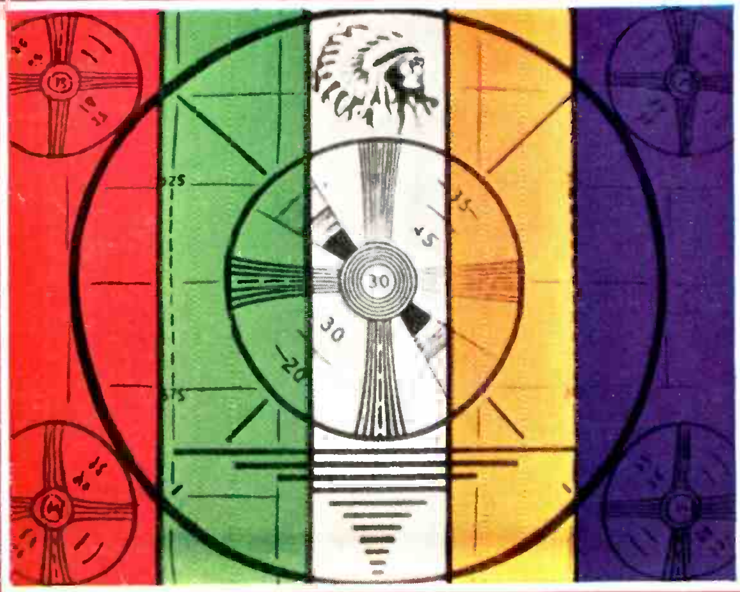
AUGUST · 1951

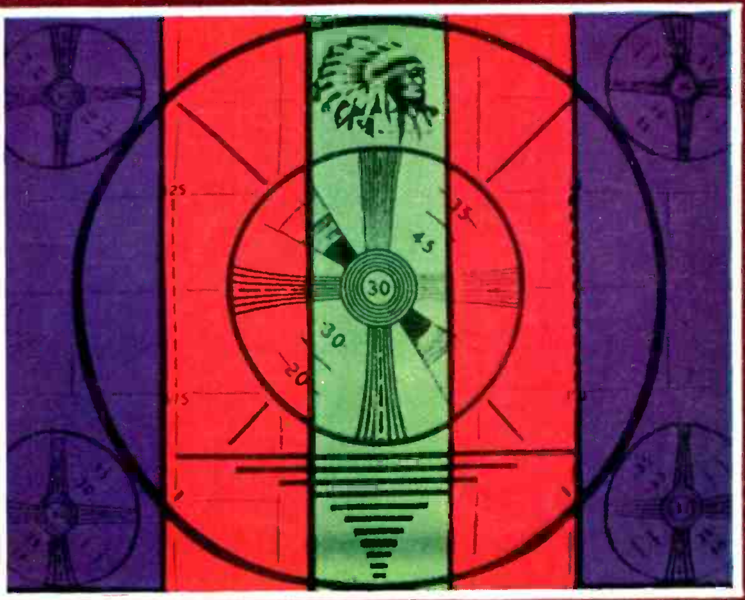
PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION

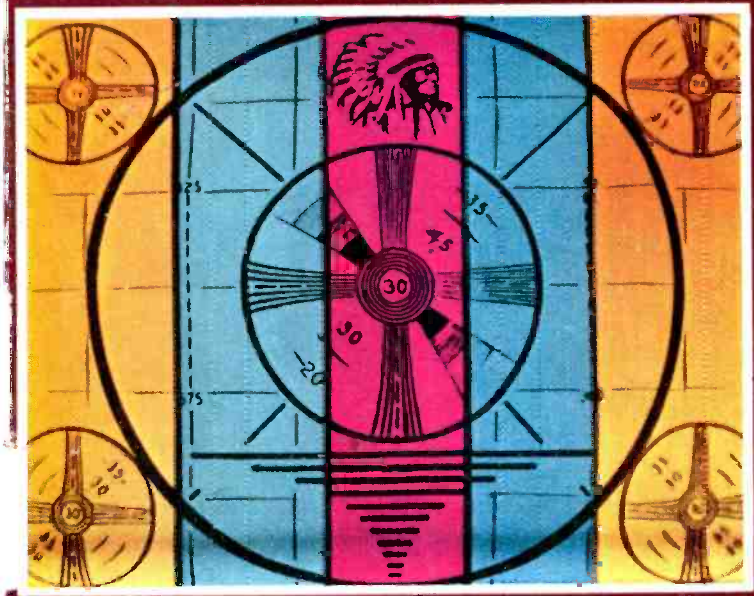


A SINGLE, DOUBLE AND TRIPLE COMBINATIONS

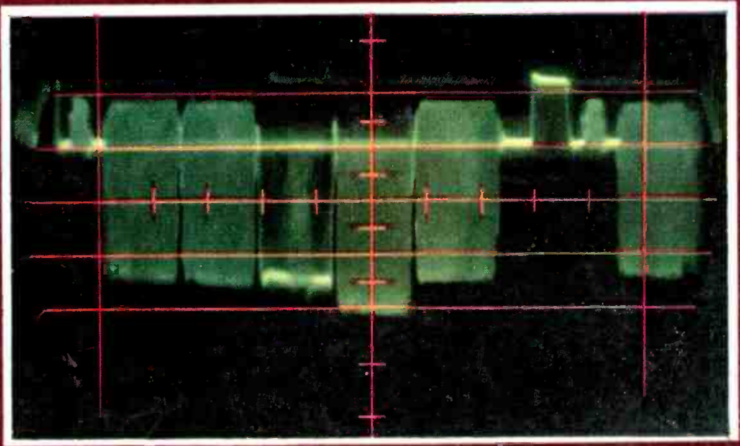


B SINGLE PRIMARIES—blue, red, green

Color-TV Signal-Generator Patterns



C PAIRS OF PRIMARIES—yellow, cyan, magenta



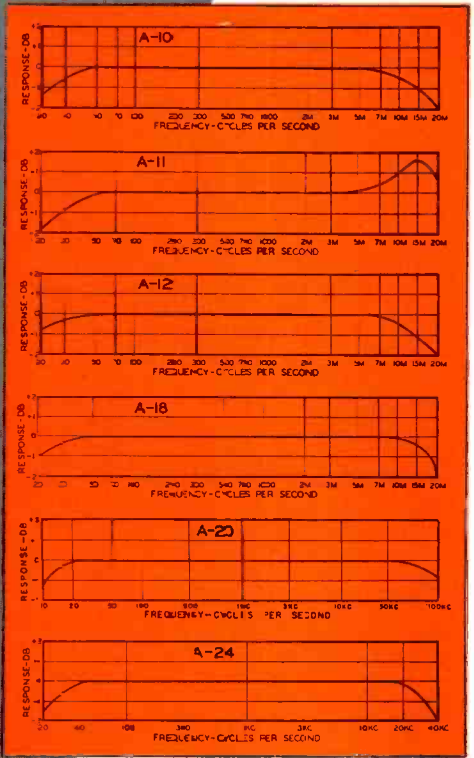
D DOT-SEQUENTIAL WAVEFORM—corresponding to picture A

ULTRA COMPACT UNITS...OUNCER UNITS

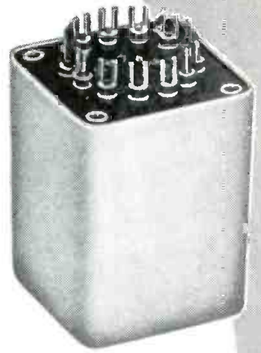
HIGH FIDELITY . . . . SMALL SIZE . . . . FROM STOCK

UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.



Type No.	Application	Primary Impedance	Secondary Impedance	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50 ohms	$16.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids (multiple alloy shields for low hum pickup)	50, 200, 500	50,000 ohms	18.00
A-12	Low impedance mike, pickup, or multiple line to grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall, in two sections	16.00
A-14	Dynamic microphone to one or two grids	30 ohms	50,000 ohms overall, in two sections	17.00
A-20	Mixing, mike, pickup, or multiple line to line	50, 125/150, 200/250, 333, 500/600 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-21	Mixing, low impedance mike, pickup, or line to line (multiple alloy shields for low hum pickup)	50, 200/250, 500/600	50, 200/250, 500/600	18.00
A-16	Single plate to single grid	15,000 ohms	60,000 ohms, 2:1 ratio	15.00
A-17	Single plate to single grid 8 MA unbalanced D.C.	As above	As above	17.00
A-18	Single plate to two grids. Split primary	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	16.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	19.00
A-24	Single plate to multiple line	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	17.00
A-26	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-27	Crystal microphone to multiple line	100,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-30	Audiochoke, 250 henrys @ 5 MA 6000 ohms D.C., 65 henrys @ 10 MA 1500 ohms D.C.			12.00
A-32	Filter choke 60 henrys @ 15 MA 2000 ohms D.C., 15 henrys @ 30 MA 500 ohms D.C.			10.00

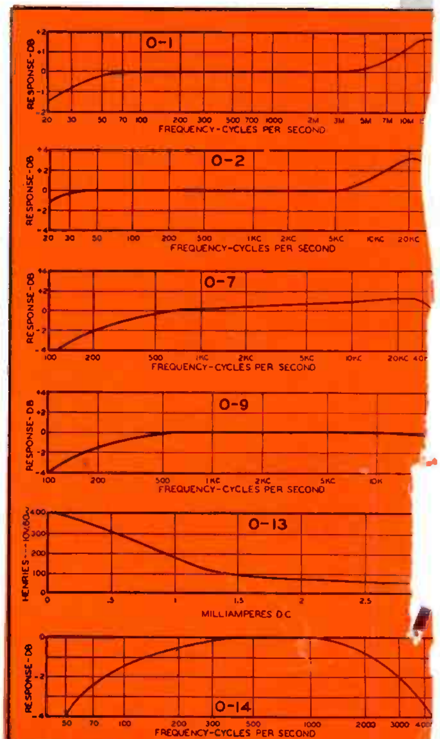


TYPE A CASE
1½" x 1½" x 2" high

UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ⅞" diameter . . . mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4000 cycles. Maximum level 0 DB.

OUNCER CASE
⅞" Dia. x 1⅞" high

Type No.	Application	Pri. Imp.	Sec. Imp.	List Price
O-1	Mike, pickup or line to 1 grid	50, 200/250 500/600	50,000	$14.00
O-2	Mike, pickup or line to 2 grids	50, 200/250 500/600	50,000	14.00
O-3	Dynamic mike to 1 grid	7.5/30	50,000	13.00
O-4	Single plate to 1 grid	15,000	60,000	11.00
O-5	Plate to grid, D.C. in Pri.	15,000	60,000	11.00
O-6	Single plate to 2 grids	15,000	95,000	13.00
O-7	Plate to 2 grids, D.C. in Pri.	15,000	95,000	13.00
O-8	Single plate to line	15,000	50, 200/250, 500/600	14.00
O-9	Plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600	14.00
O-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600	14.00
O-11	Crystal mike to line	50,000	50, 200/250, 500/600	14.00
O-12	Mixing and matching	50, 200/250	50, 200/250, 500/600	13.00
O-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C.		6000 ohms	10.00
O-14	50:1 mike or line to grid	200	½ megohm	14.00
O-15	10:1 single plate to grid	15,000	1 megohm	14.00



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electronics

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AUGUST • 1951

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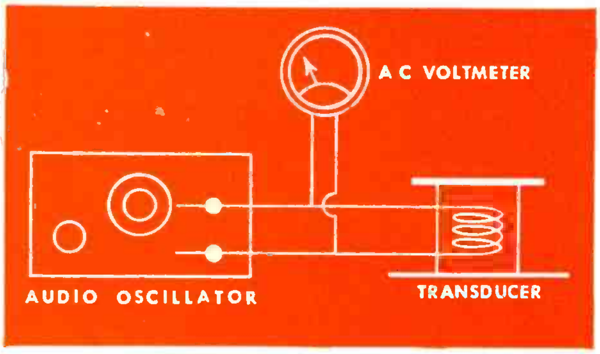
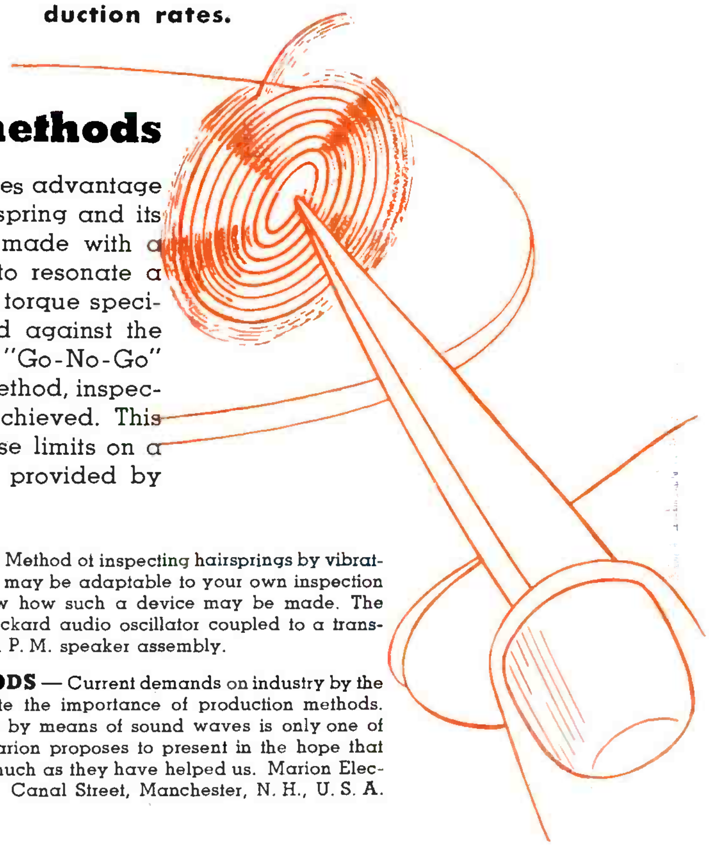
marion methods

MEASURE HAIRSPRING *TORQUE* WITH SOUND WAVES

Marion's Hairspring inspection method permits *100% inspection and control* of *hairspring characteristics* at high production rates.





Help yourself to marion methods

THE MARION METHOD of hairspring inspection takes advantage of the relationship between the torque of the hairspring and its natural resonant frequency. Initial calibration is made with a standard torsiometer and frequency is adjusted to resonate a hairspring of known torque. Hairsprings of correct torque specifications resonate when held in tweezers placed against the vibrating surface. Amplitude adjustment permits "Go-No-Go" Inspection to ± 1% of specified torque. With this method, inspection rates of 500 to 600 springs per hour may be achieved. This technique affords production torque control to close limits on a 100% basis, rather than the normal spot checking provided by standard torsiometers.

NOT FOR SALE — Marion's Method of inspecting hairsprings by vibrating them at audible frequencies may be adaptable to your own inspection problems. The illustrations show how such a device may be made. The one pictured uses a Hewlett-Packard audio oscillator coupled to a transducer which may be a modified P. M. speaker assembly.

OTHER MARION METHODS — Current demands on industry by the mobilization program accentuate the importance of production methods. Hairspring torque measurement by means of sound waves is only one of a number of methods which Marion proposes to present in the hope that some of them can help you as much as they have helped us. Marion Electrical Instrument Company, 401 Canal Street, Manchester, N. H., U. S. A.

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marion meters

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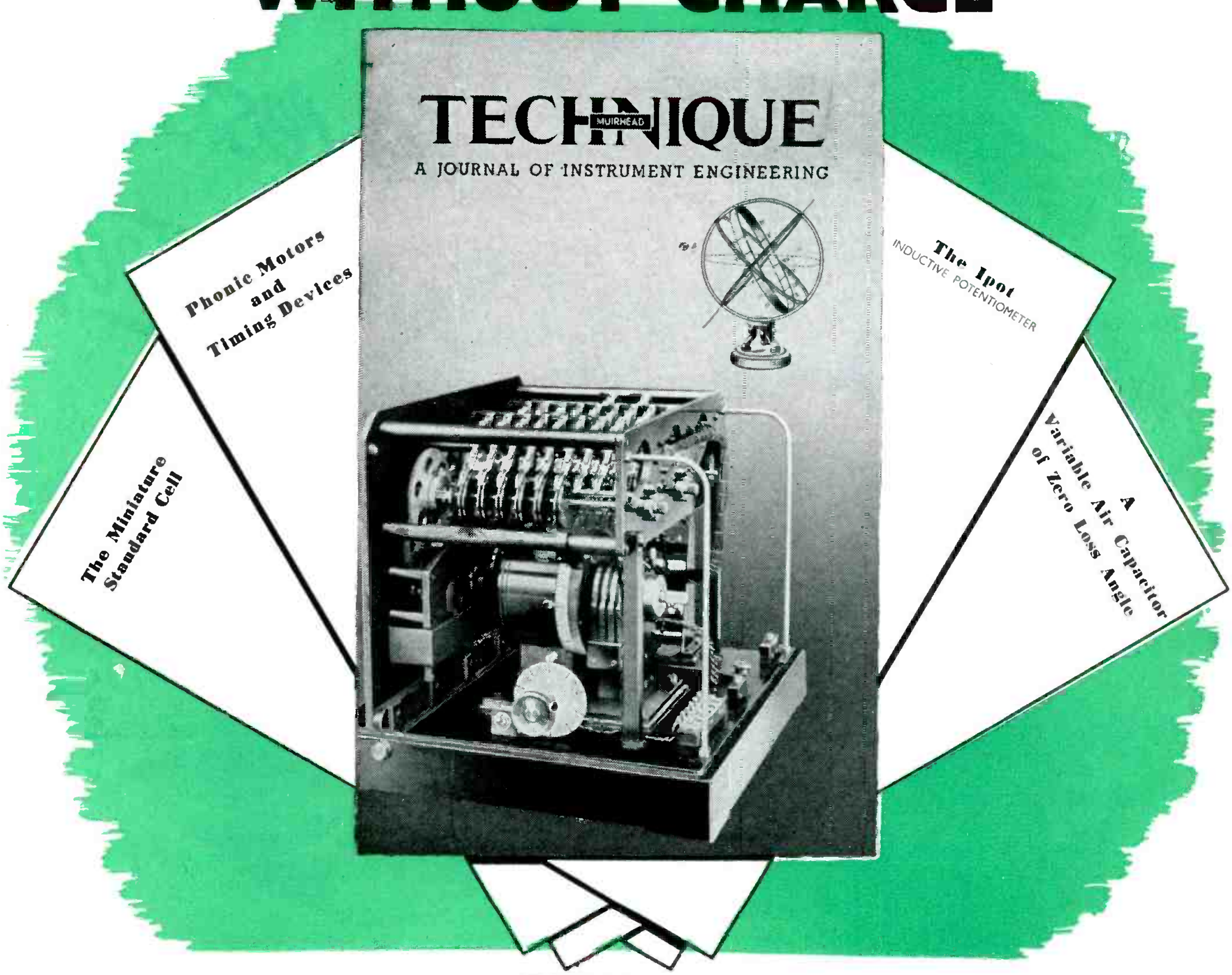

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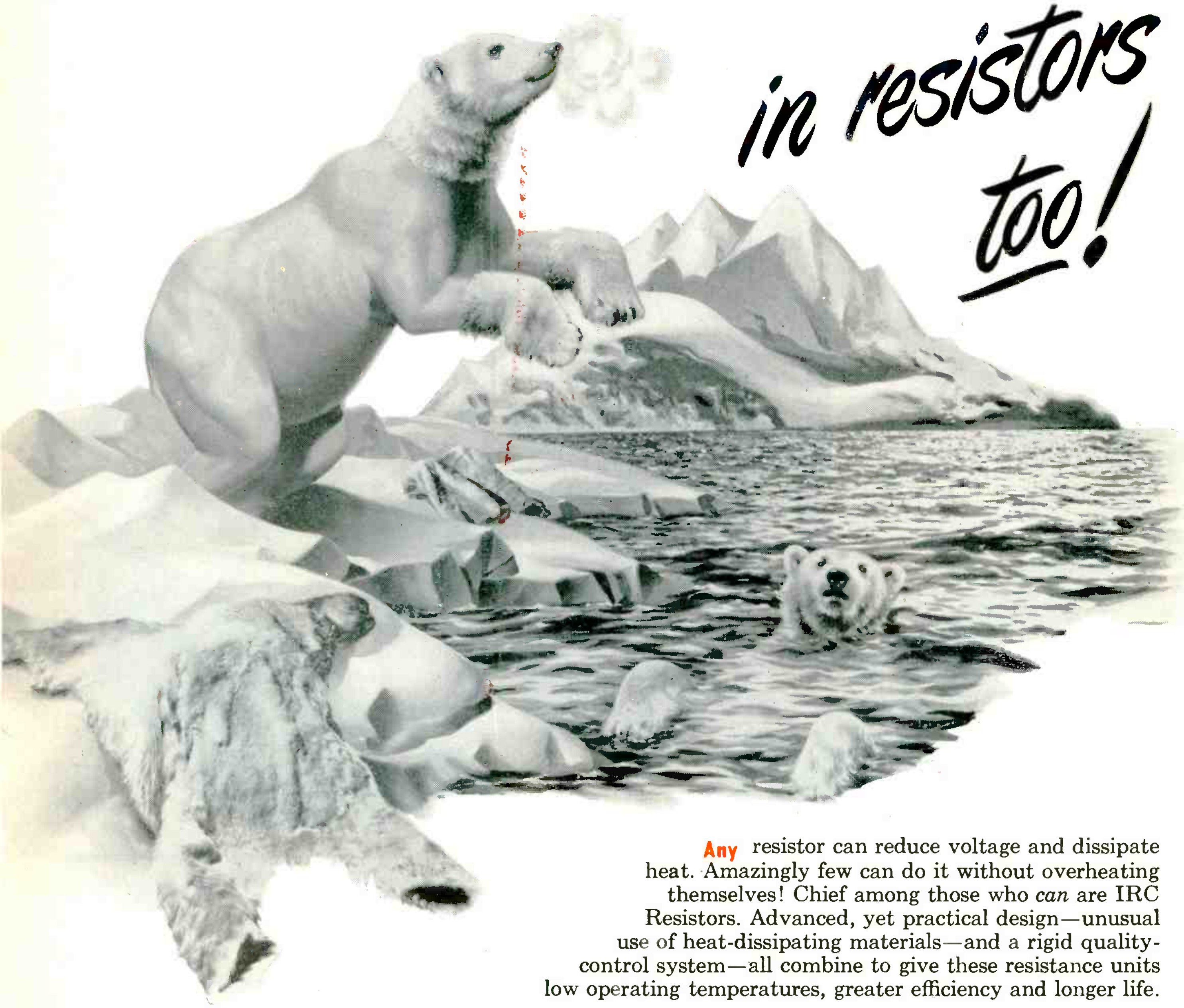
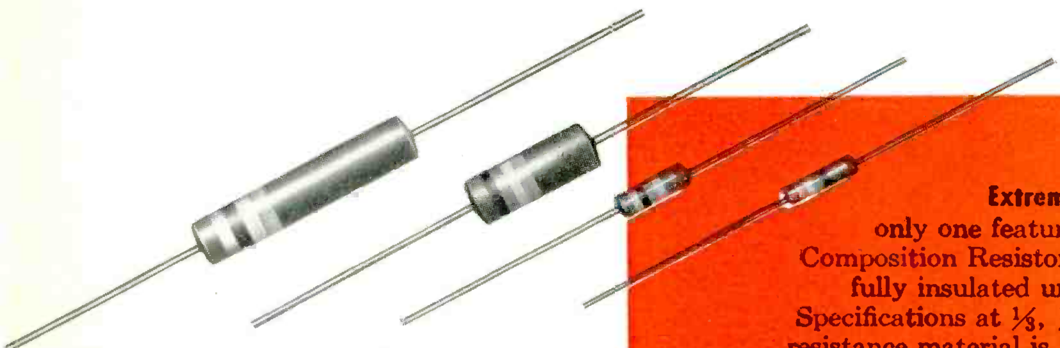
MU.29

Low temperature is *in resistors too!*



Any resistor can reduce voltage and dissipate heat. Amazingly few can do it without overheating themselves! Chief among those who *can* are IRC Resistors. Advanced, yet practical design—unusual use of heat-dissipating materials—and a rigid quality-control system—all combine to give these resistance units low operating temperatures, greater efficiency and longer life.



Low temperature coefficient and noise level. Meet and beat JAN-R-11 Specifications.

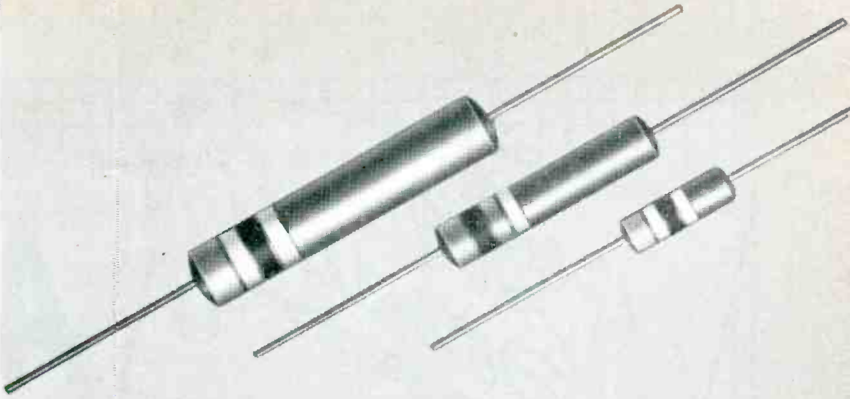
⅓, ½, 1 and 2 watts—available in ±5%, ±10%, and ±20% tolerance.

Easily meet critical requirements of television.

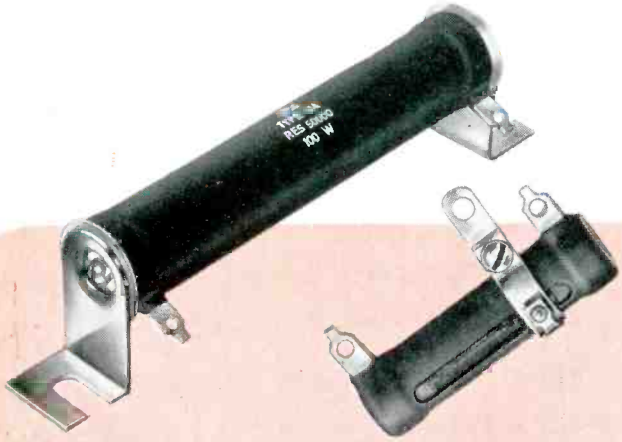
Fully tested by independent agencies under actual field conditions.

Extremely low operating temperature is only one feature of Advanced Type BT Fixed Composition Resistors. These compact, lightweight, fully insulated units actually surpass JAN-R-11 Specifications at ⅓, ½, 1 and 2 watts! In BT's, the resistance material is permanently cured and bonded to special glass. Leads extend into filament for faster heat conductivity. Molded bakelite seals element against moisture and prevents grounding. BT's are available in standard RTMA resistance ranges. Send for full details in 12-page technical data Bulletin B-1.

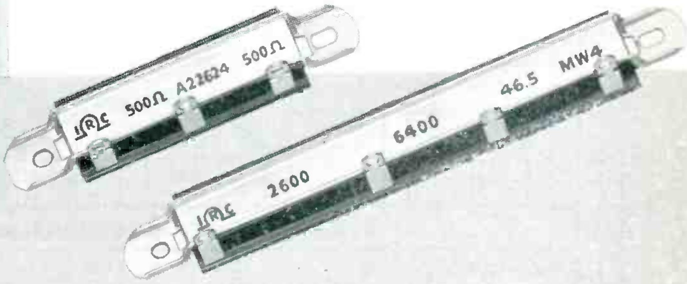
essential



Temperature coefficients cover many resistance values in IRC Type BW Insulated Wire Wound Resistors. At ½, 1 and 2 watts, they are exceptionally stable, economical units for low range applications such as meters, analyzers, spark suppression units, TV circuits, low power ignition circuits. Resistance elements are wound uniformly on insulated core. Molded phenolic housing protects against humidity and grounding. Noise and aging are negligible. Technical data Bulletin B-5 contains full details.



Besides unusually rapid dissipation of heat, IRC Fixed and Adjustable Power Wire Wound Resistors give balanced performance in every characteristic. Special cement coatings are designed for low range high temperature requirements—or for maximum protection against extreme atmospheric conditions. For exacting, heavy-duty applications—high voltage bleeders, bias supply, grid and filament dropping resistors—PWW's are available in a full range of sizes, types and terminals. Leading industrial, aircraft and broadcasting users have specified them for more than 14 years. Technical data Bulletin C-2 gives complete information.



For extremely fast heat dissipation, the unique mounting brackets of Type MW Wire Wound Resistors actually transfer heat from chassis to outside. Other radical departures from conventional design give MW's widest adaptability to individual requirements. MW's are flat wire wound resistor strips, permanently enclosed by high pressure molding in a special mica-filled phenolic compound. Special feet permit mounting on any flat metal surface. Low initial cost, lower mounting cost, flexibility in providing taps at low cost, and savings in space, all offer amazing economies. Ask for technical data Bulletin B-2.

When you're in a hot spot and need experimental or maintenance quantities of standard resistors *double-quick*, phone your IRC Distributor. IRC's Industrial Service Plan provides him with a full stock of uniformly dependable standard resistors; he can give you fast, round-the-corner delivery of small-order requirements. We'll be glad to send you his name and address.

Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

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Wherever the Circuit Says -VVV-

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Please send me complete information on the items checked below:—

- ☐ Advanced BT Resistors (B-1)
- ☐ BW Resistors (B-5)
- ☐ Power Wire Wounds (C-2)
- ☐ MW Resistors (B-2)
- ☐ Name and Address of nearest IRC Distributor

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AC VOLTAGE REGULATORS

Accuracy, with rugged construction, economical and trouble-free operation, reasonable cost — those are features that you expect, *and get*, when you specify Sorensen regulators!

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- Wide Input Range
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MODEL NO. 500-S

STANDARD AC SPECIFICATIONS

VA capacity	150 500	250 1000	2000 3000	5000 10000 15000
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Regulation accuracy	± 0.1% against line or load			
Input voltage	95-130 VAC; also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	0 to full load			
P.F. range	Down to 0.7 P.F. All models temperature compensated			

NOTE: THREE PHASE AND 400 CYCLE REGULATORS ALSO AVAILABLE. ALL REGULATORS CAN BE HERMETICALLY SEALED.

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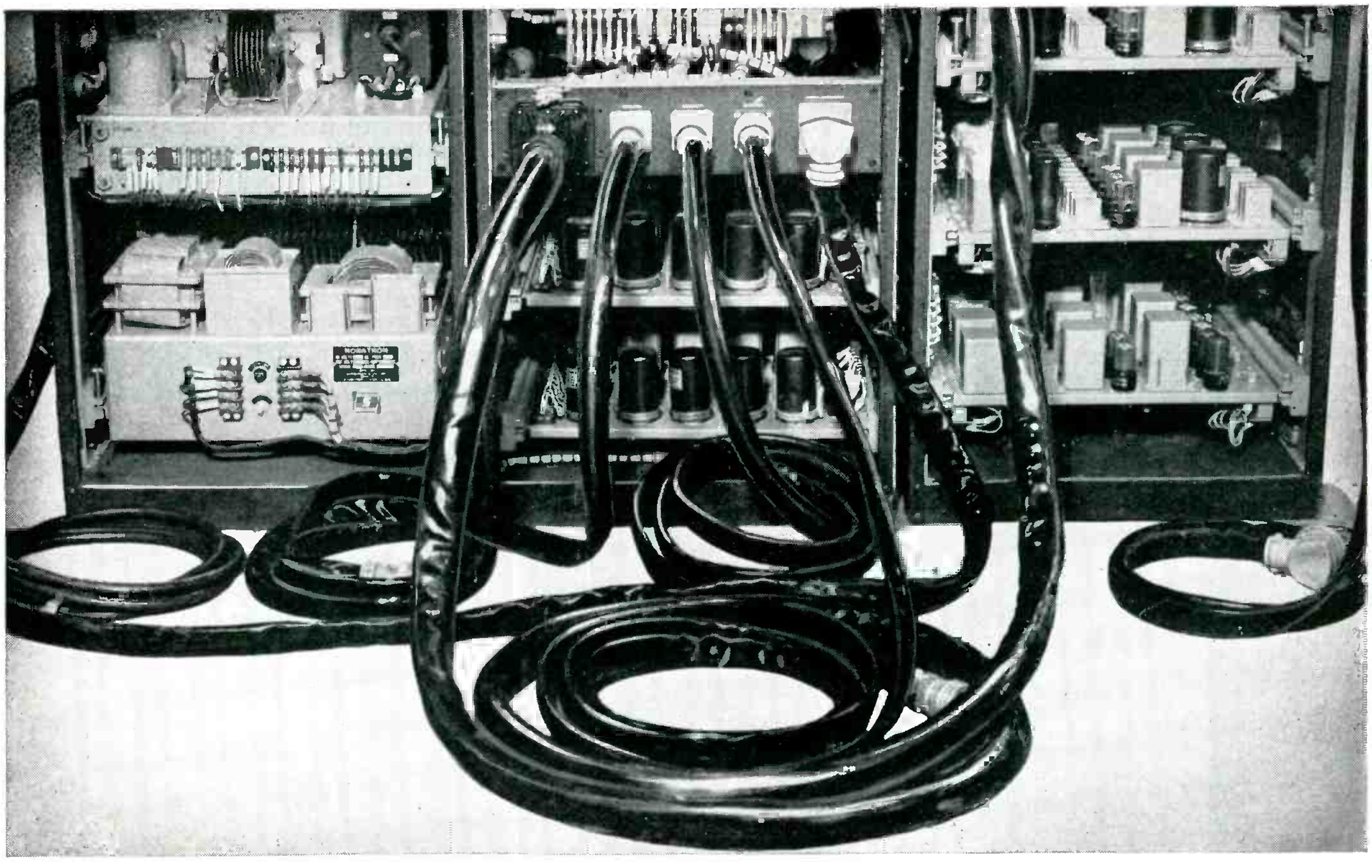

Reeves *saves space* in its Electronic Brain . . . with IRV-O-LITE Tubing

The Reeves Electronic Analog Computer (REAC)* saves plenty of man-hours in performing complex calculations. And in this Electronic Brain's complicated wiring system, shielding and terminal labeling are done exclusively with IRV-O-LITE XTE-30 Plastic Tubing—saving plenty of *space.*

XTE-30's high dielectric strength of 1,000 vpm (dry) frequently permits the use of *thinner-walled* tubing. Where space is at a premium, follow the example of Reeves and hundreds of other manufacturers—use XTE-30!

You get these *other* advantages, too, with XTE-30 Plastic Tubing: high mechanical strength; lasting flexibility; excellent chemical and moisture resistance.

XTE-30 comes in a standard range of sizes from .022" to 2" ID and even larger for special applications. Six contrasting colors simplify identification of leads and speed up complex wiring jobs. See for *yourself* what XTE-30 will do for you—just mail the coupon for free Technical Data Sheet.

** Manufactured by Reeves Instrument Corp. of N. Y., one of the outstanding producers of high precision electronic and electro-mechanical computing equipment.*

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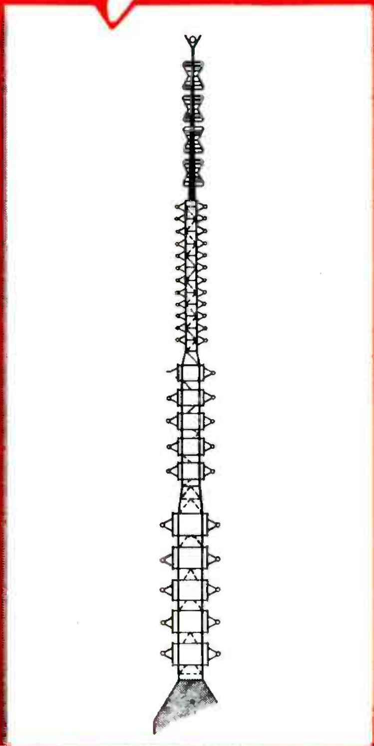
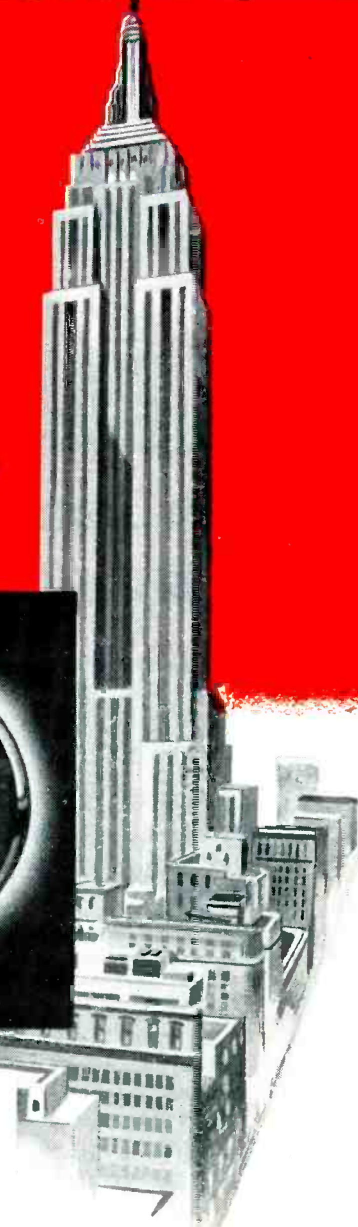
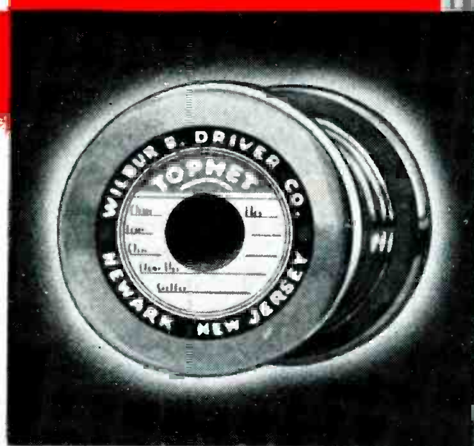
"TOTEM POLE"



—towering above the Empire State Building in New York City





The new five channel "totem pole" antenna atop the world's tallest building posed many difficult-to-solve problems. One of these—severe icing conditions—was solved with specially-designed de-icers, manufactured by Electro-Therm, Inc., of Silver Spring, Maryland and installed by RCA engineers. Tophet heating elements in the de-icers effectively prevent ice accumulations. Wherever an extra margin of dependability is required, engineers specify Tophet for greater dependability. For Tophet Resistance Wire has been proven over the years to provide top heat and top performance in applications ranging from household appliances to heavy duty industrial furnaces.

It's TOPHET for Top Heat

WILBUR B. DRIVER COMPANY

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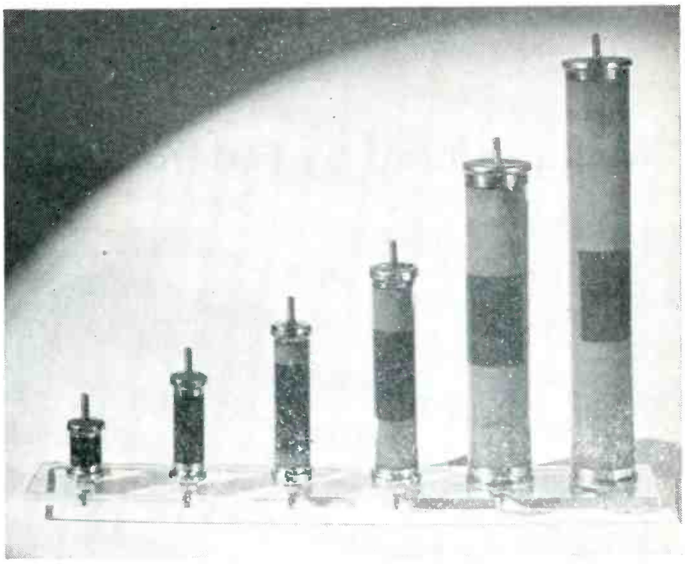
Plasticon GLASSMIKES

have been solving your engineering problems since 1943!



We originally designed Glassmikes for the Metallurgical Laboratory at the University of Chicago for use in radiation counter equipment. The Glassmike construction (metal ferrules soldered to silvered bands at each end of a glass tube) proved ideal for small, high voltage filter and coupling capacitors. As the only exclusive producers of plastic film dielectric capacitors, we use many different films and impregnation combinations. Our application experience enables us to recommend the best dielectric combination for your particular application.

Some of the more common Glassmike types are as follows:

Type **ASG**—High temperature, high voltage filter coupling and by-pass service.
Type **AAG**—High resistance, low voltage coupling and storage service.
Type **LAG**—Very high resistance, extremely low dielectric absorption.
Type **LSG**—High "Q", high voltage replacement for mica capacitors.
Type **TAG**—Similar applications to Type LAG, but for higher temperatures.
Type **TSG**—Similar application to Type LSG, but for higher temperatures.
Type **PAG**—High DC resistance, low dielectric absorption for temperatures up to 85° C.
Type **FAG**—Ultra high resistance, high voltage capacitor.

Send us your requirements and we will recommend the proper capacitor.

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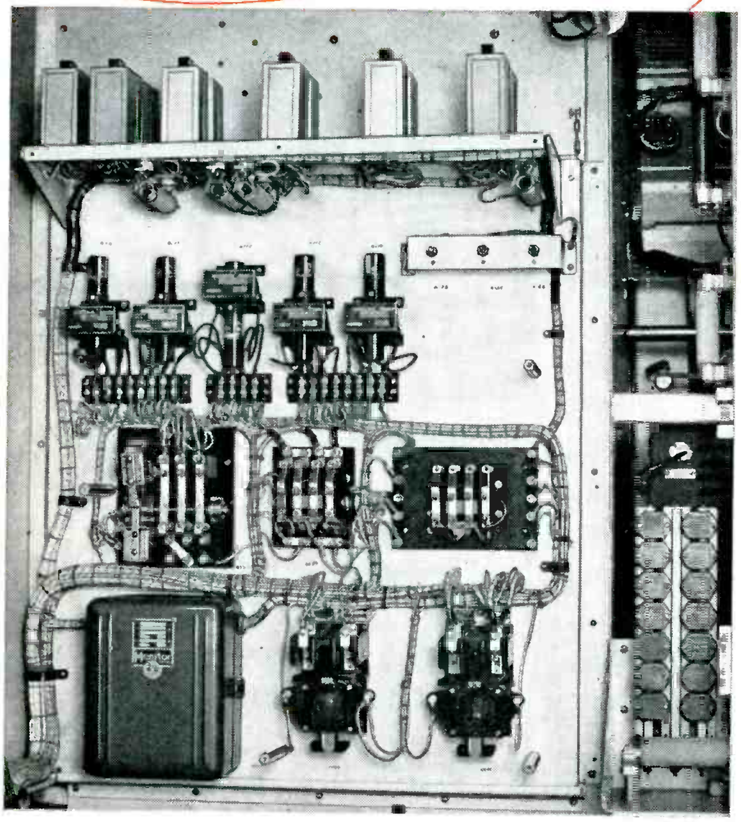
ADLAKE RELAYS AT WORK—One of a series of advertisements on specific ADLAKE applications.

Adlake Relays Are Used in LORAN Transmitters

TRADE MARK

Manufactured by Federal Telephone and Radio Corporation



Relay control panel of Loran Transmitter Model T-137, built by Federal Telephone and Radio Corporation. Five ADLAKE Relays are used to control plate and filament power and to provide overload protection—operations calling for the utmost stability in time delay.

Loran transmitters (LOng RAnge Navigation) are of prime importance to both naval and merchant fleets. The builder of these transmitters, Federal Telephone and Radio Corporation, Clifton, N. J., uses ADLAKE Relays—because ADLAKE assures the utmost reliability under all operating conditions.

ADLAKE Relays are designed and built to meet the most exacting requirements. Their mercury-to-mercury contact prevents burning, pitting and sticking, and their sturdy construction armors them against outside vibration or impact. And most important of all, *they require no maintenance*, for they are hermetically sealed against dust, dirt and moisture.

For the full story on the part ADLAKE Relays can play in *your* business, just drop a card to The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every ADLAKE Relay Gives You These Advantages:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.

SILENT AND CHATTERLESS • ABSOLUTELY SAFE • REQUIRES NO MAINTENANCE

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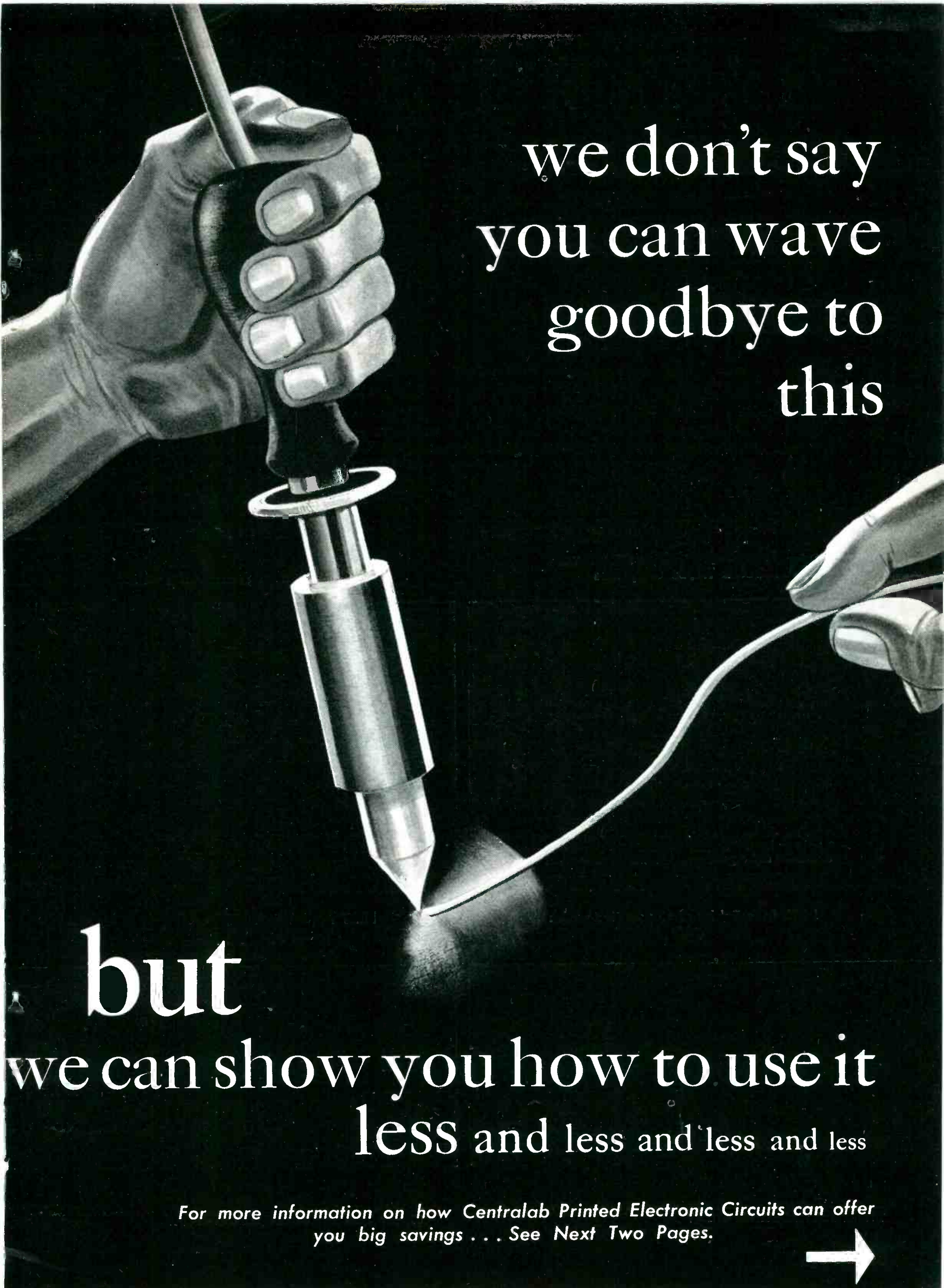
we don't say
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goodbye to
this
but
we can show you how to use it
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For more information on how Centralab Printed Electronic Circuits can offer
you big savings . . . See Next Two Pages.
→

Here's Proof: Printed Electronic

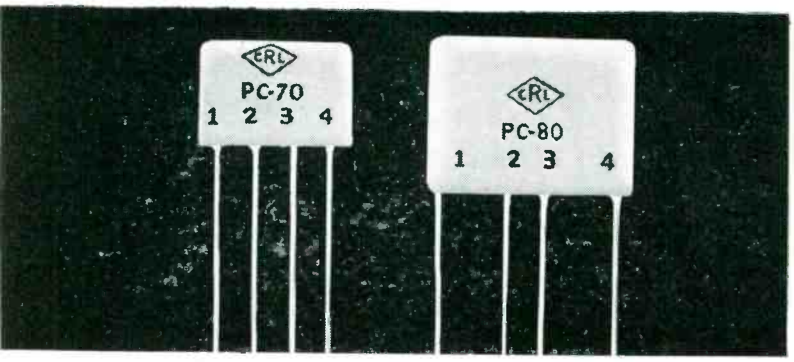
What are Printed Electronic Circuits?

Printed Electronic Circuits are complete or partial circuits (including all integral circuit connections) consisting of pure metallic silver and resistance materials fired to CRL's famous Steatite or Ceram-ic-X and brought out to convenient, permanently anchored external leads. They provide compact miniature units of widely diversified circuits — from single resistor plates to complete speech amplifiers. No other modern electronic development offers such tremendous time and cost saving advantages in low-power applications. ***Important to note:*** All PEC's illustrated are developed for standard applications. Numerous other circuit complements can be furnished for volume requirements.

How Do They Save Time and Money — Space and Weight?

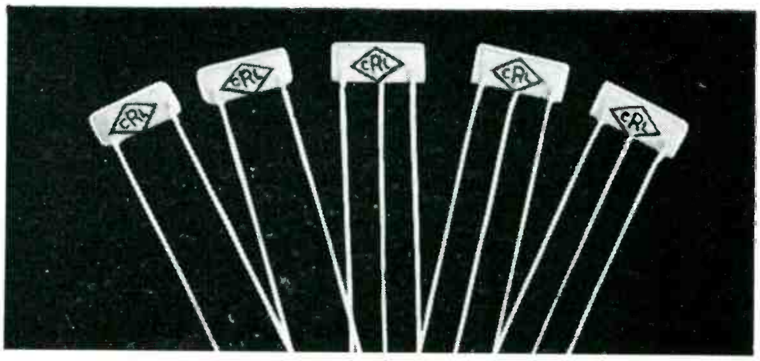
Because Printed Electronic Circuits combine several components on a single plate unit, they eliminate approximately 25% to 80% of formerly required soldered connections within the circuits they replace. This means simplified assembly — savings in material. What's more, because they replace several individual components, they cut down your purchases and inventory. Because they are complete assembled circuits, they do much to eliminate wiring errors. Their small size (note illustrations) means less space needed as well as less weight . . . important factors in today's crowded chasses.

60% Less Soldered Connections with Centralab Triode Couplates



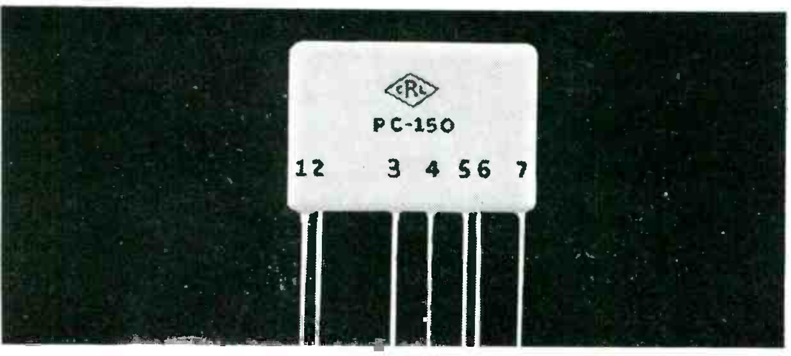
Centralab Triode Couplates replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values. Technical Bulletin 42-127.

Plate Capacitor and Resistor-Capacitors Excellent for Miniature Use



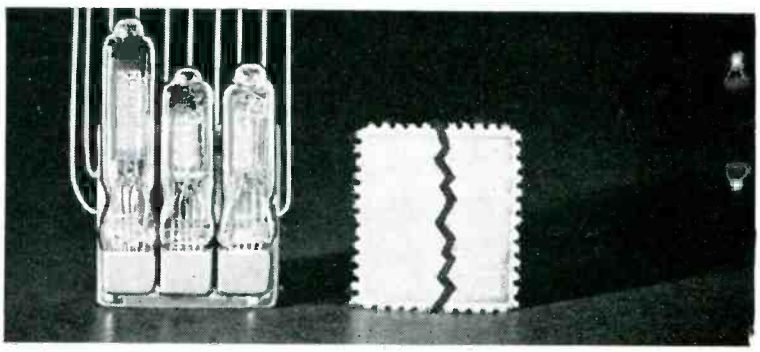
Actual size photograph of plate capacitor, resistor, and resistor-capacitor units. Because of size, they readily fit all types of miniature and portable electronic equipment... overcome crowded conditions in TV, AM, FM and record-player chassis. Technical Bulletin 42-24.

50% Less Soldered Connections with Centralab's AUDET



Audet Printed Electronic Circuits furnish all values of all components generally found in the output stage of AC-DC radio receivers. They provide 4 capacitors and 3 resistors on a small plate with only 7 leads. Technical Bulletin 42-129.

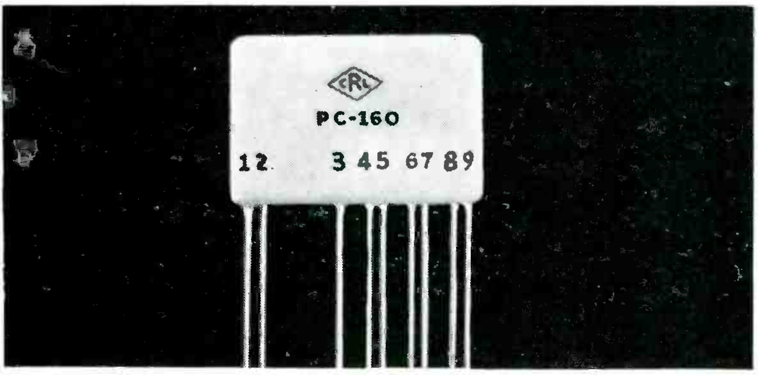
NEW Model 3 AMPEC — A Sub Miniature 3 Stage Speech Amplifier



Here's the latest outgrowth of Centralab's constant research in Printed Electronic Circuit development. The remarkably small dimensions of this new amplifier unit are approximately 1⅓₂" x ¹⁵⁄₁₆" x ¹¹⁄₃₂". Check coupon for Technical Bulletin 42-130.

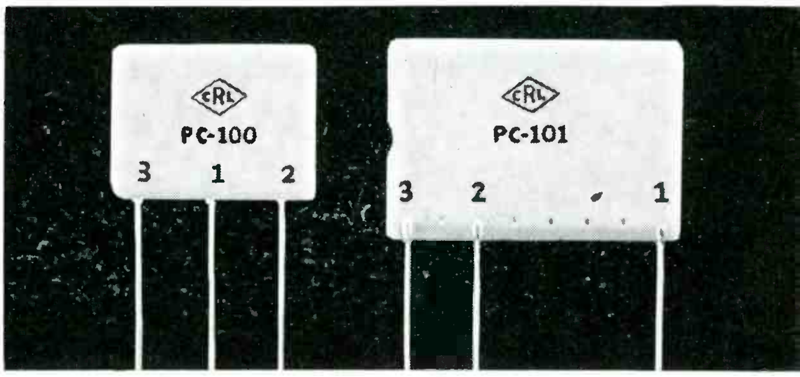
Circuits = BIG SAVINGS

50% Less Soldered Connections With Centralab's NEW PENDET



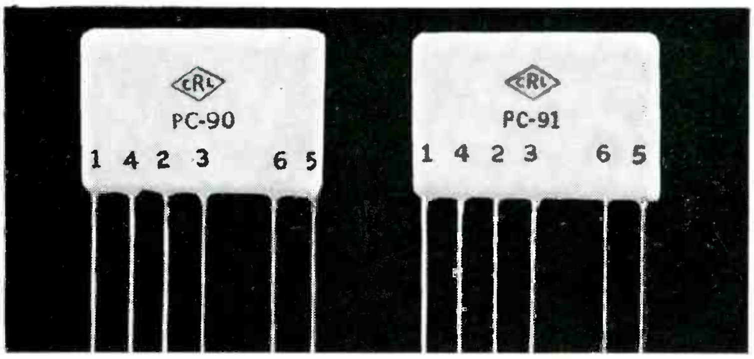
PENDET consists of 5 capacitors and 4 resistors in a single plate with only 9 leads. Similar to the popular AUDET, it is designed to couple the diodetriode and pentode tubes in the output stage of AC-DC sets. Check coupon for Technical Bulletin 42-149.

82% Less Soldered Connections With P.E.C. VERTICAL INTEGRATOR



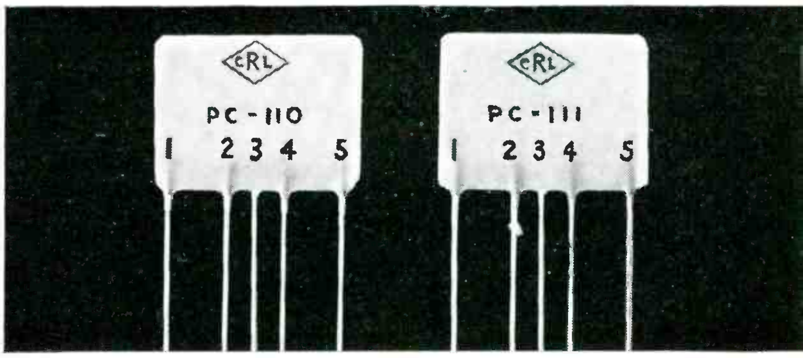
Centralab Vertical Integrators give you big savings in assembly of TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reduces former 16 soldered connections to 3! Check coupon for Technical Bulletin 42-126.

50% Less Soldered Connections With Centralab's PENTODE COUPLATE



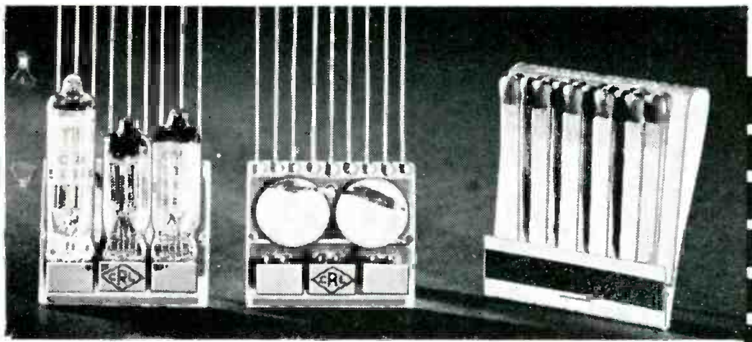
Pentode couplates are complete interstage coupling circuits consisting of 3 capacitors and 3 resistors on a small 6 lead ceramic plate. Compared with old-style audio circuits, they actually reduce soldered connections 50%—wiring errors accordingly. Technical Bulletin 42-128.

28% Less Soldered Connections With NEW FILPLATE



FILPLATES (2 resistors and 2 capacitors) for bypass and filter application in TV, FM and AM, where filter networks of comparable component values and layout are needed. Smaller than special delivery stamp. Save vital low wattage resistor stocks. Technical Bulletin 42-131.

Standard Model 2 AMPEC Miniature 3 Stage Speech Amplifier



AMPEC — A full 3-stage speech amplifier. Provides highly efficient performance. Size 1¼" x 1⅛" x .340" over tube sockets! Used in hearing aids, mike preamps and other applications where small size and outstanding performance counts. Technical Bulletin 42-117.

Centralab

Division of GLOBE-UNION INC. • Milwaukee

Centralab, Div. of Globe-Union Inc.
914 East Keefe Avenue, Milwaukee 1, Wisconsin

Please send me the Technical Bulletins on Printed Electronic Circuits as checked below:

☐ 42-24 ☐ 42-117 ☐ 42-126 ☐ 42-127 ☐ 42-128
☐ 42-129 ☐ 42-130 ☐ 42-131 ☐ 42-149

Name..

Address..

Company..

Title..

How to get any TV +

TAKE ONE OF THESE TV TRANSMITTERS...

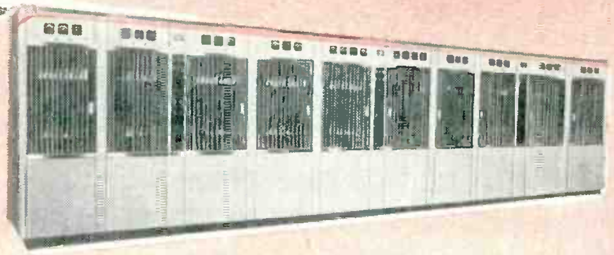
500 watts, for VHF
Type TT-500 A/B
(All Air-Cooled)

1 kw, for UHF
Type TTU-1B
(All Air-Cooled)

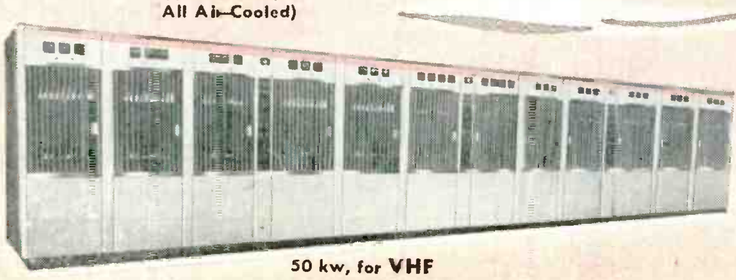
2 kw, for VHF
Type TT-2AL/H
(All Air-Cooled)

10 kw, for VHF
Type TT-10AL/H
(All Air-Cooled)

10 kw, for UHF
Type TTU-10A



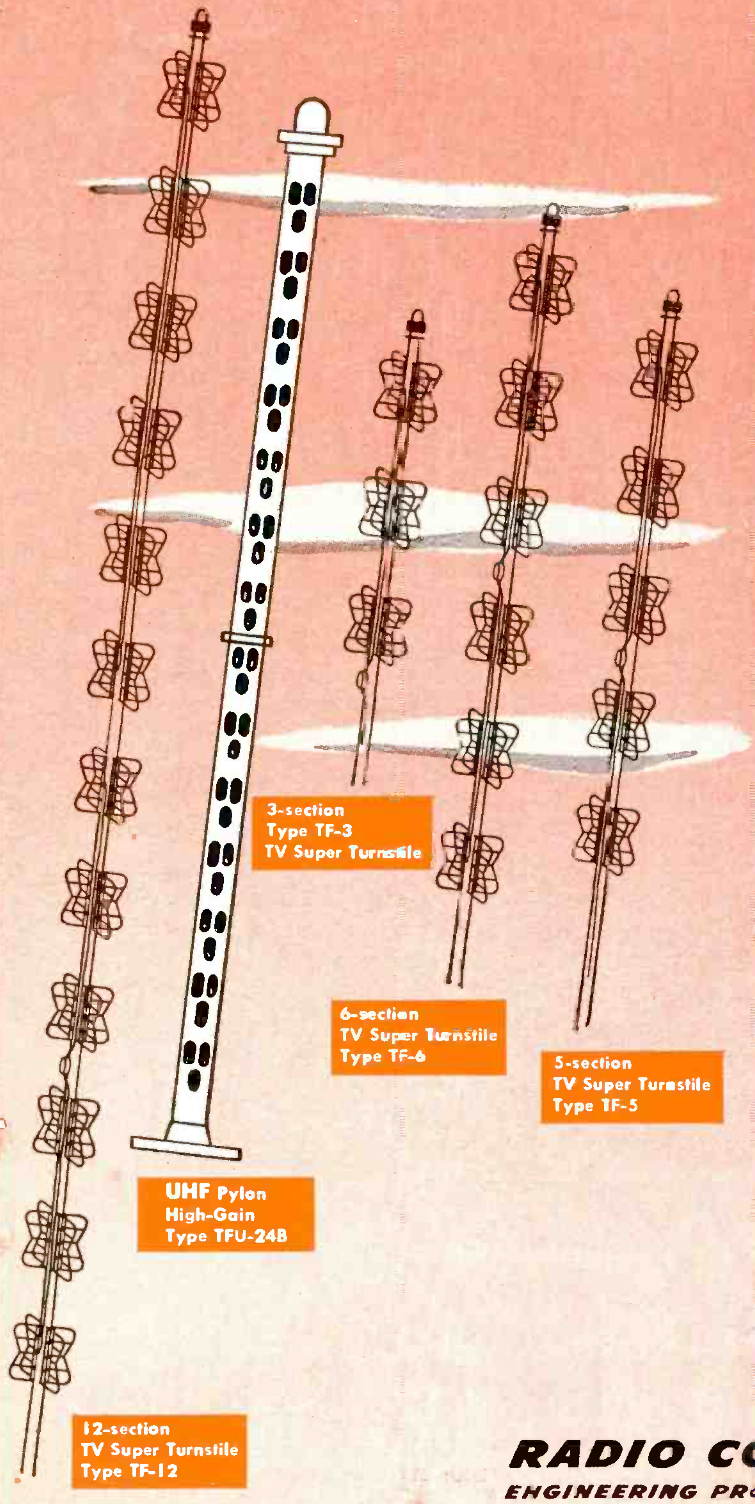
20 kw, for VHF
Type TT-20BL/H
(All Air-Cooled)



50 kw, for VHF
Type TT-50AL/H

power up to 200 KW!*

...ADD ONE OF THESE TV ANTENNAS... = YOUR POWER



With RCA's complete line of transmitters (seven different models), you can get any ERP* up to 200 kw—on any channel from 2 to 83. And in most cases, *you can get the power you want in several different ways!*

If your requirements are best met with a low-power transmitter and a high-gain antenna, *RCA has the combination!* However, if your needs are better met with a higher-power transmitter and a lower-gain antenna, *RCA has that combination too!*

Ask your RCA Sales Representative to sit down and help you plan the most practical and economical equipment setup for your station. He has an intimate knowledge of station planning—knows TV equipment from A to Z. He can tell you exactly what you'll need to get "on the air" . . . with the power you want . . . at the lowest cost.

Call him today. Or write RCA Engineering Products Department, Camden, N. J.

*Effective radiated power

RCA

RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

"... losing friends and antagonizing people"

With her new hearing aid, Grandma Crane was really enjoying life. My it was nice to hear clearly again . . . like now, talking to her grandson at camp. Then—silence—the hearing aid was dead! Nothing to do but go back to the office where she bought it. The technician will be in for a hard time—especially when Grandma Crane finds out that the trouble was just a bit of electrical insulation that failed.

That manufacturer saved a few pennies in costs—and lost dollars in good will.

The failure of electrical insulation in your product is a serious matter—for your customer and for you.

Leading electrical equipment and appliance manufacturers use BH "649"† Fiberglas Sleeving and Tubing to minimize the possibility of insulation breakdown.

Here is a superior, high voltage, Fiberglas insulation available in three grades — A-1, B-1 and C-1 . . . tough, abrasion resistant and permanently flexible. It is non-fogging and non-corrosive with unusual chemical resistance, except for Ketones, Esters and Aromatic Hydrocarbons. It will not crystallize at -67° F. BH "649" won't crack, peel, fray or split. It will take plenty of abuse without loss of these physical properties, or its dielectric strength even after the following tests . . . 15 minutes at 425°-450° F; 24 hours at 302° F; 1500 hours at 220°-230° F.

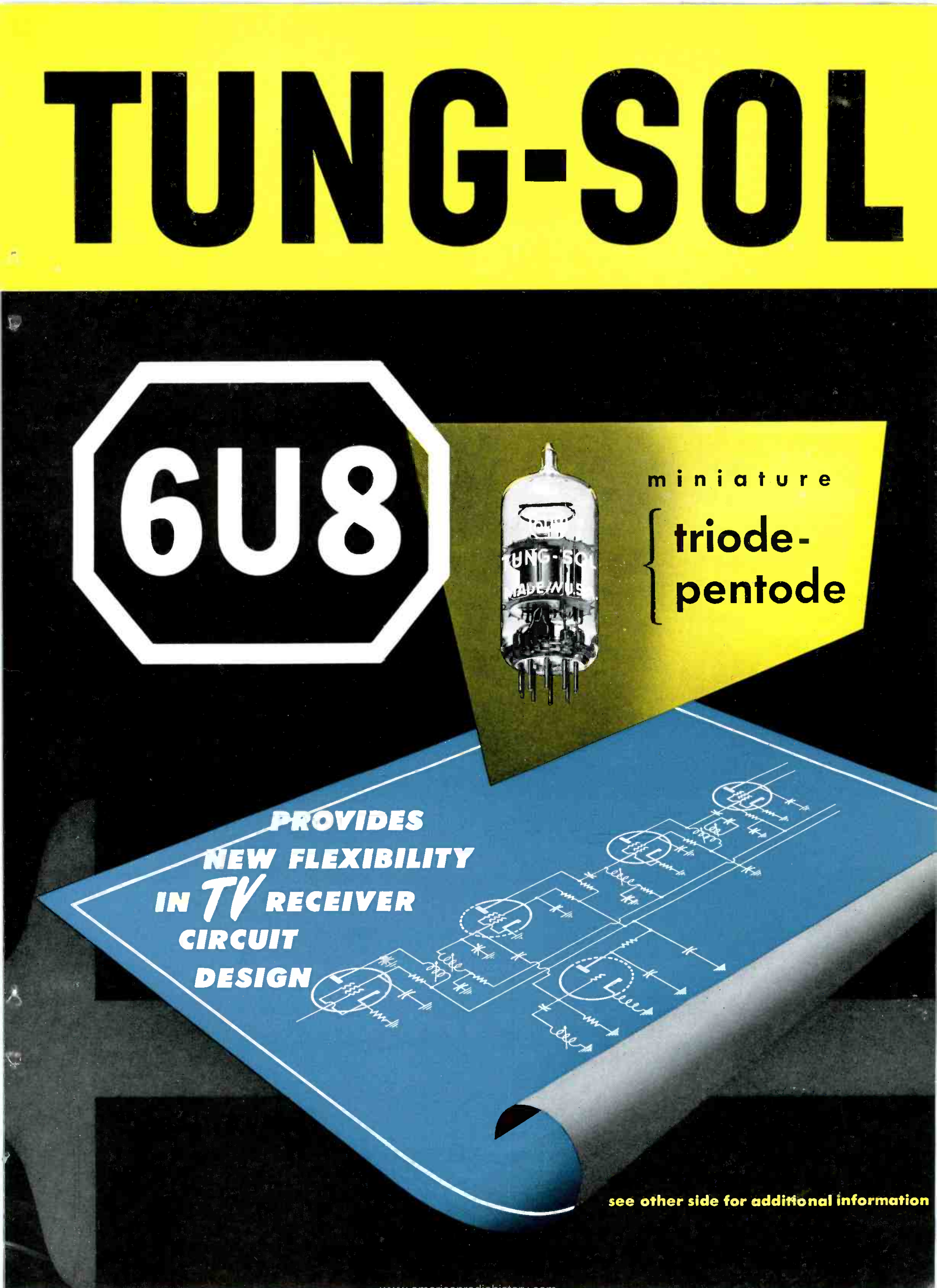
BH "649" is one of a family of BH insulations, each designed to meet particular conditions in service. Whether your problem is heat, cold, flexibility, abrasion, high voltage or resistance to chemicals, there is a BH insulation to help you. Give us a few facts about your requirements — products, temperatures, voltages. We will furnish samples for testing. Address Dept. E-8

†Patent Pending

Bentley, Harris Manufacturing Co.
Conshohocken, Pa.

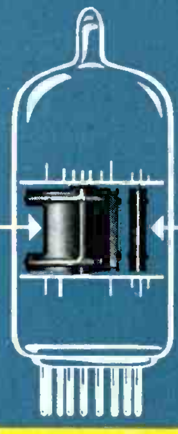
BH *Fiberglas** SLEEVINGS

*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


TUNG-SOL
6U8
miniature
triode-
pentode
PROVIDES
NEW FLEXIBILITY
IN TV RECEIVER
CIRCUIT
DESIGN
see other side for additional information

TUNG-SOL

6U8



miniature

triode-pentode

✓ Completely independent sections

✓ Versatility in circuit application

✓ Improved circuit performance

This tube has two electrically independent sections—a triode and a pentode and is intended as a local oscillator mixer for FM and TV receivers. Each section is adequately shielded, and both are capable of exceptionally good performance at the higher frequencies.

Because the two sections are completely independent, a high degree of flexibility of circuit design is available—especially valuable in TV tuner oscillator use. Performance of the 6U8 triode at low voltages is superior to that of many types previously used for this service. It has sufficient reserve emission to operate efficiently under widely varying supply voltage conditions.

The pentode provides excellent gain with low local oscillator voltage injection resulting in low oscillator radiation from TV receivers. Use of the pentode section as the mixer permits the high (40 m. c.) I. F. so desirable to reduce interference and increase stability.

The construction and characteristics of the 6U8 provide designers with extremely desirable flexibility in combining circuit functions. The pentode section of the tube may be used as an I. F. amplifier, video amplifier, sound limiter or synchronizing separator. The triode performs satisfactorily as a horizontal or vertical oscillator, or sync clipper.

Wherever there is need for a triode and a pentode in a receiver, they can be combined in the 6U8.

MECHANICAL DATA

Coated unipotential cathodes—2			
Outline drawing	RTMA 6—2	Bulb	T—6-1/2
Base	RTMA E9—1	Miniature button	9-pin
Maximum diameter			7/8"
Maximum overall length			2-3/16"
Maximum seated height			1-15/16"
Base pin connections		RTMA basing	9 AE
Pin 1—triode plate		Pin 6—pentode plate	
Pin 2—pentode grid #1		Pin 7—pentode cathode grid #3, shield	
Pin 3—pentode grid #2		Pin 8—triode cathode	
Pin 4—heater		Pin 9—triode grid	
Pin 5—heater			
Mounting position			Any

ELECTRICAL DATA

Interelectrode Capacitances	With Shield #315	Without Shield	
Pentode grid #1 to pentode plate	0.006	0.010 max.	μμf.
Pentode input	5.0	5.0	μμf.
Pentode output	3.5	2.6	μμf.
Triode grid to triode plate	1.8	1.8	μμf.
Triode grid to cathode	2.5	2.5	μμf.
Triode plate to cathode	1.0	0.4	μμf.
Cathode to heater (either section) approx.	3.0	3.0	μμf.

ELECTRICAL DATA

Ratings

Heater voltage (ac or dc)	6.3	VOLTS
Maximum heater-cathode voltage	90.0	VOLTS
Maximum plate voltage (pentode)	300.0	VOLTS
Maximum plate voltage (triode)	300.0	VOLTS
Maximum grid #2 supply voltage	300.0	VOLTS
Maximum plate dissipation (pentode)	2.8	WATTS
Maximum grid #2 dissipation	0.5	WATTS
Maximum positive dc grid #1 voltage	0	VOLTS
Maximum positive dc grid voltage (triode)	0	VOLTS
Maximum plate dissipation (triode)	2.5	WATTS

Typical Operating Conditions and Characteristics

	Triode	Pentode	
Heater voltage	6.3		VOLTS
Heater current	450		MA.
Plate voltage	150	250	VOLTS
Grid #2 voltage	. . .	110	VOLTS
Cathode resistor	56	68	OHMS
Transconductance	8500	5200	μMHOS
Grid #1 voltage (approx.) for Ib=10 ua.	-12	-10	VOLTS
Plate current	18	10	MA.
Grid #2 current	. . .	3.5	MA.
Plate resistance (approx.)	.005	0.40	MEG.
Amplification factor	40	. . .	

TUNG-SOL ELECTRON TUBES

The TUNG-SOL engineering which has produced the 6U8 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types is available on request to TUNG-SOL Commercial Engineering Department.

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

SALES OFFICES: ATLANTA · CHICAGO · DALLAS · DENVER · DETROIT · LOS ANGELES · NEWARK

TELEVISION TUBES · RADIO TUBES · DIAL LAMPS · ALSO ALL-GLASS SEALED BEAM LAMPS AND SIGNAL FLASHERS

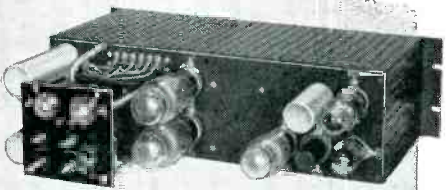
AUGUST, 1951

FOR MAXIMUM PERFORMANCE AND LONG LIFE OF ELECTRICALLY-OPERATED EQUIPMENT

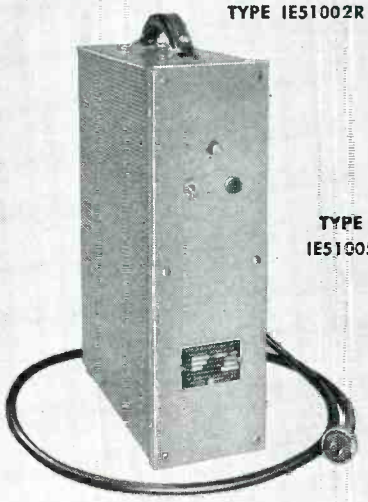
Invest in **STABILINE**

Automatic

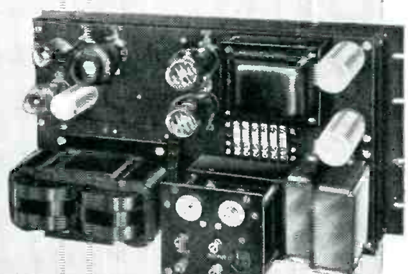
VOLTAGE REGULATORS



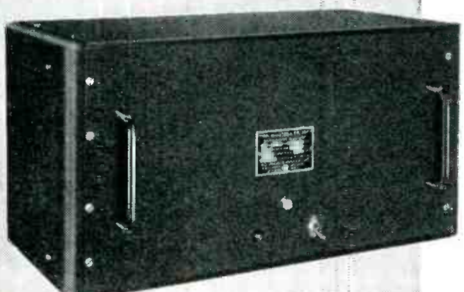
TYPE IE51002R



TYPE IE51005



TYPE IE5101R



TYPE IE5101

Manufacturers faced with the need for increased production and lower costs are becoming extremely conscious of the importance of maintaining constant voltage to electrical apparatus. The Superior Electric Company's line of STABILINE Automatic Voltage Regulators offers equipment to suit the needs of each application. Two types are available: Type IE (Instantaneous Electronic) and Type EM (Electro-Mechanical).

STABILINE Type IE is a completely electronic unit with no moving parts . . . is used where instantaneous and extremely close correction is required. It maintains a constant output voltage regardless of line variations at no load, full load or any intermediate load. The output voltage is held to within ± 0.1 volts of nominal for wide line variations; within ± 0.15 volts of nominal for any load current change or load power factor change from lagging .5 to leading .9. Maximum waveform distortion never exceeds 3%.

Standard models are available in cabinets or for relay rack mounting in numerous ratings as listed below. In the event you have a special requirement involving other frequencies or ratings, SECO voltage control engineers will study your specific problem and make recommendations without obligation.

