Variac control), 312 and 700 V.D.C., 6.3 V.A.C. also contains blower 115 V.A.C., 5 KV meter, condensers, tubes, relays and many other useful parts. Shipping Wt., 245 lb. .....**ONLY $22.50**
HAYDON TIMING MOTOR. 110V., 60 Cyc. 2/3 R.P.M. Two connected on one shaft to make unit reversible. Only $1.95
CHROMALUX STRIP HEATER, 115 V.A.C., 60 Cyc., 750 Watt, Curved, 20" x 1½" Only.....95c
HARDWARE ASSORTMENT (mostly brass)—screws, nuts, washers, rivets.....3 lbs., $1.00

O-15A BASIC MOVE. 12 Ma. 5" x 4" METAL CASE MIRROR SCALE
Lots of 10—$34

DC AMMETER



$3.85 ea.

CHOKE
400 MA 12 Hy. 90 OHM 6,000 V. D. C. TEST

$3.85
10 for $34.00

SOUND POWERED PHONES

Handset TS-10 Mfrd. by RCA for Signal Corps. Includes 6' cord and clips. .....$8.92 ea., $17.60 a pair

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5	3 16"	1/2"	5/32"	.25
N.D. 38	5/16"	7/8"	9/32"	.45
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF 170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir K37B	2 5/16"	3 1/16"	11/32"	1.00
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	40	90	300	580	.001	.003
10	47	100	330	600	.0012	.0033
20	50	110	350	620	.0013	.0039
22	56	150	370	650	.00135	.0047
24	60	160	400	680	.00136	.005
25	62	220	470		.0015	.0068
26	75	240	500		.002	.008
39	82	250	560		.0026	.0082
					.0027	.01

Price Schedule
8.2mmf to .001mfd 5¢ .0026mfd to .0082mfd 12¢
.012mfd to .002mfd 7¢ .01mfd .....18¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
10	62	180	390	560	.0012	.0033
24	66	200	395	600	.0013	.0039
25	68	208	400	620	.0015	.004
30	75	240	430	665	.002	.0047
39	100	250	466	680	.0022	.005
40	110	300	470	700	.0024	.0051
47	120	330	488	750	.0025	.01
50	125	360	500	820	.0027	
60	150	370	510		.003	

Price Schedule
10mmf to .001mfd 10¢ .003mfd to .0051mfd 50¢
.0012mfd to .0027mfd 20¢ .01mfd .....65¢

Famous Makes—OIL FILLED—Brand New

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.1	25,000	$14.95	.1	7,000	$1.30
.03	16,000	1.70	.02-02	7,000	.90
.375@	16,000 and		1	6,000	8.50
1.75@	8,000 (dual)	5.95	.1	6,000	1.75
5	7,500	23.95	.03-03	6,000	1.65
.1	7,500	1.35	2	4,000	4.50
.1-1	7,000	1.35	.25	3,000	1.75

2 mfd. 4,000 V. D. C. #23F47 SPECIAL $4.50

.2	750 V.A.C. (2,200 V.D.C.)	.39
1	2,000	.95
4	1,000	.90
3	1,000	.80
2	1,000	.65
1	800	.40
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	20	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
11.74	14.98	105.8	366.6	59,148

½ WATT—25c

.250Ω	11.1Ω	235Ω	4,451Ω	15,000Ω
.334	13.15	260	5,000	15,750
.502	46	270	5,900	17,000
.557	52	298.3	6,500	30,000
.627	55.1	400	7,000	100,000
.76	75	723.1	7,500	150,000
1.01	97.8	2,500	8,000	
1.53	125	2,850	8,500	
2.04	180	3,427	14,825	
	210	4,000		

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	55,000
3.39	10.9	7,000	50,000	70,000
5.05	270			

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	522,000Ω
120,000	130,000	320,000	600,000
125,000	160,000	470,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c
100 pieces—10% off; 1,000 pieces—20% off.

GEAR ASSORTMENT $6.50
Experimenter's dream, 100 pieces, many stainless steel
Bathtub Condenser .25 MFD 400V Side Terminal Special only.....11¢

GLYPTAL CEMENT 1 qt....75¢, 1 gal....$2.50

RG 8/U 52 OHM

10,000 ft. & over.....$47.50 per M
1,000 ft. to 9,999 ft... 50.00 per M
Smaller quantities .....6c per ft.
RG 22/U 95 OHM (2 cond.) per 1,000 ft. $100.00
RG 62/U 93 OHM per 1,000 ft.....$50.00

COAXIAL CABLE CONNECTORS

Angle Adapter 15c	Plug 28c	Socket 28c	Hood 9c
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adaptor for PL-259 A for use on small coax. 12c each.....$10.00 for 100

83-1SP	$.28	UG 21/U	.60	UG 60/U	.60
83-1J	.80	UG 22/U	.60	UG 61/U	.60
83-1T	1.12	UG 24/U	.60	UG 85/U	.60
83-22AP	.85	UG 25/U	.60	UG 87/U	.50
83-22J	.85	UG 27/U	.60	UG 167/U	2.90
83-2J	1.50	UG 59/U	.60	UG 281/U	.60
UG 13/U	.60				

FLUORESCENT BLACK LIGHT. 115V., 60 Cyc. Ballast & 4 Watt Black light Tube. Only $1.59
ARC 5. Receivers BC 454 - BC 455. Used. Good cond. W/tubes $6.95

CARBON RESISTOR ASSORTMENT

Color coded, insulated.....160 only $1.19

PULSE TRANSFORMERS

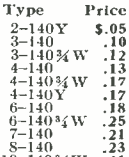
X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1¼" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core.....**$1.50**
D161310, 50 Kc to 4 Mc, 1¾" dia. x 1⅞" high, 120 to 2350 ohms.....**$3.00**
352-7178—Spec. 10, 111 Chicago Trans., equivalent to 9262 (above).....**$1.50**
TR 1018 Dinion Coil Co......**$1.25**
TR 1019 Dinion Coil Co......**$1.25**
352-7250-2A, cased 16/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm, 140 cy. to 175 KC.....**$1.25**
352-7251-2A, similar—shorter pulses.....**$1.25**
KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. **$3.50**
D106173, W. E. Freq. response 10KC to 2 MC **$9.80**
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in., 17,300 V. out (250 KVA @ ¼ microsecond).....**$15.00**
800 KVA G.E. K2731, 28000 Volt pk. output: Bifilar, pulse width; one-microsecond **$14.50**

Delay Networks—All 1400Ω

T 113—Approx. 1.2 micro sec. delay.....85c
T 114—Approx. 2.2 micro sec. delay.....85c
T 115—Similar to T 114 with tap brought out 85c

TIME DELAY RELAY

Raytheon CPX 24166
KS 10193-60 Sec.



- 115 V. 66 Cycle
- Adj. 50-70 Seconds
- 2½ seconds recycling time, spring return
- Micro Switch Contact, 10A
- Holds On as long as power is applied. Fully Cased

ONLY **$6.50**

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	3-141¾W	$.17	13-141¾W	$.67
3-140	.10	4-141W	.22	17-141Y	.78
3-140¾W	.12	4-141Y	.22	2-142¾W	.15
4-140	.13	5-141	.19	3-142	.15
4-140¾W	.17	5-141¾W	.27	5-142	.21
4-140Y	.17	5-141Y	.25	6-142¾W	.40
6-140	.18	7-141	.27	6-142	.28
6-140¾W	.25	7-141¾W	.37	7-142	.41
7-140	.21	7-141Y	.37	9-142	.41
8-140	.23	8-141¾W	.38	10-142¾W	.58
10-140¾W	.41	9-141¾W	.47	10-142Y	.64
10-140Y	.40	9-141Y	.42	13-142¾W	.82
11-140¾W	.44	10-141¾W	.47	2-150	.28
13-140	.36	11-141	.40	4-150	.52
14-140	.40	11-141Y	.57		
15-140Y	.59	12-141	.43		

5" Scope from ASB-4 tubes Included.....$9.95

FUSES

3AG			3AG		
⅛ Amp	$4.00	per 100	2 Amp	$2.50	per 100
¼	4.00	100	3	2.50	
¾	4.00	100	4	2.75	
1	2.50	100	10	3.00	
1½	2.50	100	15	3.00	

TUBE SPECIALS—New—Guaranteed

2J26	$8.29	6SN7 GT	$ .65
2X2/879	.44	6SQ7 GT	.47
3C24	.49	6V6 GT	.59
6AC7	.79	6X5 GT	.57
6AK5	.84	6Y6	.84
6AL5	.72	872A	1.88
6SJ7	.59	C5B	6.98

Minimum Orders $3. All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

WELLS RADIO-ELECTRONIC COMPONENTS

COAX-- CABLES AND CONNECTORS --TWINAX

A COMPLETE LINE OF LOW-LOSS CONNECTORS AND ADAPTERS FOR USE WITH RG CABLES. RUGGED CONSTRUCTION DIE CAST ZINC AND MACHINED BRASS SHELLS, HEAVILY SILVER PLATED. INSERTS ARE MICA FILLED AND POLYSTYRENE.

ALL ITEMS ARE IN STOCK FOR IMMEDIATE SHIPMENT.

SMALL SINGLE CONTACT CONNECTORS

83-1SP	STRAIGHT PLUG- With molded low-loss mica filled insert	$0.40
83-1SPN	3 PIECE PLUG- TAPERED BACK SHELL FOR .405" O.D.cables	.40
83-1T	"T" CONNECTOR for 83-1R Factory wired	1.50
83-1R	RECEPTACLE CHASSIS OR BOX TYPE- Low-loss mica insert	.40
83-1RTY	RECEPTACLE CHASSIS OR BOX TYPE- Polystyrene & mica insert	.45
83-1AP	ANGLE PLUG ADAPTER- Polystyrene insert- pin & socket	.40
83-1J	JUNCTION- For use with 83-1SP or 83-1SPN	.75

SMALL TWIN CONTACT CONNECTORS

83-22SP	TWIN PLUG- With low-loss mica filled dielectric insert	$0.45
83-22R	TWIN CHASSIS RECEPTACLE- For 83-22SP connector	.46

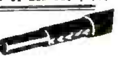
HOODS, CAPS, AND ADAPTERS

83-1H	HOOD- For RG cables, 8/U, 22/U, 63/U, 65/U, etc.	.10
83-1AC	CAP- For connectors 83-1R, 83-1RTY, 83-22R, etc.	.10
UG-175/U	ADAPTER- For adapting 83-1SP to accommodate RG-58/U	.20
UG-176/U	ADAPTER- For adapting 83-1SP to accommodate RG 59/U-	.20
10H/1774	CABLE CLAMP N-297 for use with British Connectors	.15

MISCELLANEOUS CONNECTORS

UG-18/U	$0.40	UG-85/U	$0.40	UG-167/U	$1.85	10H/538	$0.40
UG-21/U	.50	UG-87/U	1.00	UG-171/U	.45	10H/539	.40
UG-27/U	.60	UG-88/U	1.00	UG-191/U	.60	10H/568	.40
UG-29/U	1.00	UG-100/U	1.40	10H/380	.40	10H/701	.40
UG-30/U	1.50	UG-107/U	1.25	10H/381	.40	10H/702	.40
NAVY TYPE CI-49549			.40	83-2R LARGE TWIN RECEPTACLE			.50
83-1D-PL-271 of SCR-522			.75	PL-310 w/AN-3057-8 of SCR-522			.75

COAX AND TWINAX CABLES



AN NO.	NOMINAL IMPEDENCE OHMS	INNER SHIELD	JACKET MATERIAL	MAX. O.D.	SPECIAL INFORMATION	PRICE PER FT NET
RG-7/U	97.5	COPPER	BLACK VINYL	.370		$0.04
RG-9/U	51	SILVER	GRAY VINYL	.420		.13
RG-10/U	52	COPPER	" "	.475	Armored	.07
RG-17/U	52	"	" "	.870	Sh.Lgth	.40
RG-18/U	52	"	" "	.945	Armored	.40
RG-21/U	53	SILVER	" "	.332		.14
RG-25/U	47.1	COPPER	BLACK RUBBER	.500		.08
RG-35/U	47.1	"	COTTON	.475		.07
RG-26/U	48	"	BLACK RUBBER	.525	Armored	.11
RG-27/U	47	"	" "	.675	Armored	.11
RG-28/U	48	"	" "	.800		.20
RG-29/U	53.5	"	POLYETHYLENE	.184		.035

AN NO.	NOMINAL IMPEDENCE OHMS	INNER SHIELD	JACKET MATERIAL	MAX. O.D.	SPECIAL INFORMATION	PRICE PER FT NET
RG-29/U	53.5	COPPER	COTTON	.178		.03
RG-39/U	72.5	"	POLYETHYLENE	.305	Sh.Lgth	.06
RG-41/U	68.5	"	BLACK RUBBER	.466		.06
RG-54/U	58	"	" VINYL	.275		.05
RG-55/U	53.5	"	POLYETHYLENE	.206		.07
RG-57/U	95	"	BLACK VINYL	.625	2 Cond.	.18
RG-74/U	52	"	GRAY "	.615	Armored	.18
RG-37/U	55	"	POLYETHYLENE	.184		.05
RG-59/U	72	"	"	.242	Sh.Lgth	.06
LOW-LOSS BEADED COAXIAL CABLES						
72/12	72	COPPER	BLACK VINYL	.480		.09
72-12W	72	"	" "	.460	60' Coils Only	.06

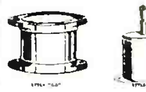
NOTE THE FOLLOWING LIST OF SPECIAL OFFERINGS:

RG-7/U This material is on the original manufacturers reels ranging from 2000 ft. upward..$37.50/M
100 foot coils .... .04/ft.

RG-29/U This material is on reels of 2000 feet or more $27.50/M
100 foot coils .... .035/ft.

4--29/UW Same as above except with cotton braid covering $25.00/M
100 foot coils .... .03/ft.

TRANSMITTING MICA CONDENSERS



Cap. Mfd.	Wrkg. Volts	Price Each
STYLE "AA" CONDENSERS		
.02	3000	$4.50
.04	1000	3.50
STYLE "A" CONDENSERS		
2mmfd	10000	$1.65
STYLE "B" CONDENSERS		
.00003	2000	$0.70
.000047	3000	.80
.00005	3000	.75
.00005	3500	.80
.000065	2500	.70
.00007	1100	.70
.00007	3000	.75
.00009	3000	.75
.000091	3000	.80
.0001	3000	.80
.0001	4000	.90
.0001	5000	1.00
.000107	3800	.85
.00011	3000	.95
.00137	3000	.95
.00015	5000	1.00
.000175	1500	1.00
.0002	1450	1.00
.0002	3000	1.00
.0002	5000	1.05
.00025	2500	.90
.00025	5000	1.10
.0003	3000	.95
.0004	3000	.95
.0004	5000	1.10
.0004	8000	1.55
.00045	3000	.95
.0005	2000	.95
.0005	3000	1.00
.00051	3000	1.00
.00052	2000	.95
.00056	3000	1.10
.0006	2500	1.05
.0006	5000	1.15
.000625	5000	1.05
.0007	3000	1.05
.00072	5000	1.15
.00075	2500	1.05
.00075	5000	1.15
.0008	3000	1.00
.0008	5000	1.15
.001	4500	1.25
.001	5000	1.30
.0011	5000	1.35
.00125	2000	1.10
.00137	3000	1.10
.0014	5000	1.35
.0015	3000	1.10
.0024	3000	1.15
.0025	2000	1.10
.00275	2000	1.10
.003	2000	1.20
.004	3000	1.50
.005	4000	1.40
.005	3000	1.50
.005	5000	1.70
.006	2000	1.30
.006	2500	1.30
.006	3500	1.45
.0063	3000	1.40
.0075	5000	1.75
.008	3000	1.46
.01	2000	1.56
.02	600	1.30
.02	1000	1.35
.02	2000	1.60
.024	1500	1.60
.025	2500	1.80
.035	1500	1.80
.05	3000	2.00
.056	1000	1.70
.08	1000	1.70
.1	1000	1.75
.15	500	1.75

Cap. Mfd.	Wrkg. Volts	Price Each
STYLE "C" CONDENSERS		
.000005	2500	$0.40
.00005	600	.30
.0001	600	.25
.0001	1200	.35
.0001	2500	.40
.0002	600	.25
.0002	2500	.40
.00022	2500	.40
.00024	2500	.45
.00025	2500	.46
.0003	2500	.46
.00039	2500	.50
.0004	600	.38
.0004	2500	.48
.0005	600	.35
.0005	1200	.40
.0005	2500	.48
.00056	1200	.40
.00075	600	.38
.00085	2500	.46
.001	600	.38
.001	1200	.40
.001	1250	.40
.001	2500	.55
.001	3750	.65
.0011	600	.35
.0015	2500	.50
.002	600	.35
.002	2500	
.002	1200	.45
.002	2500	.55
.002	3500	.60
.0022	2500	.60
.0024	2500	.50
.003	600	.40
.003	2500	.60
.0035	2500	.60
.0039	2500	.60
.004	600	.40
.004	2500	.60
.0045	600	.40
.0046	600	.45
.0047	2500	.65
.005	600	.35
.005	1200	.45
.005	2500	.60
.0051	1200	.48
.0051	2500	.65
.0056	2500	.65
.006	600	.40
.006	2500	.65
.0068	1200	.60
.007	600	.35
.0075	1200	.55
.008	1200	.56
.009	600	.50
.01	600	.40
.01	1200	.55
.01	1250	.55
.01	2500	.80
.0115	600	.40
.013	1200	.56
.015	1200	.58
.015	2000	.80
.015	2500	.60
.0175	1200	.55
.02	600	.35
.022	1200	.45
.025	600	.38
.03	600	.38
.03	1200	.50
.03	2500	.65
.033	600	.35
.033	1200	.35
.04	600	.36
.075	250	.40

Cap. Mfd.	Wrkg. Volts	Price Each
STYLE "D" CONDENSERS		
.000025	1200	$0.25
.00004	600	.20
.00005	600	.20
.00005	1200	.25
.00005	2500	.30
.0001	600	.20
.0001	1200	.25
.00015	600	.20
.00015	2500	.35
.0002	1200	.30
.0002	2500	.35
.00024	2500	.35
.00025	1200	.25
.00025	2500	.35
.0004	600	.25
.0005	1200	.30
.0005	2500	.40
.00051	2500	.35
.00065	600	.25
.0007	600	.25
.00075	600	.25
.001	600	.25
.001	1000	.35
.001	1200	.35
.001	2500	.40
.0011	2500	.40
.002	600	.25
.002	1000	.30
.002	1200	.35
.002	1250	.35
.002	2500	.40
.0022	1200	.30
.0022	2500	.40
.0025	600	.25
.0025	1200	.30
.0027	600	.25
.003	600	.25
.003	1200	.30
.0033	1200	.30
.004	600	.25
.004	1100	.35
.004	1200	.35
.004	1250	.35
.004	2500	.40
.0044	600	.25
.0047	2500	.40
.005	600	.30
.005	2500	.40
.0051	2500	.40
.006	600	.25
.006	1000	.35
.01	600	.30
.01	1200	.35
.01	1250	.40
.01	2500	.50
.014	600	.30
.015	600	.30
.02	600	.25
.022	600	.25
.024	600	.30
.025	600	.30
.025	1200	.35
.027	600	.25
.03	600	.25
STYLE "F" CONDENSERS		
[illegible]	1000	$0.40
.0002	2500	.40
.00075	1500	.30
.001	1500	.30
.002	1500	.30
.002	2500	.35
.003	1500	.30
.003	2500	.35
.004	600	.25
.004	1000	.30
.005	600	.30
.006	[illegible]	.35
.006	[illegible]	.35
.008	[illegible]	.40

METAL DRAWN PAPER CAPACITORS

STOCK NO.	CAPACITY MFG.	DCW VOLTS	NO. OF LEADS & LOCATION	FIG.	UNIT PRICE
335-14	.05	400	2 SIDE	A	$0.30
347-28	.05	600	1 SIDE	A	.25
347-10	.05	600	2 SIDE	A	.35
335-30	.1	200	1 SIDE	A	.25
407-19	.1	600	2 TOP	A	.35
407-38	.1	600	2 SIDE	A	.35
335-7	.1	600	2 TOP	A	.35
407-12	.1	1000	2 SIDE	A	.55
335-3	.2	400	2 TOP	A	.30
335-6	.2	600	2 TOP	A	.35
347-4	.25	330AC	2 SIDE	C	.35
335-15	.25	330AC	2 SIDE	C	.35
335-28	.25	400	2 TOP	A	.30
335-31	.25	400	2 SIDE	A	.30
335-2	.25	400	2 SIDE	A	.30
407-16	.25	400	1 SIDE	A	.30
347-3	.25	400	2 SIDE	A	.30
449-2	.25	600	2 TOP	A	.35
333-41	.25	600	2 TOP	A	.35
335-29	.3	400	2 TOP	A	.30
335-64	.35	400	2 BOTTOM	A	.35
335-61	.5	120	2 TOP	A	.25
347-17	.5	200	2 SIDE	A	.30
335-11	.5	400	2 SIDE	A	.30
347-5	.6	400	2 SIDE	A	.30
407-15	.5	400	2 SIDE	A	.30
407-18	.5	400	2 TOP	A	.30
335-5	.5	600	2 SIDE	A	.35
335-4	.5	600	2 TOP	A	.35
335-13	.5	600	2 TOP	A	.35
335-53	.5	600	2 SIDE	A	.35
347-14	.5	600	2 BOTTOM	A	.35
337-43	.5	600	2 BOTTOM	A	.35
407-24	.5	1000	2 TOP	B	.65
335-63	1	400	2 SIDE	B	.35
407-14	1	600	2 SIDE	B	.45
333-45	1	600	2 SIDE	B	.45
407-21	1	600	2 SIDE	B	.45
335-48	1	600	2 END	D	.45
335-58	1	1000	2 SIDE	B	.70
347-39	1.25	100	2 SIDE	C	.35
347-21	1.25	100	2 SIDE	C	.35
335-56	2	600	2 BOTTOM	B	.40
333-42	2	600	2 SIDE	B	.40
335-32	4	50	2 SIDE	A	.35
347-1	4	60	1 SIDE	B	.35
347-27	4	50	2 SIDE	B	.35
407-9	20	25	2 SIDE	A	.40
407-35	20	50	2 SIDE	A	.45
335-45	25	25	2 SIDE	A	.40
449-3	25	40	2 BOTTOM	D	.45
347-43	25	50	1 SIDE	A	.45
407-13	40	25	2 SIDE	A	.40
347-42	50	25	1 TOP	A	.45
335-40	2 x .1	100	3 SIDE	B	.25
335-63	2 x .1	200	2 BOTTOM	A	.25
347-7	2 x .1	200	2 SIDE	A	.25
347-9	2 x .1	300	3 TOP	D	.30
407-30	2 x .1	400	3 SIDE	A	.35
333-44	2 x .1	100	3 TOP	A	.35
335-35	2 x .1	600	3 TOP	A	.40
407-17	2 x .1	600	3 SIDE	A	.40
407-36	2 x .1	600	3 BOTTOM	A	.40
335-1	2 x .25	400	4 BOTTOM	B	.30
449-1	2 x .25	400	3 SIDE	A	.30
347-8	2 x .5	100	3 TOP	A	.25
335-55	2 x .5	400	2 BOTTOM	D	.38
407-4	2 x .5	400	3 SIDE	B	.35
335-43	2 x .5	600	3 SIDE	B	.40
407-31	.1 & .5	400	3 TOP	C	.35
347-30	1 & .1	300	3 TOP	D	.35
347-18	3 x .1	200	3 SIDE	A	.30
335-21	3 x .1	400	3 TOP	A	.35
335-28	3 x .1	400	3 SIDE	A	.35
335-23	3 x .1	500	3 SIDE	A	.40
335-12	3 x .1	600	3 TOP	A	.45
335-42	3 x .1	600	3 SIDE	A	.45
335-44	3 x .1	600	3 BOTTOM	A	.45
335-27	.1	600	4 BOTTOM	B	.35
	.5	200			
	.2	200			