INSTANTANEOUS ELECTRONIC CABINET MODELS

Input Voltage Range	Output Voltage Range	Frequency In Cycles	Load Range In Amperes	Load Power Factor Range	Rated Output KVA	Type
95-135	110-120	60 ± 10%	0 - 2.2		0.25	IE51002*
195-255	220-240	60 ± 10%	0 - 1.1		0.25	IE52002*
95-135	110-120	60 ± 10%	0 - 4.5	.5 lagging	0.5	IE51005*
195-255	220-240	60 ± 10%	0 - 2.2		0.5	IE52005*
95-135	110-120	50 ± 10%	0 - 4.5		0.5	IEL51005*
195-255	220-240	50 ± 10%	0 - 2.2		0.5	IEL52005*
95-135	110-120	60 ± 10%	0 - 8.5	to	1.0	IE5101*
195-255	220-240	60 ± 10%	0 - 4.5		1.0	IE5201*
95-135	110-120	50 ± 10%	0 - 8.5		1.0	IEL5101*
195-255	220-240	50 ± 10%	0 - 4.5		1.0	IEL5201*
95-135	110-120	60 ± 10%	0 - 22.0		2.5	IE5102*
195-255	220-240	60 ± 10%	0 - 11.0	.9 leading	2.5	IE5202*
195-255	220-240	50 ± 10%	0 - 11.0		2.5	IEL5202*
95-135	110-120	60 ± 10%	0 - 43.5		5.0	IE5105
195-255	220-240	60 ± 10%	0 - 22.0		5.0	IE5205

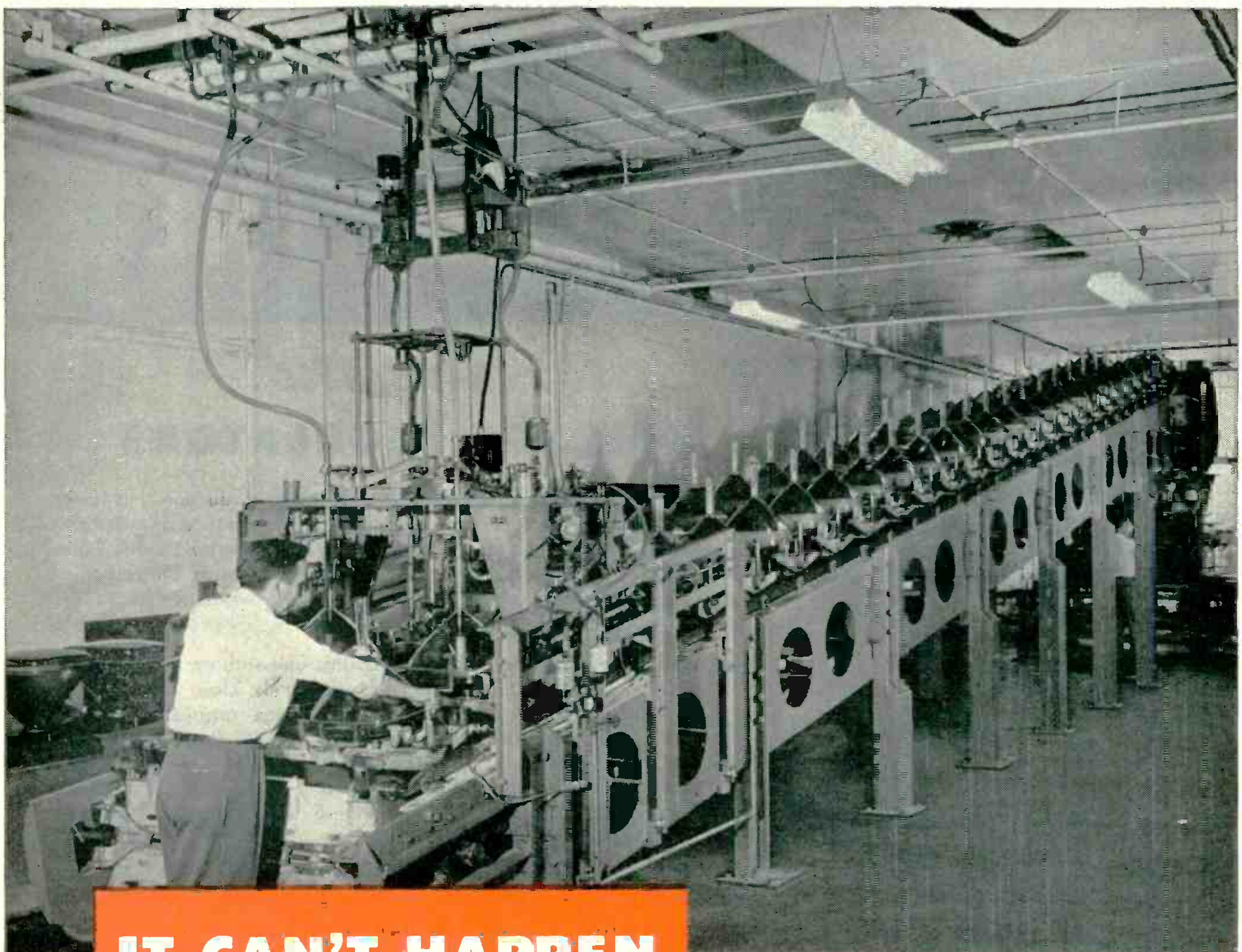
* Also offered in rack models.

REMEMBER, STABILINE TYPE EM (ELECTRO-MECHANICAL) UNITS ARE ALSO AVAILABLE. RATINGS FROM 2 TO 100 KVA. LITERATURE ON REQUEST.

There's a STABILINE Automatic Voltage Regulator for every need. Send today for literature and specific information. Write The Superior Electric Co., 408 Church St., Bristol, Conn.

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

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



IT CAN'T HAPPEN HERE!

Hytron's unique automatic settling conveyor. Machine dispenses and settles precisely uniform TV picture-tube screens. Automatic dispenser in foreground is an achievement of Hytron mechanical engineering. Vibration-proof chain-link conveyor was constructed for Hytron by Trutner and Boumans, Inc.

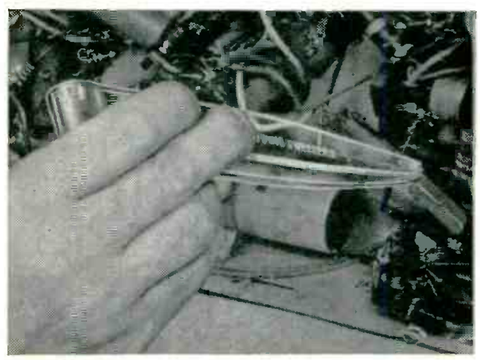
NO LIGHT SCREENS . . . NO HEAVY SCREENS . . . NO HOLES . . . NO UNEVENNESS

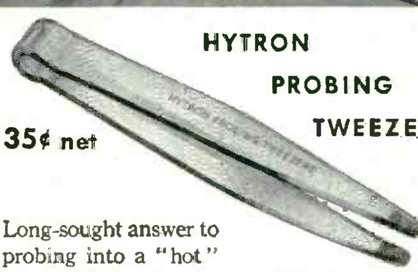
Another engineering first for you! Hytron's unique, automatic machine for dispensing and settling the screens of TV picture tubes.

What does it mean to you? A guarantee of the most uniform and finest-textured TV screens in the business. No light screens. No heavy screens. No specks from foreign particles. No unevenness.

Automatic dispenser pours exactly the right amount of chemicals into the big bottles as they travel slowly up the ramp. Conveyor's motion is so smooth a nickel standing on edge can ride it! Phosphors fall uniformly out of suspending solution . . . undisturbed — a "must" for perfect screens. Decanting or pouring off of chemical residue, loading, and unloading are equally shock-free. And there's precise electro-mechanical control throughout . . . with human errors barred!

That is why you can pick *any* Hytron picture tube. Depend on it. Any one will give you the finest screen money can buy. Yes, it pays to buy from Hytron . . . the most modern picture-tube plant in the world.





HYTRON PROBING TWEEZERS

35¢ net

Long-sought answer to probing into a "hot" set without danger . . . without detuning effects. Get your Probing Tweezers today from your Hytron Jobber.

HYTRON RADIO TUBES

MANUFACTURERS OF RECEIVING TUBES SINCE 1921

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

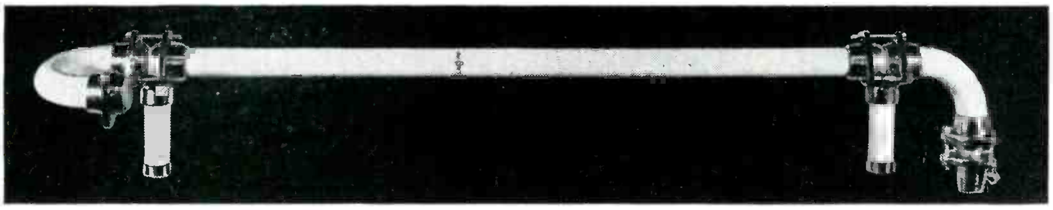
for

INSULATING WATER SYSTEMS

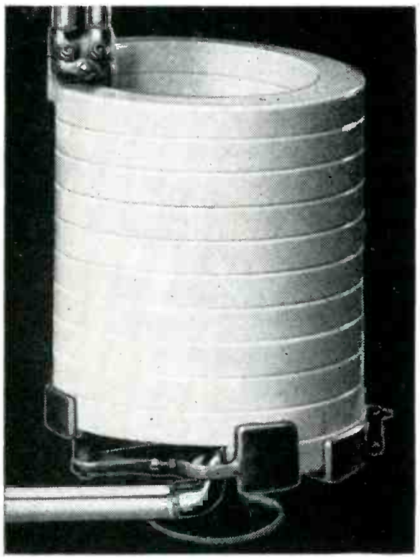
for cooling High-Power Electron Tubes

For insulating the water system for water-cooled tubes, use of Lapp porcelain obviates troubles arising from water contamination and conductivity, sludging, and electrolytic attack of fittings.

Lapp porcelain, in pipe, coils and fittings is a completely vitrified, non-porous ceramic, non-deteriorating and chemically inert. It assures permanent cleanness and high resistance of cooling water, eliminates need for frequent inspection, changing of water or failure of the water system, provides positive cooling for long tube life.



LAPP PORCELAIN PIPE Inside pipe diameters of ¾, 1, 1¼, 1½, 2 and 3″. Available in straight pipe up to 60″ lengths, 90° and 180° elbows, and fittings. All connections are swivel-type. Stand off insulators attach directly to bolts which hold pipe sections together. Metal fittings are bronze, polished heavy chrome plated.



LAPP PORCELAIN WATER COILS

Twin hole coils with inside pipe diameters ¼, ¾, 1″. Single hole coils with inside pipe diameters ⅜, 1¼, 1½″. Provide for flow of cooling water from 2 to 90 gal. per min. Coils provided with cast aluminum mounting bases, fittings, and three-foot sections of lead pipe for attachment to coil terminals.

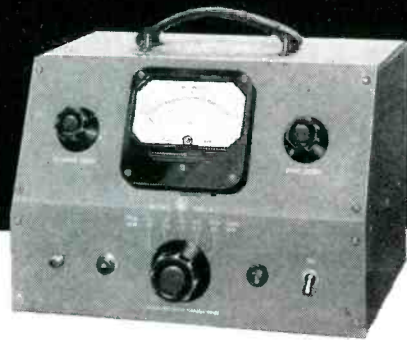
Write for complete description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

MICROWAVE POWER MEASUREMENTS

COMPLETE COVERAGE! **10 to 12,400 mc!**

Instantaneous, direct readings! No adjustment during operation! No tedious computations! Complete new instrumentation for fundamental measurements of CW or pulsed power!



Instrument	Frequencies—Coaxial	Frequencies—Waveguide	Price (f. o. b. Factory)
475B Tunable Bolometer Mount	1,000 to 4,000 mc		$200.00
476A Untuned Bolometer Mount	10 to 1,000 mc		$125.00
S485A Detector Mount*		2,600 to 3,950 mc	$125.00
G485B Detector Mount †		3,950 to 5,850 mc	$95.00
J485B Detector Mount †		5,850 to 8,200 mc	$90.00
H485B Detector Mount †		7,050 to 10,000 mc	$85.00
X485B Detector Mount †		8,200 to 12,400 mc	$75.00
430B Microwave Power Meter	For use at any microwave frequency. Operates with mounts listed above.		$250.00

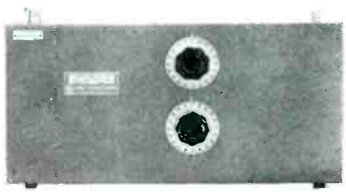
*For use with bolometer only. †For use with bolometer or crystal.

New! -hp- 430B Microwave Power Meter—measures pulsed or CW power—.02 to 10 mw

Model 430B gives you *instantaneous* rf power readings *direct* in db or mw at any frequency. (Operates with bolometer mount. Table at left shows -*hp*- mounts now available.) Measures CW power with instrument fuse or barretter as bolometer element; also measures CW or pulsed power using negative temperature coefficient thermistor at 100 or 200 ohm levels. Reads power direct .02 to 10 mw or in dbm from −20 to +10. 5 ranges selected on front panel switch. Accuracy ±5% of full scale. Higher powers may be measured by adding attenuators (-*hp*- Models 370, 380) to rf system. Directional couplers may be used to sample rf energy.

-hp- 485 Detector Mounts

For rf power measurements in wave guide systems, 2,600 to 12,400 mc (see table) in conjunction with -*hp*- 430A or 430B Power Meter and Sperry 821 barretter. Also may be used to measure relative level, or detect rf energy using a type 1N21 crystal. Semi-tuned by means of a built-in movable short.



-hp- 475B Bolometer Mount

Tunable from 1,000 to 4,000 mc for universal application, greatest convenience in making microwave power measurements. Double-stub design, coupling energy from 50 ohm coaxial systems into 100 or 200 ohm bolometers. Uses Sperry 821 barretter, thermistor or 1/100 ampere instrument fuse.

New! -hp- 476A Universal Bolometer Mount

Requires no tuning, no adjustment; measures rf power at any frequency 10 to 1,000 mc. Extremely low VSWR: Less than 1.15, 20 to 500 mc; less than 1.25, 10 to 1,000 mc. Reflected power less than 0.1 db under normal conditions. In combination with -*hp*- 430A or 430B Power Meter gives automatic, instantaneous readings from 0.02 to 10 milliwatts. Measures higher power with addition of attenuators and directional couplers. 50 ohms impedance. Has Type N connector and terminates flexible cables RG8/U, RG10/U, etc.

Get complete information! See your local -hp- representative or write to factory.

HEWLETT-PACKARD COMPANY

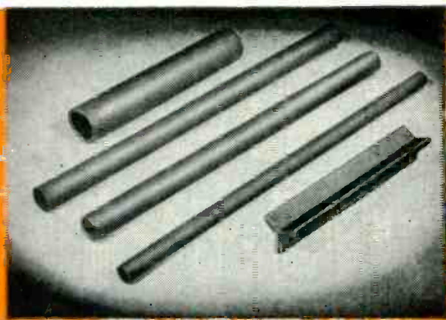
2161A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

Export: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

HEWLETT-PACKARD hp INSTRUMENTS

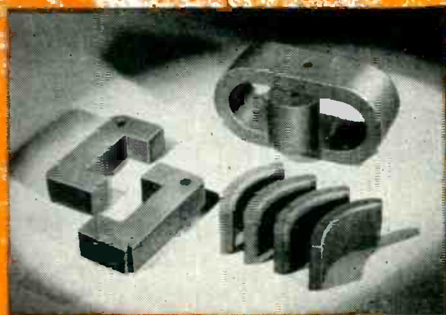
CROLOY RADIO RODS

Replacing usual loops. Spell new reception standards. Permit mounting on chassis, and final test before placement in cabinet. "Q" of order of 250 as against 80 for small loops. Usual Croloy radio rod is 8" l. by ½" d. Other sizes available.



CROLOY CORES

Molded in widest range of shapes and sizes. Deflection yokes expand TV-tube deflection angles without corresponding voltage increase. Croloy cores slash TV transformer bulk.

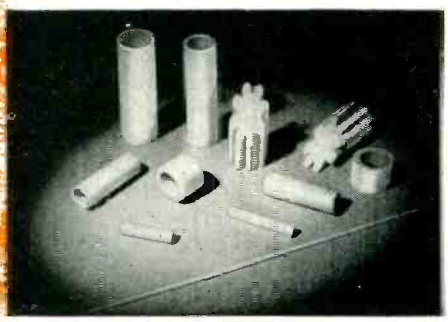


CROLOY RADIO CORES

Croloy slug tuners and I. F. coils reduce cost and raise gain. Made in widest variety of designs, sizes and modifications. With screw inserts; with threaded bodies; cup-shaped; tiny closed cores; etc. Choice of compositions to meet electronic characteristics.

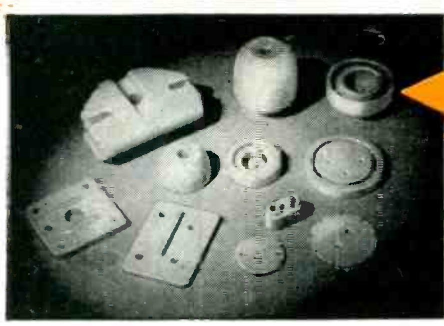
EXTRUDED CROLITE

From tiny tubes no bigger than pencil lead and with one or two longitudinal holes, to tubes, rods and blocks up to 6" dia. Widest variety of cross-sectional shapes. The Crowley extrusion technique minimizes machining.



PRESSED CROLITE

Formed in standard or custom molds into the widest choice of shapes and sizes, thereby minimizing machining. High degree of accuracy to fit with metal parts in any assembly. Plain or glazed finish.



MACHINED CROLITE

Elaborate shapes, including grooves, bobbins, holes, threads, fins and other features, can be included in Crolite machined pieces. Precision machined tools in the hands of skilled specialists, insure the matching of rigid mechanical specifications.

parts from powders

Consider Crowley your No. 1 source of supply for magnetic and ceramic pieces. For here, under one roof, are specialists who have pioneered the "parts from powders" art for the radio-electronic industry.

Crowley means production facilities that have supplied the major portion of magnetic cores in peace and war alike. Here are extrusion, molding and machining facilities that can provide steatite and other severe-service insulators in the widest range of characteristics, sizes, shapes.

By all means try Crowley! You can save time, money and trouble, just as other electronic designers, engineers and production men are doing.

Let us collaborate on your TV, radio or electronic problems. Samples, engineering aid, and quotations, on request.

HENRY L. CROWLEY & COMPANY, INC.
Pioneering POWDER-IRON and STEATITE products
1 Central Avenue
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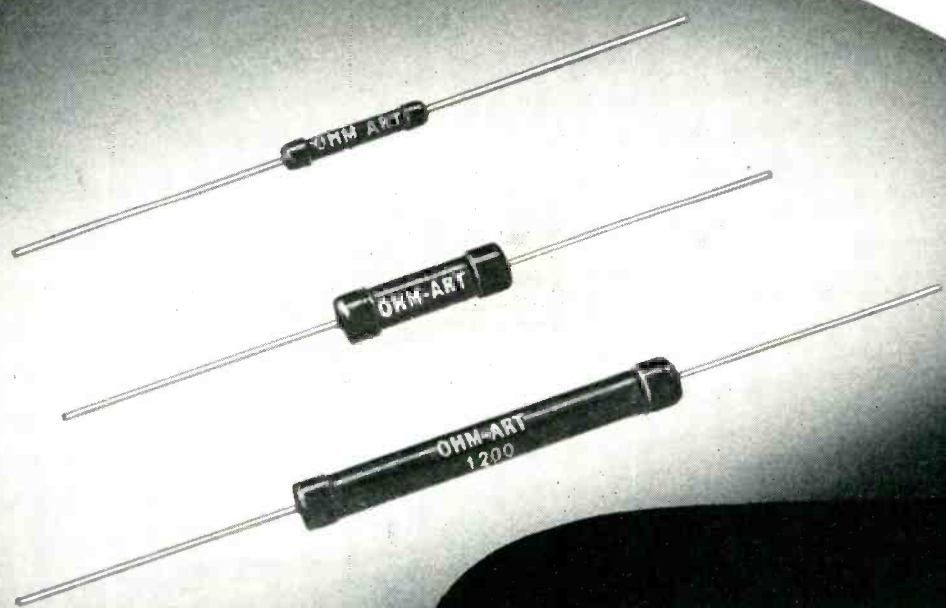
ohm-art

DEPOSITED CARBON RESISTORS



ACTUAL SIZE

OHM-ART Deposited Carbon Resistors are available in values from 30 Ohms to 100 Megohms and in power ratings from 0.5 to 2 watts. Tolerances available are 1%, 2%, 5% and 10%. These resistors have an extremely low temperature and voltage co-efficient. They have an extremely high degree of stability and will withstand peak voltages as high as 15,000 volts. In any precision electronic circuit where close control of the resistance value is required and where stability is of importance, OHM-ART Deposited Carbon Resistors will unquestionably fit the application.

OHM-ART Resistors are made under license arrangement with the Western Electric Company, Incorporated

Your inquiries will receive prompt, courteous attention.

ohm-art division

CHICAGO DIAL CO.

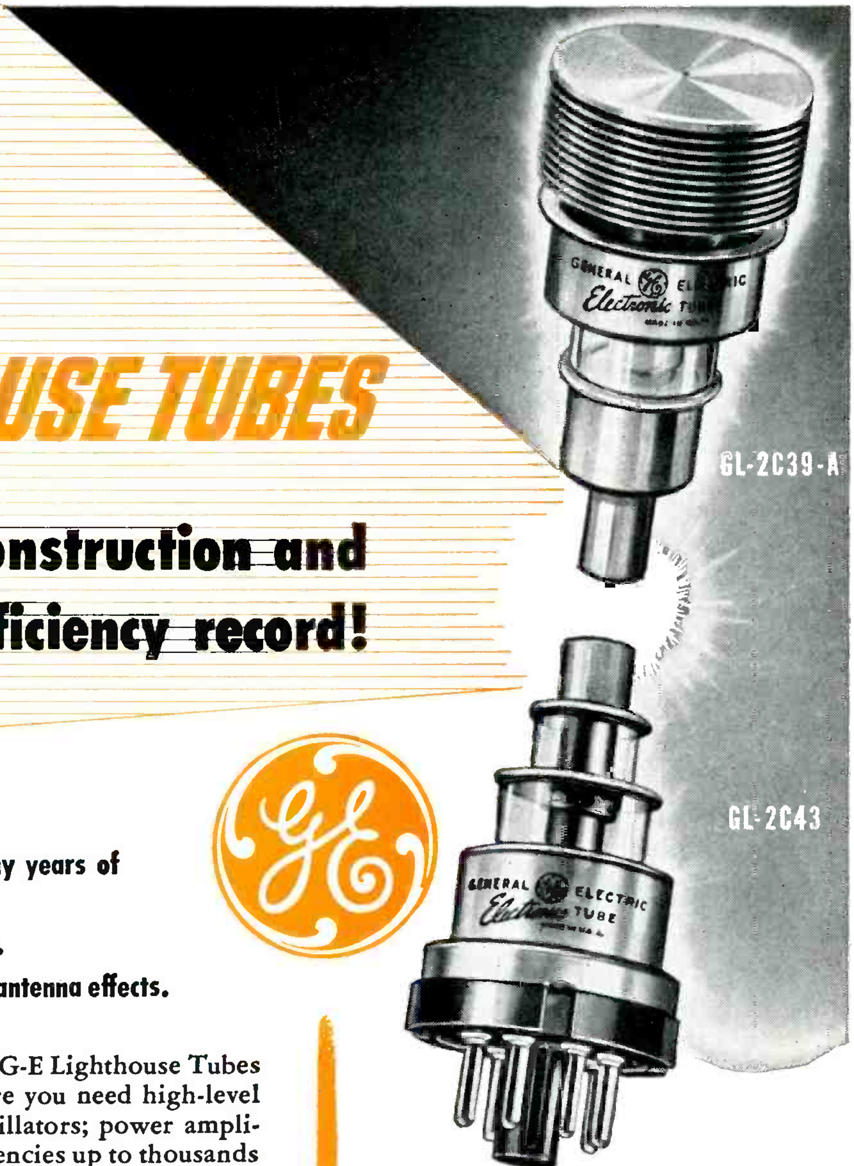
2919 S. La Salle Street • Chicago 16, Illinois

Fabricators of precision glass parts for the Electronic and allied industries.

In U-H-F it's

G-E LIGHTHOUSE TUBES

...for stronger construction and a stand-out efficiency record!



- Built for hard service.
- Pioneering u-h-f types, with many years of successful application.
- Superior electrical characteristics.
- Excellent isolation from load and antenna effects.

Check these *specific* advantages of G-E Lighthouse Tubes in v-h-f and u-h-f circuits where you need high-level detectors and mixers; pulsed and CW oscillators; power amplifiers, and frequency multipliers . . . at frequencies up to thousands of megacycles!

You can't beat G-E Lighthouse Tubes for—

- Aircraft traffic and location control equipment.
- Radio, TV, and other microwave relay equipment.
- Microwave test apparatus.
- Emergency communications equipment (police, taxi, and other fixed and mobile).
- Military and commercial communications and common-carrier equipment.

In applications such as these, General Electric tube engineers will be glad to work closely with you, and with the circuit designers at your drawing-boards. Available at all times, is G.E.'s experience with u-h-f types that goes back nearly two decades, and which you may draw on at will.

Wire or write for comprehensive Bulletin ETD-120. Learn more about G-E Lighthouse Tubes—how they'll improve the performance, increase the dependability of *your* new u-h-f circuit! *Electronics Department, Section 5, General Electric Co., Schenectady 5, N.Y.*

GL-2B22—High-frequency, high-perveance detector to beyond 1,500 mc.

GL-2C40—Radio-frequency amplifier, converter, and oscillator to 3,370 mc. Plate dissipation 6.5 w.

GL-2C43—Radio-frequency amplifier, oscillator, and frequency converter from 150 mc to 1,500 mc, and in special pulsed circuits to 3,370 mc. Plate dissipation 12 w.

GL-2C39-A—Radio-frequency amplifier, oscillator, and frequency converter from 150 mc to 2,500 mc. Plate input to 100 w.

GENERAL ELECTRIC

185-K5

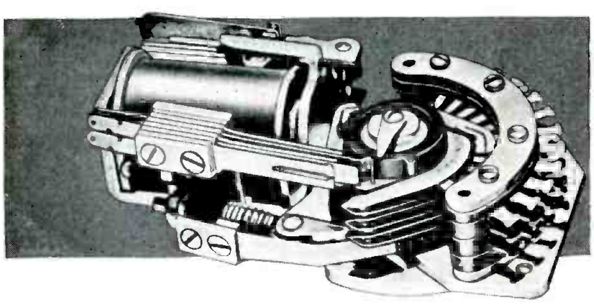
the *right* relay will improve

To be exactly RIGHT for your purpose, relays and stepping switches must be easy to "design into" your product—easy to specify, mount and connect. They must be readily available as you need them, to meet your production schedules. Most important, they must operate dependably—help your designers toward the goal of a completely trouble-free product.

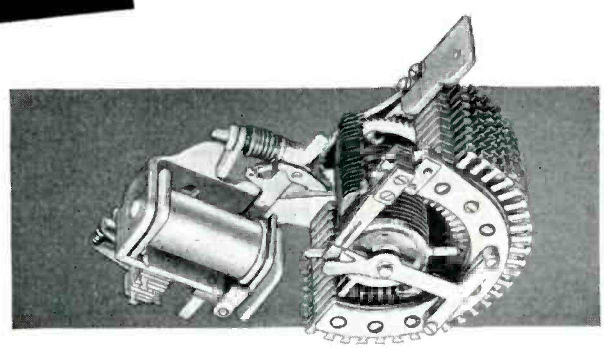
Automatic Electric relays and stepping switches are RIGHT on all counts! A wide range of standard types (including hermetically sealed relays, low-capacitance relays and the most compact stepping switch on the market!) permits your engineers to select and specify exactly the units they need. Assembled and adjusted to your exact specifications, they'll be shipped on schedule, ready to assemble into your production. And once in service, they'll go far to give your product a reputation for dependable, trouble-free operation.

For any product—for any purpose involving the use of relays or stepping switches—there is an Automatic Electric unit that's exactly RIGHT. We'll be glad to help you find it.

switches



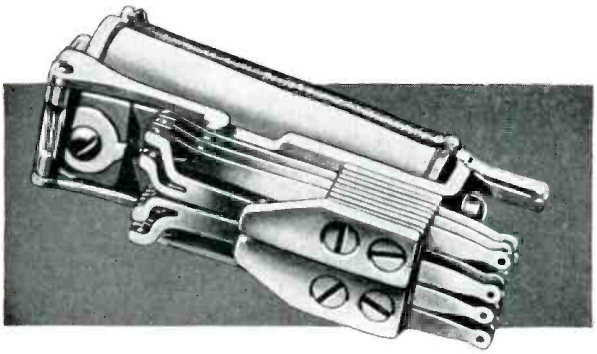
The Type 44 Miniature Stepping Switch You'll be amazed at this spring-driven d-c switch—it's so tiny and so light in weight. Yet it accommodates up to 6 bank levels, each with 10 points plus "home", and is adaptable to 10-, 20- or 30-point selection. Operation can be impulse-controlled or self-interrupted (using interrupter springs). Furnished with off-normal springs for mechanical "homing" (springs can also control auxiliary circuits). On 48 volts d-c, this switch runs 80 steps a second self-interrupted, 35 steps or more a second impulse-controlled. In rigid tests it averaged 200,000,000 steps—then required only minor readjustment.



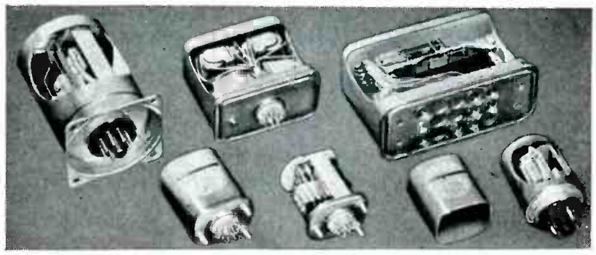
The Type 45 Stepping Switch This spring-driven switch is available both for d-c operation and with built-in rectifier for a-c operation. Accommodates up to 10 or more bank levels, each with 25 points plus "home", and is adaptable to 25- or 50-point selection. Provides for impulse-controlled or self-interrupted operation (using interrupter springs). Can be supplied with off-normal springs for mechanical "homing" (springs can also control auxiliary circuits). Runs 75 steps a second self-interrupted, and 35 steps a second impulse-controlled, on 48 volts d-c or 115 volts a-c. Has long service life, too—averaged 250,000,000 steps in rigid tests—then required only minor readjustment.

Wherever a relay or stepping switch is used in your product, it is likely to be important far beyond its cost. In fact, the performance of these components usually sets the standard of performance of the entire assembly. Thus, the use of the RIGHT relay or switch is often the simplest, most inexpensive way to make a good product better!

your product

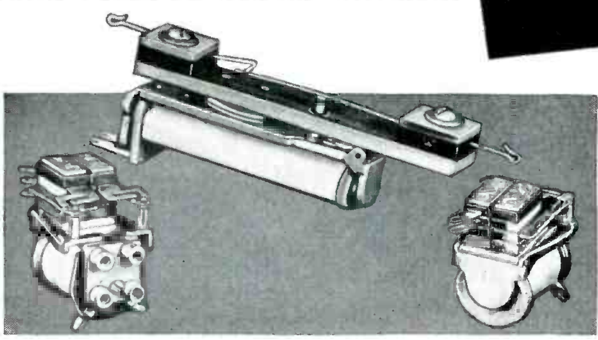


Class "B" Relays Types for extremely high speed operation and for time delays on either the operate or release strokes are available for d-c service; others for a-c operation. Independently operating "twin" contacts assure perfect contact operation. Contact points are dome-shaped to maintain uniformly low contact resistance. May be arranged in one or two pile-ups with maximum of 13 springs in each pile-up.



Hermetically Sealed Relays All Automatic Electric relays can be obtained in hermetically sealed housings. The "sealed-in" controlled atmosphere protects them from electrical or mechanical failure resulting from varying conditions of temperature, dust, humidity, acid, fungus or air pressure—and makes them completely tamper-proof.

relays



Low-Capacitance Relays For chatter-free control of high-frequency circuits. Two types, each providing exceptionally low capacitance between contact springs and between springs and ground. Equipped with "twin" contacts. Unusually small in size for compact mounting. The Class "C" relay shown above is especially suitable for strip mounting; it is only 0.687" wide and 2⅛" high and is 5-15/32" in over-all length. The Class "S" relay (above foreground) is 1" wide, 1-1/38" high and 1-19/32" over-all.

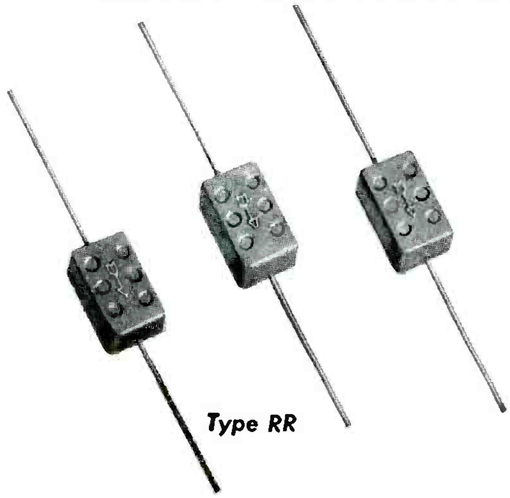
Write for our new 88-page catalog No. 4071F which gives complete specifications, performance and mounting data on the many types of relays and stepping switches manufactured by Automatic Electric Company, makers of telephone, signaling, communications and industrial electrical control apparatus. Address: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren Street, Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in Principal Cities.*

AUTOMATIC ELECTRIC

RELAYS — CHICAGO — SWITCHES

THE LITTLE INDIAN SAYS, "Tiny-but Mighty!"

SANGAMO MINIATURE SILVERED MICA CAPACITORS



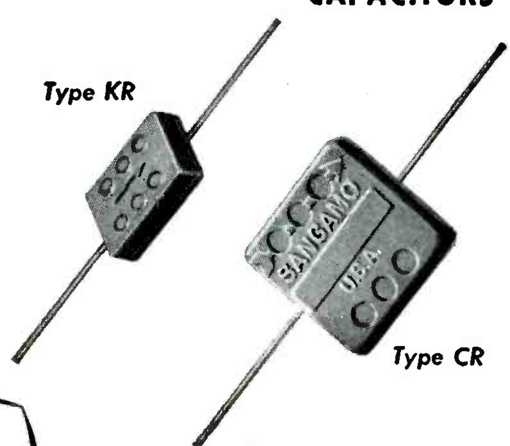
Type RR

Do a "Heap Big" job in a minimum of space

Exceptionally small, easy-to-install capacitors that can do a *big* job in *minimum* space are a helpful factor in speeding production.

Where space limitations exist, the tiny—but mighty Sangamo "Shawnee," Type RR Miniature Silvered Mica Capacitor will solve your problem without sacrificing stability or high quality. These capacitors are designed and constructed to meet the Tentative Joint Army and Navy Specification JAN-C-5A for the CM-15 case size. Whether you require Sangamo RR miniature, or standard size types KR and CR silvered mica capacitors, you can safely specify any of them for use in all types of military, or commercial radio and electronic equipment. These and many other types of Sangamo Mica Capacitors are fully described in Catalog No. 800. Write for your copy.

SANGAMO STANDARD SIZE SILVERED MICA CAPACITORS



Type KR

Type CR

Your Assurance of The SANGAMO Tribe *Dependable Performance*

PAPER · MICA · SILVER · ELECTROLYTIC CAPACITORS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

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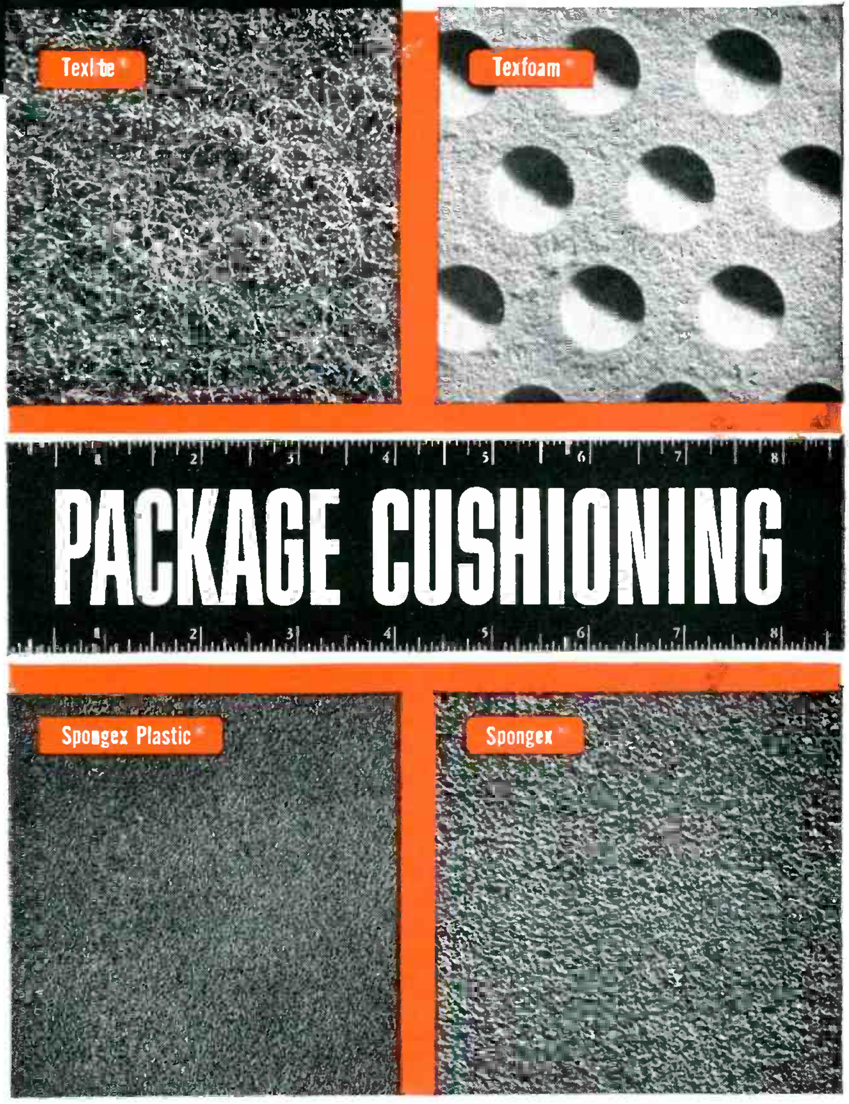
This Free New Booklet—



discusses what to look for in materials used in package cushioning

A concise, factual guide to aid in the *safe shipment of products sensitive to rough handling.* Tells how compression, compression set, damping, density, dusting, corrosiveness, fungus resistance, moisture and temperature affect performance of cushioning materials.

Send for your free copy today.

THE SPONGE RUBBER PRODUCTS COMPANY

Shelton, Connecticut

Director of Packaging Laboratory
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469 Derby Place, Shelton, Conn.

Please send me free "Package Cushioning."

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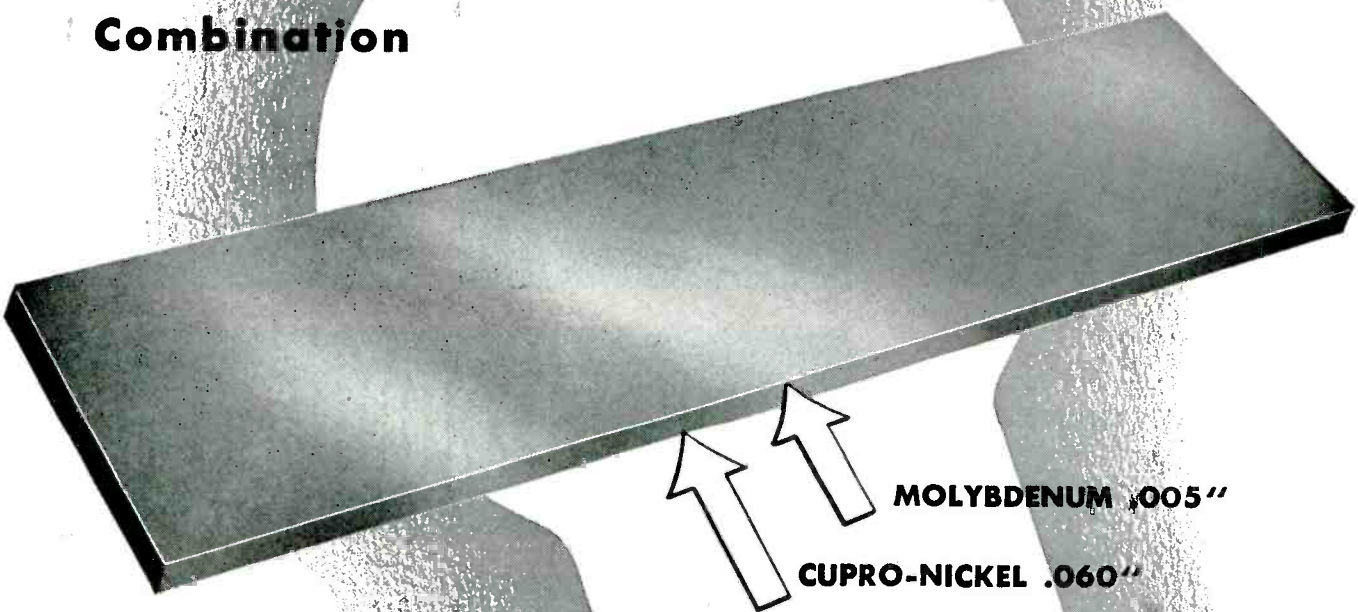
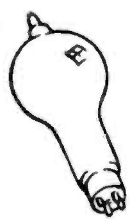
PROBLEM:

How to Prevent Contact Sticking in a Vacuum Tube

GENERAL PLATE:

Provided the Solution with a Composite Metal Combination





A leading manufacturer of radio and industrial tubes and electronic equipment was faced with a problem of finding the right metal for use as a sliding contact in vacuum tubes.

Copper provided a mechanical problem because it tended to gall.

Molybdenum was ideal but was too thick to form and too costly to machine out of solid material.

The problem was presented to General Plate whose engineers quickly found the solution by bonding *two metals into one* . . . a thin layer of molybdenum (.005") to a thicker layer of cupro-nickel (.060").

The result was a General Plate *Composite Material that was easily fabricated, gave the performance of solid molybdenum, reduced costs considerably.*

No matter what your problems, it will pay you to *check with* General Plate. Their vast experience in combining precious to base metals or base to base metals can overcome your problems . . . often reduce costs.

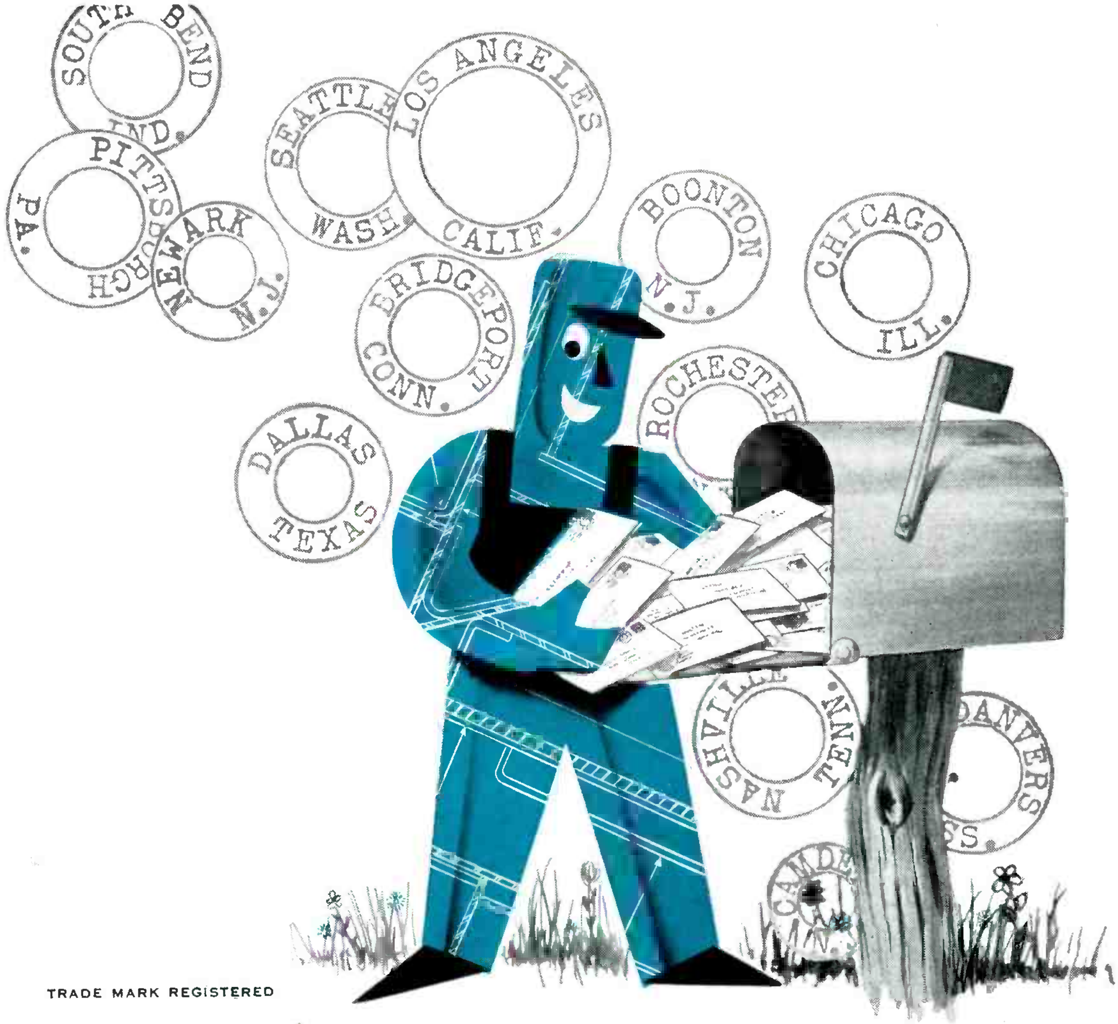
General Plate Products include — Precious to base metal laminations . . . Base metal laminations . . . Alcuplate (copper and Aluminum) . . . Silver solders . . . Laminated contacts, buttons, rivets . . . Platinum-fabrication-refining . . . Age-hardening Manganese Alloy 720.

Have You a Composite Metal Problem?
General Plate can solve it for you

GENERAL PLATE

Division of Metals & Controls Corporation

38 FOREST STREET, ATTLEBORO, MASS.



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WE GET SUCH INTERESTING MAIL!

We grow in Brooklyn, like the Tree,
But we're a *national* industry.
Our customers are far and wide,
And we produce their jobs with pride.
We build their cabinets plain and thrifty
Or housings intricate and nifty.
And no one ever need be nervous
About our workmanship or service.
It's custom-built from A to Z—

And these big benefits you'll see:
Your own design, distinctive style—
A better product by a mile!
With all details so very fine
They'll speed up your assembly line.
And here's a point that isn't funny:
Our dies can save you time and money.
Come visit our big plant and look—
Or send for our new data book.

We Invite You To Visit Our Booth #420 at the I.R.E. West Coast Convention and Pacific Electronic Exhibit—San Francisco, August 22-24

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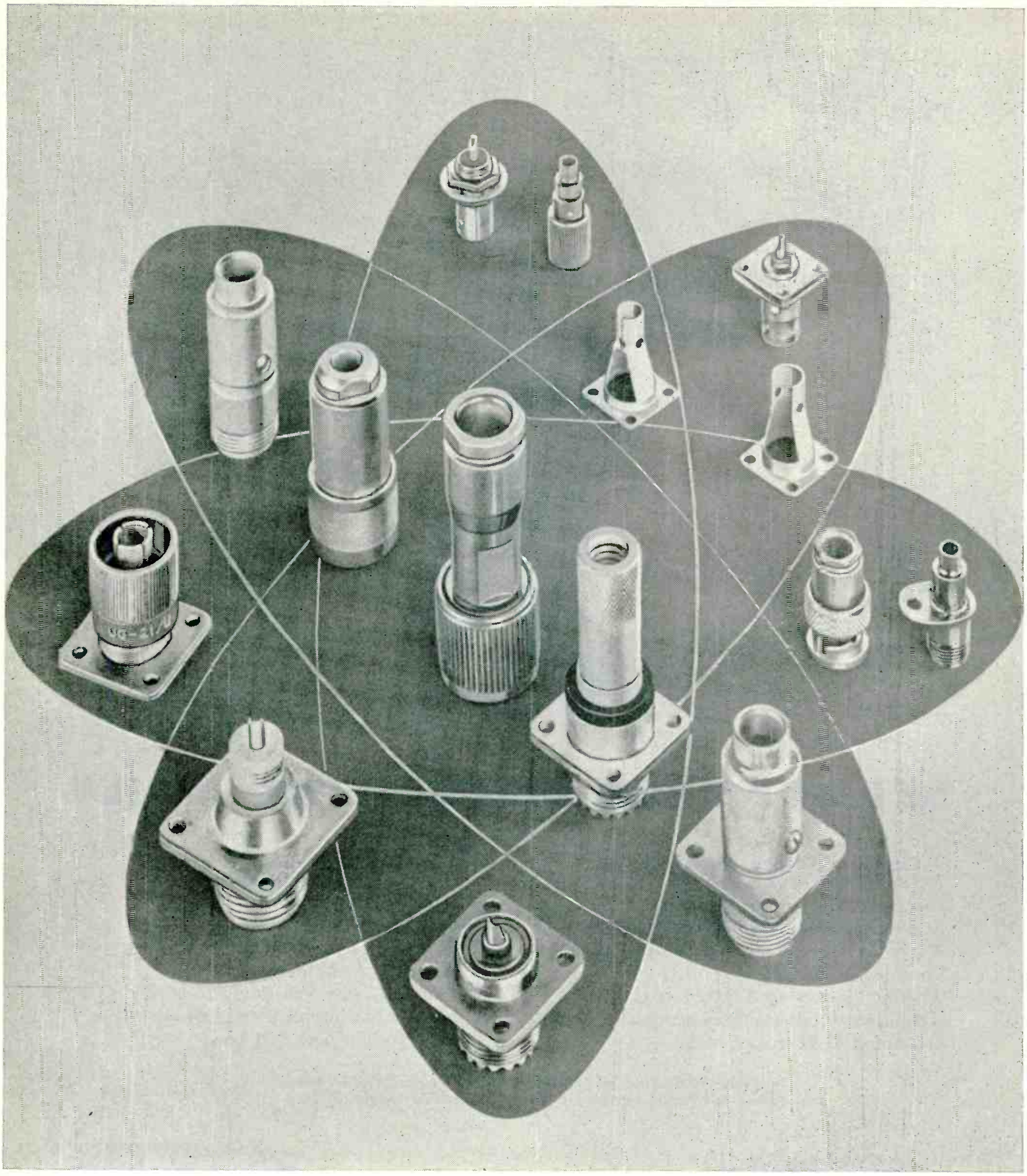

The UCINITE CO.

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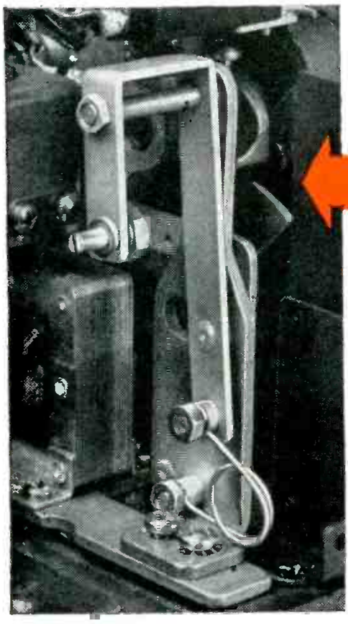
Specialists in

ELECTRICAL ASSEMBLIES,

RADIO AND AUTOMOTIVE

5 WALDES TRUARC RINGS ELIMINATE 4 TOOLING OPERATIONS... SAVE 22½¢ PER 100 UNITS

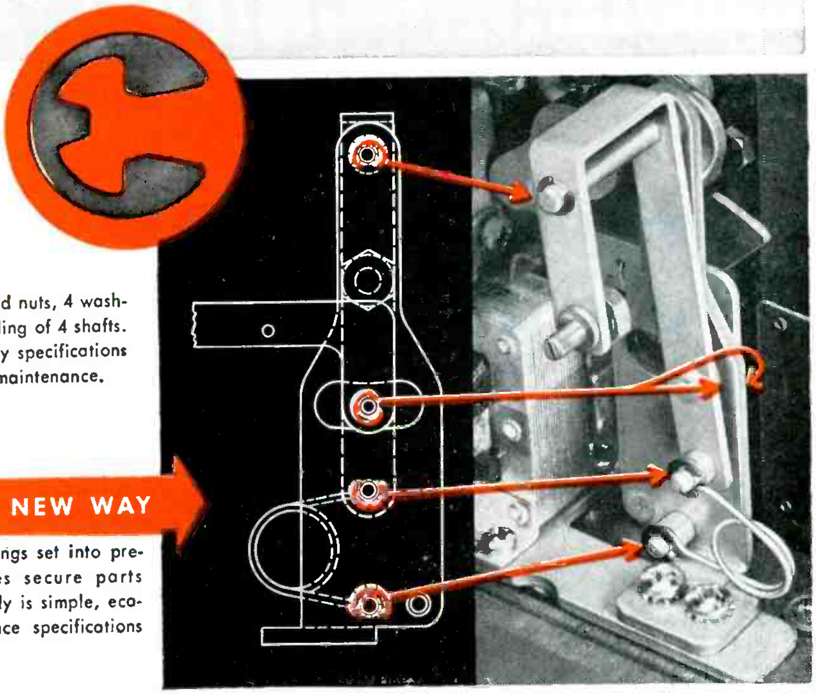


OLD WAY

Unit requires 4 hex head nuts, 4 washers, 4 shoulders, threading of 4 shafts. Clearance and end-play specifications necessary... constant maintenance.

NEW WAY

Just 5 Truarc "E" Rings set into predetermined grooves secure parts permanently. Assembly is simple, economical. No clearance specifications ...no maintenance!



5 Waldes Truarc Retaining Rings in one assembly of the Dictaphone Time-Master dictating machine brought great savings to Dictaphone Corp., Bridgeport, Conn. And this is just one of three different applications where Truarc Rings cut material, tooling and assembling costs for this product.

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

REDESIGN WITH 5 TRUARC "E" RINGS BRING THESE BIG SAVINGS...

Assembly time per unit using screws and washers . 24 seconds

Assembly time per unit using Truarc Rings . . . . 15 seconds

- Time saved per unit with Truarc Rings . . . . . . 9 seconds
- Eliminates skilled labor milling and threading operations
- Eliminates maintenance
- **TOTAL MATERIAL AND LABOR COST SAVINGS PER 100 UNITS . . 22½¢**

SEND FOR NEW BULLETINS

WALDES TRUARC REG. U. S. PAT. OFF. **RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS: U. S. PAT. 2,382,948; 2,420,921; 2,411,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place
Long Island City 1, N. Y. E083

Please send Bulletins 6, 7 and 8—giving engineering specifications for all types of Waldes Truarc Rings.

Name__________

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Be sure to see the Truarc display-Booths 215 & 216 at the Pacific Electronic Exhibit, August 22-23-24

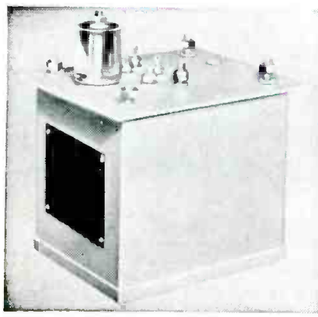
ELECTRONICS

OIL-FILLED, HERMETICALLY SEALED, COMPACT

HIGH VOLTAGE COMPONENTS

- **Withstand Mechanical Shocks**
- **Operate Continuously for Long Periods in Widely Varying Temperatures**

Available in a wide range of ratings, high-voltage components shown here are typical of units manufactured by General Electric for applications 5000 volts and above where corona must be held to a minimum. They represent many years of experience in meeting Armed Services requirements, and can be built for today's military specifications. Because these components are usually tailored for each job, please include functional requirements and any physical limitations with your inquiry. Write to *43-328A, General Electric Company, Pittsfield, Mass.*

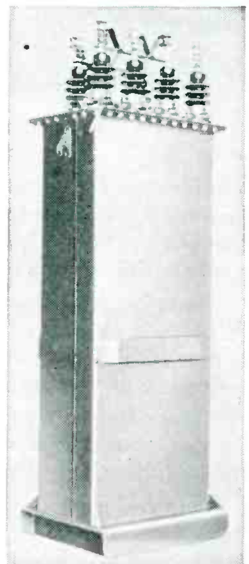


RECTIFIERS—A-c to d-c power-supply units especially built for precision work where unusually low regulation, light weight, and small size are necessary. Typical outputs available are 7, 9, and 13 kv. Illustrated 7-kv unit measures 6 x 6 x 7 in., weighs 8 lb.

PULSE TRANSFORMERS—For use with either hard-tube or line-type modulators. Available in peak-voltage ratings from 10 to 100 kv or higher; peak-power ratings up to 30,000 kva or more. Designed for operation on pulse durations from 0.1 to 20 microseconds at rates up to 4000 pps.

RESONANT REACTORS—Accurately designed and built for radar service. Currently available in peak operating voltages from 5 to 45 kv, current ratings up to 2.25 amp. Higher ratings can be provided. Inductance ratings ranging from 0.25 to 300 henrys remain constant within 5 percent at above 50 percent load current.

FILAMENT TRANSFORMERS—For special applications or for use with standard high-voltage rectifier tubes. Supplied with or without tube socket mounted integrally with high-voltage terminal. Insulated to nearly any required level.



MODULATION TRANSFORMERS—High-fidelity, low-phase shift, Pyranol* or oil-modulation transformers and reactors for high-power AM transmitters are available as integral or separate units. Highly developed designs in ratings from 3.5 to 500 kw provide wide transmission frequency range, keep down harmonic-voltage insertion. Low phase shift gives flexibility and range.

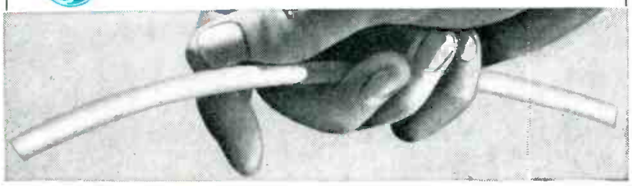
*Reg. TM of General Electric Co.

GENERAL ELECTRIC

667-16

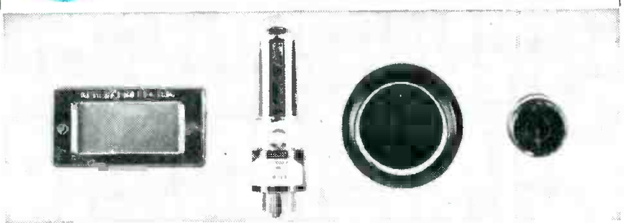
TIMELY HIGHLIGHTS ON G-E COMPONENTS

DELAY LINES—ORDER IN BULK, CUT OFF AS MUCH AS YOU NEED



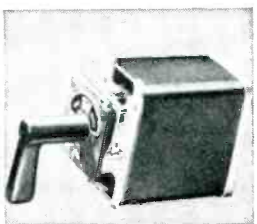
Signals with band widths up to 2 megacycles can be delayed from 0.25 to 1.0 microseconds. Available in lengths up to 100 ft. Delay equals approximately ½ microsecond per foot. Characteristic impedances of 1100 and 400 ohms per foot are available. By ordering in bulk, lengths can be cut to fit specific needs. Can be bent into 4-inch diameter coils. Uses include research and development of special circuits for electronic devices. See Bulletin GEC-459 for further information.

PHOTOVOLTAIC CELLS— MINIATURE POWER PLANTS



For accurately detecting, controlling, and measuring light and for detecting and measuring even the smallest variations in colors. These cells are especially useful where long life and stability are required or where electronic amplifiers are not practical. Available in a new hermetically sealed series with standard mounting and a wide variety of unmounted sizes. More G-E photovoltaic cells than any other make are used in scientific instruments. Characteristics, dimensions, circuits, and technical data are available in Bulletin GEC-690.

TRANSFER AND CONTROL SWITCH— OVER 10,000 POSSIBLE COMBINATIONS



Built for reliability and long service life, the G-E Type SB-1 transfer and control switch can be used for more than 10,000 possible circuit-sequence combinations. Precision construction permits as many as 40 stages — four banks of ten stages each — to be operated in tandem. Switches with up to 16 stages and 12 positions are commonly furnished. Ratings go up to 20 amp at 600 volts a-c or d-c. Standard components are interchangeable. Complete description in Bulletin GEA-4746.

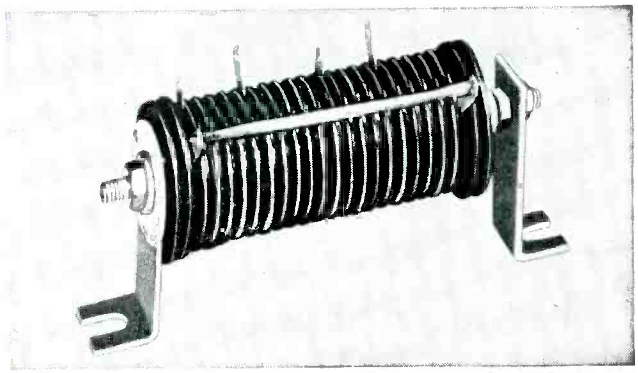
SELENIUM RECTIFIERS

. . . HIGH-VOLTAGE UNITS HAVE LIFE EXPECTANCY OF OVER 60,000 HOURS

Now available from General Electric, these 26-volt RMS selenium rectifier cells have a continuous-service life expectancy of over 60,000 hours. Their initial forward resistance is very low and samples tested after 10,000 hours of operation show an average resistance increase of less than 6 per cent.

The high-voltage output means that stacks made up of these units are about 25 percent smaller than is possible with 12-volt cells. Low resistance means cooler operation and the space saving that goes with it.

If your application calls for compact selenium stacks for use in cramped quarters, these cells provide the solution. Stacks made with the new G-E cells may be obtained with rated outputs from 18 to 126 volts d-c at 0.15 to 3.75 amp. Check Bulletin GEA-5280.



General Electric Company, Section D667-16
Schenectady 5, N. Y.

Please send me the following bulletins:

(√) Indicate for reference only

(x) For planning an immediate project

☐ GEC-459 Delay Lines
☐ GEC-690 Photovoltaic Cell
☐ GEA-4746 Here's the All-Purpose Switch
☐ GEA-5280 Selenium Rectifiers

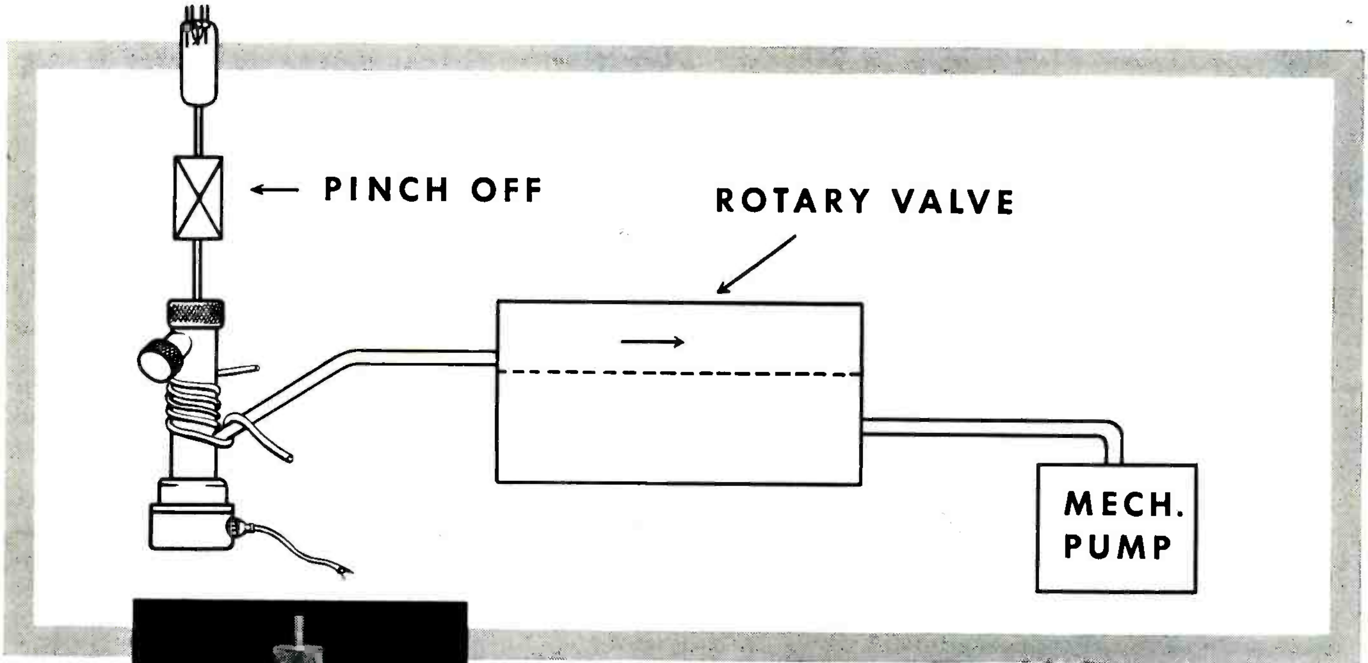
Name ____________________

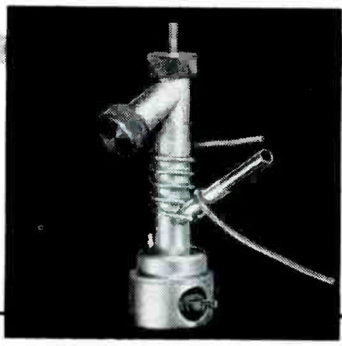
Company ____________________

Address ____________________

City ____________ State ____________

The Modern Way to Build Rotary Exhaust Equipment for Miniature Tubes



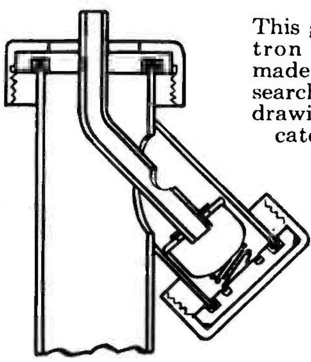


NRC's TYPE B-1 BOOSTER PUMP

- ***Provides Higher Vacuum***
- ***Reduces Exhaust Cycle***
- ***Eliminates Troublesome Oil Vapors***

Our Type B-1 Booster Pump was built to meet ideal production methods as outlined by Hytron production engineers. On the production line it exactly meets their specifications in every detail — step by step. This Booster Pump lowers production costs. Its high speed reduces the exhaust cycle. Write for details.

HYTRON-DESIGNED GLASS TRAP
Ends Important Maintenance Problem



This glass trap, designed by Hytron production engineers, is made and sold by National Research. As you can see by the drawing at the left, the trap catches and holds broken glass particles. It works on the principle of a cyclone separator. The trap can be easily cleaned. Write for full details.

INDUSTRIAL RESEARCH
PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING
AND EQUIPMENT

METALLURGY
DEHYDRATION
DISTILLATION COATING
APPLIED PHYSICS

National Research Corporation

Seventy Memorial Drive, Cambridge, Massachusetts

In the United Kingdom: BRITISH-AMERICAN RESEARCH, LTD., Head Office — Wishaw, Lanarkshire

It's a fact that

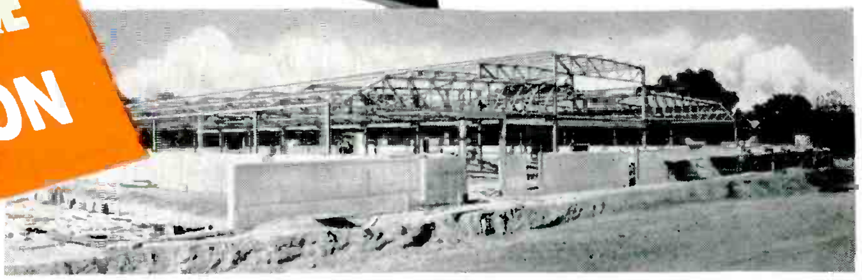
- 30% more production will soon be available from American Lava Corporation as new units rapidly near completion.
- Continuous expansion to meet customers' requirements has made American Lava the world's largest producer of custom made technical ceramics exclusively.
- Average daily production approximates four million parts and is rapidly increasing.
- This expansion program is an all out effort to supply you with custom made technical ceramics in the quality and quantity you need—when you need them.

ALSIMAG

TRADE MARK REG. U.S. PAT. OFF.

30% MORE PRODUCTION

This building, photographed in May 1951, will be completed about the time this picture is published. Other units will speedily follow.



• What is your MOST RELIABLE source for custom made technical ceramics? American Lava Corporation has an enviable reputation for delivery according to specifications—and for ability to produce ceramics of a type and quality which are frequently considered "impossible."

• New production facilities are speeding deliveries. The experience gained in half a century of specialization is available to you on request. You are most apt to find at American Lava Corporation the solution to any problem involving technical ceramics.

• Equipment shown in this mock up is under construction. Carefully selected personnel has been added to the present skilled staff to provide experienced operators for all plants.

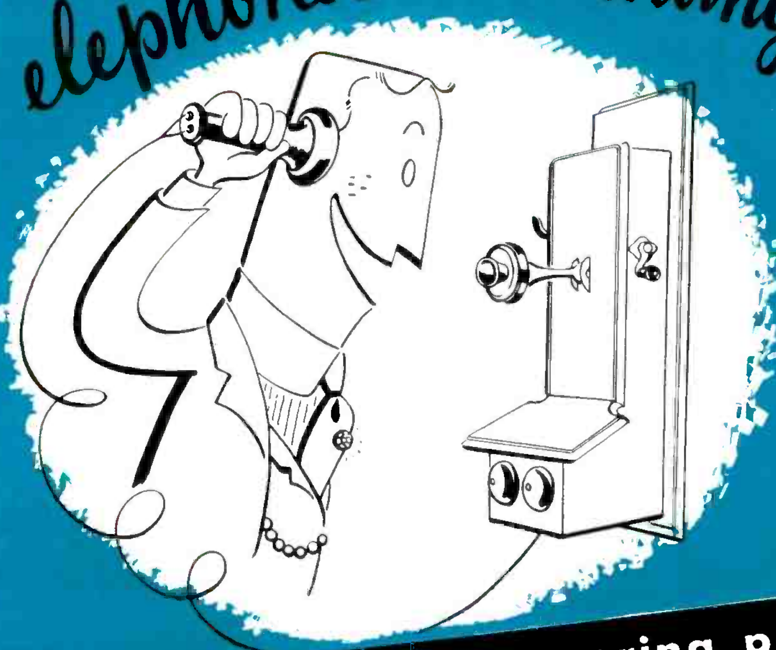
AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

50TH YEAR OF CERAMIC LEADERSHIP

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • CHICAGO, 228 North LaSalle St., Central 6-1721
PHILADELPHIA, 1649 North Broad St., Stevenson 4-2823 • LOS ANGELES, 232 South Hill St., Mutual 9076
NEW ENGLAND, 38-B Brattle St., Cambridge, Mass., Kirkland 7-4498 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

Telephones have changed....



...and in this era of engineering progress MODERN ELECTRONICS LOOK TO HI-Q*

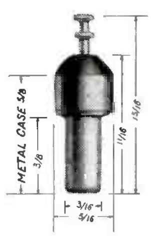
Capacitors • Trimmers • Choke Coils • Wire Wound Resistors

Yes, telephones have changed, and countless developments have played a part in electronic progress since the day of those old stem winders on the wall. Compactness, engineering precision and never-failing dependability are now demanded where the only question once was, will it work at all? In meeting these modern demands of modern electronics for modern ceramic components, **HI-Q** has led the way.

The **HI-Q** trademark is unquestioned assurance of capacitors, trimmers, choke coils and wire wound resistors that are uniformly dependable in every respect and rigidly meet specifications and tolerances. As the leading specialists in the ceramic field, **HI-Q** has come to be regarded by producers of radio, television, communications and other electronic equipment, as their best source of technical assistance in developing new components to meet the special needs of any circuit. **HI-Q** engineers are at your service any time you see fit to call them.

JOBBERS—ADDRESS: 740 Belleville Ave., New Bedford, Mass.

METAL CLAD STANDOFF



(Illustration Actual Size)

Ceramic tube of this quick mounting capacitor is enclosed in Cadmium plated metal case with special end seal for protection against humidity and temperature changes. Capacity 1500 mmf ± 500 mmf.

BETTER 4 WAYS

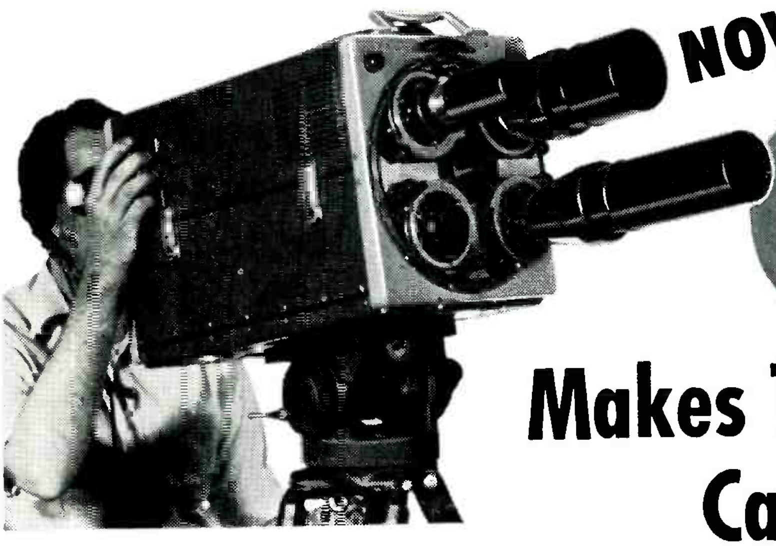
- PRECISION
- UNIFORMITY
- DEPENDABILITY
- MINIATURIZATION

** Trade Mark Registered, U. S. Patent Office*

HI-Q* **Electrical Reactance Corp.**
OLEAN, N. Y.

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

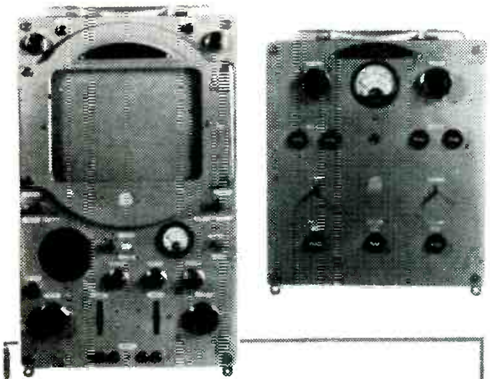
PLANTS: Olean, N. Y., Franklinville, N. Y. Jessup, Pa., Myrtle Beach, S. C.



NOW... GPL

Makes TV's Outstanding Camera Chain

Even Better!



GPL's 1951 Image Orthicon Chain is delivering even more features—better performance—than the previous model which itself set new industry standards! Compare it for ease of operation, uniform high quality, flexibility in studio or field.

Set this camera up to meet varying requirements . . . control it remotely if desired . . . select any of four lenses at the press of a button . . . adjust focus from right *or* left side of camera, with the same 300° arc of focus adjustment for all lenses . . . choose color filters, masks, at the flick of a thumb . . . control the motor-driven iris from camera or camera control unit. Normal optical focus range automatically adjusts for constant 9" diagonal at close-up, for all lenses except telephoto. Overtravel switch provides *extended* focus range, obtaining full optical focus on all lenses.

In every way, GPL's is a "human-engineered" camera chain, built to do a tough job more easily, built to do *your* specific job *best!* Arrange to see this great new model at the earliest opportunity.

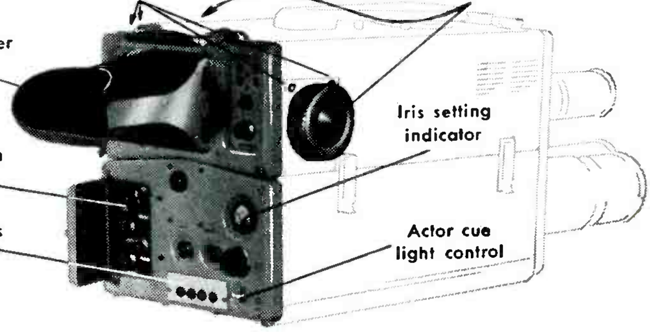
Compare

THESE FEATURES WITH ANYTHING ON THE MARKET TODAY

- Three Compact Units
- Push-button Lens Change
- Right or Left Hand Focus Knobs
- Right or Left Hand Lens Iris Control Buttons
- Turret, Focus and Iris Controls from remote location if desired
- High Resolution Integral View Finder
- Enclosed I.O. Controls
- Iris Setting Indicator
- Pre-loaded Color Filter Wheel
- Swing-up Chassis
- Focus Range Selector Switch
- Equal Flexibility in Studio or Field

WRITE, WIRE OR PHONE FOR DETAILS

FINGER-TIP OPERATION from CAMERA or REMOTE LOCATION



TV Camera Chains • TV Film Chains
TV Field and Studio Equipment
Theatre TV Equipment

GENERAL PRECISION LABORATORY
INCORPORATED

Pleasantville New York

How CLARE Engineers improved the performance of a relay without increasing its size

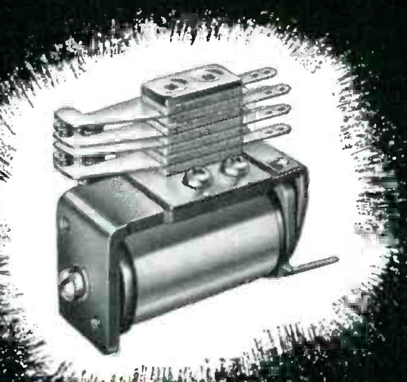
SAME VIBRATION RESISTANCE

SAME CONTACT PRESSURE

SAME FAST OPERATION

SAME SMALL SIZE

CLARE Type "KX" RELAY



GREATER OPERATING RANGE

GREATER SENSITIVITY

SPECIFICATIONS

Size: Length: 1 39/64"; Height: 1 15/32"; Width: 1". Dimensions vary with type of coil terminal used. Height shown is maximum (with 8 springs in pileup). **Weight:** Approx. 2 oz. **Coil:** Single or double wound. **Operating Voltage:** to 175 volts d-c. **Armature:** Single- or double-arm. **Contact Arrangement:** Forms A to C available. Maximum 8 springs in pileup. **Mounting:** Two #4-40 screws. Can also be furnished with 2 or 4 mounting studs tapped for #4-40 screws.

● The Clare Type "K" Relay, first of the famous Clare line of small, lightweight, telephone-type relays, is still the mainstay of design engineers who must have superior relays to operate in extremely small space.

Its fast operation, adequate contact pressure, high resistance to shock and vibration, long life and complete all-around dependability have met many complex requirements. Once in a while, however, Clare engineers have been confronted with customers' specifications which this Clare Type "K" Relay would not quite meet.

More often than not this was due to the small spool which limited coil winding to a maximum of 6500 ohms. Clare engineers have met this situation with the new Type "KX" whose sensitivity and operating range are increased by use of a slightly longer coil which can be safely wound to a maximum resistance of 8000 ohms. This additional winding space is gained by a slight change in the design and suspension of the armature which enables the length of the coil to be increased without adding materially to the over-all length of the relay.

The Type "KX", like the Type "K" and Type "R" relays, has the reed armature suspension of special alloy which engineers recognize as one of the subtler reasons for the superior performance of these small Clare relays. The Type "KX" is interchangeable with the Type "K" for mounting.

This new relay is available as either an open or hermetically sealed relay. Call your nearest Clare sales engineer . . . located in principal cities to serve you . . . or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

Write for Clare Bulletin No. 116

CLARE RELAYS

First in the Industrial Field

SPECIAL **HARNESSES, CABLES, CORDS** for Military Equipment

If you have a wiring problem on any of your Defense Projects, always consult Lenz. Here is a dependable source for Harnesses, Cables and Cords, constructed of JAN-C-76 Approved Wire, that can speed up your assembly operations.

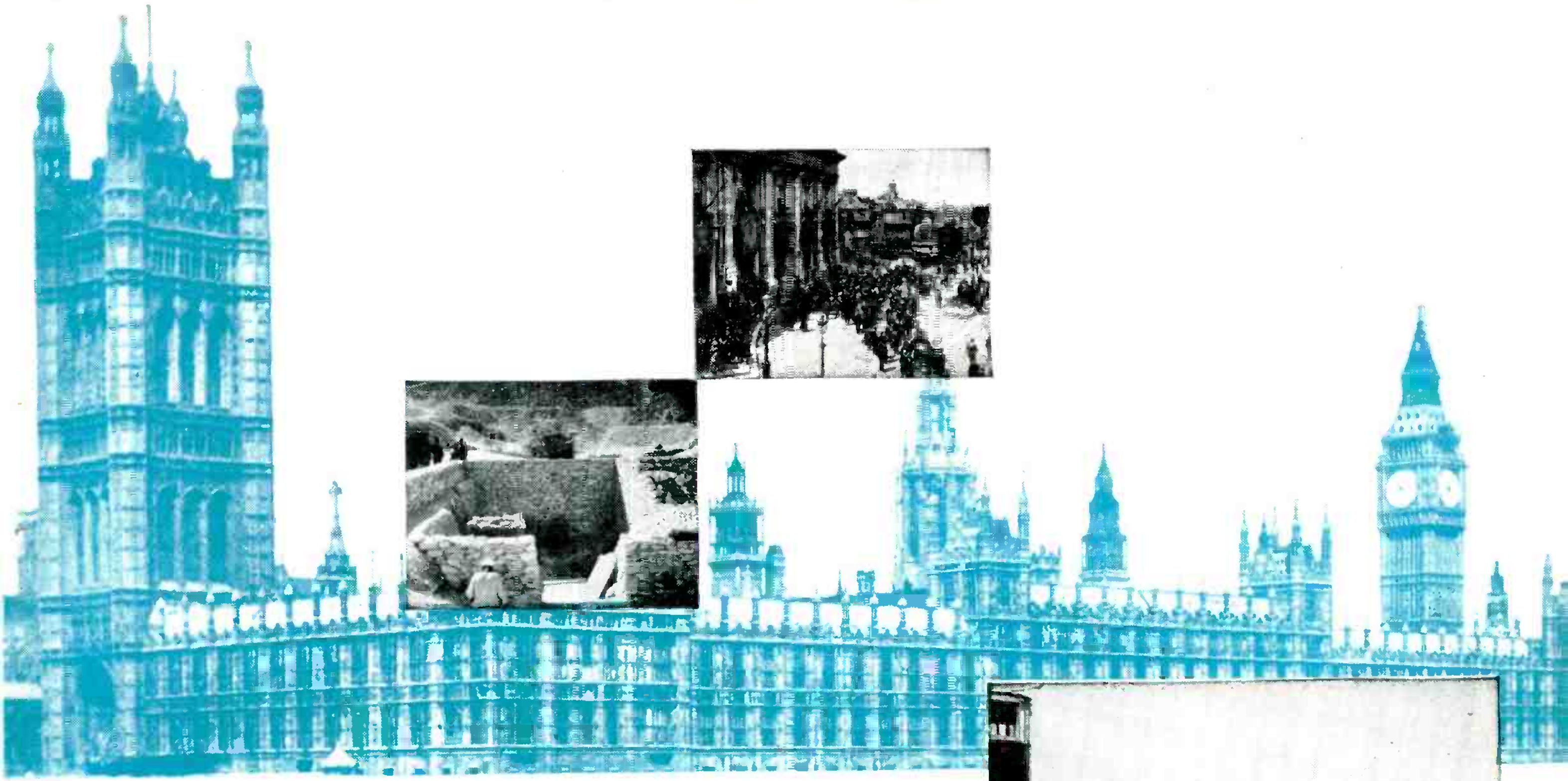
Lenz, with almost a half century of experience in the production of wires and cables—for the communications industries, is producing Thermo-Plastic Insulated Hook-Up Wires, with or without Lacquered Braids, and constructing Cables, Cords and Harnesses for many leading manufacturers of Defense Equipment.

For all your wiring needs, consult Lenz.

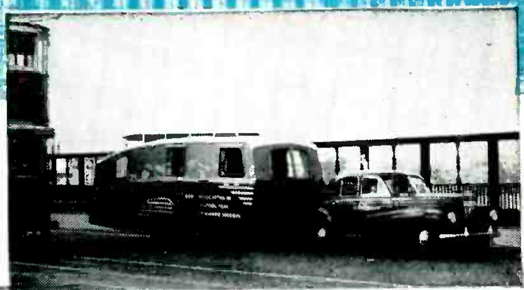
LENZ

LENZ ELECTRIC MANUFACTURING CO.

IN BUSINESS SINCE 1904 • **1751 North Western Avenue, Chicago 47, Illinois**



PRESTO selected for



"The biggest job of radio journalism ever undertaken in the United Kingdom"

KENNETH MELVIN,
New Zealand's No. 1 radio personality tours three continents with his PT-900.

wherever you go there's PRESTO

From a Hindu temple in Singapore to the dank tomb of King Tut in Egypt . . . from the imposing balcony of Mussolini's palace in Rome to the historic tower of Big Ben in London, Kenneth Melvin has taken his PRESTO tape recorder . . . recording strange voices, sounds, music, that have become living commentaries on people's customs, habits and surroundings. As official reporter for the British Festival, he is now travelling throughout the British Isles recording material for a 52-week series of network broadcasts.

"I shall be interested to discover", says Kenneth Melvin, "whether any tape-recording equipment has ever been subjected to so grueling a test as my PT-900 . . . not on a single occasion—over four months of constant operation, averaging six hours a day, under murderous variations of temperature, current, voltage and with constant man-handling from car to scene, upstairs and down cellars—*not once has it failed me.*"

Every day, thousands of PRESTO owners are discovering, just as Mr. Melvin did, that PRESTO equipment is made to give the utmost in performance and dependability. That's why . . . wherever you go there's PRESTO.

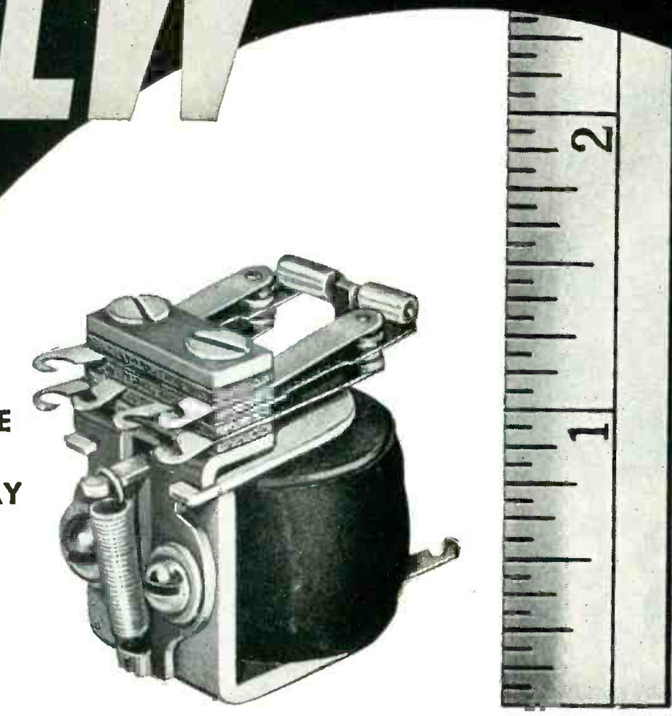
PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

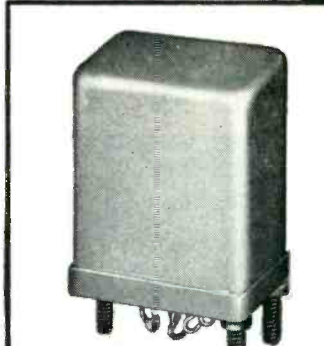
In Canada: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal
Overseas: M. Simons and Sons Company, Inc., 25 Warren St., New York, N. Y.

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

NEW Minipower Relay

TYPE
ME
RELAY





AVAILABLE
HERMETICALLY
SEALED

HERE ARE THE FACTS AND FIGURES

DIMENSIONS: 1-3/16 x 13/16 x 1-3/8

CONTACTS: 5 amp. standard. 28 volts D.C., 115 volts A.C. Up to 4 P.D.T. D.C. and up to D.P.D.T. A.C.

SENSITIVITY: D.C. 0.7 watts D.P.D.T. (0.1 watt in special applications)
A.C. 3 volt-amperes (operating range: 80% to 110% of nominal voltage)

COIL: Available for A.C. or D.C.

HEAT RISE
D.C. 50°C Rise—2 watts
85°C Rise—3.5 watts
A.C. 45°C at nominal voltage
65°C at 10% overvoltage

MOUNTING: One-screw mounting with locating pin.

HERMETICALLY SEALED DATA

DIMENSIONS OF CAN: Base: 1" x 1-1/8"
Height above chassis: 1-11/16"
Lugs: 3/8"

Available with solder terminals or special miniature plug-in base.

**VERSATILE—
FROM SIGNAL TO 5 AMP. POWER**

This latest addition to Allied's line of quality relays will meet the vibration, shock and environmental requirements for air, marine and ground applications.

**BULLETIN ME
GIVES COMPLETE DETAILS.
SEND FOR YOUR COPY TODAY**

Also, be sure to send for your copy of Allied's Relay Guide. It gives engineering data for 27 Allied relays in a concise tabular form for easy reference.

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

AL 145

WRITE FOR
BULLETIN FC-5101

APPLICATIONS:
ANTENNA CORES ○ I-F TRANSFORMERS ○ PERMEABILITY TUNING DEVICES ○ LOW-LOSS INDUCTORS ○ SATURABLE CORE REACTORS ○ HORIZONTAL OUTPUT TRANSFORMERS ○ DEFLECTION YOKES ○ TELEPHONE LOADING COILS

Be certain of top performance and an uninterrupted supply of deflection yokes and horizontal output transformers by specifying Ferroxcube 3C, the nickel-free ferrite core material.

Improved Ferroxcube 3C gives you these basic advantages: 1. High saturation flux density. 2. High permeability. 3. Improved temperature stability.

The broad experience gained during 15 years of research and manufacture since the initial development of Ferroxcube, *can be helpful to you!* Take advantage of our technical "know-how" in solving your own design problems. Ferroxcube engineers are always ready to assist you without obligation. ★ ★ ★ ★ ★ ★ ★ ★ ★

FERROXCUBE
THE MODERN CORE MATERIAL

FERROXCUBE CORPORATION OF AMERICA

A Joint Affiliate of Philips Industries and Sprague Electric Co., Managed by Sprague

50 East 41st Street . New York 17, New York . Factory: Saugerties, New York

NEW! Synchronous Motor Driven SINGLE CAM and MULTI-CAM RECYCLING TIMERS

The new Industrial Cam Recycling Timer continuously repeats a constant cycle consisting of definite ON and OFF periods which can be adjusted from 2% to 98% of the cycle. By means of percentage calibrations on the cam face any desired setting is quickly and accurately obtained. The time cycle itself can also be changed easily by substituting simple gear-rack assemblies. Thus, from one timer, by using different gear racks you can obtain 50 different cycles ranging from the lowest cycle of the timer up to nine times that cycle. The snap action switch operated by the timer is a single pole double throw, totally enclosed 10 ampere type. We can supply 500 different time cycles in this model ranging from one revolution in 15 seconds to one revolution in 72 hours.

The Multi-Cam Recycling Timer is identical to the Single Cam Timer but operates from 2 to 6 circuits and incorporates several additional features. On this timer all cams are mounted on a single driving shaft which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. This is accomplished by actually rotating the cam with finger pressure using the drum calibrations for guidance. Thus a range of timing sequences from 0% to 100% is obtainable on each circuit with ease. The elimination of cam followers and other types of moving parts makes possible this compact unit. 11 models are available with time cycles ranging from one revolution in 1 minute to one revolution in 72 hours.

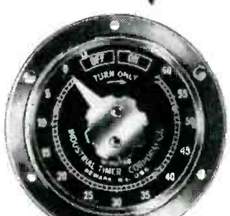
REMOTE CONTROL FOR SINGLE CYCLE OPERATION AVAILABLE.

Send today for complete details—or, if you would like to send us specifications, we shall be glad to make recommendations based on your particular needs.

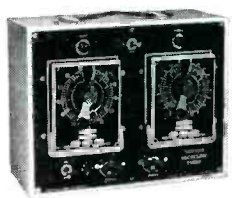
Manufacturers of These and Other Timers and Controls for Industry

TIME DELAY TIMERS

INSTANTANEOUS RESET TIMERS



MANUAL SET TIMERS



TANDEM AUTOMATIC RECYCLING TIMERS

RUNNING TIME METERS

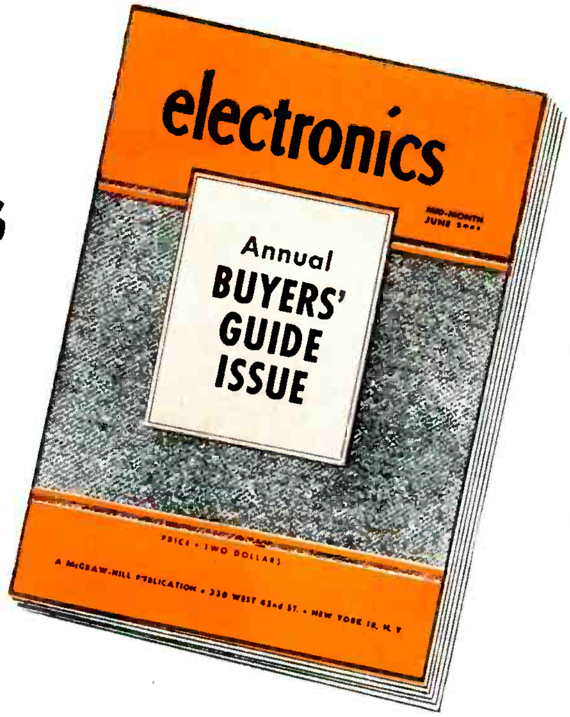
Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION

115 EDISON PLACE, NEWARK 5, N. J.

1951-1952 ELECTRONICS BUYERS' GUIDE



YOUR BOOK with the ORANGE and BLACK cover

The 650-page 1951-1952 ELECTRONICS BUYERS' GUIDE is now in the hands of every ELECTRONICS' subscriber. Sent as a bonus issue of ELECTRONICS through the cooperation of over 2,000 manufacturers of electronic and allied products, it is a valuable working tool that will be kept at the elbow of every ELECTRONICS' subscriber and reader throughout the year.

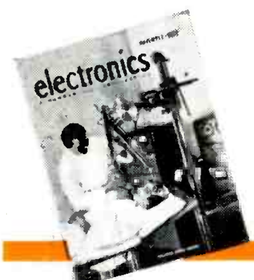
Use it . . . refer to it constantly. Mention ELECTRONICS BUYERS' GUIDE when you write to the manufacturers listed in the directory section and when you purchase products advertised in it. Such evidence of use will insure continued manufacturer cooperation in making this annual your most comprehensive source of buying information.

The products and services of 475 companies are advertised in this 13th issue of ELECTRONICS. In the directory section, more than 2,000 manufacturers are listed under 1,400 product classifications. 2,500 trade names are listed, and the names and addresses of 850 distributors of electronic products are arranged alphabetically by states. It also supplies a 36-page cumulative index to articles published in ELECTRONICS from April 1930 to December 1939.

The 1951-1952 ELECTRONICS BUYERS' GUIDE had the largest print order, and has more total pages, more pages of advertising, and more individual companies' advertising in it than any issue of ELECTRONICS published since the first in April 1930.

A publication's value to an industry is measured by the service it renders to subscribers and readers. When we can mail to every one of our over 30,000 paid subscribers—as a separate, 13th issue—a valuable working tool such as the 1951-1952 BUYERS' GUIDE, we feel we are rendering a valuable service to our subscribers, advertisers, and industry.

The 1952-1953 ELECTRONICS BUYERS' GUIDE will be published Mid-June 1952.



12 REGULAR ISSUES
supplying latest technical information, design and product news

ABC

electronics

ABP

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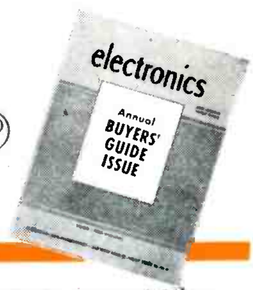


ANNUAL BUYERS' GUIDE
supplying all basic product source and technical specifying data

FOR READY REFERENCE...

A Complete List of GE Welded GERMANIUM DIODES

PLANT CAPACITY UP 200%!

WITH new plant facilities devoted entirely to the manufacture of germanium products, we can now deliver 12,000,000 diodes a year—industry's total estimated needs.

Whatever your diode requirements, let us show you that we can fill them with precision-tested units at prices as low as any in the business. Complete specifications and prices on request. Write: *General Electric Company, Section 481, Electronics Park, Syracuse, N. Y.*

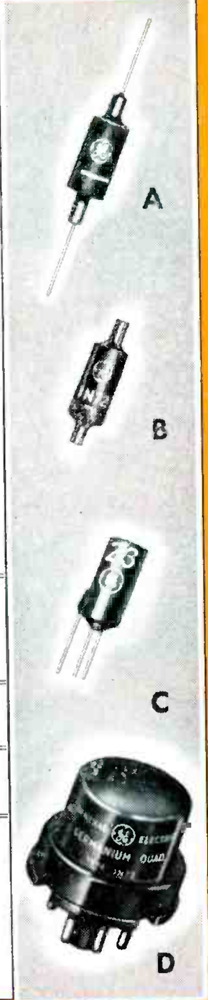
CATEGORY	RTMA DESIGNATION	G-E TYPE	PEAK INVERSE VOLTAGE	CONTIN. OPER. INV. VOLTAGE	MIN. FORWARD CURRENT (MA) AT +1V	MAX. INV. CURRENT (@a) AT —50V	AV RECTIFIED CURRENT (MA)	PEAK RECTIFIED CURRENT (MA)	SURGE CURRENT (MA)	SIZE
GENERAL PURPOSE	1N48	G5	85	70	4.0	833	50	150	400	A
	1N51	G5C	50	40	2.5	1667	25	100	300	A
	1N52	G5D	85	70	4.0	150	50	150	400	A
	1N63	G5E	125	100	4.0	50	50	150	400	A
	1N75	G5M	125	100	2.5	50	50	150	400	A
TV	1N64	G5F	20	Min. dc current in 44 mc rectifier—100@a						A
	1N65	G5G	85	70	2.5	200	50	150	400	A
JAN	1N69	G5K	75	60	5.0	850	40	125	400	A
	1N70	G5L	125	100	3.0	410	30	90	350	A
VHF		G6	15	Min. Rect. Eff. at 100 mc and 2 v signal—60%						A
UHF	1N72	G7		+3db max. noise factor over 1N21B in 500 mc mixer CKT			25	75		B
		G7A					25	75		A
		G7B	5	75% min. rect. eff. at 100 mc for detector			25	75		B
		G7C	5				25	75		A
		G7D	5	Tested for sharpness of break E-I char. for freq. multiplier			25	75		B
		G7E	5				25	75		A
		G7F	5	60% min. rect. eff. at 100 mc for detector			25	75		B
		G7G	5				25	75		A
MATCHED PAIRS Note (1)		G8	85	70	4.0	833	50	150	400	A
		G8A	85	70	4.0	150	50	150	400	A
		G8B	125	100	4.0	50	50	150	400	A
		G8C	125	100	2.5	50	50	150	400	A
QUADS	1N73	G9	75		Note (2)	50@ —10v	22.5	60	100	D
	1N74	G9A	75		Note (3)	50@ —10v	22.5	60	100	D
TRANSISTORS Note (4)		G11	Max. RMS emitter signal level—.3v; max. DC emitter current—.5 ma;							C
		G11A	Max. DC collector current—2.0 ma; power gain 17 to 21 db; power output 25 mw							C

(1) Matched at +1v so that current through higher resistance unit is within 10% of lower resistance unit.

(2) Consists of 4 balanced diodes. With 15 ma forward current; the voltage drop of each diode is 1.3v min. and 1.7v max., all diodes are within 0.1 volt of each other, and voltage drop of a pair is 0.03 volts of each other.

(3) Consists of 4 balanced diodes. With 15 ma forward current; the voltage drop of each diode is 1.2v min. and 1.8v max., all diodes are within 0.2v of each other, and voltage drop of a pair is 0.1v of each other.

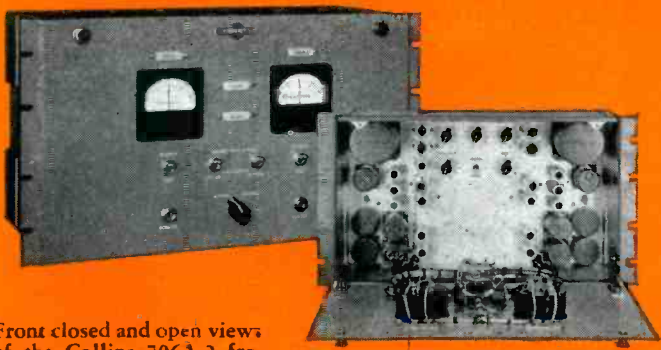
(4) Additional test over G11 for negative resistance of base current vs. base voltage characteristic for trigger circuit operation.



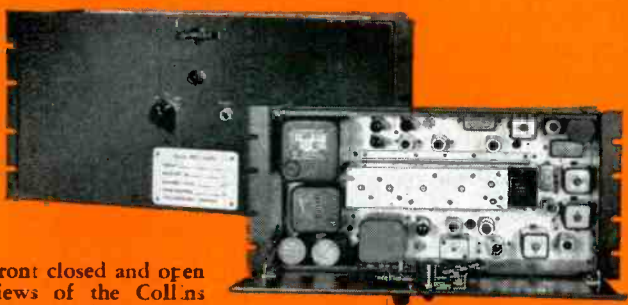
You can put your confidence in—

GENERAL ELECTRIC

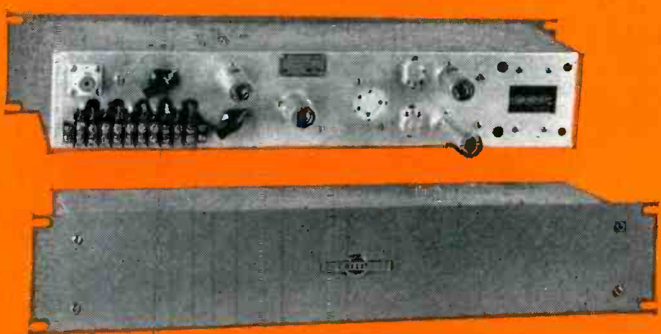
FOR RELIABLE RADIO PRINTER COMMUNICATIONS



Front closed and open views of the Collins 706A-2 frequency shift converter



Front closed and open views of the Collins 51N-5 receiver



Front and rear views of the Collins 709D-1 frequency shift keyer

Here are three basic Collins units for maximum performance and complete dependability in frequency shift radio receiving and transmitting applications.

The 706A-2 converter is designed to operate from the outputs of two 51N-5 receivers arranged for diversity reception of radio printer transmissions. In practice, both receivers operate on the same frequency within the range of 2 to 24 megacycles. However, each derives radio frequency signals from a separate directional antenna.

The 706A-2 converter automatically balances the signal from one receiver against that obtained from the other, instantaneously selects the best, and feeds it to the d-c keyer circuits and thence to the printer line. Both the receivers and the converter are engineered for unattended continuous duty, and will give long, trouble-free operation with only routine maintenance.

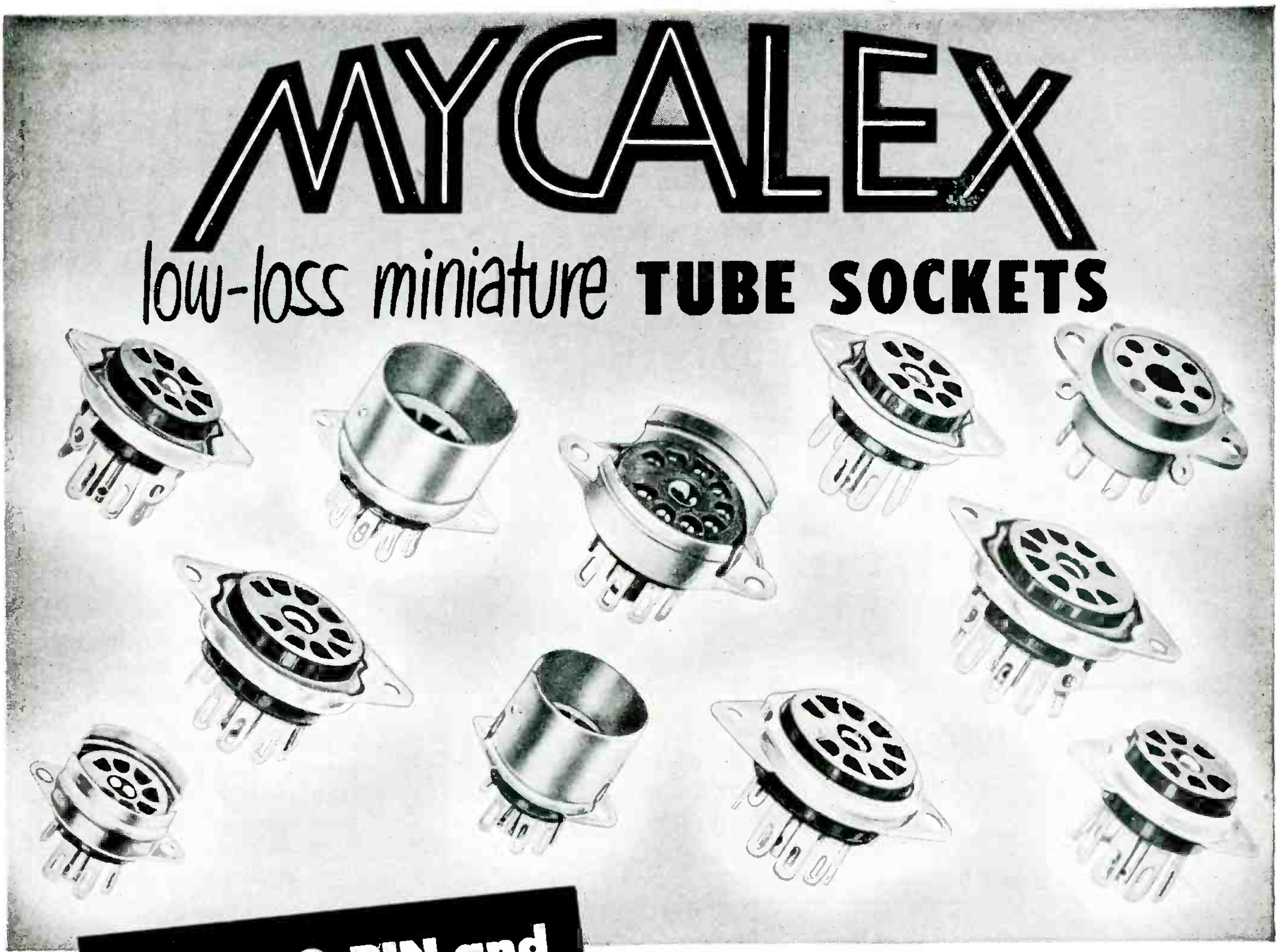
The 709D-1 frequency shift keyer was developed to provide a simple yet dependable unit for adapting existing transmitters to frequency shift operation. For such service it is most commonly coupled to the transmitter through a modified crystal holder inserted in the transmitter's crystal socket.

You will find it well worth while to consult us about your radio printer requirements.

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 W. 42nd Street, NEW YORK 18 — 2700 W. Olive Avenue, BURBANK



7-PIN, 9-PIN and SUBMINIATURES

—*available in two grades:*

MYCALEX 410 priced comparable to mica-filled phenolics. Loss factor is only .015 at 1 mc., insulation resistance 10,000 megohms. Approved fully as Grade L-4B under N.M.E.S. JAN-1-10 "Insulating Materials Ceramic, Radio, Class L".

MYCALEX 410X — low in cost but insulating properties greatly exceed those of general purpose phenolics. Loss factor is only one-fourth that of phenolics (.083 at 1 mc.) but cost is comparable. Insulation resistance 10,000 megohms.

PREMIUM INSULATION — Bodies are MYCALEX glass-bonded mica, the dielectric that combines every characteristic required in a modern insulation including low dielectric loss, high dielectric strength, high arc resistance, non-hygroscopic and great dimensional stability.

COMPETITIVELY PRICED — Although manufacture is to the most exacting quality standards and fully meets RTMA recommendations, an exclusive MYCALEX manufacturing process permits pricing at a level competitive with low cost phenolic types.

PRECISION MOLDED — An exclusive MYCALEX injection molding technique affords great dimensional accuracy, exact uniformity, superior low loss characteristics and perfect homogeneity.

MYCALEX TUBE SOCKET CORPORATION
Under Exclusive License of Mycalex Corporation of America
30 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.

INFORMATIVE DATA SHEETS

Include them in your files — Complete information including dimensional data, specifications and other pertinent facts on MYCALEX low-loss, low-cost, tube sockets. Write for your set complete with loose-leaf binder that permits the inclusion of subsequent releases and data sheets.

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Owners of 'MYCALEX' Patents and Trade-Marks
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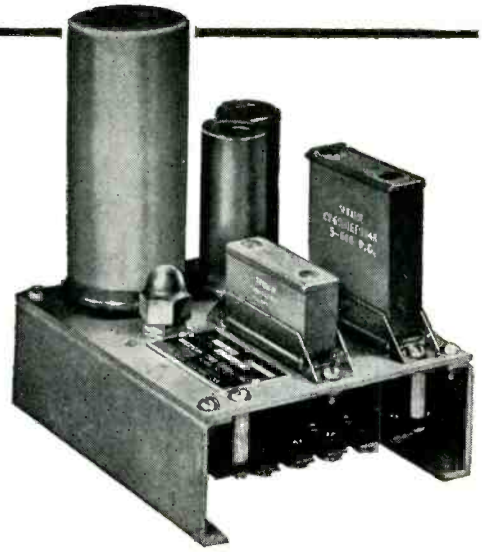
20000.
– OR ANY OTHER



precision
FREQUENCY

FROM 40 TO 20,000 CYCLES

CONSERVATIVE ACCURACY UNDER USUAL CONDITIONS

1 PART IN 100,000—(.001%)

CALIBRATED AGAINST A STANDARD ACCURATE TO 1 PART IN 10-MILLION

The basic unit of this frequency standard is an electronically driven fork,—temperature compensated and hermetically sealed against changes of humidity and barometric pressure. Through its use, any frequency or multi-frequencies between 40 and 20,000, fractional or otherwise, are obtainable.

Have you a need for any specific number of cycles in precision frequencies?

Can a source of such frequency solve your design problem or increase its factor of safety?

Have you a system that requires great accuracy, stability and dependability?

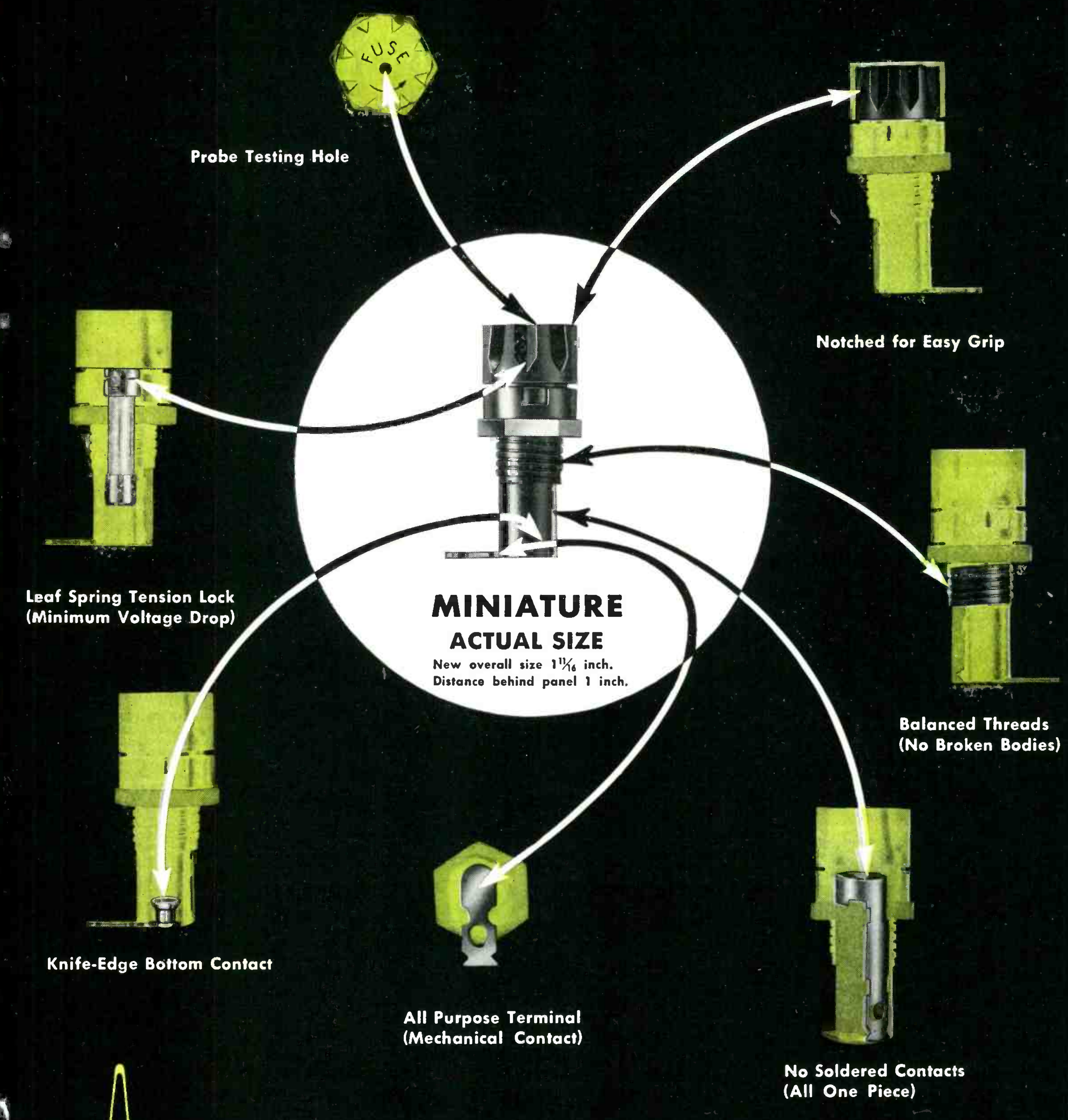
The frequencies shown at the top of the page are but a few among hundreds furnished for precision application in industries, laboratories and Government departments.

OUR ENGINEERS ARE AVAILABLE TO COOPERATE ON ANY PROBLEM

American Time Products, Inc.

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

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC CO.



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FUSE EXTRACTOR POST

Littelfuse, maker of fine fuses, now pioneers another design development with the new, miniature Fuse Extractor Post.

Write Littelfuse today — 4757 North Ravenswood, Chicago 40 — for your free sample of the newest and smallest FUSE EXTRACTOR POST.

BURTON BROWNE ADVERTISING

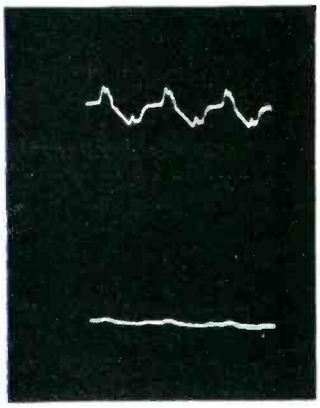
Where "Photographic Memory" *Counts!*

When you're comparing waveshapes it takes the "photographic memory" of a camera to give you the whole story in accurate, permanent form.

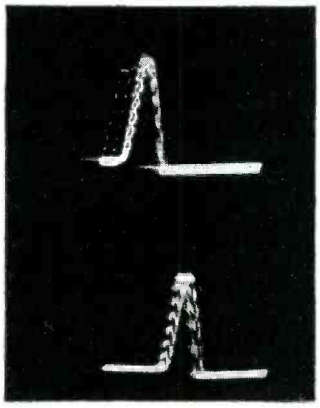
Until recently, photographic oscilloscope recording called for considerable trouble in setting up equipment and a long time period for developing the results. But today, with the Fairchild-Polaroid Oscilloscope Camera, it's an easy job to record as many traces as are needed.

Take a look at the prints below. They provided the engineer with valuable but inexpensive records for immediate evaluation. All were removed from the camera *one minute* after the final exposure was made.

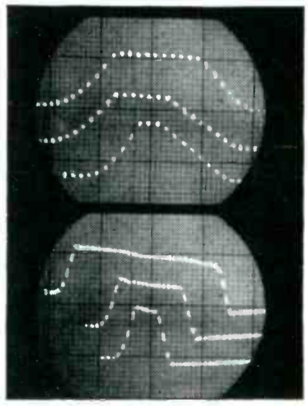
The stories of 3 "One Minute" Oscillograms



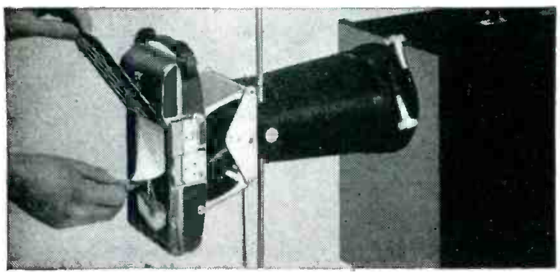
1. BEFORE AND AFTER. A visual comparison of "before and after" conditions is an easy job for the "one step" camera. Here, the upper trace shows the output of a full wave rectified power supply with insufficient filtering. The lower trace shows the effectiveness of the addition of a filtering condenser. The camera is easily adjusted to two positions (upper and lower) for two exposures; traces are exactly one half scope size.



2. SUPERIMPOSING FOR COMPARISON. The problem—determine the maximum time-interval variation between successive camera shutter openings and flash circuit closings. Instead of carefully measuring successive scope traces, the engineer superimposed several exposures for easy comparison. The length of the trace before the shutter opened is a measure of the time between the electrical contact closing and camera shutter opening.



3. MULTIPLE EXPOSURE PRE-SOLARIZATION. Here, by making 3 successive exposures on each half of the print, the engineer was able to record performance of a camera shutter at its 1/100, 1/200, 1/400 second (upper) and 1/25, 1/50, and 1/100 second settings (lower). "Pre-solarizing," the process of pre-exposing the print with the trace off the screen, made it possible to record the high writing speeds involved.



A minute after you've pulled the tab a finished print is ready for evaluation.

for still or *continuous-motion* oscilloscope recording on 35-mm film or paper

—THE FAIRCHILD OSCILLO-RECORD CAMERA

The Fairchild Oscillo-Record Camera is the first unit specifically designed for the purpose of recording cathode-ray tube images. Features: records still or continuous motion on standard 35-mm film or paper, film footage indicator, electronic speed control—1 to 3600 in./min., film capacity—100, 400 or 1000 feet.

SPECIFICATIONS

Lens and Shutter—Choice of 75mm f2.8 Wollensak Oscillo-Anastigmat with #2 Alphax shutter having speeds of 1/25 sec. to 1/100 sec., "time" and "bulb"; or, 75mm f1.9 Wollensak Oscillo-Anastigmat with #3 Alphax shutter having speeds of 1 sec. to 1/100 sec., "time" and "bulb".

Picture Size—3¼ x 4¼ in. (2 or more images per print; 16 exposures per roll of film.)

Image Size—One-half reduction of scope image.

Writing Speed—With f2.8 lens, up to 1 in/μsec at only 3000V accelerating potential; higher speeds at higher voltages. With f1.9 lens these values are approximately doubled.

Dimensions—Camera, 10½ x 5¼ x 6¼ in.; hood, 11 in. length, 7½ in. dia; adapter, 2 in. width, 6⅝ in. max. dia.

Weight—Complete, 7¾ lb.

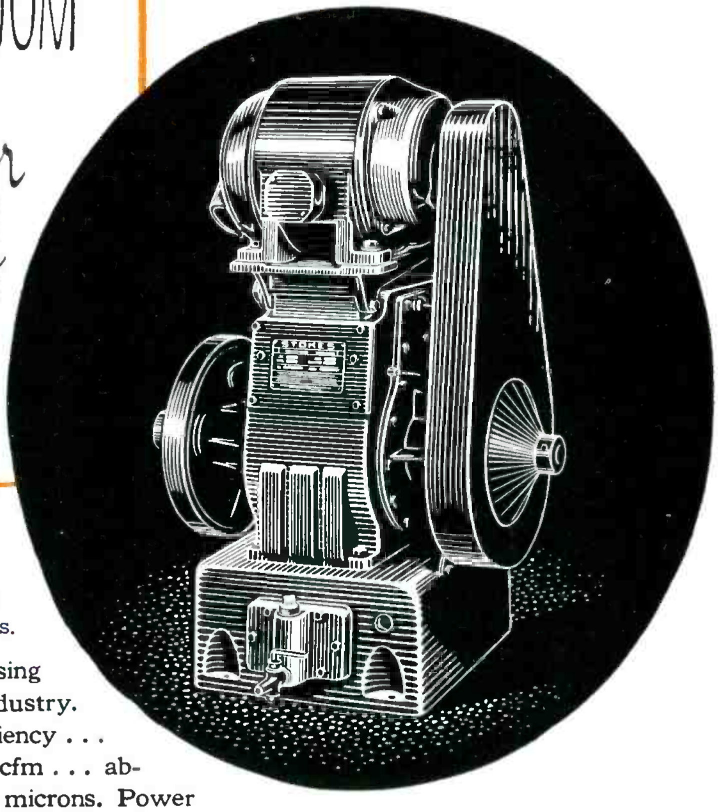
Fairchild-Polaroid Oscilloscope Camera Kits include camera, carrying case and film. Write today for complete data on the Fairchild-Polaroid and Fairchild Oscillo-Record Cameras. *Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. Dept. 120-15A1.*

FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

Visit us at booth 519 — Pacific Electronic Exhibit

STOKES HIGH VACUUM EQUIPMENT... *for every requirement of vacuum processing*



Modern design of Stokes vacuum equipment develops from the continuing contact of Stokes Engineers with processors in many fields.

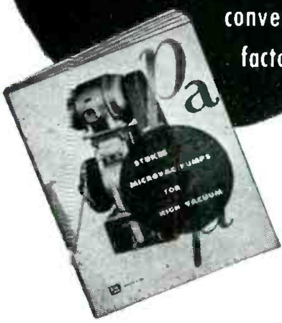
Stokes Microvac Pumps — basic to vacuum processing —are designed for the broadest requirements of industry. They have high volumetric and mechanical efficiency . . . capacities of 15 to 500 cfm . . . absolute pressures to 10 microns. Power consumption is low. Compact design with top-mounted motor requires minimum floor space.

There are but four moving parts including the high speed, full-opening exhaust valve of corrosion-resistant Teflon. Lubrication is completely automatic, without packing, stuffing-boxes or grease fittings. Wear is kept to a minimum, and long trouble-free service assured. Parts are precision-finished, standard and interchangeable.

Stokes is the only manufacturer of equipment for complete vacuum systems, including Microvac mechanical pumps, oil diffusion pumps, McLeod Gages and Vacuum Valves.

Consult with Stokes on the application of vacuum to rotary exhaust machines, house vacuum systems, vacuum impregnation, vacuum furnaces, vacuum metallizing, and to other applications in which vacuum deserves exploration.

Send for Catalog 700, "Stokes Microvac Pumps for High Vacuum", now a standard reference work on High Vacuum, containing charts, graphs, diagrams, schematics, typical problems, tables, formulas, constants, conversion factors.



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Plastics Molding Presses,
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High Vacuum Pumps and Gages,
Special Machinery

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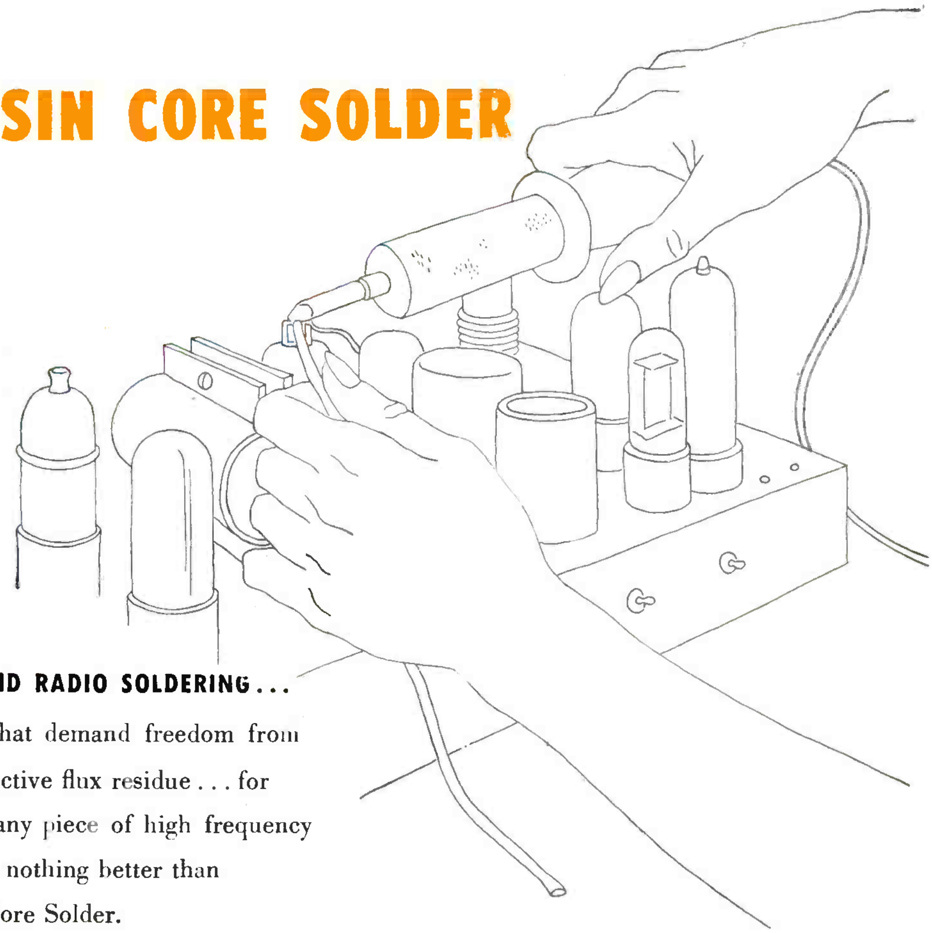
federated ROSIN CORE SOLDER



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for operations that demand freedom from corrosion and conductive flux residue . . . for soldering on any piece of high frequency equipment . . . there is nothing better than Federated Rosin Core Solder.

Each Rosin Core Solder composition is a precise alloy of tin and lead with a pure turpentine distillate flux that is effective but not corrosive. This means that current leakage at radio frequencies is prevented.

Federated Rosin Core Solder is unequalled for consistency and ease of working . . . for the permanence of the bond it produces. Look for it on the familiar orange and black metal spool. 1, 5, and 20-pound sizes.

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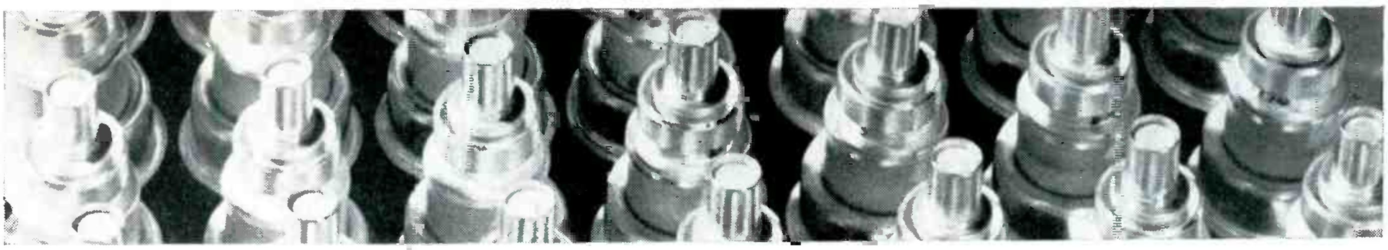

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the new Eimac ceramic 2C39 type triode

The new Eimac 2C39 type triode is specially constructed for service in which tubes are to be subjected to excessive physical and thermal abuse. Eimac engineers, in developing this improved version of the 2C39, have replaced glass with rugged ceramics. Through the use of new manufacturing techniques and ceramic materials, this new tube will operate at appreciably higher ambient operating temperatures than the glass-envelope type tube. Resistance to physical shock is also increased to a degree beyond that which is customarily associated with vacuum tube structures.

If you anticipate requirements for a tube of this type, we suggest you contact our application engineering department immediately.

EITEL-McCULLOUGH, INC.
San Bruno, California

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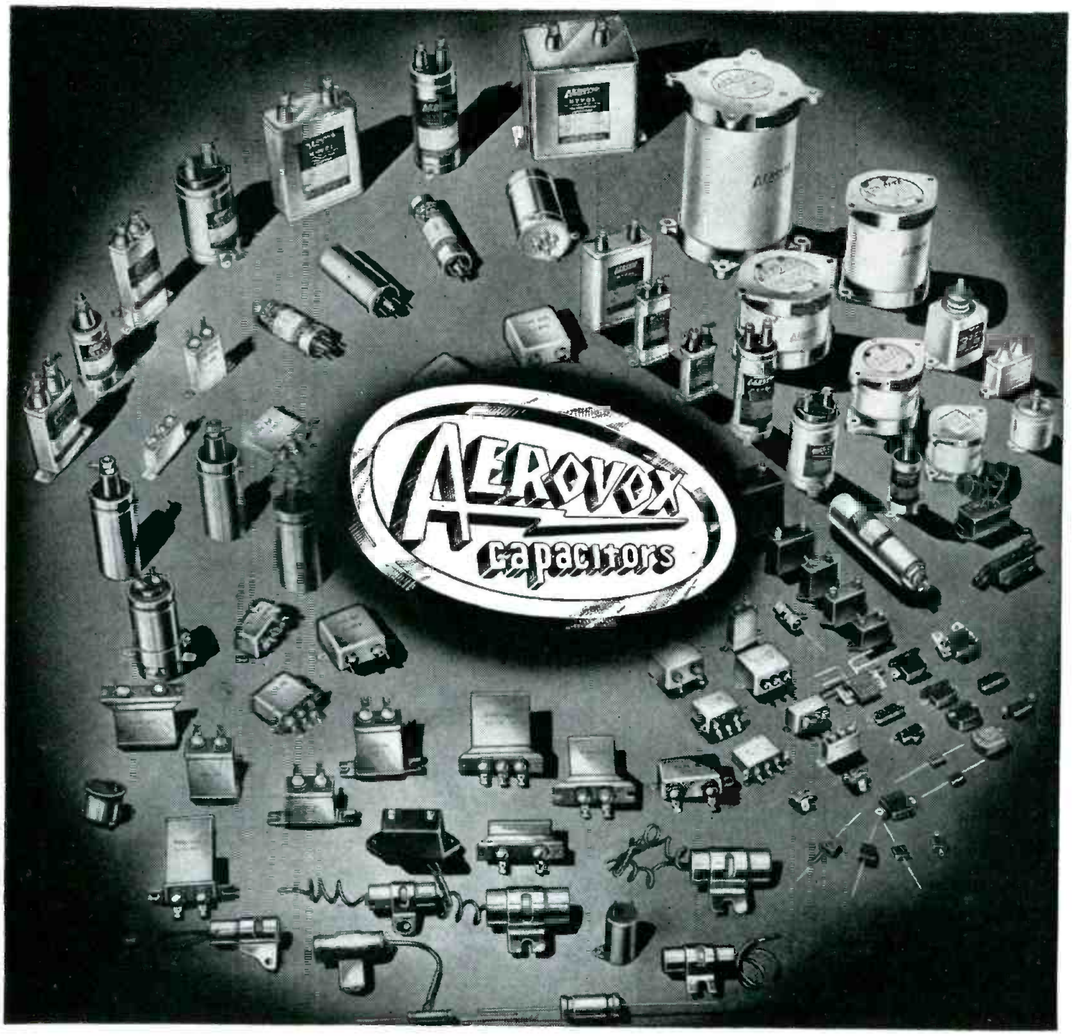
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Eimac ceramic 2C39 type triodes are another outstanding contribution to electronic progress.



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● From tiniest metallized-paper capacitor symbolizing *miniaturization*, to giant oil capacitor for atom-smashing Betatron, you are SAFE in *specifying Aerovox*. For Aerovox makes *all* categories, types, sizes and ratings. More than that: with a background experience second to none, Aerovox engineers are always ready to study your circuitry, components, operating conditions and anticipated life. Thus capacitor selection is custom-fitted to your exact requirements. And that is why Aerovox capacitors have such outstanding service records.

• Literature on request. Submit that capacitance problem for engineering aid and quotations.

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For military and civilian needs, particularly aircraft and radio-equipped vehicles.

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For extra-severe service. Aerolene impregnant eliminates necessity of stocking both oil and wax tubulars. No deterioration in stock.

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From tiniest tubulars to giant steel-case units in ratings up to 50,000 volts.

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Hermetically-sealed with vitrified ceramic seal, in tubular metal case.

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Full utilization of space-saving factor, together with self-healing feature.

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Molded thermo-plastic tubulars. Two sizes: 3/16" d. x 7/16" l.; ¼" d. x 9/16" l.

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Widest choice of containers, terminals, mountings, combinations. In 85° C. and higher temperature ratings.

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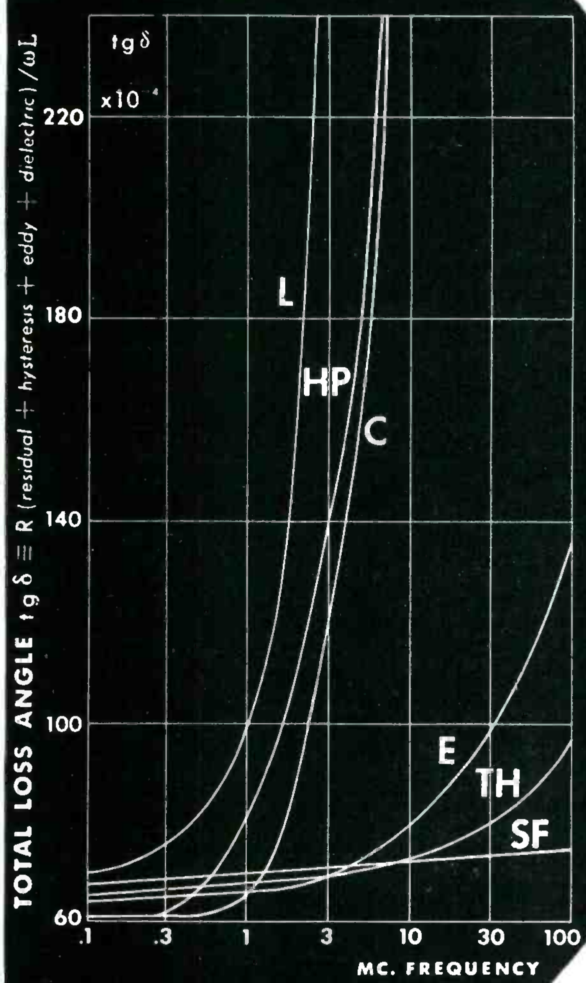
Greater purity means *greater permeability*
Smaller size means *lower power loss*

TYPICAL TOTAL LOSS ANGLES OF CORES FROM CARBONYL IRON POWDER GRADES



• This advertisement makes no comparisons between GA & F Carbonyl Iron Powders and any other material. (We assume that you will make such comparisons as your own specifications may indicate.)

GA & F Carbonyl Iron Powders are made in six grades—each of which has its own particular combination of qualities and thereby offers its own special advantages. Your selection of any particular grade will be determined by size, shape, size distribution, internal structure, condition of surface, desirable or undesirable ingredients. The particles are all spherical; the particle size distribution differs—from one grade to another.

Collectively, the six grades blanket a wide range of applications—in electronic cores over the whole frequency spectrum, in metallurgy, in chemistry, in pharmacy and in magnetic fluids. The particles may be large, soft crystals—or extremely small, hard crystals arranged in concentric spherical-shell layers. The surfaces are free and active. The purity is invariably high, with non-ferrous metals in traces only; some grades contain beneficial small amounts of carbides, nitrides and oxides.

In the smaller sizes, these powders show exceptionally low power losses in electronic cores. Thus they offer the optimum combination of permeability, particle size and structure.

The chart at the left shows the range in particle size distribution; the chart at the right shows the typical total power loss angle for each grade.

FOR FURTHER DETAILS, WE INVITE YOU TO WRITE FOR A FREE BOOK —fully illustrated with performance charts and application data. It will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Department 87.

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DIVISION OF

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Only a complete line

answers *all your* electrical measuring requirements

The case of Mastic Tile Corporation demonstrates how the complete line of Westinghouse Instruments holds answers to your electrical measurement problems.

Mastic's problem was one of predetermining load on a Banbury Mixer motor in order to facilitate the operator's job and speed the mixing cycle. It was answered by the standard Westinghouse GY-40 Recording Wattmeter with proper choice of scale, current and potential transformers, and chart speed. In fact, so well did this standard instrument accomplish its job that final results show—a 15 percent reduction in mixing cycle time along with the elimination of damaging surge shocks which can now be anticipated and prevented by the machine operator.

Westinghouse will continue to give you a wider selection for every need . . . whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or synchrotie. You get assurance of quality too, because every applicable instrument . . .

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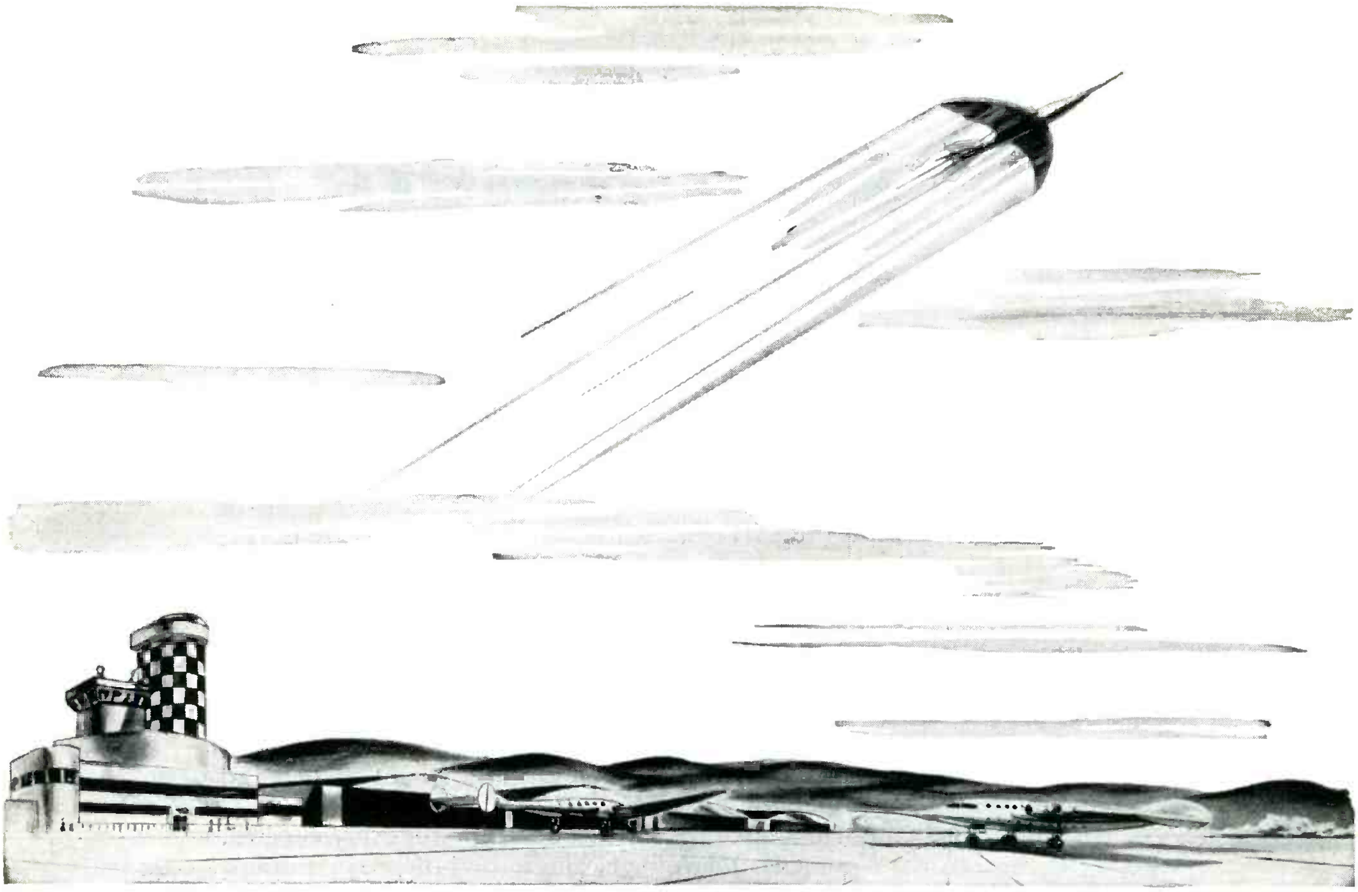
YOU CAN BE SURE.. IF IT'S
Westinghouse

INSTRUMENTS



from sea level to substratosphere . . .

VARGLAS SILICONE

Electrical Insulating Tubing and Sleeving

WITHSTANDS TEMPERATURES FROM 500° TO —85°F

VARGLAS SILICONE is a high dielectric, dimensionally stable insulating material developed by Varflex during World War II to assure dependable performance in the drastic temperatures aircraft might encounter from sea level to substratosphere. Today, Varglas Silicone serves industry in many of the tough insulating jobs that defeat ordinary insulators. A combination of *Varglas* (continuous filament Fiberglas) and *Silicone High Temperature* Resin, Varglas Silicone is the first and only Class H insulation with these features:

EFFICIENT AT 500°F. — flexible at —85°F.

MOISTURE AND FUNGUS-RESISTANT — has excellent resistance to moisture and fungus.

FIRE-RESISTANT — flame resistant and self-extinguishing.

ABRASION-RESISTANT — pliable and non-fraying.

DIELECTRICALLY STRONG — average readings up to 7,000 volts.

Available in various NEMA colors in several types and grades of tubing and sleeving — lead wire and tying cord, too.

Varflex
CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

VARFLEX *Sales Co., Inc.*
308 N. Jay St., Rome, N. Y.

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PLASTICS MOLDINGS

Large OR Small!

Every one of the plastics parts shown—from the 33-inch circular filter plate to the tiny part in the man's hand—was molded by The Richardson Company to solve a *special* problem.

For each of these parts, Richardson engineers developed a *new material*, a plastic with just the right combination of physical, electrical, and chemical properties to do the job. In several cases, the material had been considered "impossible" to produce before Richardson plastics engineers applied their broad experience and skill to the problem.

The Richardson Company stands ready to help *you* with this specialized plastics service. With its six plants, Richardson is one of the world's largest molders of plastics. Its extensive facilities are admirably geared for volume production of standard or special plastics parts—large or small.

Write for full information, today.

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

2797 Lake Street, Melrose Park, Illinois (Chicago District)

INSUROK®
Molded and Laminated Plastics

Only Richardson offers you this SPECIALIZED PLASTICS SERVICE

1 ***DEVELOPMENT OF SPECIAL PLASTICS MATERIALS***

Richardson has the personnel and complete laboratory equipment for developing new plastics — including combinations of resin, rubber, etc.—for special applications.

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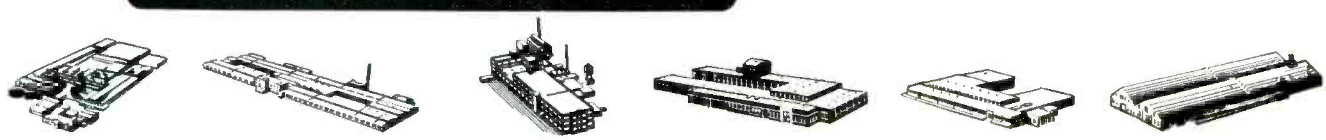
Richardson handles your problem from beginning to end—analyzes requirements; designs for appearance, performance, low cost; and develops the proper tools for quality and efficient production.

3 ***FACILITIES FOR SPECIAL MOLDING OR LAMINATING***

Richardson can select just the right production method for your special plastics part, because they use *all* methods—including molding, laminating, fabricating, post-forming, and laminate-molding.



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2,600 TO 90,000 Mc/s

It is now possible to obtain standard components from the new DeMornay-Bonardi line of Microwave System Components and Laboratory Instruments, in every frequency band, to provide a solution to the most exacting and diversified "plumbing" requirements. Mechanical design and construction of this equipment insures maximum accuracy and reliability of measurement by elimination of errors normally caused by backlash, mechanical wear, friction and temperature variations.

Electrical design provides for uniformly efficient operation over the entire band of frequencies allocated to each waveguide size, and re-settability characteristics are consistently accurate at all times.

All instruments and components are available in the following Waveguide sizes:
RG-48/U; 49/U; 50/U; 51/U; 52/U; 91/U; 53/U; 96/U; 97/U; 98/U and 99/U.

- Absorbing material is a thin metallic layer vacuum evaporated on mica.
- Two position control knob for fast positioning and vernier adjustment.
- Three point leveling adjustment.
- Kinematic design assures consistent re-settability.
- A calibration curve is supplied with each instrument giving attenuation in db versus dial reading.

SPECIFICATIONS

Frequency range	8,200 to 12,400 Mc/s
Overall length	14"
Coupling	Broad band
Tubing dim.	1"x½"x.050"
Maximum attenuation	40 db
Insertion loss	Less than .5 db
Accuracy of calibration	–.5 db to 10 db –1.0 db to 20 db –1.5 db to 40 db
Plating	Gold 50 m.s.i.
Approximate wt.	10 Lbs.

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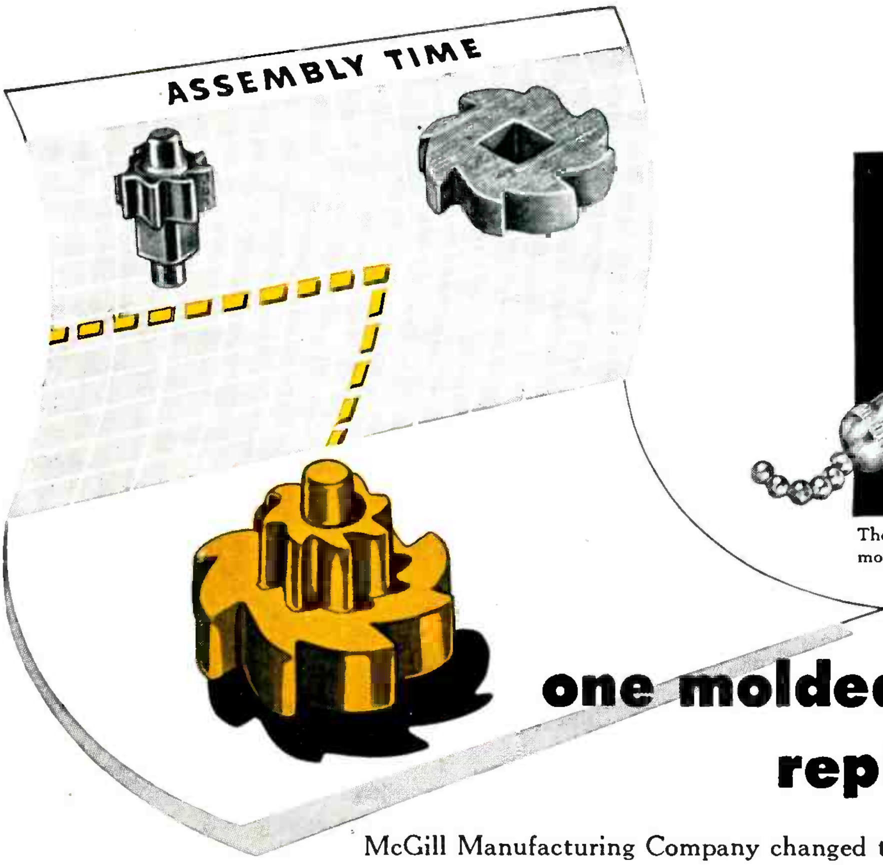
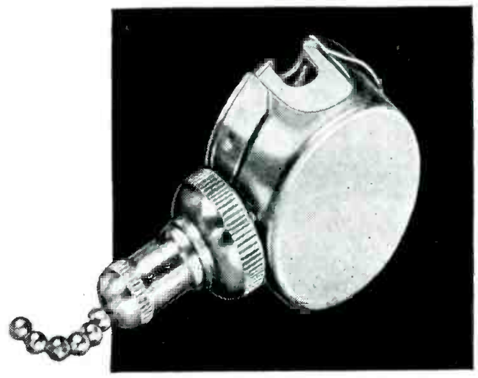


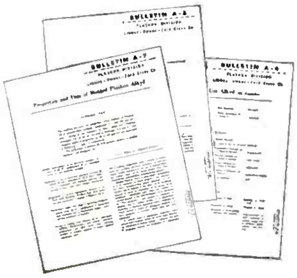


The LEVOLIER lighting switch ratchet is molded of Plaskon Alkyd by Tietz & Baur Plastics, Inc., Melrose Park, Illinois.

one molded piece replaces two!

McGill Manufacturing Company changed to Plaskon Alkyd Molding Compound for contact ratchets in its Levolier Switches — with these surprising results: One molded piece replaced two — no assembly was required! And the exceptional arc-resisting and non-tracking electrical properties of molded Plaskon Alkyd produced a better performing, longer-lasting one-piece ratchet. The most popular type Levolier switch using this ratchet is backed by an unconditional guarantee. It passes Underwriters' tests of a minimum of 24,000 operations carrying maximum electrical load and 100 operations carrying 50% overload!

Many other inherent properties of Plaskon Alkyd are helping to improve a constantly increasing variety of products. And faster production is achieved at lower cost in practically every application — thanks to the high-speed of compression molding with this amazing thermosetting plastic which cures in seconds instead of minutes.



Let us send you data on all of the desirable properties of Plaskon Alkyd — and the complete explanation of why many electrical insulating parts can be compression molded faster at less cost with Plaskon Alkyd.

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Manufacturers of Molding Compounds, Resin Glues, Coating Resins

BUSINESS BRIEFS

By W. W. MacDONALD

Sixty-Four Percent of the total military bookings of the electronics and x-ray division of Westinghouse were subcontracted during 1950. Subcontracts ranged all the way from a $62 order for brass caps that went to Hamilton Associates to a $2,938,488 order for radar antennas given to Dalmo-Victor.

The Westinghouse division mentioned sold $400,000,000 worth of radar and other electronic equipment to the armed forces during World War II.

TV Shipments to dealers in the first quarter of 1951 totalled 1,814,767, according to RTMA.

Registration at the 7th Annual Pacific Electronic Exhibit and Western IRE Convention to be held in San Francisco August 22, 23 and 24 is expected to reach 9,000, according to exhibit committee chairman Al Fry.

Fry says there will be 165 exhibit booths, showing the products of about 300 makers of electronic and nucleonic components and equipment. At press time a partial list of exhibitors indicated that there were 94 manufacturers, 22 reps exhibiting the products of 168 manufacturers, three universities and four government agencies.

Philadelphia's Chamber Of Commerce has set up permanent exhibit space at 1413 Walnut, where the armed forces and local defense-equipment contractors display new gear made for the military every two weeks. Object is to familiarize other manufacturers in the area with military requirements and so stimulate subcontracting.

Out of a similar effort by the San Francisco Chamber of Commerce has come the formation of Bay Area Electronic Resources, an organization in which 15 manufacturers of electronic equipment are members. Sargent-Rayment, Commercial Electronics, E. R. Vinson, Applied Electronics, H-K Division of Robert Dollar, Clayton F. Bane, Ampex, Electronic Engineering Associates, Huggins, Birdsell, Thor Transformer, Kaar Engineering, Lenkurt, Imperial Television and K-F Development offer their services jointly or individually for the performance of defense contracts.

Business Forecast: "I believe that by the end of 1952, the combined civilian and military production of electronic equipment by our industry will be at the rate of 4½ billion dollars a year. From the standpoint of facilities and manpower, this will be equivalent to an industry production of 3¼ billion dollars of civilian electronic equipment, which is a very substantial expansion in facilities even from recent production records."—*Robert C. Sprague, Chairman of the Board, RTMA.*

Brazil had 10,500 television receivers in use at the close of 1950. Two transmitters were in active operation, one in Rio de Janeiro and the other in Sao Paulo. Two more are scheduled for erection in 1951.

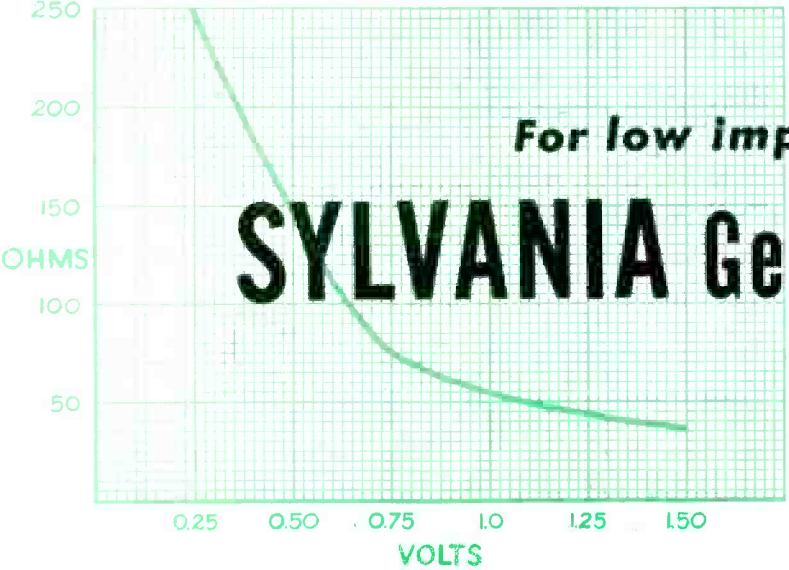
Book entitled *Industrial Research Laboratories of the United States* (see *New Books*, June, ELECTRONICS) lists 2,845, of which 350 are active in the field of electronics. Their interest in various projects within the field is indicated by the following tabulation:

Acoustics	51
Antennas	16
Coatings, protective	73
Control devices	94
Dielectric	14
Capacitors	19
Circuits, printed	6
Facsimile	9
Gamma rays	2
Geophysics	47
Germanium	3
Getters	2
Hearing devices	5
High-freq. phenomena	22
Instruments	184
Insulation, electrical	37
Isotopes	4
Liquid control devices	7
Luminescence	16
Magnetic devices	26
Measuring devices	19
Meters	15
Microwaves	13
Navigational apparatus	15
Nuclear physics	13

(Continued on p 78)

For low impedance applications...

SYLVANIA Germanium Diodes



Typical 1N56 Resistance Characteristic

1N56 DIODE with a potential of +1 volt will pass a current of 15 ma. or more. With a potential of −30 volts, less than 300 μa. will flow.

For Carrier Communications

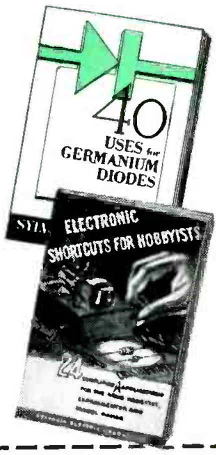
1N71 VARISTOR—The 1N71 consists of 4 matched low impedance diodes each of which, with +1 volt impressed, will pass a current within one ma. of the average current of the four.

All Germanium Diodes are notable for their low forward impedance. But the 1N56 is specially engineered to make the most of this quality.

Use this diode for high efficiency circuits with low input and output impedances. Use it for relay activation, heavy current and surge applications with low impedance coils, transformers and condensers.

Try the 1N71 varistor in carrier telegraphy and telephony work. The low shunt capacitance insures high efficiency throughout the high frequency range. You will find this varistor equally efficient in low impedance modulator circuits of the carrier suppression or carrier transmission type.

Both the 1N56 Germanium Diode and 1N71 Varistor are available from your Sylvania Distributor. Ask him for copies of the two books shown below. Price of each is only 25¢, together they comprise the most complete collection of Germanium Diode applications yet published.



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☐ *Please send me "40 Uses for Germanium Diodes." Enclosed is 25¢*

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SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 FIVE DECADES OF PROGRESS 50th ANNIVERSARY

SYLVANIA

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Visit us at Booths 401-402—Pacific Electronic Exhibit

Oscilloscopes	12
Photoelectricity	9
Physics	33
Piezoelectricity	7
Pressure control	23
Radar	22
Radiation	19
Radio	67
Radioactivity	15
Radiography	5
Recording, sound	24
Rectifiers	13
Relays	9
Resistors	18
Servomechanisms	24
Signaling devices	7
Soldering	10
Sound and noise	28
Spectrography & spectroscopy	21
Spectrometry	4
Spectrophotometry	10
Telegraphy	7
Telemetering	1
Telephony	8
Television	43
Temperature control	33
Transducers	11
Vacuum tubes	35
Vacuum technique	18
Varnishes, insulating	57
Voltage regulators	10
Wire	19
X-Rays	25

Receiver Sales by licensees for the first quarter of 1951 totalled 5,227,834, worth $486,245,840. Here's the way the total broke down:

Type	Units	Dollars
Electric		
Table (Under $12.50 billing price)	430,415	$4,239,979
Table (over $12.50 billing price)		
A-M	1,169,840	20,160,302
A-M/F-M	131,346	3,996,623
F-M (including converters)	4,550	85,022
Consoles		
A-M	7,158	161,221
A-M/F-M	4,739	560,406
Table-Radio-Phonos		
A-M	109,860	5,101,357
A-M/F-M	5,566	566,213
Console-Radio-Phonos		
A-M	21,987	2,238,769
A-M/F-M	159,989	19,925,864
Battery		
Portable A-C/D-C	291,808	5,521,916
Table	13,842	299,125
Consoles	......	......
Auto	721,989	21,504,400
Television		
Converters	914	144,409
Table Models	693,789	108,608,799
Consoles		
Direct-Viewing	1,083,742	229,454,471
Projection	861	225,341
Radio Phonos		
Direct-Viewing	186,175	56,559,5[illegible]1
Projection	12	5,149
Phonographs		
Phono only	159,465	3,297,290
With radio attachment	2,846	70,801
Without Cabinets		
A-M	1,393	89,453
A-M/F-M	1,427	178,008
Television	24,121	3,251,411

Chicago Parts Show was particularly successful in that it attracted top brass from the country's leading distributing organizations, including many who stayed away last year and the year before for political reasons.

To get into the Show you had to prove you *were* a legitimate distributor or rep, and we mean *prove*. Most exhibitors liked this rigidity, which held down overall attendance a little but confined it to quantity buyers. A few said they wouldn't have minded talking to some people from manufacturing plants, amateurs and servicemen just to keep their hand in.

Show hours were from 10 a.m. to 6 p.m. on all three days, which gave upstairs room exhibits a lively play. For our particular newshawking purposes the hours seemed a little short.

Manpower Pinch is being felt at Wright-Patterson Field as well as in industry.

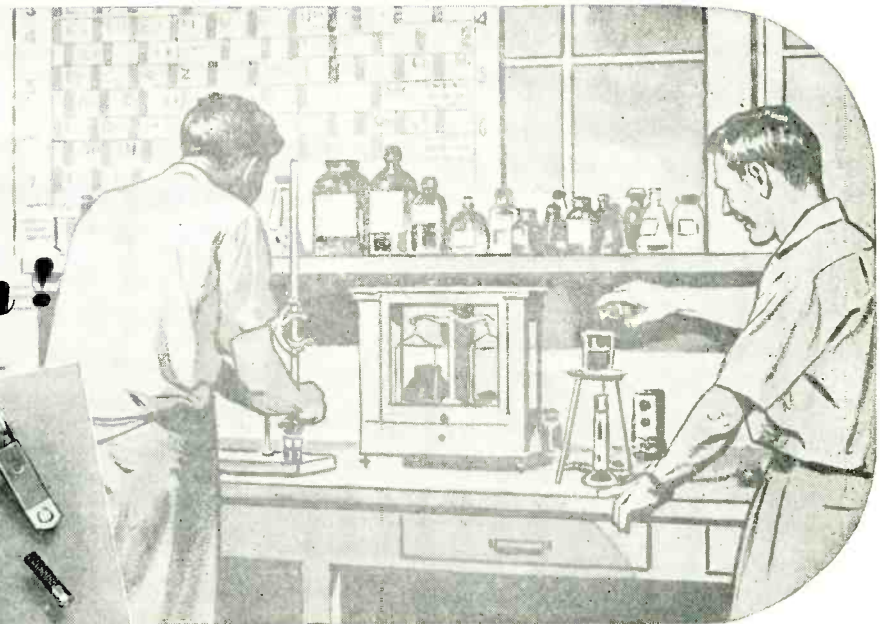
The civilian personnel division has approximately 100 types of engineering, scientific and technical positions open and considered critical, plus about 40 other types of jobs proving very hard indeed to fill.

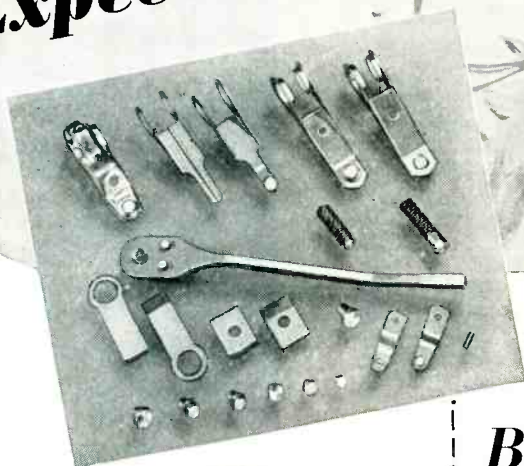
Among the types of jobs offered: Electronic engineers specializing in instrumentation, radio, wire communications and testing; General electronic scientists and specialists in instrumentation, microwave communications and tubes; Maintenance technicians specializing in electronics; Air technical intelligence specialists in bombing systems, electronics, electronuclear systems, aircraft instrument and navigation systems and electron physics; Engineering aides for electronics.

Unemployment in the television receiver manufacturing business was well over 50,000 in June, according to Robert C. Tait, president of Stromberg-Carlson and a spokesman for RTMA. Inventories were at an all-time high at 500,000 sets, with 25 carried in inventory for every one sold as against one in inventory for every set sold in the first five months of 1950.

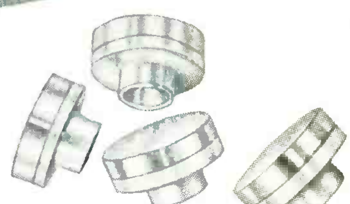
A Laboratory engaged in precision work discovered an excellent source of soft, lint-free cloth to be used in a cleaning process prior to evacuation and sealing. Later, it took some explaining to convince the Navy accountant that he should ok a bill for "one bale of diapers."

Value Beyond Expectation!





Mallory Contact Finish
Brings Laboratory Standards To Production Operations



MALLORY TUNGSTEN CONTACTS

Although all Mallory tungsten is chemically the same, the size, shape and distribution of the grain particles are carefully controlled, since these factors vitally affect its electrical and mechanical properties. Mallory will gladly work with you to find the right contacts to meet your specifications. Write today.

The Mallory "E-Treat" finish is one of the many ways in which Mallory metallurgical developments are improving performance and reducing costs of electrical contacts.

A typical example is the real help provided by Mallory for a manufacturer of automotive equipment who faced the problem of excessive failures of tungsten contacts. The application involved a critically heavy electrical load with light contact pressure. Mallory contacts with "E-Treat" finish . . . a chemically pure, highly polished face . . . were tested and enthusiastically approved. The "E-Treat" finish afforded lower contact resistance and less material transfer . . . tripled the minimum contact life. What is more, the Mallory contacts *cost less* than those formerly used!

That's value beyond expectation!

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you!

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

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Contacts *Special Metals*
Welding Materials

CROSS TALK

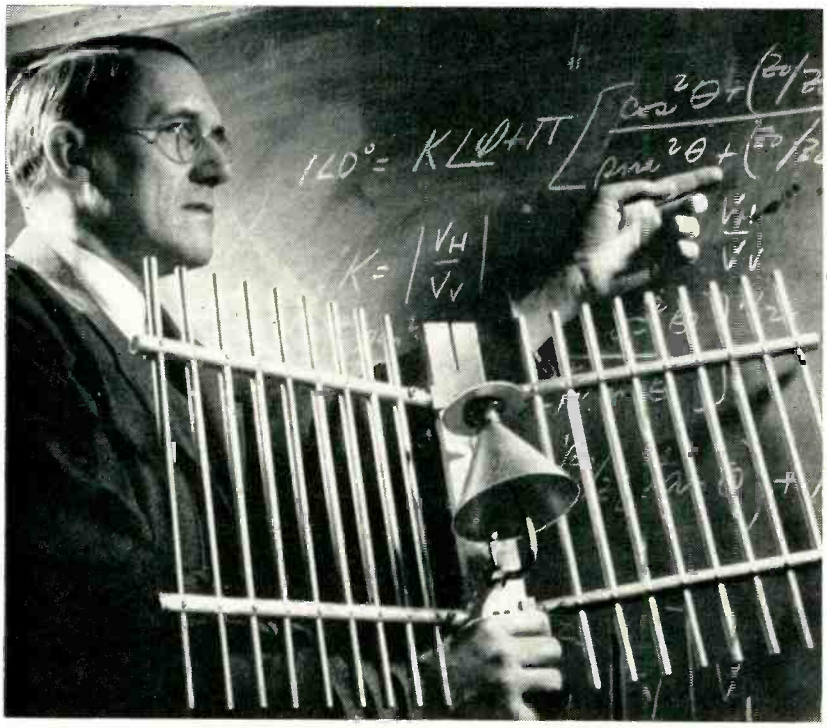
▶ **ASIA** . . . The current debate on our foreign policy in Asia emphasizes our need to support our friends in that part of the world. One such opportunity will appear in February next year, when the International Radio and Electronics Exhibition (IREE) of India will take place. We sometimes forget that there are a billion people in Asia who enjoy virtually none of the benefits of electronic science, people whose leaders are well aware of these benefits and their social and political implications. Concerned as we are with our domestic market, with its shortage of unassembled components and its oversupply of assembled television sets, we should not lose sight of the great opportunity, for service as well as profit, in the Far East. We hope that our industry will be well represented at the Indian exhibition.