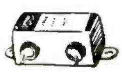


FIG. A

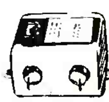


FIG. B

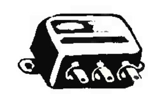


FIG. C

FIG. D

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01A	$0.45
1B22	4.35
1N21 Xtal Diode	.65
1N21B Xtal Diode	.80
1N23 Xtal Diode	.80
1N23A Xtal Diode	.85
1N27 Xtal Diode	.85
1R4/1294	.65
1R5	.95
1S5	.95
1S21	1.10
1T4	.95
2C26	.35
2C26A	.45
2C34	.55
2J21A	11.45
2J22	9.85
2J26	8.45
2J27	16.45
2J31	9.95
2J32	14.85
2J33	19.95
2J37	13.85
2J38	12.95
2J48	14.95
2X2/879	.65
3A4	.35
3A5	1.05
3AP1 CRT	3.85
3B22	2.95
3B24	1.75
3BP1 CRT	3.75
3CP1-S1	1.95
3C24/24G	.47
3D6/1299	.65
3FP7 CRT	2.95
3HP7 CRT	2.95
3GP1 CRT	3.75
3Q5	.90
REL 5	17.95
5AP1 CRT	3.95
5BP1 CRT	2.95
5CP1 CRT	3.85
5GP1 CRT	6.55
5J23	14.25
5J29	14.25
5Y3G	.40
6A6	.90
6AB7	.95
6AC7	.90
6AK6	.80
6B7	.95
6BE6	.65
6C4	.45
6C6	.75
6C21	19.75
6D6	.60
6E5	.70
6H6	.50
6J5/GT	.50
6J6	.90
6N7/GT	.80
6R7G	.80
6SF5	.65
6SG7	.70
6SH7	.40
6SJ7/GT	.65
6SK7/GT	.65
6SL7/GT	.65
6SN7/GT	.80
6SQ7/GT	.60
7A4	.65
7A7	.65
7C4/1203	.40
7C7	.65
7E6	.65
7F7	.75
7H7	.75
7N7	.75
7Q7	.65
10/VT-25A	.40
10Y/VT-25	.45
12A6	.25
12K8	.65
12SF7	.70
12SH7	.40
12SK7	.60
12SL7/GT	.70
12SR7	.40
12x825 2 amp. Tungar	2.25
13-4 Ballast	.35
15R	1.40
FG-17	2.85
REL-21	3.25
23D4 Ballast	.45
25Z6/GT	.55
28D7	.40
30/VT-67 (For Walkie Talkies)	.75
33/VT-33 (For Walkie Talkies)	.75
RK-34	.45
34	.35
39/44	.35
45 Spec.	.55
46	.80
EF50/VT250	.45
CEQ 72	1.50
72/3B24	1.75
VR-75	.90
76	.55
VR-78	.65
80	.45
FG-81-A	3.95
83	.85
83V	.95
89Y	.40
VR-90	.70
VR-92	.65
100R	3.25
FG-105	9.95
VR-105	.85
VU-111	.65
117Z3	.56
VT-127 English	.25
VT-127A	2.95
VR 150	.55
VT-158	9.85
FG-172	29.50
205B	1.95
211 (VT-4-C)	.65
215A	1.95
231D	1.30
282B	4.25
304TH	5.95
304TL	1.75
307A	4.25
316A	.75
350B	2.55
371B	.85
388A	4.95
417A	19.95
434A	7.45
446A	1.55
450TH	19.95
GL-471A	2.75
527	11.25
WL-530	17.50
WL-531	17.50
532A/1B32	3.55
GL-559	3.75
KU-610	7.45
HY-615	1.20
700B	9.95
700C	9.95
700D	9.95
702A	2.95
703A	4.85
705A	2.65
707A	19.50
707B	23.25
710A	2.15
713A	1.55
714AY	9.95
RK715B	7.95
717A	.90
721A	3.95
724A	4.65
724B	4.25
725A	19.95
726A	19.95
730A	11.95
801	.60
801A	.75
803	6.95
804	9.95
805	5.45
808	1.75
809	2.75
810	7.95
811	2.35
813	7.85
814	3.75
815	2.85
826	.49
829	3.25
830B	3.95
837	1.75
838	3.25
841	.55
843	.55
851	39.50
WL-860	2.55
861	32.50
864	.55
865	2.55
866A	1.30
869	26.50
869B	28.95
872A	2.45
874	2.15
878	2.15
930	2.20
954	.50
955	.56
956	.55
957	.56
991 (NE-16)	.30
1005	.35
1148	.40
1201	.75
1616	1.25
1619	.55
1624	1.25
1625	.45
1626	.45
1629	.45
1635	.95
2051	.95
7193	.35
8011	2.55
8012	4.25
8020	3.35
8025	7.50
9001	.70
9002	.45
9003	.65
9004	.45
9006	.45

NEON BULBS FOR RADIO USE

NE 2	$0.06
NE-15	.06
NE-16	.24
NE-20	.06
NE-21	.24
NE-48	.24
NE-51	.06

PILOT AND FLASHLIGHT BULBS

Stock No.	Mazda No.	Volts	Watts	Bulb	Base	Price
330-40	64	6-8	3CP	G-6	DC Bay	$0.07
330-31	67	12-16	1.5CP	G-4½	Min. Bay	[illegible]
330-42	Spec.	12	6	S-8	Cand. Scr.	.11
330-70	1445	12	2 amp.	G-3½	Min. Scr.	.07
330-14	49	2	.06	T-3¼	Min. Bay	[illegible]
330-15	3-6	120	3	S-6	Can. Bay	.11
330-22	PR-10	6	.5 amp.	B-3½	Min. Flang.	[illegible]
330-19	Proj. Bulb	120	500W	T-20	Med. Pf	[illegible]
LB-17C		24	.035 A	T-2	Tel. Base	.16
LB-64A		110	7W	C-7	Cand. Scr.	.17
LB-57A	53	12-16V	1 CP		Min. Bay	.07
LB-100A	Airplane Headlight	24V	250W	A-19	Med. Pf	[illegible]
LB-101	323	3	(Aircraft)	T-1¾	[illegible]	.27
LB-101A	LM-40	115V	250W	T-20	Med. Pf	[illegible]
LB-102	1196	12-16	50 CP	RP-11	DC Bay	.14
LB-102A	CC-1h	110V	100W	T-8	DC Pf	[illegible]
LB-102B	1491	2.4	.8 amp.		DC Bay	.14
LB-102C	3D2	24	(Airplane type)		DC Bay	.16
LB-104	313	28	.17 amp.	T-3¼	Min. Bay	.10
LB-105	1810	12V	.33A		Min. Bay	.12
LB-106	12A	12	.09-.11	T-2	Tel. Base	.10
LB-107	24-A2 W.E.	24	.75-.105	T-2	Tel. Base	.10
LB-108	S-14 Argon	105	2½ Watt		Med. Scr.	[illegible]
LB-109	S Telephone Type		.5 mm	T-2		.17
330-16	1177	24	[illegible]	T-3	Min. Scr.	.10

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RECEIVING TUBES		6A6	.87	6SA7GT	.52	12AU6	.72	47	.86	Thyratrons		3C24	.44	WE-274B	1.06	815	1.72
OZ4	.59	6A7	.72	6SB7Y	.79	12AU7	.86	50	1.41	OA4G	.95	3E29	4.91	WE-283A	1.27	826	.57
OZ4G	.59	6AB7/1853	.99	6SC7	.66	12AX7	.86	50A5	.79	EL-C1A	3.35	SN-4/631-P1	3.77	WE-293A	3.36	829	3.95
1A3	.45	6AC5GT	.94	6SC7GT	.61	12BA6	.64	50B5	.69	2D21	1.18	4A1	.58	304TH	3.86	830B	3.35
1A5GT	.54	6AC7 1852	.79	6SD7GT	.79	12BA7	.86	50L6GT	.57	3C23	3.20	4B22/EL-5B	5.20	304TL	.89	832	3.95
1A7GT	.69	6AC7W	1.45	6SF5	.59	12BE6	.64	55	.79	3C31/EL-C1B	3.35	4B24/EL-3C	2.44	WE-310A	7.50	832A	4.91
1AB5	.73	6AD6G	.79	6SF5GT	.59	12C8	.59	BK55B	.18	4C35	19.77	4B25/EL-6CF	8.70	WE-311A	5.80	836	.89
1B3GT/8016	1.18	6AD7G	1.13	6SF7	.72	12F5GT	.65	L55B	.18	EL-C5B	8.95	4C28	8.85	316A	.66	836A/3B27	1.29
1B4P	1.15	6AE6G	.72	6SG7	.69	12H6	.39	56	.59	C6J	4.44	4E27	12.75	350A	1.10	837	1.18
1B5 25S	1.16	6AF6G	.96	6SG7GT	.68	12J5GT	.49	57	.72	FG-17	2.89	5D21	26.50	350B	1.95	838	2.93
1C5GT	.69	6AG5	.89	6SH7	.44	12K8	.69	58	.72	FG-33	11.95	5J23	14.20	354C	19.50	841	.49
1C6	.94	6AG7	1.19	6SH7GT	.43	12Q7GT	.59	70L7GT	1.24	FG-67/1904	8.85	5J29	14.20	WE-356B	4.45	843	.59
1D5GP	1.04	6AJ5	.89	6SJ7	.59	12SA7	.59	75	.59	FG-81A	4.95	5R4GY	1.05	361A	4.75	851	27.50
1D8GT	1.04	6AK5	.89	6SJ7GT	.59	12SC7	.69	76	.59	FG-105	9.95	6C21	19.88	371B	.82	852	6.40
1E5GP	1.16	WE6AK5	1.35	6SK7	.59	12SF5	.65	77	.59	FG-172	14.50	6J4	5.20	388A	2.95	860	2.44
1E7G	.66	6AK6	.82	6SL7GT	.69	12SF7	.69	78	.59	WE355A	14.15	10T1	.58	417A	10.65	861	17.70
1G4GT	.79	6AL5	.69	6SN7GT	.64	12SG7	.69	79	.77	394A	3.77	10Y	.19	434A	3.65	864	.19
1G6GT	.79	6AQ5	.72	6SN7W	1.45	12SH7	.49	80	.45	KU-610	6.35	15R	.75	446A	.79	866A	.95
1H4G	.69	6AQ6	.65	6SQ7	.53	12SJ7	.49	81	1.41	KU-634	17.20	REL-21	3.25	450TH	19.70	869B	27.00
1H5GT	.59	6AT6	.54	6SQ7GT	.53	12SJ7GT	.49	82	.94	WL-652/657	38.00	HK-24G	.44	471A	2.75	872A	1.88
1J6G	1.04	6AU6	.72	6SR7	.59	12SK7	.59	83	.79			RK-25	2.11	507AX	1.47	874	1.65
1L4	.66	6AV6	.55	6SS7	.65	12SK7GT	.59	83V	1.15	884	1.35	RK-34/2C34	.28	527	9.75	876	.39
1LA4	.94	6B4G	.94	6ST7	.79	12SL7GT	.69	84/6Z4	.65	885	.88	REL-36	.78	530	17.20	878	1.85
1LB4	.94	6B8	.79	6T7G	1.15	12SN7GT	.79	89Y	.55	1614	.97	RK-47	4.92	531	17.80	954	.39
1LC5	.73	6B8G	.79	6T8	1.04	12SQ7	.59	117L7GT	1.24	1665	.97	EF-50	.45	532A	3.15	955	.39
1LC6	.94	6BA6	.65	6U5/6G5	.72	12SR7	.69	117N7GT	1.24	1904	8.85	VT-52	.36	559	1.41	956	.49
1LD5	.94	6BA7	.86	6U7G	.65	12X3	.88	117P7GT	1.24	2050	.83	53A	3.82	561	1.45	957	.49
1LE3	.73	6BE6	.65	6W4GT	.65	14A4	.88	117Z3	.54	2051	.49	RK-59	2.44	579B	5.85	958A	.49
1LH4	.94	6BG6G	1.72	6V6	1.07	14A7/12B7	.79	117Z6GT	.87			RK-60/1641	.59	HY615	.29	991	.29
1LN5	.88	6BH6	.72	6V6G	.59	14B6	.79	UV199	.52	Transmitting & Special Purpose Tubes		RK-72	.92	631-P1	3.77	1005	.24
1N5GT	.69	6BJ6	.72	6V6GT	.59	14B8	.79	FM-1000	.97			RK-73	.92	700B	16.90	1201A/7E5	.29
1N6G	.72	6C4	.21	6W7G	.79	14C5	.79	Cathode Ray Tubes				VR-75	.98	700C	16.90	1203/7C4	.19
1P5GT	.59	6C5	.60	6X4	.59	14H7	.79					VR-78	.34	700D	16.90	1294/1R4	.29
1Q5GT	.94	6C6	.69	6X5GT	.59	14J7	.89	3AP1	4.63			VR-90/OB3	.81	702A	2.95	1299/3D6	.29
1R4	.29	6C8G	.89	6Y6G	.88	14N7	.89	3AP4/906P4	5.94	OA2	1.32	VT-98 (BR)	29.90	702B	3.87	1602	.68
1R5	.69	6D6	.59	6Z7G	1.09	14W7	.96	3BP1	2.59	1B22	3.87	C100E	2.30	703A	3.90	1611	.77
1S4	.86	6D8G	.87	6ZY5G	.79	14X7	.96	3CP1	1.87	1B23	8.95	100R	2.90	704A	2.75	1613	.61
1S5	.64	6E5	.79	7A4/XXL	.65	19	1.16	3DP1A	5.75	1B24	4.90	WE-101D	1.65	705A	1.17	1616	.87
1T4	.64	6F5	.60	7A6	.65	19T8	1.04	3EP1	2.92	1B26	4.50	WE-101F	3.62	707A	5.22	1619	.19
1T5GT	.94	6F5GT	.60	7A7	.65	22	1.16	3HP7	4.91	1B29	2.90	VR-105/OC3	.72	707B	6.95	1624	.69
1U4	.72	6F6	.69	7AD7	.95	24A	.66	4AP10	5.35	1B32	3.15	WE-113A	1.32	708A	4.85	1625	.19
1V	.69	6F7	.72	7AG7	.79	25L6GT	.59	5AP1	3.75	1B36	4.50	WE-120A	1.47	710A	2.25	1626	.29
2A3	.89	6F8G	.89	7A8	.65	25Z5	.55	5AP4	4.75	1B42	9.80	WE-121A	1.97	713A	1.45	1629	.29
2A7	.89	6G6G	.88	7B4	.65	25Z6GT	.49	5BP1	1.89	1H20	.58	WE-124A	3.80	714AY	6.95	1630	3.11
2B7	.79	6H6	.49	7B6	.64	26	.59	5CP1	2.87	2B22	1.41	VT-127A	2.40	715A	6.75	1631	1.38
2E5	.94	6H6GT	.48	7C4	.19	27	.49	5CP7	3.76	2C22	.22	VR-150/OD3	.72	715B	9.95	1636	3.77
2X2/879	.49	6J5	.49	7C5	.64	28D7	.61	5FP7	.57	2C26	.27	203A	6.40	717A	.97	1638	.70
2X2A	.79	6J5G	.48	7C7	.65	30 Spec.	.48	5HP4	2.90	2C34/RK-34	.28	203B	4.33	721A	3.93	1641/RK-60	.59
3A4	.61	6J5GT	.48	7E5	.29	31	.62	5JP4	9.55	2C44	.79	WE-205B	1.70	723A/B	16.50	1644	1.17
3A5	.96	6J6	.89	7E6	.64	32	.99	5MP1	10.65	2E22	1.25	WE-205F	2.85	724A	3.22	1960	1.21
3A8GT	1.76	6J7	.72	7F7	.79	33	.99	5MP5	10.65	2J21A	8.95	CE-206	2.95	724B	3.22	UX-6653	.65
3B7/1291	.29	6J7GT	.71	7F8	.92	34	.99	7BP1	12.87	2J22	8.95	211	.62	725A	8.95	7193	.22
3C6 (XXB)	1.15	6J8G	.96	7H7	.72	35/51	.72	7BP7	4.95	2J26	7.80	WE-215A	.24	726A	14.50	8011	.87
3D6/1299	.29	6K5GT	.86	7K7	.95	35A5	.65	7BP14	14.95	2J27	13.70	221A	1.95	730A	10.95	8012	1.45
3Q4	.69	6K6GT	.52	7L7	.79	35L6GT	.59	9LP7	3.88	2J31	9.60	WE-231D	1.25	731A	2.45	8012A	1.91
3Q5GT	.79	6K7	.54	7N7	.79	35W4	.45	905	4.47	2J32	14.45	WE-245A	1.35	WL787	9.80	8013	.92
3S4	.61	6K7G	.54	7Q7	.65	35Y4	.65	10BP4	24.66	2J33	19.90	WE-249C	1.88	800	1.88	8013A	1.42
3V4	.72	6K8	.83	7S7	.96	35Z3	.65	10FP4	28.88	2J34	19.90	WE-257A	2.77	801A	.48	8016	1.18
5AZ4	.48	6K8GT	.79	7V7	.96	35Z5GT	.44	12DP7	12.85	2J37	13.70	WE-259A	4.22	802	4.25	8020	1.39
5R4GY	1.05	6L6	1.22	7W7	.96	36	.69	12GP7	12.85	2J38	12.70	WE-271A	6.75	803	4.87	8025	3.17
5T4	.89	6L6G	1.11	7Y4	.65	37	.59	Photo Cells		2J48	14.95			804	8.95	9001	.42
5U4G	.59	6L6GA	.87	7Z4	.65	38	.69			2J61	36.20			805	4.75	9002	.39
5X4G	.59	6L7	.87	10Y	.19	39/44	.49	CE-1C/918	.88	2JB51	3.89			807	1.15	9003	.39
5Y3GT	.38	6N7	.87	12A6	.24	41	.59	1P24	.29	2K23	23.95			808	2.19	9004	.39
5Y4G	.46	6P7G	1.28	12A7	1.16	42	.59	923	.97	2X2/879	.49			810	6.55	9006	.29
5Z3	.59	6Q7	.69	12A8GT	.72	43	.59	927	1.67	2X2A	.79			811	1.71	189048 (6A-Tungar)	3.15
5Z4	.79	6R7	.89	12AH7GT	.87	45	.59	930	.88	3B22/EL-IC	1.12			813	6.95		
		6S7	.94	12AT6	.59	45Z5GT	.65	931A	3.22	3B24	1.07			814	3.79		
		6S7G	1.02	12AT7	.99	46	.84	1645	1.67	3B27/836A	1.29						

COAXIAL CONNECTORS

83-1AP	.09	UG-30/U	.94
83-1H	.10	UG-33/U	14.80
83-1J	.68	UG-34/U	12.80
83-1R	.28	UG-36/U	12.80
83-1RTY	.45	UG-37/U	12.80
83-1SP	.28	UG-58/U	.57
83-1SPN	.28	UG-85/U	.62
83-1T	1.12	UG-86/U	1.22
83-22AP	.85	UG-87/U	.68
83-22F	.88	UG-171/U	1.33
83-22R	.48	UG-176/U	.16
83-22SP	.48	UG-180A/U	3.82
UG-7 AP	2.14	UG-191/AP	57
UG-12/U	.63	MX-195/U	.41
UG-21/U	.67	UG-197/U	1.33
UG-22/U	.86	UG-206/U	.58
UG-23/U	.63	UG-254/U	.88
UG-24/U	.67	UG-255/U	.82
UG-27/U	.68	UG-264/U	1.74
UG-29/U	.83	MX-367/U	.15

10H-528	British Pye recept.	.46
10H-529	British Pye plug	.46
10H-628	British Pye feed-thru	.66
D-163950	WE Holmdel plug	.85
ES-685696-5	WE Holmdel 70 ohm tack	.85
ES-689172-1	WE Holmdel plug	.85

Type "J" POTENTIOMETERS

100 (SS) 50K (SS)
500 60K
1000 (SS) 100K
6500 (SS) 100K (SS)
10K 150K
10K (SS) 200K (SS)
15K (SS) 250K (SS)
20K (SS) 500K (SS)
25K 1meg. (SS)
25K (SS)

All shaft lengths min. 3/8" except where marked (SS)—screw slot

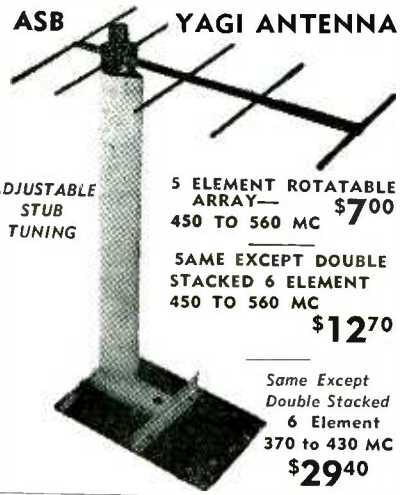
38c Each

RADIATION COUNTER TUBES

AMPEREX 151N GAMMA COUNTER..... 9.85
AMPEREX 100 C BETA COUNTER.....49.50
AMPEREX 200 C ALPHA COUNTER.....59.40

All material brand new and fully guaranteed. Terms 20% cash w/ order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna.

ASB YAGI ANTENNA



ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY— 450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

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AT-38A/APT—(70 to 400 MC).....$13.70
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MODEL AS8-4 — Radar Equipment — Complete — Brand New $69.75
CWI-60AAG Range Calibrator for ASB.....$34.95
PHASE SHIFT CAPACITOR—Type D-150734—4 Stator—Single Rotor $2.69

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTOR

Type 937-0240

Freq. Cycles	100	Res.—Phase 1	3060
Volts—Phase 1	85	Res.—Phase 2	7760
Volts—Phase 2	68	No. of Poles	4
Current—Phase 1—110 MA		Speed—RPM	2650
Current—Phase 2—40MA		Weight—Oz.	6.5
Input Watts—No Load 2650 RPM CW			5.8
Input Watts—Stalled			5.0
Torque Stalled—(Oz. In.)			.80
Temp. Rise (°C)—2650 RPM—No Load			54
Temp. Rise (°C)—Stalled			54
Reversing Time—(Seconds)			0.1
Moment of Inertia (G. CM.²)			6.7

Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

GENERAL ELECTRIC
FG-172
THYRATRONS
$14.50

$10.00 EA.
IN LOTS OF 10
BRAND NEW
ORIGINAL CARTONS
FULLY
GUARANTEED

AMERTRAN
FILAMENT TRANSF.
Pri— 115 Volt, 60 cy.
Sec—5 Volt—190 Amp.
35 KV. Insul.
$19.50

AT-48/UP
3 CM HORN ANT.
$3.95
$3.50 each (Lots of 10)
Type N Plug to connect to Probe 67c

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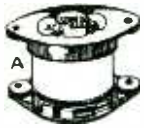
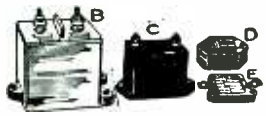
HIGH CURRENT MICAS



Type G4 Ceramic Case
5¾" High, 5" Diameter
Tolerance 5% or Better

CAP MFD	Amps 1 Mc	Amps 300 Kc	KV DC	Price Each
.08	60	42	4	$30.50
.1	70	50	4	32.50
.05	60	42	5	27.50
.037	45	35	6	29.50
.02	40	30	9	32.50
.02	55	38	10	34.50
.0117	40	27	14	27.50
.0075	39	27	15	27.50
.009	40	25	15	32.50
.00978	40	25	15	32.50
.01	43	28	15	34.50
.0025	23	15	20	32.50
.00315	26	18	20	33.50
.00411	27	18	20	34.50
.004	30	20	22	38.50
.0033	25	16	25	38.50
.00082	14	8	30	30.50
.001	16	10	30	31.50
.00132	20	12	30	32.50
.00153	21	13	30	33.50
TYPE G3 4" High 5" DIAMETER				
.0013	15	9	15	19.50
G1 2½" High 2-1/16 DIAMETER				
.004	16	11	6	4.95

BAKELITE CASED MICAS



MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	D .005	3 KV	$ .70
E .01	600	.26	C .005	3 KV	1.24
D .02	600	.26	C .006	3 KV	1.50
E .027	600	.26	D .002	3 KV	.70
C .01	1 KV	.45	C .0001	5 KV	.70
C .056	1 KV	.50	C .0005	5 KV	.85
C .07	1 KV	.55	C .0015	5 KV	1.60
D .02	1200	.35	C .003	5 KV	1.90
C .024	1500	.65	C .005	5 KV	2.50
C .033	1500	.75	B .007	5 KV	2.75
C .015	2 KV	.80	B .002	6 KV	3.50
C .02	2 KV	.90	B .003	6 KV	3.75
D .002	2500	.45	B .006	6 KV	4.25
E .005	2500	.55	B .0005	8 KV	2.90
C .025	2500	1.25	B .0012	8 KV	3.25
C .001	3 KV	.90	B .003	8 KV	4.75
C .002	3 KV	.95	B .004	8 KV	5.59

CONSTANT VOLTAGE TRANSF.

Thordarson. Prl. 95-135 or 190-270 volts 60 cycles. Output 115 volts, 350 VA.....$29.75 ea.

CHOKE BARGAINS

6 Henry 60 ma 300 ohms.....3 for $0.99
6 Henry 60 ma 220 ohms.....2 for .99
8 Henry 160 ma 140 ohms..... .99
1.5 Henry 250 ma 72 ohms..... .59
6 Henry 300 ma 65 ohms..... 3.75
4.3 Henry 620 ma 42 ohms..... 6.95
Swing. Choke 1.6/12 Henry 1 Amp/100 ma 15 ohm 17.95

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20 mfd 330 vac—1.85 4 mfd 2000 vdc—3.95
5 mfd 150 vac— .49 10 mfd 2000 vdc—6.95
1 mfd 600 vdc— .29 2 mfd 4000 vdc—4.95
2 mfd 600 vdc— .39 1 mfd 5000 vdc—4.50
4 mfd 600 vdc— .59 .1/.1 mfd 7000 vdc—2.25
6 mfd 600 vdc— .79 .1 mfd 7500 vdc—1.95
3/3 mfd 600 vdc— .79 1 mfd 7500 vdc—9.25
10 mfd 600 vdc— .89 .01/.01 mfd 12 kv dc—5.75
20 mfd 600 vdc—1.99
4 mfd 1000 vdc— .95 .005/.01 mfd 12 kv dc—5.50
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25 .65 mfd 12,500 vdc—12.95
4 mfd 1500 vdc—2.25
6 mfd 1500 vdc—2.95 .75/.35mfd8/16kv—7.95
1 mfd 2000 vdc—1.45 2 mfd 18 kv dc—59.50
2 mfd 2000 vdc—2.25 Mfd 15 kv dc—15.95

W. W. POWER RHEOSTAT

25 Ohms 25 Watt..... .49
150 Ohms 50 Watt..... .59
250 Ohms 50 Watt..... .59
300 Ohms 50 Watt..... .59
Dual 200 Ohms 50 Watt..... .79
8 Ohms 150 Watts..... 1.79
25 Ohms 600 Watts with Knob..... 5.95

PANEL METERS—BRAND NEW

2" WESTON .0-1 Ma Dc 26 ohms res.....$3.50
2" GE 0-1 Ma DC (volt scale)..... 2.95
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2" GE 0-30 Volts DC 1000 ohm/v..... 2.50
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2" GE 0-1 Amp RF (Internal Thermo)..... 2.45
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3" DEJUR 0-100 Ma DC..... 2.95
3" GE 0-200 Ma DC..... 3.95
3" WESTON 0-50 Amps AC..... 4.95
3" TRIPLETT 75 Amps AC..... 2.95
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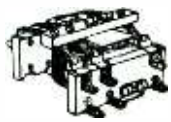
6" WESTON 0-10 Amps DC Mod. 271..... 9.95



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110 V. 60 cycle coil Steatite insulation. Only $1.95 each.

DUNCO RELAY. 6 Volt 60 Cycle AC Coil DPDT Ceramic Insulation 1.95

WESTERN ELECTRIC TRANSTAT Input 115 Volts. 60 Cycles. Output continuously variable from 0-130 Volts. 10 Amps. 1.3 KVA .....15.45 ea.

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110V 60 Cy Pri. Fully Cased.
5 Volt 15 Amp.....$2.75
2.5 Volt 10 Amp..... 3.19
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MULTIPLE SECONDARIES

5¼V CT 21A. 7.5V 6A, 7.5V 6A.....$4.95
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Industrial Instruments model L2AU 110/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter can be extended to 500000 megohms with external supply. Sloping hardwood Cabinet 15"x8"x 10". Brand new with tubes plus running spare parts including extra tubes. Great value. Only $69.50.

50 megohm 35 watt Resistor with mount..$1.95 each; 10 for $15.00

1500, 5000 Ohm 100 Watt Ferrule Resistors.
20,000 Ohm 50 Watt Ferrule Resistors.
Any Types Only 10 for .99.

MINATURE HEADPHONES

250 ohms imp. Can be used for sound power Telephones, etc.
Type HS 30 ..... .69 ea.

LARGE QUANTITY AVAILABLE AT REDUCED PRICES

Hi Imp. Transformer for Above..... .49

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

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watts. 60 to 10,000 cps±1 DB. GREAT VALUE .....ea. $2.75

Thermal Time Delay Relay. 15 to 30 seconds, plugs into 4 Prong Tube Socket Glass Enclosed. 250 V. .95 ea.

Mallory Vibropack Kit. 6 Volt Input. Output 300 Volts at 100 MA. Transformer & Vibrator. $5.95 for both

U. H. F. COAX. CONNECTORS

831AP-UG12U, UG-14U-831, R831SP..... .35 ea.

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass 29 ea. 10 for.....$2.50

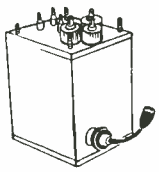
HIGH CURRENT PLATE TRANSFORMER

820 Volts CT at 775 MA. Pri. 110/220 Volts 60 Cycles. Wt. 36 lbs. Fully Cased..... 6.95

SCOPE TRANSFORMERS

Pri 110V 60CY — Hermetically Sealed
2500 V @ 12MA.....$3.95
1050V @ 20Ma, 20V 4.5A, 2.5V 5A..... 4.75

SCOPE AND FIL. TRANSFORMER



Pri. 115 volts, 60 cycles. Sec. 1100 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 $6.75

WESTINGHOUSE

Type MN Overcurrent Relay, Adjustable from 250 ma. to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $5.95.

WIRE WOUND RESISTORS

5 Watt type AA. 20-25-50-200-470-2500-4000 ohms ..... $.09 ea.
10 watt type AB. 25-40-84-400-470-1325-1000-2000-4000 ohms ..... .15 ea.
20 watt type DG. 50-70-100-150-300-750-1000-1500-2500-2700-5000-7500 10000-16000-20000-30000 ohms ..... .20 ea.

30 WATT WIRE WOUND RESISTORS

Ohms: 100-150-1500-2500-3k-4k-4500-5k-5300-10k 15k-18k ..... .15 ea. 8 for .99

ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms..... .25
50 Watt: 80, 100, 500 Ohms..... .35
75 Watt: 40, 80, 100, 150, 200 Ohms..... .39
100 Watt: 20, 50, 75, 120, 180 Ohms..... .49
150 Watt: 50, 100 Ohms..... .59

ALLEN BRADLEY SOLENOID

110 V. 60 cycle coil. DPST .25 Amp Contacts...$3.95

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Single Pole, 6 Position, 50 Amp. Contacts. Model 112 .....$3.95

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.004 1000 VDC Micas.....9 for .99
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.05 600 VDC Oil Tubular.....10 for .99
10 MMF Midget Variable Cond.....4 for .99
Heinman 5 Amp 110 VAC CKT Breaker..... .99
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2 MFD 250 VAC Oil Cond.....5 for .99
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Erie .0005 N750D Ceramicons.....15 for .99
.1x.1 2 KV DC Oil-Condenser..... .79
H&H SPST P.B. Switch N.O.....5 for .99
1/40 Amp (25 Ma) Littlefuses.....15 for .99
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Butterfly Cond. 2-11 MMF Ball Bearings....2 for .99
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GENERAL PURPOSE TRANSFORMERS

Ideal for Bias, Filament Isolation, Stepdown, etc. 2 isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amps. Fully cased.....Now $1.49 ea.

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.

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188 Washington St., New York 7, N. Y. *DEPARTMENT EA*

LINEAR SAWTOOTH POTENTIOMETER

No. KS 15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.

$5.75 Brand New

FULL WAVE BRIDGE TYPE SELENIUM RECTIFIER

Input up to 36V A.C.
Output up to 28V D.C. at 1.1 amps.

8 plates 2½" diameter Fed. Tel. & Tel. Co. Brand New **$2.75**

MICROWAVE RECEIVERS

Types APR1, APR4, APR5A
(38 to 6000 MCs)

Also Tuning Units in stock
TN1, TN2, TN3, TN16, TN17, TN18

Prices on request

12 and 24 Volt POWER KIT

Consists of Power Trans. and full wave bridge selenium rectifier. Input: 115/230 A.C. Output: 12/24V D.C. at 1.1 amps. Fine for operating relays, small motors dynamotors, or for low voltage D.C. source in laboratories, etc.

Brand New **$7.95**

Filament Transformers

For type 866 tubes

Input: 115 volts. Output: 2.5 volts center tapped, at 10 amps. Glazed porcelain standoff insulated for high voltage breakdown. Mfgd. by Kenyon.

Brand New **$3.95**

Micro-Wave Lavoie Freq. Meter

375 to 725 MCS

Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 MIN. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries $69.50

Full data on request.

MP22 Mast Base Insulator

Ideal for marine, mobile vertical whip antennas. Complete, new with mounting plate and hardware.....$2.75

3CM Antenna Horn For receiving or transmitting Type AT-48/UP with coax recept. Brand new $4.75

LINE FILTER

Elimostat 20 amp. 115 volts A.C. or 600 D.C. Brand new $1.75

PILOT LAMP

Aircraft "grain of wheat" 3V Mazda G.E. 323 Brand New .....10¢ ea.

High Voltage Capacitors

Oil Filled

.25 MFD., 20KV., 35 lbs. $15.75
.5 MFD., 25KV., 35 lbs. $23.50
1 MFD., 15KV., 35 lbs. $16.50
1 MFD., 7.5KV., 15 lbs. $5.95

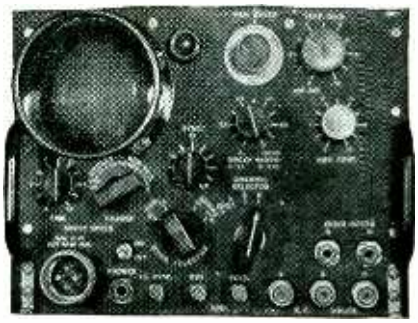
All brand new. Made by prominent manufacturers

BROADCAST EQUIPMENT

Limiter Amplifiers, type BC730C. Rack Mounting with dust covers. Milliameter and D.B. meter on front panel. Brand new with tubes.....$89.50

Attenuator Panel, R.C.A. Type 89-C. Model MI-7515-E. Brand new.....$149.50

MODEL AN/APA 10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:

(1) Panoramic (2) Aural

(3) Oscillographic (4) Oscillosocopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc, 5.2mc, or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

Includes 80 page T. M..... **$195.00**

LINE VOLTAGE STABILIZERS

Raytheon—Navy Type, CRP-301407 Input: 92-138V, 57/63 CPS., 1 PH. Output: 115V, 0.82 KVA., 1% Reg., 0.96 PF. Weight 250 lbs. Enclosed in Navy Grey Ventillated Cabinet for Wall Mounting.
Brand New $97.50
Raytheon—Spec. No. W 5768 Input: 95-130V., 1.25A., 60 CPS., 1 PH., Output: 115V., 60 watts.. Load P.F. 90%.
Brand New $12.50
SOLA—Cat. No. 3004., 115V., 60 cy.. 1 PH 500 V.A. $32.50

THERMOSTATIC TIME DELAY RELAY

Amperite type 115 No.—45 Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V-3A., A. C. (or 440V., A.C. 2A) max. voltage on contacts—1000. max voltage bet. contacts and heater—1500. Size 3 9/32 x 1¼" overall. Made for U. S. Navy.....$1.10

AUTO TRANSFORMER

G.E. 400 cy. Cat. No. 80G184 K.V.A. .945S—.520P Volts 460/345/230/115 New $4.50

FILAMENT TRANS.

400/2600 cy.

Input: 0/75/80/85/105/115/125V Output: 5V3A, 5V3A, 5V3A, 5V3A, 5V6A, 5V6A, 6.3V5A, 6.3V5A $3.95

THYRATRON POWER TRANS.

Raytheon UX8876. 400/1600 cy. PRI: 115V, 1 PH. Sec: 50-0-50V at 0.5A, 6.3V 1.2A Test RMS1780 $2.75

Pulse, Input Trigger Inverting

Westinghouse 145 R.N. Fosterized.....$2.65

PULSE

Utah No. 9350..... ...$1.25

BLOCKING, OSC.

Westinghouse #132 Fosterized S/N 132 .....$2.95

Synchro Differential

90/90 volts, 400 cycles. Brand new in sealed containers. Ford Inst. type 5SDG. Brand new.....$12.50

SYNCHRO TRANSMITTERS

115 Volt—60 cycle. Brand new in sealed metal containers. No. C78248. Size 5. Brand New. Per Pair $14.75

MERCURY CONTACT VACUUM RELAYS

WE Type D-168479

Glass sealed, mercury-wetted contact switches surrounded by operating coils encased in metal housings on octal tube base. S.P.D.T. contacts. 2 coils, 700 and 3300 ohms. Operating current coils seriesed 6.6 MA releasing at 5.2MA. Operating life 1000 hrs. at 60 operations per sec. Use for • High speed keying • tabulating • sorting and computing machines • Relay amplifiers • Vibrator supplies • Servo Mechanisms, etc.

Send for 4 page technical data

$4.75 ea. Brand New

SWEEP GENERATOR CAPACITOR

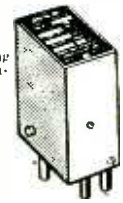
High speed ball bearings. Split stator silver plated coaxial type, 5-10 mmfd. Brand new $1.00

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil. Brand new.$1.00

TWO-IN-ONE CRYSTAL UNITS

Bendix type MX-9E



Each unit contains 2 crystals differing in freq. by 455 kc. Following frequencies available:

2457-2912	4287-4742
2481-2936	4310-4765
2530-2985	4360-4815
2539-2994	4435-4890
2560-3015	4702.5-5157.5
2562.5-3017.5	4713-5168
2407-2862	4930-5385
2945-3400	4935-5390
3820-4275	4975-5430
3860-4315	5080-5535
4002.5-4457.5	6485-6940
4175-4630	6515-6970
4242.5-4697.5	

Special price in lots of 100

$1.65 Brand New

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR

Available in quantity—following frequencies

5910—6350—6370—6470—6510
6610—6670—6690—6940—7270
7350—7380—7390—7480—7580
9720—Kilocycles

Brand New **$1.00**

SOUND POWERED FIELD SETS

Type TP-3

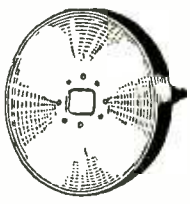
Contained in serviceable canvas cases. Brand new—export packed Per unit as illustrated.....$24.50

SOUND POWERED BATTLE PHONES

Western Electric Type 0 #D173312. Brand new in original cartons.

Per unit as illustrated.....$19.50

PARABOLOIDS



Spun Magnesium, 17½" dia.. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center.

Brand new per pair $8.75

TUBE HEATERS

Type WAAGE 100 watts Brand new .50

400 CYCLE INVERTERS

Bendix Pioneer type 12121-A. Input: 24 volts D.C. at 18 amps. 12,000 RPM. Output: 115 volts, 400 cy., 3 PH., 250V.A. Weight: 10.6 lbs. Brand new...$129.50

Bendix Pioneer type 12117-2-B. Input: 24 volts D.C. at 1 amp. Output: 26 volts, 400 cy., 6VA., 1 Ph. Weight: 2.1 lbs.....$17.50

General Electric type 5D21NJ3A. Input: 24 volts D.C. Output: 115V., 400 cy. at 485V.A. Brand new..$12.50

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT
INC.
5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

SELENIUM RECTIFIERS
— and —
ELECTRONIC COMPONENTS

THREE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0–126VAC Type #	Current	Output 0–130 *VDC Price
3B7–4	4 AMP.	$32.95
3B7–6	6 AMP.	48.90
3B7–15	15 AMP.	70.00

Input 0–234VAC Type #	Current	Output 0–250 *VDC Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–15	15 AMP.	120.00

SINGLE PHASE FULL WAVE CENTER TAPPED RECTIFIERS

Input 10–0–10VAC Type #	Current	Output 9–8 *VDC Price
C1–10	10 AMP.	$6.95
C1–20	20 AMP.	10.95
C1–30	30 AMP.	14.95
C1–40	40 AMP.	17.95
C1–50	50 AMP.	20.95
C1–80	80 AMP.	28.95
C1–120	120 AMP.	38.95

CUSTOM DC POWER SUPPLIES
Built to your specifications. For:
- INDUSTRY
- LABORATORIES
- UNIVERSITIES
- GOVERNMENT AGENCIES

We will be pleased to quote on your requirements.

SINGLE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0–18VAC Type #	Current	Output 0–12 *VDC Price
B1–250	250 MA.	$ .98
B1–500	500 MA.	1.95
B1–1	1 AMP.	2.49
B1–1X5	1.5 AMP.	2.95
B1–3X5	3.5 AMP.	4.50
B1–5	5 AMP.	5.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95
B1–80	80 AMP.	44.95

Input 0–35VAC Type	Current	Output 0–26 *VDC Price
B2–150	150 MA.	$ .98
B2–250	250 MA.	1.25
B2–300	300 MA.	1.50
B2–1	1 AMP.	3.95
B2–2	2 AMP.	4.95
B2–3x5	3.5 AMP.	6.95
B2–5	5 AMP.	9.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
B2–30	30 AMP.	36.95
B2–40	40 AMP.	44.95

Input 0–54VAC Type #	Current	Output 0–38 *VDC Price
B3–150	150 MA.	$1.25
B3–250	250 MA.	1.95
B3–600	600 MA.	3.25
B3–5	5 AMP.	13.95
B3–10	10 AMP.	24.95

Input 0–72VAC Type #	Current	Output 0–50 *VDC Price
B4–600	600 MA.	$3.95
B4–3	3 AMP.	14.95
B4–5	5 AMP.	17.95
B4–10	10 AMP.	27.95

Input 0–115VAC Type #	Current	Output 0–90 *VDC Price
B6–150	150 MA.	$1.95
B6–250	250 MA.	2.95
B6–600	600 MA.	5.95
B6–750	750 MA.	6.95
B6–1X5	1.5 AMP.	10.95
B6–3X5	3.5 AMP.	18.95
B6–5	5 AMP.	24.95
B6–10	10 AMP.	36.95
B6–15	15 AMP.	54.95

Input 0–234VAC Type #	Current	Output 0–190 *VDC Price
B13–600	600 MA.	$12.95
B13–1X5	1.5 AMP.	19.95
B13–3	3 AMP.	35.95
B13–5	5 AMP.	48.95
B13–10	10 AMP.	69.95

★ *Select Proper Capacitor to Obtain Higher VDC Than Indicated.*

RECTIFIER CAPACITORS

CF-14	3000 MFD	12VDC	1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-2	2000 MFD	15VDC	1.69
CF-20	2500 MFD	15VDC	1.95
CF-3	1000 MFD	25VDC	1.25
CF-4	2X3500 MFD	25VDC	3.45
CF-5	1500 MFD	30VDC	2.49
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF-19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-21	1200 MFD	90VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	200VDC	3.25
CF-12	125 MFD	350VDC	2.49

RECTIFIER TRANSFORMERS

All Primaries 115VAC 50/60 Cycles

Type #	Volts	Amps.	Price
XF15–12	15	12	$3.95
TXF36–2	36	2	3.95
TXF36–5	36	5	4.95
TXF36–10	36	10	7.95
TXF36–15	36	15	11.95
TXF36–20	36	20	17.95
XFC18–14	18 VCT	14	5.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts. XFC type is tapped to deliver 16, 17, 18 Volts Center-Tapped.

RECTIFIER CHOKES

Type No.	Hy.	Amps.	D.C.Res.	Price
HY5	.02	5	.25	$3.25
HY5A	.028	5	.09	3.95
HY10	.02	10	.30	9.95
HY10A	.014	10	.04	7.95
HY15	.015	15	.30	13.95
HY20A	.007	20	.02	12.95

Type "A" low resistance chokes are specially suited for circuits requiring excellent voltage regulation.

RECTIFIER SURGE PROTECTION

When an inductive DC circuit is opened, a high voltage surge is produced that may damage a rectifier power supply. This danger can be reduced by the application of a non-linear resistance device known as Thyrite. Further information will be found in catalog #719.

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and Type C1 ..... $ .35 per set
For Types B13 ..... .70 per set
For Types 3B ..... 1.05 per set

RECTIFIER KIT #612-10

6 and 12 VDC at 10 Amps.

This unit will deliver unfiltered direct current for operation of motors, dynamotors, solenoids, electroplating, battery charging and similar equipment.
The two output voltages may be used simultaneously, and varied above and below their nominal ranges.
Complete with schematic diagram; shpg. wt., 12 lbs. **$15.95**

Filter Kits For #612-10

1 Section choke input, 10% ripple..$9.64
2 Section choke input, 2% ripple..19.28

VACUUM CAPACITORS

Standard Brands

12 Mmfd	20 Kv.	$4.95
50 Mmfd	20 Kv.	4.95
50 Mmfd	32 Kv.	5.95

EDISON THERMO TIME DELAY RELAY

Heater voltage 115 V. Norm. open SPST contacts. 15-30 sec. delay. Contact rating 115 V. 3A., 440 V. 2A. Size 3¾" x 1⅛" diam. Standard 4 prong tube base ..... **98c ea.**

OIL CONDENSERS

2 Mfd 200VDC Bathtub ..... $ .20
.5 Mfd 400VDC telephone type ... .20
2 Mfd 400VDC Bathtub ..... .30
2X.1 Mfd 600VDC Bathtub..... .39
6 Mfd 600VDC w/mtg. Clamp .... .79
8 Mfd 660VAC/2000VDC w/Brkts. 3.50
15-.15 Mfd 8000VDC Voltage Doubler Type 26F381 w/Brkts..... 3.95

SPECIAL—LIMITED QUALITY FAMOUS BRAND VITAMIN Q PHOTOFLASH CAPACITORS

8 Mfd-3000 V.D.C.—36 Watt Sec. 4½"x 3¾"x1¾". Wt. 1-lb. 12-oz. Price, each $5.95

3 for $15.00

ATTENTION!!!
Bulletin #713, listing various government and commercial surplus items, is now available upon request.