▶ **AETAT** . . . Dr. Walter Schottky, to whom we owe much of our early knowledge of electron emission and the behavior of vacuum tubes, was 65 on July 23rd. When notice of this even came to our attention, we were reminded that electronics is a young man's game, even as it starts its second half century. The 25th anniversary of IRE in Canada was celebrated in Toronto only last month, as was the same anniversary of the founding of the Detroit Section.

Marconi would have been 77 this year if he had lived. Many of his contemporaries have achieved three score and ten years and are still with us: Alexanderson (73) Langmuir (70), Zenneck (80), Lynde Wheeler (76), G. W. Pierce (79), Donald McNicol (75), DeForest (77), Hoyt Taylor (72). With Schottky in the three-score bracket are many other illustrious founders of our science: Armstrong (60), T. L. Eckersley (64), Hazeltine (64), Heising (62), Van der Pol (62) and Zworykin (61). To Dr. Schottky and his colleagues, our felicitations!

▶ **STAGES** . . . One of KGGF's engineers recently took a long look at their 10-kw transmitter at Coffeyville, Kansas, contemplating what manner of gadget it was. He found that said transmitter employs 51 tubes, a quartz crystal, several germanium diodes, in 47 separate a-f and r-f stages, and that the signal undergoes 14 changes in frequency from microphone to antenna. The ratio works out to be about three tubes per frequency change, which we hereby christen the "Gillette factor" after the engineer in question. In receivers, things happen more quickly, three frequency changes (r-f, i-f, a-f) in as few as four tubes. All of which sets us to wondering how many tubes and frequency changes are involved in transmitting a television image from a camera in a New York studio to a receiver picture tube in St. Louis, Missouri. The first reader who sends us a reasonable answer, backed up with full evidence, will have his subscription to this journal extended for a three-year term. The second reader so doing is out of luck. This offer expires September 30, 1951.

DEFENSE DEPARTMENT



Equipment of tomorrow frequently depends upon today's basic research

DO YOU NEED TO KNOW . . .

What the short and long-term prospects are for you personally in basic research?

What is ahead for your company or college in the way of military research contracts?

What types of projects are most likely to receive Defense Department support?

What kind of coordination the Services are apt to arrange between similar projects?

This Article May Provide the Answers

The ARMY

By HAROLD A. ZAHL

Director of Research
Signal Corps Engineering Laboratories
Fort Monmouth, N. J.

WITH THE CLOSE of World War II, there followed a rapid dispersal of the greatest collection of scientific manpower ever mobilized against a single objective. The nation was all-out for defense, but technologically this inferred applied research, engineering, production, training, and combat. Ironically, with almost total mobilization of the nation's scientists and engineers, basic research was neglected in the rush to quickly make weapons using the science of the day. In retrospect, we see that had the war extended over a substantially greater period of time, the absence of basic research as part of our defense plan might well have been disastrous.

Following the close of the war, numerous reports prepared by such notables as Vannevar Bush, John R. Steelman, and others, strongly urged that intensive basic research be considered as our principal bulwark for long-term defense, and that a National Science Foundation be established immediately to augment the military effort and further carry research into areas where military interests, ostensibly at least, appeared more remote. Legislative delays in establishing the Foundation resulted in the military services, and later also the Atomic Energy Commission, contributing the major portion of the funds and many of the facilities for the country's post-war basic research program. Through this effort, combined with that of private support, basic research within the U. S. reached an all-time high in 1950. Many results of this research have already been put to use in our weapons program and also in strictly civilian interests.

In the aftermath of the President's declaration on December 16th of a state of national emergency, and in the following rearmament rush, there appeared some signs suggesting that basic research within the U. S. might in part at least be forced to yield to the exigencies of the emergency. In reaction to this general feeling, the Department of Defense has taken the position that while production must be accelerated and development activities greatly increased, it is also imperative that basic research continue apace, since by the time-scale on which the present emergency and possible all-out conflict appears to be plotted, basic research and success therein may well be necessary to our very survival. Implementing this policy, each Service has agreed separately to support basic research by a percentage of its research and development budget; and further, should the present international tension

PLANS for Basic Research

Mobilization requirements have speeded up applied research, development and production engineering to meet current military electronic needs. To many it appears that this rules out expansion of basic research and even involves curtailment of existing projects. Such is not the case, however, according to spokesmen for all three branches of our armed forces

ease and permit a reduction in military expenditures, then a fixed minimum will still be maintained for continuity and stability. This broad agreement will again be reviewed in three years from the present.

Manpower Policy

Obviously, during the initial phases of the present emergency, there must be a considerable reshuffling of technological personnel within industry, institutions of learning and government laboratories. Full-scale war would naturally impose still greater changes. Even now, however, it is a serious fact that industry is desperately in need of high-caliber personnel for development and engineering work on defense orders, while government laboratories with almost equal vigor are reaching for similarly qualified men.

Paradoxical to the apparent manpower shortage, because of greatly reduced enrollments due to direct military demands for young men, there exists in the staffs of our universities an increasing number of high-caliber technical men who apparently will be forced to make adjustments due to reduced university budgets. Many of these scientists and engineers will, of necessity or through the magnetism of higher remuneration or personal desire to contribute more directly to the cause of the emergency, yield to the call for work in industry or government. In many instances such shifts represent a direct or potential loss of basic research workers. That some such personnel changes occur, however, is required as the nation girds itself for defense; in fact, is absolutely necessary for quick and intelligent rearmament where technology and production are our strongest weapons. Still, with the university being the traditional home of basic research, such turnovers in manpower must be watched with caution, lest they become so great as to seriously threaten our major means for keeping truly creative effort at a level consistent with a long-term emergency. Even more important on a long-term basis, if the educational structure of our schools becomes too weakened a prolonged crisis would confront us with a grave shortage of scientists and eventually even a loss of the system which produces them. This in effect would, in less than a generation, precipitate a national catastrophe of the first order.

Selection of Projects

Recognizing that strong forces do exist, pulling many individuals with outstanding research reputations into the generally more remunerative applied fields, it must also be admitted that a reasonable number of private and government dollars still appear to be going into basic research. Hidden in this situation, however, is the danger that basic research, while admittedly important, is never urgent, and in the rush many of us too easily shift our thinking toward the urgent and accept the dollar statement as satisfactory, without the realization that unless the vast military-supported program is watched with great care there may be a considerable proportion of technical mediocrity eventually supported, instead of research capable of adding real and significant contributions to our fund of knowledge. We shall never win a war or hold our own technically in an indefinitely long emergency solely on the number of reports delivered to a contracting officer and added to a collection. To truly remain technologically ahead of our potential enemies research must produce and hold world leadership in our scientific knowledge, which at the same time must also be geared to the direct military effort, for the criterion of research success, in a military sense, lies in the performance of military weapons in the hands of our troops.

The above leads to the obvious fact that the problem of the military services effectively contributing toward and maintaining a basic research program is not solved merely by the availability or expenditure of dollars. While there are many volunteers for basic research, those obviously deserving of unquestioned support, together with full freedom for their creative effort, are unfortunately very small. Thus the question arises—by what ground rules does one determine whose efforts should be supported with the military dollar? Many of those who wish to participate in the

DEFINITION

BASIC RESEARCH, as defined by the Research and Development Board, refers to theoretical or experimental studies directed toward the increase of knowledge, either by advance into unknown areas or by detailed filling-in of areas whose general boundaries are already known. Immediate practical application is not necessarily a direct objective of the investigation program on a relatively undirected basis without change of their peacetime environments would actually require guidance in order to make their efforts effective. For the government to militarily gain in a direct sense from a program substantially more geographically diversified than today's widespread contractual effort, with its host of attendant administrative and technical coordination problems, would also require a proportionate increase in top-notch scientists diverted to assure program coordination, absence of undesirable duplication, and concurrent application studies. Coordination is further complicated in that, while basic research as such is generally considered unclassified, once important findings are made classification almost invariably follows, regardless of the volumes written on the desirability of a free interchange of information.

Choice of Facilities

It would appear that the present situation in regards to military support of basic research calls more for expanding proven existing research centers, both externally and in military laboratories, rather than for further decentralization. This trend is already being felt and will undoubtedly continue toward establishment of numerous scientific groups of substantial size under direct Service sponsorship, largely in universities, for concentrated effort of direct military interest. Highly qualified individuals are now needed to help organize, join, or assist groups in translating the results arising from these more concentrated approaches into weapons. While within such laboratories direct military interests must of necessity be emphasized, considerable opportunity will also exist for work on basic problems related to the applied aspects of the group's technical assignment.

In the physical sciences, a number of such laboratories under joint Service sponsorship are already functioning; some since 1946—for example, at Harvard, Princeton, Columbia, Stanford, Massachusetts Institute of Technology, Bell Telephone Laboratories and the General Electric Company, while at the time of this writing others are in varying stages of planning or negotiation.

Long-Term Objective

It must be noted, however, that while establishment of larger units and team play of necessity appears to be today's organizational trend, it is also true that individuals whose previous background indicates outstanding qualifications for lone effort, or effort with a small assisting group, should be privately supported or, if private support is not available, should be supported by the military. Equally important, such persons must be further encouraged by allowing them to continue their work on geographical coordinates of their own choosing, for success in basic research begins with the choice of the individual and not necessarily by regimenting all research personnel into million-dollar facilities.

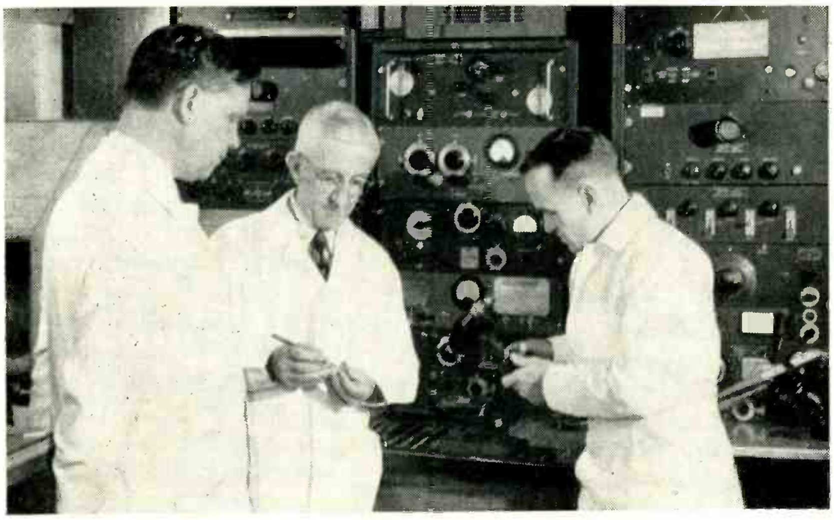
The Signal Corps, with its major development interest in electronics, fed from basic and applied research within the field of the physical sciences—in addition to substantial contractual participation — plans continuance of a basic and particularly a strong applied research effort within its own laboratories to supplement the fast-moving development and engineering program which naturally constitutes its principal laboratory effort. This internal research program carries a threefold objective: first, while it is hoped such effort may lead to discoveries vital to the military effort, as a guaranteed by-product, it is certain to assist in maintaining the scientific environment necessary for leadership in the field of electronics; second, to maintain a corps of specialists available in an advisory capacity to development engineers working on new or improved equipments; and third, to stand ready as a highly trained technological reserve for the possible eventuality, when all existing facilities capable of assisting must be directed toward the solution of intricate problems thrown back from combat areas for immediate solution.

In all the above, a strong stand has been taken in support of continuing a steady level of truly basic research during the emergency, or in fact even during total mobilization or major combat should such be thrust upon us. However, it is only through the orderly superposition of applied research, development and production that new military weapons can be born and made available in time to troops. The intricacies pertaining to the interrelationship between elements of the scientific-engineering-military team structure, further, make it imperative that everyone in the chain appreciate the contributions of the others. Applied research, development and particularly production have long occupied pedestals of distinction in the minds of those charged with military planning. For basic research, it may be said that never before in our history has a better understanding and greater appreciation of its importance existed than now. In spite of apparent vicissitudes born through the early rushes of the emergency, it is still felt that the conditions remain for keeping a vigorous program underway, and as we move into the uncertainties of the future, the Department of the Army, in its contributions to the national defense, does not intend to lower its long-range technical sights.

The NAVY

By E. R. PIORE
Deputy Chief and Chief Scientist
Office of Naval Research
Washington, D. C.

THE HONORABLE Dan A. Kimball, Under Secretary of the Navy, and Commissioner Gordon Dean, Chairman of the Atomic Energy Commission, issued a joint statement on December 15, 1950, which read in part: "One very essential condition for maintaining our national strength, whether for peace



Checking growth of crystals at Squier Signal Laboratory

or for war, is that research in the sciences, which is basic to all technological progress, be kept at a high level." This is a broad statement of the Navy policy in regard to basic research during this period of increased military effort to improve the readiness of our forces in the field.

The Office of Naval Research, after very careful thought, has taken the following action to implement the policy stated above:

(a) It is continuing the basic research program at the same annual fiscal level that the program enjoyed prior to the recent increase in military appropriations.

(b) At the same time, ONR has increased the average life of contracts for research.

It is hoped that these procedures will give stability to the basic research program and some assurance to scientists and engineers during this period of uncertainty and rapid expansion of the military technical effort in the country.

Basic Research Problems

The policy, and its implementation, is due to the expanded demand for technical people occasioned by the procurement program initiated by the military services, and the additional sums of money available for research and development. A large production effort in military equipment always reflects itself in an increased demand on development facilities and engineering manpower. It is felt that this demand for manpower should not come initially from those engaged in basic research. This group, although small, is highly competent and imaginative. It is the hope that, pursuing the policy stated above, this small group could be kept initially as a reserve—scientific shock troops. The policy is an attempt to introduce some countermeasure, however small, to the potential flow of all technical manpower to development of new weapons. We are not prepared at this time to commit all our technical reserves in ideas and manpower to weapons and weapons systems. It is desirable that the transition from basic research to development of weapons be gradual and thoughtful, and that the rate of this transition be determined by the character of present and future military needs.

Actually, at present, there is a drift in university, industrial, and governmental laboratories from basic research to the study of more urgent military problems. ONR obviously is involved in this drift by making funds available and by indicating the existence of very urgent unsolved problems. We are calling on our reserves to some extent, but only after a very careful examination of the areas that need attention and the talents of the people that can make an important and vital contribution to those technical and military areas. This is always done in consultation with the engineers and scientists involved. It is necessary to assure ourselves that the problems being tackled have a high probability of successful solution—in a technical and military sense—in a comparatively short time.

Study-Group Approach

One finds at this time that the major effort among those groups which in the past have been engaged in basic research is on analysis and study of technical areas and needs in the military services, thus determining the new and additional problems in applied research and development that should be undertaken now in our laboratories throughout the country. In other words, the emphasis is on studying the situation rather than on setting up large laboratories, such as the Radiation Laboratory at MIT during the last war. ONR is encouraging this approach. It may insure the proper and intelligent use of our reserves. In addition, it commits our reserves for a limited period of time—for the duration of a study. We are in a period of identifying technical problems in the military setting, and engineers and scientists are familiarizing and identifying themselves with these problems. The state of readiness for an intensified emergency is being improved.

When the studies have been concluded and the validity of the results determined, it becomes necessary to examine the recommendations and to ascertain how large a load can be carried in the existing laboratories and research and development facilities. If the laboratories and research and development facilities are inadequate, an assessment must be made relative to expanding the facilities and adding new manpower to them on the one hand, or establishing new facilities and organizing new teams. Then additional manpower may have to be drawn from those groups that are engaged in basic research. Actually, certain critical technical areas have already been found that require at this time the establishment of new groups so that our military effectiveness can be increased in those areas at the earliest possible date.

In summary, the Office of Naval Research has been trying to maintain its program of basic research, superimposing on it study groups and, when necessary, intensifying work in certain applied and development areas. At this time an attempt is being made to keep to a minimum disrupting influences on basic research.

How does electronics, an engineering field, live in terms of this brief and general summary? For a moment we might as well forget the definition of electronics—the editors of ELECTRONICS solve this problem daily—and look at the more troublesome problem of basic research in an engineering field.

Broad Electronic Needs

Normally one looks to the sciences for basic research and to engineering for the application of this information. The transistor came from scientists who were concerned with the solid state, rather than from those who were trained in electronics. However, one can rightly argue that the future of the transistor, as an important component in electronic systems, depends on basic and fundamental investigation from the engineering rather than from the scientific point of view. The control of various parameters that make the transistor an important electronic device may not have a profound effect on the theory of the solid state.

Another example of basic research in electronic engineering is the current activity in the statistical theory of communication, analyzing the problem in the time domain. Still another is continued investigations of the interaction of electron beams with themselves and the electromagnetic field—exemplified by the traveling-wave-tube type of research.

Basic research in electronic engineering is a fundamental and philosophical approach to a problem with the goal of controlling nature in a reproducible manner, as contrasted to basic research in science where the interest is in a more profound understanding of the external world. In presenting an argument for the retention of some manpower for basic research, it is necessary that these engineering problems have a broad and revolutionary impact on some aspects of art.

Nature of Current Work

The three examples are cited to indicate that basic research is to be found in engineering as well as in the scientific fields. At this time it does not appear that new functions for electronic systems in warfare, such as radar, which saw its baptism of fire in the last war, will be found. But unless we maintain a strong basic research program in electronics, the improvements in existing electronic warfare systems will be marginal, accompanied by an ever-increasing number of components, tubes, and knobs, usually with a reduction in overall reliability of the system. We are looking to those areas that will permit us to modify radically the character of the system so that its utility on the battlefield can be increased. Automotive power, the automobile, was used in 1914-1917 and yet the Jeep in the last war had a profound effect on the maner in which the war was fought.

To be a bit more explicit, in a certain sense the single factor that imposes a severe limitation on greater exploitation of electronic equipments is lack of reliability. The solution may come, not from the direct-development approach to increase the reliability of each component, but rather from the introduction of redundancy into the components of the systems in a premeditated fashion. Further analysis may show that many components are vestigial, and that other components are obsolescent.

A more general, venturesome statement can be made to the effect that within the next few years profound changes may be seen in the design and application of electronic systems. The backbone of these changes is the current work in progress in basic and fundamental engineering investigations in various laboratories. Some of the laboratories are managed by industry, others by government, and still others by academic institutions. Already there are results that need further development to be incorporated into the military system.

It is well to point out that in the last war we had and maintained electronic superiority on all battlefronts and in all types of operations. This very important advantage we may not be able to maintain. If perchance we lose it, one available way to regain this advantage is to have a reserve in being—a reserve not only of brainpower but also of fundamental ideas on which the brainpower can draw.

With the large post-war expansion in academic, industrial, and governmental research and development facilities and activities, one may ask why we are already facing the problem of committing our reserve. The answer is simple. The expansion mentioned above kept pace with the expansion of the national income. The new defense effort is expanding our economy. This imposes an additional load on our research and development manpower and facilities.

The AIR FORCE

By J. W. MARCHETTI

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Air Force Cambridge Laboratories
Cambridge, Mass.

THE AIR FORCE as an organization is a relative newcomer to the field of basic research. During the years of World War II, it leaned heavily on Office of Scientific Research and Development organizations for getting its research done, particularly in the field of electronics. During the past five years, however, we have had to develop a certain maturity in this field.

The signs are very clear that this maturity is indeed being realized. Only recently a new command has been set up called the Research and Development Command. The organizational level of this command is an indication of the seriousness attached to its technical problems by the Air Force. Although the new command will carry the primary responsibility for equipments needed by our fighting airmen, it will also be vitally interested in basic or background research. Just as industrial concerns have found that aggressive research departments are their best guarantee of solvency in periods five to ten years ahead, so also do we realize that the outcome of future wars may well be determined by the quality and quantity of basic research efforts during years of peace.

Distribution of Contracts

The distribution of basic research in electronics depends on the location of personnel best fitted to carry on that research. College laboratories are the major recipients of basic research support and usually such support is on an unclassified basis. Industrial laboratories occasionally handle our basic research problems, but only in those instances where the particular skills desired happen to obtain in men having industrial affiliations. Service laboratories are mainly dedicated to applied research and development engineering. The Air Force Cambridge Research Laboratory is an example of a laboratory dedicated entirely to research in the fields of electronics and geophysics. At this laboratory, no development work is done. Models are built on an experimental basis or theoretical analyses of problems conducted. The choice between theoretical or experimental approach depends for the most part on suitability to the problem at hand. The typical output of this Service laboratory is a report telling how a certain job might be done and, perhaps, some experimental gear on which proofs of performance and measurements can be made. The research output of a Service laboratory such as this may require considerable engineering before a useful end item is ready for use. This additional engineering is done either by another Service laboratory or industry.

Future Military Needs

Military operations are becoming more and more a pitting of scientific skill against scientific skill. Under such conditions, the easy-to-do technical things are quickly put to the test of battle and further progress in weapons can only be made by increasing our store of basic knowledge. In the present emergency, one might suppose the urgency of immediate equipments would relegate to the background any efforts on basic research. We do not intend to follow any such pattern, but will continue the support of basic things regardless of any emergency that may obtain. Experience has shown that both basic and applied work need one another's mutual stimulus, and striking a happy balance between these two is as important as striking the balance between theory and experiment.

One might wonder just how the line is drawn between basic research to be supported and research that should not be supported. There is little knowledge of a scientific nature which in time of war has no military application. Practically all knowledge can be used in one way or another in a battle and the support thereof. Drawing the line is a serious Service responsibility. A decision must be made on the basis of potential usefulness, cost, likelihood of success, capability of the manpower available, and need for security. It is not our intent to draw this line so tightly that due to lack of breadth and scope of research we will be unable to do our job well. Nor can the Service draw the line so loosely that it will be criticized for getting into fields of endeavor that are beyond its interest or, in fact, interfering with the interests of others. In making decisions on research we will operate quite similarly to a progressive business organization in which the profit motive has been replaced by the motive of contributing to the national security by assuring a strong air arm.

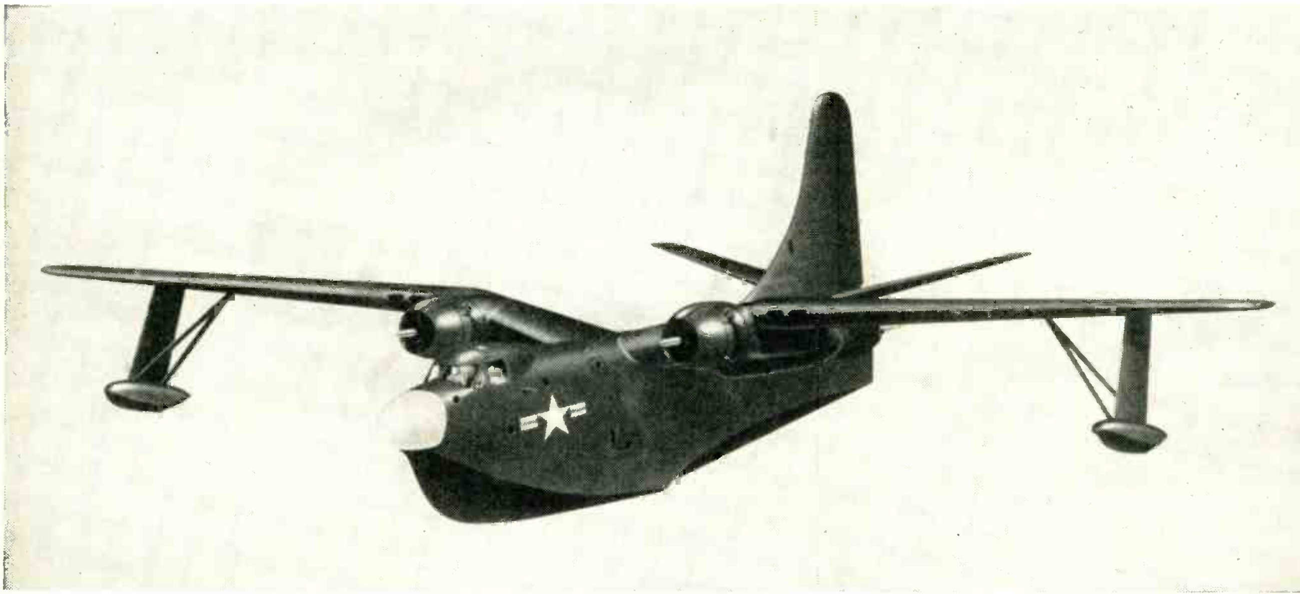
Electronic engineers are vitally needed by the Air Force as they are indeed needed by almost everyone else. The present scarcity often seems to be a hopeless situation, but for those whose memory goes back a decade or so it is difficult to resist a silent chuckle at the young graduate who cannot make up his mind what job to take because he has at least three or four to choose from. At least from his point of view it is a healthy situation and indeed I believe it is a healthy situation since it indicates to us that as a nation we are making a concerted effort to solve our technical problems, be they in research, development or production engineering. The scarcity of talent is a real incentive to the more effective utilization of our present manpower. All of us must be as effective as possible regardless of the particular field we have chosen.

Mobilization Period Planning

During the past six years a technical type has evolved which General Roger B. Colton has called a "military engineer". He is an unusual sort of individual with technical training who knows in quite some detail the inside workings of our military equipment and carries around in his mind an odd assortment of such letters and numbers as AN/42; JAN7 and XDQ. This man is usually a systems man and his evolution indicates quite clearly the major role of technical equipment in our military operations.

From military engineer to tester on the one hand and research scientist on the other, one will find within the Service the full gamut of technical opportunity. In times of stress the development and production engineering is of course expanded, but very definitely not at the expense of our efforts on basic research or applied research for that matter. While the nut-and-bolt portion of our work must expand at a terriffic rate, it is quite true that our research effort gets only a modest increase, but it gets an increase nevertheless, not curtailment.

Just as we derive benefit from sponsoring basic research I would also like to feel that the art as represented by its frontiers is also advanced by this partnership. It is rather the exceptional case today when research can be done with "love and string and sealing wax", or an occasional "ice pail". More often than not, it requires the teamwork of experienced men and financial support in excess of that available to private individuals. The same forces which have created the large industrial laboratory for the solution of these problems have also been responsible for the trend research has taken in the Air Force. We are very definitely in research, for its sake and for our sake.



Martin P5M-1 Marlin, latest design of antisubmarine flying boat built for U. S. Navy. Keel of hull goes under water from nose to tail, giving greater stability when landing in heavy seas to listen for submarine that has submerged after being detected by radar or other airborne electronic equipment

Airborne Submarine

Recent improvements in submarine weapons and electronic equipment, and corresponding improvements in the equipment of aircraft designed especially for detecting and sinking submarines. Sonar and hydrophones are carried on some air units

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SUBMARINE WEAPONS and equipment are improving. Equipment now includes radar, radar search receivers, radio and radar jamming transmitters, hydrophones and sonar. New torpedoes have longer ranges and are more dependable. They can be fired from beyond the range of underwater detecting devices, leave no tell-tale wake and are often equipped with homing devices that guide the torpedo to the sound made by the ship's propellers.

The submarine itself now uses the snorkel breathing tube, so small that it practically defies radar detection yet permits diesel-engine propulsion while submerged. Engines themselves are being improved, making it logical to assume that submerged speeds will increase to 25 knots. Furthermore, if the Walter closed-cycle hydrogen-peroxide engine can be cured of its habit of blowing up, there will be no need for air intake and exhaust tubes. This would eliminate the snorkel, our last radar target.

If there should be another full-scale war, we can be sure that the submarine will be used by both sides, not only for attacks against shipping and naval units but also for mine laying, as troop and cargo carriers, as radar pickets to give advanced warning of air raids, and as guided-missile launchers.

Antisubmarine weapons and equipment are improving too. In addition to radar, we have added magnetic airborne detectors, sonobuoys, radar search receivers, depth charges, heavy-caliber guns and rockets to antisubmarine aircraft.

The magnetic airborne detector is usually suspended below the airplane by a cable while sweeping an ocean area. Unfortunately, its range is so limited that it is useful only for localization when a submarine is known to be in the vicinity, or for continuous patrol of restricted areas like harbor entrances or channels.

Sonobuoys are dropped into the water in a pattern by an airplane when a radar-sighted submarine submerges. A hydrophone on each sonobuoy sinks below the surface and a telescoping antenna shoots above the surface. The hydrophone picks up the noise made by the submarine propellers, and the unit transmits this noise by radio to the aircraft overhead. Depth charges are then dropped on or near the noisiest sonobuoy.

In the early hectic days of World War II, aircraft were usually delivered to the Navy without special equipment. These aircraft were sent immediately to modification

New U.S. Navy long-range patrol plane for photo reconnaissance, mine-laying and antisubmarine duties. Known as the Martin P4M-1 Mercator, the plane carries jet engines in the same nacelles with the piston engines, to provide additional power and speed for take-off and when over the target area. Both radomes face downward

Detection Systems

centers. New equipments were becoming available so rapidly that it was not possible to install them for optimum performance and ease of operation. In fact, the end result was often a haphazard arrangement of antennas, radars, direction finders, bomb racks, searchlights and guns.

The aircraft manufacturers, and especially their aerodynamicists, were not too pleased to find their products resembling porcupines, with performance seriously impaired by all these appurtenances. As a result, even before the close of hostilities, the concept of naval aircraft design was changed to that of an integrated weapon especially configured for specific missions.

One example of integration of various equipment with an aircraft is the Martin P4M Mercator. This airplane was specifically designed for mine-laying and bombing, and is also an effective antisubmarine weapon. All Navy aircraft must be versatile. For that reason, the Mercator, with only minor modification, can be assigned secondary missions of area search and reconnaissance. Mine-laying missions require long range and heavy payload, along with fire power, armor, and speed for protection against enemy aircraft and ground defenses. Therefore, it was decided to install twin turrets fore and aft and a deck turret. Provision was also made for waist guns although these are not normally carried in peacetime. Allowance was made for installation of protective armor plate for the engines and crew.

The radar antenna is enclosed in a streamlined radome aft of the big bomb bay, and other antennas have been streamlined or imbedded in the ship. There are plastic sections in the leading edge of the wing which act as windows for these antennas.

The Mercator appears to be a twin - engine airplane. Actually there are two jet engines, one on each side, mounted just aft and below the piston engines. In spite of the Mercator's size, its take-off run is surprisingly short especially when all four engines are used. Under many load conditions, only the piston engines are necessary for take-off. If all four engines are used, the jets are secured after take-off because the piston engines are fully capable of producing cruising speed. The jets are again used over the target area to minimize the time spent in enemy territory under fire.

Another example of system engineering is the Martin P5M Marlin. Carefully specialized airplane design combined with a selected complement of electronic equipment make it ideal for its primary mission of submarine hunting and killing in the open ocean. Like all Navy aircraft, it has secondary missions which include air-sea rescue, transport, hospital and reconnaissance. With only minor modifications, it can perform any of these missions.

The P5M hull has a long, deep afterbody which permits it to land and take off in heavy seas.

Another forward step in improving the aerodynamics of modern aircraft is seen in the utilization of the P5M engine nacelles. Depth charges and torpedoes which used to be suspended under the wings, where they caused considerable drag, are now housed in the nacelles. Antennas have likewise been either streamlined or imbedded to improve over-all performance.

PLANS FOR COMPATIBLE

WHEN THE FCC announced its decision to adopt the CBS field-sequential color television system last October, the Commission stated that it would have been preferable to adopt a compatible color system, if such a system had been ready for commercial use. The National Television System Committee (NTSC) decided, shortly thereafter, to set up an Ad Hoc Committee to study compatible systems and to draw up broad standards on which field tests might be based.

The Committee, formed on November 20, 1950, consisted of D. B. Smith (Philco), Chairman, E. W. Engstrom (RCA), T. T. Goldsmith, Jr. (DuMont), I. J. Kaar (General Electric), A. V. Loughren (Hazeltine). R. M. Bowie (Sylvania) joined the committee later. The committee members were chosen to represent research organizations active in the development of color television systems. Axel G. Jensen of the Bell Laboratories served as observer. The Committee attended demonstrations of various system proposals at the Hazeltine, Philco, DuMont and GE laboratories and at the NBC-RCA color test facilities at Washington. On April 19, 1951 it issued a unanimous report to the NTSC.

The report contains five proposed color system standards, drawn in broad terms, but omits any detailed numerical values, stating the latter should be determined by industry field tests.

The system defined by the broad standards will, in the opinion of the committee members, "provide for the maximum utilization of the existing 6-mc channels . . . . . (that is) it will transmit the maximum amount of information useful to the viewer with regard to picture clarity, color fidelity, picture brightness, freedom from flicker and other deleterious effects, of any system of color television now known to us."

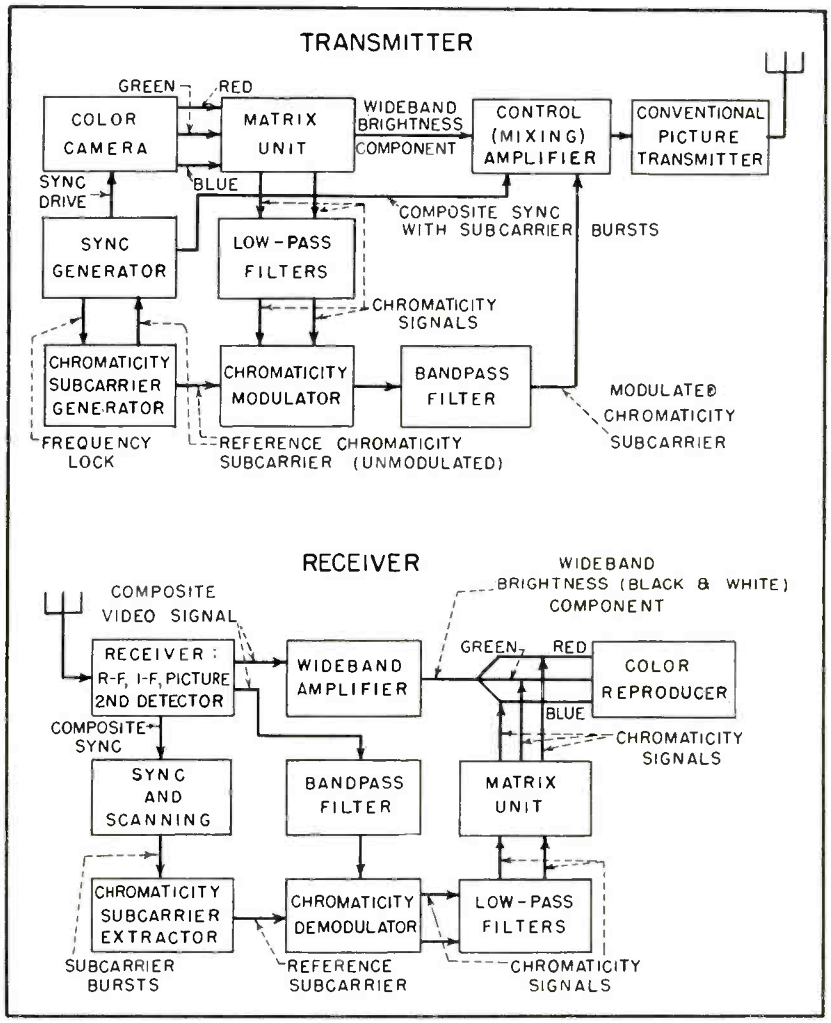


FIG. 1—Block diagram of composite color system as implied by the broad standards proposed by Ad Hoc Committee

Composite System

Essentially the proposed system involves the transmission of a high-quality black-and-white picture signal in accordance with the present FCC standards, which carries the brightness information, plus a subcarrier within the video band which carries the color (chromaticity) information. The color subcarrier is so synchronized and modulated that it causes minimum interference with the brightness component. Accordingly, portions of the color image which appear predominantly in shades of gray are substantially free from interferences due to the color subcarrier, while highly-colored portions of the image show dot-structure to a degree depending on the degree of overlap between the brightness carrier sidebands and the color subcarrier sidebands and the relative percentage of modulation. The technique of utilizing a color carrier which is an odd multiple of half the line scan frequency as proposed by Dome of General Electric is utilized further to reduce interference. Observers noted that this method of transmission was common to the experimental systems demonstrated by Hazeltine (March, 1950), RCA (December, 1950) and Philco (February, 1951).

"Color" as used herein implies the presence of brightness, hue and saturation. "Chromaticity" implies the presence of hue and saturation components only.

COLOR TELEVISION

Ad Hoc Committee of NTSC proposes broad standards for "composite system" using by-passed monochrome signal and color subcarrier, recommends industry conduct field tests to establish such items as chromaticity subcarrier frequency, manipulation of primaries, details, color sync method and bandpass limits

The standards proposed by the Ad Hoc Committee as a basis for the industry field tests are as follows:

"1. The present FCC transmission standards for black-and-white television shall continue to be used for the transmission of compatible color television.

"2. Chromatic information shall be transmitted by means of a color subcarrier modulated in amplitude and phase with respect to a reference subcarrier of the same frequency. The color subcarrier shall be transmitted simultaneously with the video signal and during only the video portion of the composite signal.

"Synchronizing signals to transmit information concerning the reference subcarrier shall be transmitted only during the synchronizing and blanking intervals of the composite video signal.

"2.1. To ensure practical invisibility of the color subcarrier its normal frequency, but not phase, shall be related to the horizontal scanning frequency in the following manner: The color subcarrier frequency shall be an odd multiple of half the horizontal scanning frequency.

"2.2. For standard operating conditions, the amplitude of the primary video signal and the amplitude and phase of the color subcarrier shall be specified in terms of a "proper" set of taking characteristics.

(Definition: A "proper" set of taking characteristics is defined as a set, each one of which is a linear combination of ICI distribution characteristics.)

"3. The color sync signal shall be transmitted by means of a burst of the reference carrier superimposed on the back porch following each horizontal sync pulse, in accordance with the detail shown in Appendix B (Fig. 2)."

The report does not contain a graphical illustration of the proposed system. The block diagram shown in Fig. 1, prepared by ELECTRONICS, illustrates the basic principles. At the upper left is a color camera which views the object and produces three signals, corresponding to a proper set (see Standard 2.2 above) of three primary colors (red, green and blue). The camera scanning is controlled by the sync generator, at the left, which produces standard FCC black-and-white sync signals, and generates the color sync burst (Fig. 2) under the control of the color subcarrier generator.

The three color signals from the camera are passed through a linear computer which transforms the color signals into another "proper set" of color signals, related to the original camera output signals by linear simultaneous equations with constant coefficients. This unit is sometimes known as a "matrix unit". Its purpose is to secure color signals whose form is better adapted to transmission, with respect to signal-to-noise ratio for example, than the signals generated by the camera.

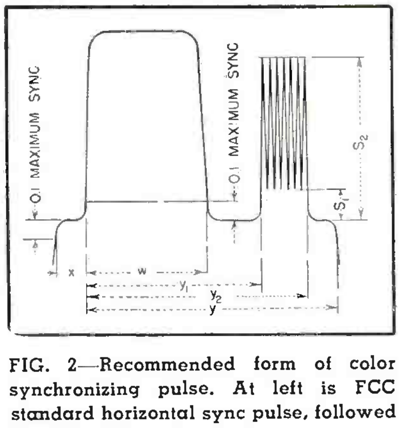


FIG. 2—Recommended form of color synchronizing pulse. At left is FCC standard horizontal sync pulse, followed by a sinewave burst at the chromaticity carrier frequency. Exact dimensions and number of cycles in burst are to be established by field test

The output of the matrix computer consists of three signals, one representative of the brightness component, the other two of the chromaticity components. The brightness black-and-white component is passed with wide bandwidth to a control amplifier where it is combined with the sync signals and the chromaticity subcarrier as noted below.

The chromaticity components are passed through low-pass filters (cutoff frequency not specified in the report, but lower than that of the brightness signal to the chromaticity modulator. Here the chromaticity signals modulate the subcarrier in amplitude and phase. The subcarrier itself is generated, as shown at the left, in a generator, associated with the sync generator, such that the chromaticity subcarrier freqency is an odd multiple (455 or 507) of half the line-scanning frequency.

The output of the chromaticity modulator is a sinewave modulated by the chromaticity signals, in such a way that the chromaticity signals do not interfere with each other and may be separated at the receiver by a synchronous detector demodulator. The chromaticity subcarrier is then passed through a bandpass filter which confines the signal to the upper portion of the video band.

At the control amplifier (upper center of Fig. 1) the black-and-white signal, the sync signal with sub-carrier bursts added, and the modulated chromaticity subcarrier are combined. The composite video signal thereby produced is passed to a conventional 6-mc picture transmitter and the resulting r-f signal is radiated in the usual manner.

At the receiver, shown at the bottom of Fig. 1, the r-f signal is amplified at r-f and i-f in the usual manner and demodulated. The composite video signal thus recovered is utilized in three ways: to operate the conventional sync and scanning circuits; to control (by means of the subcarrier bursts) the chromaticity demodulator; and to actuate a matrix unit.

At the chromaticity demodulator the two chromaticity signals (previously mentioned in the description of the transmitter) are recovered. The chromaticity signals and the composite video signal are then passed through a matrix unit which performs, in principle, a transformation similar to that carried out by the transmitter matrix unit.

The transmitter matrix and its complementary receiver matrix can perform in several ways. For instance, the transmitter matrix may deliver three color signals each containing chromaticity and brightness information, or the transmitter matrix may deliver only two *chromaticity* signals (no brightness) plus a separate signal containing brightness alone. In either case the receiver matrix must match the scheme chosen at the transmitter. Figure 1 illustrates the scheme wherein brightness is held independent of chromaticity after the transmitter matrix and right up to the color reproducer itself where recombination takes place in the reconstruction of the picture.

It must be emphasized that the diagram of Fig. 1 does not represent a specific system, and in particular it does not specifically represent the RCA, Hazeltine or Philco systems demonstrated up to the present. It is intended merely to show in simple form one embodiment of the elements of the system implied by the Ad Hoc Committee standards as stated in the report.

When the proposed compatible color signal is used with conventional (existing) black-and-white receivers, the chromaticity subcarrier has a secondary effect, and the image is produced essentially by the brightness black and white portion of the composite video signal. Moreover, the chromaticity sync bursts are so located in the sync wave form that they have no effect on the scanning of conventional black-and-white receivers. Consequently, when such receivers are tuned to the color transmissions, they produce images which are virtually indistinguishable from those produced by standard black-and-white transmissions. The principal difference, in the black-and-white reproduction of the color signal, is the presence of a dot structure in portions of the image corresponding to highly colored parts of the subject. The visibility of this dot structure depends on the relative amplitude of the chromaticity subcarrier sidebands and the degree of overlap between the bandpass regions assigned to the brightness and chromaticity sidebands. Among the important points to be established in the field tests are the amplitude and bandpass limits which represent the optimum compromise between faithful color transmission and the quality of compatible reception on black-and-white receivers.

Future Plans

The committee expressed the hope that various organizations in the industry would undertake field tests within the scope of the proposed standards, and recommended that NTSC set up a program to coordinate the tests and to publish the results to interested industrial and governmental agencies.

Several companies indicated to the committee their intention to conduct such tests and gave details in an appendix to the report. The DuMont Laboratories stated that they would conduct color tv tests on station KE2XDN, Passaic, N. J. on 608-614 mc and station KE2XDR, New York, N. Y. on 708-714 mc. In addition, station WABD in New York, channel 5, would be available during off hours for experimental transmission of compatible color images, upon proper authorization from the FCC. The General Electric Company stated that it would

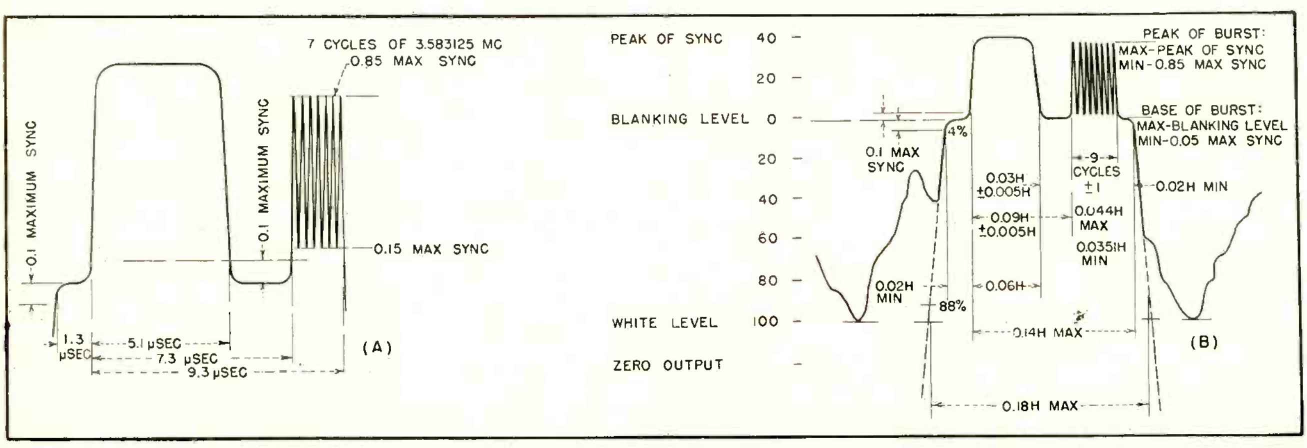


FIG. 3—Color sync pulses used by Philco (A) and RCA (B) during field tests

provide a uhf transmitter at Syracuse, New York which would operate in accordance with the proposed standards of the Ad Hoc Committee. Home-type receivers would be constructed and operated in the Syracuse area for sufficient time to accumulate the required field-test data.

The Hazeltine Corporation stated that color television signals would be available at their laboratory at Little Neck, N. Y., although it was not stated whether the signals would be put on the air. Among the types of signal to be tested was the original RCA proposal, with red, green and blue signals having equal weighting and equal phase intervals, with color subcarrier frequency of 3.58 mc. This signal is essentially that demonstrated by RCA in December, 1950 at Washington. A second system to be tested would employ the modified constant-luminance signal developed by Hazeltine, in which the color signals are weighted in approximate proportion to their luminance, with unequal phase intervals, with a 90-degree change in the subcarrier phase on odd fields, and with various color signal intensities relative to the brightness signal intensity. Also tested would be the use of oscillating color sequence (red, green, blue on even fields; red, blue, green on odd fields) at color subcarrier frequencies of 3.58 and 3.99 mc.

The Philco Corporation described the compatible color system currently being tested at station WPTZ, Philadelphia (channel 3) between 9:00 and 10:30 a.m., Monday through Friday. This is the so-called "X-Y-Z" system described by Philco engineers at the IRE convention last March. The brightness signal is of high definition and is represented by the Y black-and-white or brightness coordinate in the I.C.I. system of color specification. Two color-difference signals (rather than the three shown in Fig. 1), proportional to X-Y (red-minus-brightness and 0.33 (Z-Y) (blue-minus-brightness) are imposed in quadrature on the color subcarrier. The subcarrier frequency is 3.583125 mc, which is the 455th multiple of half the line-scanning frequency. The subcarrier burst used, shown in Fig. 3A, consists of seven cycles, phased to correspond with the phase of the 0.33 (Z-Y) component. The subcarrier phase is shifted 90 degrees on alternate fields, returning to reference phase during the intervening fields.

NEW PANELS OF NTSC

Chairman	Vice Chairman
Panel 11. Subjective Aspects of Color	
A. N. Goldsmith	D. E. Hyndman, Eastman Kodak
Panel 12. Color System Analysis	
D. G. Fink, *Electronics*	A. G. Jensen, Bell Labs.
Panel 13. Color Video Standards	
A. V. Loughren, Hazeltine	W. T. Wintringham, Bell Labs.
Panel 14. Color Synchronizing Standards	
D. E. Harnett, General Electric	M. R. Briggs, Westinghouse
Panel 15. Compatibility	
D. E. Noble, Motorola	Rinaldo DeCola, Admiral
Panel 16. Field Testing	
T. T. Goldsmith, DuMont Labs.	G. E. Gustafson, Zenith
Panel 17. Network	
Frank Marx, A.B.C.	R. E. Shelby, N.B.C.
Panel 18. Coordination	
D. B. Smith, Philco	I. J. Kaar, General Electric
Panel 19. Definitions	
R. M. Bowie, Sylvania	M. W. Baldwin, Jr., Bell Labs.

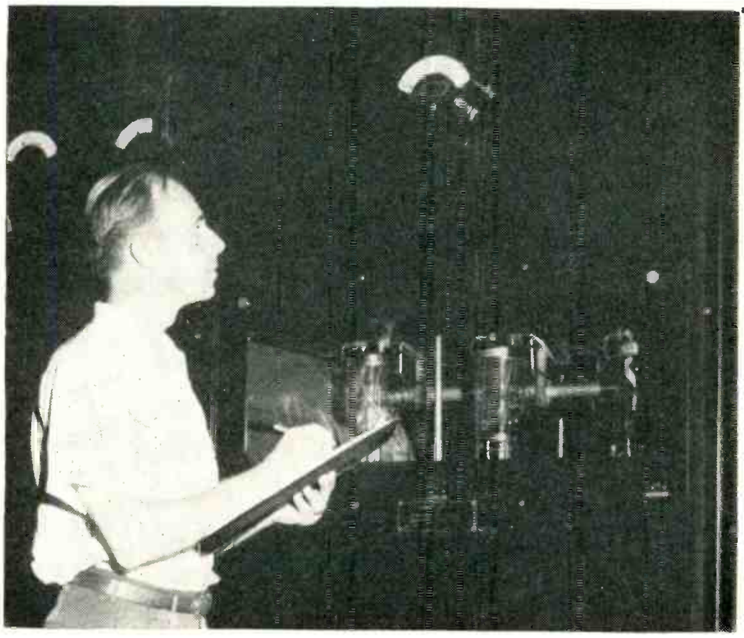
Test transmissions over the NBC-RCA transmitter in New York, station KE2XJV (WNBT, channel 4) were planned during off hours and have since begun. The color subcarrier is 3.583125 mc, as in the Philco transmissions. In addition, it was planned to test the frequency 3.992625 mc (the 507th multiple of half the line scanning frequency) following investigations of receiver i-f characteristics and the effect of oscillating the color sequence.

The color sequence is green, red, blue on one set of alternate fields, blue, red, green on the intervening fields, the reversal to be accomplished by interchanging the blue and red sampling signals. Three color-difference signals, with equal weighting and at equal phase intervals, are employed.

The subcarrier burst of the RCA-NBC tests, shown in Fig. 3B consists of nine cycles, plus or minus 1 cycle. The color difference signals contain information having a flat spectrum out to 2 mc, and a gradual slope to 30 db down at the sampling frequency. The by-passed black-and-white signal is flat to 3 mc and drops off 6 db at 4 mc. The camera taking characteristics are such as to produce proper color reproduction on a receiver color reproducer having the following primary colors: red $-x = 0.678$, $y = 0.322$; green $-$ $x = 0.204$, $y = 0.732$; blue $-$ $x = 0.146$, $y = 0.088$.

In releasing the report, W. R. G. Baker, Chairman of the NTSC, stated that the proposed standards were not intended for submission to the FCC but were designed to serve as a basis for cooperative industry field tests. When the remaining questions are settled by these tests, over the period of the next several months, definite numerical proposals for a full set of compatible color standards would be devised and offered for the approval of the industry, through NTSC, prior to submission to the FCC.—D.G.F.

War-Emergency Operation



WOR has no trouble shifting frequency on its emergency Western Electric transmitter (above). Some other broadcasters will find the job difficult

IN EVERY RECENT period of national or local emergency, the broadcast stations have played an important part in keeping the public informed and in maintaining morale. At present, as during World War II, the chief concern is their possible secondary role as navigation aids to enemy aircraft. Recently, the Federal Communications Commission, acting as the appropriate government agency for the several agencies concerned, outlined the problem to the broadcasters with one possible solution.

For the broadcasters, the plan indicates in a general way how they will operate their transmitters and what their program fare must be during an alert. Whether they will operate at all depends upon their desire to cooperate in the overall system. At present, there is no plan for the operation of television or frequency-modulation transmitters after they have sent their initial warning message. Only amplitude-modulation transmitters are considered for alert operation.

The engineering details are more complex and many of them should not be freely revealed. However, the present plan has been designed to furnish at least a minimum of fairly good broadcast reception to most parts of the country and to deny navigational information to aircraft equipped with any type of modern direction-finding equipment. Its nature is such that even if every single detail of the operation were known, direction finders would still be unable to use the signals. Only widespread sabotage and enemy control of the broadcast plant can compromise the system.

Synchronous Frequency

The basis of the plan is operation by all participating stations upon a common or synchronous frequency. Provided each transmitter maintains a tolerance of ±20 cycles (as presently required under normal service) great difficulty is experienced in obtaining a line of position with d-f equipment. And broadcast reception of a common program is excellent. In actual practice, stations can be grouped on a geographical basis using two or more common frequencies throughout the country. By this means, a greater number of programs (appropriate to the various areas) can be presented, one to a group, with good reception in the coverage areas of each group. Navigational information is only very slightly enhanced using several common frequencies.

It is known, however, that a modern automatic direction finder will indicate the direction of the strongest signal in a common-frequency group. Given sufficient time, or with the aid of espionage, an aircraft could eventually determine the location of the strongest signal and from that, the orientation of the desired target.

Sequential and Pulsating

To overcome the vulnerability of simple common-frequency operation two other techniques can be added, either of which practically eliminates compromising the system for military security. These techniques have been termed sequential operation and pulsating power operation. It should be remembered that in every case, each station in a common-frequency group transmits exactly the same program from a common source.

Common-frequency sequential operation requires that each station of a cluster or group operate intermittently for about a minute. As the first station leaves the air, another immediately comes on. Ideally, the sequence in which the

BROAD PROBLEM

The problem of how to deny navigational aid to enemy aircraft in the event of war is tremendous. Just how complex it is becomes apparent to anyone glancing at an aeronautical chart, or listening for a quarter hour to airways communications channels. How can we, for example, silence radio ranges, beacons, loran and all the rest without jeopardizing our own transportation at sea and in the air?

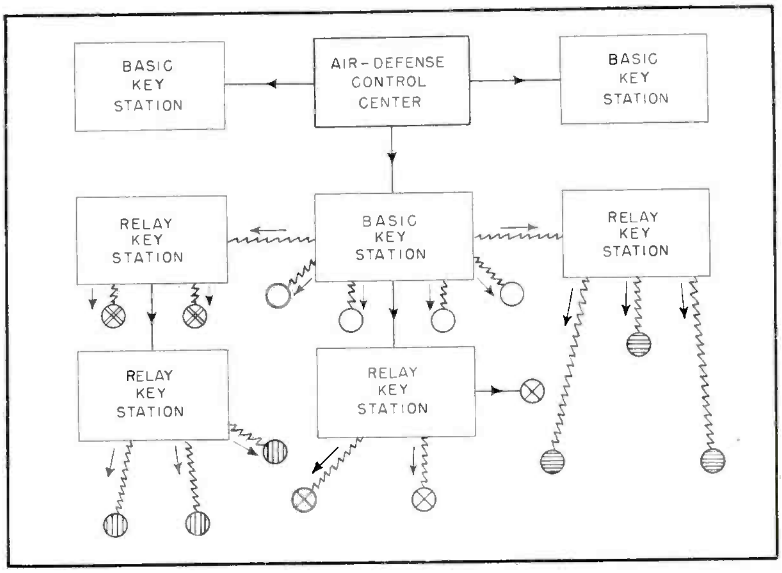
Making a minimum a-m broadcast service available at all times without offering aid and comfort to the enemy, and his missiles, is a small part of the whole task. The editors hope that this article may stir up ideas applicable to other services

# of Broadcast Stations

Stations in the a-m band, which have proved our best source of public information during disaster and flood, must remain on the air for Civilian Defense. How to prevent their being used as targets for enemy missiles during an alert is explained

stations follow one another should be varied. It will probably be necessary during the initial stages of the plan for each station to be manually controlled and remain on the air for as long as two minutes. Tests show that transmission periods of less than half a minute result in greater deception. Eventually, electronic equipment may be available so that the group sequence can be controlled from a central point.

Pulsating operation can be employed either by single stations or groups of stations and requires reducing the output power of the transmitter over a 10-to-1 ratio, preferably in periods varying from less than half a minute to not more than a minute. It will obviously be quite a trick to reduce power from a 50-kilowatt transmitter down to 5 kw and this technique may not be applicable in many cases. However, it is planned generally to limit alert power to 5 kw in order to equalize signal strengths. Under common-frequency pulsating operation it may often be possible for stations in adjacent towns or cities, if not too close together, to transmit different program material.



Chain of command for alert warnings from air-defense control centers via basic-key and relay-key broadcast stations to satellites. Solid lines are telephone; broken lines are radio links. Circles represent stations in common-frequency groups

Overall Plan

The block diagram gives a representative picture of the various station interconnections that would be necessary. Orders originate in the various air-defense control centers, but their implementation will largely reside in the basic key stations and the relay key stations. Programs and control signals or orders will progress to each individual station by any one means or combination of several means, including land-line and direct pickup of broadcasts.

While there is presently no compulsion for any broadcaster to enter into these plans, it is obvious that the effectiveness of the system increases directly with the number of stations in a group. Therefore, it might be necessary for the FCC to draft certain broadcast facilities. It is likewise apparent that the plan will cost money. Estimates vary from about $500 for a small station to many times this amount for the big ones. Costs of new crystals and ovens, frequency changing systems, antenna switching and retuning mechanisms running into many dollars will be paid for by the broadcasters, according to the plan. In addition, each station must provide itself with an alert receiver to supplement wire lines. Since nondirectional operation will be used during the alert, it may be less expensive to use existing auxiliary antennas or even to erect simple antennas where switching off all but one tower of a directive array might prove cumbersome and expensive.

The block diagram indicates that a large number of permanent telephone lines and additional toll calls will be required just to set up the system and rehearse operations. These facilities will be paid for by the government.

Operation of television and f-m stations (as well as isolated a-m stations) will be a matter for further study. The former classes of stations are generally operated in the heart of a city and, as is particularly true of the Empire State installations in New York City, present an excellent target under normal conditions of service. Besides, in the event of widespread power failures their utility would be limited because there are so few automobile or battery operated tv and f-m receivers in the hands of the public.

Electronic Protection

Central station in which alarm and supervisory signals from subscriber's premises are received and recorded

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TODAY, the United States is facing much the same situation as in the early years of World War II. Every effort is being made to cut down any possibility of work stoppages in war plants. The electronic industry, through the establishment of security safeguards in the physical plant of each industrial concern, can have a far-reaching effect on this security program.

During World War II, the country embarked on a wholesale program of plant protection, both Governmental and industrial. New concepts of plant protection were developed and the use of protective equipment together with normal guard forces became essential in order that manpower be spared and the same ultimate plant safety conditions obtained.

In February 1942[1], a review of electronic intrusion-detection systems was presented in ELECTRONICS. This article pointed out how detection systems might be employed to improve plant security conditions.

Early equipment involved crudely constructed manual and semiautomatic alarm-initiating devices from which signals originated and were sent over simple signaling circuits to appropriate remote annunciation points. These early "switches" were sometimes supplemented by time-clock equipment which added a measure of safety against failure of patrols or guards to regularly send signals while making their rounds.

Branching out from this fundamental watchman type of circuit, additional "switches" were installed at points of entry, such as windows, doors, and skylights. Such switches were connected to remote annunciating points to give warning of entry ahead of the time an intruder actually completed his entrance. Later, windows themselves were supplied with metal-foil circuits and barriers of dowel screening were installed over skylights and vulnerable wall and door areas. Floor traps consisting of switches actuated by trip cords stretched about the premises further complicated the life of an intruder who had successfully avoided any of the previously mentioned entrance barriers.

Complete enclosures such as safes and vaults had similar protective devices applied to their doors and any duct openings. These devices were supplemented in more recent years by vibration, temperature and air-pressure-operated detecting equipment.

With very few exceptions, all the early protective devices were connected into simple d-c series circuits usually terminating in a relay or similar device. Dry-cell batteries were often used to power the system.

The use of vacuum tubes as opposed to simple d-c relay circuits, played a prominent part in subsequent development work. The theory of the newer developments was to provide equipment which would signal the approach of an intruder before, rather than after, an attack upon a premises had begun. As in the early stages of World War II and now, this latter consideration is of particular importance in the control of sabotage.

One of the first developments in

for War Plants

Electronic devices offer increased protection against burglary and sabotage in plants engaged in military production. Advanced design in photoelectric, capacity-alarm and sound-detection systems as well as proposed boundary protection systems are discussed

the early 1930's was the photoelectric intrusion - detection system. In the system, a beam of light projecting from a light source to a light detector or receiver was arranged to actuate a local or remote signal. At first, relatively crude phototubes were worked to their output limit in order to drive delicate intermediate control relays connected directly into phototube circuits. Maximum useful beam range rarely exceeded twenty feet.

Makers of most modern photoelectric detection equipment use standard prefocused or sealed-beam lamps of high candle power, usually modified to insure long life. Lenses used at both projector and receiver-detector are usually of the plano-convex or biconvex type mounted singly unless particularly sharp beam patterns are needed. In the latter case, multielement lenses are sometimes employed. Focusing adjustments are provided to make for easy maintenance and adjustment at time of installation and after.

Improvements in phototube manufacture at the present time allow the industry to use either photoemissive or photoconductive anode surfaces with photocells of the cesium oxide or lead-sulphide type, respectively. Higher outputs gained when using the photoconductive cell give a system added sensitivity and wider range of light frequency acceptance. The latter means that filtered light, normally used in systems extending into the infrared range for only a very short portion of the spectrum in early models, can now be successfully accepted over a wide range of infrared light because of the tremendously increased spectral response of the photocell itself. Increased knowledge in the design of filters makes the cell and the filter itself compatible.

Beam Lengths

Actual beam lengths used today in commercial and Government indoor applications do not often exceed 200 feet. Present day design, however, permits extension of such beams to several times this distance by the use of mirrors, if necessary. Interfering objects and other impediments normally found indoors frequently prevent installation of single beams over these longer distances. It is usually found more practical to break up the beam pattern using more than one set of light source and light detector-receiver.

Not long after photoelectric-beam intrusion-detection equipment became a reality, it was found necessary to establish some sort of guide relating to the speed of operation expected of the system to successfully detect normal intrusion. The guide was established by trial and error through tests made by reputable manufacturers and was subsequently adopted by the Underwriters' Laboratories as a standard. The standard states that the speed of operation of the equipment generally must be such that at their least sensitive settings, photoelectric detecting equipment must initiate a signal when a cylindrical object six inches in diameter with its axis and direction of motion perpendicular to the beam axis, travels through the beam at a speed of 8.8 feet per second (six miles per hour) or less.

The d-c amplifiers used in the static-beam photoelectric systems (in contrast to the modulated type) generally employ a single stage, single tube or two tubes to provide the necessary gain in an average installation. These must be a compromise between sensitivity and stability; excessive amplification renders systems susceptible to paralysis or triggering by slight variations in ambient light. The limiting effect of ambient light is frequently minimized by placing hoods over the projector and detector-receiver lenses. Masking of the phototubes themselves within the detector-receiver unit is effective and serves to exclude extraneous light from the phototube and to confine energy reaching the light-sensitive surface as much as possible to that originating at the projector unit.

The masking described has an additional feature of making it difficult for intruders to paralyze photoelectric systems by shining

Outdoor photoelectric protection of Atomic Energy Commission Building

flashlight beams and other outside light sources into the phototube to hold the circuit in the standby position. The angle at which light must enter to keep the circuit in its normal operative condition is also quite critical.

The difficulty of maintaining accurate beam alignment is multiplied by mirrors, particularly when beam distances are extended to considerable lengths. To avoid misalignment, the general practice is to mount mirrors in rigid frames, supported by strong brackets fastened to the floor instead of to the walls.

While the light reflection loss introduced by mirrors is normally not more than 15 to 20 percent with a silver-backed mirror, most companies increase that loss factor to as much as 50 percent in establishing maximum beam distances when mirrors are used. In such cases, the mirrors cut down the basic units required to protect a given area but introduce beam length reductions which may be impractical and uneconomical. It is generally not recommended that mirrors be called upon to reflect beams at angles greater than 45 degrees with respect to their surfaces (90-degree angle between incoming and outgoing beams). Even at smaller angles, the loss is sufficient to warrant some reduction in beam throw ratings for each successive reflection.

The 50-percent loss factor mentioned is considered practical because of the major problem of dust forming on mirror surfaces and its consequent reduction in the reflecting characteristics or reflecting ability of the mirror. Cowls and shades are often placed on photoelectric equipment and mirrors to reduce the dust formation. Often it is found more economical to use multiple or duplicate sets of equipment rather than to try to extend a single set of equipment in beam length by the use of a mirror. This is economically practical because of the comparatively low cost of static beam equipment.

Most companies today limit the use of static beam equipment to indoor applications because of the serious paralyzing effects of ambient light from the sun and other sources on the receiving equipment.

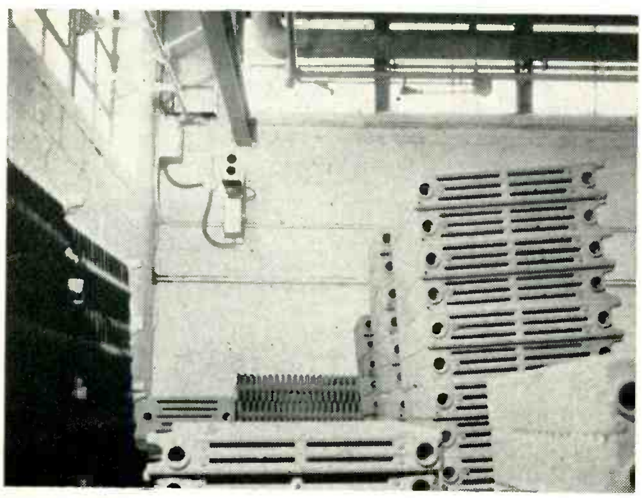
Modulated Light

To protect a perimeter adequately against unlawful intrusion outdoors, the modulated-light type of photoelectric equipment is employed. Long-range coverage is possible with modulated devices and is important when considering the protection of fence perimeters for industrial plants engaged in the production of war material. Sometimes where long beams are required indoors, outdoor equipment of the modulated type may be used to gain distances not attainable with the static type.

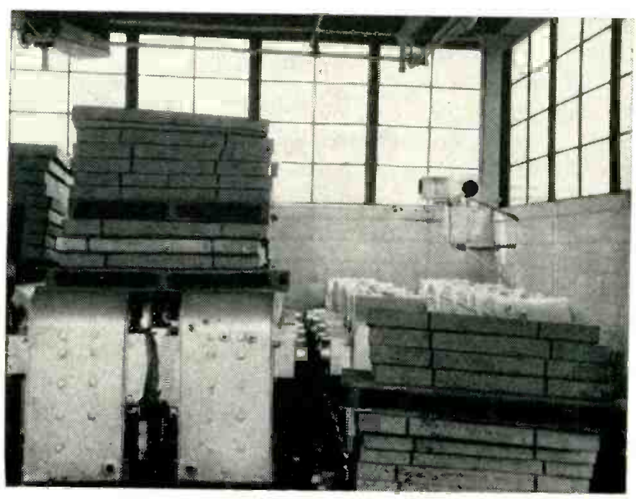
Most modulated-beam systems use projector units, lamps, optical filters and lenses similar to those found in static-beam systems. One such system is electronically modulated rather than mechanically modulated and uses low-power light output, with consequent limitation on beam distance. To return to the preponderance of modulated systems now on the market, 100 percent modulation is accomplished by the use of a suitable interrupter interposed between the lamp and the lens and rotating at a predetermined rate. The prime mover for the modulator is usually a small synchronous motor and the modulator is designed to interrupt the beam somewhere between 500 and 1,000 times a second.

Energy received by the phototube is amplified and an audio band-pass filter tuned to the modulation frequency is included in the amplifier. The receiver is sensitive only to the frequency of the modulated light and the final rectifier stage of the amplifier converts the received impulses into power with which a d-c signal relay may be operated.

As long as sufficient light intensity is received by the phototube to satisfy its threshold operating requirements, comparatively wide variations in ambient light intensity do not paralyze or trigger the system because amplification occurs only at the critical modulation frequency. Relay current may be held within desirable limits by incorporating some form of avc in the amplifier circuit to render the system still more tolerant to the effects of transient increases or decreases



Inside photoelectric protection of warehouse. Two light sources are shown at right angles. Beams protect entire row of windows which run the complete length of both walls



A second location in the same warehouse. Here, two photocell receivers are mounted at right angles. Beams reach the receivers from light sources located at the other ends of both walls

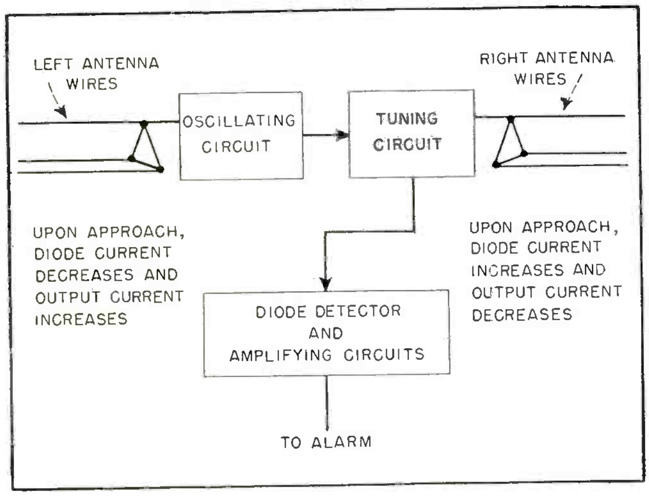


FIG. 1—Block diagram for outdoor capacity-type intrusion detection system of the type shown in Fig. 2

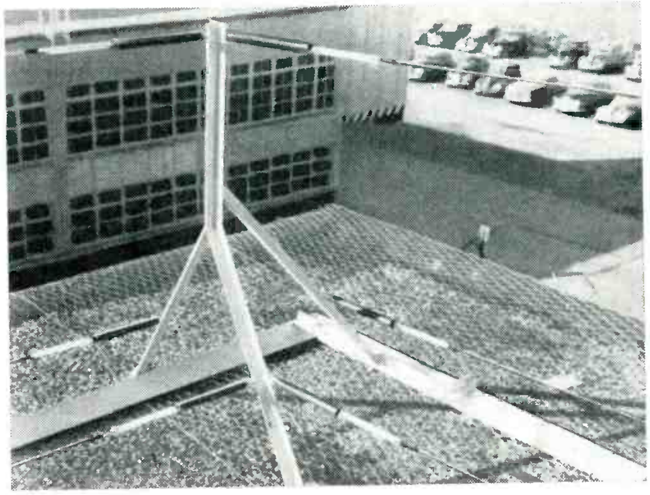


FIG. 2—Detail of capacity-alarm antenna wires on roof, showing counterpoise and wire-tension springs

in light intensity. The system is then insensitive to light from the sun, a flashlight or modulated light at other frequencies.

Continuous trouble-free maintenance of outdoor photoelectric equipment is so important that most operating companies have spent considerable sums over the last few years to improve the basic mechanical and electrical components of such systems. Improvements in motor modulator design and electronic components have not been uncommon and attempts have been made to make the systems more consistent with the application to which they have been placed. The present manufacture of photoconductive cathode surfaces has increased the range of infrared sensitivity of such systems to a point where they can now be used with a greater degree of safety when subject to fogs and other interfering media. While it is recognized that these units are bulky and are difficult to conceal in any perimeter intrusion - detection system, they nevertheless offer a type of protection widely accepted by industrial plant-protection engineers.

Photoelectric intrusion detectors are at a disadvantage where industrial plants are laid out on extremely irregular property plots and on hilly ground requiring coverage of many vertical as well as horizontal angles. Because irregular topography necessitates the use of a plurality of units, such a system is expensive. Capacity-operated relays are often used for such outdoor protection work.

Capacity relay equipment has been used for protection indoors during the last several years. Where cubical content is not excessive as in filing cabinets and safes and where large metal objects do not move from day to day with respect to the safe, this type of protection is applicable. Many circuits were used by protection companies, all operating on the principle that the capacity between antenna and ground is relatively small whereas capacity to ground added by an intruder approaching the system represents a considerable increase in total circuit capacity. As there is always plenty of capacity change on which to base usable circuit output, adjustments can be made to hold over long periods without drifting, because the capacity between safe and ground remains fairly constant.

Outdoor Capacity Systems

To handle the problem of irregular topography, an outdoor version of the capacity relay system was developed. By erecting antenna arrays on suitable posts about the perimeter of a war plant, it was possible to follow land contours with ease and provide a good protection barrier to an intruder. The circuit principle used for outdoor perimeter systems was much the same as that used for indoor safe protection systems. Because the effects of weather had to be taken into account, provision had to be made to balance out the effects produced by rain, snow, ice and slow growth of vegetation.

A system developed during World War II and put into limited use as a capacity relay system for plant boundary protection has been used within the last six years on a larger scale. This system has been extended to the protection of roofs, as shown in Fig. 1, 2 and 3 and other outdoor surfaces of buildings themselves. Limitations with respect to favorable ground conditions thought important in the early stages of development have now been overcome by erecting a ground counterpoise making the system independent of surrounding building or earth ground potentials. Limitations on the amount of capacity which one electronic unit can embrace still confine antenna lengths to a maximum of about 200 feet on each side of a control unit. However, protection of this type must be zoned every few hundred feet of length to permit accurate guard response to alarms originating from a specific location.

Early models of capacity-type equipment used a two-wire antenna array until experiments proved that better protection could be accomplished by a triangular antenna configuration. The latter system uses two antenna wires stretched tightly about 18 inches from the ground on insulator posts spaced about 25 feet apart. The third wire forming the triangle usually is placed about 48 inches above the ground.

Further experiments proved that

with some slight reduction in sensitivity, spur antenna extensions could be connected to the triangular configuration to permit coverage up to distances of six to eight feet above ground at boundary points of particularly critical importance. Thus, a curtain of protection produced by an induction field of electromagnetic energy radiating a foot or so from the antenna array was produced. An approach to the array caused system unbalance and a resulting alarm.

Frequencies used in the oscillator portion of the circuit vary from 150 to 200 kc. The system is designed to maintain a continual slight unbalance between oscillator and tuning sections under normal stable conditions. A block diagram of the circuit shown in Fig. 1 depicts the components used. Entry of a foreign body into the antenna field introduces additional capacitive reactance back into the coupling coil to which the antenna is attached and tunes the coupling circuit in the direction of resonance at the frequency to which the oscillator has been set. A sharp increase in diode-detector current results. A pulse is sent from the diode to the amplifying circuits whose output terminates in a signal relay inserted in the final stage.

Triggering of the circuit by slow ambient variations in antenna to ground capacitance is minimized by using coupling capacitors of several microfarads between the amplifier stages. Changes in capacity which occur at extremely slow rates such as those caused by weather conditions do not build up sufficiently to trigger the relay in the output stage. Circuit values are adjusted so that it is virtually impossible for an intruder to move into the antenna field slowly enough to take advantage of this effect.

Because the capacity system lent itself so well to boundary protection, considerable time and money has been spent in improving upon the principle in an effort to build a more stable system having less sensitivity to unwanted influences such as radiated airborne r-f energy, power-line surges, weather effects and others. Present equipment takes advantage of recent tube refinement, eliminating the use of electrolytic capacitors whose life has been unpredictable and greatly emphasizes the rugged construction needed for important outdoor applications.

Use of the same principle has been extended beyond that previously described for the protection of safes to embrace protection for critical areas indoors. A view of the subscriber's instrument for this type of protection is shown in Fig. 4. A single-ended version of the outdoor capacity-relay equipment is now in use to provide a protection barrier for stockrooms and other inside enclosures. Instead of using conventional forms of screening, inexpensive antenna arrays are erected about an enclosure and provide a complete wall of protection. Antenna arrays may take the form of thin brass strips mounted on either side of a doorway, on showcases, wooden studding or other building structure. Where metallic surfaces are involved, suitable insulation is used.

Unlike the earlier versions of safe and file-cabinet-type capacity relays, as much as 4,000 $\mu\mu$f of loading on the expanded circuit instead of the original 1,000 to 1,500 $\mu\mu$f may be used. This new protection can be extended to factory-type fenestra windows or to office casement windows in place of conventional foil and screens. The results would be the same from a protection standpoint and the improvement in appearance would be obvious.

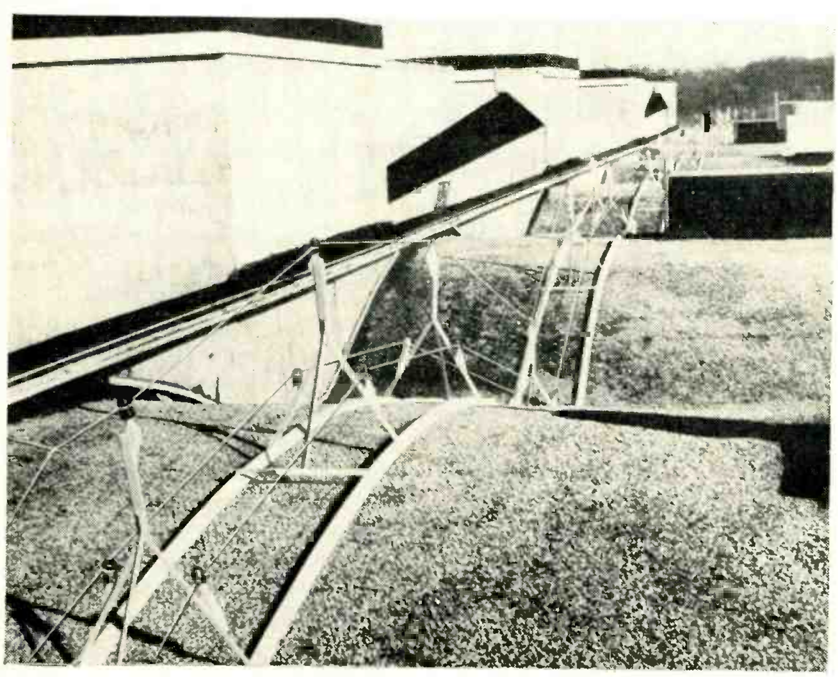


FIG. 3—Capacity alarm system on vaulted roof. Extra supports are used to make antenna wires conform to roof contours

Experimental Systems

Just as in World War II, design engineers are now looking for even better forms of protection. Under study at this time are systems for outdoor application using pulse-modulated sources of high-frequency radio energy designed to beam the energy in much the same manner as photoelectric without the inherent faults with respect to weather. Other forms of antenna arrays using high-frequency radio energy are under study and, while none of these has been used extensively, they show the trend of thinking and the application of electronic principles being considered by engineers.

To improve and simplify the systems necessary to protect indoor enclosures adequately, many companies have for years considered the problem of space protection. It has always appeared logical that a system capable of detecting motion within a confined space and yet not requiring complicated equipment would be the ultimate ideal of the protection engineer. Progress within the last three or four years in the design of space protection systems has resulted in the develop-

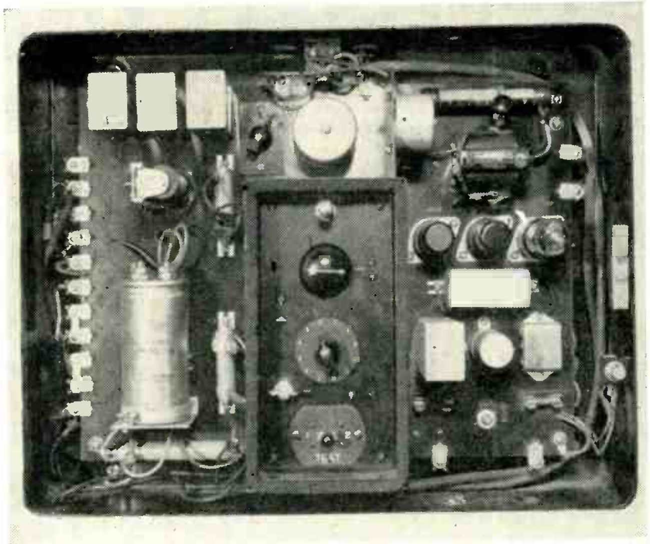


FIG. 4—Chassis of subscriber's instrument for capacity-type protection of safes and file cabinets

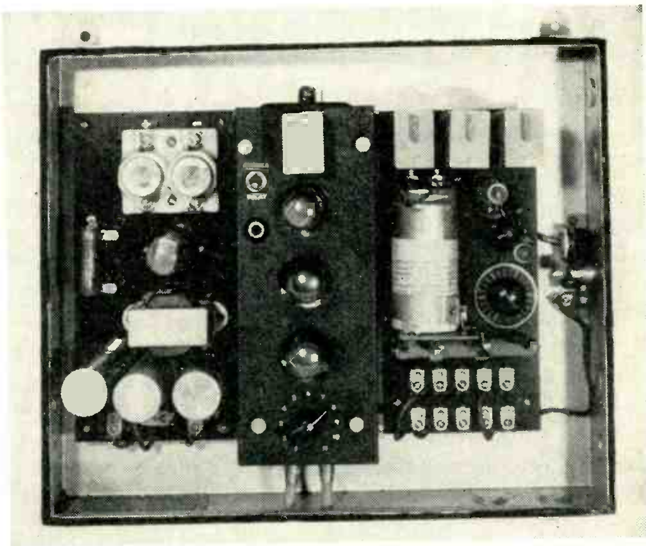


FIG. 5—Chassis of subscriber's instrument for vault sound-detection system

ment and testing of equipment which will do just this with a minimum of components involved. Although extensive industry application of this idea does not yet exist, it should be noted that it may become very useful.