G-R VARIAC

Type 100-R 2KVA. Input: 110 or 220 V.A.C. 60 cps., Output: 0-220 or 0-270 volts. Brand New—Limited quantity. Shpgwt 36 lbs. $39.50

VARIABLE AIR TRIMMERS

Standard Brands—Screw Driver Adjust

	Each	Lots of 10	Lots of 100
7.5 MMFD	$.29	$2.20	$18.00
25 MMFD	.31	2.40	20.00
50 MMFD	.33	2.60	22.00
100 MMFD	.41	3.40	30.00
140 MMFD	.49	4.20	38.00

D-C PANEL METERS

Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%.

0-5 Amperes D-C	Any range
0-2 Amperes D-C	$2.49 each
0-15 Volts D-C	

Minimum order $3.00. No C.O.D.'s. Add 10% for Prepaid Parcel Post and Handling. Terms: Net 10 days in the presence of approved credit.

All prices subject to change without notice.
All Prices F.O.B. our NYC Warehouse

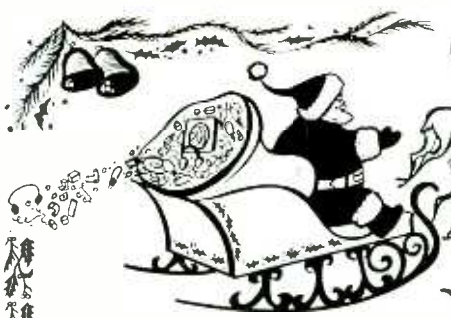
PILOT LIGHT ASSEMBLIES

Aircraft type, panel mounting, amber jewel. Knurled rim, controls "Dim-Bright", Bakelite and aluminum construction. Bulb replaceable from front panel. For single contact bayonet bulbs, up to T-3¼ size. Dimensions: 2¼" overall length, 3¼" diameter, ⅝" panel mtg hole.

IMMEDIATE DELIVERY — 500 to Carton. Request Prices on company letterhead.

WRITE FOR SELENIUM RECTIFIER CATALOG #719

OPAD-GREEN COMPANY
71 Warren St.
New York 7, N.Y.
Phone: BEekman 3-7385-6



THERE *is* A SANTA CLAUS at LIFE ELECTRONICS

LOOK AT THESE "GIVE AWAY" VALUES

• RESISTORS
EB½, GB1 and HB2

LIFE OFFERS THE MOST COMPLETE INVENTORY OF ½, 1 and 2 WATT RESISTORS IN 5% and 10% TOLERANCES IN THE COUNTRY

Stock	Wattage	Tol.	Price Sched.* 1–99	100 or more
EB½	½ Watt	10%	$.06	$.04
EB½	½ Watt	5%	.12	.08
GB1	1 Watt	10%	.09	.06
GB1	1 Watt	5%	.18	.12
HB2	2 Watt	10%	.15	.10
HB2	2 Watt	5%	.30	.15

*Prices shown are " per size "

THE FOLLOWING VALUES ARE AVAILABLE IN 10% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	100	1000	10000	.1	1.0	10.0
12	120	1200	12000	.12	1.2	12.0
15	150	1500	15000	.15	1.5	15.0
18	180	1800	18000	.18	1.8	18.0
22	220	2200	22000	.22	2.2	22.0
27	270	2700	27000	.27	2.7	
33	330	3300	33000	.33	3.3	
39	390	3900	39000	.39	3.9	
47	470	4700	47000	.47	4.7	
56	560	5600	56000	.56	5.6	
68	680	6800	68000	.68	6.8	
82	820	8200	82000	.82	8.2	

THE FOLLOWING VALUES ARE AVAILABLE IN 5% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	68	470	3300	22000	0.15	1.0	6.8
11	75	510	3600	24000	0.16	1.1	7.5
12	82	560	3900	27000	0.18	1.2	8.2
13	91	620	4300	30000	0.20	1.3	9.1
15	100	680	4700	33000	0.22	1.5	10.0
16	110	750	5100	36000	0.24	1.8	11.0
18	120	820	5600	39000	0.27	2.0	12.0
20	130	910	6200	43000	0.30	2.2	13.0
22	150	1000	6800	47000	0.33	2.2	15.0
24	100	1100	7500	51000	0.36	2.4	16.0
27	180	1200	8200	56000	0.39	2.7	18.0
30	200	1300	9100	62000	0.43	3.0	20.0
33	220	1500	10000	68000	0.47	3.3	22.0
36	240	1600	11000	75000	0.51	3.6	
39	270	1800	12000	82000	0.56	3.9	
43	300	2000	13000	91000	0.62	4.3	
47	330	2200	15000	0.1	0.68	4.7	
51	360	2400	15000	0.11	0.75	5.1	
56	390	2700	18000	0.12	0.82	5.6	
62	430	3000	20000	0.13	0.91	6.2	

TYPE "J" POTENTIOMETERS

No better pot at any price, no source more complete than Life Electronic Sales.

Available in screw-driver and regular shafts locking and non-locking type bushings.
When ordering locking type bushing potentiometers, locking nuts are available at $.05 each.
Type "J" pots available in the following values from stock.
Specify whether regular or screw-driver shaft is required.

Single Pots				Dual Pots	Triple Pots
Ohms	Ohms	Ohms	Ohms		
50	1000	10000	60000	3000	150,000
60	1300	15000	70000	10000	500,000
100	1500	20000	100000	25000	
200	2000	22000	200000	50000	Price Schedule
250	2500	25000	250000	100000	
400	3000	30000	500000	250000	Single pots..S.50
500	5000	35000	600000	500000	Dual pots..1.50
600	6500	50000	1 Meg	1 Meg	Triple pots.2.50
				5 Meg	

SILICON DIODES

Type	Design Freq. (mc)	Price each
1N21	3,000	$.50
1N21B	3,000	1.00
1N23	10,000	1.25
1N23A	10,000	1.50
1N23B	10,000	2.00

GERMANIUM DIODES

Type	Price each
1N34	$.85
1N35	2.00

"UHF" COAXIAL CABLE CONNECTORS

83-1T 83-1SP 83-1SPN 83-1R

No.	AN No.	Description	Ea.	Per C.
83-1SP	PL259	Plug	.35	.28
83-168	UG176U	Adapter	.15	.12
83-185	UG175U	Adapter	.15	.13
83-1SPN	PL259A	Plug	.35	.28
83-776	UG203U	Plug	.61	.55
83-1R	SO239	Receptacle	.35	.28
83-1RTY	.....	Receptacle	.50	.45
83-1H	UG106U	Hood	.12	.10
83-1HP	.....	Hood	.27	.24
83-765	UG177U	Hood	.31	.25
83-1AC	.....	Cap and chain	.61	.50
83-1BC	.....	Cap and chain	.38	.34
83-1T	M358	"T" connector	1.12	.98
83-1AP	M359A	Angle adapter	.35	.28
83-1J	PL258	Junction	.85	.70
83-1F	PL274	Feed thru	1.12	.98
83-22SP	UG102U	Twin plug	.50	.40
83-22R	UG103U	Twin recept	.50	.40
83-22AP	UG104U	Twin ang. adapt.	.98	.80
83-22J	UG105U	Twin junction	1.25	1.12
83-22T	UG196U	Twin "T"	1.65	1.50
83-22F	PL275	Twin feed thru	1.50	1.35
83-2SP	PL295	L'ge twin plug	1.94	1.75
83-2R	SO265	L'ge twin recept.	1.44	1.30
83-2H	M365	L'ge Hood	.24	.22
83-2AC	.....	L'ge CAP and chain	.61	.55
83-2AP	PL325	L'ge Twin angle adapt.	2.08	1.88
83-2J	PL305	L'ge twin junction	1.45	1.30

COAXIAL CABLES

BRAND NEW! ! !
JAN APPROVED! ! !

RG No.	Impedance	Price per Thousand Ft.
RG5U	52.5 ohms	$70.00
RG6U	76.0 ohms	150.00
RG7U	97.5 ohms	70.00
RG8U	52.0 ohms	55.00
RG9U	51.0 ohms	135.00
RG9AU	51.0 ohms	125.00
RG10U	52.0 ohms	125.00
RG11U	75.0 ohms	100.00
RG12U	75.0 ohms	190.00
RG13U	75.0 ohms	125.00
RG18U	52.0 ohms	450.00
RG19U	52.0 ohms	350.00
RG20U	52.0 ohms	450.00
RG22U	95.0 ohms	120.00
RG24U	125.0 ohms	240.00
RG25U	48.0 ohms	575.00
RG27U	48.0 ohms	290.00
RG29U	53.5 ohms	50.00
RG34U	71.0 ohms	125.00
RG38U	52.5 ohms	400.00
RG39U	72.5 ohms	180.00
RG41U	67.5 ohms	575.00
RG54U	58.0 ohms	65.00
RG54AU	58.0 ohms	75.00
RG57U	95.0 ohms	100.00
RG58U	53.5 ohms	50.00
RG59U	73.0 ohms	45.00
RG62U	93.0 ohms	50.00
RG65U	950.0 ohms	250.00
RG71U	93.0 ohms	175.00
RG74U	52.0 ohms	250.00
RG78U	48.0 ohms	80.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50% to prices shown.

BRAND NEW!! UG TYPE CONNECTORS JAN APPROVED!!

UG 30/U UG 88/U UG 290/U UG 306/U UG 352/U

AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.
UG9 U....	$.95	UG23BU...	1.29	UG88 U...	1.17	UG146 U..	2.25	UG235 U..	28.50
UG10 U....	1.56	UG27AU...	2.25	UG89/U...	.95	UG155, U..	.40	UG236 U..	11.75
UG11 U....	1.45	UG28 U...	2.34	UG90/U...	1.05	UG154 U..	5.35	UG241/U..	2.20
UG12 U....	.95	UG29/U...	1.22	UG91/U...	1.25	UG156 U..	4.25	UG242/U..	2.50
UG13 U....	1.56	UG29AU...	1.36	UG91AU...	1.05	UG157, U..	4.25	UG243/U..	2.75
UG14/U...	1.45	UG31 U...	1.75	UG92/U...	1.10	UG160/U..	1.90	UG244 U..	2.50
UG15/U...	.95	UG32 U...	20.00	UG92AU...	1.35	UG160AU..	1.55	UG245/U..	1.25
UG16/U...	1.56	UG33 U...	20.00	UG93/U...	1.25	UG167/U..	3.00	UG246 U..	1.45
UG17 U....	1.45	UG34 U...	17.50	UG93AU...	1.45	UG173/U..	.30	UG252/U..	4.50
UG18 U....	.99	UG35AU...	16.00	UG94 U...	1.25	UG174/U..	16.00	UG254/U..	1.82
UG18/AU..	1.05	UG36 U...	16.00	UG94AU...	1.05	UG188/U..	.95	UG255/U..	1.85
UG19BU...	1.09	UG37/U...	16.00	UG95/U...	1.10	UG195/....	.75	UG259 U..	4.10
UG19/U....	1.28	UG37AU...	16.00	UG95AU...	1.35	UG197/U..	5.00	UG260/U..	.99
UG19AU...	1.38	UG57/U...	.99	UG96/U...	1.25	UG201 U..	1.83	UG261/U..	.95
UG19BU...	1.45	UG58/U...	.65	UG96AU...	1.45	UG202 U..	2.75	UG262/U..	1.05
UG20/U....	1.17	UG59 U...	2.75	UG97/U...	3.50	UG204 U..	2.25	UG269/U..	2.60
UG20AU...	1.26	UG59AU...	1.70	UG98/U...	1.55	UG206/U..	1.02	UG270 U..	6.50
UG20BU..	1.41	UG60 U...	1.90	UG100/U..	2.34	UG208, U..	28.00	UG273 U..	1.50
UG21 U...	.99	UG60AU...	1.30	UG101/U..	2.95	UG212 U..	4.50	UG274 U..	1.98
UG21AU...	1.05	UG61/U...	2.05	UG107/U..	2.25	UG213 U..	4.50	UG279 U..	2.40
UG21BU...	1.09	UG61AU...	1.80	UG108/U..	1.75	UG215, U..	3.35	UG287 U..	5.25
UG22/U....	1.08	UG62 U...	28.00	UG109/U..	1.75	UG216 U..	8.70	UG290 U..	.85
UG22AU...	1.38	UG83 U...	1.50	UG114/U..	1.50	UG217 U..	3.10	UG291 U..	1.05
UG22BU...	1.34	UG85, U...	1.65	UG115/U..	1.33	UG218 U..	6.50	UG306 U..	2.03
UG23, U...	.99	UG86/U...	1.69	UG123/U..	.45	UG222 U..	35.00	UG333 U..	4.70
UG23AU...	1.26	UG87 U...	1.40	UG131/U..	6.00	UG231/U..	2.00	UG334 U..	5.75
								UG352 U..	6.00

TUBE SPECIALS

2K41	$65.00
2J36	125.00
5J29	14.95
5J32	35.00
417A	12.95
1Q26	35.00
889	75.00
327A	3.00

ODDS 'N' ENDS SPECIALS

50 Mmfd Air Trimmers	$ .29
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=TJU50020 2 mfd 5000 Volt	9.95
Dual 7-45 Mmfd Silver Trimmer	.49
JBT Model 31F 58-62 Cycle Freq. Meter	4.95
1 Pound Roll Linen Lacing Cord	1.65

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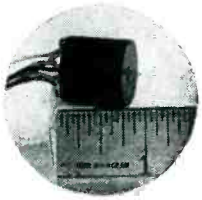
MINIATURE DC SELSYN INDICATOR



Miniature indicator. 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-268. **Price $6.75 each.**

G.E. POSITION TRANSMITTER

Type 8TJ9—continuously rotatable 360° wound potentiometer. Taps every 120 degrees. Two 180° opposed sliders. 24 v. d-c operation with indicator described above. Stock #SA-13. **Price $4.75 each.**

DC GENERATOR

Ford Instrument Co. Compound Wound. Bu. of Ordnance Dwg. 223128. 115 v. d-c @ 0.75 amperes. Cont. duty. Ideal for laboratory use. **Special low price $2.95 ea.** Stock #SA-258.

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

Prices on Request

LP-21-LM Compass Loops

New

Motor driven loop enclosed in graphited zeppelin housing includes Autosyn transmitter.

$9.50 each

MAGNESYNS

Pioneer CL-3

Use as transmitter or indicator on 26 v. 400 cy. or 52 v. 800 cy. May be used as indicator with 360° potentiometer on d-c.

Stock #SA-6 **Price $1.45 each**

DYNAMOTOR

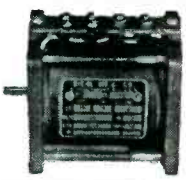
D-101 27 v. d-c in @ 1.5 amps d-c out. 285 v. @ 0.60 amps. Stock #SA-187.

Price $1.50 each

Remote Position Indicating System

6-12 v. 60 cycles 5 inch indicator with 0 to 360° dial. Heavy duty transmitter. Stock #SA-115. **Price $9.95 per system**

AC-SERVO MOTORS



Diehl FPE-25-11

Navy CDA-211052

New condition except shaft machined to shorter length.

Special $9.75 ea.

Minneapolis-Honeywell

60 cycle Servo Motor Type M623CY1X1

17 watts. 162 rpm.

#SA-277.

Price $19.50 ea.

Pioneer Type CK-2.

26 v. 400 cycles fixed phase, var. phase 49 v. max. 1.05 in/oz. Stall torque. Rotor moment of inertia 7 gm/cm: With 40:1 gear reduction.

Stock #SA-97A. **Price $6.50 each.** Also available less gear train as Stock #SA-97. **Price $4.25 each.**

KOLLSMAN 400 cy. RATE GENERATOR

Model 863-04302

Output 4.2 volts per 1000 rpm.

#SA-280.

Price $16.50

MERCURY CONTACT RELAY

W.E. D-168479

Millisecond switching at up to 60 c.p.s. Technical data on request. Stock #SA-259. **Price $4.75 ea. Special qty. prices.**

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Universal Electric DC

W.E. KS-5603-I-02, 28 v. d-c 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA233.

Price $1.95 ea. plus 15c p.p.

OSTER PM MOTOR

Alinco Field

27.5 v. d-c. Can also be used as rate generator. #SA-281 **$3.75 each**

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5 v d-c 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension, 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75**

Delco 506925 Constant Speed DC Motor, 27 v. d-c 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.**

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Stock #SA-180 **Price $19.50 each**

Elinco B-64 DC Servo Unit—80 v. d-c max. armature voltage, 27.5 v. field. 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.

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General Electric 2 RPM Motor. Type 5BA10FJ228. 27 v. d-c @ 0.6 amps. 10 lb/in torque at 2 rpm. Shunt wound. L-C noise filter. Stock #SA-274. **Price $6.75 each.**

General Electric ½ HP D-C Motor. Type 5BA50LJ66. Armature voltage 60 v. max. field 27 v. Armature current 9.25 amps. field 2.3 amps. 4600 rpm. 7" lg. x 4¼" diam. with 2½" worm gear shaft ⅝" diam. Stock #SA-270. **Price $12.50 each.**

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DPDT 110V. slide switch---------- .19
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Telephone type, plate sensitive relay-7000 ohm, SPDT---------- 1.95

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1 Meg. multiplier, 1% tolerance------ .89
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100 assorted ½ watt resistors in popular sizes ---------- 1.49

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500 W.V.D.C. 10c ea. 12 for $1.00
Available capacity (MFFD's), 2, 3, 4, 5, 7, 8, 8½, 10, 11, 12, 15, 24, 25, 30, 40, 100, 120, 125, 140, 232, 350, 375, 400, 470, 45, 50, 51, dual 60, 70, 72, 75, 80, 81, 95, 500, 1000 and 5000.

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1MFD-5000 V. paper oil type------- 2.95
1MFD-6000 V. paper oil type------- 4.95
.1 MFD-7000 V. tubulars--- 1.95
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1 MFD-1000 V.---------- .44
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Assorted micas-------per one hundred 1.95

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TN-3A 300-1000 MC Detector (uses 1N29 XTAL ---------- 2.95
TN-30 135-485 MC Oscillator
TN 300-1000 MC oscillator (uses 368AS doorknob tube) ---------- 3.95
Ceramic silver padders—dual 3 to 12 MMFD or 3 to 20 MMFD --------- .19
Ceramic mica padder—single 5-20 MMFD per doz---------- .50

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MODULATION & DRIVER XFMRS-RC 1206 mod. xfmr., 815 class AB2, 56W. audio. RC1205 driver xfmr. 6SN7 to 815, class AB-2 (companion to RC 1206). Both units for only ----------$4.95
SCOPE XFMR.—pri. 110V-60 cy., sec. 4000V. at 10 ma., 6x4x3½"-- 3.95
AUDIO OSC. XFMR. with FEEDBACK and OUTPUT windings---- .95
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304TL—Ideal for 1 KW final, induction heater or dielectric heater. Efficient operation at 1500-3000 V. —typical operation 2500V. at 400 ma. ----------$ .75

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3 A P 1	$2.95
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AN-3108-36-15S	AN-3100-32-6P
AN-3108-28-2S	10H-529
PL-Q37	AN-3057-24
AN-3106-24-2S	AN-3102-14S-1P
AN-3106-28-2P	PL-147
AN-3057-16	AN-3106-32-101S
AN-3057-8	AN-3102-18-20S
UG-21/U	U-16/
PL-Q171-10H/414	PL-112
AN-3108-14S-2S	PL-118
AN-3102-14S-2S	AN-3102-20-27P
AN-3108-40-1S	MC-136
PL-182-10H/258-S	ARC-9589
AN-3108-22-17P	AN-3102-22-14P
AN-3108-24-19P	AN-3102-14S-75
AN-3106-22-1S	AN-3106-18-12S
AN-3102-18-5S	AN-3106-16S-1P
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BC 223 AX Transmitter—BRAND NEW—801 oscillators and 801 PA's, (2) 46 mods. & (1) 46 speech amp. 4 xtal freqs. and master osc. on selector switch—tone voice or CW mod., 10-30 W. output. Ideal for 80 meter band. Complete with 2 coils TU 17A 2000-3000 kc, TU-25 3500-5250 kc.—black crackle case. Two extra cases to store coils. Freq. chart and tubes incl., packed in orig. cases, less xtals.----------$39.95

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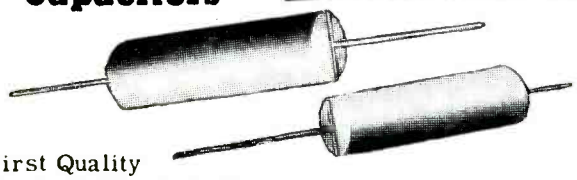

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SC2024	.002	3/8 x1 1/8	.085	.076	.069
SC4024	.004	3/8 x1 1/8	.085	.076	.069
SC5024	.005	3/8 x1 1/8	.085	.076	.069
SC6024	.006	3/8 x1 1/8	.085	.076	.069
SC1034	.01	3/8 x1 1/8	.085	.076	.069
SC1534	.015	3/8 x1 1/8	.085	.076	.069
SC2034	.02	3/8 x1 1/8	.085	.076	.069
SC4034	.03	7/16 x1 1/4	.085	.076	.069
SC5034	.05	7/16 x1 1/4	.105	.092	.083
SC6034	.06	7/16 x1 1/4	.12	.107	.096
SC1044	.1	1/2 x1 1/2	.12	.107	.096
SC1544	.15	9/16 x1 5/8	.12	.107	.096
SC2044	.2	5/8 x2	.135	.122	.109
SC2544	.25	5/8 x2	.15	.135	.122
SC5044	.5	7/8 x2	.20	.18	.162
SC1054	1.	1 1/16 x2 1/2	.305.	.275	.247
	600 V. D. C. WORKING				
SC2516	.00025	3/8 x1 1/8	.085	.076	.069
SC5016	.0005	3/8 x1 1/8	.085	.076	.069
SC7516	.00075	3/8 x1 1/8	.085	.076	.069
SC1026	.001	3/8 x1 1/8	.085	.076	.069
SC2026	.002	3/8 x1 1/8	.085	.076	.069
SC3026	.003	3/8 x1 1/8	.085	.076	.069
SC4026	.004	3/8 x1 1/8	.085	.076	.069
SC5026	.005	3/8 x1 1/8	.085	.076	.069
SC6026	.006	3/8 x1 1/8	.085	.076	.069
SC8026	.008	7/16 x1 1/4	.085	.076	.069
SC1036	.01	7/16 x1 1/4	.105	.092	.083
SC1536	.015	7/16 x1 1/4	.105	.092	.083
SC2036	.02	7/16 x1 1/4	.105	.092	.083
SC3036	.03	1/2 x1 1/2	.12	.107	.096
SC4036	.04	1/2 x1 1/2	.12	.107	.096
SC5036	.05	1/2 x1 1/2	.135	.122	.109
SC6036	.06	9/16 x1 5/8	.135	.122	.109
SC8036	.08	5/8 x2	.15	.135	.122
SC1046	.1	5/8 x2	.15	.135	.122
SC1546	.15	5/8 x2	.17	.153	.138
SC2046	.2	3/4 x2	.19	.17	.15
SC2546	.25	7/8 x2	.19	.17	.15
SC5046	.5	1 x2 1/8	.27	.24	.217
SC1056	1.	1 3/8 x2 5/8	.42	.38	.343
	1000 V. D. C. WORKING				
SC10210	.001	3/8 x1 1/8	$ .105	$ .092	$ .083
SC20210	.002	3/8 x1 1/8	.105	.092	.083
SC30210	.003	3/8 x1 1/8	.12	.107	.096
SC40210	.004	3/8 x1 1/8	.12	.107	.096
SC50210	.005	7/16 x1 1/4	.135	.122	.109
SC60210	.006	7/16 x1 1/4	.135	.122	.109
SC80210	.008	7/16 x1 1/4	.15	.135	.122
SC10310	.01	7/16 x1 1/4	.17	.153	.138
SC15310	.015	1/2 x1 1/2	.17	.153	.138
SC20310	.02	1/2 x1 1/2	.17	.153	.138
SC30310	.03	1/2 x1 1/2	.19	.17	.15
SC40310	.04	5/8 x2	.19	.17	.15
SC50310	.05	5/8 x2	.20	.18	.162
SC60310	.06	5/8 x2	.20	.18	.162
SC80310	.8	3/4 x2	.22	.197	.18
SC10410	.1	3/4 x2	.25	.225	.202
SC15410	.15	1 1/16 x2 1/2	.27	.24	.217
SC25410	.25	1 1/16 x2 1/2	.30	.27	.24

200 and 1600 volt units also available. Phone or write for complete list and prices.

60/40 Solder tin/lead

IMMEDIATE DELIVERY
FIRST TIME IN 10 YEARS

World-famous Ersin Multi-Core solder. .064 inch diameter. #16 S.W.G.
$1.45 a lb. on 7 lb. spools

Coaxial Connectors

A complete line of Army-Navy type UG coaxial connectors made by Kings Electronics is listed in our September Monthly Mailer. It is the only such listing available. Kings Electronics holds more type approvals under JAN C-71 and other applicable specifications than any other manufacturer. These connectors are brand new but cost no more than surplus. Write today for your copy.

Sun Radio MONTHLY MAILER

Items on this page are typical of those listed in the Sun Radio Monthly Mailer, a new publication which brings to the industrial electronics field news of new, unusual or particularly interesting items from our large, varied, and up-to-date stock. Each issue includes a page of bargains for quantity buyers. You'll like it!

To get on the mailing list for the Sun Radio Monthly Mailer, write us on your letterhead.

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122-124 DUANE STREET
NEW YORK 7, N. Y.
TELEPHONE BARCLAY 7-1840

WORTHWHILE SAVINGS TO YOU:

T-102 — Filament Transformer. American Transformer Co. Spec. 29106. Type WS .050 KVA, 50/60 cyc. Single phase, 35 KVA test, 12 KV D.C. operating. Primary 115 V., secondary 5 V., 10 amps with integral standoff insulator and socket for 250 T. 371, 872 and 5563, etc., rectifier tubes $12.50 Net Wt 15¾ lbs. Dim. 6½" W x 6" D x 12" H.O.A.

MOTOR GENERATORS AND PUMPS

G.E. type CC-21991: Input 115 v d-c @ 5.7 amps. Output 115 v a-c 60 cyc. single phase, 350 va @ 85% P.F. $58.00
G.E. type CC-21990: Input 32 v d-c @ 22 amps. Output 115 v a-c 60 cyc. single phase, 350 va @ 85% P.F. $63.00
Portable Vacuum Pump Assembly: Leland 110/220 v 60 c. 1 phase 1 h.p. motor with S CFM automatic oiler; mounted on tubular steel frame $86.00

CONSTANT VOLTAGE TRANSFORMERS

95 to 125 v. 50 c. 1 ph. input; 115 v. output:
120 va $13.20
380 va 27.00
500 va 34.00

Raytheon

198 to 242 v. 50/60 c. 1 ph. input; 220 v. 500 w. output $38.00

NEW RA-38 RECTIFIERS

115 v., 60 cy. 1 phase input, output 0-15,000 v. d-c @ 500 ma. Write for detailed information.

G.E. BATTERY CHARGER TRANSFORMER

Cat. #WS-99316. Pri. 105-115-125v. 60 cyc.: Secondary 105-90-75-60-45-30v. @ 6 amps. each side of center tap. Voltage reduced 10% & 20% thru tapped primary: Two X 5 v. 18 amp. C.T. (Tungar filaments) & two X 7 v. 10 amp. 7¼" H. x 8¾" W. x 5½" D. Wt. 56 lbs. New—original packing. G.E. net $52.00, our price $17.50

GASOLINE GENERATOR

Onan type CDO-7300I-A (for TBW Radio Equip.) 120 v. 800 c. 1 ph. @ 9.8 amps. 14 v. d-c @ 20 amps. New, in water-tight metal case $140.00

TUBE STOCK CLOSEOUT

DISCOUNTS 20% on orders over 100.00
30% on orders over 500.00

( ) indicates stock on hand. Subject to prior sale & limited to present stock.

All Tubes are New, of Standard Mfg., in original boxes.

Type	Price
1B22 (10)	$4.25
1B23 (10)	4.75
2J62 (50)	37.50
3B22 (175)	2.50
3B24 (15)	1.50
3C23 (300)	2.25
4B28/S2891 4	
6 A. Rectigon (450)	2.75
15E (200)	1.25
250TL (6)	19.50
304TL 115 v. 60 c. HV filament transformer & socket (40)	7.50
307A/RK75 (40)	3.75
316A (30)	.35
388A (30)	2.75
450TH (4)	22.50
700A (2)	9.75
701A (7)	3.50
702A (25)	2.75
703A (125)	2.75
704A (5)	1.00
705A (30)	1.00
706BY (6)	12.50
706EY (4)	12.50
707A (20)	12.50
707B (75)	7.50
708A (7)	2.75
713A (15)	.75
714AY (200)	3.75
715A (15)	7.50
717A (10)	.50
719A (10)	9.50
721A (1)	2.75
722A (15)	7.50
725A (7)	8.50
730A (9)	10.50
811 (7)	1.50
830B (5)	3.25
846 (2)	47.50
872A (300)	1.75
921 (40)	1.25
931A (300)	2.50
C5B (20)	7.75
C6A (40)	8.25
C6J (50)	4.75
FG81A (200)	3.75
WE-203A (4)	8.75
VT98(Br.) (30)	12.50

NEW CAPACITORS

2 mfd 600 v. d-c tubular..$.30; 10 for $2.50; $20.00 per C.
3.5/5 mfd 1,000 v. d-c $.90 4 for $3.00
3 x 1.0 mfd 1,200 v. d-c wk; isolated sections $1.20
1.25/1.25 mfd 7.5 kv d-c or .625 mfd 15 kv d-c; Standard Brand $12.50
.25/25 mfd 7.5 kv d-c or .125 mfd 12 kv d-c $3.75
1.0 mfd 25 kv d-c; Standard Brand..$36.00
500 mfd 200 wv d-c electrolytic; insulated terminals ..... .95
.001 mfd 25 kv d-c mica; 25 A @ 3,000 kc, 18 A. @ 1,000 kc, 11A. @ 300 kc. $25.00
50 mmfd 32 kv d-c tubular vacuum..$4.95
9.12 mfd 1265 v. a-c, 4000 v d-c. New; Standard Brand $17.00

METERS

Weston or Westinghouse

3" 0-120 a-c amps. w/current transf..$8.50
3" 0-20 kv d-c w/precision multiplier. 18.00
3" 0-4 kv d-c w/precision multiplier. 9.50

SPECIALS

Westinghouse Meter Multiplier: Type R-5 1 meg., ½% tol., w.w noninductive $1.25
Tube WL 386/ML-3W; 125 KV X-ray oil immersion rect.; 10 v. 11.6 A. fil..$32.00
CRAMER Time Delay Relay: TD2 1208; 0-120 sec., 115 v. 60 c., syn. motor-driven; 10 A., 115 v., S.P.N.O. contact $4.95
Motor: 27 v. d-c, 0.7 A., 110 R.P.M., 1 oz./ft. torque $3.50
Solenoids: 115 v., 60 c; continuous wt. 5¼ lbs. $2.75
Intermittent, wt. 9 lbs. $2.75
Indicator: 1-81-A Radio Compass. New $3.85

RESISTORS

200 watt wire wound resistors, ferrule ends 160,000 ohm, 5,000 ohm, or 1,000 ohm $1.00

TRANSTATS

Variac 115 v, 50/60 c. input; 0-135 v @ 1 amp output. Type 200B..$9.50
Variac 115 v. 50/60 c. input; 0-135 v @ 5 amps output. Type 200 CU $14.00
115 v. 50/60 c; 0-130 v. 10 amp output $24.50
115 v. 60 c; 103-126 v. 2.17 amp output $9.50
115/230 v. 50/60 c; 0-260 v. 2.5 amp output $21.50

TRANSFORMERS

115 v. 60c. primaries
Amertran: 17,600 v @ 10.4 K.V.A. cont. $65.00
Amertran: 8,800-0-8,800 v @ 10.4 K. V. A. cont. $75.00
Westinghouse: 18,400-0-18,400 v @ 9 K. V. A., cont., plus 2 WL-531 rect. tubes, fil. transf. & 50 h 575 ma choke $160.00
24 v. @ 1 amp. uncased $1.60

RELAYS

Westinghouse Type SC-M Overcurrent relay, .2 to 1 A., .8 A. cont. rating 20-40% drop out ratio $12.95
A-B 810 Overload Relay, 6.3-18-1 A., 600 v. max $7.95

CHOKES

Amertran: Swinging, 900 h @ 16 ma, 25 h @ 525 ma, 35,000 v test..$42.00
Kenyon: 20 h @ 300 ma. 15,000 v test $12.00

CONTACTORS

I.T.E.: 115 v, 60 c. coil, Single pole 115 A. 600 v. with barriers, adj. time delay & remote contact control trip $10.95
A-B #RC-3301: 115 v. 60 c. coil D.P.S.T. 15 amp contactor $4.95
Monitor: 115 v. 60 c. coil N.O.D.P. contactor, 100 A. 600 v. N. C. 15,-600 v. 1.0A. contact. One N. O. & one N. C. interlock w/150 A & 30A. renewable fuses $8.95

DRY DISC RECTIFIERS

Continuous Duty Ratings

3.5 v a-c, FWB, 1.8 v d-c @ 1.0 amp. $ .90 each, 4 for $3.00
6.5 v a-c, FWCT, 2.2 v d-c @ 3.0 amps. $1.20 each, 5 for $5.00
0-36 v a-c, HW, 200 ma d-c $ .75 each, 2 for $1.00
0-54 v a-c, FWB, 1.6 amps d-c $4.40
0-154 v a-c, FWB, 600 ma d-c $6.85
0-180 v a-c, FWB, 400 ma d-c $6.90

ASD RADAR TRANSMITTER & MODLULATOR

3 centimeter: complete with 725A magnetron, cavity, two 723A/B Klystrons, one RKR73, four 72's, one 715B, one 829B, two 724B's, two 6AC7's, one 1N23 crystal diode, high voltage supply, two cooling blowers, etc. Input: 115 v. 400 c. N-2 condition $110.00
Preamp assembly: includes plumbing (2) 723 A/B's, (2) 6AC7's, (2) 724B's, 1N23, etc. $37.50
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All merchandise in "as new" condition. Add approx. 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C. O. D. All prices f.o.b. Los Angeles Warehouse. Write for additional detail information on any of the above items and for special quantity discounts. Telephone MAdison 6-5391.

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BC-319-A TRANSMITTER. CW only 300 watts output Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes.
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WILCOX, 96-200A 2-KW RF section. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Less tubes.
PRICE $300.00

TBK-10, 500 W., 2-18.1 MC, CW Telegraph Transmitter designed for ship installation. Almost new condition, complete with tubes, but less MG set and accessories. **PRICE, EACH** $350.00

WILCOX 98A Ground Station, A-3 emission 50 to 200 mc, 50 W. output, 4-channels dial telephone selection, with receiver for above frequency coverage, and remote control unit. For 110 volts AC. Excellent condition. With tubes.
PRICE, EACH $600.00

LINK FM Transmitter-Receiver, 70-100 MC. 50 Watts Output. Model 1498 DC. Wall style cabinet containing transmitter, receiver and 14 V.D.C. power supply, handset. Dim.: 34"x21"x11". NEW CONDITION. Complete with tubes, crystals, special telescopic antenna, instruction book, 50 W. output. **PRICE EACH** $500.00

MODEL SVC100L/110 TRANSMITTER. Output A1 150-watts, A2-A3-50 W. Mfd. by Phillips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from 90-260 volts 50/60 cy. A.C. **COMPLETE,** with tubes $450.00

BC-1100 (RC-263). 75W. A1, 50W, A2, 4 channel dial selection of channel. 1.5-10 mcs. 110-260V 25-60c. AC., with remote control. New.
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SUPREME ship-to-shore transmitter receiver. 110W output, 9 channel, 2-3 mcs., crystal controlled for 110V. 60c. A.C. Condition N-2. Complete with tubes and microphone. **EACH** $500.00

MASTER POWER METER PANEL, for measuring voltage, current, and frequency of 2 to 4 50 KW power units of 240 v. 3-phase-3 wire or 3-phase-4 wire, 60 cycles AC. Measures each phase lead. Measures current 0-300 or 0-600 amps., through selection of current transformers. Dim: 22"x34"x20". Has many industrial applications. NEW condition.
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DZ-2 DIRECTION-FINDING EQUIPMENT, with loop assembly, 28 V. DC operation, 15-70 & 100-1500 Kcs. NEW.
PRICE, EACH $150.00

SCR-511 "POGO STICK" WALKY-TALKY. Portable low-power AM radiotelephone for 2 to 6 mc operation, with 13 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Transmitter receiver BC-745 of this SCR-511 includes telescopic antenna and "Press-Talk" Switch as well as all cables. Range 5 miles, plus. With PE-157 2-volt storage battery operated Vibrator Power Supply, 2-Volt Battery (less electrolyte), T-17 mike, all ready for immediate operation. NEW.
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32 VOLT DC to AC ROTARY CONVERTER, mfd. by Kato. For yachts, workboats, or farm installation. Output 110 V., 60 cycles AC, rated 225 watt but good to 300 watts. All NEW units.
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DECK ENTRANCE INSULATORS, bowl and flange type. 8⅞" dia. with heavy galvanized metal flange and bell. Top bell 6¼" dia. 11½" brass feed-thru rod. Very high voltage insulation. Individually packed in cartons, all NEW.
12 FOR $18.00

GENERAL ELECTRIC AMPLIDYNE M.G. SET, generator type #V-5875677, motor type #73AB58, Navy #CG-21ABU, 115/230V, 60c., motor rated at ¾ HP., generator output 250V. DC at 375W. NEW. $60.00

GENERAL ELECTRIC AMPLIDYNE MODEL 5AM78AB47 MOTOR GENERATOR SET. Motor 3HP 440V, 3 phase. Output 250V. DC at 3 amps. and 60V. DC at 12.5 amps. Excellent Condition. $85.00

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Infra-Red Image Converter Tube (British) to make "Snooperscopes," "Sniperscopes," and other devices that see in the dark. Operates with invisible infra-red rays, without scanning or amplifiers. See October Radio Electronics for interesting constructional article! Supplied with technical data and diagrams. Every tube guaranteed!
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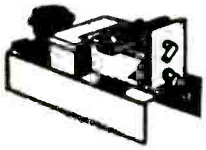

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Compact, beautifully built line oscillator employing two W E. 368AS (703A) "doorknob" tubes in push-pull. Exceptionally stable. 5W output at 420mc, 2W at 700mc. Independent grid and plate tuning. Adjustable output coupling and tuning assembly. Coaxial output connection. Built-in blower may be operated from 110VAC. Power requirements: 300VDC/150ma, 1.2V/4A, 1.2V/4A. 5¼"x6½"x11½". 7 lb. Supplied complete with tubes. Ideal for 420mc amateur operation or for use in the 460-470mc citizens radio band. **Stock No. APO-66....$8.95**
Spare 368AS/703A tubes.....**$1.69 ea.**

JAN TUBES

BRAND NEW IN ORIGINAL CARTONS
*(Except as specified with *)*

1B24	$4.75	RKR-73	$0.95	954	$0.39
2C44	1.75	304TH	3.95	955	.39
2D21	1.19	304TL	1.95	956	.49
2J38	14.95	417A	19.95	957	.39
2J48	14.95	705A	1.95	958A	.39
2K28	24.95	715B	9.95	959	.39
2X2A	0.89	715C	24.95	991/NE16	.29
3D21A	1.95	723A/B	14.95	2050	.79
5R4GY	1.09	724B	4.75	8013	1.49
6AC7*	.79	725A	7.50	9001	.39
6AG7	1.19	805	3.95	9002	.39
6AK5	1.09	811	1.95	9003	.39
6AL5	.75	814	3.95	9004	.39
6J6	.95	815	1.95	9006	.39
6SL7GT	.69	829B	4.75	OB3/VR90	.89
6SU7GT/Y	1.29	872A	1.69	OC3/VR105	.89
6Y6G	.88	902A	3.95	OD3/VR150	.69
72/3B24	.95	931A*	3.95		

Specify JAN tubes when ordering.
** Manufacturers bulk pack JAN.*

Wide Range Butterfly Wavemeter & Oscillator Elements

Precision wide range butterfly circuit elements. Sturdily constructed. Mounted in ball bearings. Suitable for motor drive. Ideal for use as wavemeters and oscillators (See description below.)

Stock No.	Freq. (mc.)	Notes*	Unit Price
TN-20	105–330	1, 3	$4.95
TN2A	75–300	1, 4	4.95
TN-30	135–485	2, 3	5.95
TN3A	300–1000	2, 5	6.95

Brand new, in original packing.

* NOTES: 1) Aluminum construction
2) Silver-plated brass
3) Designed as oscillator element (955 acorn triode)
4) Has diode socket mounted on unit (955 as diode)
5) Has crystal diode mount for 1N21 crystal

WE CARRY A LARGE AND VARIED INVENTORY WHICH INCLUDES:

- AMPLIFIERS
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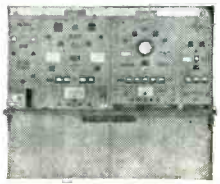

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Complete Guaranteed Shipboard Radio Unit! SAVE! ! ! !

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Some used, Some new, All guaranteed. All items subject to prior sale.

MACKAY RADIO Models Available
155 and 156 Type Radiotelegraph Transmitters
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Write immediately for Bargain Prices! ! ! Act Now! ! !

DON'T MISS THIS MONTH'S SURPLUS SPECIALS!

Heavy Duty ½" Red Pilot Light Holders—19c ea—ten for $1.50 (New)

(Used but Good) Western Electric Aircraft Receiver, Model RU/19 Type CW-46048D 24 v. D.C. c/w six tubes, one coil and plug, less power supply—$2.85 ea. New J-38 Telegraph Keys, on Bakelite Base, in original cartons—25¢ ea.—ten for $2.00.

DYNAMIC MICROPHONE
REPLACEMENT UNIT
(New—in original boxes)

50 ohms impedance
$2.35 ea.

Repair that old Microphone

MOBILE DYNAMOTOR SPECIAL

Type 377—Model 1
Input—14 volts
8 amperes
Output—425 volts
163 mils

Made for Western Electric by Eclipse Aviation
New—in original cartons)
$4.85 ea.

Complete with Filter and Starting Relay—no plugs furnished.

ADVANCE RELAYS! !
Type 1605—6 volts D. C.
D.P.S.T.
(New—in original boxes)

59¢.—ten for $5.00

R.C.A. and Remler 250-watt Audio Systems, c/w Speakers. Prices on request. Telephone Switchboards and Accessories. Mark II Transmitter-Receivers (New), with Power Supply and Mounting Rack. No accessories. While they last—$25.00 ea. Bendix Aircraft Transmitters, Receivers and Power Supplies, Control Heads, Relay Boxes, Loops, etc. Write your requirements. Marine, Aircraft, Television items by the hundreds. Write or wire your needs.

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AIRCRAFT BLOWERS

Westinghouse Type FL 115 v. 400 cy. with capacitor

Price $1.95

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Gyro, driven by series motor, provides electrical signals for both the roll and pitch of the aircraft. Has many valuable parts such as precision variable resistors, bearings, contacts, etc. Amphenol connector not included. Original price $1500.00

Special $4.95

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Three channel servo amplifier consisting of many valuable electronic parts including 6 relays, 7 tubes, etc. Unit removed from new aircraft.

Super Special $5.95

PIONEER AMPLIFIERS

Shock-mounted case and chassis includes many transformers, condensers, potentiometers, etc. Supplied less output transformer and tubes.

Our Low Price 98c

NOISE FILTERS

3 chokes and three oil-filled AC capacitors mounted in an assembly with 4 pin Amphenol connector.

A Steal at 39c

NEON BLOWN FUSE INDICATORS

Rated for 110-220 volts either AC or DC. Can also be used for general testing for "opens" "shorts", etc.

Price 39c

TUBES

6SN7	$ .59
6H6	.39
7F7	.59
7N7	.59
7Y4	.59
CIB—Grid control rectifier (thyratron)	1.95

TERMS: 20% cash with order—balance C.O.D. Orders accompanied by payment in full must include sufficient postage, otherwise shipment will be made via Railway Express collect. Minimum order $2.00

ELECTRO-DEVICES
Incorporated
Box No. 1941 PATERSON, N.J.

TEST EQUIPMENT

X BAND SIGNAL GENERATOR, 8500-9600 mc, calibrated wavemeter and attenuator, for 110 V 60 cps operation.

SPECTRUM ANALYZER FOR X BAND, TSX-3SE, Sylvania, good working order, 110 V 60 cps.

TS-45A/APM-3 SIGNAL GENERATOR, 9200-9600 mc, 110 V 60-800 cps.

X BAND WAVEMETER CAVITY, TRANSMISSION TYPE, 9200-11000 mc.....$15.00

WAVEMETER CAVITY, 8500-9600 mc, **TRANSMISSION TYPE**.....$35.00

TS-155B/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 v, 60 cy. NEW.

TS-155A/UP S BAND SIGNAL GENERATOR, pulsed calibrated output, 110 v, 60 cy. NEW.

SPECTRUM ANALYZER FOR S BAND, TSS-4SE, Sylvania, good working order, 110 V, 60 cps.

TPS-51PB/20, S BAND 20 db PAD.....$20.00

X BAND PICK-UP HORN.....$10.00

TS-62/AP ECHO BOX FOR X BAND

APR-1 RADAR SEARCH RECEIVER, complete with tuning units for range of 38-4000 mc, 30 mc I.F., 2 mc wide.

TUNING UNITS for **APR-1** or **APR-4 RECEIVERS** (can be used with any 30 mc amplifier):

TN-16, range 30-90 mc
TN-17, range 80-300 mc
TN-19, range 1000-2000mc
TN-54, range 2000-4000 mc

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier direct reading VSWR meter, slotted wave guide with gear drive traveling probe, matched termination and various adapters, with carrying case, NEW. UNITS I AND II are available separately, or together as a test set.

TA-16 VOLTAGE STANDING WAVE RATIO MEASURING AMPLIFIER (similar to the amplifier of TS-12/AP Test Set).....$180.00

S BAND SIGNAL GENERATOR CAVITY with cut-off attenuator. 2300-2950 mc, 2C49 tube, with modulator chassis.....$30.00

HIGH PASS FILTER F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc $12.00

UPN-1 S BAND BEACON RECEIVER TRANSMITTER.....$75.00

S BAND TEST LOAD, TPS-55P/BT. 50 ohms $8.00

X BAND TEST LOAD, TS-108/AP. 150 watts accessories.....$35.00

LAE-2 SIGNAL GENERATOR, 520-1400 mc. CW & pulse modulation, calibrated output 110 V. 60 cps, used, good condition.