An example of such a system is one operating at a frequency slightly above the audio range in which sound energy is directed from a transducer into an enclosure and reflected back from the multiple surfaces in the enclosure to a receiving transducer. If a stable condition exists in the enclosure filled with such energy, no signal output is obtained. When motion occurs, a frequency change is presented to the receiver. The new frequency may be above or below the initial transmitted carrier frequency. Design of the receiving equipment is such that it can discriminate between the carrier frequency and the difference frequency, using the latter to initiate an alarm.

Space detection systems are not new in principle, but long-term experience of the major operating companies shows that wholesale use of such a system must be approached with caution. There are many interfering factors rendering such systems unstable and until these are properly evaluated, the more tried and tested methods are preferred. For instance, acoustically actuated vault-protection systems are used in hundreds of locations today and will continue to be used for many years. These systems are designed to operate an alarm when physical attack upon the exterior surfaces of the walls or ceilings occur. They do not trigger on relatively low-level sounds which might result from common building vibration. Detecting devices installed within the vaults function through sounds transmitted to them from the outside through walls, ceilings or floors. The subscriber's instrument chassis for a vault sound detection system is shown in Fig. 5. Output voltage from the crystal-microphone detectors is amplified and diode rectified. The resulting d-c actuates a signal relay.

Established values of ambient noise level specified by Underwriters' Laboratories, Inc., are used as guides by the industry in determining amplifier gain requirements. Most systems are used in vaults of masonry construction and the sensitivity of the system depends on whether or not the vaults are reverberant or nonreverberant.

Conclusions

The information presented covering systems suitable for improving industrial plant security and protection has been based, for the most part, on data of long standing and on practices known to be effective. Knowing the importance of plant protection today, all major companies dealing in this type of equipment are continually looking for better and more economical ways to do a protection job. Money expended for research has paid dividends and companies are well aware that the field of protection still has a large reservoir of untapped ideas. The theoretical ideal of a boundary protection system might be said to comprise an intangible barrier of controllable thickness and perhaps unlimited height. The barrier should be capable of handling all types of land topography and should withstand without difficulty the rigors of weather and other similar phenomena. Many of the systems on the market today approach this ideal, but all still have certain limitations.

The ultimate in protection for interior spaces would anticipate the elimination of most common forms of traps and contacts and provide intangible protection for the space enclosed by four walls, a ceiling and a floor. Good practice dictates that such protection completely assured of the absence of false alarms would still require some supervision over normal openings to an enclosure. The next ten years will bring to light many advancements and refinements of the basic principles now incorporated in today's equipment. Meanwhile, the industry has available now many types of equipment from which to choose in improving its security picture.

REFERENCE

(1) Electronic Intrusion-Detection Systems, ELECTRONICS, 15, p 38, Feb. 1942.

Industrial TRISTIMULUS

ONE requirement of an electronic colorimeter for industrial use is that it detect small color differences in the darker colors quickly and reliably with a sensitivity surpassing that of the human eye. A second requirement is that the instrument be sufficiently rugged, stable and simple in operation for use as a production tool.

In the instrument engineered to meet these requirements, operating controls are reduced to a minimum. The instrument measures on a three-color basis known as tristimulus colorimetry. The color that is to be matched or evaluated is viewed by the phototube first through blue glass, then through green glass and then through amber glass. The meter indicates the percent difference between sample and standard for each of these primary colors. The sample can be as small as one-half inch in diameter.

The optical system, based on the flicker photometer principle, is shown in Fig. 1. Sample and standard are viewed alternately 30 times per second just as in a spectrophotometer. Illumination is provided by an incandescent light source within an integrating sphere. Color temperature of the source is preserved by voltage control and lamp calibration. Either reflectance or transmission measurements may be made on any commercial color. The optics includes four lens elements, field stops, stray light stops, source filters, tristimulus filters and a multiplier phototube. Source filters permit comparison under standardized 2,848-deg K incandescent illumination, daylight illumination (Corning 5900 filter) or directly under illumination from external sources.

Transmission measurements of dyes and other liquids are made by placing a sample and standard in the openings of the transmission measurement holder. Clamps are provided for holding colored transparent solid objects at the same locations. Other clamps hold sample and standard against parts in the integrating sphere for reflectance measurements.

A small a-c motor drives a decentered lens in the optical system so that light from sample and standard are alternately focused on the type 1P22 phototube. Actually, the optics never completely eliminates either sample or standard; instead, it alternates from about 20 percent sample and 80 percent standard to 80 percent sample and 20 percent standard.

If reflected or transmitted light from sample and standard are identical, the phototube output will be unchanged by the flicker. If the two differ, an alternating current will be generated in the phototube circuit.

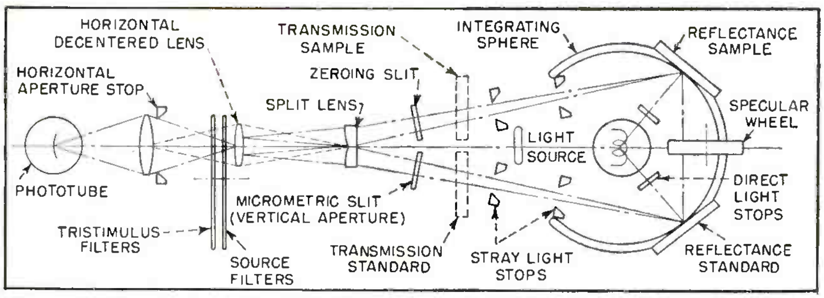


FIG. 1—Optical system, shown in line for clarity. Actual system is folded for compactness. Rotating decentered lens allows phototube to view sample and standard alternately 30 times per second

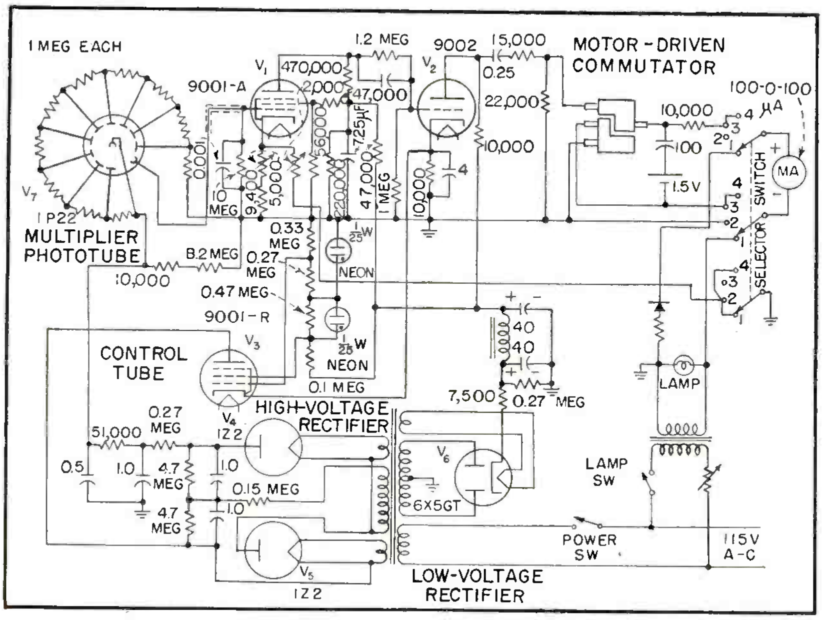


FIG. 2—Complete circuit. Motor switch operates synchronously with flicker-producing rotating decentered lens to convert a-c output of amplifier to d-c for microammeter. Selector switch positions are: 1—check lamp voltage; 2—stand-by position; 3—high-sensitivity range (90—110 percent); 4—low-sensitivity range (65—150 percent)

Electronic System

The electronic circuit of the colorimeter employs a total of seven tubes, connected as in Fig. 2. The high-impedance resistor network for the phototube is soldered directly to the tube pins. A high-permeability magnetic shield is then slipped over the tube and assembled to a flanged metal base with suitable gasketing. Three leads are brought out, from the anode, cathode and dynode 9. The entire net-

COLOR MATCHER

Flicker-photometer type instrument using multiplier phototube in constant-current circuit surpasses sensitivity of human eye in matching even darkest plastic, textile and dye colors. Meter indicates brightness ratio of sample to standard for each ICI tristimulus color

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work is potted with a special polymerizing resin that remains plastic but fully protects the high-impedance networks against moisture. When installed in the instrument, an electrostatic shield is fitted over the terminal pins for final shielding. The phototube tube is thus built in to last for the life of the instrument.

When light from the optical system reaches the phototube, the light consists of two components: (1) A steady component representing the mean brightness of sample and standard as viewed through the particular source and tristimulus filters selected by the operator; (2) an alternating or flicker component of magnitude representing the difference in brightness between sample and standard as viewed through the same filters.

The circuit measures the steady component and the flicker component, and performs the computation necessary to express the percentage difference between sample and standard.

The d-c output of the phototube is amplified by V_1 and V_2, which are connected as a d-c amplifier. The resulting voltage drop across the cathode resistor of V_2, proportional to the steady brightness component, is applied to the cathode of V_3. Variations in brightness change the plate-cathode voltage of V_3 and thereby change the loading that this tube places on high-voltage rectifiers V_4 and V_5. As a result, this tight d-c feedback loop controls the voltage supply to the phototube in such a manner that the mean current output of the tube is substantially constant for steady-light brightness variations of 5,000 to 1. A given percentage difference in any one color will then produce a proportional a-c output voltage at V_2. This is rectified by a commutator on the optical flicker motor, and the resulting d-c voltage is applied to a zero-center d-c microammeter which is calibrated to read percentage difference directly. Flicker and rectifier action are synchronous, hence polarity of the d-c output indicates whether the sample is brighter or less bright than the standard for a particular primary color.

In effect, the sensitivity of the phototube is varied inversely with brightness of light reaching it, just as the iris of the human eye acts to decrease the eye sensitivity when a brighter object is viewed. The range of automatic accommodation is comparable to that of the eye, but is faster, has no fatigue factor with time, and gives a sensitivity exceeding that of the human eye for variations of as much as 10,000 to 1 in brightness. This permits comparison of samples reflecting only 1 percent to an accuracy of ½ percent of reflected light.

To assure measurements truly based on color, regardless of illumination intensity, the instrument computes the ratio of sample brightness to standard brightness. This ratio is indicated on a wide-scale direct-reading meter with full-scale range of 91 percent to 110 percent (corresponding to differences of +10 percent or −9 percent in relative brightness). A less sensitive scale range covers 70-percent to 145-percent ratios.

A direct-reading micrometric slit permits evaluation of colors relative to white or colored reference standards beyond the range of the meter. Comparison is on a tristimulus basis. With properly calibrated standards, colors can be defined to high accuracy in tristimulus terms; reflectances or transmissions as low as 0.1 percent can be measured.

The 9001 regulator tube is operating satisfactorily despite an unusually high plate voltage. About 60 instruments are in service at present, some of which have been operating two years. Many of the units work 24 hours a day, yet tube replacement is practically zero. The only tubes that gave trouble were the 1654's originally used in the high-voltage supply. These have been replaced with 1Z2's which give much better service.

Tolerance in Matching

Color matching involves getting the meter readings for the three primary tristimulus colors up to 100 percent or, from a practical standpoint, sufficiently close to 100 percent to be acceptable to the observer. The absolute tolerance to be set for a measurement varies with each industry. If all these numbers go up and down together, corresponding to a change in the brightness of the color, experience to date in the textile and paint industries indicates that 2-percent tolerance is acceptable. This means that if all three numbers go up and down together from 98 percent to 102 percent, regardless of how light or dark the color is, the match will be within eye color tolerance.

If one number wanders differently from the other two, there is a difference in color rather than a difference in brightness. Only about 1.5 percent can be tolerated for precision matches.

New Cathode Design

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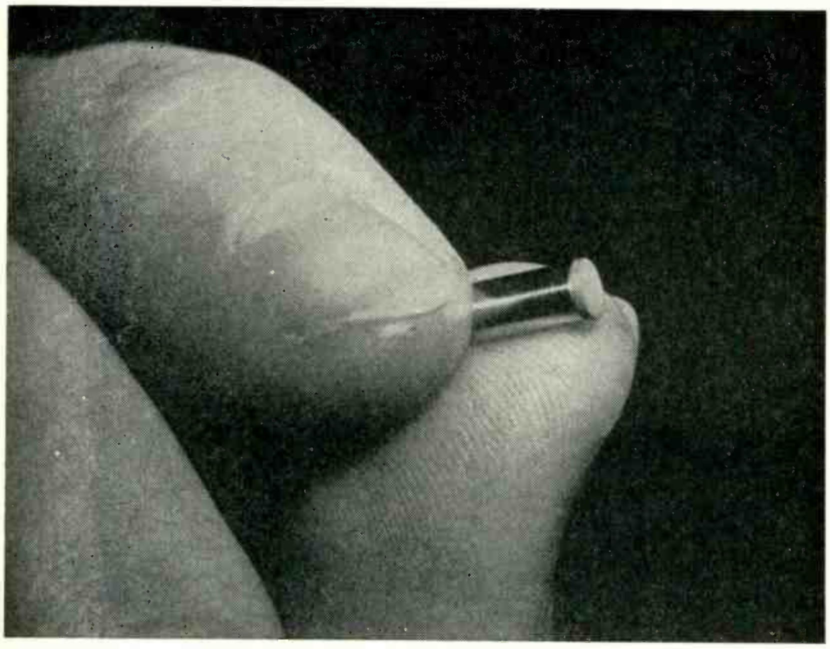

Assembled planar type L-cathode

Advances in the electron tube art in recent years have placed severe demands on the heart of the electron tube—the cathode. The requirements for higher powers, high-frequency operation, rugged construction, and low-noise operation have taxed the capabilities of the conventional cathode types to their limit.

The great majority of electron tubes employ cathodes of one of three types: tungsten, thoriated tungsten, or oxide coated. Some of the more general characteristics of these cathodes are given in Table I.

With a specific application in mind which required a cathode capable of high emission density and good mechanical strength, a new cathode was developed in the Philips Research Laboratories[1] in Holland which not only provided these characteristics but also gave exceptionally long life and good resistance to poisoning. This cathode, which has been designated the L-cathode, should find wide application in tubes of all types where reliable performance is desired, especially where the cathode loading is severe.

Figures 1A and 1B show two examples of this cathode: the cylindrical type, especially applicable to magnetrons; and the planar type which is applicable to high-frequency disk-seal triodes, klystrons, cathode-ray tubes and other conventional electron tubes. The materials used in the construction of these two types of cathodes and their emission characteristics are identical.

The body of the planar type cathode consists essentially of two sections formed from one piece of molybdenum. The lower section is open at one end and contains a filament for indirectly heating the cathode. The upper section contains a small quantity of barium-strontium-carbonate and is sealed by a cap of porous tungsten so that the means of escape of the active materials is via the pores of the tungsten material. The porous tungsten cap is formed by compressing tungsten powder under high pressure and sintering at high temperatures. The photograph shows an assembled L-cathode of the planar type.

Emission Characteristics

The first characteristic to be considered in comparing the emission of different types of cathodes is the variation of emission density with temperature. This characteristic is given in Fig. 2 for the L-cathode and the three cathodes whose properties are shown in Table I. This cathode curve falls between that of the oxide-coated cathode and the thoriated-tungsten cathode. It should be noted that for continuous operation only about one hundredth part of the saturation emission may be drawn from the oxide-coated cathode. Higher emission densities would result in damage to the surface layer. Therefore, it is apparent that under d-c conditions the oxide-cathode cannot practically operate over the range indicated. The three other types of cathodes can be operated continuously close to saturation emission, and of these the L-cathode has the most favorable temperature-emission characteristic.

Another important cathode property to be considered is its efficiency; that is, the thermionic current emitted in amperes per watt of heater power. The theoretical efficiencies of the four types of cathodes under consideration are shown in Fig. 3. These curves are based on the emission-temperature characteristics and the radiation properties of the cathode surfaces. It should be realized that the cathode shown in Fig. 1B is much less efficient than that shown in Fig. 1A and that the over-all efficiency of a cathode depends largely upon the geometry.

It will be noted that the theoretical efficiency of the new cathode is greater than that of the tungsten and thoriated-tungsten cathodes but less than that of the normal oxide-coated cathode. From the curves we can conclude that in applications where relatively small current densities are required and where the heater power requirements must be kept to a minimum,

Improves Tube Reliability

High emission density and good mechanical strength are combined with good temperature-emission characteristic and excellent resistance to high voltage and high-speed gas ions. Structure contains reservoir of barium-strontium-carbonate emitting material

the oxide-coated cathode may have preference. However, other factors, which will be discussed further, enter into the selection of a cathode.

Emission Mechanism

Since both the L-cathode and the oxide-coated cathode derive their emission from a supply of barium-strontium-carbonate, it might be supposed that the L-cathode could be regarded as a variation of the oxide-coated cathode. However, if we investigate the emission mechanisms more closely it is seen that this is not the case.

The L-cathode is quite different. The thermionic emission from any surface is largely determined by the work function (the energy, usually measured in electron volts, required to transfer an electron from the interior of the material across the boundary into the adjacent medium). In general, the smaller the work function of the material, the higher the emission from the material at a given temperature. Thus, by comparing values of the work functions, an indication can be obtained regarding the behavior of the various materials as thermionic emitters.

The work functions of the four cathode types under consideration are given in Table II. It is apparent that the L-cathode has characteristics different from a pure metallic tungsten emitter and also from a conventional BaSrO coated cathode. It will be noted that of those substances listed in the table, the pure metal tungsten emitter has the highest work function and the oxide-coated cathode, a semiconductor, the lowest work function. The thoriated tungsten cathode has a monatomic layer of thorium on the surface of the tungsten which greatly reduces the high work function of the tungsten. The work function of the L-cathode lies even lower than that of the thoriated-tungsten emitter because of a barium-on-oxygen layer on the tungsten surface which is more effective than thorium in lowering the work

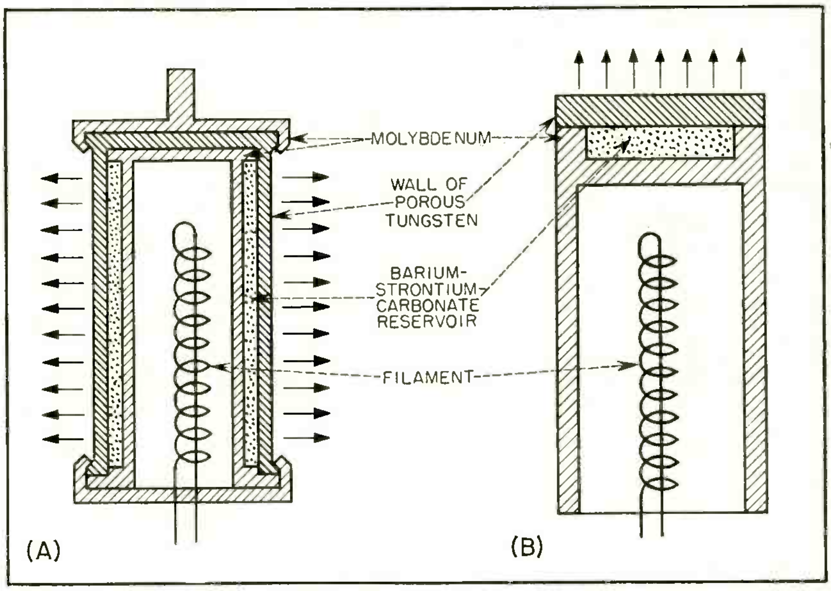

FIG. 1—Cross section of two basic forms of L-cathode: (A) with cylindrical emitting surface and (B) with planar type flat emitting surface

Table I—Summary of Characteristics for L-Cathode and Three Other Types

Type of Cathode	Max. Useful Thermionic Emission in amp per cm^2	Max. Useful Thermionic Yield in amp per watt	Poisonability	Resistance to High Voltage	Resistance to High-Speed Gas Ions
Tungsten	1	0.006	Small	Good	Good
Thoriated Tungsten	2	0.070	Large	Good	Poor
Oxide Cathode D-C	0.5	0.25	Large	Poor	Good for a short time
Oxide Cathode Pulsed	50	20.00	Large	Fairly good	
L-Cathode	300	10.0	Small	Excellent	Excellent

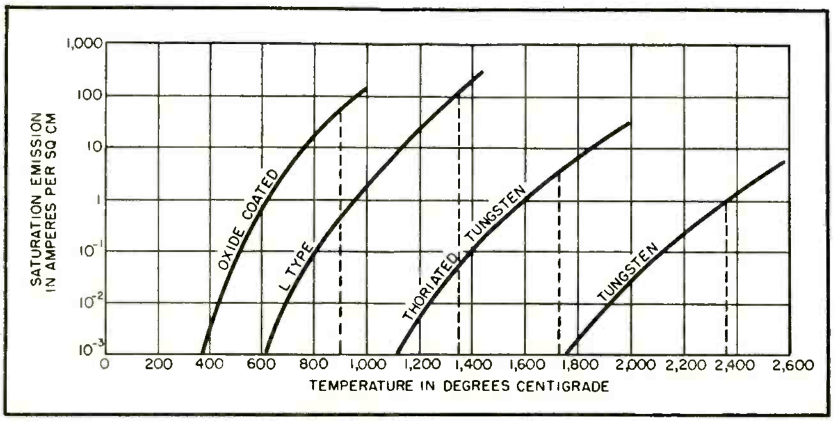

FIG. 2—Saturation emission as a function of true temperature for L-cathode and three other types. Vertical dotted line indicates maximum operating temperature for each cathode. This situation can be realized under both pulse and d-c conditions for all cathodes except oxide coated, the d-c emission of which is limited

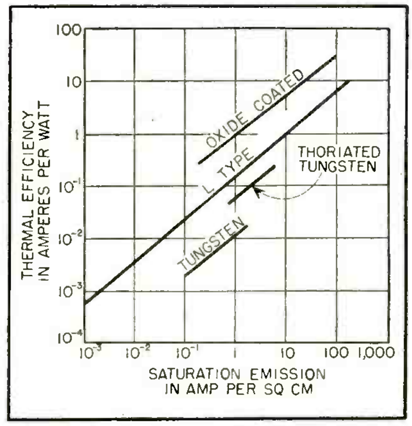

FIG. 3—Theoretical thermal efficiency as function of saturation emission in amperes per square centimeter of cathode emitting surface

function of the emitting surface.

The inactivated cathode has an adsorbed layer of oxygen on the tungsten and the surface layer of barium on oxygen is formed during the activation process in the following steps:[2]

(a) The BaO is chemically reduced by the tungsten, forming Ba vapor of low partial pressure at the bottom of the porous tungsten plug.

(b) Barium is carried through the plug by both a gas flow through the pores and surface diffusion over the pore walls.

(c) Barium diffuses over the external emitting surface.

The barium which is slowly lost by evaporation from the cathode surface is continually replenished from the reservoir. Termination of life appears to be associated with the exhaustion of the barium supply. This supply can be made relatively large and accounts for the long life characteristic of the L-cathode.

Other Properties

The rugged construction of the cathode and its smooth mat emitting surface provide several advantages. It is not subject to damage while being mounted. The emitting surface can be made flat to within very close tolerances. In high-voltage operations no permanent damage results from arcing. The coating of the metallic surface is not subject to stripping under the influence of high electrostatic forces as is the case with the emitting layer of the oxide-coated cathode.

The troublesome interface effects found in oxide-coated cathodes are eliminated.[3] The cathode, while subject to poisoning by oxygen or oxygen compounds, recovers quickly. In fact, these cathodes may be used in demountable tubes where all that is necessary for proper operation after exposure to the atmosphere is a second activation process.

Applications

Life has been found to be a function only of the temperature at which the cathode is operated and the quantity of barium in the pellet. Life tests have shown that the cathode when operating at 1,050 C and at an emission density of 2 amp per sq cm has a life of thousands of hours. As the operating temperature is increased, the life is decreased so that when operating in the higher temperature regions where the emission is 250 to 300 amp per sq cm, the life would be expected to be reduced to some hundreds of hours.

The L-cathode has been used successfully in magnetrons, klystrons, disk-seal triodes, iconoscopes, special cathode-ray tubes and other types of tubes where a high degree of reliability is required.

The smooth emitting surface makes it possible to hold the cathode-to-grid spacing to close tolerances. In magnetron applications, while the secondary-emission ratio has been found to be appreciably greater than one, it is not as large as the ratio found with conventional oxide-coated cathodes. In both reflex tubes and magnetrons the cathodes have proved capable of withstanding the heavy electron bombardment which takes place. In two similar reflex klystrons working in the 10-cm region with a continuous cathode load of approximately 2 amp per sq cm, the L-cathode had an average life ten times greater than that of the conventional oxide-coated cathode.

Other applications of the new cathode are being explored. Some of its remarkable characteristics seem best suited for high-quality tubes where long life, good mechanical strength, and rigidity are required. The cathodes have been made available in experimental quantities to Government laboratories and the electron tube industry in this country, and production facilities are being established to meet large scale requirements.

Table II—Work Functions

Type of Cathode	Work Function (volts)
Tungsten	4.44 to 4.63
Thoriated Tungsten	2.6 to 2.9
Oxide-Coated Cathode	1.0 to 1.5
L-Cathode	1.6 to 2.0

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(1) Lemmens, Jansen and Loosjes, *Philips Technical Review*, **11**, p 341, June 1950.
(2) F. K. du Pré and E. S. Rittner, Concerning the Mechanism of Operation of the L-Cathode, paper presented before American Physical Society, New York, Jan. 1951.
(3) Eisenstein, "Advances in Electronics," p 24, Academic Press Inc., New York, 1948.

Sidefire Helix UHF-TV Transmitting Antenna

Radiation-attenuated traveling-wave helical antenna provides power gain of 20 with a beaming bandwidth of 20 megacycles at one-db points. Design offers advantages of structural rigidity and ease of installation and adjustment

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TWO PRIME requirements of tv transmitting antennas are high gain and a uniform azimuth pattern. Also desirable are a minimum of feed complexities and a structure capable of withstanding all types of weather.

Antennas used thus far consist of a multiplicity of bays, the power gain being approximately equal to the number of bays. Each bay requires a feed point, with resulting complications. To reduce the number of bays and feed points, each feed point must provide illumination of an appreciable portion of the total aperture. This may be done by means of a traveling wave.

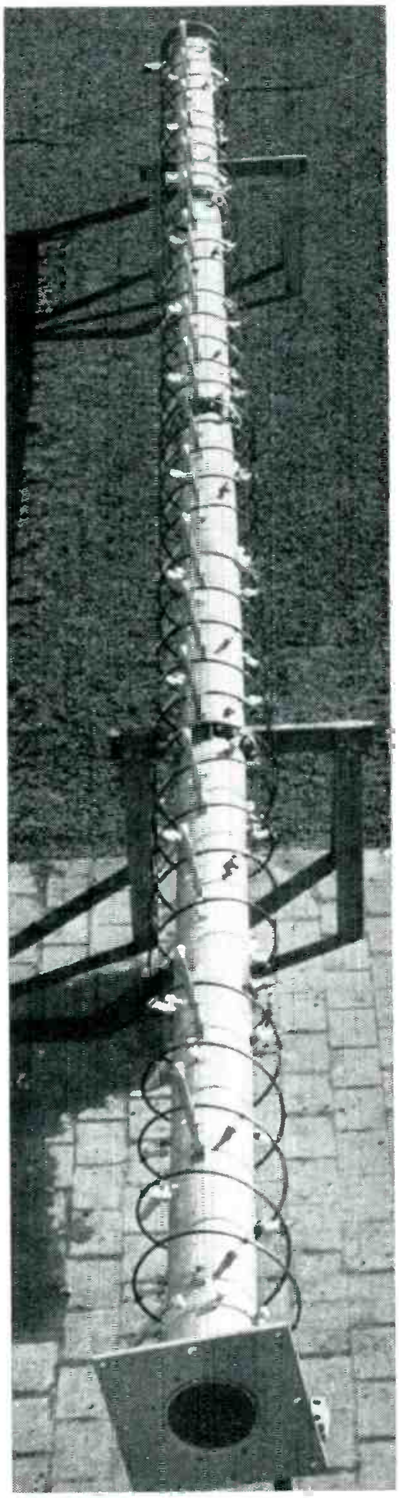
High-Mode Helical Radiator

The antenna described in this article uses the traveling-wave principle to excite a large portion of the aperture from a single feed. Further, this traveling-wave is made to suffer rather high attenuation due to radiation loss. The far end of the conductor may be left open or shorted, rather than terminated, with negligible effects from the reflections occurring at the unterminated ends because of the small amount of energy remaining in the wave at this point. Thus, each portion of the wire serves as a radiator and as a feed for successive portions simultaneously.

Since horizontal polarization is desired, it is necessary that the traveling wave of current have its greater component horizontal, yet some vertical travel must be achieved in order that required vertical aperture may be secured. A helix can meet the requirements if its pitch and diameter are properly controlled.

The helix must meet certain dimensional requirements as necessitated by the frequency. The currents at like points in each turn of the helix must be in phase. Thus the current, in progressing from turn to turn, must be delayed for each turn a time equal to that consumed by an integral number of cycles. In other words, each turn must be an integral number of wavelengths in helical circumference as measured at the velocity of propagation along the helix.

It is necessary, of course, to be able to support this helical radiator, preferably with a strong metal mast. The spacing of the helix from the mast must be such that an appreciable amount of radiation loss will occur along the helix per turn. The total length of the helix must be adjusted, commensurate with the loss per turn, so that the order of resonance occurring due to end reflections is low enough to



Four-bay 500-mc antenna offers power gain of twenty

This article is based on a paper presented at the fifth annual NARTB Broadcast Engineering Conference, April 1951, in Chicago.

avoid partial cloverleafing of the horizontal pattern because of the resonant current component. The active length of the helix must not be so great that the beaming bandwidth is too narrow because of progressive phase shift, yet long enough that a fair portion of the aperture is illuminated by one feed.

The operation of the helix can be analyzed by studying the radiation from one turn, and then applying well-known array factors to sum up the effect of all the turns.

Figure 1 shows the calculated results for the vertical pattern up to modes including the fifth (mode numbers correspond to numbers of wavelengths per helix turn). Note that the one-wavelength mode radiates rather uniformly in most directions, better along the axis than in its plane. This is the mode commonly used in the well-known endfire helices.

The one-wavelength mode does not lend itself to practical mast support. The strong loop field passes directly through the center of the loop, and a large metallic member causes serious disruption of normal operation. By using a higher-order mode, where the field at the center is zero, and where the diameter per turn is large enough to permit a sufficiently strong support without seriously disturbing operation, the desired radiation characteristics can be obtained.

Figures 2A and 2B show a sketch of the instantaneous fields existing in one turn of a first and second mode helix. Figure 2C shows the second mode helix field after a mast of required supporting size (for a power gain of 20) has been inserted along the axis. The fields of the one-wavelength helix would induce large counter currents in a mast the size of that in Fig. 2C. The net radiation loss per turn, because of the close mast spacing, would be too small to permit construction of a practical attenuated-traveling-wave antenna. The fields in the second mode helix have not been seriously disturbed and the mast counter currents are proportionately reduced. The radiation loss per turn is now large enough to result in a useful attenuated traveling-wave. The mast size may now be adjusted to provide the desired loss per turn.

The mathematical analysis of one turn for the unattenuated case shows that the azimuth pattern is independent of azimuth angle or helix pitch in the plane at right angles to the helix axis, or the horizon. However, the pattern gradually becomes scalloped as the vertical, or parallelism with the helix axis, is approached. The depth of scalloping is a function of the helix pitch angle. No scalloping occurs with zero pitch angle. The scalloping is insignificant in the region of the horizontal beam produced by a practical helix.

Naturally, there is some component of vertically polarized radiation from the helix because of the helix pitch. The percentage of this component is appreciable when based on the analysis of a single turn. However, by making use of a right and a left hand helix, placed end to end and fed in the center, the vertical components can largely be made to cancel, while the horizontal components are reinforced.

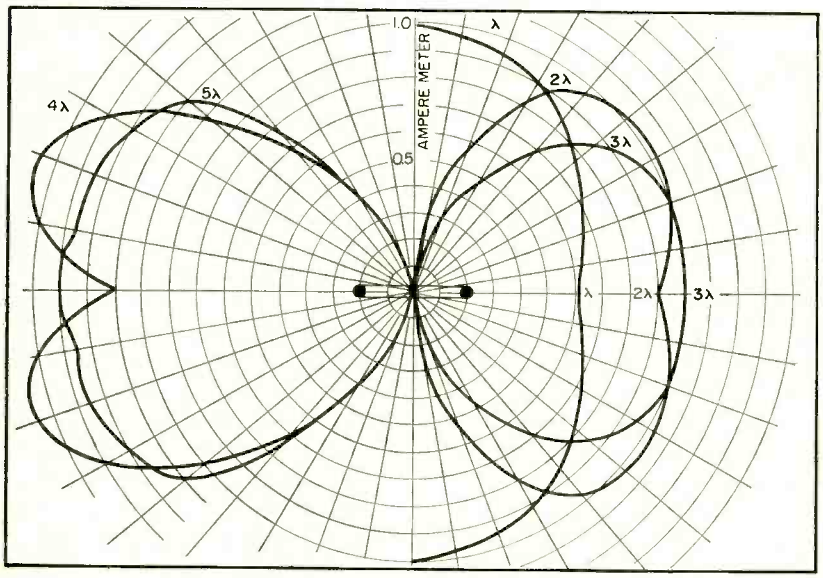


FIG. 1—Vertical patterns from one turn of integral-mode helix with zero pitch and attenuation. Patterns are shown up to fifth mode

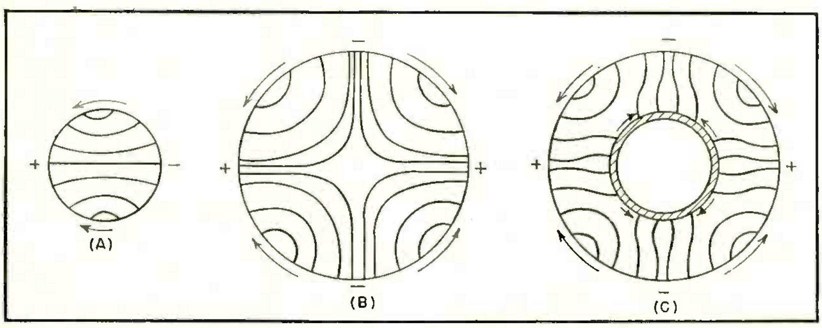


FIG. 2—Partial instantaneous fields in first-mode helix without mast (A), in second mode without mast (B), and in second mode with mast (C)

Four-Bay Antenna

The high-gain antenna is made of four vertically-stacked bays each having a power gain of five. Most of the initial development work was done on models in the 2,000 and 1,000-mc region to facilitate construction and handling. Since all four bays of the high-gain antenna are electrically identical, only one bay will be described in some detail. Operation in the second mode was found to satisfy all electrical and mechanical requirements. That is, each turn of the helix is two wavelengths in circumference at the velocity of propagation along the helix. The antenna has thus come to be called a second-mode side-fire helical antenna.

The length of one bay is five wavelengths. This length also corresponds to the distance between feed points of the four bays. A series feed is used and the distance between feeds must be an integral number of wavelengths to yield in-phase feeding of the four bays. The five-wavelength bay spacing results in near optimum array factor for the particular pattern produced by one bay.

Figure 3A shows the vertical pattern produced by one bay of a 500-mc model. Note the lack of side lobes, in spite of the fact that each bay in itself is in reality a multibay array. This results from the exponential energy distribution over the aperture of one bay. Figure 3B shows the horizontal pattern attained for a one-day model having certain constructional features.

Feed System

A right and a left hand helix are used in each bay. Each helix has five turns. The two helices are placed end to end, and fed at their junction, which is in the center of the bay.

The use of center feed on each bay prevents beam tilt in the beam of the basic bays. The upper and lower portions advance and retard in phase, keeping the maximum field on the horizon. However, the beamwidth will increase, resulting in a net reduction of gain. The beaming bandwidth is defined as the total frequency separation between the two points where the half-power beamwidth has increased 1 db.

For television purposes, it was decided to make this bandwidth on the order of twenty megacycles, to insure that over the channel the gain variation would be negligible. The beaming curve has a rather flat bottom; the channel under consideration may be placed on this flat portion. Feeding the two helices in parallel has the advantage of reducing the feed resistance per bay to a more convenient value.

By estimating the attenuation and calculating the surge impedance, it was found that the net distributed radiation resistance per turn is on the order of 200 ohms. In the uhf range, even such a high value of distributed resistance results in insignificant phase angle in the surge impedance of the helix.

The helices are supported by Kel-F insulators. This material has excellent mechanical and weathering properties, combined with a very low dielectric constant. A low dielectric constant is desirable to prevent reflections at the support points. The loss factor is high compared to polystyrene or Teflon, but not high enough to result in sufficient loss to cause damage to the insulators, even with ten kilowatts into one bay. There are, of course, no resonant high-voltage points to cause trouble. The ends of the helix may be grounded to the mast to provide lightning protection.

The intrabay feed system is coaxial, with the mast itself serving as the outer conductor. The inner conductor is shorted to the mast a quarter-wave above the top bay feed for mechanical support and r-f isolation of the rest of the mast. The main-line input at the bottom of the antenna is designed for $3\frac{1}{8}$-inch line. This input enters the mast from the side through a special matched T. The inner conductor is again shorted to the mast a quarter-wave below this input.

The individual bays are probe-coupled to the inner conductor not making direct connection. The probes are adjusted so that each bay receives one-quarter of the input power. Impedance match is maintained throughout the mast coax for maximum bandwidth.

The hollow inner conductor is of adequate size to permit the beacon lighting cable to pass directly up inside it. Thus a means is provided for running this cable without danger of disturbing the antenna operation as might occur if the cable had to be run outside the mast.

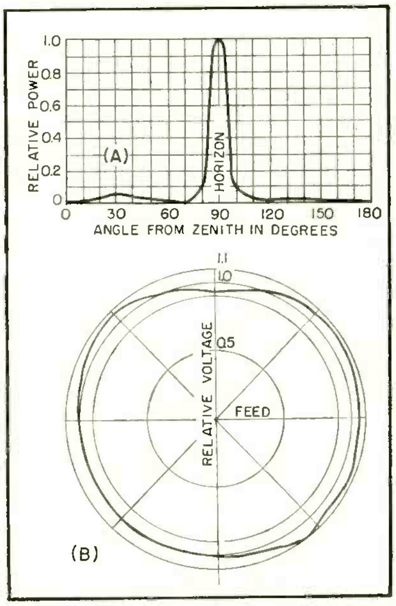


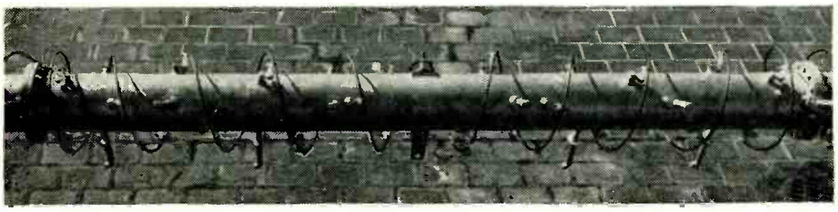
FIG. 3—Measured vertical pattern (A) and horizontal voltage pattern (B) of single-bay 500-mc model

The series type feed system used will cause overall beam tilt to result when the frequency is shifted far enough from center. Over one television channel the amount of tilt occurring is inconsequential.

For very high installations it might be desirable to tilt the beam downward so as to graze the horizon, because of the narrow beam. This antenna lends itself admirably to simply accomplishing this beam tilt to the small amounts desired without disturbing the impedance and power distribution. Because the currents on the antenna are of the traveling-wave type, the instantaneous phase is a function of azimuth. Hence, by mechanically rotating one portion of the antenna relative to the other portion, beam tilt can be produced because the relative phase between bays has now been effectively changed.

Sleet-melting is accomplished by running sufficiently high 60-cycle current through the helix Copperweld conductors.

To Professor Howard G. Smith of Cornell University, who spent the summer of 1950 with G-E, goes much of the credit for development of successful operating models of this antenna. Credit is also due R. E. Fisk, who contributed many ideas and gave patient assistance.



Closeup view of one bay of 500-mc sidefire helical antenna. Each turn of the helix is two wavelengths long at the velocity of propagation along the helix

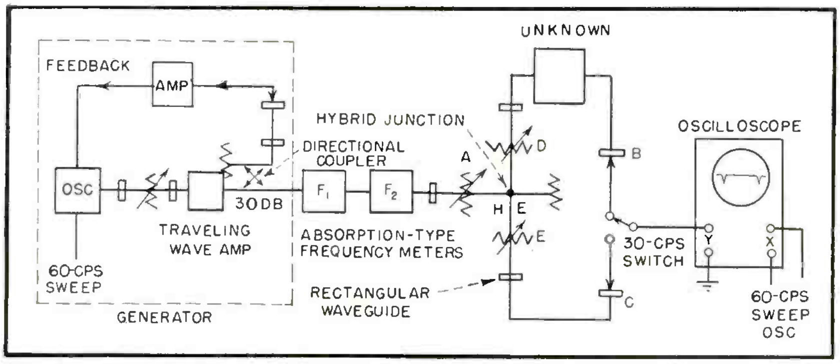


FIG. 1—Basic circuit using 500-mc sweep at 60-cps rate in 4 kmc region

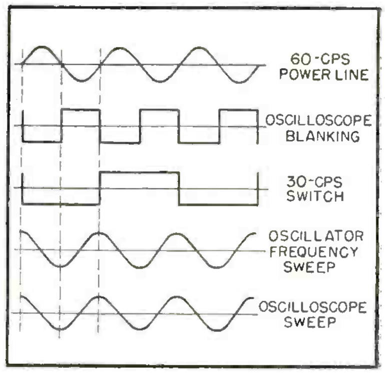


FIG. 2—Control voltage waveshapes

Traveling-Wave Amplifier Measurements

Rapid sweep-frequency technique used at 4,000 mc can be applied to all broad-band amplifier measurements. Oscilloscope display shows transmission accurate to 0.1 db and return-loss values up to 40 db

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EXTENSION of microwave common-carrier circuits for transcontinental television programming has necessitated the development of quick and accurate test procedures. Techniques described in this article have direct application at 4,000 mc, but the same methods are also in general use in the regions of both 60 and 400 mc.

For general studies of broadband networks, amplifiers and particularly traveling-wave tubes, it is advantageous to use sweep-frequency measuring techniques. By these methods it is possible at a glance to observe either the transmission or impedance characteristics. When adjustments are made, the effect on the overall characteristic is seen. This is particularly important in double-coupled or staggered-circuit work.

By careful design and construction of the measuring equipment it is possible to make transmission measurements to an accuracy of better than 2 percent over ranges of 500 megacycles in the 4,000 megacycle common-carrier band.

A block diagram of the basic circuit is shown in Fig. 1. At the left is the r-f power source consisting of a low-power microwave oscillator of the close-spaced triode type driving a traveling-wave amplifier having an output of about one watt, which is sufficient for the type of measurement to be described. By mechanical means, the oscillator is swept at a 60-cycle rate from 3,700 to 4,200 megacycles.

A small amount of power from the traveling-wave tube is rectified by a crystal, is amplified and fed back to the grid-bias circuit of the oscillator to provide envelope feedback around both the oscillator and amplifier. In this manner the output of the traveling-wave amplifier is made flat to about ±0.2 db over the band.

The power passes two absorption-type frequency meters that provide two markers on the oscilloscope trace to indicate the band limits. The power divides equally in the hybrid junction, passes through two attenuators, and is rectified in two identical crystals.

The outputs of the crystals are switched at a 30-cycle rate by a polarized mercury-type relay and are alternately connected to the Y-axis amplifier of a standard oscilloscope. Attenuators *D* and *E* are adjusted until the traces coincide and the gain of the Y-axis amplifier is adjusted for a sensitivity of one db per inch deflection between the two traces as measured by either attenuator *D* or *E*.

A circuit to be measured may now be placed in the unknown position. Attenuator *D* is adjusted until the traces again coincide. The gain or loss of the circuit is indicated by the change in attenuator setting and the flatness is indicated to an accuracy of about 0.1 db on the oscilloscope scale by direct comparison of the oscilloscope traces.

Figure 2 shows the waveshapes of the control voltages referred to the 60-cycle power-line wave. Waveshapes of oscilloscope blanking, 30-cycle switch voltage, oscillator frequency and oscilloscope sweep

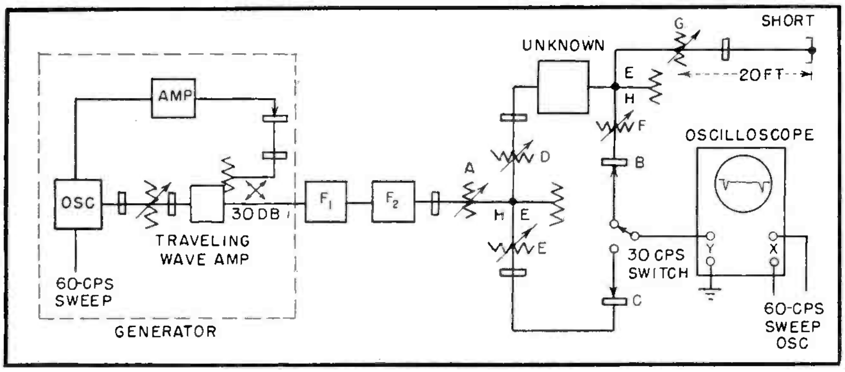

FIG. 3—Circuits for measuring transmission and output-impedance characteristics of broad-band networks or t-w amplifiers

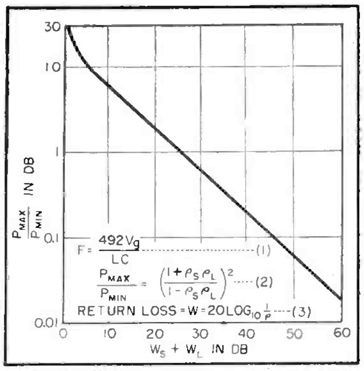

FIG. 4—Relationships used in the long-line impedance measuring

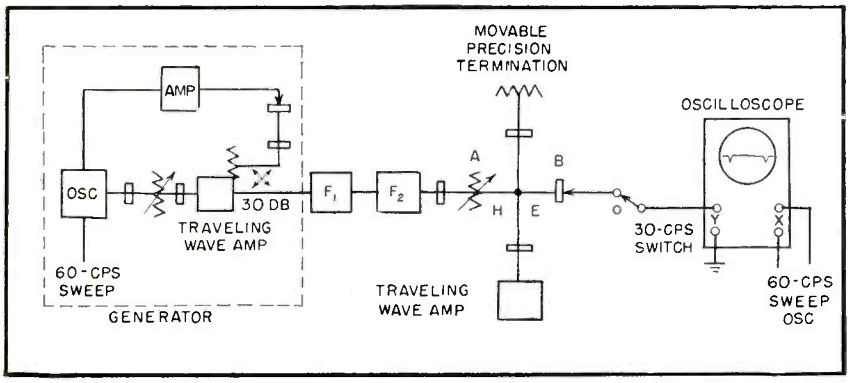

FIG. 5—Modification to measure input impedance of the t-w amplifier

versus time are shown. The oscilloscope sweep voltage is made to match approximately the oscillator frequency-sweep characteristic so that the frequency display is linear to within 10 percent. Each time the oscillator frequency is increasing the 30-cycle switch operates connecting one of the two crystals B or C to the oscilloscope. Hysteresis effects of the mechanical sweep mechanism are eliminated.

Figure 3 shows the circuit to measure simultaneously both the transmission and output impedance characteristics of traveling-wave amplifiers or broad-band networks. Measurements at both high and low power can be made. The circuit is similar to the basic circuit shown in Fig.1 except for the addition of a second hybrid junction, two calibrated attenuators, and a 20-foot section of shorted waveguide.

The set is calibrated by omitting the traveling-wave amplifier to be tested and adjusting attenuators D and E until the traces coincide as before with attenuator G at maximum attenuation. The amplifier to be measured is inserted and attenuator D is adjusted until the traces again coincide. The change in attenuator D setting is the gain. By substituting a power meter for crystal B and taking into account the 3-db loss in the hybrid junction and the loss of attenuator F the power output may be measured.

The output impedance of the traveling-wave amplifier with the tube delivering its normal power output may also be measured by adjusting attenuator G for a convenient amplitude of ripples on the transmission characteristic such as 0.1 db. With this amplitude of ripples the sum of the return loss of the sending and load impedances is 45 db. For this ripple amplitude, the return loss is the difference between 45 db and twice the sum of the loss of the 20-foot waveguide, the loss of the hybrid junction and the attenuation of attenuator G.

The equations on Fig. 4 show some simple relationships as used in the long-line method of measuring output impedance. Equation 1 is the frequency in megacycles between ripples related to the line length. In this relation, V_g is the group velocity; L is the length of the line in feet; and C is the velocity of light. The line length is chosen to provide the desired resolution of impedance characteristic.

Equation 2 is the relation of the standing wave as seen on the oscilloscope to the reflection coefficients of the source and load impedances. Equation 3 is the relation of return loss to reflection coefficient.

Equations 2 and 3 are plotted in Fig. 4. For convenience the point corresponding to a total W of 45 db is chosen in making measurements.

The arrangement of apparatus shown in Fig. 5 is used to measure the input impedance of the traveling-wave amplifier. To calibrate, a short circuit is substituted for the traveling-wave amplifier under test, attenuator A is set to 40 db and the gain of the oscilloscope is adjusted until the signal trace is separated from the base line by 0.1 inch. A return loss of 40 db can now be measured.

The base line is obtained by disconnecting one crystal from the 30-cycle switch. The accuracy of measurement is checked by connecting a termination with a W of about 40 db in place of the traveling-wave amplifier under test and setting attenuator A to zero db. Movement of the precision termination will cause ripples to move on the signal trace. If the balance of the hybrid is good and the W of the precision termination is satisfactory, these ripples will be small compared to a W reading of 40 db.

The traveling-wave amplifier input impedance may now be measured by connecting it as shown and adjusting attenuator A for 0.1-inch deflection on the oscilloscope. The return loss is read directly as the difference in attenuator A setting.

WHERE A MULTIPLICITY of information sources must be observed, some system of scanning or sequential sampling may be employed so that certain pieces of measuring equipment need not be duplicated for each information source to be studied. Where the information sources are of low level, special design problems arise. Several high-speed scanning systems are described below that are applicable to low-level operation.

There are two general types of scanners. First, scanners in which the commutating element also carries the information; and second, the type in which the information-carrying element is controlled by a separate commutating system. The capacitance scanner is one of the first type.

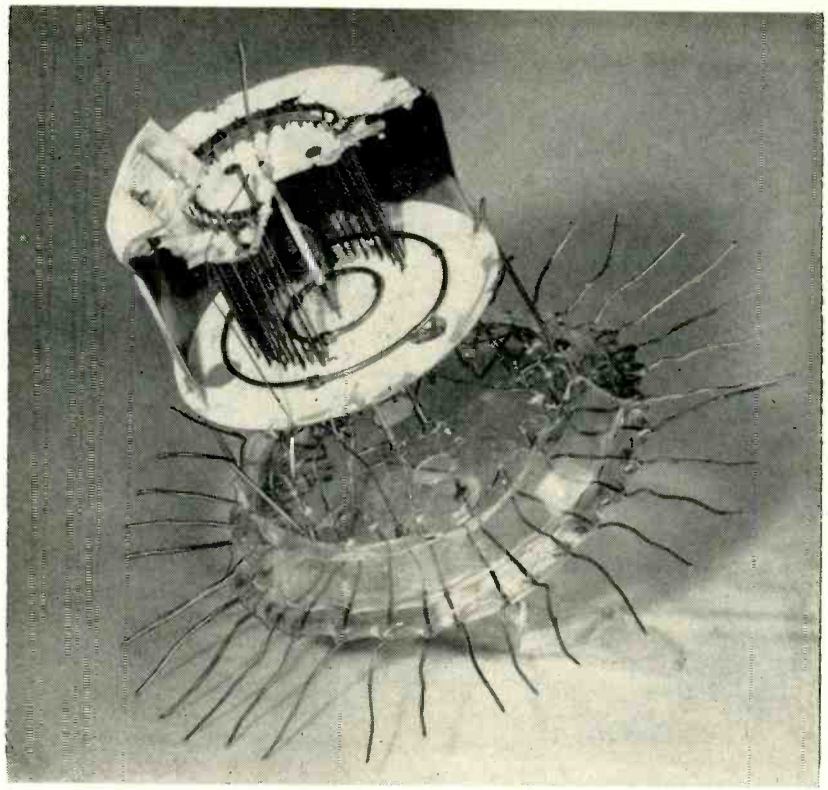

FIG. 1—Cutaway view of multiple element radial beam tube scanner

High-Speed

Capacitance Scanner

Basically, the capacitance scanner consists of a large number of input plates to which the individual signal sources are attached. The information applied to the input plate is capacitively coupled to a pickup plate which is moved successively from one plate to another in a predetermined order.

Within the frequency limits of the scanner, the capacitance system is an ideal scanning device. The noise components resulting from the scanning operation are practically eliminated since the variation in average d-c potential from input element to input element is negligible and no direct current flows through the scanner. The noise performance is limited by the output impedance, Johnson noise, and the losses through the scanner.

As is true with most mechanical devices, the life of the capacitance scanner is limited. Another basic limitation of this type of scanner is the top operating speed.

MERB Tube Scanner

For very high scanning rates it is necessary to go to the use of electron beams or electronic circuits. Figure 1 shows a cutaway view of a typical multiple element radial beam tube scanner. For the sake of simplicity the abbreviation MERB tube[1] will be used in connection with this tube. Figure 2 is a photograph of such a tube in a complete 50-element scanner. The arrangement of the elements is shown in Fig. 3.

The physical construction and relative location of the elements is similar to a standard pentode. A common heater and cathode are located at the center as an electron source. The next element out is the inner grid or accelerating grid common to all elements; next, the screen posts, then the signal grids, in the suppressor grid position, and finally the plate. Each signal grid is separated from the adjacent signal grid by a post. The MERB tube shown in Fig. 1 has twenty-five separate signal grids.

In operation, the tube is placed in a strong uniform magnetic field perpendicular to the cathode so that the electron stream from the cathode is focused into a radial beam which flows through one of the signal grid elements to the plate. The focusing of the electron beam is controlled both by the strength of the field and by the voltages on the tube elements. By varying the voltage on this signal grid the current to the plate can be varied. By rotating the field about the axis of the cathode the electron stream can be focused successively on each signal grid. The focusing action of the field produces a double-ended electron beam; with the result that all elements are scanned twice with each revolution. The scanning rate is twice the number of elements times the excitation frequency.

In the scanning system shown in Fig. 2 the MERB tube is used to scan 50 input elements. Each input element has a preamplifier and each element of the MERB tube is connected to two preamplifier outputs. By switching the input preamplifiers *on* alternately in groups as each end of the scanner beam comes around, all 50 elements are scanned by one revolution of the field about the MERB tube. This

This article is based on a paper presented at the 1950 National Electronics Conference. The Conference paper appears in the *NEC Proceedings*.

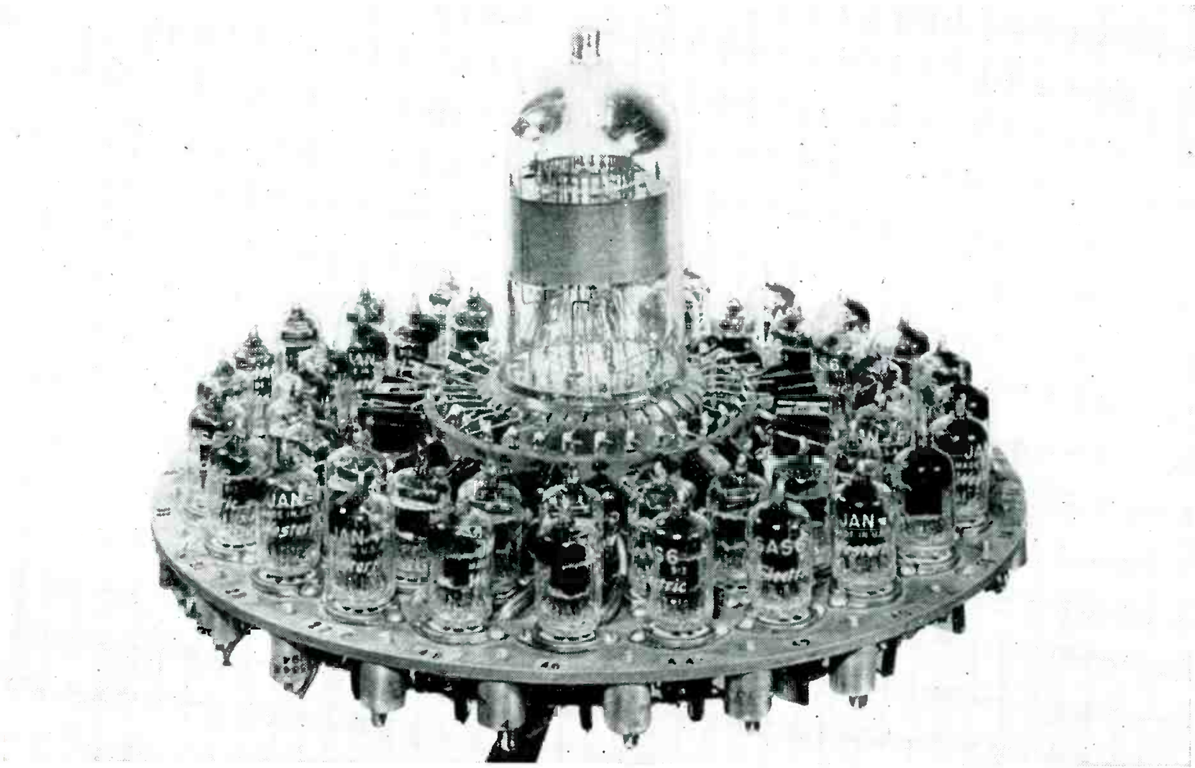

FIG. 2—Complete scanner using multiple-element radial beam tube to sample 50 different signal sources

Sampling Techniques

Space, materials and money can be saved by scanning low-level information sources and using common amplifying, indicating and recording equipment. Survey of sampling systems helps designers choose best system for application to future developments

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same system could be extended to enable a 25-element MERB tube to scan any multiple of 25 inputs.

The major precaution necessary to keep the scanning noise of the MERB tube at a low level is to operate with very low plate current. Low plate current and reasonable transmission is obtained by the use of low voltages on the tube elements. This method of operation necessitates accepting relatively high loss through the tubes, about 6 to 1. The actual gain or loss through the scanner is not in itself too important except for its affect on overall signal-to-noise ratio of the system. The scanner noise should always be greater than the thermal noise level in the scanner output circuit. For most applications it has been necessary to use a one-tube preamplifier ahead of each element to get optimum signal-to-noise ratio.

F-M Scanner

Figure 4 shows a circuit diagram of an f-m scanner. This scanner is the type in which a vacuum-tube amplifier is provided for each input element. The vacuum-tube amplifier is normally biased *off* so that no information can be transmitted from the input to the common output. When it is desired to read information from that particular input element the vacuum-tube amplifier is biased *on* and allowed to transmit the information to the

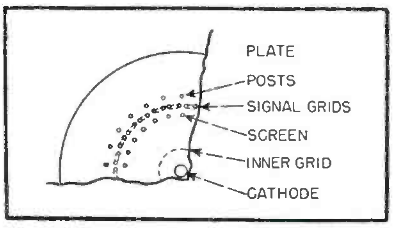

FIG. 3—Physical construction and element arrangement of MERB tube is similar to standard pentode

output circuit. Several methods are available for performing this switching operation. The particular commutation control element described here is called an f-m scanner control unit. It has the advantage that the equipment required at the scanner itself is small and light and does not necessarily contain vacuum tubes. Only one line is needed between the scanner and the control element, and the control element can be remotely located if necessary. The number of elements is not restricted and can be easily changed.

Each scanner element is provided with a tuned circuit T_1 and diode rectifier D. Power is coupled into each tuned circuit from a common bus coming from the control unit. When the common bus is excited at the frequency of the tuned circuit, an a-c voltage is transmitted to the diode rectifier element and a d-c output proportional to the excitation on the common bus is applied to the grid of the scanner tube. If the tube is normally biased *off* and the polarity of the rectified signal is such as to bias the tube *on*, then that particular tube can be turned on by exciting the common bus at the frequency of the resonant circuit. If each resonant circuit of the different scanner elements is tuned to a slightly different frequency from the one next to it, the circuits can be switched *on* in sequence by sweeping the common bus excitation frequency through the range of the tuned resonant circuits.

Smooth commutation from element to element is obtained by using the tuned circuit resonance curve as the switching pulse. A smooth or linear sweep frequency rate is used in this case. If desired, an effective square-wave pulse can be applied to each grid by stepping the frequency from that of one tuned circuit to that of the next and so on. It is also possible to stop and turn on only one element at a time and look at that element for as long as necessary by merely exciting the common bus at that particular frequency.

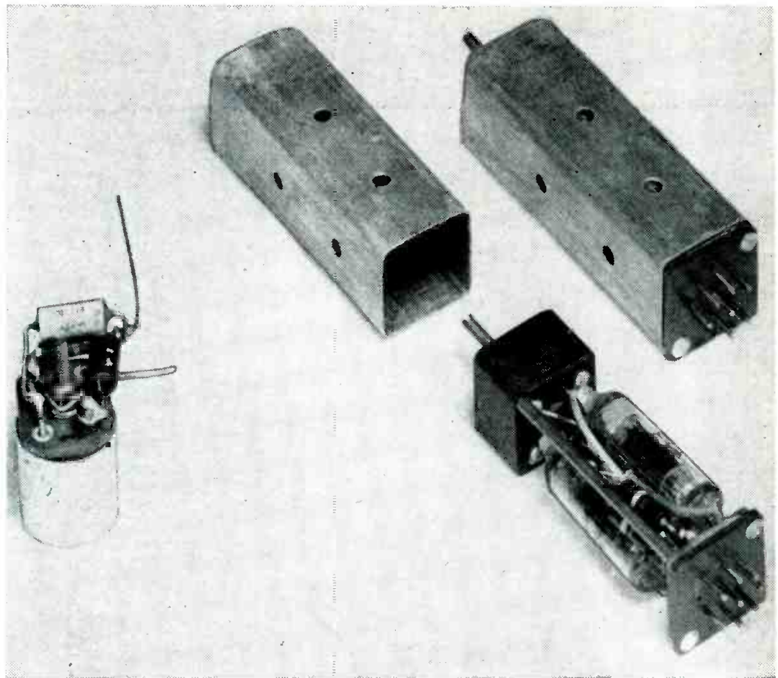

FIG. 5—Subminiature f-m scanner elements

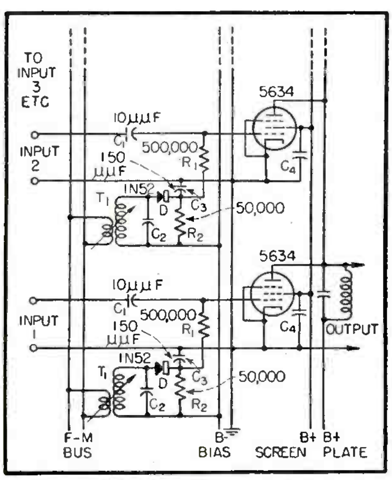

FIG. 4—Typical f-m scanner circuit

Figure 5 shows two different types of resonant frequency circuits and diode rectifier elements. The unit on the right and center uses subminiature tubes and contains both controlled preamplifier and the switching circuit. The unit on the left uses a germanium diode mounted directly on the tuned circuit. The preamplifier is not included.

Scanning Noise

A scanner as it operates, scanning the input circuits, will generate in its output circuit a complex voltage or current fluctuation which is caused by the scanning action. This noise voltage or current fluctuation is a complex wave which repeats each scanning cycle. In general, this scanning noise is larger than the Johnson noise of the system and is the noise level which limits the application of the scanner to low-noise circuits.

The scanning noise of a scanner is actually made up of a broad spectrum of finite frequency components each of which is a multiple of the scanning rate. The amplitude of each of these components decreases as the frequency of the component increases. In practice, the scanner output is fed into a band-pass filter which allows only the frequencies around the signal frequency to pass.

If the proper restrictions are placed upon the band pass of the filter following the scanner it is possible to plot a universal noise characteristic curve for the scanner. This noise characteristic will be the same regardless of the actual scanning rate of the scanner. The restriction which must be placed upon the band pass of the system following the scanner is that the band pass be just wide enough to pass the important modulation components introduced by the scanning action. Under these conditions the band pass becomes a fixed multiple of the scanning frequency, the multiplying factor depending upon the shape of the scanner output wave.

The actual noise characteristic for a scanner can be obtained at any practical operating scanning speed. It is possible to evaluate a scanning apparatus with normally available laboratory equipment and using low or readily available scanning speeds. If the information obtained is plotted as shown in Fig. 6 with a horizontal scale which is a multiple of the scanning rate, the resultant curve is the noise characteristic of the scanner and can be applied to all operating scanning rates for the scanner to determine the circuits required ahead of the scanner.

The two curves on Fig. 6 show the noise characteristic of the MERB tube scanner and the f-m scanner. Both characteristics have essentially the same shape. The level of the noise curve depends upon how well balanced are the different tubes or elements of the scanner. If all of the elements are exactly the same and are switched simultaneously there will be very little scanning noise generated. Practically speaking, this is never true; hence, the amount of noise generated in a scanner depends upon the patience and ability of the designer to select tubes or design a circuit to eliminate tube variations.

The actual rate of cutoff of the noise characteristic curve can be improved by the use of properly shaped pulses for switching. Smooth commutation such as that available in the f-m unit will tend to reduce the high-frequency components of the noise. This is shown by the faster decay in the characteristic curve for the f-m scanner. In this particular case the element amplifiers were operated at normal plate current levels. In general, the level of the noise charactertistic can be reduced by operating the tubes at very low current levels.

Reducing Noise

Once the noise characteristic of a scanner is obtained it is fairly easy to outline methods which can be used to make a scanner operate at lower signal levels. Two general approaches can be applied. One is to modify the external circuit to make the best use of the scanner noise characteristic; the other is to work directly with the scanner to try to reduce the level of the noise characteristic.

A study of the noise characteristic curve will show that there are two ways of reducing noise by external circuit modifications. One is to increase the frequency of the signal carrier and the other is to reduce the band pass to the absolute minimum required to pass the information. If the application permits, raising the carrier frequency is an easy way to reduce scanner noise. If the signal frequency cannot be changed, the operating frequency of the scanner can often be raised by mixing in the scanner. The normal loss in gain due to mixing must be taken into account so that a larger increase in frequency is required than would be needed if mixing were not used.

In working with the scanner directly there are four methods or approaches for improving the noise characteristic or reducing the amount of noise generated by the scanning action. All four methods are based on reducing the amplitude of the variation between elements or reducing the switching rate between elements:

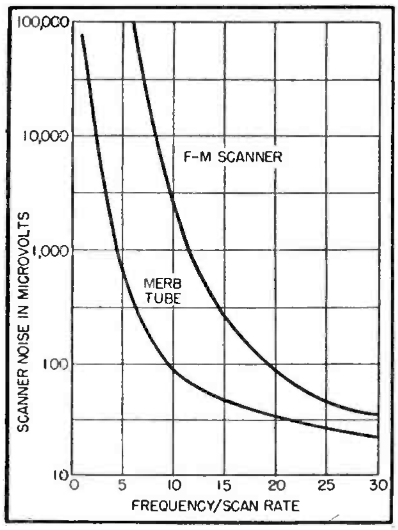

FIG. 6—Noise characteristics of two scanner types

(1) Reduction of the quiescent or average d-c level of the scanner to the absolute minimum necessary to give useable results. The scanning noise components are proportional to the average current. If the average current can be reduced without a proportional reduction in signal gain, a net improvement in signal-to-noise ratio results.

(2) Balancing of all the scanner elements so that differences between d-c element values are reduced to a minimum.

(3) Increasing the cross-over time between elements. This can be done by proper shaping of the transfer conditions so that a minimum amount of high-frequency components is generated. In general, the noise is generated during the switching period between elements and is caused by dissimilarity between elements of the scanner or gaps in transmission between elements. Any procedure which tends to reduce the dissimilarity and eliminate the gap or reduce the rapidity with which the dissimilarity or gap occurs will aid in reducing the amplitude of the high frequency component generated by the scanning action. An improvement of this kind makes the noise characteristic decay faster with increase in signal frequency.

(4) Reduction of scanning rate. If a slower scanning rate can be tolerated, this will have the same effect as increasing the signal carrier frequency. In addition, a narrower band pass can also be used.

The foregoing methods for improving signal to noise performance of a scanner can be applied to any such commutating device. In general, to utilize a scanner at very low signal levels it is necessary that the information in the signal be available to the scanner at a frequency higher than the scanning rate. Just how much higher will depend upon how low a signal level must be observed and upon the noise characteristic of the particular scanner.

The scanners described here have utilized a switching characteristic or wave form approaching a cosine function in order to obtain smooth commutation. Other switching characteristics will produce a different scanner noise characteristic curve, but the basic problems are the same. Optimum scanner design for any application requires a suitable compromise between circuit complexity, switching characteristics, scanning rate, and scanning noise performance.

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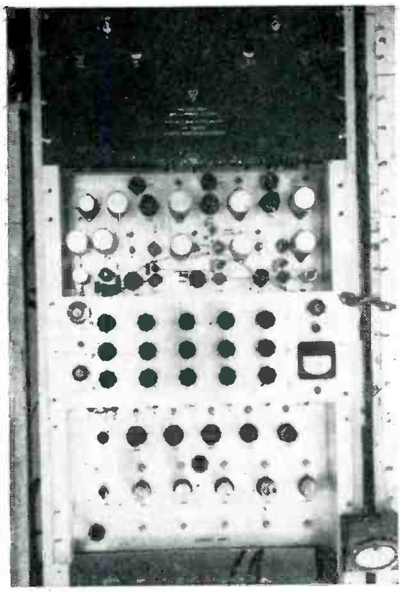
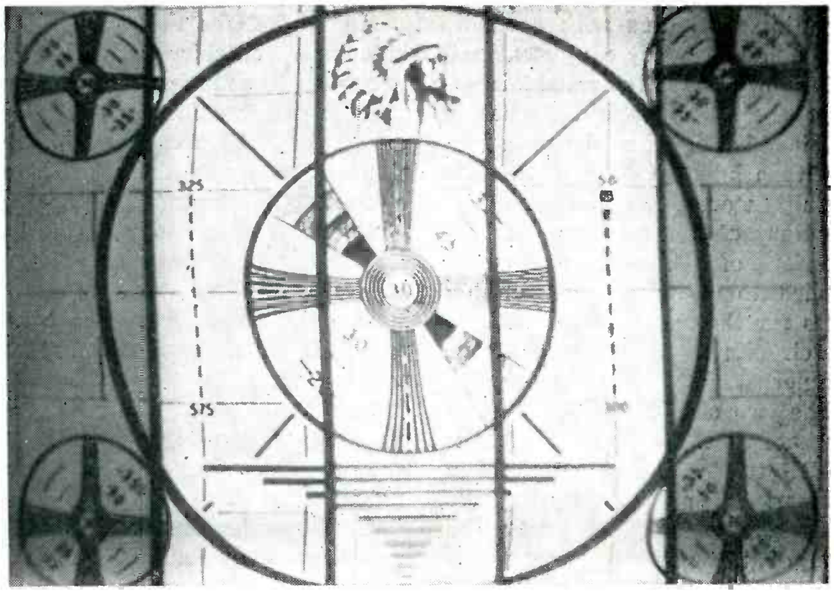
(1) A. M. Skellett, Magnetically Focused Radial Beam Vacuum Tube, Jour. App. Phy., p 704, Oct. 1944.



Color generator, exclusive of power supplies, occupies 24½ panel inches



In color, bars from left to right would appear as red, green, white, yellow and blue for this particular setting of color potentiometers

Picture Generator

Simple equipment is added to conventional black-and-white picture-generating setup to provide color-striped pictures for testing either simultaneous and dot-sequential systems or field-sequential system. Complete adjustability of colors is possible

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THE CURRENT INTEREST in color television systems is, among other things, likely to produce the need for a simple means of generating color television signals.

In the early stages of the present monochrome television system, complete camera chains were soon discarded in favor of the simpler and more reliable monoscope pattern generator as a general laboratory and test line video signal source. In the design, development, and manufacture of color television apparatus, a simple and reliable signal generator is also highly desirable. Current techniques for the production of color television signals rely heavily upon flying-spot scanners or direct-pickup cameras. Although these devices may be made reliable, they are not particularly simple, nor are they inexpensive. In addition, the versatility of subject material provided by such apparatus is a feature of questionable merit for routine testing.

The purpose of this article is to describe a simple all-electronic source of color television images which may be added to an existing black-and-white television installation. The unit will provide signals for either simultaneous and dot-sequential systems employing current monochrome standards or for the recently standardized field-sequential system.

Output from the apparatus consists of a monoscope or other television test pattern upon which is superimposed a series of five vertical bars. The hue and saturation of each bar is independently variable and under the operator's control. Any color combination whatever, including black or white, may be obtained. The color signal generator derives its input signals, including the monoscope pattern, from existing television equipment.

Color Mixers

A block diagram of the signal generator is shown in Fig. 1. The black-and-white video pattern to be "colored" is inserted at the lower left of the sketch. Following amplification in the two-stage video amplifier, the signal is applied simultaneously to the three mixer, or modulator, stages marked green, red and blue. When no modulating

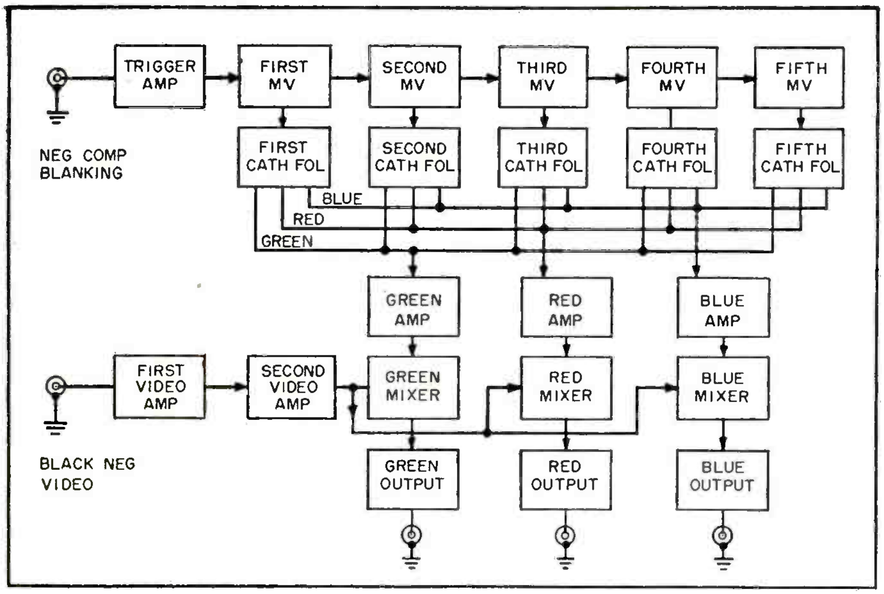


FIG. 1—Chain of five multivibrators, triggered by blanking signal, turns on five different colors during horizontal trace

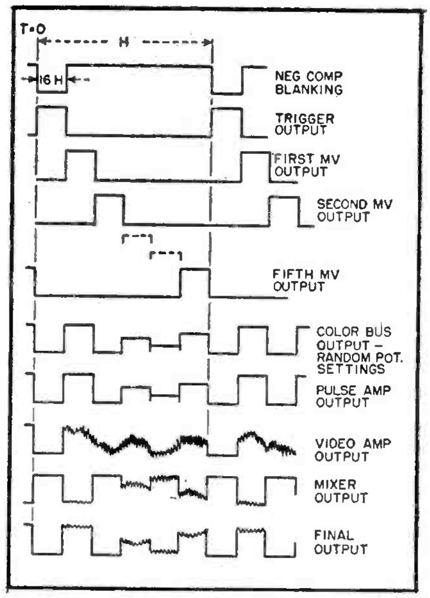


FIG. 2—Waveform chart shows functions of various stages during trace

For Color Television

signal is applied to the three mixers, we may assume that the gains of each mixer-output tube combination may be so adjusted that the green, red, and blue output signals are indentical, or nearly so; that is, the apparatus becomes essentially a triple output distribution amplifier. For a properly balanced three-color display, this condition will correspond, by convention, to a black-and-white picture. To obtain a color picture, the gains of the mixer tubes must be individually modulated in some desirable manner. One form of modulating signal which produces a useful geometrical color pattern may be obtained from the components shown in the upper portion of the diagram.

A negative composite blanking signal, that is, a white picture, is used as the triggering voltage for the input stage of a chain of five one-shot multivibrators. The trigger amplifier and first multivibrator are arranged to fire on the trailing edge of the blanking waveform, so that operation of the circuit begins synchronously with the start of the television system trace time. Upon completion of its turnover cycle the first multivibrator triggers the second of the chain; the second fires the third, and so on, until the action terminates with the operation of the fifth and last stage.

Each multivibrator is adjusted to have a pulse width of approximately one-fifth the system trace time, so that the entire action requires one line of the television picture. Consequently, the voltages applied to the cathode follower stages consist of five successive pulses occurring in time sequence across the picture from left to right.

The cathode followers (which also operate as limiters) are provided with a network of three potentiometers and three resistors in each of their cathode circuits. The object of this arrangement is to permit any amplitude of any one or more of the five pulses to be delivered to the three bus bars marked green, red and blue. The bus bars, in turn, are connected via suitable amplifiers to the suppressor grids of the green, red and blue mixer-modulator tubes, so that modulation of the input video signal in accordance with the various pulse amplitudes is the end result.

Figure 2 illustrates the functions of the various components of the block diagram. The blanking signal which triggers the five multivibrators is at the top. The second line shows the output of the trigger amplifier, an inversion of the input voltage. The first pulse generator output is shown on the third line of the chart. The second, third, fourth, and fifth pulses are generated in sequence—each one generated by relaxation of the previous stage.

A random mixture of the five pulses is shown at the center of the figure, while modulation of a video signal by this waveform is shown on the remaining lines. It should be noted that the bottom line, marked final output, represents the signal for one color only. When the apparatus is adjusted to produce a color picture, the three signal outputs will differ from one another as the green, red, and blue content of the picture varies across the image.

Since the timing of the pattern generator is determined entirely by

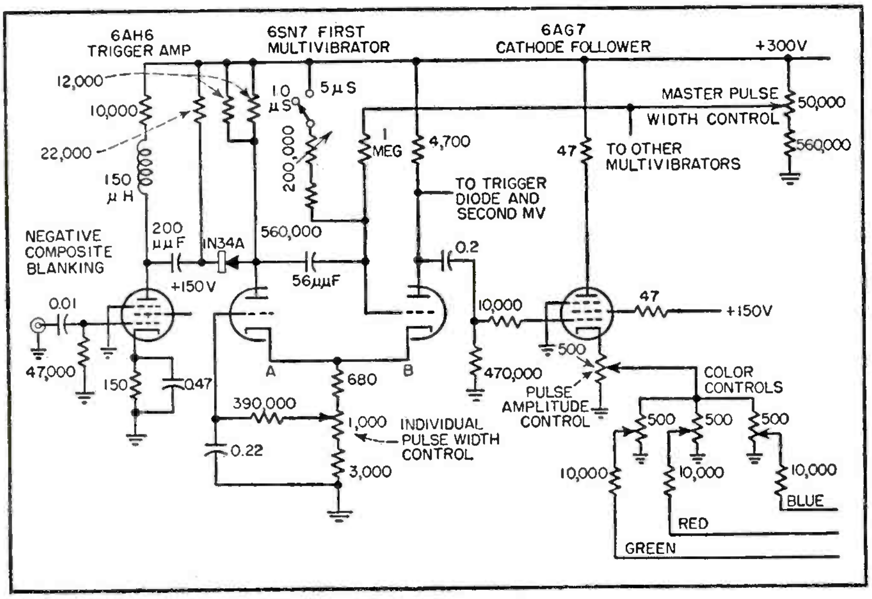


FIG. 3—Circuit of keying pulse generator. The switch adjusting the multivibrator time constant allows quick changeover from present standards to field-sequential standards

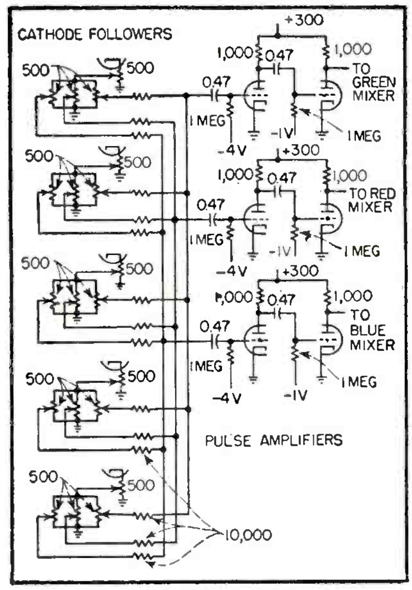


FIG. 4—Fifteen potentiometers in pulse mixer circuit shown permit adjustment of color in each band

the repetition rate of the input blanking signal, operation at line rates other than that standardized for black and white television may be obtained by changing the five pulse durations appropriately. To accommodate operation with the field-sequential color television system, we have included a ganged switch in the active grid time constant of each multivibrator, which may be used to halve the pulse width. The waveform chart would be the same for the higher speed operation.