LAF-1 SIGNAL GENERATOR, 100-600 mc. CW & pulse modulation, calibrated output, good condition, 110 V, 60 cps operation.

GENERAL RADIO SIGNAL GENERATOR MODEL 522, 250-1000 mc, good operating condition.

GENERAL RADIO POWER OUTPUT METER, MODEL 583-A.....$45.00

GENERAL RADIO VACUUM TUBE VOLTMETER MODEL 726, good working order $120.00

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case, new $175.00

FEDERAL RADIO SIGNAL GENERATOR MODEL 804C, 7.5-330 mc, good operating condition

MEASUREMENTS 78E, 50-75 mc, calibrated output.....$100.00

FERRIS MODEL 22A SIGNAL GENERATOR, 85 kc to 25 mc. Output .2 microvolts to 1 volt, modulation variable, good working order $175.00

FERRIS MODEL 10 B SIGNAL GENERATOR, 85 kc to 25 mc, calbrated output, good working order.....$100.00

LABORATORY RECTIFIER, Sylvania 541-A, 3500 volts at 2 amperes DC

LB-3 LIMIT BRIDGE, INDUSTRIAL PRODUCTS.....$60.00

P-4 SYNCHROSCOPES, made by Sylvania or Browning Lab.....$175.00

SIGNAL GENERATOR 1-72-K, 100 kc-32 mc, output not calibrated, 110 v, 60 cps....$35.00

AUDIO OSCILLATOR, HICKOK 198, RC tuned, 20-20000 cps.....$45.00

TEST SET TS-278/AP FOR AN/APG-13, synchronized, delayed pulse signal generator, 400-430 mc, calibrated waveguide below cutoff attenuator, synchronized marker generator, 115 V, 60 cps, NEW, COMPLETE.....$160.00

TS-10/AP FOR APN-1.....$40.00

RCA SCOPE, 5" MODEL 160B, NEW, export packed.....$125.00

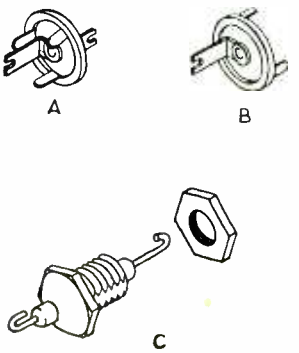
CLOUGH BRENGLE RESISTANCE CAPACITY BRIDGE, model 230A, new.....$50.00

FIXED ATTENUATOR PADS, 20 db + 0 — 2 db, DC—1200 mc, 50 ohms. VSWP 1.3 or less, 2 watts average power.....$30.00

MUTUAL INDUCTANCE ATTENUATOR, Calibrated: frequency range .1 to 1000 mc by means of plug-in coils, attenuation range 120 db $100.00

MUTUAL INDUCTANCE OR PISTON TYPE ATTENUATOR, type N connector's rack and pinion drive, attenuation variable 120 decibles, calibrated 20-120 db. frequency range 300-2000 mc.....$32.00

MUTUAL INDUCTANCE OR PISTON TYPE ATTENUATOR, similar to above, except upper frequency limit is 3300 mc.....$32.00



CERAMIC FEED-THRU CAPACITORS
Type A..... 300 mmf..... 10 for $2.00
Type B..... 300 mmf..... 10 for $2.00
Type C..... 55 mmf..... 10 for $1.00

TRANSFORMERS, 115 volts, 60 cps primaries:

1. 6250, 3250 and 2000 volts, tapped primary, voltage doubler, 12.5 kv ins.....$14.00
2. 6250 volts 80 ma. ungrounded, G.E. voltage doubler, 12.5 kv ins.....$12.00
3. 2 secondaries at 500 volts 5 amps each, wt 210 pounds.....$50.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 ko impedance ratio 120 to 2350 ohms $3.00

PULSE TRANSFORMER, UTAH 9280.....$1.50

PULSE TRANSFORMER 132-AWP.....$6.00

PULSE TRANSFORMER, GE 68G, 828G-1..$5.00

PULSE TRANSFORMER, Westinghouse 145-EWP $10.00

TS-10/AP CALIBRATED DELAY FOR APN-1 $25.00

TS-203/AP CALIBRATED SELSYN.....$10.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

U.H.F. RIGHT ANGLE ADAPTER 83-1AP 10 for $2.50; 1000 for $125.00

W.E. TELEPHONE NETWORKS: D-161638, D-161844, D-162627, D-162629, D-162631, D-162632, D-162624, D-162635.....$1.00 each

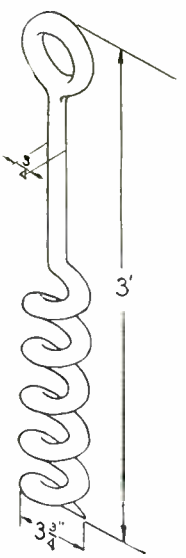
SD-3 SHIPBOARD RADAR, New and complete with test equipment.....$1050.00

SQ RADAR, used but in good working order, complete with antenna, control unit.....$650.00

SN RADAR, used, good working order, complete.....$550.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032.....$3.00

PULSE FORMING NETWORK, 20 kv. .92 microsecond, 50 ohms, 800 p.p.s.....$40.00



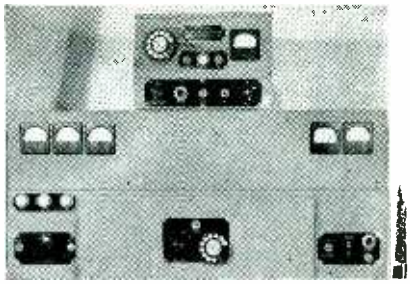
ANCHOR SCREWS from AB26CR Mast Equipment.....$2.00 each

ELECTRO IMPULSE LABORATORY
P. O. Box 250 *Eatontown 3-0768* **Red Bank, N. J.**

Columbia Electronics, Ltd.

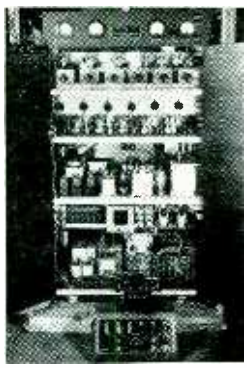
RAYTHEON RECTICHARGER W-3155

Supply current at a constant voltage and supplies current to a storage battery, providing an automatic AC-DC power system; No moving parts; No adjustments; Life of the battery increases as much as 40%; Eliminates voltage variations. 11/12 cells, 22-24 volts at 3 amp. output; Input 95-130 volts, 60 cycles; Weight 180 pounds. $45.00



1100-A FOUR TRANSMITTERS IN ONE

Can be preset on 4 bands. Has BFO or xtal on each from 1.5 to 10 mcs. Oscillators are all between 1.5 and 5 mcs. 6L6 osc. VR-150 regulator, buffer or doubler is a 6L6 into 3-807's in parallel. 125 watts on phone and 125 watts on cw. modulator has 4-6L6's in push-pull parallel. Rig has telephone dial on front for selecting any one of 4 transmitters, selecting phone, CW, turning heaters on, plate current, or turning everything off. Also has remote control unit for remote operation. Used, but in excellent condition. $225.00 With Remote

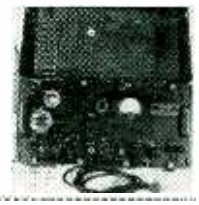


TCR TRANSMITTER

w/remote control, 6-channel, pre-set frequencies in 2 to Mc. 125-Watts output with A2 or A3 emission. Input: 105 to 125, or 210 to 250 volts at 60-cycle (50-60 cy) $275.00

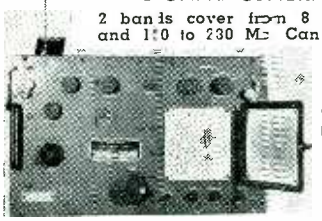
TS-13/AP TEST SET

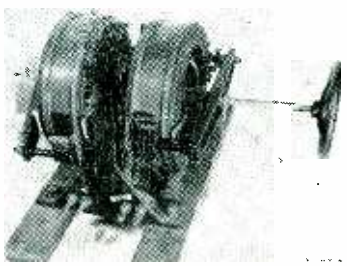
for APS-4 radar, etc. Near new, excellent condition. $275.00



I-222-A RF SIGNAL GENERATOR

2 bands cover from 8 to 15 Mc., and 150 to 230 Mc. Can use up to the 3-harmonic; 110 V, 60 cycle built in power supply. New. $125.00

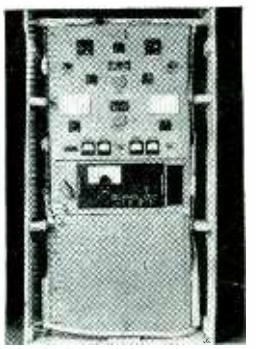




VARIAC TRANSTAT AMERTRAN

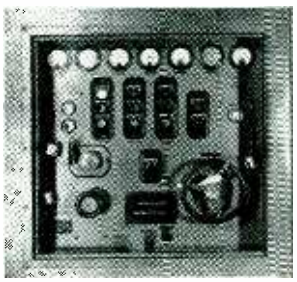
Input 0-115 V., 50-60 cycle; output 115 V 100 amps. 11.5 Kva. Excellent condition. $75.00

MODEL ET-8023-D1 TRANSMITTER



High frequency radio telegraph transmitter. Continuous frequency range of 2 to 24 Mcs., with A1 or A2 emission. Xmitter can be converted to A3 by slight modification of audio amplifier. 225-watts output. Input power 115-VDC. Has center section for Receiver housing. Xtal or M.O. control, with or without Receiver.

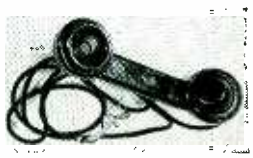
$325.00 Less Receiver



RA-38 RECTIFIER

115 V. 60 cycles, single phase input, output 0-15,000 VDC at 500 ma.

Near New. $275.00



WECO TELEPHONE

No. D-14842, butt-in type with push-to-talk button on side of handle. Brand new. $3.50

COLUMBIA ELECTRONICS LTD.

524 S. SAN PEDRO ST.
LOS ANGELES 13, CALIF.
Cable Address: COLELECT

25% deposit with order. Balance C.O.D.
All items subject to prior sale.

SURPLUS Laboratory Equipment

GENERAL RADIO
107-M Variable Inductor $35.00
616D Het. Freq. Meter
726A, 727A VTVM
775-A Frequency Limit Monitor (1.6 to 45 Mc) $125.00

FERRIS
16-C Std. Signal Generator 50 Kc to 25 Mc
33A Crystal Calibrator
34-A U.H.F. Crystal Calibrator $149.00
18-C V.H.F. Signal Generator

WESTERN ELECTRIC
RA-90A H.V. Power Supplies, New + 4900-1000V: Input 110V 400 CPS $15.00
TS5/AP Range Calibrators, New $50.00

WESTON
Model 45 (0-75 V.D.C. ± 0.5% $35.00
796 Megohmeter (0-200 Megohms) $50.00

MULTIFLEX
MG3 Spotlight Galvanometer $125.00
.00254 gamp. per MM

BOONTON
140-A Beat Frequency Generator ..... $495.00 (20 Cps to 5 Mc ± 2%)
110-A QX CHECKERS
120-A V.H.F. Circuit Checkers ..... $95.00 (3 Ranges—27-210 Mc.) For TV & FM
DUMONT 208B, 224A Scopes; 185A S.W. Gen
RCA Audio Freq. Meter MEAS. CORP. 78B.
SHALLCROSS 630 Wheatstone Bridge $60.00

ALL PRICES F.O.B. N. Y. C.
WAREHOUSE SUBJECT TO PRIOR SALE
SEND FOR COMPLETE LIST

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FAR ROCKAWAY, N. Y.
Cable address NATINSTRU, NEW YORK
TELEPHONE FAr Rockaway 7-1123

POWER SUPPLIES
0-15000 V—.5 amp DC output—115 AC input $395.00
0-15000 V—.035 amp DC output—115 AC input $215.00
CO-AX—CABLE—RG-38-U—FLEXIBLE 55 OHMS ..... 10c Ft.
RADAR—SA—SC—SG—SN—SO—SCR 296—SCR 545—SCR 533—T-2—RC—188 I.F.F.—COMPONENTS AND UNITS. TEST SETS—OAK—TS/33—SL—TS/36 545 OSCILLATOR—3CM—WAVE & WATT METER.
SONAR—QBD—QBF—NJ—components & equipment.
AMPLIFIERS—400 Watt output—115 AC 60 cycle Input. Ideal for 400 cycle test work $125.00
CIRCUIT BREAKERS—120 V AC—20-AMPS—H.C.B. Co. 1.00
RHEOSTATS—50 watt—22—80 or 125 OHMS—Ceramic 1.00
CONDENSERS—D-168574—16MFD—400V—CO—EF—50-+85° C 7.50
TEST CORD—ES-718593-WE Connectors 2.50
NETWORKS—D162693—D164855—D162769—D162770—T48149 and dozens of other types.
TRANSFORMER—Commutator type-input-115V-50/60 cycle 1 phase-output 3x90V @3AMP. type KS-15095Lol $35.00
TRANSFORMER—110V input—7500V output ½KW—Sealed 17.50
MC-363 A Range converter (Mickey Mouse) less tubes 85.00
INSULATORS—8" long—ceramic & Bronze Standoff 1.25
TRANSFORMERS—5 KW—220/5500V Bridge Type 85.00
MOTOR INVERTER—115V—0/16 Cycles—0/20 RPM—GE5SMY—2 Phase—40 Pole—5 Wire—Size 4" Dia x 5¼" O.A.—Synchronous 12.50

VETSALCO INC.

For Electronics

78-21st Ave. *Armory 4-4435* Paterson, N. J.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

ALLEN-BRADLEY CONTROLS

TYPE "J"

ohms	shaft	bush.	ohms	shaft	bush.
50	5/8"	1/2"†	10K	1/8"*	1/2"†
60	1/8"*	1/2"†	10K	3/8"	3/8"
60	5/8"	1/2"†	11K	1/4"	1/4"
100	5/8"	1/2"†	12K	3/8"	3/8"
100	1/8"*	1/2"†	15K	1-1/8	3/8"
150	1/8"*	3/8"	15K	1/8"*	1/2"†
300	3/8"	1/4"	16K	1/4"	1/4"
400	1/8"*	1/2"†	20K	1/8"*	1/2"†
500	1/8"*	1/2"†	20K	3/8"	3/8"
500	1/2"	1/2"†	22K	1/8"*	1/2"†
500	3/8"	1/4"	25K	1/8"*	1/2"†
600	1/2"	1/2"	30K	1/4"	3/8"
600	1/8"*	1/4"	50K	1/8"*	1/2"†
1000	1/8"*	1/2"†	50K	3/8"	3/8"
1000	5/8"	1/2"†	75K	5/16"	7/16"
1200	1/4"*	1/4"	80K	1/2"	1/4"
1300	1/4"*	1/4"	100K	1/8"*	1/2"†
1500	1/8"*	1/2"†	100K	9/16"	3/8"
2000	1/8"*	3/8"	150K	1/8"*	1/2"†
2100	1/8"*	1/2"†	200K	1/8"*	1/2"†
2200	1/8"*	3/8"	200K	3/8"	3/8"
2500	1/8"*	3/8"	250K	1/8"*	1/2"†
4000	1-1/8	3/8"	250K	7/16"	1/2"
4700	3/8"*	1/2"	300K	1/8"*	1/2"†
5000	5/8"	1/2"†	350K	1/8"*	1/2"†
5000	1/2"	1/4"	1meg	1/8"*	1/2"†
5000	1/8"*	1/2"†	1meg	3/8"	3/8"
6500	1/8"*	1/4"	4meg	1/2"	3/8"

50c each

TYPE "JJ" DUALS

ohms	shaft	ohms	shaft
100/100	1/8"*	130K/130K	1/4"*
200/200	1/2"	150K/150K	3/8"
500/500	1/8"*	200K/200K	3/8"
500/500	2-1/8	250K/250K	1/2"
600/600	1-1/2	300K/300K	1/2"
2K/2K	1/8"*	350K/5K	3/8"
5K/5K	2-1/8	350K/25K	5/16"
10K/10K	3/8"	500K/8K	1/2"
20K/2K	3/8"	500K/500K	1/8"*
25K/10K	2-3/4	560K/560K	1/2"
35K/5K	3/8"	700K/700K	1/2"
40K/7K	3/8"	800K/75K	1/2"
50K/50K	1-1/4	1meg/1meg	3/8"
100K/100K	1/8"*	4meg/4meg	3/8"
100K/100K	1/2"	5meg/5meg	1 2"

$1.25 each

TYPE "JJJ" TRIPLES

ohms	shaft
20K/200K/15K	3/8"
20K/200K/20K	3/8"
45K/27K/2500	1/4"
700K/700K/700K	3/4"
750K/750K/750K	1-3/8"
800K/800K/800K	1-3/8"
1meg/1meg/1meg	3/4"

$1.95 each

*Screwdriver slot.
†Locking bushing.

OIL CONDENSERS

Mfd.	Volt.	Each
.1	3000	$0.75
.25	2000	.95
.25	3000	1.10
.25	3500	1.15
1	500	.28
1	600	.35
2	400	.35
2	600	.39
4	600	.59
6	400	.75
6	600	.79
10	600	.98
14	600	1.75
15	600	1.98
15	1000	2.75
30	90v AC 3 Phase	3.95
3x4	400 Plug-in	1.49

SPECIAL WHILE THEY LAST

PL-55
Lock-in Type
28¢
lots of 100
lots of 1000—25¢
less than 100—35¢

BATHTUBS

Mfd	200V	400V	600V
.033	....	17¢	....
.05	17¢	19¢	21¢
.1	18¢	20¢	22¢
.15	....	....	22¢
.25	19¢	21¢	23¢
.35	....	22¢	....
.5	20¢	23¢	25¢
.75	....	....	30¢
1.0	29¢	32¢	35¢
2.0	....	44¢	49¢

4/500V	35¢	2x05/1500V	35¢
8/500V	50¢	2x.1/600V	28¢
16/450V	55¢	2x.25/600V	30¢
25/25V	27¢	2x.5/600V	35¢
25/50V	28¢	2x1/600V	59¢
25/75V	30¢	2x200/9V	49¢
40/25V	27¢	3x.05/600V	40¢
50/25V	28¢	3x.1/600V	45¢
200 12V	25¢	3x.25/600V	50¢
300/6V	35¢	3x1/100V	40¢

RADIO NOISE FILTERS

A—MALLORY #NFI2-7, 115 volts AC. Filters hash out of power line. Case 3¼ x 3 x 1..... .98
B—SPRAGUE #JX-51, 10amp 6-30V DC. Case 2 x 2 x 1⅛..... .69
C—MALLORY #NFI-1 Batt-Motor. Case 3⅛ x 3⅞ x 2⅜..... 1.49

POWER RHEOSTATS

ohms	watt	ea.	ohms	watt	ea.
5	50	$1.24	378	150	$2.74
5	150	2.74	400	25	.98
6	25	.98	500	25	.98
6	50	1.24	500	75	1.97
7	25	.98	585	150	2.74
7.5	100	2.25	750	25	.98
8	50	1.24	750	150	2.74
10	25	.98	1000	25	.98
12	25	.98	1200	225	3.25
15	25	.98	1250	50	1.24
16	50	1.24	1250	150	2.74
22	50	1.24	1500	50	1.24
25	25	.98	2000	25	.98
50	25	.98	2000	50	1.24
50	50	1.24	2500	100	2.25
60	25	.98	3000	25	.98
75	150	2.74	3000	100	2.25
80	50	1.24	3500	50	1.24
80	500	4.95	5000	25	.98
100	50	1.24	5000	50	1.24
125	25	.98	7500	50	1.24
150	50	1.24	7500	100	2.25
200	25	.98	10000	50	1.24
250	25	.98	10000	100	2.25
350	25	.98	20000	150	2.74

(Discounts to Quantity Users.)

BIRTCHER TUBE CLAMPS

#926-A
#926-A1
#926-B
#926-B1
#926-B22
#926-C
#926-C5

18¢ ea.

AMPHENOL "AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

"UHF" Coax Cable Connectors

Cat. No.	Army No.	Type	Ea.	Per/C
83-1AP	M-359	Plug	.35	.28
83-1D	PL-271	Adap	1.25	1.00
83-1F	PL-274	Feed	1.10	.90
83-1R	SO-239	Rec.	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-22R	SO-264	Rec.	.50	.40
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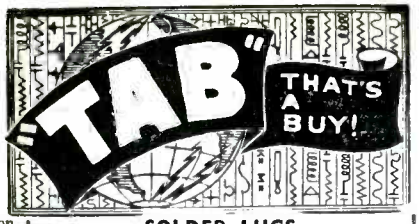

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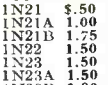

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1N26	3.00	27.50
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0.116	75	340	697	1818	2463	5910	14250	32000
0.42	80	350	699	1830	2485	6000	14400	33000
0.425	81.4	360	700	1865	2490	6100	14500	35000
0.607	88	366.6	711	1892	2500	6125	14550	37000
0.7	89.8	370	733	1894	2525	6140	14600	38140
1.03	90	375	740	1895	2600	6200	15000	38500
1.3	95	380	750	1896	2625	6300	16000	39000
1.75	100	389	800	1897	2635	6495	16500	39500
2.5	101	390	806	1898	2700	6500	16800	40000
3	105	400	850	1899	2750	6840	17000	42000
3.83	105.7	410	854	1900	2850	6990	17500	43000
3.95	107	414.3	899	1901	2860	7000	17977	45000
1	120	418.8	900	1902	2870	7320	18000	47000
4.35	121.2	425	910	1903	2900	7500	18300	47500
5	125	426.9	917	1904	3000	7700	18380	48000
5.025	130	427	946	1905	3100	7717	18500	48660
6.25	135	440	978	1906	3163	7900	18800	49000
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7.8	150	460	1056	1909	3300	8000	20000	55000
7.9	160	470	1067	1910	3333	8094	20441	56000
8	165	475	1100	1911	3384	8250	20500	57065
10.38	170	478	1110	1912	3500	8500	21000	58333
11.25	175	480	1150	1913	3509	8700	21500	60000
12	179	487	1155	1914	3700	8770	22000	61430
13.52	182	500	1162	1915	3730	9000	22500	62000
14.2	182.4	518	1175	1916	3760	9100	22990	64000
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19	225	580	1322	1926	4300	9902	24000	70000
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22	235	600	1355	1980	4440	10430	25000	73500
23	240	612	1400	2000	4444	10500	25200	75000
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30	260	641	1510	2141	4850	11000	26500	85000
31.5	271	645	1518	2142	4885	11400	26600	85750
37	275	649	1600	2145	4900	11500	27000	88000
48	280	650	1640	2150	5000	11690	27500	90000
49	286	657	1646	2160	5100	12000	28000	91000
50	289	665	1650	2180	5210	12500	28430	93300
51.78	299	670	1670	2187	5235	12600	28500	95000
55	300	673	1680	2195	5270	13000	29000	
56.7	310	675	1710	2200	5300	13100	29500	
60	311.5	680	1712	2250	5500	13500	29990	
63	320	681	1740	2300	5600	13550	30000	
68	325	684	1770	2400	5730	13600	31000	

Any Size Above, Each 25c. Ten for $1.98

100000	147000	185000	229000	294000	353500	478000	654000
110000	150000	186600	230000	300000	375000	500000	660000
115000	155000	190000	235500	307500	380000	520000	690000
116667	160000	198000	238000	311000	400000	521000	700000
120000	165000	200000	240000	314000	402000	525000	716300
125000	166750	201000	245000	316000	420000	543000	750000
130000	167000	205000	250000	325000	422000	550000	761300
135000	169200	210000	265000	330000	425000	570000	800000
140000	175000	215000	268000	330000	450000	575000	813000
141000	180000	220000	270000	333500	458000	600000	850000
145000	180600	225000	275000	350000	470000	620000	900000
					650000	950000	930000

Any Size Above, Each 35c. Ten for $2.98

Megohms	1.579	2	2.75	3.673	4.5	6.5	7.74	11.55
1	1.35	1.6	2.11	2.8	3.75	4.7	6.6	8	12.1
1.1	1.39	1.65	2.2	2.855	3.9	5	6.7	8.02	12.83
1.2	1.4	1.75	2.25	3	4	5.5	7	8.5	13
1.25	1.5	1.8	2.5	3.3	4.23	6	7.5	9.05	13.85
1.3	1.57	1.9	2.7	3.5	4.25	6.3	7.62	9.5	10
								10	25

Any Size Above, Each 70c' Ten for $5.98

VACUUM PRECISION HIVOLTAGE RESISTORS

Megohms—.12,.25,.6,.75,.8,.99,1,1.5,2,3,3.75—½%accy,Ea$1: 10/$7.50
High Voltage High Frequency Resistors Standard Brands
JAN-R29 MFC105 1Meg/1KV/½%accy$1.98; 6 for $10
WW 20Meg/20KV/½%accy $15.95
High Voltage High Frequency Resistors Standard Brands
MVT 2Meg/5W/7.5KVwkg ..... $1.08; 10 for $8.98
MVT 2.5Meg/5W/7.5KVwkg ..... 108; 10 for 8.98
MVP 5Meg/10W/10KVwkg ..... 1.49; 8 for 10.00
MVP 7Meg/10W/10KVwkg ..... 1.49; 8 for 10.00
MVP 10Meg/10W/10KVwkg ..... 1.49; 8 for 10.00
12 Meg/10W/10KVwkg ..... 1.49; 8 for 10.00
MVZ 30 Meg/20W/25KVwkg ..... 1.98; 6 for 10.00
MVE 50 Meg/25W/40KVwkg ..... 1.98; 6 for 10.00

DAVEN IRC ATTENUATORS

5000ohms/20pos $1.98
"TEE"Dual1500ohms /20pos 2.98
IRC 100,000ohms/20 pos 1.98
IRC 250,000ohms/20 pos 2.49
Rheostat 20ohm/50Watt w/knob & Dial Plate ..... 69¢
Rheostats 25Watt (Leading Mfgr's) Slotted Shaft 350,500, 1500,5000ohms 3 for ..... 98¢

STORAGE BATTERIES

G-E PortableRadioBatty 2V/25AH Perfect Subst RADIO 25-2. Fits IdenticalSpace(6x2½x2½") Leads Readily Adapted. A Seven$$Buy $2.98
2V11AH Willard BB206U .. 1.89
6V/6AH WillardNT6/BB214U 1.75
6V/25AH Willard 3.98
36VminiBR18/BR52 ..... 81¢
USN HydrometerKit&Box .. 1.98
BatAcid (R'ExpOnly) 1 pt 59c; 2 pts ..... 98¢

HI Q CNDRS.

2, 3, 4.7, 5.7, 5, 10, 11, 22, 25, 33, 43, 47, 50, 60, 75, 100, 120, 200, 1000, mmf CER-AMICONS "TAB" SPECIAL. Each 8c; 10 for 69¢; 100 for $4.98.

UHF ANTENNA

12"/30cm AT5/ARR1 Convertible Citizen's Band Threaded Coax Term Insltd Silv Pl Cont w/ waterproof gask flange & hardware for MOBILE mtg BRAND NEW 39¢; 4/$1.00
PL259 for Above 29c
ANT AN130B Spring Swiveled Whip 33"lg, SPECIAL 98c
ANT AN131A 11ft Compr Spring 8 Sections 98c
MAST BASE MP22 ..... $3.95
MAST BASE MP48 ..... 3.98
ANT MS49 to 42, 12½ft Whip 1.69
ANT MS49 to 53, 16ft Whip 2.49
ANT MS49 to 56, (2-53's) 26½ ft. Whip 5.98

GIBSON GIRL TRANSMITTER
174/CRT3 p/o SCR578 Like New SOS xmtr, Crank, Dyn 28V & 300V also Tubes Parts SPECIAL ..$4.98
G... Lamp & Ant ..... .89
G'GAL Hav'sackBag w'prf ... .98
G GAL BOX KITE 17x17x36" 2.98
G'GAL BALLOON 50"&Hydrogen gas generator 4.98
G'GAL PARACHUTE 12 foot 1.98

"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

THAT'S A BUY "TAB" THAT'S A BUY

DEPT. 12E SIX CHURCH ST. NEW YORK 6, N.Y., U.S.A. - CORNER CHURCH & LIBERTY STS. ROOM 200

"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

TOP TRANSFORMER BUYS!

Power Transformers—115V/50-60 cps input

Volts Out	Amp	Filaments	Each
770V	.0025	2.5V/3A	$1.98
550VCT	.050	6.3V/.5, 2.5VCT 1.75	2.49
2 x 200V	.35	2 x 20V.01A	2.49
2 x 110VCT	.01	6.3V/10, 2.5VCT/7	2.75
2 x 110V	.010	6.3/2.5, 2 x 2.5V/7	3.45
550VCT	.100	6.3V/1.8, 6.3/.6	2.29
580VCT	.040	5VCT/3A	2.49
100VCT	.017	5VCT/3A	2.25
2300V	.004	2.5/2A	7.49
100VCT, 65V	.100	6.3VCT/10, 40V/.1, 18VCT/.1, 18-6/.1, 6.3/.1	3.49
1500V	.160	2.5VCT/12, 30V/.01	6.95
1100V, 400V	.250	6.3V/.6A	6.95
78V	.300	6.3V/2A	1.79
825VCT	.190	5VCT/3A	3.95
800VCT	.150	5V/3A, 2.5V/2	3.98
2 x 300V	.042	55V/.125, 45/3.5	3.95
585	.086	5V/3, 6.3V/6	3.95
1080VCT	.055	6.3V/1.2, 6.3/1.2	5.95
600VCT	.155	6.3VCT/5, 5VCT/3	3.95
1120V	.600	2 x 5VCT/6-2A, 6.3VCT 3, 6.3/.300	14.95
215VCT	300	5VCT/6A	2.29

Plate Transformers—115V/50-60 cps input

Volts Out	Amp.	Each	Volts Out	Amp.	Each
65V	.500	$1.49	70V	1	$1.95
500VCT	.150	3.00	100V	3	1.95
650VCT	.015		1620VCT	.400	11.95
2 x 150V	2 x .940	4.25	246VCT	.800	3.95
600VCT	.0165	2.49	121V	1.5	2.25
250VCT	.077		126.5V	1.5	
690V	.450	4.95	132V	1.5	
1470VCT	1.2	24.00			

Filament Transformers—115V/50-60 cps input

Rating	Each	Rating	Each
2.5V/5A HV ins.	$1.79	30VCT/.330, 34VCT/.380	$1.95
6.3V 2A, 78/300	1.79		
36V/1.11	1.49	6.3V/2.5, 2 x 2.5/7	3.25
5VCT/20A	5.49	2 x 2.5VCT/6.5A	3.25
4V/16A, 2.5V/1.75 HV ins.	4.75	2.5V/1.75,5 V/3A, 6.5/8A, 6.5V/.6A	3.85
5V/115A	12.95		
7.2V7, 6.4/10, 6.4/2, 2 x 26.2/2.5, 16V/1	5.95	10VCT/13A, 10VCT/3 25	6.95
6.3VCT/20, 6 3V/1.8, 6.3V/.6	5.25	5VCT 13.5, 2 x 5VCT 6.75	6.95
6.3VCT/1, 6 3VCT/7	2.75	1.3V/3091 Kva 6.3VCT/.6A, 5V/2A	2.95
6.3 5, 6.3/1A	2.25	6.3VCT/2A, 5.3VCT/2A	1.85
6.3VCT/3.2, 6.3VCT/1	2.25	6.3V/1A, 6.3V 1A	2.45
5V/6A	2.25	6.3/2.5/7A, 2.5V 7A	1.95
6.3VCT/1A, 5V/2A	1.65	6V/3A	3.25
			1.10

SPECIAL TYPES

Input	Output	Each
6, 12, 24 or 115VDC, or 230VAC	420VCT/85Ma, 6.3V/1.9, Univ Vibrator Xfmr	$2.39
230V 60 cy	230V/.05A	1.10
115V 60 cy	115V/78V-410A/.600MA	1.59
110/115/120/125	13.5V/1.11A	1.49
210/220/230	2.5VCT/4A	1.49
230V 60 cy	2.5V/6.5A	1.95
230V 60 cy	200V/20A, 4 x 6.3/.900A	2.95
220, 440V	286VCT/290MA	2.95
220V 60 cy	260V/.03, 100/1, 6.3/4.2	2.95
200V 60 cy	700VCT/.75, 40VCT/.1A, 15/10/15V/.1A	2.39
45/78/90	Tapped 1V to 10V	2.95
220V 60 cy	2 x 40V/.05, 2 x 5V/6A, 12.6V/1A	2.95
220V 60 cy	24V/6A, 5V/3, 2 x 6.3/1A	2.29
43 78/90/115/180/230	2.5V/6.5A, 2.5/6.5, 6.3/4A	3.95
110/115/120/125	6/12/18/24/75/100/115V/150A	2.49
230V 60 cy	5V/9A MV INS	4.25
200V 60 cy	700VCT/.08A, 110VCT/.08A 24V/.08, 6.3V/.3, 6.3VCT/1.5V/3A, 5V/5A, 2.7V/5A	4.25
230V 60 cy	400V/.03, 190V/.03A 5 2.5, 5V/2.5A, W/2-866 Sockets	4.25
50V 60 cy	2 x 750V/.901A	1.95
6V & 12V	84V/.009, 51V/.003, 1.4V/500 Vibrator Transformer	1.95
230V 60 cy	250V/.1A, 5V/2A, 5V 9A	4.95
220-440	3 x 2.5V/5A, 2.5V/15A	5.95
230V-115V	5VCT/7.5, 5V/7.5, 5VCT 15A	10.95
440V/60 cy 3PH	220V 30W 3 phase or 220V & 6V 1 phase 60 cy	5.95
230V 60 cy	110V/200, 33V/200, 5V/10A, 2.5-1.4/10A, 1500V/.160	7.95
95-130V 60 cy	115V/3.6A, 40.9V/3.3A	10.95
220/440V	115V/6.52A	12.95
220-440V	115V/110/105/-7A	13.95

T.V. Transformer, 7" or 9" scope. 3000v/5MA, 720vct/200MA, 6.4/8.7A, 6.4/6A, 5/3A, 1.25/.3A. Price... **$4.95**

VARIABLE AIR CAPACITOR
30MMF PER SECT. 2 SECT.
VERY GOOD FOR HIGH POWER FINAL W/INS COUPLING $1.98
HEINEMAN CKT

Bkrs. For AC DC Operation
Amperes .010, 3, 7, 10, 50, 80, 100, 150.

Klixon 25A 98cEa. $1.45
Dual 8 & 25 Amp.....$2.49
De Ion 35 Amp.....$3.75

Precision Resistors

ohms	ohms	ohms
1.01	250	10000
3	430	12000
5	468	17000
5.05	800	17300
10.1	920	20000
18	1100	25000
43.5	1450	30000
50	1900	33000
75	2230	35000
82	4300	40000
120	5000	50000
125	7000	55000
128	75000	55000
150	8500	75000
200		

Each $25c, 10 for $2.00

84000	150000	250000
100000	170000	500000
120000	220000	

Each 35c. 10 for $3.25

1 Meg. ea.....70c
6.330 Meg. $1.00

XMTR COILS AIR WOUND

80 MTR Bar Prong 100 w $1.19
40 MTR 5 Prong 50w plug in socket $1.19
160MTR 5 Prong 50w plug in socket $1.19
40 MTR 3 Prong Bar 100w $1.19
#C538 2-3.5 MC 300w Fix Link $1.19
#1735 2-3.5 MC. 300 w Var. Link $1.49
#C590 5-7 MC. 300w Fix. Link $1.19
160 MTR Bar Type 100 w $1.19

ROTARY BEAM COUPLER

RF Coupler 360° rotation 1 turn coupling link. Plastic case mount on side. Price.. **$2.95**

TRANSTAT AMERTRAN

Input: 0.115 v. 50-60 cycle. Max. output: 115 v. 100 amp.

All units are new, guaranteed $95

2 KVA: 90-130v input 50-60 cycles, output 115v 2 kva type RH Amertran. $29.95 each

XFMR TELEV PWR SUPPLY KITS

BASIC 3" and 5" T.V. PWR SUPPLY

Trans. 1080V/55Ma. 6.3V/1.2A, 6.3/1.2A, 2-.1 Mfg 2500V 2X2 Tube, Socket, 1-00000 ohm Resis. Price $7.49

BASIC 5" AND 7" TV PWR SUPPLY KIT

Trans. 2300 V/4Ma. 2.5/2A, 2-.1 Mfd 7500V Pvr. 2X2 Tube, Socket, 1-100-000ohm Resis $9.50

TV TRANSFORMER

3000V/5Ma. 720VCT/200 Ma, 6.4V/8.7A, 6.4V/.6A, 5V/3A, 1.25/.3A Fil & Plate Voltage for 7" & 9" Tube $4.95

BASIC 15 WATT AMPLIFIER KIT

Pwr. Supply contains Trans. 880VCT/200MA, Dual 10Hy 200MA Choke, 2—7MFD 600V, 5T4 Tube, Socket. Price $10.49

BASIC 50 WATT AMPLIFIER KIT

Pwr. Supply contains Trans. 880VCT/200MA, Dual 10Hy 200MA Choke, 2—7MFD 600V, 5T4 Tube, Socket. Price $10.49

932 PHOTO TUBE

Gas Phototube having SI response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source.

Send for Data. Price **75c**

1619—1619—1619

Octal Base Pentode Aversatile High Perveance Tube..... **21c**

10 Tubes for $2.00

FILTER CHOKE

5 HY 40 MA, 3 for	$ .99	20 HY 50 MA.....	$ .79
30 HY 25 MA.....	.79	11.5 HY 90 MA.....	1.39
25 HY 25 .065A.....	1.00	6 HY 150 MA.....	.99
8.5 HY 125 MA.....	1.49	25 HY 75 MA.....	1.25
1.75 HY 100 MA.....	.59	.030 HY 2A.....	1.39
30 HY 24 MA.....	.98	5 HY 150 MA.....	1.45
15 HY 100 MA.....	1.39	Dual 7 HY 75 MA, 11 HY 60 MA.....	1.39
2 HY 600 MA.....	1.95	75 HY 225 MA	2.25
Swing: 1.0-3.0 HY .225-.02A.		400 MA.....	1.75
Dual: .22 HY 600 MA; 44 HY		.100 HY 1.4A.....	1.95
Dual: 1.52 HY .167A	1.95	.333 HY 1.12A.....	2.29
Dual: 120 HY 17 MA	2.49	1 HY 1 Amp.....	3.95
Dual: 10 HY 200 MA	3.50	20 HY 300 MA.....	7.95
3.5 HY 500 MA.....	4.95	10 HY 450 MA.....	12.95
10 HY 500 MA.....	12.95	Swing: 9.26 HY .525/.075 MA.....	14.95
Swing: 9.26 HY .525/.075 MA.....	14.95	6 HY 175 MA.....	1.50
6 HY 175 MA.....	1.50	2.5 HY 150 MA.....	1.25
.116 Hy 150 MA.....	4.25	.01 HY 2.5A.....	1.45
.35 HY 350 MA.....	7.25	5 HY 200 MA.....	1.45

AMPHENOL "AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote Rated Concerns Send P. O.

TUBES:

01-A
1B36
2C21
2C22
2J21-A
2J22
2J26
2J27
2J31
2J32
2J38
2J39
2J34
2J40
2J49
3J3
2K41
2X2/879
3BP1
2C24
3C30
3D6
3CP1
3D21-A
3DP1
3EP1
3FP7
3Q5
5BP1
5CP1
5FP7
5130
6G
6SC7
7C4
7E5
7E6
10Y
12A6
12K8Y
12SF7
12SR7
15P
28D7
30 (Spec)
45 (Spec)
39/44
35/51
227A
225
268-A
355-A
417A
530
531
532
559
562
615
700 A,B,C, D
703-A
704-A
705-A
706 AY BY,DY
706 FY, FY,GY
707-B
714AY
715-B
720BY
720CY
721-A
723-A/B
724B
725-A
726-A
728 AY, BY,CY
728 DY, EY,FY, GY
730A
800
801-A
804
815
836
837
843
860
861
874
876
1005
1619
1624
1629
1961
9002
9004
CEQ 72
EF 50
F-127
FC 258A
GL 532
FC 271
GL 562
GL 623
GL 697
ML 100
QK 59
QK 60
QK 61
QK 62
VR 91
VR 130
VR 135
VR 137
VU 120
VU 134
WL 532
WN 150
WT 260

DYNA MOTORS

PE 86
DM 416
DY-2/ARR-2
DM 36
DM 53AZ
PE 73CM
DM[21
DM[25
DM[28R
DM[33A
DM[42
PE 101C
BD AR 93
23350
35X045B
ZA .0515
ZA .0516
B-19 pack
D-104
DA-3A
5053
CW 21AAX
BD 77KM
PE 94
DY12

Birtcher Tube Clamps

926C
926-16
926-B1
926-B2
926-B8
926-C15
926-C-13
926B
926C-19
926B-16
926A-14
926A
926C1
926-A11
Each 15¢
10 $1.40
100 12.00

Ceramicons

Mmf		Mmf	
1	25	8.5	58
3	27	11	60
3.1	35	15	62
4	30	20	67
5	47	24	70
6	50	79	
7	57	115	
		125	
		150	
		180	
		200	
		220	
		240	
		250	
		350	
		1000	

100 For $7.50

Button

40	100
180	200
175	500
185	

Feed Thru

50
500
470

100 for $9.50

WRITE OR PHONE FOR QUANTITY AND PRICE OF ITEMS REQUIRED

ELECTROLYTIC CONDENSERS

FRESH NOT SURPLUS
LUG TERM DY TYPE
FRESH NEW

18c ea. 10 For $1.75

Mfd.	Volt
30	250
40	200
40	300
2 x 20	20
20 + 10	150
30 + 30	25
40 + 40	25
40	400
50	200
2 x 10	150
2 x 20	25
30 + 15	150
40 + 40	150
20 + 20	150
10	350
10	200
8	450
40	250
40	150
40/20	150
25/40	25/200
2 x 40	150

29c each. 10 For $2.75

2 x 10	300	
225	15	
20/20	350/25	
20/30	250	
2 x 30	150	
30 + 20	150	
30/20	350/25	
10/50/100	450/100/50	
15-15/20	350/25	
15-15/40	150/25	
25-25/10	25/350	
20-20/10	50/400	
2 x 20	150	
20/20	400/25	
10-20/20	350/25	
10-15/20	350/25	
15-15/20	250/25	
10-10/20	350/20	
3 x 10	150	
3 x 8	150	
12	525	
15	450	
10	450	
20	525	
80	150	
40 + 20 + 20	150	
40/20	150/25	
40/25	200/25	
40/30	150	
10/50/100	350/100/50	
10/10-10	25/150/150	
16	450	
20	350	
15	250	
2x90,20	200/50	$.79
150-20/6	25/50	.49
120-60-20	150/25	.49
3x20	450	.69
2x20/20	450/25	.39
20-8/25	450/25	.49
40-20/20	450/25	.69
40+10+10	450	.98
40/40/25	475/400/50	.59
40/20/25	450/50	.69
40/40/16	450/400/350	.89
4x20	450	.98
2x30-15/20	400/25	.89
30-15-10/20	450/25	.89
3x10/10	450/25	.69
3x10/20	400/25	.69
80/40/150	400/50	.98
2x80/60	250	.65
150-50-25	150	.49
20-10/50	450/50	.49
2x20/20	400/25	.59
40-20/20	400/25	.59
40-40/25	400/25	.59
40-10/80	450/150	.69
40-40-10	450	.69
40-30/10	450	.89
3x15-30	300	.69
2x30/20x10	450	.98

DS TYPE CARDBOARD w/LONG PIGTAILS

Mfd.	Volt	Price
2x10	450	$.45
3x40	150	.65
20-20	150	.34
22-20	250	.45
30-30	150	.40
32-32	350	.49
39-50	150	.42
40-20	150	.42
32-32	250	.49
40-40	150	.42
32-16	450	.55
3x40/10	150	.98
80-40-30/100	150/25	.98
8-8/25	450/75	.98
30-20/20	450/25	.98
20-16/10	200/25	.50
50-30	350	.55
2x5020	150/25	.69
8	450	.35
16	450	.40
20	150	.18
20	450	.40

WRITE FOR OTHER VALUES IN STOCK

COMMUNICATIONS EQUIPMENT COMPANY
RADAR TELEVISION ELECTRONICS
FM MICROWAVE RADIO SONAR
CABLE ADDRESS: COMSUPO
PHONE DIGBY 9-4124
131 LIBERTY ST. DEP'T E
NEW YORK 7, N.Y.
C.E.C. MONEY BACK GUARANTEE, $3 MIN. ORDER.
F.O.B. N.Y.C. SEND MONEY ORDER OR CHECK, ONLY SHIPPING CHARGES SENT C.O.D.

Additional Searchlight Advertisement on page 278

INDEX TO ADVERTISERS

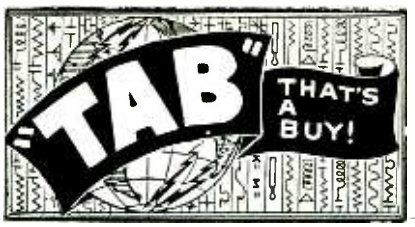
G-E 2J1G1 Selsyns Buy!

with DATA 24V or 110V 60 cyc AC

Used Tested, TWO for.... **$1.49**

Blowers—Cool That Tube!