Trigger Circuit

A simplified schematic diagram of the trigger amplifier and one of the pulse generators is shown in Fig. 3. The multivibrator is of the cathode-coupled one-shot type and is straightforward in design. The negative composite blanking signal applied to the grid of the 6AH6 trigger amplifier causes an abrupt drop in the amplifier plate voltage synchronous with the trailing edge of the blanking signal. The 6SN7 multivibrator and the 1N34A diode are arranged in such a way that the pulse generator is sensitive only to negative-going voltages. Accordingly, operation of the multivibrator is initiated by the trailing edge of the blanking signal.

The relaxation time of the multivibrator is controlled in the usual manner through the application of a variable bias voltage to the active control grid. In addition, as previously noted, a switch is provided to vary the time constant in this grid by a factor of two-to-one so that operation on either field sequential color standards or current black and white standards may be obtained. The second multivibrator of the chain is triggered by recovery of the first inasmuch as a large negative voltage drop appears at the first multivibrator output plate at this point in the cycle.

Mixing of the pulses generated by the multivibrators of Fig. 3 occurs in the cathode circuits of the five cathode followers which are shown at the center of the block diagram. In Fig. 4 may be seen the manner in which the five cathode-follower outputs are combined into three independently variable modulating waveforms. The word "independent" is based on the assumption that one percent crosscoupling between the various pulse amplitude controls is tolerable. Practical laboratory experience with the equipment indicates this to be the case.

Mixer Circuit

The circuit arrangement is such that any amplitude of any pulse may be applied to any one of the three bus bars by appropriate manipulation of the fifteen potentiometers. With reference to the generated color pattern, it might be said that the potentiometers of cathode-follower number one correspond to the red, green, and blue values of bar number one in the color picture, and so on.

Initial amplitude adjustment of each keying pulse is provided by a screw-driver adjustment, so that the pulse voltages from the cathode followers may be equalized. The 10,000-ohm resistors between the potentiometers and the bus bars provide isolation from crosscoupling. A simple two-stage amplifier is provided to raise the output from each color bus bar to a level suitable for operation of the video modulator tubes.

One of the modulator stages is shown in Fig. 5. The video signal is applied to the control grid of a 6AS6, while the pulse modulation voltage is applied to the suppressor. The d-c component is reinserted for both input signals so that operation of the modulator will be unaffected by variations in duty cycle of the video or pulse information. A meter is provided which may be switched into the cathode circuit of each modulator tube for the purpose of setting black current to within a few hundred microamperes of cutoff. Each modulator is followed by a conventional high-impedance current driver for low-impedance lines. The signal delivered to a 75-ohm cable from each output may be adjusted to a maximum of two volts peak-to-peak. The output signal does not contain synchronizing information since sync is seldom, if ever, present on a video signal at this point in a color television system.

Color-Monochrome Switch

Finally, the pattern generator contains one very useful device which will be appreciated by those who have been working with color television systems. This is a switch, called a COLOR-MONOCHROME switch, which may be operated to produce an unmodulated black-and-white output from the apparatus. When set to the COLOR position, the generator produces the color pattern set-up on the control panel. When the switch is set to MONOCHROME, the generator becomes essentially a distribution amplifier; that is, the video signals on all three outputs are identical, and are unmodulated. This arrangement is useful for checking the color balance of subsequent apparatus.

Some typical laboratory applications of the pattern generator's color signals might be of interest. For this purpose we will choose a monoscope test chart modulated so that the colors produced are red, green, white, yellow and blue as shown in the test pattern photo.

Oscillograms

First, this color signal may be applied to a dot-sequential color transmitter and the resulting video output observed on an oscilloscope operating at line rate. The oscillogram of Fig. 6A shows the sync signal, the color sync burst, and the video information together with the superimposed color carrier. The transmitter we are observing samples the color information at symmetrical angles, and is adjusted in accordance with the operating practice implied in the early proposals for a color television system of this type. It can be seen that the red, green, and blue areas, being saturated single colors, cause the color carrier to swing below black. For the yellow area, which is a saturated two-color area, overmodulation beyond reference white occurs, while for the white central area, the color carrier disappears altogether.

If the color carrier is removed, as in Fig. 6B, it may be seen that this transmitter is correctly adjusted to weigh red, green, and blue equally in the monochrome component of the transmitted signal. It is worthy of note that for any one color the contribution to the monochrome is one-third; for yellow it is two-thirds; and for white, of course, three-thirds.

Having checked the transmitter adjustments, the performance of the color receiver may be examined. It is desirable that the receiver reproduce the colors of the original scene with reasonable accuracy. That is, the phase of the local color subcarrier oscillator at the receiver must be correctly located.

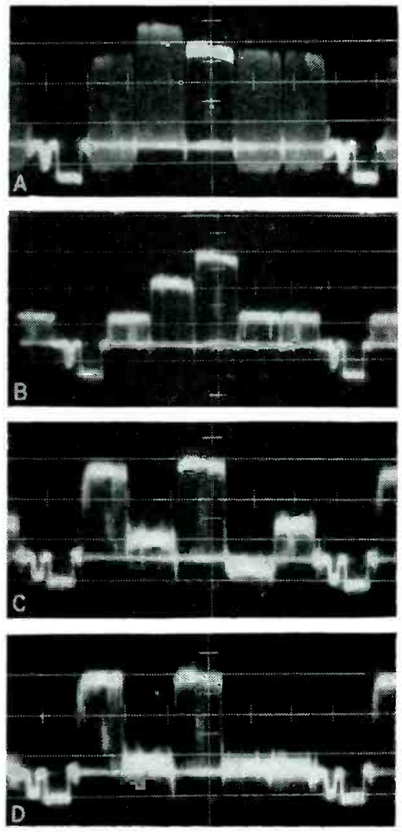


FIG. 6—Oscillograms show waveforms with different combinations of information, as explained individually in text

Let us connect the oscilloscope to the blue video signal channel of the receiver and observe the result. The original colors were red, green, white, yellow and blue, in that order. Therefore, an oscilloscope connected to the blue channel should show no signal during the red and green bars, full signal for the white area, no signal for the yellow bar, and full signal for the blue area. The oscillogram of Fig. 6C shows that this is not the case. Due to misphasing at the receiver, both the red and green areas of the signal show some output in the blue channel. In particular, the blue tube is slightly illuminated during the red area while it is driven below cutoff during the green area. In addition, the blue tube is not at full brightness during the blue area. Obviously, a readjustment of the receiver phase control is required. This operation is readily performed by adjusting for minimum signal in the red and green areas.

Figure 6D shows conditions prevailing in the blue channel for correct phasing.

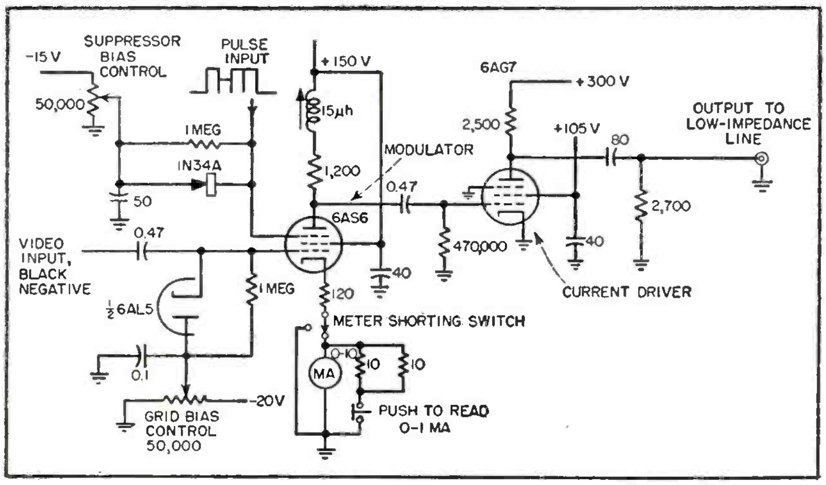
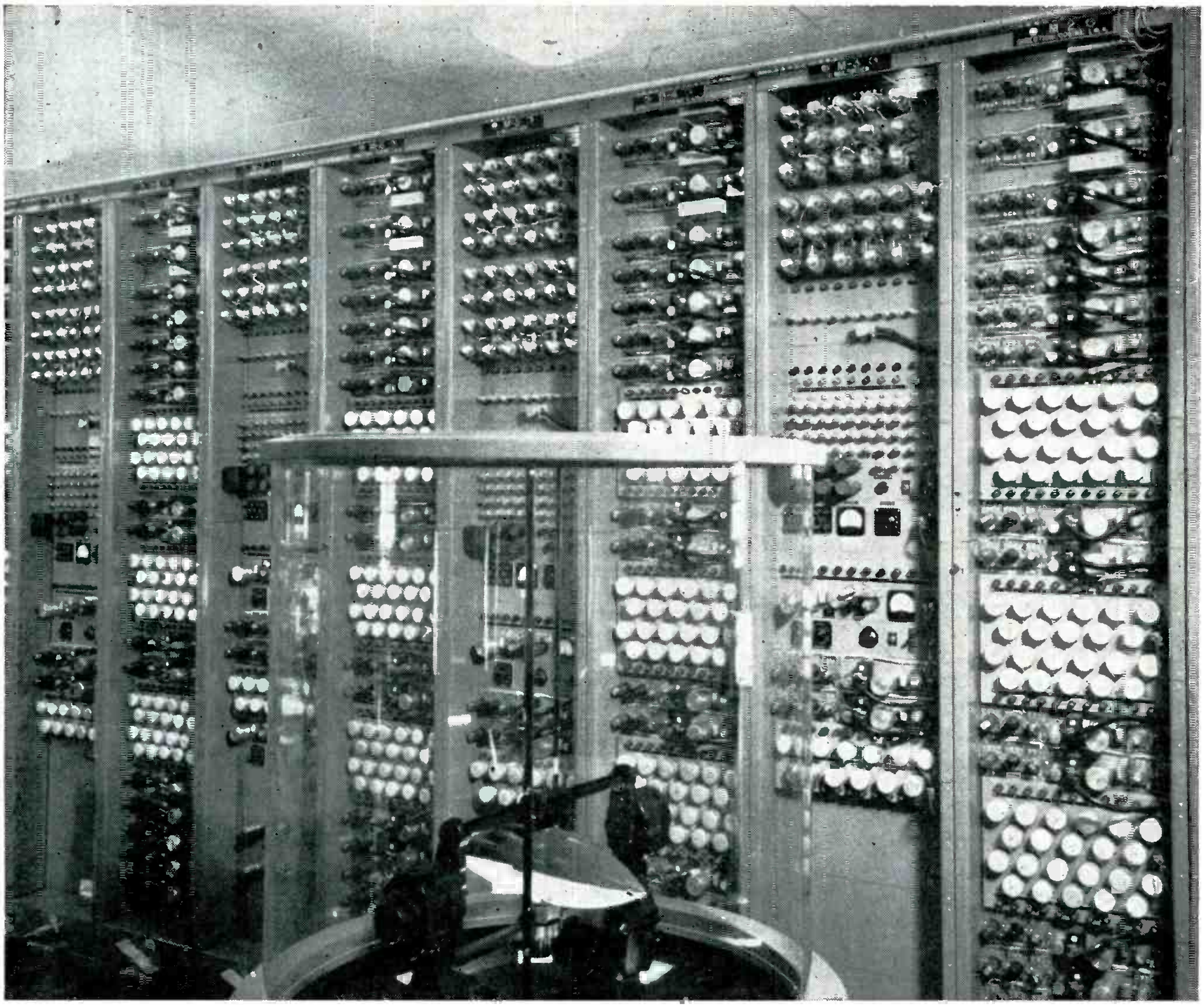


FIG. 5—Video information is fed to control grid of modulator, while pulse modulation voltage is applied to the suppressor



STEP MULTIPLIER RACKS (first, third, fifth and seventh racks from left) in missile simulator section of Project Typhoon computer. In foreground is servo-controlled missile model to show attitude of missile constantly during solution of target-interception problem

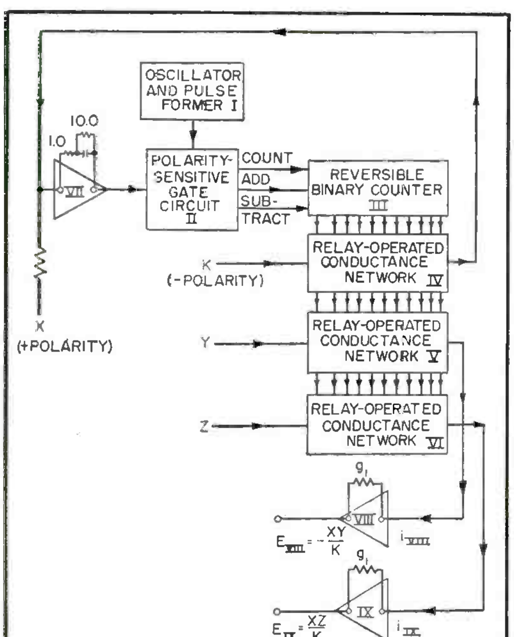


FIG. 1—Basic block diagram of step multiplier

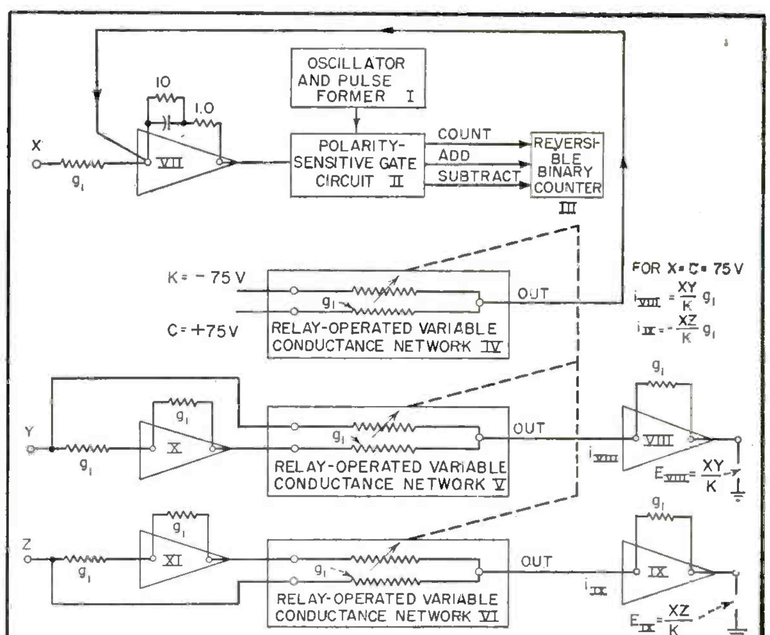


FIG. 2—Method of handling input voltages of both signs in multiplier

Step Multiplier in Guided Missile Computer

Need for test firings of new missile designs is minimized by simulating missile and target characteristics with new 4,000-tube analog computer. Required precision is obtained with reversible binary counter and relay-operated conductance networks in step multiplier

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PROJECT TYPHOON is a large-scale analog-type computer built specifically for the investigation of problems relative to the design of complete guided missile systems, under contract with the Office of Naval Research, Special Devices Center. The computer is divided into several sections, each of which handles some particular phase of a complete guided missile system problem. The major sections are (a) the missile simulator, (b) aerodynamic computer, (c) guidance computer, (d) target simulator computer, (e) recording and display devices and (f) power supply to operate complete simulator.

The input to the missile simulator computer consists of voltages representing aerodynamic forces along the three missile axes (roll, pitch and yaw), aerodynamic torques about the three missile axes, initial position of missile in earth axes, initial spin velocities about the three missile axes, initial linear velocities along the three missile axes, and initial attitude of missile axes relatives to earth axes expressed as direction cosines.

The output consists of missile position in earth coordinates, missile velocities in earth axes, missile linear velocities in missile axes, missile angular velocities (spins) about missile axes, and missile attitude in terms of direction cosines of missile axes relative to earth axes. Among the components required for this section are several high-speed multipliers of high precision. High-precision multipliers were required particularly for maintaining orthogonality of the earth and missile axes systems as the computation proceeds. The step multiplier as described in this article was developed for this application. Thirty-six multiplications and eighteen integrations are made in this section.

The guidance computer is a flexible arrangement of components interconnected by means of patch cords in a manner dependent on the nature of the guidance system. It receives information from the target simulator and missile simulator and delivers its output to the aerodynamic computer.

The aerodynamic computer receives missile velocity, altitude and attitude information from the missile simulator, and missile fin deflection information from the guidance computer. It computes the aerodynamic forces and torques, and routes this information to the missile simulator section. Thus, a closed-loop computing system is formed.

Target trajectory is generated as target position in earth coordinates by the target simulator. Target maneuvers are made by operation of target speed, climb and turn controls.

The recording and display devices consist of two Electronic Associates Variplotters which are normally used for missile and target trajectory plotting in both the horizontal and vertical planes, eighteen GE photoelectric recorders which may be used to record any eighteen variables desired, a missile model which assumes the attitude and fin deflections of the missile being simulated, and a three-dimensional trajectory model which moves objects representing the missile and target in three dimensions.

An idea of the size of the computer may be gained from the following tabulation of certain components:

Section	Stabilized D-C Amplifiers	Computing Servo Units
Aerodynamics	135	6
Guidance	148	11
Missile Simulator	135	
Target Simulator	9	2
Recording	18	
TOTAL	445	19

There are a large number of various other types of components which have not been tabulated. For example, a large bank of polystyrene capacitors in the guidance computer makes possible 80 simultaneous integrations in this section. The computing equipment is mounted in 43 special racks, each rack being 9 feet high. Forty of the racks are standard width, and three are double standard width. About 4,000 vacuum tubes are employed, and the total power consumption is 46 kilowatts.

Step Multiplier Design

Project Typhoon requires a multiplier of very high precision and moderate speed of response, for application in certain critical parts. Servo-type multipliers to meet both requirements seemed to be beyond the realm of practicability, and no all-electronic multiplier investigated had sufficiently high accuracy. As a consequence, the step multiplier was developed.

In principle, the step multiplier and servo multiplier are similar. Figure 1 is a basic block diagram of the step multiplier. The count stored in the reversible binary counter is made proportional to the input variable X. The conductances of the relay-operated conductance networks are each made proportional to the count stored in the reversible binary counter, and hence are proportional also to the variable X. Thus, if a voltage Y is applied to the input of one of the conductance networks (V), the output current will be XY and will appear as a voltage proportional to XY at the output terminals of amplifier VIII.

The reversible binary counter either counts at a rate determined by the frequency of the oscillator, or the number in the register remains stationary, depending upon the value of the input voltage to the polarity-sensitive gate circuits. If this input voltage exceeds a certain positive value, the counter will subtract one unit for every pulse from the pulse former. If this input voltage exceeds a certain negative value, the counter will add one unit for every pulse from the pulse former. Should this voltage be zero, or any value between the minimum add or subtract voltages, the count will remain stationary.

If the current fed back to the summing point of amplifier VII from conductance network IV is of the same magnitude but of opposite polarity relative to the current fed to the same point by the variable X, the output of VII will be zero and the count will remain stationary. Should this not be the case, the counter will count in the proper direction and change the conductance of IV until the aforementioned condition prevails. Thus, if G is the conductance of each conductance network, K is the input voltage to conductance network IV and X is the input voltage to summing conductance g_1,

$$G = Xg_1/K \qquad (1)$$

The input currents to amplifiers VIII and IX will then be

$$i_{VIII} = XYg_1/K$$
$$i_{IX} = XZg_1/K$$

The output voltages of amplifiers VIII and IX will be

$$E_{VIII} = -XY/K \qquad (2)$$
$$E_{IX} = -XZ/K \qquad (3)$$

since the feedback conductance of each amplifier is g_1.

Negative values for G are not obtainable since the conductance networks are composed of passive elements only. Hence, some scheme must be provided so that negative and positive values for X may be handled. This may be accomplished by effectively adding a fixed voltage C to X of greater magnitude than X will ever be, and subtracting a voltage CY/K from the output of the multiplier. This is illustrated in block diagram form in Fig. 2 for two different output arrangements. One output, E_{VIII}, will be $-XY/K$, while the other output, E_{IX}, will be $+XZ/K$. It is convenient to choose $C = +75$ volts, $K = -75$ volts, and a value of G for the conductance networks equal to g_1 when the count in the counter is half of the full-scale value. The multiplier thus arranged is capable of accepting values for X which vary between $+75$ volts and -75 volts.

Reversible Binary Counter

Figure 3 is a block diagram of the reversible binary counter. Positive pulses are continuously fed into pulse input terminal B. The count of the counter will remain stationary when the value of the error input voltage at terminal A is zero. If the error input voltage increases in a positive direction, the voltage on the subtract bus will rise to zero and will be prevented from going positive by the diode limiter. This places the subtract gates in the active state so that they can transmit pulses. The add gates will be in the inactive state because the potential of the add bus will be negative. Further increasing the error input voltage will energize the pulse gate so that pulses present at terminal B will be transmitted to the counter, and one unit will be subtracted from the count of the counter for each pulse appearing at B.

For negative error input signals, the potential of the add bus will become zero, and the add gates will be made active. The subtract bus will be negative and the subtract gates will be inactive. Further excursion of the error input signal in the negative direction will activate the pulse gate, and will cause one unit to be added to the count for each pulse appearing at input B.

Thus, the counter will either add

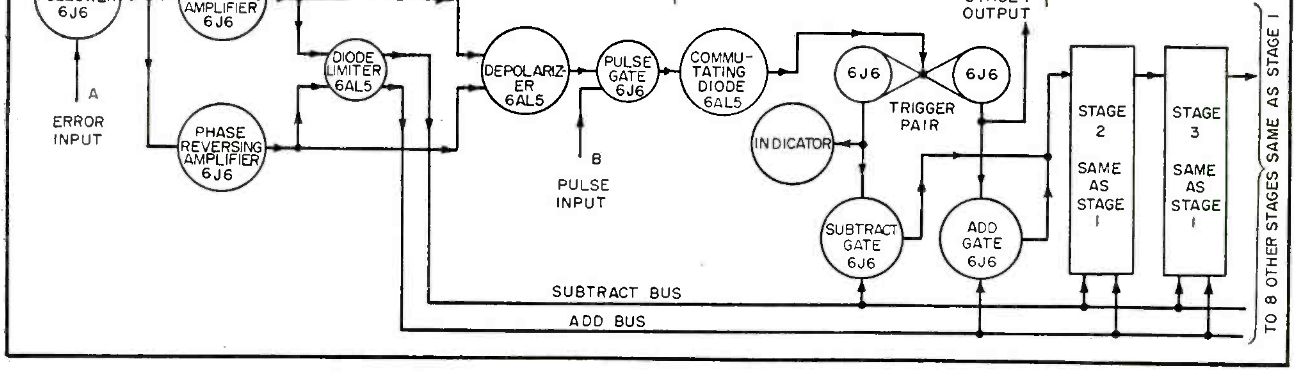

FIG. 3—Block diagram of eleven-stage reversible binary counter

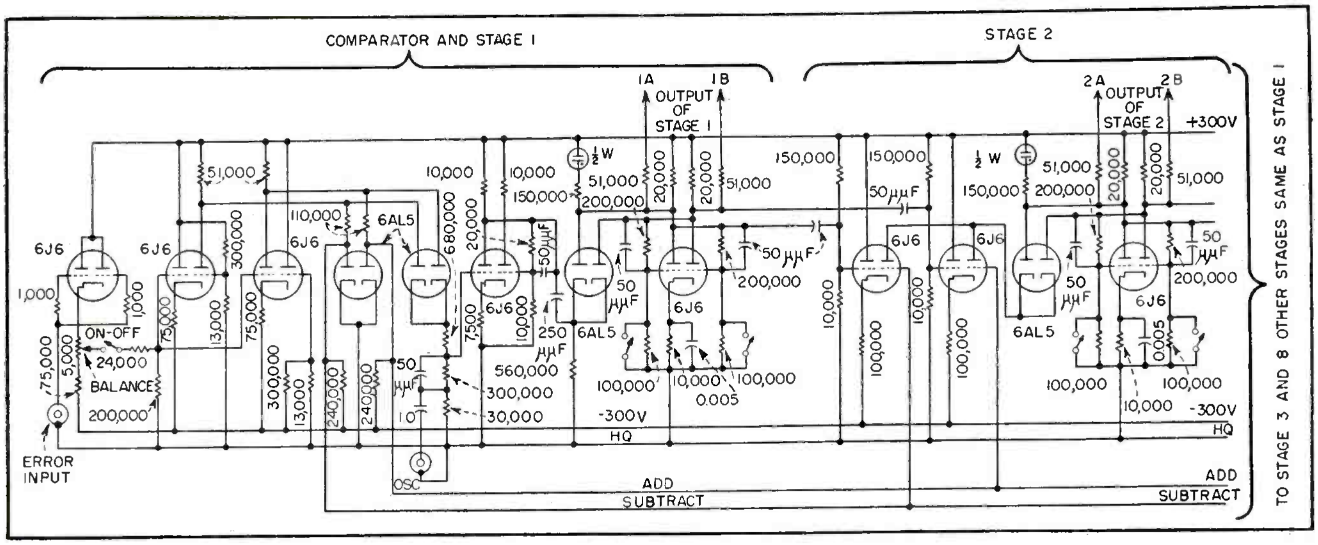

FIG. 4—Circuit used in first two stages of reversible binary counter

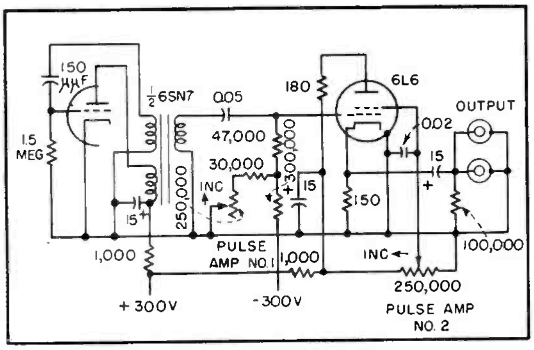

FIG. 5—Blocking oscillator used to generate pulses

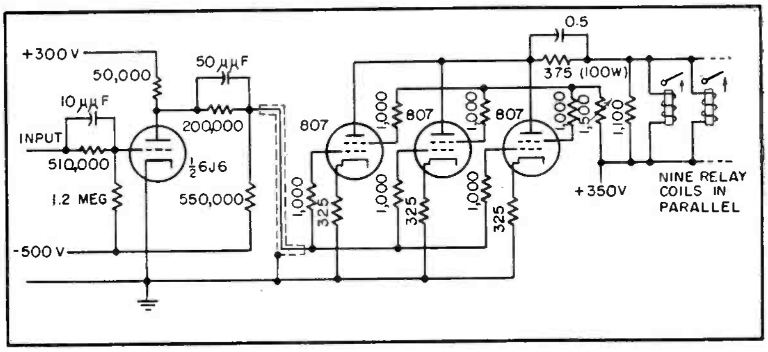

FIG. 6—Relay drive amplifier used to actuate relays of variable-conductance network

or subtract one unit from the count for each pulse at input B, dependent on the polarity of the error signal at input A. The particular mode of operation is obtained by proper choice of the carry-over connections by means of the add or subtract gates.

Figure 4 is the schematic diagram of the first two stages of the counter. The other 9 stages are similar. Diode commutating tubes are used as coupling elements to insure positive counting. The output of each trigger pair is differentiated at the input grid of each gate tube so that the gate tubes transmit pulses. Only negative input pulses will change the state of a trigger pair; positive pulses have no effect.

Each trigger pair has associated with it a neon light to indicate its state. Two pushbuttons per trigger pair are available for setting the state of each stage of the counter, or in other words, the count when the error input voltage is either zero or is disconnected. The output of each stage drives an amplifier which in turn controls the relays of the conductance networks associated with that stage. Pulses for operating the counter are obtained from the blocking oscillator circuit of Fig. 5.

High-Speed Relays

The rate at which the multiplier (X) may be varied and still have the values of the conductances in the variable-conductance networks accurately follow is a function of the speed at which the associated relays can operate. Since high-speed operation was desired, the use of high-speed relays was necessary. It was not possible to find a suitable commercially available relay so one was specifically designed for the job. It is characterized by an extremely light armature which is carefully damped by proper use of tungsten-loaded rubber dampers. The relay exhibits no chatter, and will either close or open within 100 microseconds after application of control voltage to the coil.

Relay Drive Amplifiers

The time required for a relay to close or open is a function of the rate of rise or fall of the coil current, among other things. Consequently, a relay drive amplifier circuit was designed to cause the coil current to rise or fall as rapidly as practicable without damaging the coil insulation. The rate of rise of current through a coil, with resistance and capacitance disregarded, is given by

$$dI/dt = E/L \qquad (4)$$

where dI/dt is the rate of change of current in the coil, E is the voltage across the coil and L is the inductance of the coil in henrys.

To obtain rapid rise of current, E must be large. However, the maximum current must be limited to a safe value, otherwise the coil would burn up. The high-speed relays used were designed for a steady-state coil current of 50 ma.

A constant-current type of drive amplifier is used. Since the tube drop would normally be high for tubes driving closed relays, the tube dissipation would be high, necessitating the use of fairly large tubes. To reduce tube dissipation, a resistor bypassed with a capacitor is inserted in series with the plates of each parallel group of tubes. Approximately full plate supply voltage is impressed across the relay at the instant the drive tubes are made conducting. As the current builds up in the relay coils, the voltage drop across the relay coils decreases and the voltage drop across the tubes increases. The capacitor across the series resistor will charge up rather slowly, and thus this network will have negligible effect upon the rate of buildup of relay current. In the steady-state conducting condition, there will be very little voltage drop across the relay coils, little across the tubes, and considerable voltage across the resistor-capacitor network.

When cutting off the tubes, the voltage developed across the relay coils will be a function of the coil current, the capacitance across the coils, the inductance, and the resistance across the coils. Neglecting the capacitance, the peak voltage will be $E_c = I_c R_s$, where E_c is peak voltage developed across the coils, I_c is coil current at the instant that current is cut off, and R_s is resistance shunted across the coils. To prevent E_c from exceeding a safe value, R_s must be chosen accordingly. If R_s is made too small, the time for opening will be excessive.

Typhoon incorporates multipliers with either four, six, nine or eleven relay coils per drive amplifier. The relay drive amplifier in Fig. 6 is designed to drive nine relay coils in parallel.

Variable-Conductance Networks

Each variable-conductance network consists of eleven T networks whose inputs and outputs are paralleled, and one non-switched conductance. The transfer conductance of each T network may be made zero (relay closed) or a predetermined value (relay open). Transfer conductance values for the various different networks in a set are chosen on a scale of two basis.

The signal amplifiers used in conjunction with the step multiplier are all similar, and are of the wide-band chopper-stabilized type[1] shown in Fig. 7. Their use eliminates the necessity for manual adjustment of d-c zero offset, and they do not drift.

Interpolation Effect

Should the value of the variable X be such that the conductance networks cannot accurately match this condition because their conductance values vary by discrete steps corresponding to 1 part in 1,024, the conductance value will oscillate between the two adjacent values which straddle the value called for by X.

A partial integrating circuit is used in the feedback network of the error-sensing amplifier (amplifier VII in Fig. 2). The gain of this amplifier for d-c is 11 times the gain for frequencies above a few cycles. The incorporation of some integration in this network is necessary for stable operation of the feedback loop when the loop gain is high.

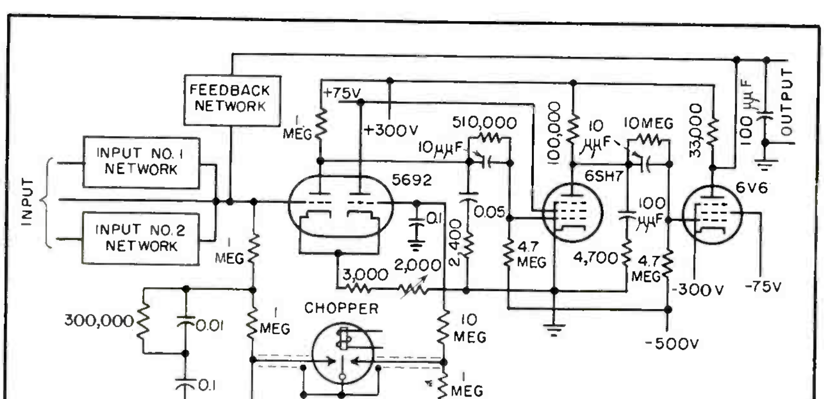

FIG. 7—Circuit of stabilized d-c amplifier used with step multiplier

Performance

The step multiplier is very similar in principle to the servo type of multiplier which incorporates a gang of similar linear potentiometers. Multipliers which tracked very well were needed in the missile simulator section. The step multiplier meets this requirement very well since each conductance network may be adjusted to the calculated value within ±0.001 percent of full-scale conductance. It was not possible to obtain potentiometers which would track as well.

The speed at which X may be varied yet have the counter track is a function of the oscillator frequency which drives the counter, and also a function of the relay speed.

Since the relays require about 100 microseconds to close or open, they are the limiting factor in speed of operation. An oscillator frequency of about 1,000-cps is used, and consequently about one second is required to change the value of the multiplier (X) from zero to full scale. The rate at which the multiplicands (Y and Z) may be changed is a function of the band width of the conductance networks and associated amplifiers.

The author wishes to acknowledge the contributions to the project of A. W. Vance, who conceived the basic principle of the step multiplier, and R. F. Brady and F. F. Shoup, who jointly contributed to the development of high-speed relays employed.

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(1) Edwin A. Goldberg, Stabilization of Wide-Band Direct-Current Amplifiers for Zero and Gain, *RCA Review*, p 296, June 1950.

Use of cadmium-sulfide crystal in a detector for inspecting cans of baby food. Partially filled can has paper band around it as does nozzle holding crystal. Light above nozzle is illuminated briefly as low-content can passes between x-ray source at left and nozzle.

Beam Stabilizer for Industrial X-Rays

Transmitted beam intensity is held within close limits by use of cadmium-sulfide crystals in stabilizer bridge circuit. Industrial inspecting equipment may then be used to detect small changes in beam intensity caused by minute flaws in opaque objects

By JOHN E. JACOBS

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APPLICATION of x-radiation to high-speed automatic inspection of opaque objects for minute flaws has increased the requirements for x-ray beam stability over those previously encountered.

For an automatic system of x-ray inspection to compete successfully with radiography or fluoroscopy, it must offer the resolution obtained by these methods. It is necessary to detect, on the basis of transmitted radiation, variations in x-ray intensity of a few percent. This is most easily accomplished by designing the associated detecting equipment to be extremely sensitive to slight variations in intensity. Two units embodying this precise control are now undergoing tests, each installation requiring special adaptation and engineering.

In a single-channel system, a comparison method using two detectors may be used to reduce the effects of x-ray beam instability. For the scanning of large, irregular shapes, a multiplicity of inspecting stations is needed. To attempt to compensate each individual station against beam changes is a major project and usually results in a system that is difficult to keep in balance. The apparent answer to this problem is to stabilize the x-ray source itself in such manner that the transmitted beam intensity is held within close limits.

Regulation of the x-ray beam for

this application is complicated by two factors. The first is that the x-ray output is proportional to the first power of the tube current and the square of the applied peak tube voltage.[1] Commercially available regulators are not satisfactory because they work on the rms value of the wave. Furthermore, waveform distortion is prevalent in x-ray transformers.

The second factor that contributes to the problem is the relation of x-radiation transmitted through material and the voltage applied to the x-ray tube. Referring to Fig. 1, the addition of any material between the beam and the detector has the effect of making only the higher values of impressed x-ray tube voltage effective in determining the intensity received. This means that a change in applied x-ray tube voltage of a few percent will result in a change of the order of ten times percentagewise in the intensity of the beam transmitted through the material.

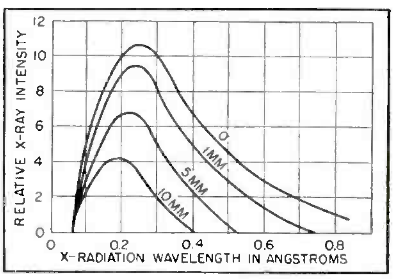

FIG. 1—Quality of x-radiation transmitted as aluminum is added between x-ray tube and detector

The previous discussion leads to one conclusion regarding the stabilization of x-ray beams; the detecting element of such a stabilizing loop should be x-ray sensitive with the same amount of filtration between it and the x-ray tube as is shown by an object to be inspected.

Stabilization Methods

The x-ray tube current may be stabilized to within ± 0.1 percent by an electronically controlled series impedance in the primary of the filament transformer.[2] This method has been used to control x-ray output by adapting a photomultiplier and fluorescent screen in a comparison circuit.[3] Regulators of the saturated-inductance type do not function satisfactorily to regulate x-ray tube voltage because of their waveform distortion.[4] Another approach has been to adapt a series tube regulator,[5] such as is used in laboratory power supplies. This has the disadvantage of requiring the regulating loop to be insulated to withstand the x-ray voltage, which often exceeds 100,000 volts.

For simplicity and economy it is desired that the regulation of the x-ray tube voltage take place in the primary of the high-tension transformer. The regulating device used should be one with less than 6 cycles response time and should introduce a minimum amount of waveform distortion.

Recently, numerous references have been made to the use of cadmium sulphide as a detector of x-radiation.[6,7,8] This material has several advantages. The first is its natural amplification and the second is its high absorption of x-rays as compared to other detectors. The radiation transmitted by an object is only the hard radiation and an efficient detector of this type of radiation is needed.

Because of the density of cadmium and sulphur as compared to the gases used in ionization chambers, it is possible to use a thickness of CdS that will absorb practically all of the radiation. The intensity-wavelength ratios of Fig. 1 are preserved in such a detector. Crystals of CdS have the further advantage of retaining their natural amplification which, in some cases, is in the order of 10^6 even when the crystals are reduced to small cross sections. This makes for a compact, extremely efficient detector.

A sketch of the setup used for checking fuse trains by means of a cadmium-sulfide detector is shown in Fig. 2. In this application, a $\frac{1}{8}$-in. void in the powder train inside a $\frac{1}{4}$-in. diameter cord can be detected with the fuse moving at the rate of 60 feet per minute. The indicator may consist of any one of many possible relay-actuated devices. The relay may operate a meter, chart a graph, work a rejection lever to remove the product from the line, ring a bell and so forth.

A fundamental electronic property of semiconductors of the cadmium-sulphide type lends itself very well to regulator service. Over the intensity range encountered, the number of electrons present in the conduction band at any time is a linear function of the incident intensity. However, any decrease in intensity results in the electrons starting to recombine in accordance with the familiar relation $dn/dt = -bn^2$ where b is the recombination coefficient and n is the number of electrons present in the band. Any change in the beam intensity will show up as the square of the change, as the current measured is proportional to dn/dt. This is a

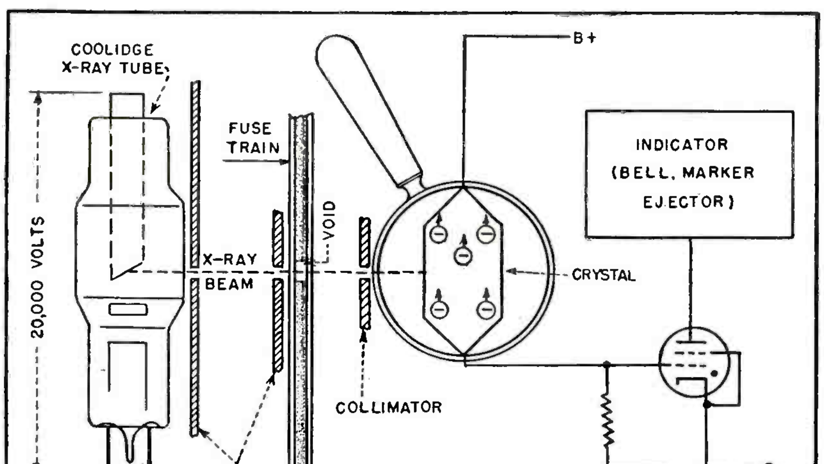

FIG. 2—Application of cadmium-sulfide crystal for checking blast fuses. Amplified output from the crystal is used to actuate any convenient mechanism for indicating a fault in the fuse train

distinct advantage from the standpoint of regulator performance.

The variable-ratio autotransformer-type regulator was chosen for its simplicity and low waveform distortion. Referring to Fig. 3, the CdS crystal is used in a bridge circuit similar to the way a resistor would be used. The CdS crystals behave as a resistor, the resistance of which is a function of the incident intensity. Unless the power-carrying capabilities are exceeded, the crystals obey Ohm's law. If the voltage is doubled, the current for a given incident intensity is doubled.

Regulator Performance

Output from the crystal-resistance bridge circuit is passed through a bridged-T network that serves to stabilize the regulator loop. The network output voltage is compared with the reference voltage of a VR105; any difference is amplified and used to control the regulator tubes. In this case, two triode-connected 6L6's were used. These tubes control the saturable inductor serving as part of the common leg of an autotransformer. Characteristics of the saturable inductor used are shown in Fig. 4.

To check regulator performance, three runs covering three-hour periods were made on typical workdays. An aluminum filter was placed in the beam to establish the condition shown in Fig. 1. To record the output, a special fluorescent-screen photomultiplier pickup was used; arranged to eliminate falling off of response with time. The output of the amplifier was recorded by a high-speed photoelectric recorder. Figure 5A shows the output of the x-ray generator without the regulator. In this case, the output varies over ±15 percent. The large increase at 4:30 is attributed to the factory shutting down at that time.

Using an identical setup, a commercially available electronic regulator of the saturable-inductor type was placed between the line and the x-ray generator. Figure 5B shows that this regulator affords considerable improvement but still leaves much to be desired. The controlling element of the regulator loop in this case was a temperature-limited diode. An attempt was made to schedule the tests over the same period, as experience has shown that Figure 5A is typical for afternoon line conditions at the factory.

The commercial regulator used for Figure 5B is better than it appears in this application. It is because of the relations existing in an x-ray generator as previously described that commercially available regulators perform as they do when used to stabilize x-ray beams.

Figure 5C shows the effect of placing the CdS regulator on the line. Essentially the only difference between the results as shown by Fig. 5B and 5C is that the error voltage fed to the regulator loop in the case of Fig. 5B is proportional to the rms value of the stabilizer output and in the case of Fig. 5C is proportional to the intensity of the x-rays transmitted through the filtering material.

Since the regulator was developed specifically for automatic inspection applications, no provision was made to handle wide kilovoltage variations. In every application of this type the x-ray generator is set to the optimum kilovoltage by means of an autotransformer. The regulator loop then serves to vary the applied kilovoltage by ±30 percent about the mean value in response to the output of the CdS crystal. The variable resistor in the bridge circuit serves to balance the bridge in the middle of the range once it is established. It is not anticipated that voltage variations outside this range will be encountered in practice.

On the basis of laboratory investigations still in progress, changing of the crystal characteristics with use appears to be insignificant. Once installed and calibrated, the stabilizer should maintain constant x-ray output and penetration regardless of x-ray tube aging.

The author wishes to acknowledge the assistance of A. L. Pace, Industrial Section, General Electric X-Ray Corporation, in taking various measurements.

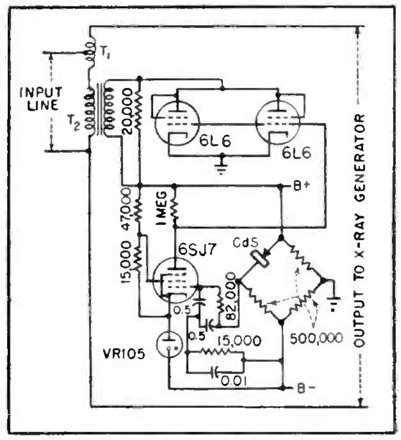

FIG. 3—Schematic diagram of regulator circuit

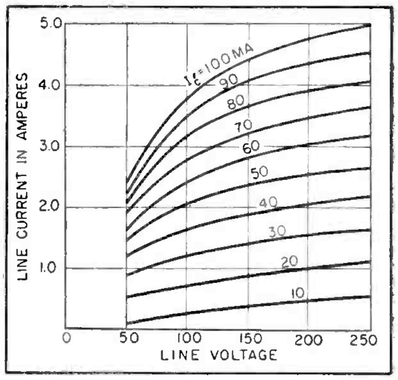

FIG. 4—Volt-ampere characteristics of saturable inductor

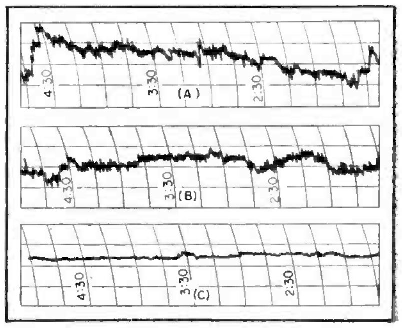

FIG. 5—Output of x-ray generator: (A) unregulated, (B) regulated with ordinary electronic stabilizer and (C) regulated with CdS controlled stabilizer

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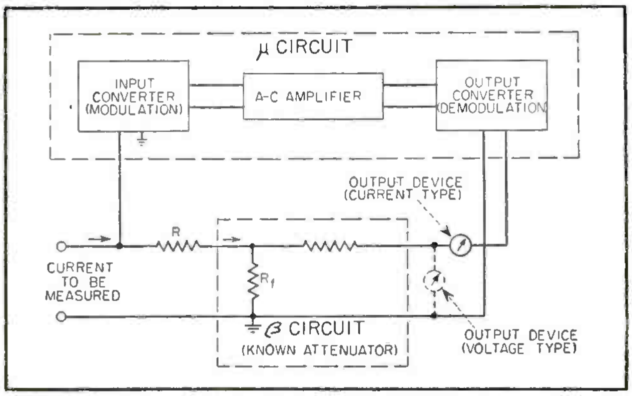


FIG. 1—Basic arrangement of d-c amplifier in which input converter sets limit of zero-offset reduction

Front panel of amplifier, showing zero-center meter having 25-micromicroampere and 25-microvolt basic ranges

D-C Amplifier with

Input required to bring output to zero is less than 1.6 times peak-to-peak thermal fluctuations in new contact-modulated d-c amplifier, corresponding to zero-offset of 10^{-12} ampere on current ranges and 1 microvolt on 20,000-megohm-per-volt voltage ranges

By WILL McADAM, R. E. TARPLEY and A. J. WILLIAMS, Jr.
Research Department, Leeds and Northrup Co., Philadelphia, Pa.

AN ANNOYING characteristic of practical amplifiers is that when their signal inputs are zero, their outputs are not exactly zero.

The zero-signal output, or noise output, from an amplifier may contain components of all frequencies within the transmission band of the amplifier. For example, amplifiers for d-c, to which this discussion is confined, can have in their zero-signal outputs very-low-frequency components and a d-c component. These output components can be brought to zero by the application of an input having proper magnitude and polarity. Zero-offset is herein considered as the amount of amplifier input required to bring the low-frequency and d-c components of the output to zero.

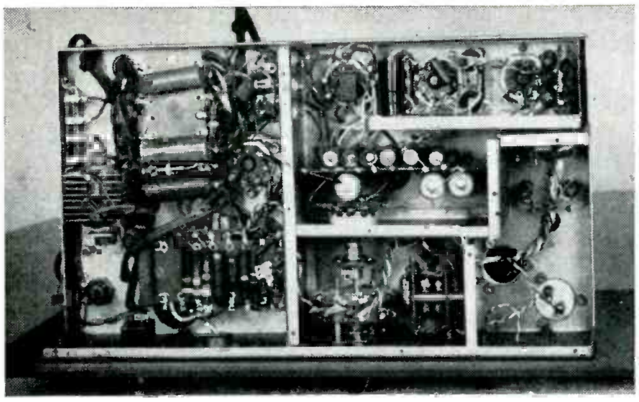
In measurements made with d-c amplifiers, zero-offset can be a component of error, since at any time the amplifier output represents the amplified sum of its signal input and its zero-offset. The error arising from zero-offset is variable in nature because its origin lies in sources affected by uncontrolled conditions such as ambient temperature, line voltage and stray fields. Without special measuring techniques, the limit of uncertainty in measurements made with an amplifier cannot be less than the maximum zero-offset of the amplifier. While zero-offset error can be eliminated by making measurements of the differential type, in general this requires removal of the signal from the amplifier, an inconvenience at best and often a practical impossibility.

The Noise Problem

A contact modulator has previously been described[1] which produces zero-offsetting voltages not exceeding 0.5 microvolt and zero-offsetting currents not exceeding 1×10^{-12} ampere. Using this contact modulator, d-c amplifiers have been constructed[1] having zero-offsets less than 0.5 microvolt with input circuits of about 10^4 ohms. Zero-offsets not greater than 1×10^{-12} ampere have been observed when these amplifiers were adapted to 10^9 ohm input circuits. No amplifier, however, has been available in which the zero-offset is at the same time limited to both 0.5 microvolt and 1×10^{-12} ampere. The problem was to build an amplifier in which the zero-offset would be limited to these two values simultaneously and so approach the limits of performance imposed by its contact modulator much more closely than either of the two amplifiers mentioned (5×10^{-19} watts as compared to 2.5×10^{-17} watts for the 10^4 ohm circuit and 1×10^{-15} watts for the 10^9 ohm circuit).

It is suggested in the previous paper[1] that since the thermal-agitation noise in an amplifier represents the final limit of certainty in measuring with the amplifier, a figure of merit for the zero-offset might be its value relative to the theoretical thermal-agitation noise.[2,3,4,5,6] The amplifier described

This article is based on a paper presented at the 1950 National Electronics Conference. The Conference paper appears in the *NEC Proceedings*.



Bottom of amplifier. Chassis cover completes shielding needed to reduce zero-offset

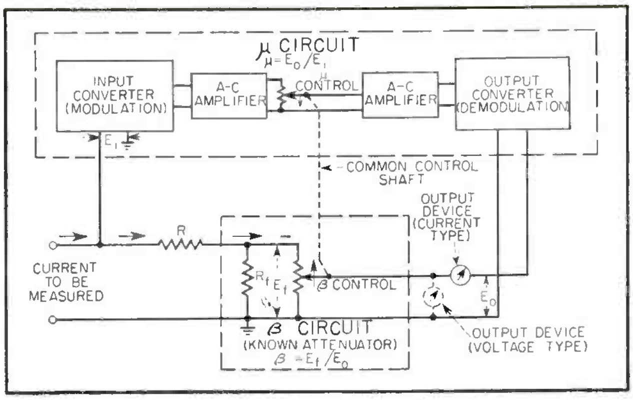


FIG. 2—Preferred range-changing method, in which effective current gain is set by a known attenuator

Reduced Zero-Offset

with the 10^4 ohm circuit exhibited zero-offset which exceeded the peak-to-peak thermal-agitation noise by a factor consistently less than 7.

The amplifier to be described uses the contact modulator mentioned above, and has characteristics approaching closely the limits imposed by the contact modulator. The amplifier zero-offset is at the same time less than 1 microvolt and less than 1×10^{-12} ampere.

Amplifier Design

The amplifier is arranged primarily for current measurement, as shown in Fig. 1 and in more detail in Fig. 2 and 3. It employs the parallel-type feedback useful for current measurement.[1] The action of the circuit is to reduce the current into the input converter to a small fraction of that flowing in R, thus causing the steady-state impedance between the input terminals to be very low (a small fraction of R, so that measurements are of the null-current type).

All amplification in the system is done at a carrier frequency of 60 cps in R-C coupled amplifier stages having poor low-frequency transmission characteristics. Synchronous rectification of the a-c amplifier output and overall d-c feedback are used to stabilize the effective gain to a high degree.[1] The d-c feedback current, or the d-c voltage developed across a part of the feedback circuit, is used as the amplifier output and hence as a measure of the input quantity.

With sufficient gain built into the forward or μ path of the amplifier, the effective current gain is determined solely by the ratio of resistances R and R_f. This ratio must, therefore, be accurately known. In a single-range model of the amplifier, following the arrangement of Fig. 1, the ratio R/R_f was made 2×10^6 so that a 100-microampere output instrument was deflected fully by an input of 50×10^{-12} ampere. The zero-offset of 1×10^{-12} ampere caused by the input converter thus amounted to only 2 percent of the range.

A zero-offset representing at once a current of 1×10^{-12} ampere and 0.5 microvolt dictates an input circuit impedence of 0.5 megohm. However, because the amplifier was meant to be primarily current-sensitive, a value of 1 megohm was chosen for R to favor the performance for current measurements. The amplifier input circuit impedance is thus about 1 megohm, since it is largely determined by the value of R, and the maximum zero-offset represents both 1×10^{-12} ampere and 1 microvolt. Powerwise, this is 1×10^{-18} watt.

The good current sensitivity of the arrangement just described suggests its use for voltage measurements. The adaptation is simple, the only requirement being the inclusion of an accurately known resistance in series with the current-measuring terminals. A second 1-megohm resistor has been included for this purpose, as shown in Fig. 3, giving the instrument a basic voltage range of 50 microvolts with a current drain of 5×10^{-11} amperes at this input voltage (20,000,000,000 ohms per volt).

Range Changing

The usefulness of an amplifier as a measuring instrument is greatly enhanced by the provision of multiple-range features. Range-changing can be accomplished in this type of amplifier by varying the ohmic value of R or R_f (Fig. 1), by varying the portion of R traversed by the unknown current, or by changing the ratio of the current flowing in R_f to the total output current. An early method of range-changing for a current-measuring amplifier[1] consists of connecting one input terminal to a movable tap on the known resistance R. The current gain then depends upon the position of the tap. This method has the advantage of keeping essentially constant the $\mu\beta$ product of the amplifier, hence its stability against oscillation for various ranges. Further, it has the advantage of minimizing the potential drop between input terminals for all ranges; the input impedance, therefore, is decreased as the range is increased. However, the method has the distinct disadvantage that the noise output of the amplifier appears as a constant fraction of full output, regardless of the current range of the instrument.

The behavior of the amplifier noise output with the range-changing method just mentioned is illustrated in Fig. 4A. Increase in the measuring range with a constant-valued input signal can be seen to result in decrease in the average (desired) output without any corresponding decrease in the noise output. The noise, therefore, represents greater input equivalents on greater ranges.

A preferred range-changing method is one which yields a noise output which diminishes as the measuring range of the amplifier is increased, and also incorporates the advantages of a constant $\mu\beta$ product.

Range-changing by varying the ratio of the current flowing in R_f to the total output current produces the desired reduction of the noise output with increasing range. However, any change in this ratio is a change in the feedback transmission β (the attenuation from the output terminals to R_f is changed). Range-changing by this method, therefore, can fulfill the constant $\mu\beta$ product requirement necessary to preferred range-changing only if changes in the value of β for range control are accompanied by simultaneous inverse changes in the value of μ.

This preferred method of range changing is accomplished in the amplifier, as shown in Fig. 2 and 3, by including variable divider networks in both the μ and β paths. Operation of these variable dividers is from a common shaft, and they are so arranged that an increase of attenuation in one divider is accompanied by a simultaneous decrease of attenuation in the other, maintaining the product of the attenuations of the two dividers constant (except for the three lower ranges as explained below). The values of R, R_f, and β are chosen so that on its narrowest range, the amplifier has the same current sensitivity as the single-range version mentioned previously in connection with Fig. 1, 100 microamperes output for 50 $\times$ 10^{-12} ampere input. As in the single-range circuit, provision for voltage measurements is made by inclusion of a fixed multiplier resistor, hence the range-changing mechanism provides a voltage range corresponding to each current range.

The changes in output signal and in output noise caused by changing the amplifier range in the preferred way are illustrated in Fig. 4B. The noise output can be taken to represent a constant noise current (or voltage) at the input terminals of the amplifier.

With a 100-microampere output instrument, the performance of the amplifier shows a slight progressive falling-off on its 250, 100 and 50 micromicroampere ranges. This occurs because the limited forward gain available requires that the $\mu\beta$ product for these three lower ranges be reduced below its value for the other ranges. The falling-off in performance is most obviously an increase in response time, the time for 99-percent response on the 50 $\times$ 10^{-12} ampere range being about 6 seconds as compared with about 2.5 seconds for the higher ranges.

When it is essential to have both a 2.5-second response time and a 50 $\times$ 10^{-12} ampere range, the 100-microampere output instrument should be replaced with a 10-microampere instrument, and the scale multiplier set to 10 (the normal setting for a 500 $\times$ 10^{-12} ampere range). Since 10-microampere instruments are somewhat special, it has been found convenient to use a fast, narrow-range electronic recorder for the output device. To simplify shielding, a voltage recorder with a 0.1-volt range has been used by connecting it to terminals in the amplifier normally

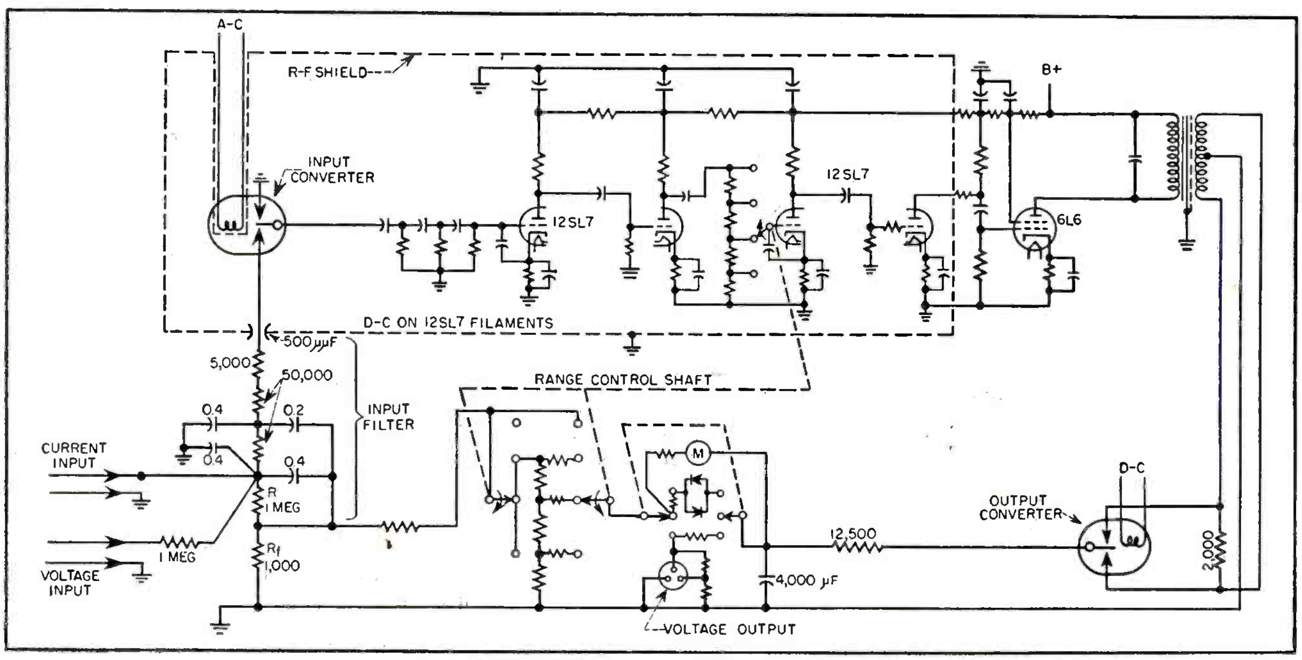


FIG. 3—Simplified circuit diagram of multi-purpose contact-modulated d-c amplifier. Calibrated woven-wire 1-megohm resistor in voltage input lead sets impedance level at 1 megohm

supplying 1.0 volt of output.

The impedance appearing between the input terminals of the amplifier is low for d-c and low-frequency inputs, for which rebalancing can be completed, but it is higher for higher-frequency inputs, for which rebalancing cannot be completed because of delay. The delay in rebalancing depends on the time-constant of the low-pass filter in the β circuit (Fig. 3) and the gain around the feedback loop. The delay has been found experimentally to result in a rebalancing time of about 2.5 seconds (for 99 percent response to an abrupt change of input) on all but the lower three ranges. An approximate equivalent circuit can be found by a calculation involving the experimentally-determined rebalancing time, the experimentally-determined gain around the feedback loop and the circuit values shown in Fig. 3. An equivalent circuit that approximates the amplifier input closely on all but the three lower ranges consists of a 1-megohm resistance shunted by the series combination of a 543,000-henry inductance and a 1,700-ohm resistance.

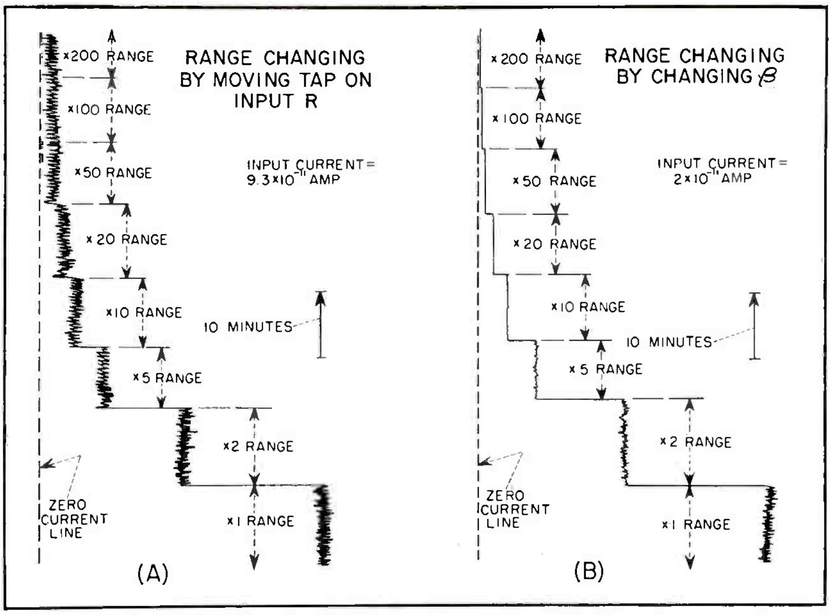


FIG. 4—Comparison of noise behavior with different range-changing methods. A change in deflection between the two highest ranges can be seen with preferred method (B), but not with other method

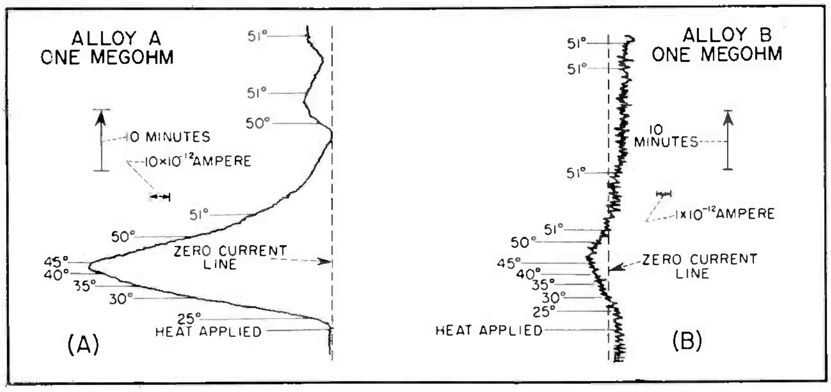


FIG. 5—Thermally-induced current outputs from resistors using different alloys. Temperature of air surrounding resistors is given in degees C. Alloy B was used for the input resistors of the amplifier

Reducing Zero-Offset

The use of a contact-modulated amplifier avoids most of the zero-offsets connected with amplification which are encountered in direct-coupled amplifiers that follow conventional design practices.

Even with contact modulation, however, zero-offsets can arise from disturbances of electric, magnetic, mechanical and thermal nature.[1] Preventive measures against zero-offset are chosen on the basis of the frequencies of the disturbing signals and their point of entry into the circuit. Zero-offsetting disturbances in the amplifier have been broken down into three classes—those of power frequency, those of radio frequencies and those of lower frequencies in or near the pass-band of the amplifier. The zero-offset resulting from each of these types of disturbance can be attacked nearly independently, using techniques appropriate to the frequency range of the disturbance, as described with considerable detail in a previous paper.[1]

In building the present amplifier all of the precautions so described were used, but at first the zero-offset was discouragingly large. Its source was traced to the resistors and the capacitors used in the input filter, as shown in Fig. 3.

The one-megohm resistor used for current measurement and the companion one-megohm multiplier resistor added for voltage measurement must be made of wire in order to have a satisfactorily low temperature coefficient of resistance. In order to minimize loops in these resistors and so minimize the voltage developed in them by changing magnetic fields, woven wire resistors are used. Early resistors of this type were suspected of causing zero-offset. Fig. 5A shows the result of a test to determine if this zero-offset resulted from thermal disturbances. A temperature gradient was set up in a resistor of this type by increasing the ambient temperature 20 degrees in 10 minutes. The resulting gradient produced a current of about 2×10^{-10} ampere. While this temperature change is more severe than would be encountered under ordinary service conditions, the test showed that production of current by resistors could result in considerable zero-offset. Figure 5B shows the result of a similar test on a resistor of similar construction made from a different resistance alloy. The generated current is small, in spite of the severe temperature change, showing that this resistor qualifies for use in the amplifier.

The four capacitors used in the input filter (Fig. 3) were suspected

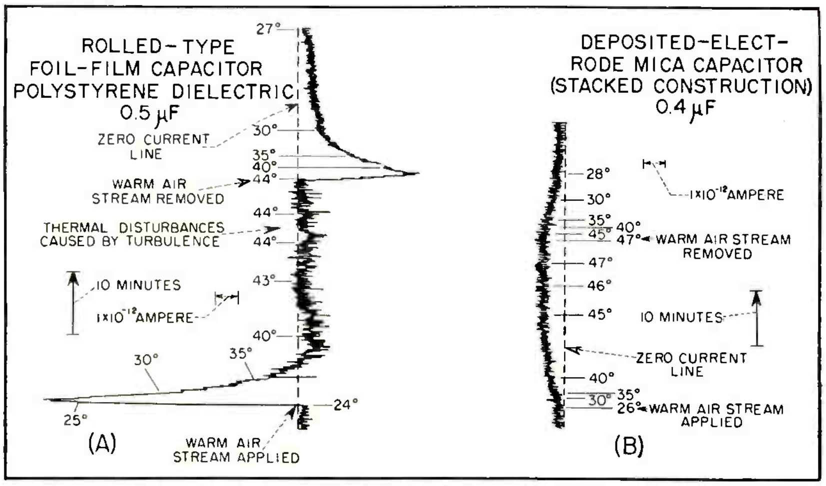


FIG. 6—Thermally-induced current outputs from two different capacitor constructions. Temperatures of capacitor cases in degrees C are indicated

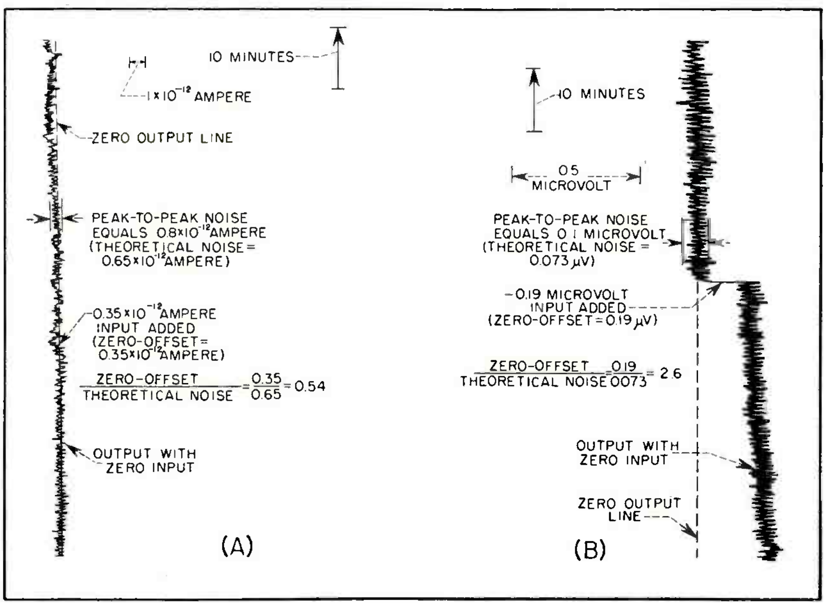


FIG. 7—Relation of zero-offset to noise in present amplifier (A) and early version (B) when both were operating well within their ratings

of causing zero-offset, so they also were given the temperature gradient test. Fig. 6A shows the results of a test on one of the four capacitors using an early type of construction. While the temperature change is more severe than would be encountered under ordinary service conditions, it is evident that use of such a capacitor could result in considerable zero-offset. Figure 6B shows the effect of a similar temperature change on a mica capacitor[7] of about the same capacitance value. The generated current was small, in spite of the severe temperature change, showing that this capacitor is qualified for use in the amplifier.

Figure 7A shows a typical record of the output of the amplifier equipped with good resistors and capacitors. At one time when the zero-offset appeared to be about 0.35×10^{-12} ampere a signal of -0.35×10^{-12} ampere was applied to the input, bringing the average output back to the zero-output line. From more extensive tests it appears that the zero-offset will not exceed 1×10^{-12} ampere. Using this figure, the ratio of maximum zero-offset current to theoretical peak-to-peak noise current is $1 \times 10^{-12}/0.65 \times 10^{-12} = 1.6$.

Figure 7B shows for comparison a typical record of the amplifier described in a previous paper[1] for which the ratio of maximum zero-offset voltage to theoretical peak-to-peak noise voltage is $0.5 \times 10^{-6}/0.073 \times 10^{-6} = 7$. The present amplifier therefore shows a factor of improvement of more than 4 based on the figures of merit represented by these ratios.

Applications

The amplifier which has been described in this paper is not commercially available; to date only a few experimental units have been built. The units which have been completed, however, have found a number of uses in our own investigations and elsewhere.

As might be suspected from its characteristics, the amplifier is particularly well suited to the measurement of insulation resistance; its current sensitivity permits the measurement of high resistances with only small applied potentials. For example, with only 1 volt applied, a micro-micromho of leakage can be detected.

Its capabilities in making high-resistance measurements make the amplifier useful in studies of capacitor dielectrics. In addition to the simple insulation resistance characteristics of dielectrics, the phenomena of absorbed charge in capacitors, residual and thermal outputs from capacitors and current outputs from resistors are effects which have been studied with the amplifier.

The authors are grateful to J. W. Harsch, W. D. Voelker and C. A. Alberts for the mica capacitors used, and to W. H. Packer for his continuing assistance in the development of the contact modulator.

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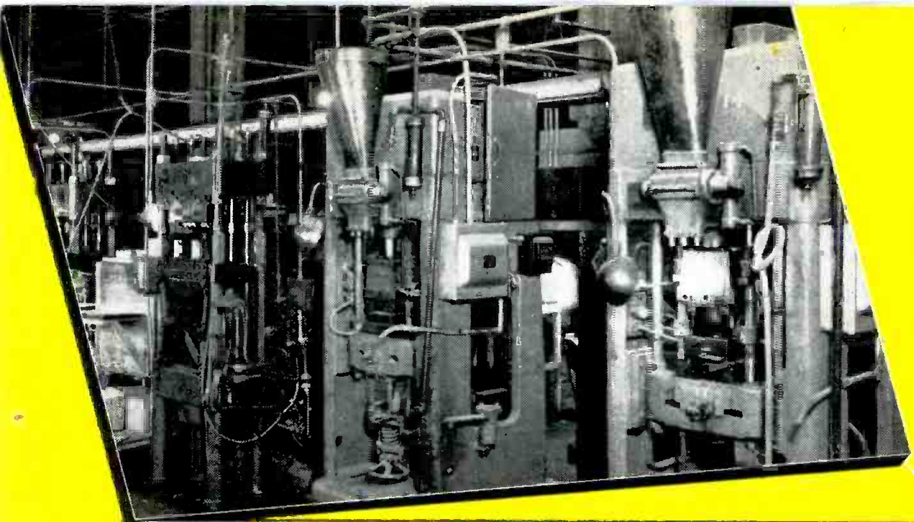

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Field-Power Conversion

Direct-reading conversion chart enables quick transfer of propagation data from field-strength to power-density values. Gain in db above 1 microvolt per meter and gain or loss in db above 1 microwatt per square meter shows at a glance

By ROBERT E. PERRY

Electrical Engineer
Boeing Aircraft Co.
Seattle, Washington

IN calculations involving propagation curves it is often convenient to do the computation in terms of power density rather than in terms of field strength, which is given in most propagation curves. Changing field intensity into power density can be greatly simplified by the conversion chart.

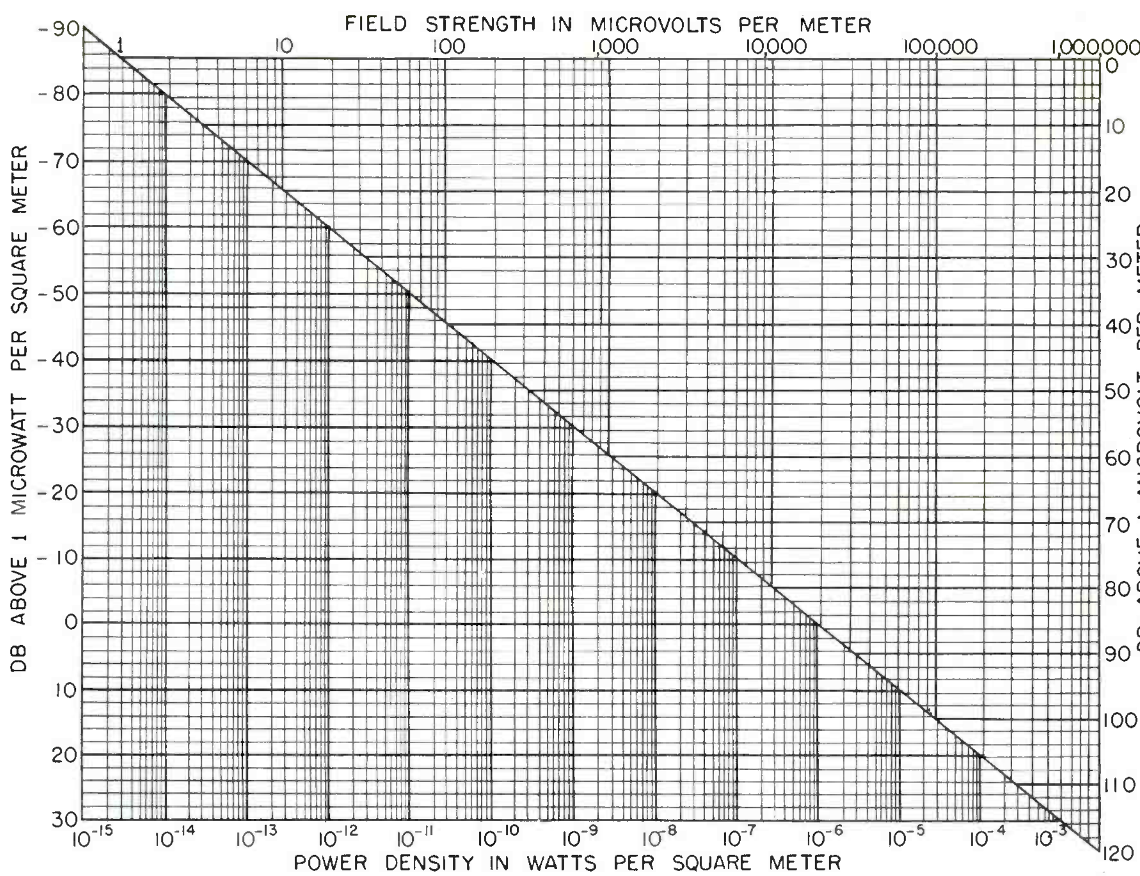
The chart is based upon the equation

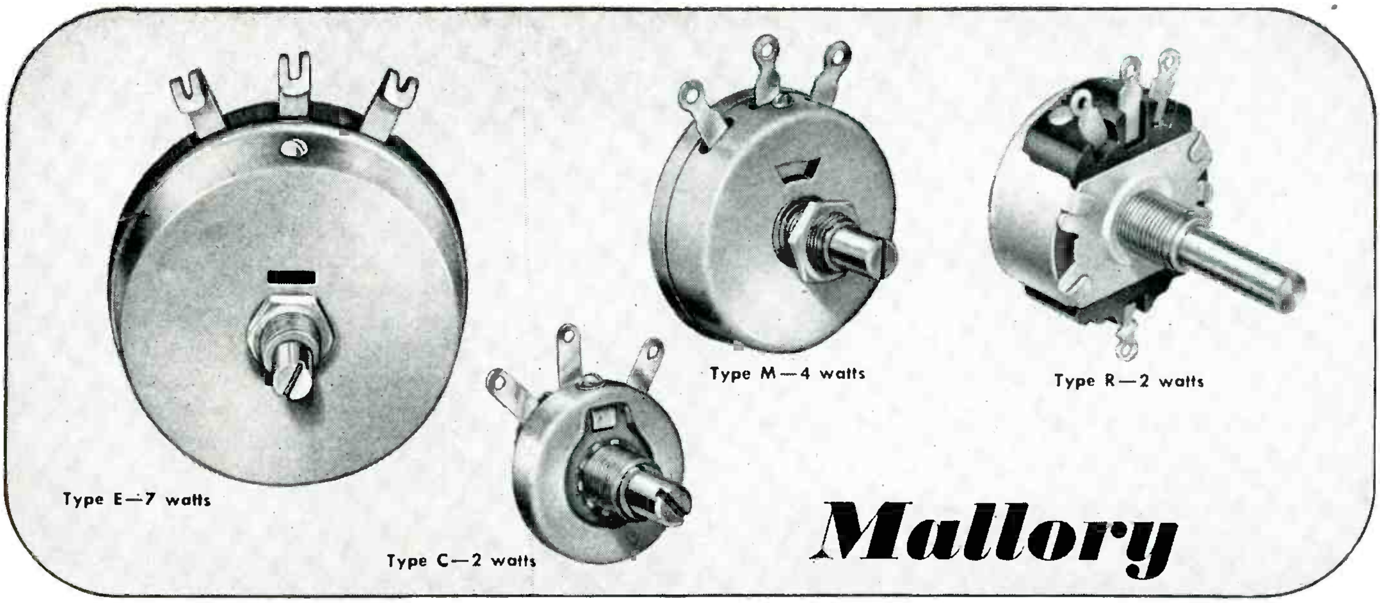
$$P = \frac{E^2}{120\,\pi}$$

where E is the field intensity, P is the power density and 120π is the resistance of free space.

The conversion chart is direct reading. A value on the left scale can be found in terms of the scale on the right side by reading directly across, or it can be read in terms of the upper or lower scale by reading over to the diagonal line and then up or down to the desired scale.

For example, a field of 500 μv per meter corresponds to a power density of approximately 7×10^{-10} watts per square meter. It is 54 db above 1 μv per meter, or about 32 db below 1 μw per square meter.





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TUBES AT WORK

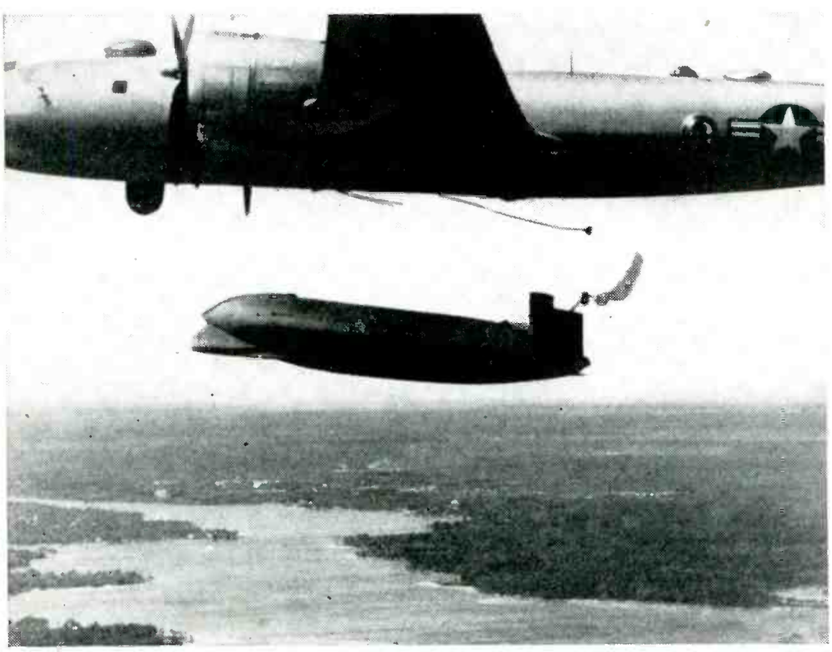
Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Radio to Save Lives

THE AIR FORCE'S big A-3 lifeboat, dropped by parachute in air-sea rescue operations, will soon have radio control that will bring it up to survivors, allow them to board and then set the boat on course by an operator in the plane which dropped the boat. By simply maneuvering a stick on a small control box he can take over when the A-3 hits the water and keep control until the survivors can take control.

The A-3 itself is of all-metal construction, measures 30 feet long and is designed to carry 15 men. It is powered by a four-cylinder water-cooled engine, housed in a water-tight compartment. Carried "bombed up" under the SB-29 (research and rescue version of the B-29 bomber), the A-3 is dropped by a 100-foot parachute.



The new radio-controlled lifeboat is shown just after being released from beneath a Boeing SB-29 Superfort

When the boat hits the water, the chute is jettisoned by an explosive charge. A sea anchor goes out as the chute is released and holds the boat in position.

Before development of the radio-controlled system, the A-3 was dropped in the vicinity of the survivors, allowing for drift. The sea anchor held it in place, and if all went well the survivors drifted down to the boat. With the new system, the boat comes to them.

Transmitter and Receiver

After the chute is jettisoned, the operator in the carrier plane takes over on a five-frequency transmitter which is matched up by a five-frequency receiver in the boat. He sends his first signal from the control box. This, in order, releases the stabilizing fins which held the boat steady in descent, frees the rudder board, opens the engine's air vents and cranks the motor intermittently. When the motor catches and is running at a fast idle, the sea anchor is released.