40CFM/28vacdc	$3.49
70CFM/115v400cy	4.49
100CFM/12-vacdc	5.95
100CFM/28vacdc	4.95
XFMR StepUp 12or28v to115vac	1.98
100CFM/115vacdc	7.98
180CFM/115vacdc	10.98
250CFM/28vacdc	8.95
250CFM/28vacdc Plus 28to115vac XFMR	11.95



MERCURY THERMO-REGULATOR

Dual Ckt, 105°F & 32°F, Extremely Sensitive & Accurate —for Most Exacting Requirements — RESEARCH, FIRE PREV, FREEZE PT CONTROL, or MAX-MIN TEMP Control. Brand New. Individ. Boxed w/data & ckt List OVER $20. "TAB" SPECIAL 98c; 12 for $10

Beckman pH Meter Foundation

Industrial Type Removed from Precision Equip for INSTANT measurement of pH. With UltraSens meter (SIMPSON 29 or equiv). Less Case & Acces., ... $19.95

TUBES . . . "TAB" TESTED & GUARANTEED

OA3/VR75	$.98	2C26	.25	5Y3GT	.37	6SD7GT	.45	12BA7	.89	EF50	.40	GL451	1.90	922	1.19	12QP4	49.98
OA4G	1.05	2C34/RK34	.55	5Z3	.81	6SF5	.48	12BD6	.59	50A5	.73	460/		923	.85	16AP4	55.00
OB2	1.80	2C39	18.00	5Z4	.74	6SF7	.58	12BE6	.45	50B5	.54	HF200	11.98	927/CE25	1.26	902	3.75
OB3/VR90	.74	2C40	3.75	C6A	6.95	6SG7	.57	12C8	.35	50C5	.59	WL468	7.49	930	.75	905	3.89
OC3/VR105	.75	2C43/464A	8.91	6A3	.98	6SH7	.38	12H6	.34	50L6GT	.52	RH507	9.98	931A	3.95	910/3APL	4.75
OD3/VR150	.53	2C44	1.69	6A4	1.29	6SJ7GT	.55	12J5GT	.35	50X6	.98	527	7.49	954	.18	912	89.98
OZ4	.87	2C51	6.45	6A6	.88	6SK7GT	.45	12J7GT	.78	50Y6	.63	530	4.90	955	.18	914	45.00
C1A	3.25	2D21	.90	6A7M	.68	6SL7GT	.55	12K8	.59	57	.47	531	1.80	956	.37		
O1A	.45	2E5	.89	6A8	.78	6SN7GT	.55	12L8GT	1.59	58	.53	WL531	1.95	957	.20	**Tungar Bulbs**	
1A3	.59	2E22	1.34	6AB7/1853	.77	6SN7WGT	.89	12Q7GT	.55	RK65	22.98	GL534/		958	.35	12X825	2.25
1A4	1.26	2E24	3.98	6AC5	1.08	6SQ7GT	.44	12S8GT	.79	FG67	12.75	1S21	1.95	SD968	4.98	16X897	2.49
1A5GT	.70	2E25/HY65	2.98	6AC7	.75	6SF7	.56	12SA7GT	.55	HY69	2.29	544	4.98	991	.25	20X672	2.95
1A6	1.26	2E26	3.45	6AD6G	.81	6ST7	.57	12SC7	.55	70L7GT	1.15	GL546	1.69	1000UHF	59.95	189048GE	3.49
1A7GT	.69	2E30	2.35	6AD7	1.17	6ST7	.75	12SF7	.56	71	.65	550P1	19.95	FM1000	.95	199698	2.95
1B3/8016	.81	2J21	11.98	6AF6G	.77	6T7G	.95	12SG7	.55	72	.95	575A/975	12.75	CK1005	.18	289881	2.50
1B21/471A	2.95	2J21A	11.98	6AG5	.72	6T8	.98	12SH7	.34	CRD72	1.85	601B	.19	1609	5.98	859483	3.98
1B22	4.50	2J22	9.75	6AG7	1.08	6U5/6G5	.63	12SJ7GT	.49	CRP72	1.37	KU610	9.50	1613/6F6X	.55		
1B23	9.00	2J25	98.00	6AH6	.98	6U6GT	.89	12SK7GT	.55	73	1.67	HY615	.27	1614	1.42	**Ballast**	
1B24	4.85	2J26	8.89	6AJ5	.73	6U7G	.54	12SK7M	.52	NR74	.29	WL619	19.75	1616	.89	1P1	.49
1B26	4.50	2J27	14.50	6AK5	.78	6V6GT	.59	12SL7GT	.63	75	.56	KU627	7.49	1619	.18	4A1	1.29
1B27	4.75	2J31	18.95	6AK6	.81	6V6GTY	.90	12SN7GT	.49	76	.45	631P1/SN4	3.98	1620	4.95	PM5	.98
1B29	3.39	2J32	23.95	6AL5	.59	6V6M	.92	12SQ7GT	.49	77	.45	WL632A	8.98	1622	1.75	PM6	.98
1B32	4.90	2J33	19.50	6AL7	1.00	6W4GT	.72	12SR7GT	.37	78	.45	701A	3.50	1624	1.69	6-11	.49
1B37	45.00	2J34	19.50	6AQ5	.52	6W7G	.87	12X3	.90	80	.36	702A/702B	3.20	1625	.37	7H12	.49
1B38	37.00	2J37	23.50	6AS5	.59	6X4	.54	12Z3	.72	81	1.29	703A	3.75	1626	.35	PM8	2.98
1B41	49.95	2J38	23.50	6AS6	1.49	6X5GT	.48	14A7/12B7	.67	FG81A	4.45	704A	1.08	1629	.26	9-3	.49
1B53	49.95	2J39	34.00	6AS7G	4.40	6Y6G	.65	14AF7	.86	82	.85	705A/8021	1.05	1632	.89	10-4B	.49
1B54	49.95	2J47	39.95	6AT6	.45	6Z7G	1.08	14B6	.65	82V	.95	707	7.98	1633	.97	13-4	.49
1B56	49.95	2J48	45.00	6AU6	.53	6ZY5G	.67	14B8	.77	83	.70	710A/8011	.65	1635	1.49	20-4	.49
1C5	.86	2J49	24.00	6AV6	.43	7A4/XXL	.57	14C7	.86	83V	1.05	713A	1.49	1641/RK60	.68	K49A	.36
1C6	1.26	2J50	40.00	6B4G	.96	7A5	.70	14H7	.63	84/6Z4	.57	715B	7.29	2050	.95	K55B	.36
1C7G	1.27	2J53	40.00	6B7	.89	7A6	.65	14N7	.86	85	.57	717A	.61	2051	.42	M55B	.39
1D5GP	1.25	2J56	81.00	6B8G	.88	7A7	.56	14Q7	.55	89	.36	721A	2.85	5514	4.85	L62A	.49
1E5	1.38	2J61	39.00	6BA6	.49	7A8	.69	14R7	.65	VR92	.23	722A/287A	9.95	5516	5.85	K50B	.36
1E7G	1.17	2J62	39.00	6BE6	.52	7AF7	.70	15E	1.44	FG104	14.98	723A	6.95	C376	2.98	WL121A	2.61
1F4G	1.05	2K23	24.50	6BF6	.52	7AG7	.69	15R	.75	FG105	10.75	723A/B	14.95	UX6653	.69	C376	2.98
1F7GV	1.55	2K25	23.25	6BG6G	1.39	7B4	.55	FG17	3.98	HY114B	.81	724A/B	3.90	8012A	1.45	ZB583	3.98
1G4GT	1.05	2K28	24.89	6BH6	.52	7B5	.70	RK18	.98	HY115/145	.80	725A	8.75	8013A	2.50		
1G6GT	.67	2K29	24.95	6BJ6	.59	7B6	.58	19	.95	117L7	1.23	726A	6.98	8020	1.90	**Mazda Pilots**	
1H4G	.87	2V3G	1.05	6C4	.24	7B7	.57	19T8	.98	117N7GT	1.36	726C	29.98	9001	.34	44Box10	.50
1H5G	.65	2X2	.27	6C5	.47	7B8	.70	20	1.17	117P7GT	1.20	730A	10.90	9002	.30	49Box10	.60
1H6G	1.27	3A4	.36	6C6	.52	7C4/1203A	.36	PJ21	4.98	117Z3	.49	802	4.23	9003	.35	55Box10	.50
1J6	.79	3A5	1.20	6C6G	.55	7C5	.49	REL21	4.85	117Z6GT	.77	803	4.75	9004	.27	64 Each	.07
1L4	.49	3B7/1291	.29	6C8G	.65	7C6	.69	RX21	3.20	117Z7GT	1.49	804	6.90	9005	1.49	S6 T4/3W	.18
1LA4GT	1.05	3B22	2.68	6C21	23.95	7C7	.57	PJ22/		F127A	16.95	805	4.75	9006	.18	100W 20V	.25
1LB4	1.05	3B24	1.85	6D4	2.75	7C23	69.00	CE1C	1.49	CV148	7.90	807	1.10	**C'Ray Tubes**		291Box10	.36
1LC6	.85	3B25	4.95	6D6	.45	7E5/1201	.65	24G/3C24	.45	155	.98	808	1.35	2AP1A	4.85	311/28V	.15
1LE3GT	.96	3B28	5.89	6E5	.81	7E6	.57	25A6	1.04	VT158	9.85	809	2.40	3AP1	4.75	313/28V	.15
1LH4	1.05	3C23	2.48	6E6	1.05	7E7	.65	25AC5	1.14	FG166	49.00	810	7.90	3BP1	2.85	323 3V	.10
1LN5	.75	3C31/C1B	1.98	6F5	.55	7F7	.64	25B6	1.49	FG172	29.50	811	1.67	3CP1	2.65	**Sylvania S6/**	
1N5GT	.69	3C45	24.95	6F6	.59	7F8	1.03	25BQ6	1.08	FG190	12.98	812	2.98	3CP1-S1	2.49	**6W 120V**	.15
1P5GT	.69	3D6 1299	.29	6F7	.80	7G7/1232	.98	25L6GT	.52	205B/VT2	1.69	813	8.90	3DP1	1.87	**Wstghs C7/**	
1P24	.85	3D21A	1.37	6F8	1.04	7H7	.62	25W4GT	.79	207	1.10	814	2.61	3EP1	2.75	**7W 120V**	.09
1Q5GT	.96	3D22	7.49	6C6	1.05	7J7	.98	25Y5	1.08	211/VT4C	.45	815	2.40	3FP7	.98	**Med. Screw Base**	
1Q26	75.00	3E29/829B	7.98	6H6	.43	7K7	1.05	25Z5	.46	RX215	9.95	816	1.05	3GP1	6.55	**15W/125V**	.08
1R4/1294	.98	3Q4	.54	6H6GT	.38	7L7	.67	25Z6GT	.49	WE215A	.25	826	.42	3HP7	3.49	**25W/125V**	.08
1R5	.59	3Q5	.89	C6J	4.75	7N7	.65	FG27A	9.50	227A	2.90	SD828	3.98	4AP10	5.90		
1S4	.49	3S4	.79	6J4	4.93	7Q7	.57	28D7	.35	231	1.20	829B	7.29	5BP1	1.98	**Neon Bulbs**	
1S5	.54	3V4	.69	6J5GT	.48	7R7	.63	30	.39	250TH	24.98	832	3.98	5BP4	4.50	**NE2 100for 3.98**	
1S21	3.75	4C33	81.00	6J6	.72	7S7	.89	31	.36	250TL	24.98	832A	4.20	5CP1	1.75	**NE16 991**	.25
1T4	.54	4C35	19.45	6J7	.65	7T7	1.03	32	.89	282B	8.49	836	.98	5CP7	7.50	**NE32**	.35
1T5GT	1.05	4J31	95.00	6K5GT	.86	7V7	.89	FG32	4.98	304TH	5.95	837	2.35	5FP5	6.49	**NE45/W**	.24
1U4	.69	4J32	95.00	6K6GT	.45	7W7	.85	32L7GT	.95	304TL	1.39	838	3.20	5FP7	1.26	**NE51 NE20**	.07
1U5	.69	4J42/700	29.85	6K7	.48	7X7/XXFM	.85	FG33	8.49	307A/RK75	3.80	842	2.75	5FP14	18.95	**Dialco Type**	
1V	.59	4J47	45.00	6K8	.86	7Y4	.49	35A5	.65	316A	.38	843	.39	4HP1	4.95	**Bull's Eye Pilot**	
1X2	.98	4T4.2	9.95	6L5	.84	7Z4	.55	35B5	.59	323A	8.98	845	4.15	5JP2	11.75	**Lite Complete**	
1Z2	1.98	5C22	47.00	6L6	.98	10Y	.60	35C5	.60	327A	2.90	851	14.95	5LP1	18.00	**W/**	
2A3	.93	5C30/C5B	8.49	6L7	.77	12A6	.18	35L6GT	.54	350	1.23	860	2.39	5LP5	18.00	**S6-115V bulb**	
2A4G	1.08	5D21	27.90	6N7GT	.90	12A7	.96	35W4	.35	350B	1.98	861	10.79	5LP7	18.00	**or Neon Bulb**	
2A5	.80	5J29	17.39	6P5G	.81	12A8GT	.56	35Y4	.49	355A	19.95	864	.45	5MP1	2.89	**Chromed 2 for**	
2A6	1.05	5J32	99.00	6Q7	.57	12AH7GT	.84	35Z5GT	.41	371B	.84	865	.95	7BP7	4.65	**98¢**	
2A7	1.05	5R4GY	1.12	6R7	.77	12AT6	.45	REL36/6J4	.75	380A	.79	866A	1.04	7CP1	12.95	**Tel Slide**	
2B4	.98	5T4	.88	6S7	.85	12AT7	.75	37	.36	388A	.40	866Jr	1.00	7HP7	5.95	**Lamps**	
2B7	.85	5Y4G	.52	6S8GT	.79	12AU6	.59	38	.34	393A	3.80	868/PJ23	1.90	9GP7	12.33	**6, 12, 24, 48, 55v**	
2B22/GL559	.73	5V4G	.88	6SA7GT	.43	12AU7	.69	39/44	.25	394A	3.75	869	30.00	9LP7	2.21	**Each 18¢**	
2C21/1642	.81	5W4	.74	6SB7Y	.81	12AX7	.89	CRC40	.54	FP400	7.98	872A	1.49	10BP4	19.75	**Tubes Gtd Exc**	
2C22/7193	.18	5X4G	.71	6SC7	.57	12BA6	.56	41	.50	417A	19.95	874	.55	12DP7	12.49	**Open Fil &**	
								43	.57	GL434	3.45	876	.36	12GP1	49.98	**Bkge**	
								45S/VT52	.27	446A/2C40	1.17	878	1.95	12GP7	11.80	**Tubes Sent**	
								46	.65	446B	1.80	884/6Q5G	1.49	12JP4	34.75	**Only Via R'Exp**	
								48	1.56	450TH	17.75	885	1.49	12KP4	34.75	**Min. Tube**	
								50	1.49	450TL	49.95	920	2.70	12LP4	34.00	**Order $5.00**	

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Kit 886A's & Xformer

115VACin 2.5VCT/10A out 10KV insul & Tubes & Sockets, only.... $5.95
872A kit Tubes SktsXfmr 12.95

Tv Pwr Supply Xfmr

HI-VOLTAGEforCRTubes 5" to 20" & Plate Volts for ALL Tubes & ALL Fil's. Complete w/data for 5000 to 20000 Volt Circuits; also Full Wave Output 300VDC/ 275 Ma & 6.4V/ 10.3A, 5.4V/8A, 2.5V/3A, Inpt 105-125 VAC/50-400 cyc HypersilCore Oil Impreg W.E. for USN SPECIAL.... $8.98

1800V 'SCOPE PWR SUPPLY

Ideal CRT Xfmr1800V DblrCkt; 115VAC Inpt; Outpt—900V/35Ma, 2x2.5V/2A on Sect 4KVinsSigC Spec, HermSld. Two 2x2tubes&ALL FltrParts&Data ... $5.98

Transformers—115V 60 cyc Input

2240vct/500ma,12v/14.25A, 19.2V-18.3V-17.5v/2.5A, 2.5V/10A, 30V/5ma. Autoformer on Pri..... $19.98
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700VCT/120ma, 115V/100ma, 2x6.3V/1A, 5V/2A Csd HVins..... $2.98
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500VCT/60ma, 6.3V/4A USNH'Sld. $1.29
420VCT/85ma. 6.3V/1.9A&Pri's6-12-24-115VDC&230VACUnivVibXfmrCsd. $2.39
2x330VCT/10ma (or660VCT/10ma) .$1.49
1200VCT/300ma&18V/1AwndgHV .$6.95
1800V/4maUSNCsdAltec/GEHVins. $3.29
2100V/10ma STANCOR Csd HVins. 3.98
3000V/10maWE/ChiTransCsdHVins 4.50
5000V/10ma (for2X2) Csd 7.95
7500or15000V'Dblr/35ma 17.95
10800VCTor2100V'Dbh@95msCsd .19.95
2.5V/1.75A, 4V/16A 20KVins Csd. 4.95
2.5V/2A (for2X2) HVins 69¢; 10 for. 5.98
5VCT/60A KENYON HVins..... 6.95
5V/15A KENYON HVins..... 12.95
6.3VCT/.6a USN Csd HVins..... 1.39
6.3VCT/4A (gud6.5A) Csd HV USN. 1.69
12.6VCT/1.25aH'SldHVins $1.49; 2for 2.79

FILTER CHOKES

13.5Hy/1Amp/42ohm/17KVins ...$4.00
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15Hy/400maor20Hy/300ma/12KVins 7.95

OIL CONDENSERS—FAMOUS MAKES—BRAND NEW

Mfd	Each	Mfd	Each	Mfd	Each	Mfd	Each	Mfd	Each	Mfd	Each
25 wvdc		**500 wvdc**		**700 wvdc**		**1500 wvdc**		**5500 wvdc**			
50	$3.98	.5	.13	4	.79	6	2.69	2	10.98	225 vac/630dc	
50 wvdc		1	.15	**800 wvdc**		24	6.98	**7000 wvdc**		3.3	.49
4	.29	4	.55	1	.29	**2000 wvdc**		.002	.98	230 vac/660dc	
150 wvdc		**600 wvdc**		**1000 wvdc**		.1	.89	.0075	1.29	5	.90
1-1-3-5	.59	.034	.12	.5	.39	2x0.1	1.08	.1	2.69	330vac/1000dc	
250 wvdc		.1	.23	.25	.59	1	1.27	**7500 wvdc**		1	.55
1	.11	**600 wvdc**		.45	.63	2	1.98	.03	1.98	1.5	.60
30	.79	.2	.25	1	.45	3	3.49	.05	2.29	1.75	.65
2x.5	.13	.25	.32	2	.89	4	3.98	.1	2.89	2	.65
300 wvdc		.5	.32	4	1.89	5	4.98	1	7.98	2.5	.75
1.2	.15	1	.35	5	1.98	8	8.98	**8000 wvdc**		2.8	.80
400 wvdc		2	.40	8	2.49	**2500 wvdc**		2x.15	3.49	3	.85
.1	.10	3	.49	10	2.98	.25	.74	**12500 wvdc**		4	.87
.25	.11	4	.65	15	3.98	1	1.89	.65	14.89	5	1.00
.5	.12	5	.90	**1400 wvdc**		**3000 wvdc**		2	19.98	12	3.69
1	.13	6	.95	.5	.69	.1	1.90	**15000 wvdc**		15	3.98
2	.25	7	.98	**1500 wvdc**		.5	2.49	.0016	4.98	25	4.98
4	.44	10	1.15	.025	.59	2	3.98	**16000 wvdc**		40	7.98
6	.59	2x.05	.09	.05	.39	4	5.95	.05	5.29	405vac/1200dc	
8	.69	2x.1	.27	.1	.59	**3600 wvdc**		**25000 wvdc**		**1000 cycles**	
10	.79	2x.25	.20	.25	.69	1	3.25	.00025	4.95	.15	.98
30	1.49	2x.5	.38	2x.1	.79	**4000 wvdc**		1	95.00	600vac/1800dc	
2x.1	.10	2x2	.55	**1500 wvdc**		1	3.75	**AC Rated**		10	4.49
2x.5	.13	2x8	1.79	.5	.98	3x.2	2.98	**220 vac/600dc**		16	5.98
2x5	.59	3x.05	.12	.75	1.03	**5000 wvdc**		.2	2.25	20	6.98
3x.1	.15	3x.1	.33	1	1.09	.2	9.98	2	.39	660vac/2000dc	
3x.25	.18	3x.22	.22	2	1.69	4	16.00	4	.55	5	3.75
500 wvdc		3x.25	.50	4	2.39	5	2.49	5	.90	6	3.95
.1	.10	3x8	2.98	5	2.49					10	5.49
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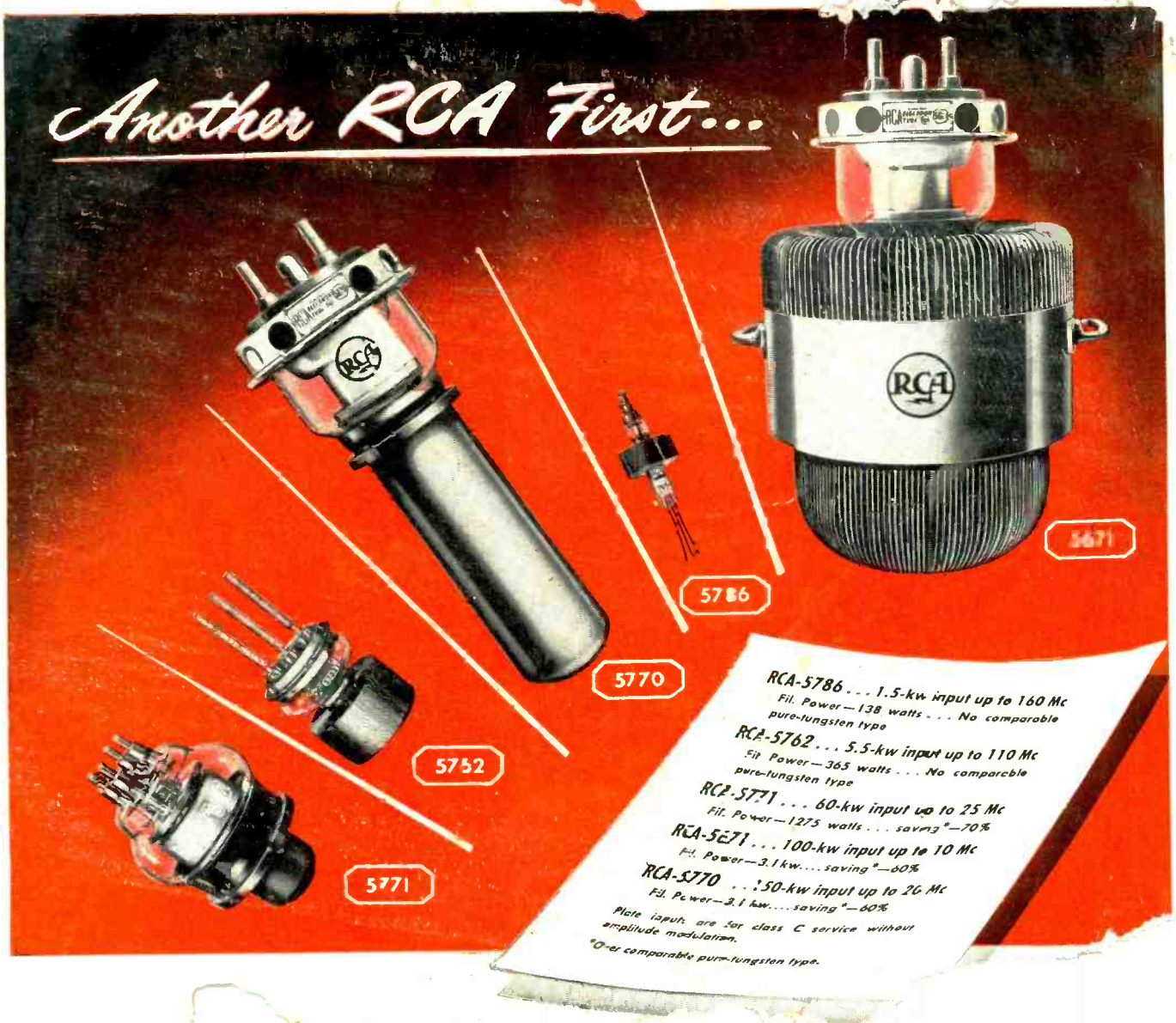

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