At the operator's next signal, the engine speeds up, the reduction gear goes into forward, and the boat moves ahead. The operator can control its direction right and left and a flux-gate gyro compass connected to the servo electric system on the boat will keep it on whatever course he sets.

The operator stops the boat when it comes up to the survivors' raft and idles the motor while they board. The boat is equipped with a walkie-talkie radio set for communication between the rescued men and the operator in the plane, who will then set the A-3 on its correct course. The gyro compass will keep it on that course with only slight variations that can be checked by a magnetic compass.

The boat itself is equipped with duplicate controls and a manual over-ride which would enable the survivors to break off the radio control at any time.

The A-3 is equipped with rations, survival equipment and gasoline enough to cruise 800 miles. If the distance is longer than that, the boat can be resupplied from the air, since its preset course will be known.

The system, developed by the

Equipment Laboratory of the Air Materiel Command and built by the Westinghouse Electric Corporation, is expected to be completely installed in all the Air Force's A-3 boats by early 1952. Transmitters have already been installed in all SB-29's.

Automatic Sheet-Folding Machine

By Ronald C. Walker

Reading, England

PHOTOELECTRIC relay equipment was recently installed in a British laundry for the purpose of folding sheets. The apparatus performs the operations which previously required the attention of two girls and ensures that the laundered sheets are neatly folded twice in the same direction.

Before reaching the detecting point in the various stages of processing, the sheets pass through an ironer and thence are fed on to a conveyor comprising a number of parallel webbing belts. When each sheet reaches a certain point in its forward travel on this conveyor, the leading edge intercepts a light beam which actuates the relay in an associated amplifier.

The photocell relay admits air pressure to a series of pneumatically operated claws arranged in line at right angles to the direction of motion. The leading edge of the sheet is then gripped and held and at the same time slightly raised above the moving belts which continue to carry the end portion of the sheet forward and underneath the stationary front edge, so that a fold is formed.

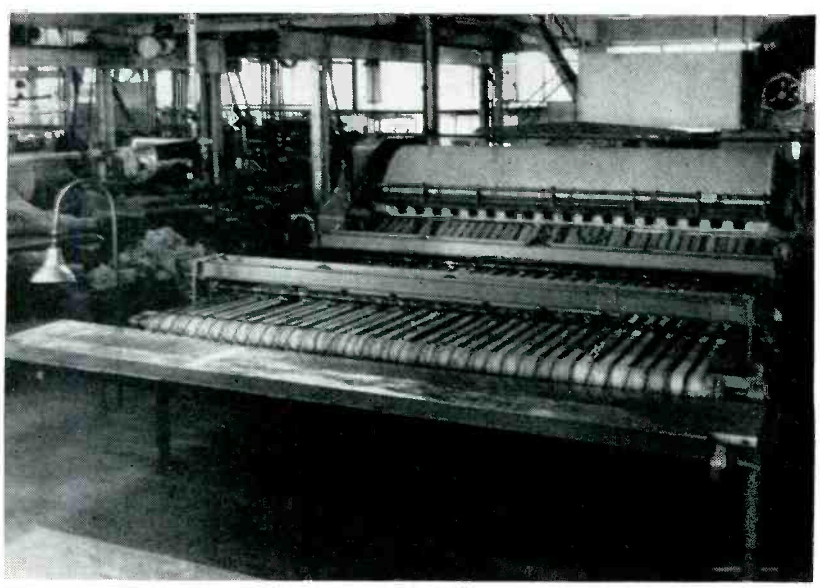
When the two halves just overlap one another, the fold is complete and the trailing edge uncovers the light beam again. The claws then release and the sheet travels forward in the folded condition.

After the first fold, the sheet moves on to another detecting point where the process is repeated with the aid of a second and similar photoelectric equipment, thus giving a second fold.

Though the photoelectric apparatus in this particular case is employed for folding sheets, it is equally applicable to industries where textiles, leather, paper and so forth have to be handled in the same way.

A further application of light-sensitive cells in the laundry has resulted in considerable saving of fuel. After the clothes are washed, they are dried by passing on a moving conveyor around a room heated by a steam radiator. The drying process is accelerated by means of a fan which circulates the hot air. The fan, which is controlled by a simple photoelectric relay, is in the circuit as long as the light beam spanning the room is intercepted by the clothes being carried around on the conveyor.

If, for any reason, there is a temporary hold up in the material being loaded on the conveyor, the light beam is no longer obscured and the fan is shut down. As soon as more clothes come along, it starts up again. This ensures a considerable saving of fuel by preventing the operation of a large fan when no clothes are in the room for drying purposes.



Automatic sheet-folding machine operated by photocell relay circuits

Impedance Measurement at Audio Frequencies

By Paul W. Klipsch

Klipsch and Associates
Hope, Arkansas

DURING the course of loudspeaker development, the necessity for making voice-coil impedance measurements was continuous. The inductometer impedance bridge was capable of yielding the desired information but was slow due to the necessity of balancing simultaneously the resistive and reactive components. Several methods involving a single resistance balance to obtain equal voltages across a calibrated resistor and the unknown were tried.

The most desirable indicator was found to be a cathode-ray oscilloscope in which the vertical and horizontal deflections serve respectively for the voltage measuring devices across the unknown impedance and across a calibrated variable resistor.

In Fig. 1, R is a calibrated slide-wire resistor or decade box and Z is the unknown impedance. The cathode-ray oscilloscope is illustrated in simplified form.

Operation

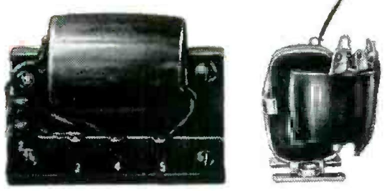
The operation is as follows: a known resistor is substituted for Z, preferably of a value within the known range of variation of Z.

(continued on page 154)

Ceroc 200

CERAMIC-COATED MAGNET WIRE

...FOR HIGHER RATINGS IN SMALLER WINDINGS



Same v-a rating! At the left is a filament transformer for a radio transmitter wound with double vinyl-acetyl insulated wire and impregnated with synthetic varnish. It is rated at 1,000 hours life under 85°C. ambient temperature operation. At the right is the same transformer, redesigned, and wound with CEROC 200 and impregnated with silicone resin. It has a rated life of 10,000 hours at 160°C. ambient temperature operation!

Shrink the size of small transformers, chokes, relay coils, and other wire-wound electrical components by winding them with Sprague's CEROC 200 Magnet Wire.

This wire has an exclusive ceramic-silicone insulation which permits continuous operation at 200°C. Size for size, it safely carries far larger currents than ordinary magnet wires using conventional insulating materials. Consequently, CEROC 200 can save both copper and magnetic materials for you.

Write for Engineering Bulletins 401 and 403B

• • •

Ceroc T Wherever higher temperatures and severe mechanical stresses are present, investigate CEROC T, the most heat-resistant of all magnet wires! For specifications on this 250°C. ceramic-Teflon insulated wire, write for Engineering Bulletin 402F.

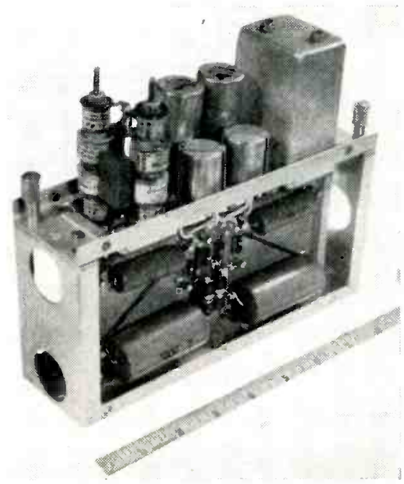
SPRAGUE®

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY
NORTH ADAMS, MASSACHUSETTS

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK



Commercial plug-in assembly containing two synchro-data telemetering circuits

Converter Circuit for Phase-Shift Telemetering

BY F. G. WILLEY

Servo Corporation of America
New Hyde Park, New York

TELEMETERING is the name commonly applied to the transmission of data from one location to another. A quantity which is to be telemetered may be of one of two types: (1) A scalar quantity has a value which lies between two specified numerical limits. (2) A cyclic quantity, such as the angular position of a shaft, has no minimum or maximum limits and is capable of continuous rotation.

A cyclic quantity may be expressed as a periodic pseudo-scalar quantity, as in angular measurement where we count up to 360° and then arbitrarily start counting again from zero. In many servo and telemetering applications, the arbitrary jump to zero is inconvenient to mechanize.

A cyclic quantity may also be expressed, or recoded, into two or more continuous periodically-varying scalar values. This produces a system having no discontinuities but requiring two or more channels for transmission. A common example of this is the standard synchro which codes the position of a shaft as relative amplitudes of three carrier voltages:

$E \sin \omega t \sin \theta$

$E \sin \omega t \sin (\theta + 120°)$

$E \sin \omega t \sin (\theta + 240°)$

where Θ is the angle of the synchro shaft.

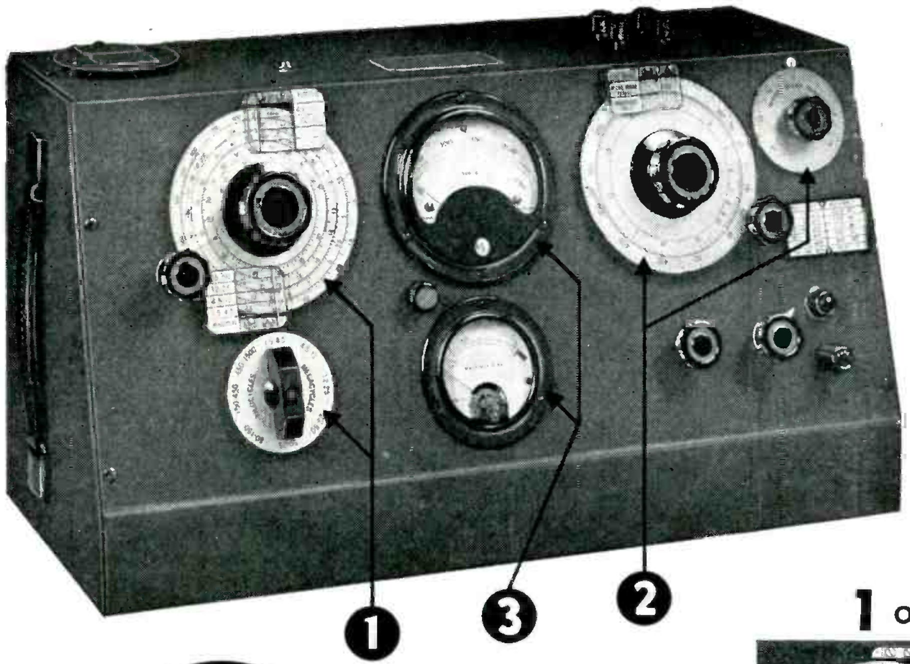
Coding Systems

Since the data to be transmitted actually represents only one quantity (angle) it should be possible to find a means of coding which would produce a single transmittible signal which is cyclic in nature rather than scalar. A quantity which has the required characteristic is the phase shift of a single frequency carrier from a reference wave of the same frequency. Thus in order to transmit N different cyclic quantities, it is necessary to transmit $(N + 1)$ sine waves of the same frequency, the extra one being

(continued on p 212)

MEASURING POWER FACTOR OF LOW-LOSS DIELECTRIC MATERIALS

Equipment used at National Bureau of Standards for making power factor measurements on low-loss dielectrics. Measurements as low as 10^{-4} may be made to three significant figures from 1 kc to 300 mc. In the center is the micrometer electrode and coil mounted on negative resistance circuit. Power supplies and measuring instruments are shown in background. (For complete details and circuitry, see p 224)



EXAMINE THESE

Direct Reading Features

WHICH SIMPLIFY ACCURATE MEASUREMENTS

The Q METER

TYPE 160-A

50 kc. to 75 mc.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* features which save time and simplify operation.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

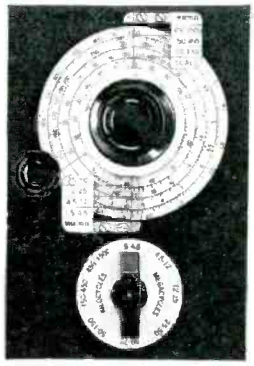
Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero,—3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

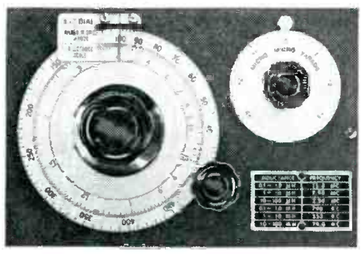
Catalog "H" containing further information available upon request.

1 OSCILLATOR FREQUENCY DIAL.



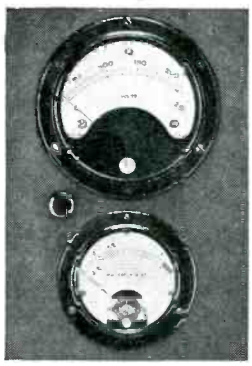
This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIALS.



L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in MMF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 MMF through zero to —3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.



For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY
GENERATOR AND OTHER DIRECT READING INSTRUMENTS

BOONTON RADIO *Corporation*
BOONTON · N·J · U·S·A·

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Interesting Laboratory Devices Are Featured . . . Technical Data Are Given for New Miniature Equipment . . . Thirty Bulletins Are Described

Lighthouse Tube

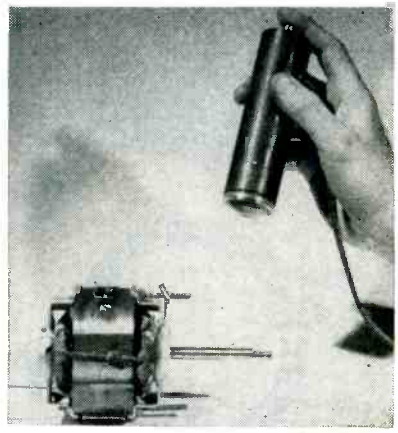
GENERAL ELECTRIC CO., Schenectady, N. Y., has put into production another in the series of lighthouse tubes used in radar during World War II. The GL-2C39A high-mu triode can also be used in radio communications and other military equipments. Its nonmilitary applications include aircraft traffic and location controls, broadcast relay equipment, microwave test apparatus, and utility telemetering and communications systems. The tube can operate at full rating up to frequencies as high as 2,500 mc. Maximum d-c plate voltage is 1,000 volts and dissipation is 100 watts.

Square-Wave Generator

ELECTRO - MECHANICAL RESEARCH, INC., Ridgefield, Conn. Model 43A square-wave generator is a versatile laboratory instrument for use in testing audio, video and r-f amplifiers and networks. It includes a wide-range variable-frequency multivibrator that drives a two-stage clipper circuit to produce negative-going square waves. Freqency range is from 6 cycles to 1,000,000 cycles with self-contained generator. Output voltage is approximately 24 volts peak-to-peak when the generator is operated on a 115-volt line. The voltage is delivered at the end of a 300-ohm transmission line that is 24 in. long from driving point to termination. Power consumption is approximately 125 watts at 115 volts, 60 cycles.

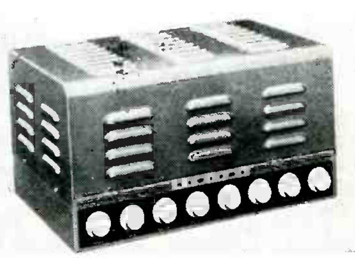
Laboratory Monitor

TRACERLAB, INC., 130 High St., Boston 10, Mass. Developed specifically for use as a routine contamination monitor in radioactivity laboratories, the SU-3B laboratory monitor is especially useful for several important applications. They are: checking laboratory bench tops for contamination; checking laboratory glassware in tracer experiments for adequate decontamination; steady monitoring of laboratory background counting rate to detect large scale fluctuations; and monitoring fingertips and laboratory coats for contamination. The instrument is compact, direct reading and a-c operated, and it has three full-scale meter ranges of 200, 2,000 and 20,000 counts per minute. It comes completely equipped including a mica end-window Geiger tube enclosed in a detachable probe assembly connected to the instrument by a convenient length of flexible cable.



Stroboscope

THE SYNCHROSCOPE CO., 57 William St., New York 5, N. Y., has introduced a portable flashlight-type stroboscope capable of indicating synchronous speeds. It is ideal for production and laboratory testing as well as field servicing of synchronous motors, time switches, timing devices, aircraft motors, generators, business machines and other devices using synchronous speeds. The instrument uses an electronic cold-cathode triode tube that rectifies the line source and gives off a pulse of light only during the positive portion of the a-c cycle.



High-Power Amplifier

NEWCOMB AUDIO PRODUCTS CO., 6824 Lexington Ave., Hollywood 38,

RAYTHEON FILAMENTARY SUBMINIATURE TUBES

for supreme reliability and long life
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TRANSCRIBE THIS STATEMENT 25,000 TIMES

DICTAPHONE CORPORATION

did it — checked the average life of over 25,000 RAYTHEON CK510AX Subminiature Tubes used in their Time-Master Transcriber and found these tubes were good for *five years* of operation (more than 9000 hours on the job) before replacement could be expected.

Performance like this is taken for granted by thousands of users of Raytheon Subminiature Tubes. That's why they are standard throughout the world — *more of them in use than all other makes combined.*

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	Typical Operating Conditions: Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk = 200
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk = 220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk = 500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
CK5829	Similar to 6AL5	0.300x0.400	1.5	6.3	150			117ac	5.0 per section			
CK5975	Triode, Amplifier Oscillator	0.400	1.5	6.3	175	4000		200	12.5			Rk = 680
CK5995	Half Wave Rectifier	0.400	1.75	6.3	300				45	Inverse peak 850 volts		
FILAMENT TYPES												
1AD4	Shielded RF Pentode	0.300x0.400	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg = 2meg
1AG5	Diode-Pentode Det. Amplifier	0.285x0.385	1.5	1.25	30	350		45	0.8	45	0.25	Rg = 5meg
1AH4	Pentode, RF Amplifier	0.285x0.385	1.5	1.25	40	750		45	0.75	45	0.2	Rg = 5meg
2E31-32	Shielded RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	Rg = 5meg
2E35-36	Output Pentode for pocket radio	0.290x0.390	1.56	1.25	30		6	45.0	0.45	45.0	0.11	−1.25
2G21-22	Triode Heptode for pocket radio	0.300x0.400	1.56	1.25	50	60 conv. cond.		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp. Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.385	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	−1.5
CK527AX	Output Pentode 15 ma. filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK534AX	Voltage Amplifier	0.285x0.385	1.25	0.625	15	30†		15.0	0.0047	15.0	0.0014	−0.625
CK535AX	Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK574AX	Shielded Pentode RF Amplifier	0.285x0.385	1.25	0.625	20	160		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	−6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.285x0.385	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.285x0.385	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	Shielded RF Pentode	0.285x0.385	1.5	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5×10^{-13} amps.	0.285x0.400	1.25	0.625	20	1.5†		12.0	0.22			−3.0
CK5785	High voltage rectifier	0.300x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
CK5851	Class C. RF Beam Tetrode	0.400	1.6	1.25/2.5	120/60	1600		125	5.5	125	0.9	−7.5
CK5886/CK571AX	Electrometer Pentode Max. grid current 2×10^{-13} amps.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		−3.0
CK5889	7.5 ma. filament electrometer pentode $I_g = 3 \times 10^{-15}$ amps. max.	0.400	1.75	1.25	7.5	10		12.0	0.004	4.0	0.004	−2.0
CK6029/CK573AX	Triode, High Freq. Oscillator	0.300x0.400	1.5	1.25	200	2000		90.0	11.0			−4.0
CK6050	Triode, UHF Oscillator	0.285x0.385	1.5	1.25	120	1600		135	4.0			−5.0
CK6088/CK522AX	Output Pentode	0.285x0.385	1.5	1.25	20	450	1.2	22.5	0.30	22.5	0.08	0
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.625	Operating voltage 87. Operating current range 1.5 to 3.5 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ® RK ®

†Voltage Gain Ratio.

RAYTHEON ®

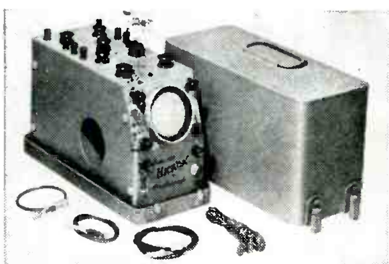
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES

Calif. Model E-50D amplifier provides two individual 25-watt output channels on separate controls for a total of 50 watts of undistorted audio power. Flexibility makes it ideal for installations in which individual control is desirable simultaneously for two auditoriums of different power requirements. It has inputs for three microphones and one phonograph. Distortion is less than 5 percent for each 25-watt channel. Ample inverse feedback insures good output regulation. An amplifier jack on the chassis permits connecting another E-50D thus providing a total of 100 watts from four separately controlled channels.

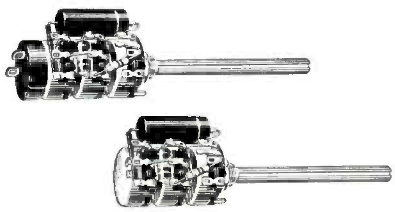


Small Oscilloscope

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. Model 380 Miniscope has a frequency coverage to 2.5 mc and features a sensitivity of 0.1 rms volt per inch, direct connection to c-r tube elements, provision for z-axis modulation and a telescopic light shield. It is designed for industrial and laboratory engineering use. The instrument measures 6 in. wide × 9 in. high × 13¼ in. deep, and weighs only 14 lb. Price is approximately $290.

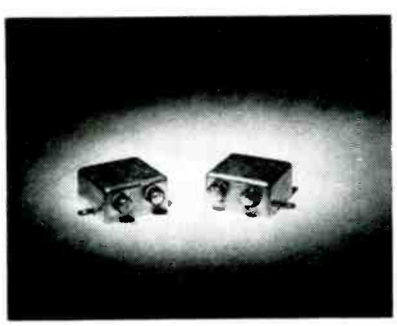
Isotope Ratemeter

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. The model 524 is a laboratory-quality counting ratemeter for detecting and measuring alpha, beta and gamma radiation. Six ranges of sensitivity are provided with full-scale readings from 300 to 100,000 counts per minute. A three-position time-constant selector and an enclosed loudspeaker for aural monitoring are featured. Provision for a scintillation counter as well as adaptability for various specialized counter tubes are incorporated. The instrument requires 110 volts a-c.



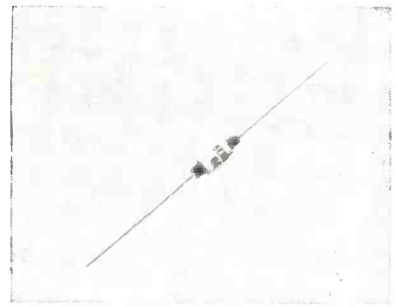
Variable Loudness Control

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. Revolutionary in the continuously variable audio-compensated control, as opposed to former single or double-tapped, or stepped-type controls, the type LCI offers the following advantages: greater smoothness of adjustment; easy installation, requiring only three connections; less space requirements than previous controls now on the market; and it is less expensive than controls with required taps or the step-type control and associated components previously required to get equal performance. Complete information as to installation, performance and specifications is found in a 14-page leaflet, with full charts and graphs.



D-C Capacitors

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has available a new line of capacitors that meet all the requirements of F characteristics of JAN-C-25 for 100-volt d-c units. For applications where an expected life of 1,000 hours is satisfactory, the rating can be increased to 150 volts and temperatures to 40 C. Test results show that there is negligible change in capacitance from −40 C to 105 C and the units give full life expectancy at temperatures as low as −55 C. These thin-paper, thin-foil capacitors are comparable in all ways with previously offered paper dielectric units and, in addition, are smaller in size and lighter in weight.



Germanium Diode

BERKSHIRE LABORATORIES, 506 Lexington Road, Concord, Mass. The GCD-1 high-back-resistance germanium diodes pass JAN-1A crystal specifications for cycle immersion in hot and cold water and for temperature cycling. Continuous reverse working voltage is 80 volts maximum; peak back voltage for zero dynamic resistance is 90 volts minimum; ambient temperature range is −50 to +75 C; average life, more than 10,000 hours; and shunt capacitance, 0.8 $\mu\mu$f. The diodes operate satisfactorily from d-c to above 100 mc. Price is $2.50.

Electronic Counter

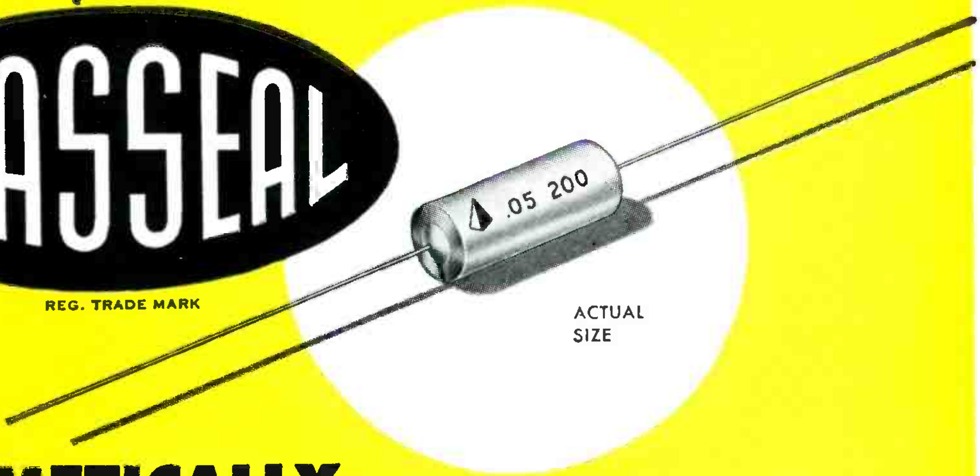
GENERAL CONTROL CO., 1200 Soldiers Field Rd., Boston 34, Mass.,

(continued on page 248)

Announcing

GLASSEAL

REG. TRADE MARK



ACTUAL SIZE

HERMETICALLY-SEALED *Miniature* TUBULAR PAPER CAPACITORS by PYRAMID

Pyramid Type PG "GLASSEAL" miniature paper capacitors are assembled in metal tubes with glass-metal terminals. They will fully meet the most exacting demands of high vacuum, high pressure, temperature cycling, immersion cycling and corrosion tests.

TEMPERATURE RANGES: −55° to +125°C.

CAPACITANCE RANGE:	.001 mfd. to 1.0 mfd.
VOLTAGE RANGE:	100 to 600 v.d.c. operating

Your inquiries are invited

PYRAMID Electric Company

GENERAL OFFICES and PLANT NO. 1
1445 HUDSON BLVD. • NORTH BERGEN, N. J.

PLANT NO. 2
155 OXFORD ST. • PATERSON, N. J.

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

NBS Opens New Lab Center

Aerial view of National Bureau of Standards' Corona, Calif., laboratories

ESTABLISHMENT of a new National Bureau of Standards laboratory center at Corona, Calif., to be devoted to various phases of electronic research, development and engineering was recently announced. To be known as the Corona Laboratories, the new center will be primarily concerned with technical problems of importance to the Department of Defense. About 22 buildings formerly used by the Navy are being renovated to accommodate NBS research and development activities being transferred there from Washington. Limited operations began at the laboratory in June and full-scale operation is planned for September.

In the near future the most important activity at the Corona laboratories will be the development of guided missiles. Every phase of missile development will be covered, from theoretical and applied research to construction of experimental parts and units. An analog computer is being set up in the laboratories to be used in flight simulation problems where trajectories of guided missiles must be computed mathematically. The computer, occupying about 1,000 square feet of floor space, can solve problems in minutes that would take trained mathematicians weeks to solve. Other equipment at the new center will include electronic laboratories, machine shops, wind tunnel, jet engine test cells and altitude chambers.

Technical Writers Needed

AN URGENT need for technical writers exists in the Ordnance Development Division of the National Bureau of Standards. Salaries range from $4,600 to $6,400, depending upon the applicants' experience and education.

This Division is engaged in research and development of electronic ordnance devices for the armed forces. Examples of the type of work reported in the division are:

(1) Experimental work in energy radiation and propagation, static fields, electronic systems and electronic circuitry for military applications.

(2) Development of radio transmission lines and filters, antenna designs and radiation and collection systems, and research and development in electronic circuits for these systems, including gating circuits and servo loops.

(3) Electronic packaging and production techniques on electronic assemblies.

(4) Design and development of electron tubes to meet unusual requirements.

(5) Statistical analysis of field test data, including studies directed toward devising new and better testing plans and techniques.

Further information concerning the work and the benefits of Government employment can be had by writing to the Personnel Officer, Division 13, National Bureau of Standards, Washington 25, D.C. A booklet describing work at the Bureau will be sent on request.

FCC Nonbroadcast Applications

The Federal Communications Commission in announcing revision of its Form 401, "Application for New or Modified Radio Station Construction Permit (Other than Broadcasting)", warns that applicants who use the old, unrevised form after August 1, 1951, may have the application returned. The new form will contain questions involving recently adopted Part 17 of the rules that concern the construction, marking and lighting of antenna towers and supporting structures.

RTMA Election Report

ROBERT C. SPRAGUE, president of the Sprague Electric Co., was reelected chairman of the board of directors of the RTMA at its recent convention in Chicago. The board also reelected Leslie F. Muter as treasurer, and renamed W. R. G. Baker as director of the engineering department, James D. Secrest as secretary and general manager, and John W. Van Allen as general counsel.

Two new directors and 12 former directors were elected. The new directors are Robert S. Alexander, president of Wells-Gardner & Co. and Harlan B. Foulke, vice-president and director of sales of Arvin Industries, Inc. Reelected for three-year terms are: Benjamin Abrams of Emerson Radio & Phonograph Corp.; Max F. Balcom of

The BSR range of Phonographs now leads the field in both design and appearance. The resources of a modern factory coupled with years of experience enable us to make these claims and still sell at comperitive prices.

MODELS ILLUSTRATED

GU4. Three speed Phonograph unit with high fidelity pick-up and automatic stop. The pick-up is complete with two permanent sapphire stylii and the turntable is fitted with removable rubber mat. MU14. Three speed Phonomotor. Speed change is effected merely by rotation of the speed change knob. The turntable diameter is 10 inches. MU15. Phonomotor for 78 R.P.M. only employs an 8 inch diameter turntable and is extremely robust reliable and inexpensive.

Further details available on application.

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Telephone: Tuckahoe 3-9391

Made by Birmingham Sound Reproducers Ltd., Old Hill, Staffs. England Grams: 'Electronic Old Hill, Cradley Heath.'

H. C. Bonfig of Zenith Radio Corp.; Herbert W. Clough of Belden Mfg. Co.; John W. Craig of Crosley Division, Avco Mfg. Corp.; E. G. Fossum of Stewart-Warner Electric Div.; G. Richard Fryling of Erie Resistor Corp.; J. J. Kahn of Standard Transformer Corp.; F. R. Lack of Western Electric Co., Inc.; W. A. MacDonald of Hazeltine Electronics Corp.; and A. D. Plamondon, Jr., of The Indiana Steel Products Co.

MEETINGS

AUG. 15-18: 1951 APCO Conference, Everglades Hotel, Miami, Florida.

AUG. 17-18: 12th Annual Summer Seminar of the Emporium Section of IRE, Emporium, Pa.

AUG. 20-23: AIEE Pacific General Meeting, Multnomah Hotel, Portland, Oregon.

AUG. 22-24: Seventh Annual Pacific Electronic Exhibit and West Coast Annual IRE Convention, San Francisco Civic Auditorium, San Francisco, Calif.

AUG. 28-SEPT. 8: Eighteenth British National Radio Show, Earls Court, London, England.

SEPT. 10-13: Annual Electronic Parts Distributors' Convention and Show, Cleveland Auditorium, Cleveland, Ohio.

SEPT. 10-14: Sixth National Instrument Conference and Exhibit, sponsored by Instrument Society of America, Sam Houston Coliseum, Houston, Texas.

OCT. 2-4: Twenty-Eighth Annual Session of the Communications Section of the Association of American Railroads, Chateau Frontenac, Quebec, Canada.

OCT. 8-10: AIEE Conference on Aircraft Equipment, Hollywood Roosevelt Hotel, Los Angeles, Calif.

OCT. 22-24: 1951 National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

OCT. 22-26: AIEE Fall General Meeting, Hotel Cleveland, Cleveland, Ohio.

OCT. 29-31: Radio Fall Meeting, sponsored by IRE, and RTMA, King Edward Hotel, Toronto, Ontario, Canada.

NOV. 1-3: Third Annual Convention and Audio Fair Exhibition of the Audio Engineering Society, Hotel New Yorker, New York City.

NOV. 12-15: NEMA Convention, Haddon Hall, Atlantic City, N. J.

Revised Maritime Service Rules

THE Federal Communications Commission has announced an order making overall revisions to Part 7, Coastal and Marine Relay Services and Part 8, Ship Service, of their Rules and Regulations, effective July 23, 1951.

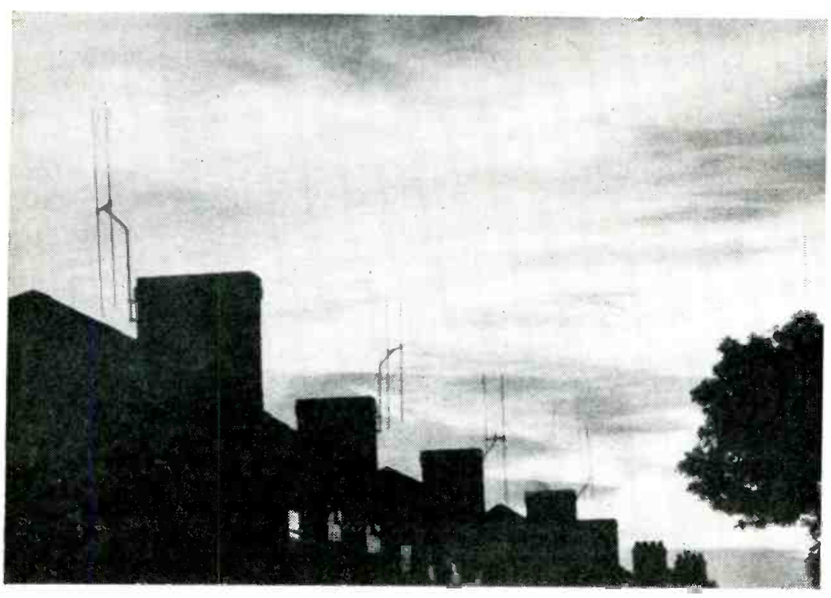
Although the order is so voluminous, some 300 pages, that copies are not generally available, it is planned to publish it in a future single issue of the Federal Register. This edition can be ordered prior to publication at about 20¢ a copy from the Superintendent of Documents, at U.S. Government Printing Office, Washington 25, D. C.

Among other objectives, the revised rules are intended to enhance safety of life at sea by providing type approval or type acceptance for radio equipments, by requiring installation of automatic alarm-signal keyers and inauguration of a radiotelephone distress frequency at 2,182 kilocycles. It is noted, however, that outside of the Great Lakes region, there exists no formal monitoring service for this frequency.

Other provisions include expansion of service for public correspondence and limited service stations, particularly at the very-high frequencies between 152 and 162 mc.

The so-called Marine-Utility class of station has been authorized for low-power, portable vhf radiotelephone operations characterized by the needs of harbor pilots. A Marine Fixed class using the band between 2,100 and 2,210 kc is available for transmission of the communications incident to off-shore oil-well drilling.

STRANGE SKYLINE



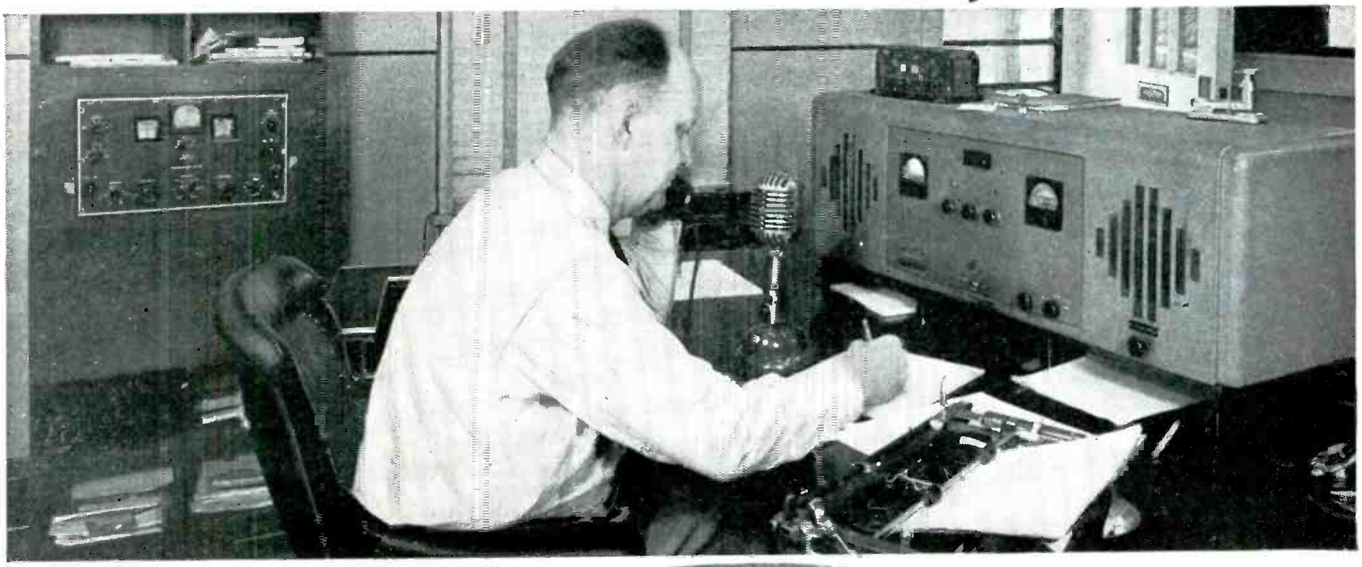
Not a view of storm-tossed television antennas as seen in the United States but the normal rooftop scene of any British city. In England, the receiving dipoles are oriented for vertical polarization of the transmitted signals instead of the horizontal polarization used for tv transmissions here

NTSC Reorganizes

THE National Television System Committee, which recently released an ad hoc committee report on a

(continued on page 275)

WHEN EMERGENCY CALLS FOR *Speed...*



1. In Minneapolis, the police radio network is linked to hospital ambulances by two-way mobile rigs equipped with Sylvania receiving and transmitting tubes. Immediately the Minneapolis Police headquarters hears of an accident, a General Hospital ambulance is alerted by 2-way radio and routed to the scene.

2. Police cars nearby are also instructed to go to the location and lend whatever police help is needed.

Minneapolis calls on Sylvania tubes

3. This quick, efficient coordination between the Minneapolis Hospital and the Police Department has been an important factor in enabling this city to win the *National Safety Council award as the nation's "Safest City" . . . for 2 successive years.*

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NEW BOOKS

Pulse Techniques

BY SIDNEY MOSKOWITZ AND JOSEPH RACKER. *Prentice-Hall, Inc., New York*, 1951, 300 *pages*, $6.65.

THE AUTHORS' purpose in writing the book, in their own words, is to enable individuals with an electrical engineering background to analyze and design circuits for the transmission and utilization of pulses. They have kept mathematics to a minimum with a practical application viewpoint in mind.

After a short introductory chapter where the nomenclature is discussed, the transient response of linear networks is covered in the second chapter. The transform method of solving transient problems and a very short table of Fourier mates are included. Chapter 3 is devoted to the design of pulse networks and delay lines. The fourth chapter, on linear pulse amplifiers, discusses various wide-band amplifiers including the transmission-line amplifier and the cathode follower. Chapter 5, on pulse shapers and clamping circuits, covers limiters, clippers, integrators, differentiators, shapers and d-c restorers. Chapter 6, on pulse generation, is rather short for a very important subject in pulse techniques but all of the basic types are covered.

The applications and practical uses are taken up in chapter 7 on measurements and instruments, 8 on pulse communication systems and 9 on aerial navigation aids. These are each about 20 pages long. Also included are three appendices, one on the complex variable, another on the pulse response of

(continued on page 286)

RELEASED THIS MONTH

An Introduction to Electron Optics; L. Jacob; Methuen's Monograph; Wiley; $2.00.

Electric Transmission Lines; H. H. Skilling; McGraw-Hill; $6.50.

Television Principles; R. B. Dome; McGraw-Hill; $5.50.

Ultrasonics; P. Vigoureux; Wiley; $4.00.

Improved COUNTING RATE METER for Continuously Monitoring RADIO-ACTIVE MATERIALS

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Newly Designed Pre-Amplifier: *in small cylindrical anodized aluminum case; easy decontamination; long cable may be used; case equipped with tripod-type mounting thread (bench-top mount in photo is accessory sold separately)*

Quenching Circuit *operates with self-quenching or non-self-quenching counter tubes*

Greatly Increased Sensitivity: *counting rate meter sensitivity increased four-fold; now responds to ¼-volt pulses*

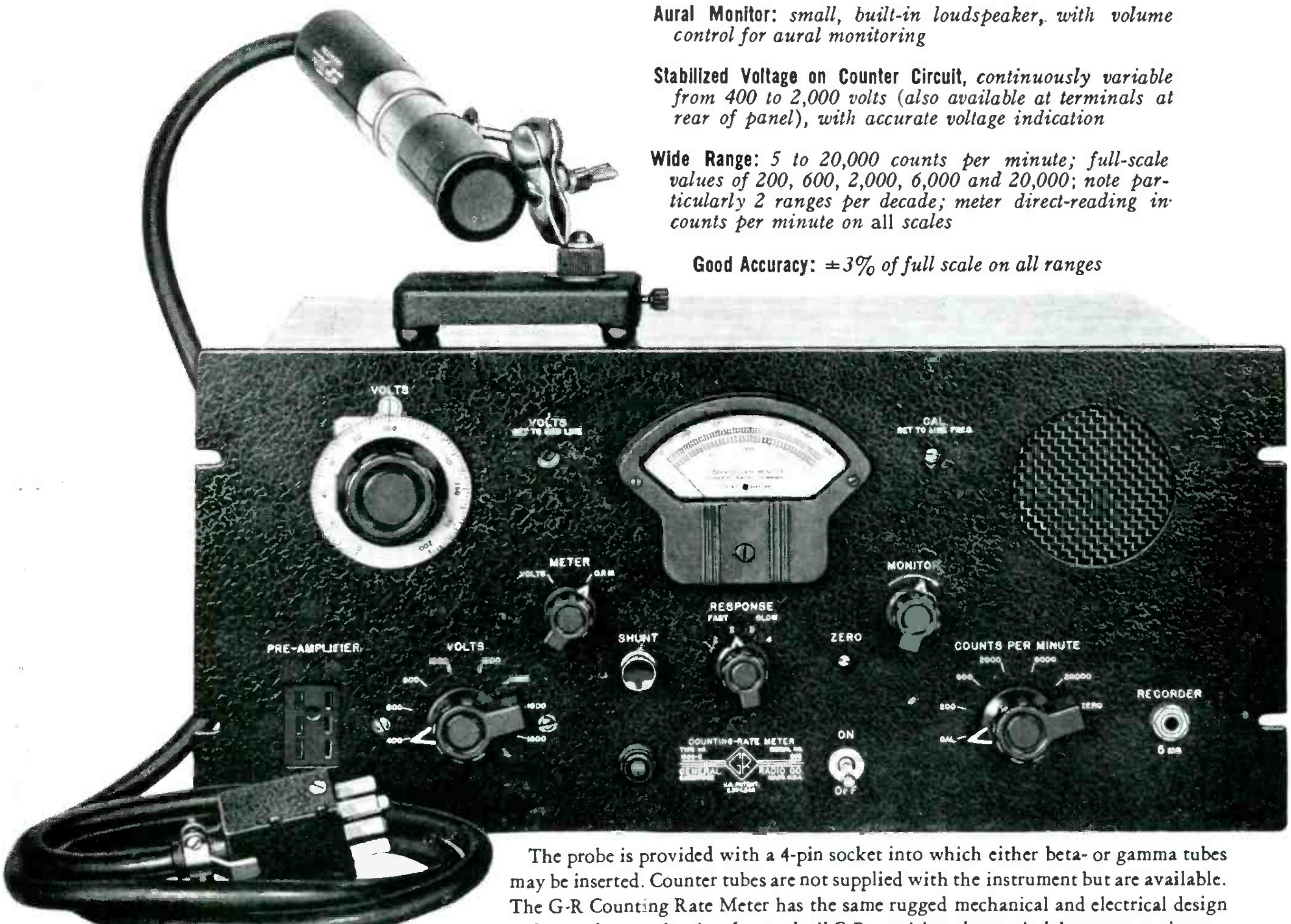
Panel Jack Terminals *for 5 ma pen recorder providing continuous picture of what happens while radio-active material is being monitored; in absence of operator will indicate spurious activity*

Aural Monitor: *small, built-in loudspeaker, with volume control for aural monitoring*

Stabilized Voltage on Counter Circuit, *continuously variable from 400 to 2,000 volts (also available at terminals at rear of panel), with accurate voltage indication*

Wide Range: *5 to 20,000 counts per minute; full-scale values of 200, 600, 2,000, 6,000 and 20,000; note particularly 2 ranges per decade; meter direct-reading in counts per minute on* all *scales*

Good Accuracy: *±3% of full scale on all ranges*



The probe is provided with a 4-pin socket into which either beta- or gamma tubes may be inserted. Counter tubes are not supplied with the instrument but are available. The G-R Counting Rate Meter has the same rugged mechanical and electrical design and manufacture that has featured *all* G-R precision electronic laboratory equipment since 1915.

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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.

Another First

DEAR SIRS:

THE AUTHOR of the article "Possible Phototube" which was published in ELECTRONICS (September, 1950, p 132), certainly overlooked that this same photocell was already developed and built in the Laboratories of Zeiss Ikon A. G., Dresden, Germany, by the writer and W. Lang. There was published an article describing the development in the *Zeitschrift für Instrumentenkunde*, 57 (1937, p 249) with the title *"Uber lichtelektrische Zellen für Messungen im sichtbaren Spektralberich"* (About photoelectric cells for measurements in the visible spectrum).

DR. PAUL GÖRLICH
Moskauer Geb.
USSR

To All Tech Reps

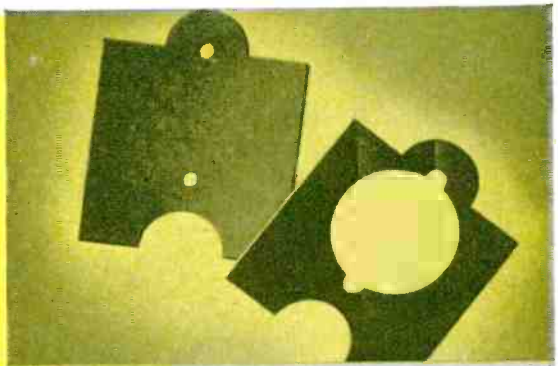
DEAR SIRS:

A COMPARATIVELY NEW type of field engineering has come into existence as a result of the growing need of the U. S. Army for technical personnel and the ever-increasing flow of American technical equipment to friendly nations under provisions of various mutual defense treaties.

In the latter case, because of the unfamiliarity of the recipient nations with American types of electronic equipment, methods of operation, preventative maintenance techniques and methods of training, the United States is providing field engineers to assist in the instruction of foreign nations, so that

(Continued on page 300)

YOU CAN MAKE IT BETTER WITH Taylor Laminated Plastics



This two-part radio insulator is typical of Taylor's ability to mass-produce accurate parts. Each is stamped in a single operation, one from Taylor Vulcanized Fibre and the other from Grade XXXP-10 Taylor Phenol Fibre, noted for its high dielectric strength. Whatever *combination* of qualities you may need, it's a good bet that one of the many Taylor grades can fulfill your requirements.

If Your Problem

is to design your product or part with a material that offers a *combination* of electrical, mechanical and chemical properties such as high tensile, flexural and impact strength... resistance to corrosion, moisture and abrasion . . . attractive appearance . . . high insulating qualities . . . high speed machineability . . . light weight with great strength and many other desirable characteristics—

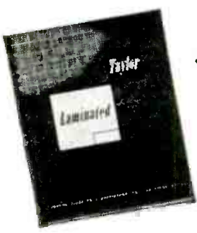
A Good Solution

to your problem is Taylor Laminated Plastics. As insulating parts and structural members, Taylor Vulcanized Fibre, Phenol Fibre and Combination Materials, available in a variety of grades, offer you a better, cheaper . . . faster means of developing a *better* product. If you do your own fabricating, Taylor can supply you with sheets, tubes, rods and rolls. If you seek a source of supply for finished parts, Taylor's completely equipped Fabricating Department is at your service.

Taylor Post Forming Material is a special grade of Phenol Fibre produced in fully-cured sheet form, for the specific purpose of forming to various shapes by heating and forming operations. This Taylor product makes it possible to transform a flat sheet into one with relatively deep draws and compound curves, with little sacrifice in the strength of material.

More Information

on Taylor Laminated Plastics and their application is available. If you have a design problem as indicated above, write today for the new 1951 Taylor Laminated Plastics Catalog. If possible, state your problem. Your copy will be sent you promptly, and experienced Taylor Sales Engineers will be happy to consult with you without obligation.



The new 1951 Taylor Catalog contains complete specifications and description of Taylor Laminated Plastics. See for yourself how you can make your product or part better *with these versatile Taylor materials. Write today for Catalog* E-8.

More than half a century's experience in the field of laminated plastics gives Taylor the edge whenever there's a problem involving the design and fabrication of laminated plastics. There is practically no limit to the variety of shapes that may be quickly, accurately and economically produced from these versatile materials. Combining light weight and great strength with insulating, electrical or dielectric properties to fit hundreds of applications, Taylor Laminated Plastics can help you produce a *better* product.

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TAYLOR FIBRE CO.
NORRISTOWN, PENNSYLVANIA
WEST COAST FACTORY: LA VERNE, CALIF.

 (continued from page 138)

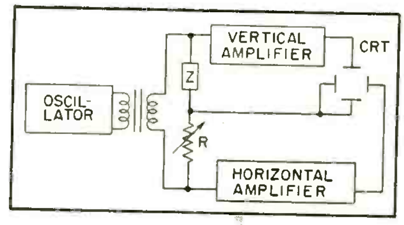

FIG. 1—Impedance measuring circuit

The resistor R is made equal to the known resistance. The vertical and horizontal gains are adjusted to give the same deflection, for instance 2 inches on a 5-inch crt. The impedance is then substituted for the known resistor, the output of the oscillator set for the desired frequency and a convenient voltage output, the value of R is adjusted until the resulting Lissajous figure has the same horizontal and vertical deflections. Then the absolute value of $Z = R$. Power factor, phase angle, or resistive and reactive components may be determined from the shape of the Lissajous ellipse. The phase angle will be subject to some error if the phase shifts in the vertical and horizontal amplifiers differ. If phase angle is important, care should be taken to make the amplifiers as nearly identical as possible.

The order of magnitude of the power factor can be determined at a glance. Phase angles close to zero will give a narrow ellipse, zero power factor will result in a circle. Nonlinearity of any appreciable magnitude will be indicated by a nonelliptical Lissajous figure. While this procedure is hardly suitable for nonlinearity or distortion measurement, it will serve to indicate when something is wrong to any appreciable degree.

One precaution should be pointed out. The oscillator or its output amplifier will need to be isolated by a suitable transformer. As shown in Fig. 1, the center terminal of the "bridge" is connected to crt ground and this must not be a ground common to the oscillator.

Ultrasonic Soldering Iron

AN ULTRASONIC soldering iron has been developed for the special purpose of tinning aluminum. In the soldering operation, the aluminum is subjected to intense ultrasonic

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Gray engineers found SELETRON's tiny new selenium rectifier No. 16Y2 a powerhouse of efficiency for all its half-inch square cell size, and incorporated it into the Audograph's compact design . . . It functions direct at 120 volts to operate the back spacer. No. 16Y2 is rated at 130V input, 100V output, .050 output amps. Weighs less than half an ounce!

Millions of dependable SELETRON Selenium Rectifiers are in service. They are available for every purpose from the miniatures used in radio, TV and other electronic circuits, all the way up to the giant stack assemblies required for heavy industrial purposes.

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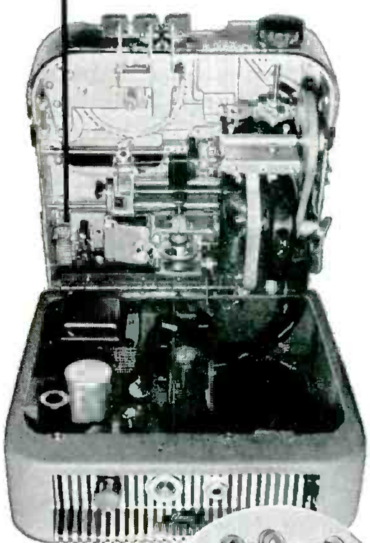

Seletron Rectifier 16Y2 shown actual size

*Audograph, T.M. of The Gray Mfg. Co., Hartford, Conn.

Seletron

T.M. REG. U.S. PAT. OFF.

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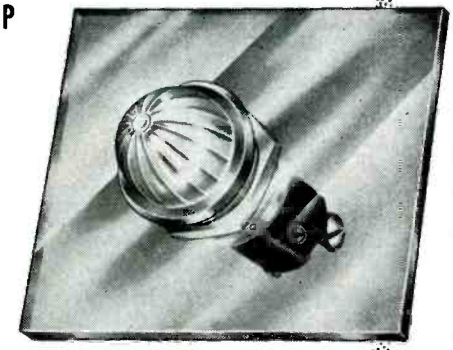

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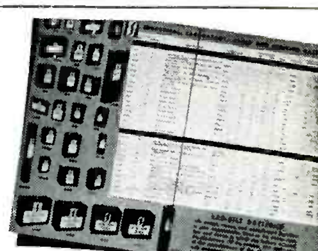

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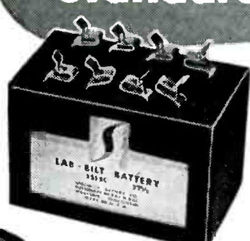

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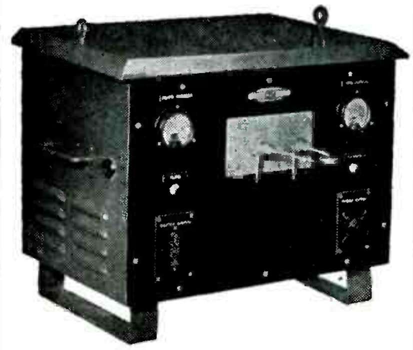

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Simple . . . Easy to Operate . . . Economical Standardization of Unit Makes This New Low Price Possible.

This compact induction heater saves space, yet performs with high efficiency. Operates from 220-volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise time cycle required for your particular job. Cost, complete, only $650. Immediate delivery from stock.

Scientific Electric Electronic Heaters are made in the following ranges of Power: 1-2-3½-5-7½-10-12½-15-18-25-40-60-80-100-250KW.

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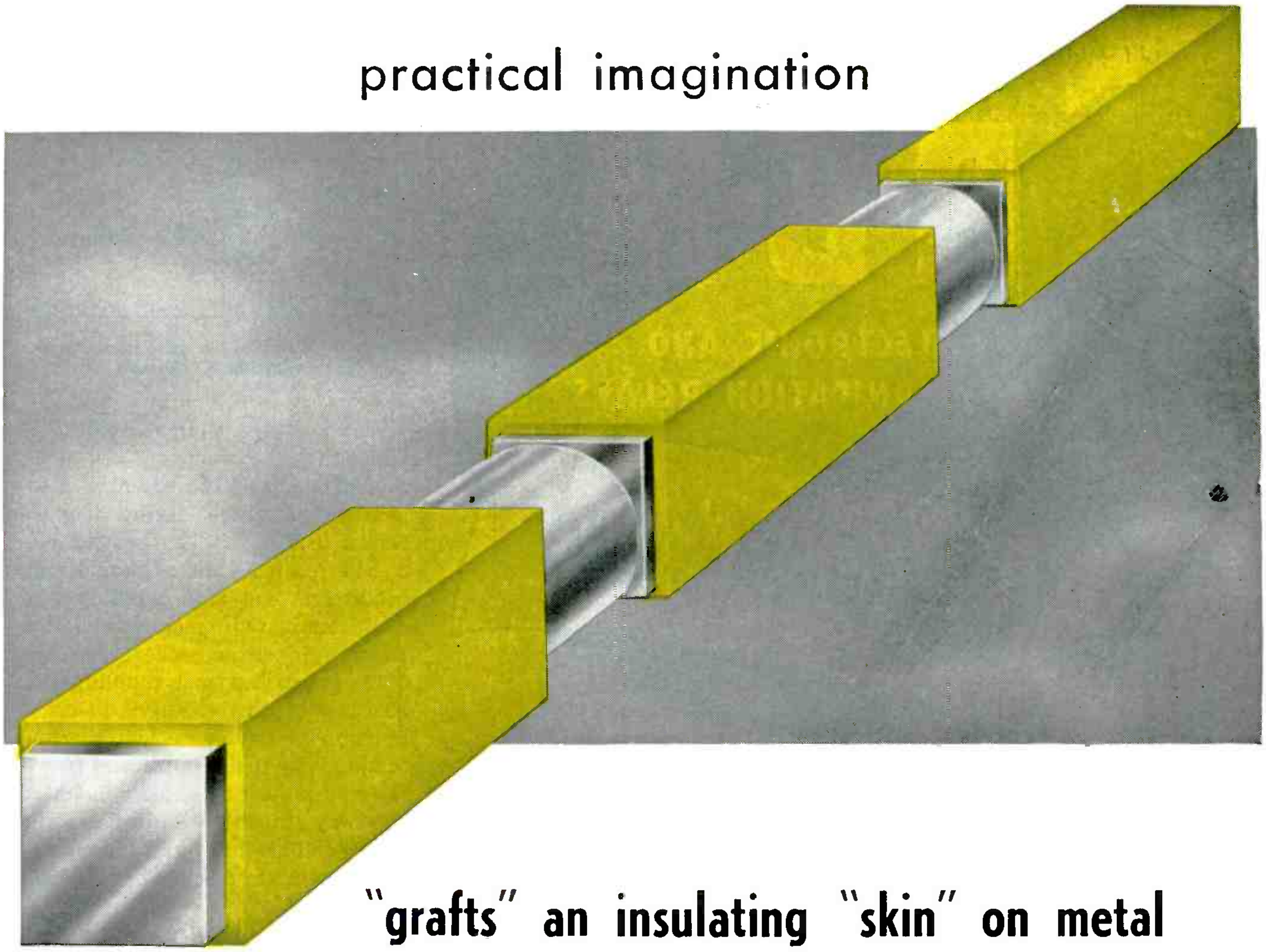
practical imagination

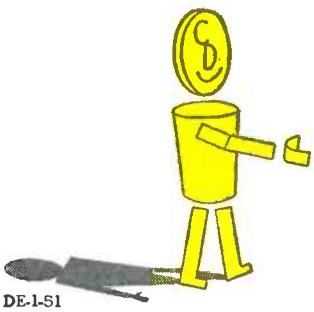


"grafts" an insulating "skin" on metal

Here is another example of the practical imagination C-D engineers can put to work to solve your problems. In this case a heavy electrical connector had to be covered with a safe, efficient insulation. The material best suited to do the job was C-D Dilecto.

The next requirement was to make this insulation an integral part of the whole piece. Here is where practical imagination went to work. The solution was to laminate and mold the Dilecto directly on the metal bar.

When you have a problem involving plastics—whether it is simple or complex—be sure to check with C-D engineers for a practical, unbiased recommendation. They can choose the material best suited to your needs from a wide range of grades of five basic plastics to give you any combination of mechanical, electrical or chemical characteristics. A call to your nearest C-D office will bring you this kind of help any time—all the time.



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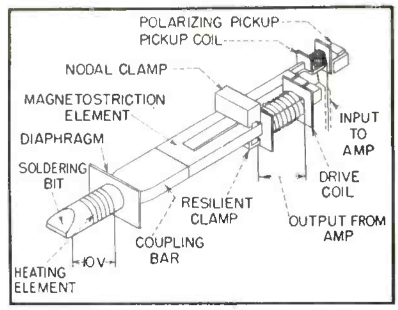


FIG. 1—Sketch of the main components of the ultrasonic soldering iron

vibrations as molten solder is applied to it.

A drawing of the essential components of the soldering iron is shown in Fig. 1. The heating element is located close to the soldering bit at one end of a coupling bar. The laminated magnetostriction element is silver soldered to the other end of the same coupling bar. The coupling bar itself is made of a material having a low thermal conductivity to minimize heat transfer, and it forms a nodally mounted half-wavelength vibrator. The driver coil assembly and the mounting clamps are designed to be heat resistant.

An inexpensive electronic system is used with the soldering iron to keep the applied frequency the same as the resonant frequency of the vibrator. The vibrator itself is included in the oscillatory system. A pickup coil has a voltage induced in it as the magnetostriction element moves. Output from the pickup coil is amplified and fed back to the driver coil to move the vibrator. The circulating signal is then essentially at the resonant frequency of the device.

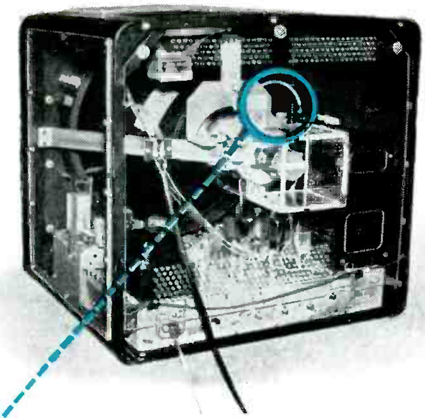
The information in this article was abstracted from the January 1951 issue of the *Journal of the British Institution of Radio Engineers*, page 17.

A-M or F-M for British VHF Broadcasting

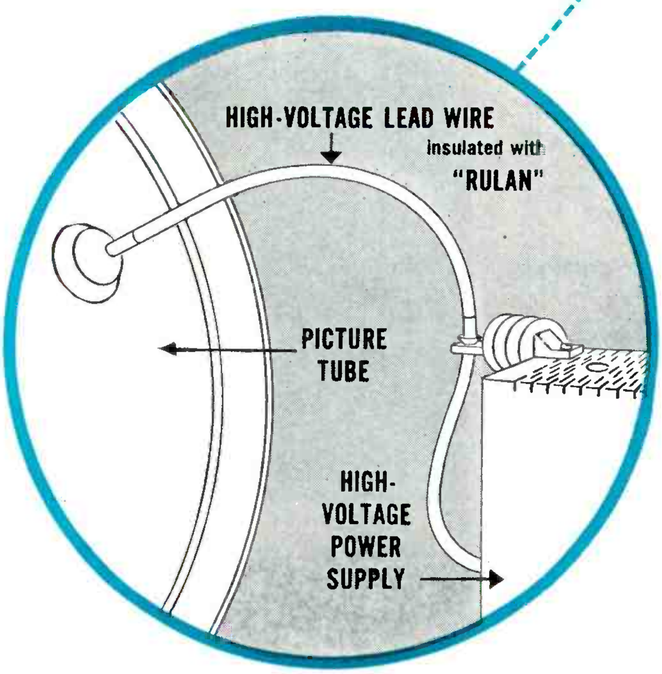
By Edmund Updale

London, England

TEST TRANSMISSIONS have been under way at the BBC vhf transmitting station at Wrotham, Kent, England, for some time to determine whether a-m or f-m is the better system for vhf broadcasting;



Dielectric strength of Du Pont "Rulan"



permits smaller cable in RCA Victor TV receiver; flame-resistance increases safety

This high-voltage DC lead wire insulated with Du Pont "Rulan"* flame-retardant plastic is a space-saver in RCA Victor television receivers. The high dielectric strength of "Rulan" permits a thinner insulating jacket for the cable. The jacket on a 10,000-volt lead is thin as a soda straw!

The insulation efficiency of "Rulan" is shown by its high resistance to corona in these TV leads. The dielectric constant is 2.7 and the power factor is 0.002—both constant over a wide range of frequencies. "Rulan" is non-tracking. And—important for safety—"Rulan" is flame-resistant and will not support combustion.

You'll be seeing more and more of this tough, flexible insulating plastic. "Rulan" can be used with no sacrifice of efficiency at temperatures as low as -76° F. and has very low water-absorption (only 0.02% by A.S.T.M. test). Excellent for neon sign cable, high-voltage hook-up wire, multi-conductor cable, signal control wire, high-voltage street-lighting cable, and many other applications where a flame-resistant insulation is needed.

Because "Rulan" contains no plasticizer, it is useful in non-migrating jackets. It can be extruded onto wire at high speeds and can be injection-molded.

Demand for Du Pont "Rulan" currently exceeds supply. However, we suggest you investigate the versatile properties of "Rulan" for future application. For more information write:

*TRADE-MARK

E. I. du Pont de Nemours & Co. (Inc.),
Polychemicals Dept., District Offices:
350 Fifth Avenue, New York 1, New York
7 S. Dearborn St., Chicago 3, Illinois
845 E. 60th St., Los Angeles 1, California

Sketch shows high-voltage wire insulated with "Rulan" connected to kinescope in RCA Victor receiver. Extruded insulation of "Rulan" is only 45 mils thick for 10 kv, 67 mils for 20 kv, and 93 mils for 40 kv.

Wire manufactured by Anaconda Wire & Cable Company, New York, N. Y.

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MIDGET CONDENSER MICROPHONE

for Precision Sound Measurements and High Quality Sound Recording

Built to give years of service without change in calibration. Even without dessicators, Kellogg Midget Condenser Microphones show no detectable drift in laboratory service. Proven in use for optimum performance for more than 15 years.

- RUGGED CONSTRUCTION
- EXCEPTIONAL CALIBRATION STABILITY
- UNAFFECTED BY VARIATIONS IN HUMIDITY

PRINCIPAL CHARACTERISTICS

	MODEL A	MODEL B
RESPONSE (Referred to 1 volt/dyne/cm²)	-59 db	-55 db
FLAT TO WITHIN	± 3 db from 20 to 11,000 cps, for closed cavity without grille.	± 4 db from 20 to 15,000 cps with or without grille for perpendicular incidence in free field.

Users Include government laboratories, universities, audio development laboratories, sound studios and industrial plants manufacturing sound equipment.

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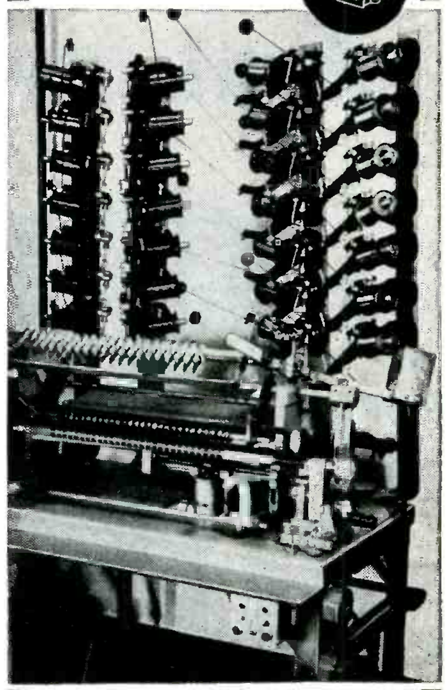
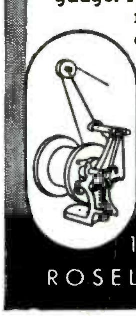
WITH YOUR PRESENT COIL-WINDING MACHINE!



— use PAMARCO

Wire DeReeling Tensions for PERFECT COILS

Installation of these inexpensive PAMARCO tensions lowers winding costs because each machine will accommodate more coils at *higher* winding speeds. In addition to increased production, PAMARCO tensions raise production quality. Free-running action practically eliminates wire breakage and shorted turns. Simple thumb screw setting quickly adjusts for any wire gauge. No tools or special skill are needed for operation. For complete data call or write.



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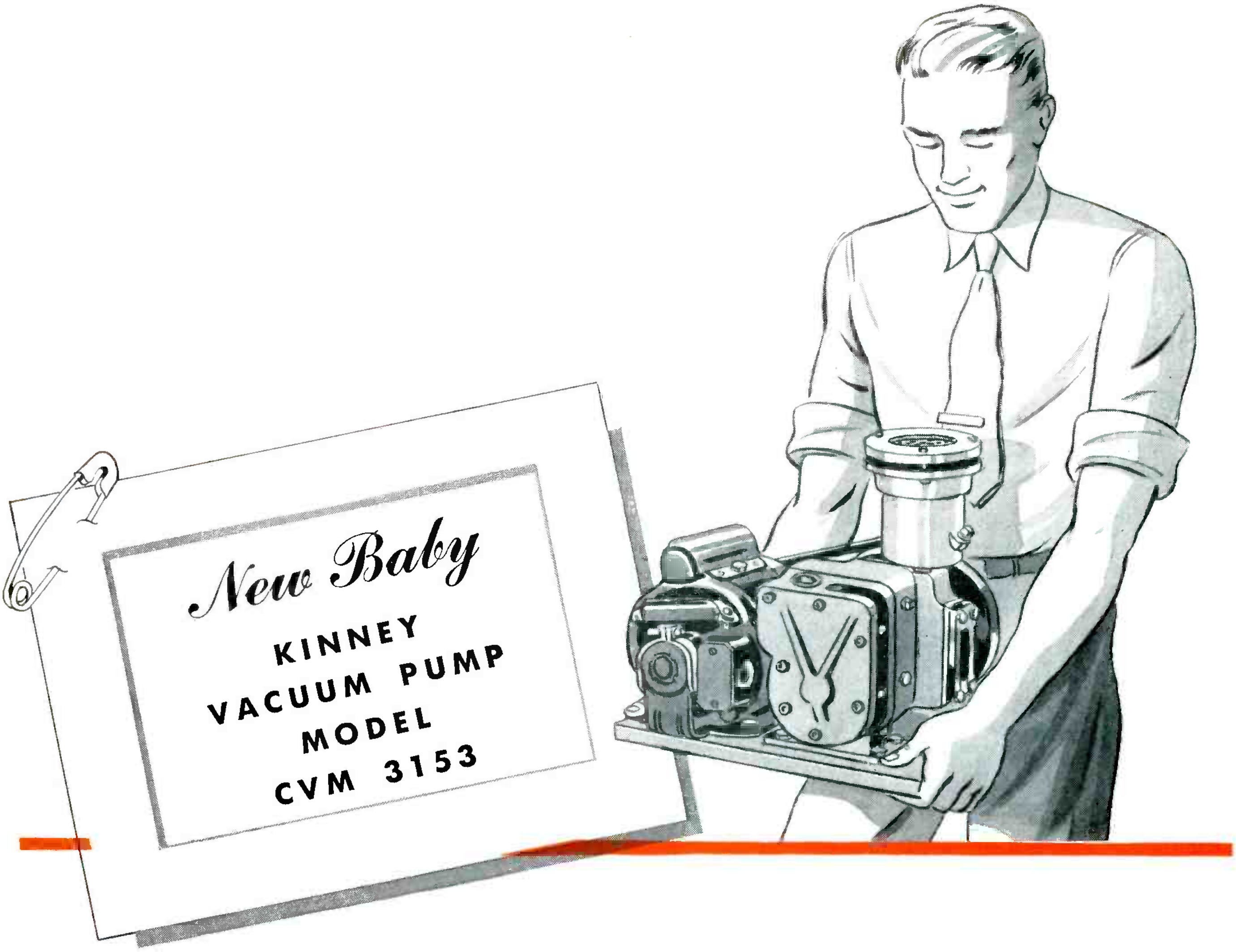


The Model CVM 3153 is the newest and smallest member of the complete Kinney Vacuum Pump family. Compare it with any other mechanical vacuum pump in its class for:

FREE AIR DISPLACEMENT (2 cu. ft. per min.)
POWER (¼ HP motor)
ULTIMATE LOW ABSOLUTE PRESSURE (0.1 micron or better)
SIZE (14¾" x 10¾" x 13¼" high)
WEIGHT (only 70 lbs. complete)

Compare its quiet operation, its ease of starting, its sound construction . . . and you'll see why Model CVM 3153 is an important step forward in vacuum processing.

Wherever small size and big performance are required, put Kinney Model CVM 3153 to work. Use it in the laboratory. Use it in full scale processing installations, by itself or as a backing pump. Use it in permanent installations or as a portable unit for on-the-spot repair, service, or test work.

There's a Kinney Vacuum Pump for every service, from the big Single Stage 702 cu. ft. per min. Model 181420 to our "New Baby", Model 3153. KINNEY MANUFACTURING CO., 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Foreign Representatives: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland . . . C.I.R.E., Piazza Cavour 25, Rome, Italy.

Kinney
VACUUM PUMPS

Write today for Bulletins V51 and V51-A

the equipment used for the tests is described in the following paragraphs.

The f-m transmitter at the British station has a power of 25 kw and operates on a mean carrier frequency of 91.4 mc with a maximum deviation of ±75 kc. The f-m transmitter incorporates a system in which a quartz crystal oscillator is connected through a quarter-wave network to a balanced modulator. The susceptance of the balanced modulator varies with the modulating signal and, in turn, varies the frequency generated by the crystal oscillator.

Output from the crystal modulator is passed through three frequency-doubling stages and one tripling stage to produce the carrier frequency. Following the tripling stage are six stages of amplification. The first two amplifying stages are conventional push-pull stages and the rest are single-ended grounded-grid stages with coaxial-line tuning elements. The output stage consists of two tubes in parallel.

The a-m transmitter has unmodulated power of 18 kw and operates on a carrier frequency of 93.8 mc. The drive equipment and the r-f amplifiers are like those in the f-m transmitter except that the balanced modulator is made inoperative. The a-f modulator has four stages. The final stage consists of two tubes operating push-pull to

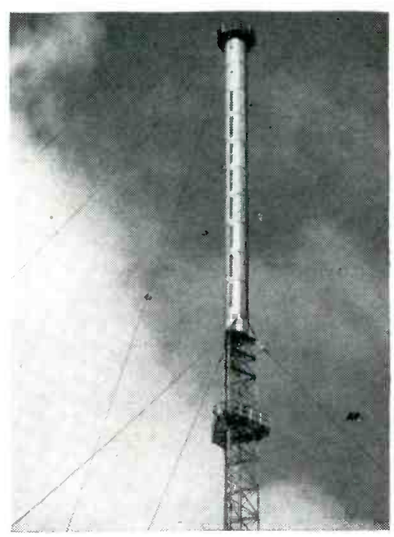
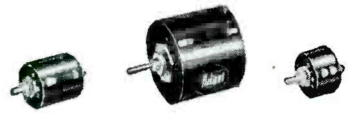


FIG. 1—The vhf antenna and part of the triangular support mast. The antenna is shared by both the f-m and a-m transmitters

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.

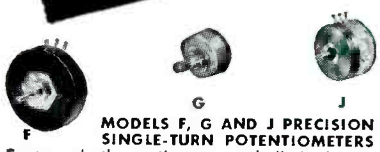


A B C

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.

D E

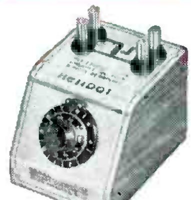
MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234" coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373" coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.



F G J

MODELS F, G AND J 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.
J—2" dia., 5 watts, electrical rotation 357°—resistances 50 to 50,000 ohms.

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.



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.

FOR PRECISION POTENTIOMETERS come to Helipot

...world's largest manufacturer of such equipment!

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.

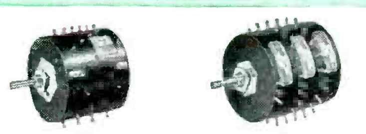
So if you have a problem requiring precision potentiometers your best bet is to bring it to The HELIPOT Corporation, world's largest manufacturer of such equipment. A call or letter outlining your problem will receive immediate attention!

***Trade Marks Registered*

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

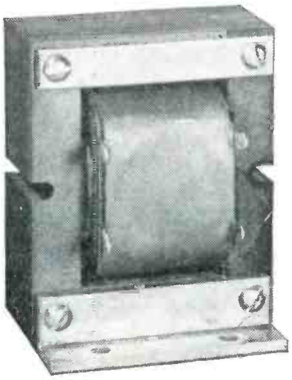
MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

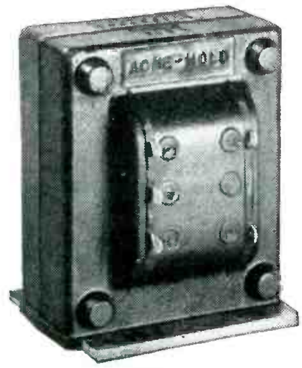
Field Offices: Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles and Fort Myers, Florida. Export Agents: Fratham Co., New York 18, N.Y.

Attention: ELECTRONIC ENGINEERS

Are You Looking For A Material To Completely Impregnate, Mold, and Encapsulate Electrical Components?



Before



After

Acme Star Compound withstands rugged humidity and thermal cycling, as well as salt spray tests.

Millions of ACME-MOLD coils are in service and now Acme offers Star Compound for your use.

Write today for further details

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THE ACME WIRE CO.
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INSULATING VARNISHES
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MAGNET WIRE
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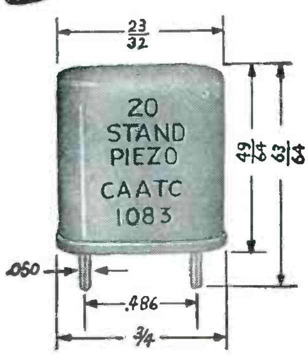
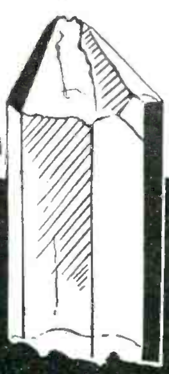
Eliminate CRYSTAL TEMPERATURE CONTROL COSTS . . .



Now you can forget temperature control. Just specify Standard's Type 20 Crystal Unit for your products.

In addition to lowering power requirements and weight, it increases compactness, durability and dependability. Type 20 meets all Government specifications, too.

Discover how the Standard Type 20 can cut costs and increase sales for you. A letter will bring Engineering data and complete details by return mail.



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- **Proven**
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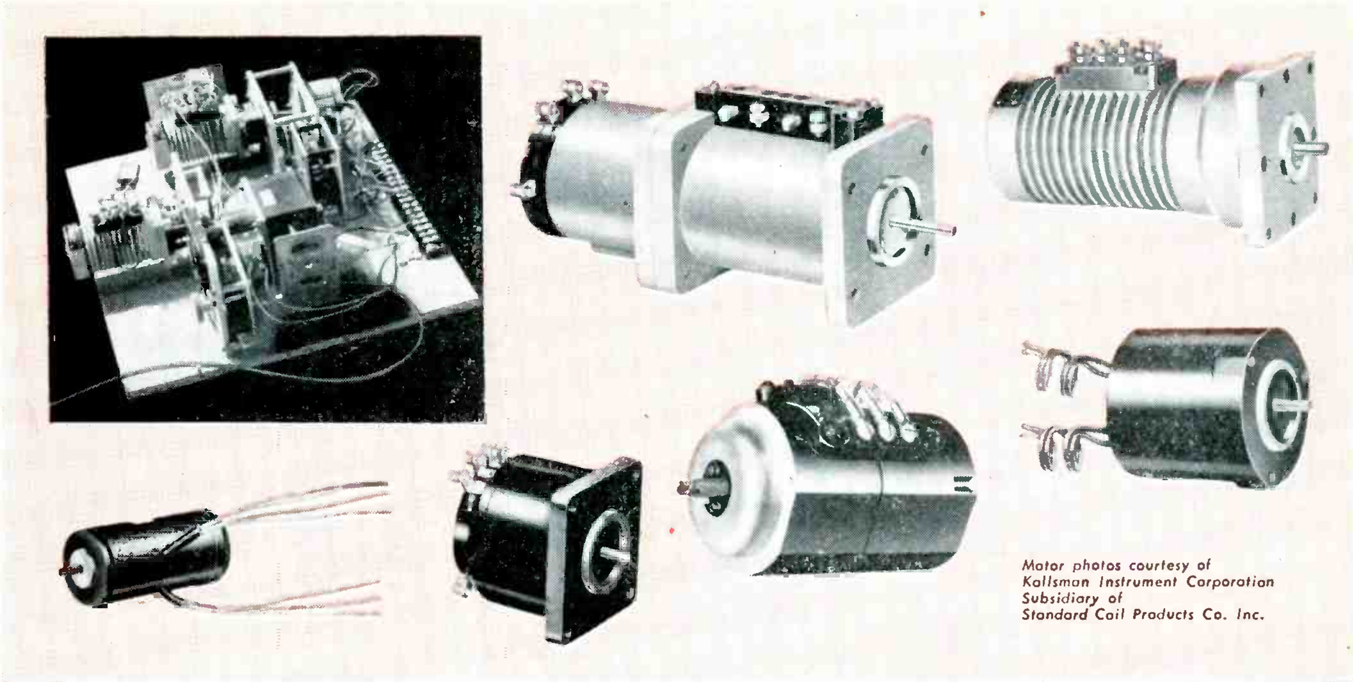
modulate the output of the trans-



Motor photos courtesy of
Kollsman Instrument Corporation
Subsidiary of
Standard Coil Products Co. Inc.

For what kinds of motors is electronics the best sales medium?

ELECTRONICS is the quickest, surest and most preferred sales medium for motors like those illustrated and for most fractional horsepower motors. A good rule to go by is: The smaller the horsepower, the better the electronic market. Induction and synchronous motors, induction generators, synchros, motor generators, phase shifters, permanent magnet generators, tachometer generators and hysteresis motors are some examples of the types of "motors" for which electronics offers a big market.

How big is this electronic motor market?

For the types of motors illustrated above, one of the outstanding motor manufacturers estimates that "upwards of 230,000 such devices will be used during 1951 and their total value will be in excess of $15,000,000."

ELECTRONICS' Research Department estimates, on the basis of past years' markets, that the entire 1951 electronics motor market will be in excess of one hundred and twenty five million dollars-at-factory.

Where will all these motors be used?

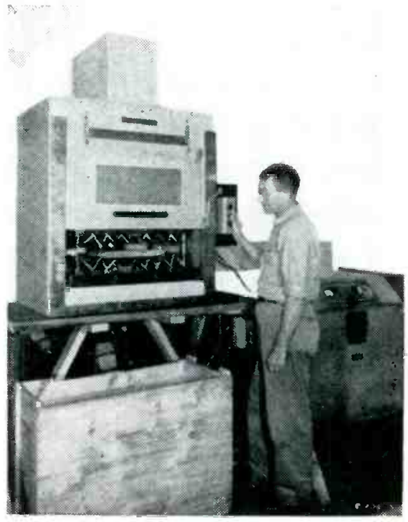
A great many will be used in electronic war gear this year. The rest will be used in electronics throughout industry in the same proportion as ELECTRONICS, the magazine, is read throughout industry. It's a simple little trick called self-leveling circulation . . . in every field of industry the circulation of ELECTRONICS increases in direct ratio to the growth of the use of electronics in that field. ELECTRONICS is everywhere in industry where electronics is used and where there is a market for electronic and allied products.

and the important question: How to get YOUR MOTORS used in electronics?

The answer to that is: Get them designed-in by selling the design engineers on the advantages of your motors. Exactly like all other components, materials and allied products used in electronics, every motor used is designed-in and specified by the electronic design engineers who are, almost without exception, subscribers to, or readers of ELECTRONICS . . . for whom its advertising pages are the chief, often the only source of electronic engineering information on motors.

That's your answer — ELECTRONICS advertising, your key to specialized motor sales throughout industry

THE DIRECT ROUTE TO — — — — — — A $2,000,000,000 MARKET PLACE



Test operation of shuttle-bonding press

pressure on both the straight and curved portions of the shuttle face. This method produces a uniform bond along the length of the shuttle.

The new Westinghouse technique uses what is known as stray-field heating with electrodes embedded in rubber on the surface of thick rubber dies to heat the glue line for the purpose of polymerizing the thermosetting plastic glue used.

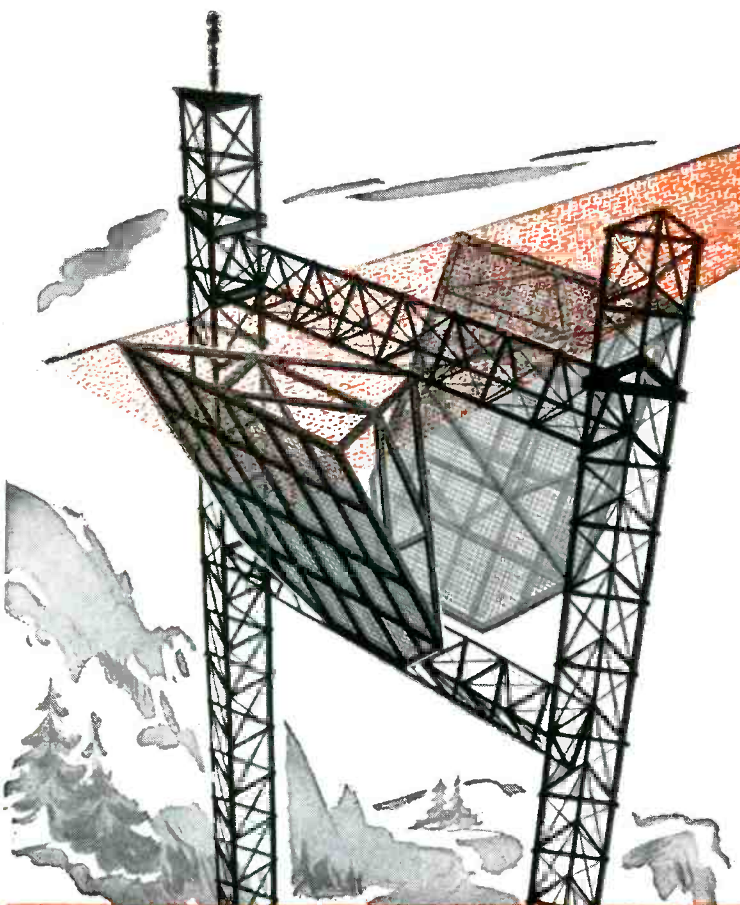
The r-f generator supplies dielectric heat at a frequency of about 13.6 mc. A standard steel die set used in a hydraulic arbor press makes up the upper and lower platens on which are mounted the electrodes and rubber dies.

The final design uses solid rod-type electrodes running transverse to the shuttle. The rods are flexible enough to conform to the contours of tapered shuttles and heavy enough not to bend over the edge of the shuttle when pressure is applied.

A special rubber mat made of pure gum rubber completely encloses the electrodes. Wedges placed between the rubber dies and press platens allow uniform pressure on tapered ends. One set of electrodes and one press may be used to bond all size shuttles.

An Automatic Time Announcer

SUPPLYING OF time announcements over telephone lines has been a service of telephone companies for many years. The time-announcing equipment to be described is one

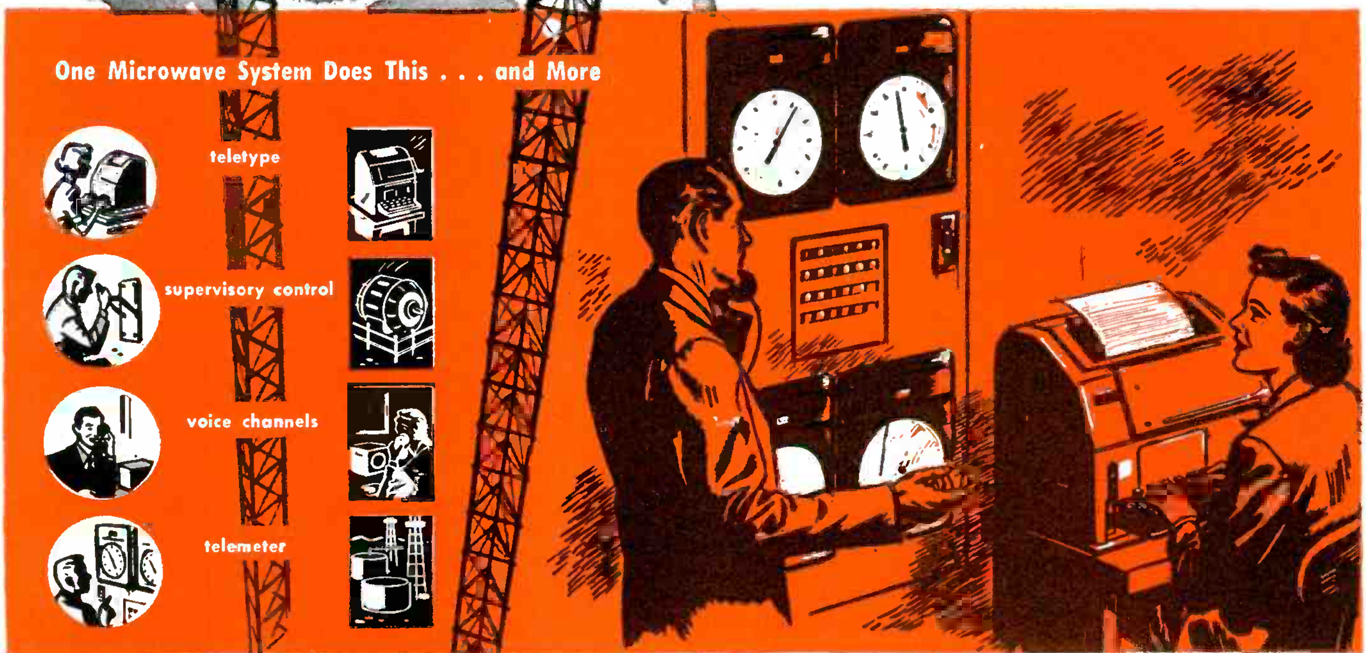


Motorola microwave

Multiply your present communication facilities, realize new economies, and make sure of the greatest possibilities for future expansion, by insisting on a MOTOROLA, superior-engineered Microwave System.

With the most *private-owned* microwave mileage now in operation, Motorola offers you the benefit of EXPERIENCE, *plus* many immediate and practical advantages.

Operating in the proven 6000 Mc. frequency band, Motorola Microwave provides maximum effective power gain. The superior frequency-division multiplexing system provides optimum reliability. All your electronic equipment is at ground level for fast, precision maintenance.



Installations

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Brazos River Electric Transmission Cooperative
City of Dayton, Ohio
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Motorola Microwave is the super communication "pack horse" of complete round-the-clock reliability. Cross-town or cross-country, office to plant—to branch—to mobile crews, it provides multi-channel facilities for voice circuits, supervisory control networks, telemeter, and teletype, 2-way radio tie-in, with innumerable additional combinations for automatically and simultaneously operating your entire system. Motorola Microwave means efficient, economical point-to-point communication.

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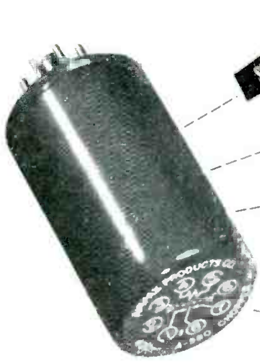
World leaders in FM 2-way radio communications • 2-way mobile • portable • microwave • carrier and control • supervisory control equipment

5 Big Reasons WHY AIRPAX CHOPPERS ARE AN ESTABLISHED STANDARD FOR THE INDUSTRY!



STABILITY!

RELIABILITY!

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A-N SPECIFICATIONS!

120 VOLT DRIVE
CAN BE CORRECTED TO
ZERO PHASE ANGLE!

AIRPAX A580
400 CYCLE CHOPPERS

Modulating minute DC potentials, this chopper combines rugged action with sensitivity and precision for delicate servo applications.

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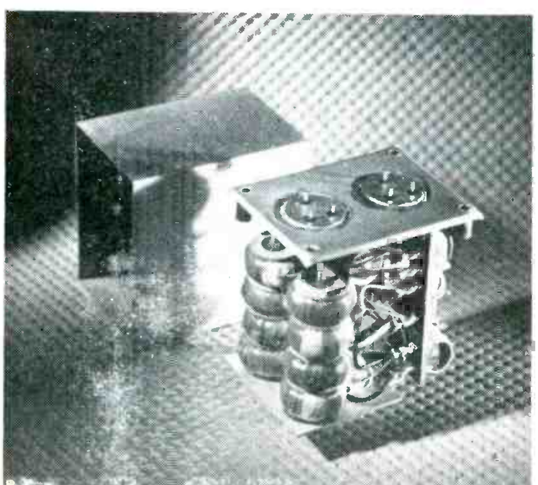
FILTER VERSATILITY

Check your filter problems at Lenkurt. Lenkurt combines filter know-how—gained from years of carrier engineering—with the most modern facilities for molding precision magnetic parts, winding toroids in a wide range of sizes and sealing assemblies for maximum life.



Small-sized hermetically-sealed unit illustrated contains two filters: a low-pass and a band-pass, designed for single sideband carrier application. Other types to your specifications. Write:

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HIGH SPEED ELECTRONIC
PREDETERMINED COUNTERS

For these applications:

- AUTOMATIC MACHINE CONTROL
- PACKAGING BY PREDETERMINED COUNT
- LINEAL MEASUREMENTS
- FREQUENCY MEASUREMENTS
- TIME INTERVAL CONTROL

The ONLY counter with ALL these features!

- COUNTS AT RATES UP TO 60,000 PER MINUTE
- ABSOLUTE ACCURACY
- INSTANTANEOUS AUTOMATIC RESET
- NO MOVING PARTS, FRICTION OR INERTIA
- SIMPLE DIAL SELECTION OF COUNT

Potter Predetermined Electronic Counters extend the field of automatic counting and control far beyond the scope and capabilities of existing mechanical and electromechanical devices. There are no moving parts, therefore, wear, slippage and inertial effects are eliminated.

Although the standard models count at rates up to 60,000 per minute, counters capable of counting at higher rates are available.

A complete line of photoelectric and electromagnetic detectors, for counting any material or action, can be supplied.

The instruments are easily applied to any problem requiring the precise measurement or control of QUANTITY, LENGTH, TIME, FREQUENCY, REVOLUTION or CAM SEQUENCE. Absolute accuracy of count is guaranteed.

Write today for an accurate appraisal of your problem to Dept. 6-C.

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Visit us at booth 812—Pacific Electronic Exhibit

device capable of providing this service automatically.

The equipment manufactured by the Automatic Electric Company was designed with three requirements in mind: verbal announcements should be used rather than signals, the recording medium should be continuous with no switching interruptions and the equipment should be simple to operate so that announcements could be recorded easily and inexpensively.

In the equipment shown in Fig. 1, a 2,700-foot length of magnetic tape made of cellulose acetate with an iron-oxide coating passes between two standard 16-mm film reels, 10½ inches in diameter. Three separate sound channels are recorded on the tape, two for time announcements and the third for synchronization.

The entire 2,700 feet of tape are used by one channel for providing time announcements for six hours. At the end of this period, the tape direction is reversed and the pickup circuit is switched to the second channel. The second channel is

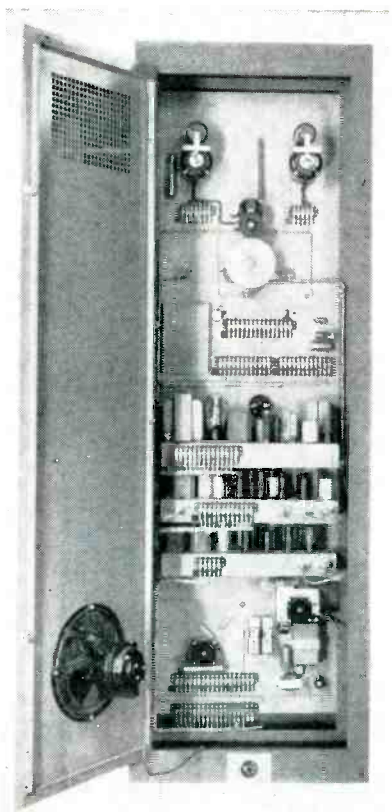
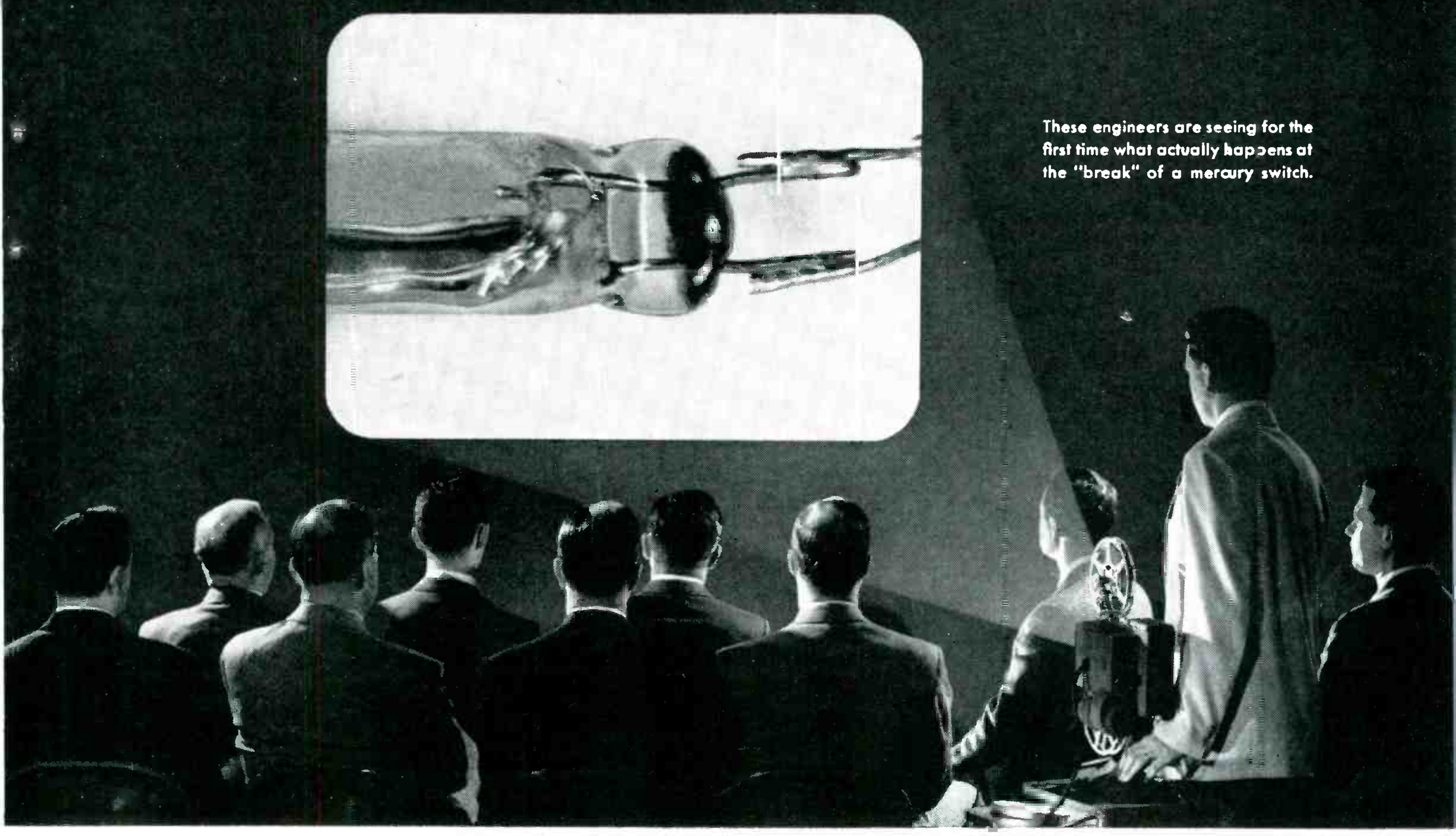


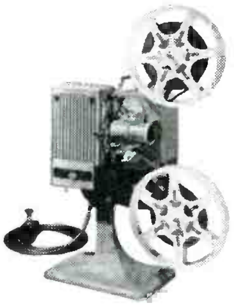
FIG. 1—Rear view of the automatic time announcer. Tape-reel drive motors are visible at top and power supply and amplifier chassis near center

Now... High Speed Movies of Mechanical Action *and* Oscillograph Traces Combined on One Film!



The Kodak High Speed Camera can now be supplied with a special feature which permits the recording of cathode-ray oscillograph traces through the back of the film. This makes possible high speed motion pictures of mechanical action with its electrical aspects simultaneously superimposed *on the same 16mm film.* When projected at normal speed, you get a complete picture of combined mechanical and electrical action slowed down as much as 200 times.

This basic improvement has countless new applications for solving design, production, and product performance problems through high speed movies, particularly those involving electrical equipment. Since an argon lamp times the film travel, extremely accurate analysis is possible. This unique tool may be the answer for which you have been looking. Further information and a copy of the booklet "Magnifying Time" will gladly be sent on request.



The Kodascope Sixteen-10R Projector... To show your high speed movies so that you can study the critical phases of action, this moderately priced projector is equipped with a remote-control push button for reversing film direction over and over again. Its 2-inch $f/1.6$ lens and 750-watt lamp (replaceable by a 1000-watt lamp if needed) assure bright screen illumination, sharp from edge to edge. Important details stand out clearly, even if exposure conditions have not been optimum.

EASTMAN KODAK COMPANY, Industrial Photographic Division, Rochester 4, N. Y.

High Speed Movies

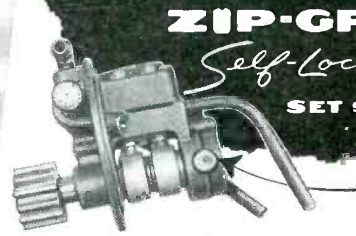
...a function of photography

Kodak
TRADE-MARK

"HAVE NEVER WORKED LOOSE On Over 3000 Pumps!"

—says this manufacturer about

ZIP-GRIP* *Self-Locking* **SET SCREWS**



Williams Machine & Tool Co., Omaha, Neb., writes... "The ZIP-GRIP* Self-Locking Set Screw eliminates use of nut, and spot facing. Not one has worked loose on 3000 pumps built and in use now about one year."

Send for FREE Demonstrator that Shows You Why... over 125 Manufacturers adopted ZIP-GRIP* Self-Locking Set Screws in one year's time.

With your ZIP-GRIP* Action Demonstrator we'll also send you illustrated Data Sheet and offer of Engineering Test Samples to suit set screw application conditions that have been puzzling you.

*Pat. Pending

Makers of SETKO SET SCREWS

Set Screw & Mfg. Co.

470 Main St. Bartlett, Ill. (Chicago suburb)

We specialize in Solving Puzzling Set Screw Problems.

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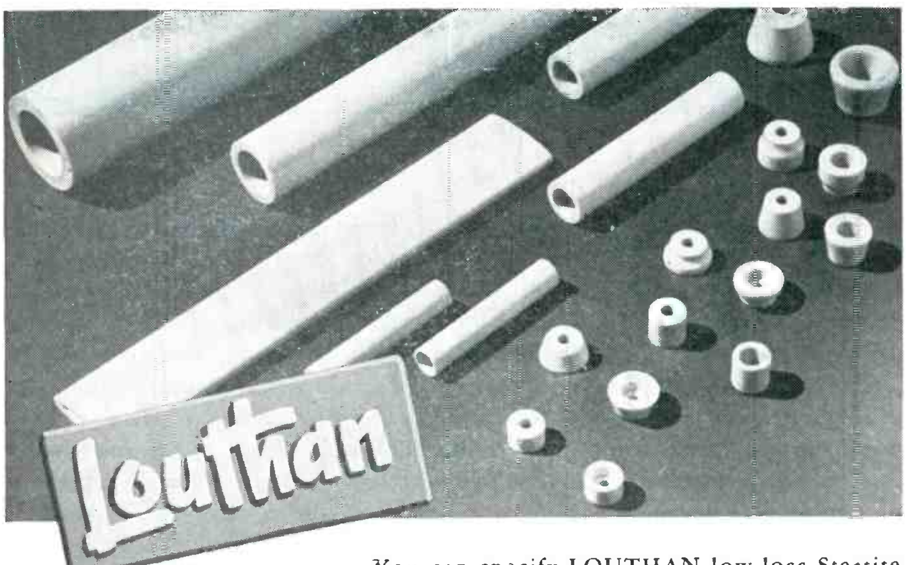

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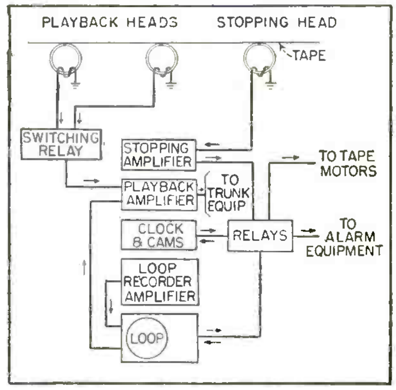


FIG. 2—Block diagram of circuit components of equipment

recorded in the reverse direction and provides time announcements for the next six hours.

The time tape supplied for the automatic time announcer is reproduced from a master tape. From the master tape, any number of copies may be made.

Approximately three seconds after the time announcement is made, the tone signal is heard. Announcements are made every fifteen seconds and each one is continuous.

Commercial announcements may be provided by a loop recorder which transmits from a length of magnetic tape mounted on the rim of a drum approximately ten inches in diameter.

A synchronous master clock controls the operation of the time announcer and employs eleven cams to perform all the required functions.

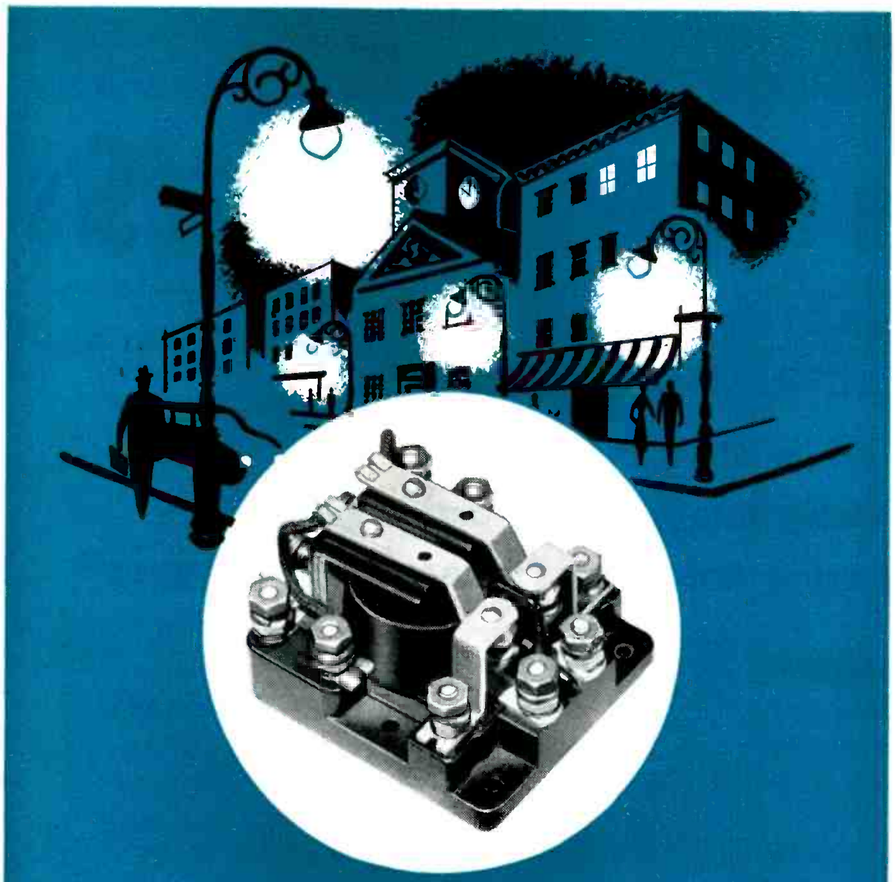
A block diagram of the time announcer is shown in Fig. 2. Audio output is about ten watts which is sufficient to take care of at least 50 trunks simultaneously without an appreciable decrease in volume.

This material was abstracted from an article, "The Automatic Time Announcer", by E. S. Peterson which appeared on page 148 of *The Automatic Electric Technical Journal* for January 1951.

Circuit Printers for Flat and Cylindrical Surfaces

TWO SEMIAUTOMATIC machines for printing electronic circuits, one for flat surfaces and the other for cylindrical surfaces, have recently been developed at NBS.

In the flat-plate printer, a turntable accepts the unprinted plate at



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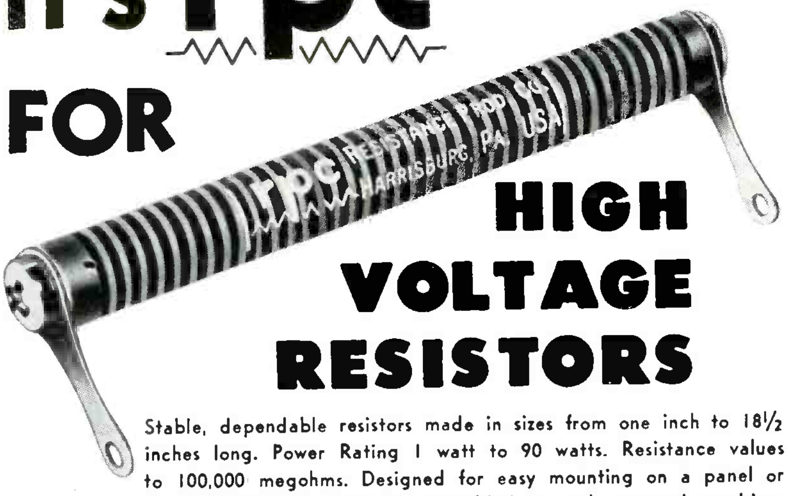

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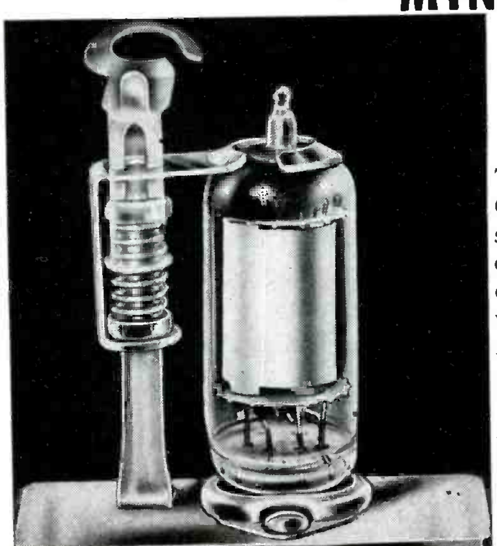

POSITIVE PROTECTION AGAINST LATERAL AND VERTICAL SHOCK!

The *New* Birtcher Type 2 Tube Clamp holds miniature tubes in their sockets under the most demanding conditions of vibration, impact and climate. Made of stainless steel and weighing less than ½ ounce, this *New* clamp for miniature tubes is easy to apply, sure in effect. The base is keyed to the chassis by a single machine screw or rivet...saving time in assembly and preventing rotation. There are no separate parts to drop or lose during assembly or during use. Birtcher Tube Clamp Type 2 is all one piece and requires no welding, brazing or soldering at any point.

If you use miniature tubes, protect them against lateral and vertical shock with the Birtcher Tube Clamp (Type 2). Write for sample and literature.

Builder of millions of stainless steel Locking Type Tube Clamps for hundreds of electronic manufacturers.

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Specific Gravity	1.18 -1.20
Coef. of Thermal Expan.	25-60.4 x 10^{-6}
Heat Resistance	230 - 250°F
Water Absorption 24 hrs.	0.10%
Rockwell Hardness M Scale	85-95
Tensile Strength psi	11,370
Flexural Strength psi	15,540
Modulus of Elasticity psi	426 x 10^{-6}
Izod Impact (Ft. lbs. in notch)	.45
Compressive Strength psi	14,100

ELECTRICAL PROPERTIES

POWER FACTOR	60 cycles	0.0011	10^3 cycles	0.0042
	1 megacycle	0.026	10 megacycles	0.035
DIELECTRIC CONSTANT	60 cycles	3.88	10^3 cycles	3.70
	1 megacycle	3.49	10 megacycles	3.17
LOSS FACTOR	60 cycles	0.0043	10^3 cycles	0.015
	1 megacycle	0.091	10 megacycles	0.110
DIELECTRIC STRENGTH	step by step (⅛ inch section)	350 Volts/mil		
ARC RESISTANCE		135 seconds		

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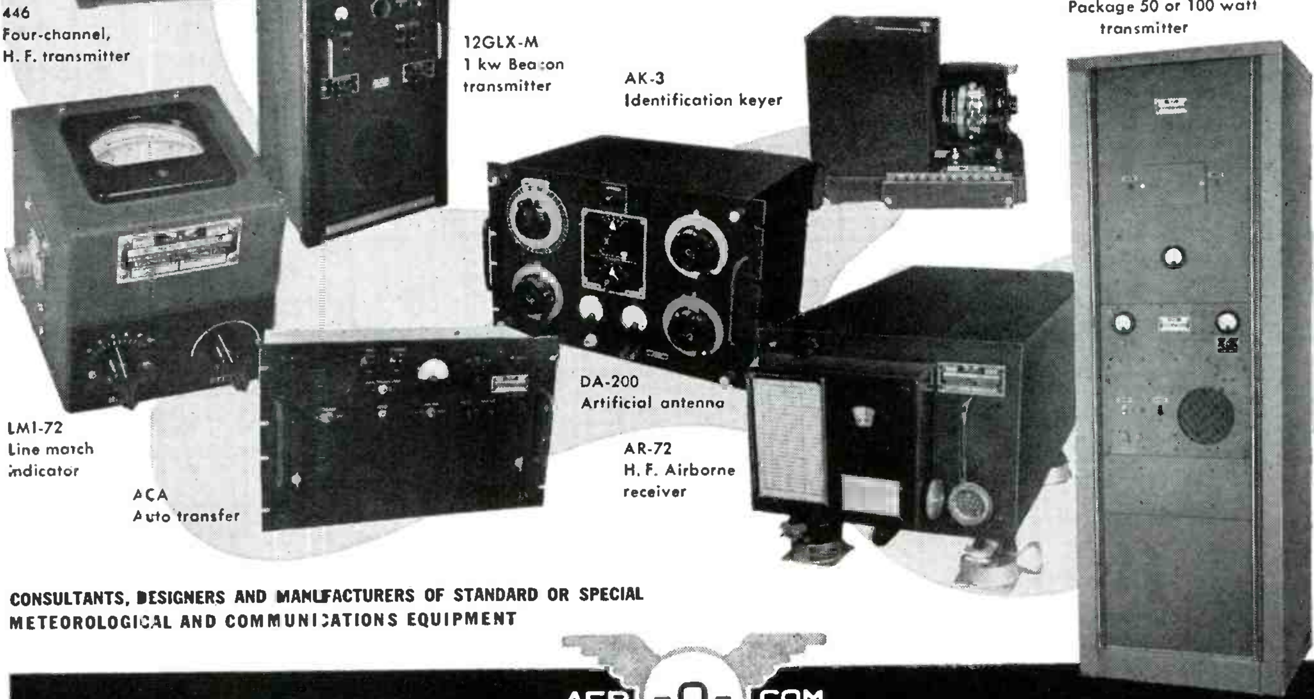
But – Aerocom was able to expand plant facilities and production so that, now, some equipment is available with only small delays.

Despite the pressure for new equipment, corners will not be cut . . . Aerocom quality will be maintained.



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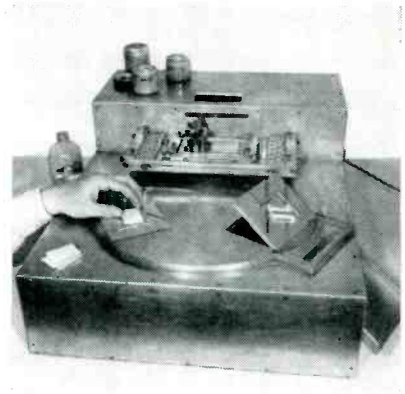


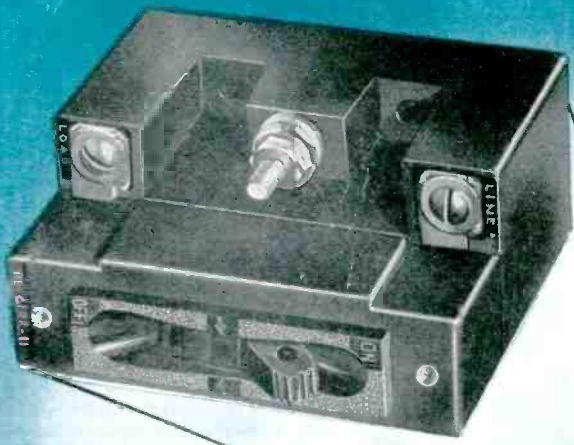
Circuit printer for flat surfaces. The ceramic plate being loaded on the turntable (left) will be carried to the rear of the machine where a silver circuit pattern will be impressed on it. The printed plate will then be carried to the unloading position (right) where it will be flipped into the discharge chute

a loading position, carries it to a printing position, then carries the printed plate to an unloading position, where it is automatically flipped into a chute.

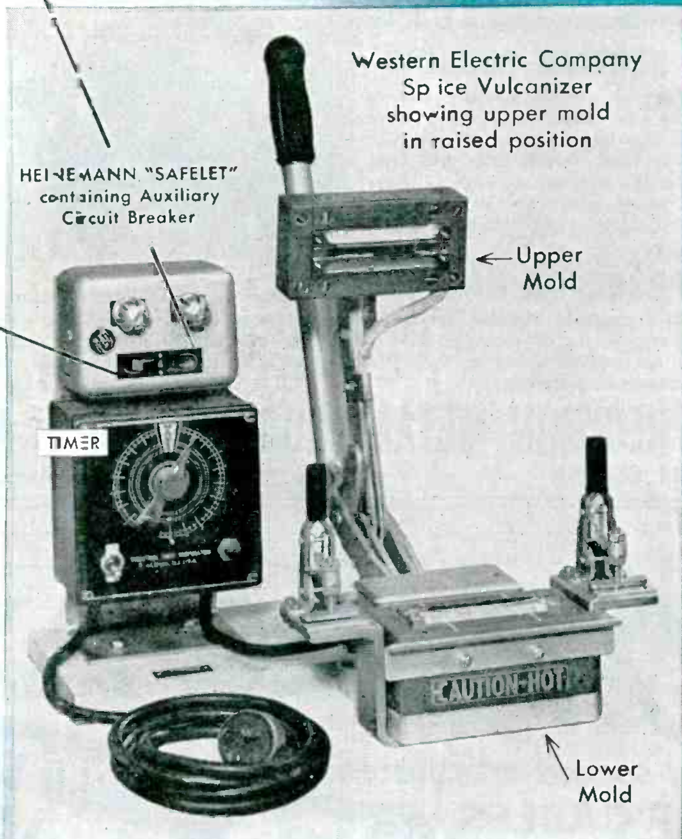
In regular operation, three plates are processed simultaneously. While the first plate is unloaded, the second is printed, and the third is loaded. The turntable stops while the operations are performed, then advances the plates one-third of a revolution, stops again, and so forth. The usual production rate, about 1,000 plates per hour, can be increased to 1,500 per hour without loss of printing quality but at the expense of excessive wear and tear on the machine.

As the turntable advances the plates from position to position, they rest on rectangular platens about 3 by 4 inches in size. The flat platens are normally flush with the turntable. When a plate-carrying platen reaches the printing position, the platen rises and presses the plate against the underside of the printing screen, which occupies a fixed horizontal position. While the plate is held against the screen, a rubber squeegee is automatically moved over the top surface of the printing screen, forcing conducting paint through the screen onto the plate in the desired pattern. The platen is then lowered to its original position and is advanced by the turntable another third of a revolution to the unloading position. Here the platen is tilted, and the printed

HEINEMANN
MAGNETIC CIRCUIT BREAKERS



helps Western Electric salvage millions of feet of drop wire per year



The HEINEMANN *Fully Magnetic* CIRCUIT BREAKER shown above is absolutely dependable at all times, regardless of surrounding temperatures. As demanded in this installation, the breaker trips *INSTANTLY* on overload (where needed, a magnetic-hydraulic Time Delay can be furnished to retard tripping for a predetermined time). Rotation of the high speed latch releases contacts which are under heavy spring pressure, while magnetic blowout action gives instant arc interruption.

Write for
Bulletins 3200 and 1010

How it Works

Used for salvaging short lengths of drop wire, this machine makes unique use of the HEINEMANN *Fully Magnetic* CIRCUIT BREAKER. When the mold is closed and the temperature reaches the vulcanizing heat, a thermoswitch located in the lower mold closes and throws into the circuit a resistance, which is in parallel with the heaters. This reduction in resistance increases the current so that it exceeds the rated value of the circuit breaker. The Heinemann breaker then opens, permanently disconnects the current to the elements, and extinguishes a red light which is used to visually indicate the heat period. The magnetic breaker, which is equipped with auxiliary contacts, then acting as a single pole—double throw switch, transfers the current to the timer which through a relay operates a white light that remains illuminated for the entire cure period. At the end of the cure period the relay opens and the light goes out.

EST. 1888

HEINEMANN ELECTRIC COMPANY

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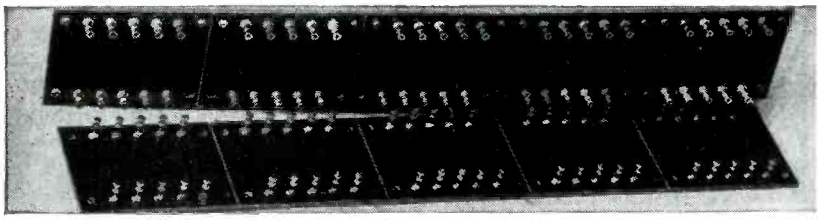

STANDARD UNIVERSAL SECTION BOARDS

Precision universal section boards have met with enthusiastic approval. Engineers, Laboratory Technicians, and Designers find it invaluable as a low cost aid in development and prototype work. Available in 4 widths, each board has 5 sections, each with 10 terminals and 4 mounting holes. One or more sections can be easily separated to suit a particular job. PMP offers a choice of 2 terminal types: No. 100 (Double Turret) or No. 400 (Tubular Turret). Also choice of board material: LE or XXX phenolic. XXX phenolic as board material has found wide acceptance and use in high frequency applications.

SECTION SCORING

The illustration clearly shows the ease with which one or more of the five sections of the PMP Universal Board may be used. Scoring is deep enough to make a clean break but not too deep to remain rigid if all five are used.

PRECISION HARDWARE: Many items in the Electronic Hardware field, such as handles, ferrules, thumb screws, stand-offs, etc., are kept in stock. Many years of experience in all types of metal fabrication, enables PMP to offer manufacturers a specialized service in the designing and production of custom components.

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LOW ATTEN TYPES	IMPED OHMS	ATTEN db100ft of 100 Mc/s.	LOADING Kw	O.D."
A 1	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

HIGH POWER FLEXIBLE

LOW CAPAC TYPES	CAPAC mmf/ft	IMPED OHMS	ATTEN db/100ft 100Mc/s.	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.1	1.03

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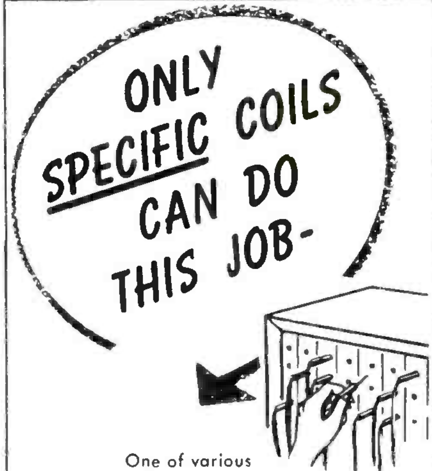
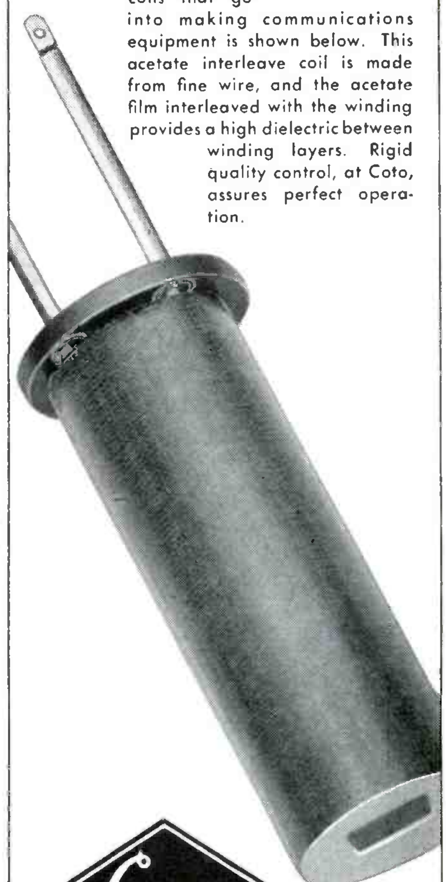


One of various coils that go into making communications equipment is shown below. This acetate interleave coil is made from fine wire, and the acetate film interleaved with the winding provides a high dielectric between winding layers. Rigid quality control, at Coto, assures perfect operation.



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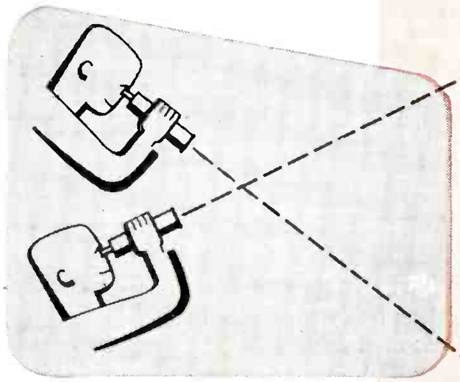

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For high volume and surface resistivity

For high dielectric constant

For low loss factor

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For low cost

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Literally hundreds of glasses with widely varying electrical characteristics are available at Corning—glasses that meet almost every electrical requirement. In V.H.F. and U.H.F. applications, where miniaturization and low loss pose difficult problems, one of Corning's glasses often proves the answer. And glasses can be obtained with high physical and thermal shock resistance, and excellent sealing properties, when these characteristics are needed.

While Corning manufactures much standard electronic glassware, such as electronic tube blanks, television tube blanks, sealing beads, and glass tubing, our engineers are ready to work with you on special requirements. In the hands of Corning technicians, glass can be made in a surprising variety of complicated shapes, often to extremely close tolerances. Their technical know-how, years of practical experience, and complete research and engineering facilities are available to help solve your problems. Let us know what you have in mind!

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plate slides into the discharge chute.

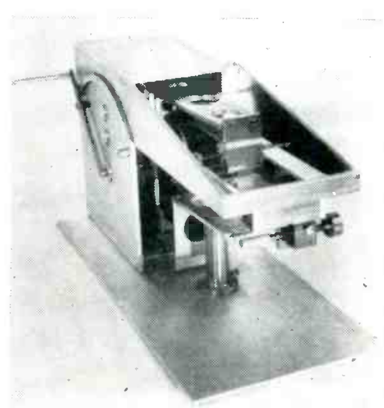
The flat-surface printer is at present loaded by hand, one plate at a time, as the turntable moves the three platens past the loading position. Otherwise the process, including the flipping of the printed plates into the discharge chute, is entirely automatic.

Cylindrical-Surface Printer

The cylindrical-surface printer was developed for the printing of cylindrical ceramic forms less than 0.5 inch in diameter. Such small ceramic cylinders are usually out of round and present a much more difficult printing problem than larger, more perfect forms.

The cylindrical-surface printer is loaded manually by slipping the cylinder to be printed over a mandrel. A single stroke of a hand-operated control lever then puts the machine through the entire printing cycle and operates a release mechanism which drops off the printed cylinder.

This printer differs from a conventional printer in that the squeegee remains stationary. As the control lever is brought forward, the mandrel, bearing the cylinder to be printed, rises to meet the stenciled screen. Simultaneously the squeegee, which is directly above the mandrel, drops to press against the top surface of the screen. The screen, which remains flat and horizontal at all times, then starts to move (forward on one stroke, backward on the next) over the cylinder and the cylinder rotates in response



Circuit printer for cylindrical surfaces. A single forward-and-back stroke of the control lever (left) puts the machine through an entire printing operation and drops off the printed cylinder

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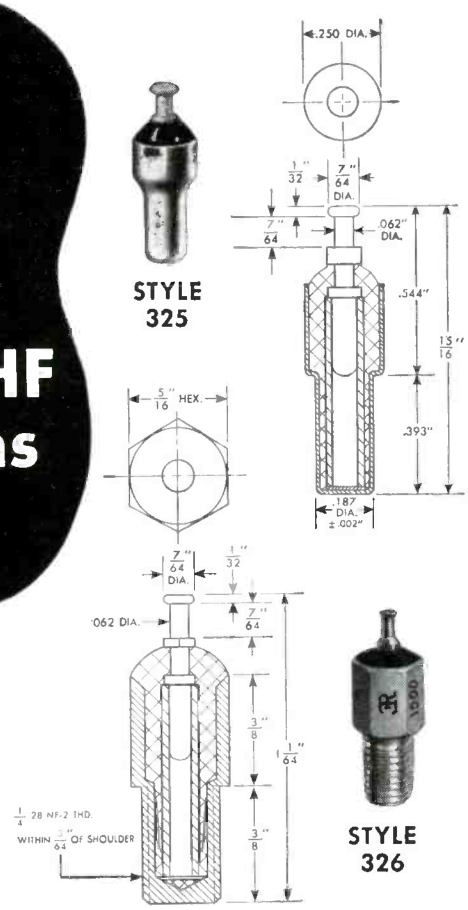

STYLE 325

STYLE 326

BETTER by-passing is one solution to control of regeneration in high frequency receivers. The Erie Styles 325 and 326 Stand-off Ceramicons offer outstanding features for extremely efficient by-passing. Style 325 is designed for push-on clip mounting to chassis; Style 326 is for threaded mounting installation.

This basic design provides, in a hermetically sealed case, a by-pass-to-ground through the shortest possible path. Full advantage is taken of the concentric electrode configuration in maintaining this short path by making connection to the outer electrode at the plane of the chassis. The result is an extremely low and uniform series inductance. In assembly operations both location and length of leads are accurately fixed, resulting in better mechanical uniformity. This feature has been demonstrated to be of particular importance in good VHF and UHF design.

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1. Tubular ceramic capacitor is completely sealed.
2. Very low and uniform inductance path to ground.
3. Electrical shielding is provided by means of the grounded metal case.
4. Post terminal provides a sturdy tie point for several connections, and is made essentially to match tube socket terminal height in the interest of maintaining uniform short leads.

SPECIFICATIONS

Standard available capacitance values in MMF: 10, 33, 47, 68, 82, 100, 680, 1,000, 1,500. Voltage Rating, 500 VDC.

Electronics Division

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to the horizontal motion of the screen pressing against it. While the cylinder rolls against the screen, the squeegee forces conducting paint onto the cylinder through the pervious pattern of the screen. When the cylinder has made one complete revolution, both cylinder and squeegee are moved away from the screen. As the control lever is moved back to its starting position, the mandrel carrying the cylinder is rotated from a horizontal to a downward position, a release mechanism on the mandrel is actuated, and the printed cylinder drops off.

With hand loading of the cylindrical surface printer, an operator can easily print 1,500 cylinders in an 8-hour day. An automatic feed mechanism and electric drive should increase the production rate to a probable 500 or 1,000 cylinders per hour.

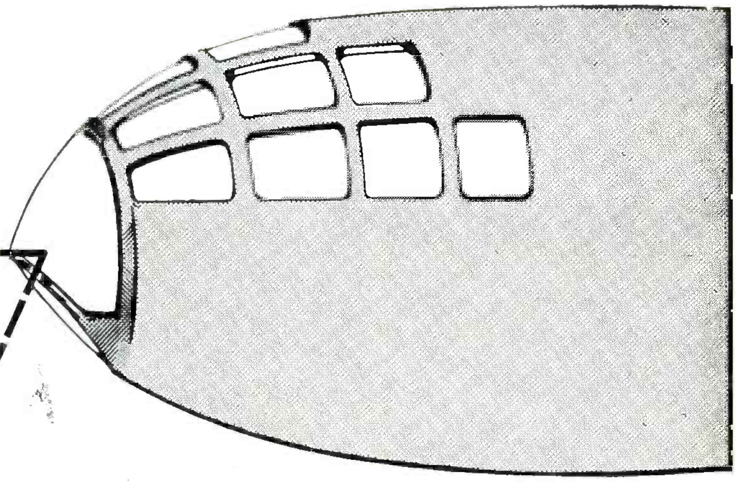
Automatic Audio Level Riding

By T. K. Abernethy
Chief Engineer
Stations WSIC and WSIC-FM
Statesville, N. C.

All broadcasting stations have, in common, the prime problem of keeping consistant audio levels in regards to changes from program to program and also from music to speech within a program.

Most stations use a compression or limiting amplifier. The purpose served by the limiter is twofold. First, the peak levels which would cause objectional distortion due to overloading of the transmitter are held below the overload value. Second, by compressing program peaks, the average modulation can be substantially increased. This increase helps considerably because of the large increase in the number of a-m stations on the broadcast band with its attending increase of interference.

With a reasonable amount of compression, a station is able to override background noise and interference from co-channel and adjacent channel stations. An otherwise listenable signal can not be kept so unless a good gain-riding



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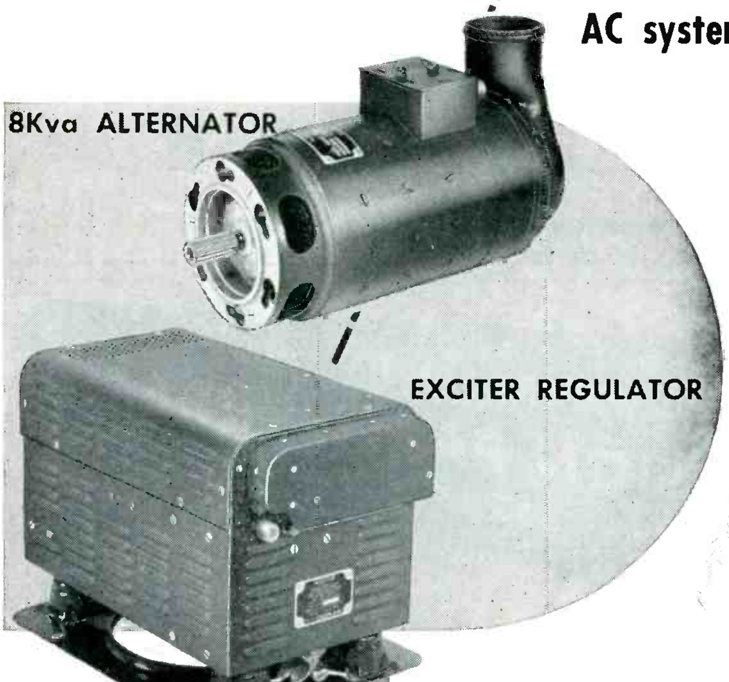

above the horizon — it's Eicor's electronamic team supplying the safe, sure, AC power your nesi-glass deicing system needs for perfect flight-vision under all flying conditions. ***beyond the horizon*** — again this dynamic Eicor team provides the ultimate in closely controlled alternating current, the power necessary to give vision to the far-reaching, far-searching eyes of your aircraft's radar and its associate equipment. You can be assured of the flight-reliability of these units. Designed to rigid and exacting AN Specifications, the Eicor 8Kva Alternator and Exciter Regulator have proven their dependability of performance over thousands of operational flying hours. The Eicor 8Kva Alternator will generate 115/208 volts, three phase, or 115 volts, single phase, at frequencies of 380-1000 cycles and over a speed range of 3800-10,000 rpm. Sensitive voltage regulation and field excitation for the alternator is supplied by its team-mate, the Eicor electronic Exciter Regulator. This Exciter Regulator can also be used in any power circuit, for excitation supply, having a range rating characteristic output of 0.5 to 5.5 amperes DC and 14.0 to 170.0 volts D.C.

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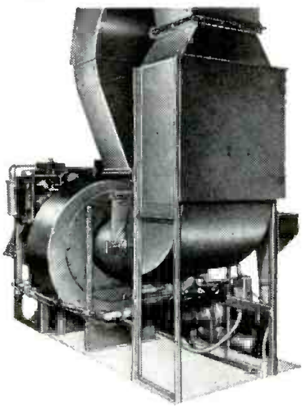

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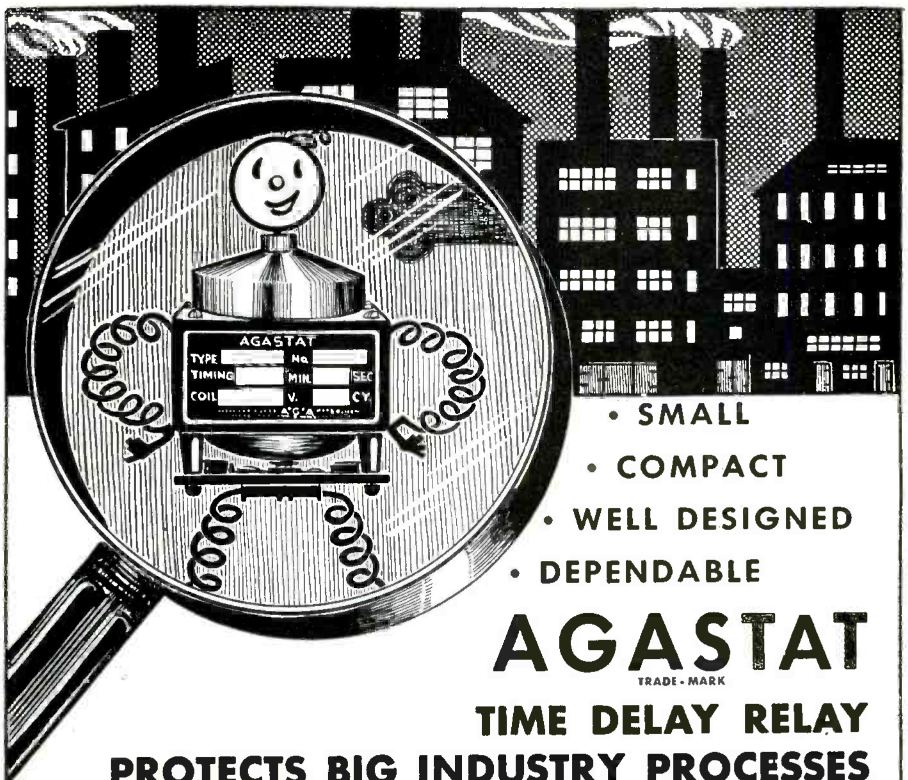

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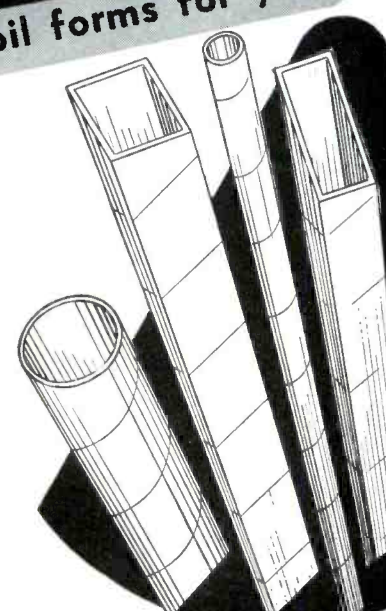

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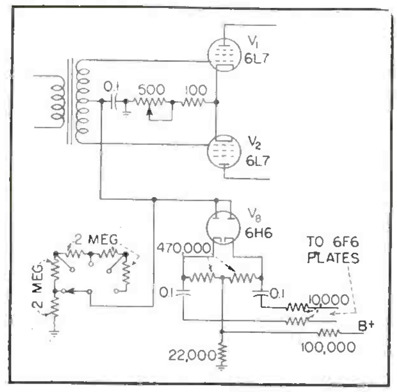


FIG. 1—Original circuit of Raytheon RL-10 amplifier before modification for automatic level riding

job is done to keep the audio level, and hence limiting, at the optimum value.

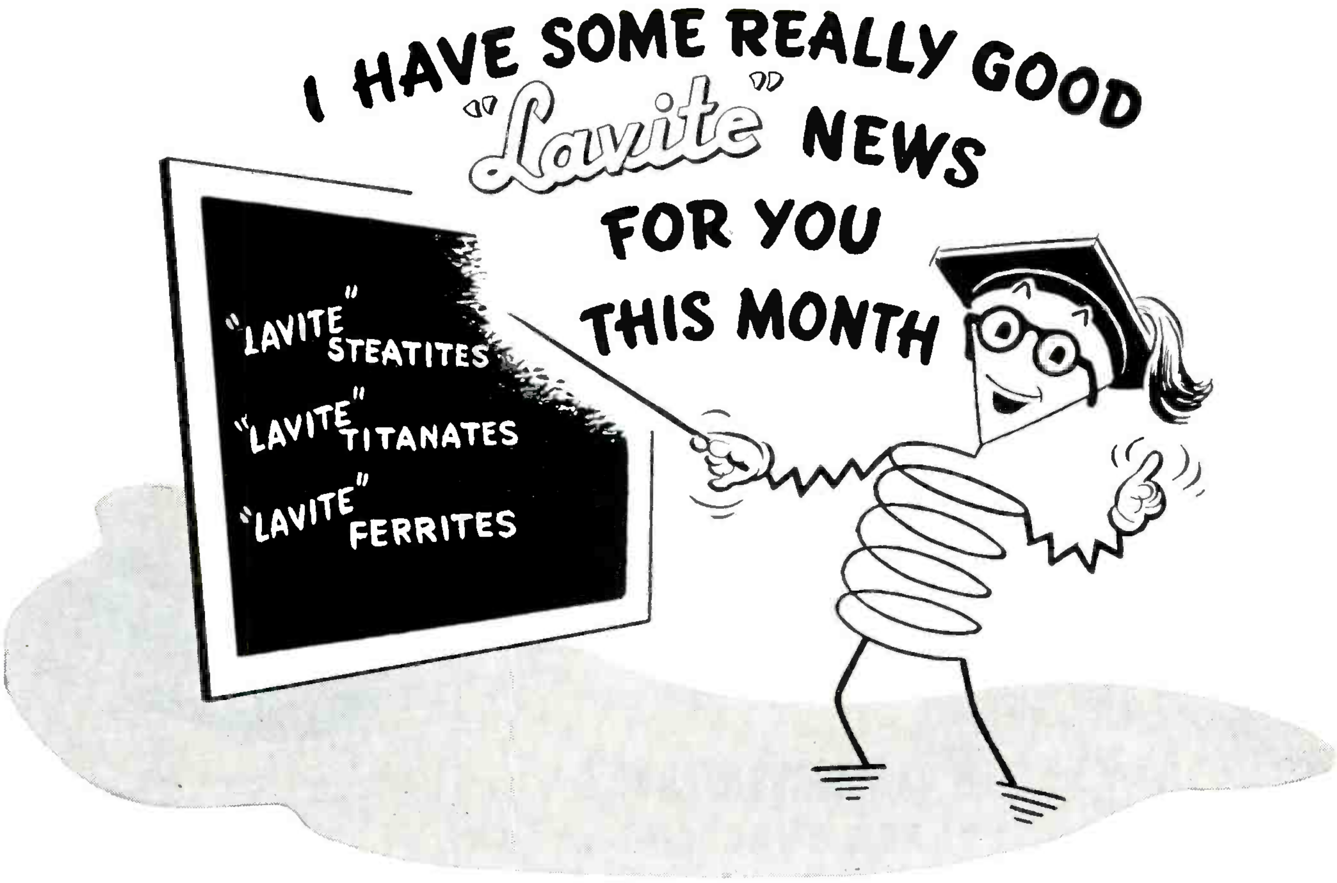
The circuits shown for automatic gain riding are adaptable for both a-m and f-m stations and can be applied to any limiting amplifier. Most engineers do not want to use compression on f-m programs, for they wish to retain the dynamic range that f-m affords, due to absence of noise and interference. They do express the need for a limiting amplifier, even if used only for limiting peaks which would otherwise over modulate the f-m transmitter and thereby cause serious distortion in f-m receivers.

With some modification of the limiter input circuit, the limiting amplifier can be made an automatic gain-riding amplifier also.

The amount of limiting can be set and the amplifier will limit this value over a wide range of input level variations from console or line. The amount of limiting is arbitrarily set at approximately 10 db and the reference level is set at 10 db (or more, if desired) above 0 db compression, as shown on the limiter meter. Then, if the level decreases, the reference point of limiting is increased a like amount, and the amount of limiting is corrected to its former value of 10 db.

For f-m, the amplifier is set for no limiting, but in practice it actually amounts to about 2 db and the level is corrected automatically from around − 15 db to 0 db, using 0 db as reference level. This amounts to an input level of 15 db above that which would modulate the transmitter 100 percent, with no limiting taking place.

The level correction and set



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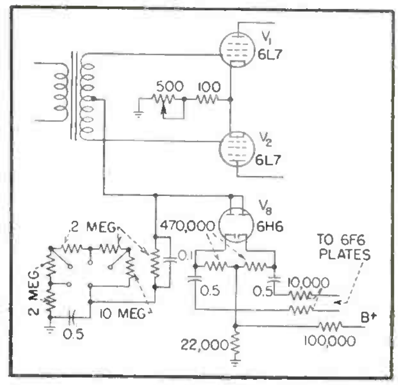


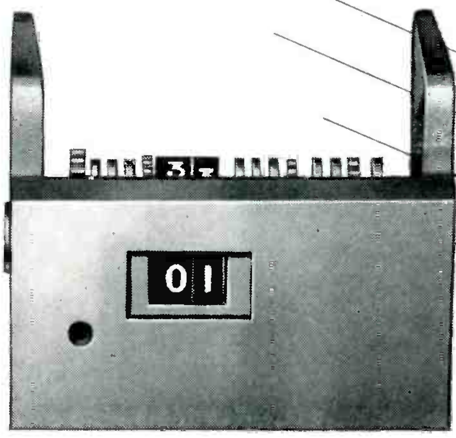
FIG. 2—Modification of RL-10 amplifier for level riding with limiting for a-m

amount of limiting is accomplished by using two time constants in the limiter circuit; one fast and one slow. As the rectified voltage is fed to the fast time constant circuit, part of this voltage is stored in the slow time constant circuit, because the two are in series.

In Fig. 1 is shown the limiting circuit of the Raytheon RL-10 before modification by the author. The changes shown in Fig. 2 were made for 10 db of limiting and for level excursions from −10 db to ±5 db, which is extreme but often encountered. Under normal program level the limiter meter indicates a drop in gain of the amplifier of 10 db and the meter will still show 10 db of limiting—varying from 10 db to 20 db on the meter. If the level should drop 8 db there would still be 10 db of limiting and the reference level on the meter would then ride at 2 db.

Although it was not necessary to do so, the 0.1-μf capacitors ahead of the 6H6 rectifier were changed to 0.5 μf to lower the source impedance for the limiter bias. This will make the attack time about twice as fast and much smoother. This change should be made whether used for automatically riding gain or not.

Fig. 3 shows the same amplifier where it is desired to maintain the dynamic range as in f-m program material. Limiting ordinarily is of the order of about 2 db on most programs, but sudden increases in level are not discernable to the listener because the level is corrected so fast. Sudden decreases in level are noticed because of the slow recovery time constant. This feature seems to be quite desirable. The level increase by the amplifier



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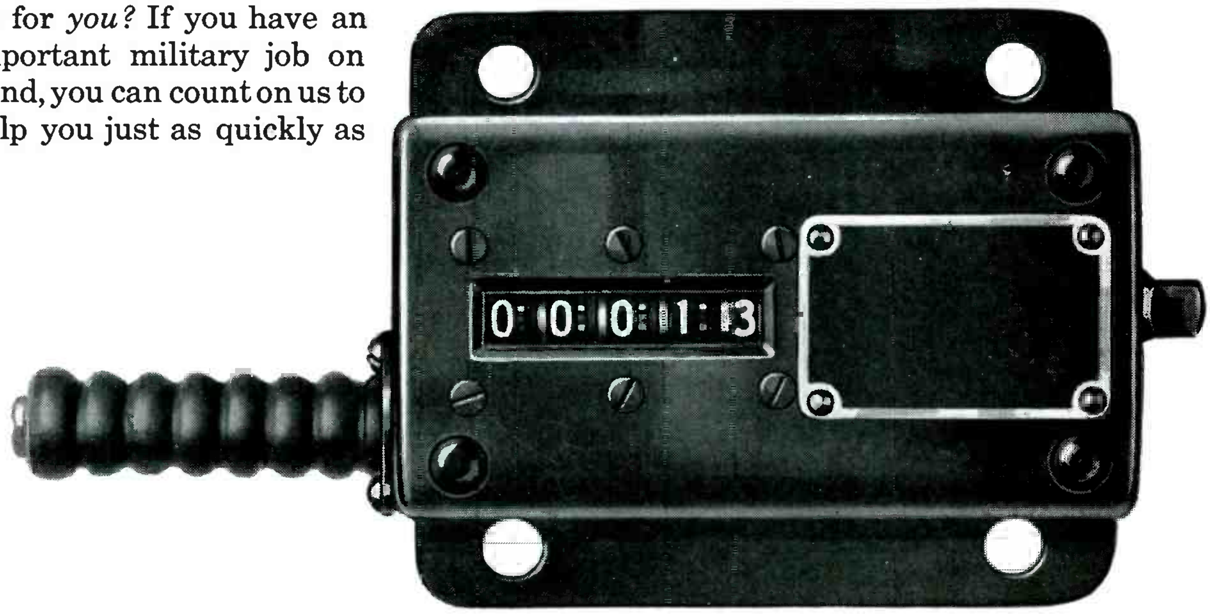

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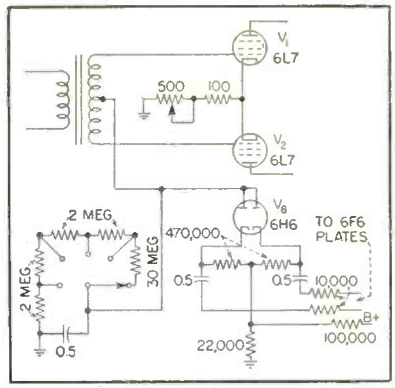


FIG 3—Modified circuit of RL-10 amplifier for automatic level riding for f-m

is slow enough so that the listener is very seldom aware of the level changes, as there is little change in the dynamic range of the f-m programs.

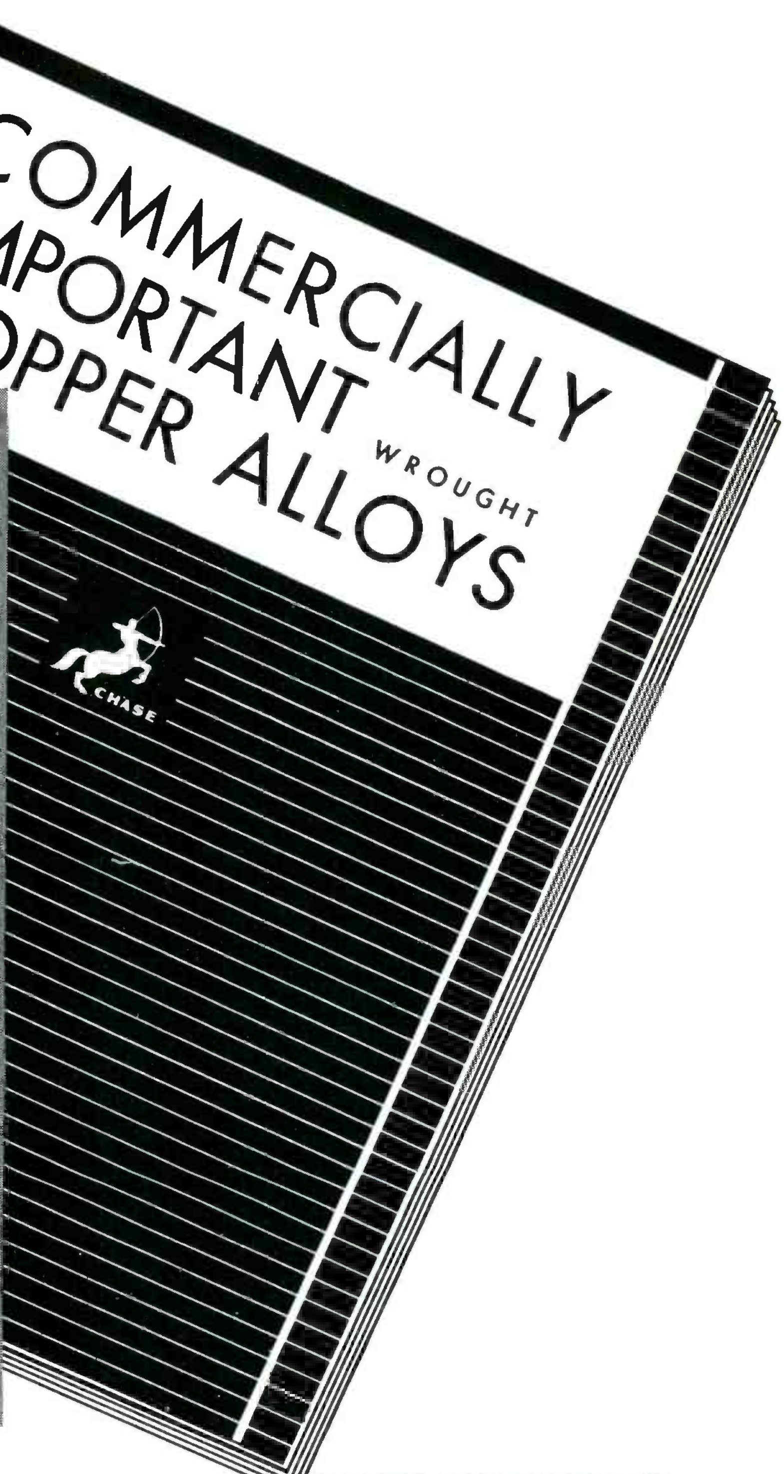
Since peak limiting is not desirable on the f-m programs, the reference level on the f-m limiter amplifier meter can be set at 15 db, or more, below 0 db (no limiting). This is an actual input of ±15 db above reference level of 0 db for 100-percent modulation of the transmitter.

Wide-Range Voltage Regulators

By Joseph Houle
Washington, D. C.

A REGULATED power supply whose voltage can be adjusted from a few hundred volts down to zero is often needed. Of the many series-tube regulators, no conventional circuit is operable below about 100 volts output because too little plate voltage is then available for the d-c voltage-amplifier tube. While the voltage range of such regulators can be extended downward by means of floating B batteries in the control circuit, this expedient is not usually a complete nor a desirable solution.

To extend the range down to zero without using auxiliary batteries, it is possible to use a circuit having an auxiliary negative supply after a disclosure by White[1]. This general principle has, it is believed, been applied commercially. Figure 1 shows a regulated supply delivering 0 to 300 volts, that was designed by the writer in 1947. A d-c



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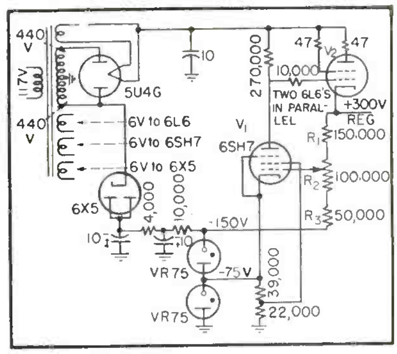


FIG. 1—Schematic diagram of a 0 to 300-v regulated supply with straight d-c control amplifier

amplifier tube V_1 controls the series tubes V_2 in the usual way, but the cathode of V_1 is returned to a point 75 volts below ground.

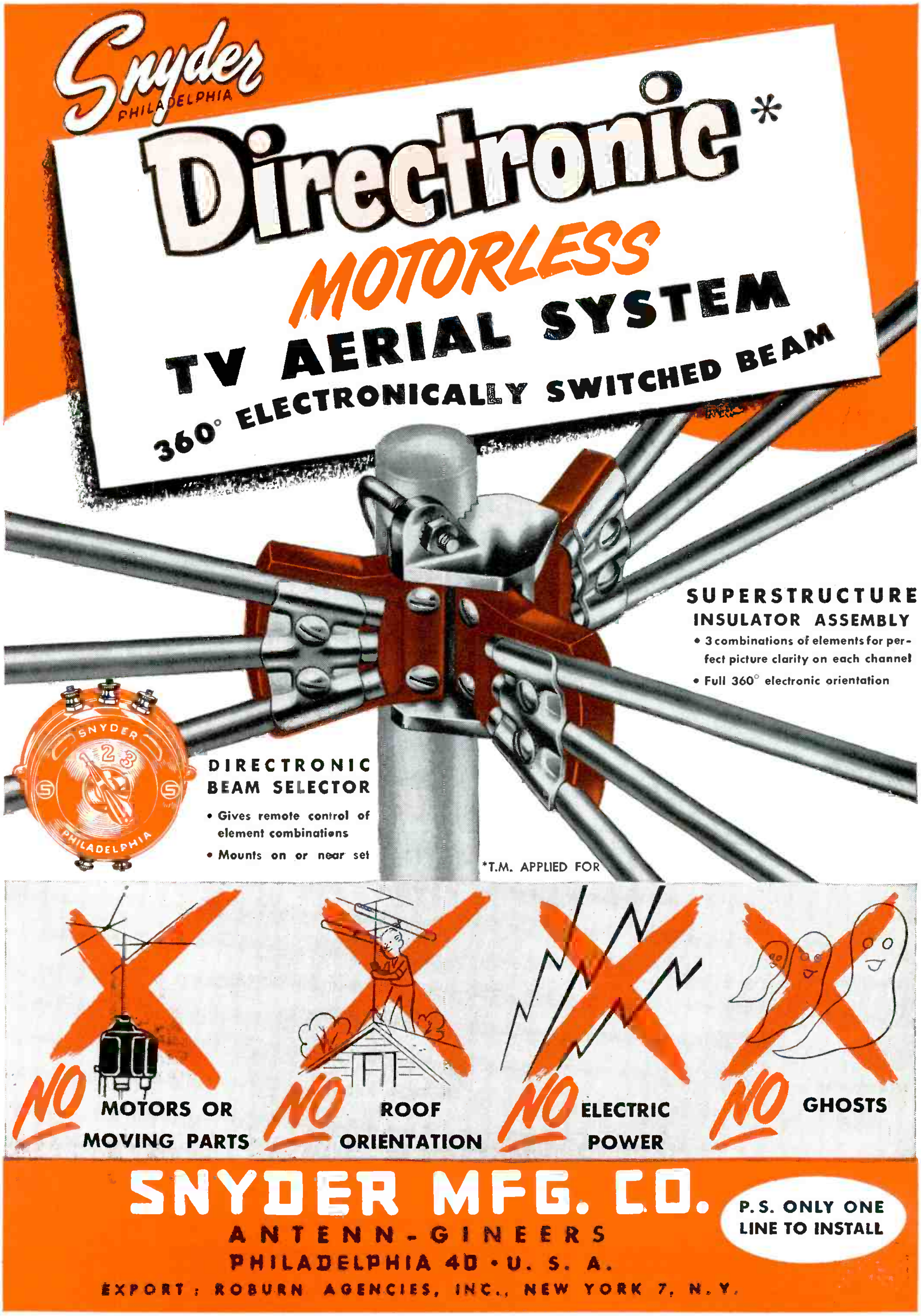
The output voltage is adjusted conventionally by a potentiometer R_2, but the negative end of the divider string R_1 R_2 R_3 is returned to a point 150 volts below ground in order to preserve a favorable control ratio at low output voltages. Unfortunately, while the circuit looks simple, too many separate heater windings are required and the power dissipation in auxiliary circuits is excessive, so that the supply is bulkier than one might infer from the diagram.

Carrier D-C Amplifier

The designer is handicapped by the necessity for a common return connection in the output and d-c amplifier circuits, which makes the plate voltages for the d-c amplifier dependent on the output voltage of the supply. What is needed is a four-terminal d-c amplifier, whose output is divorced completely from the operating potentials of the tubes.

Such a four-terminal amplifier is realizable by using a carrier-voltage principle. Amplification is effected at a carrier frequency, isolation is effected by capacitors or transformers and the d-c is recovered with a diode.

For the present application, d-c modulation is best carried out by means of a germanium crystal rectifier. Carrier voltage is applied to the rectifier at low level, and the resulting carrier voltage across a load resistor is changed by varying the d-c bias on the crystal. Such a circuit and its transfer characteristics are shown in Fig. 2. For this regu-



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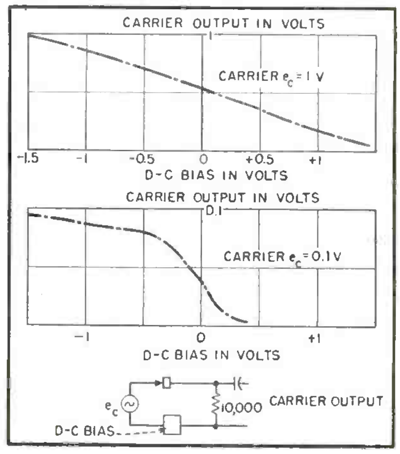

FIG. 2—Carrier modulator with crystal diode. Slope is about twice as steep at 0.1-v input carrier level but linearity is poorer

lator application the low input impedance is of no consequence, nor is waveform distortion.

Carrier-Type Regulator

The circuit of a complete regulated d-c power supply using a four-terminal carrier-type d-c control amplifier is shown in Fig. 3. While the circuit looks comparatively complex, its physical realization is relatively compact and efficient. The additional components are all small and cheap and power dissipation in auxiliary circuits is low.

The circuit of Fig. 3 will deliver from 0 to 300 volts with an internal impedance of about 40 ohms. Current output at high output voltages is determined by the current passed by the series tube V_4 at zero bias and is determined at low voltages by the allowable plate dissipation of that tube.

The source of carrier voltage is an ordinary oscillator, V_1. A convenient carrier frequency was chosen as 150 kc. A winding L_2 of a few turns on the oscillator coil form L_1 takes off a signal of about 1 volt for excitation of the carrier modulator system.

The modulator comprises a 1N38 crystal diode and a load resistor R_1. The d-c control voltage, varying the conduction of the 1N38 diode, is the difference between a fixed fraction of the d-c output voltage, taken from point A on a divider and the potential of the slider B on a potentiometer P_1 across a d-c reference source V_5. If point A becomes more positive than point B, the conduction of the 1N38 diode will increase

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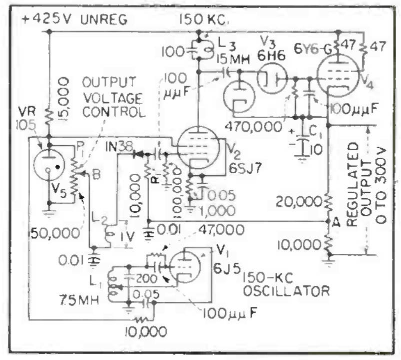


FIG. 3—Schematic of a 0 to 300-v regulated supply with carrier-type four-terminal d-c control amplifier

and more carrier voltage will appear across diode load resistor R_1.

Amplification of the controlled carrier voltage is effected by a conventional tuned amplifier V_2. Recovery of the d-c signal after amplification is carried out by a 6H6 diode V_3, connected as a voltage doubler.

The return side of the voltage doubler is connected directly to the cathode of the series tube V_4. The rectified d-c is negative on the V_4 grid. An increase in the d-c output voltage at the cathode of V_4 will bias the 1N38 so as to increase the carrier voltage; the voltage rectified by the 6H6 will increase and bias the series tube V_4 in a regulatory manner.

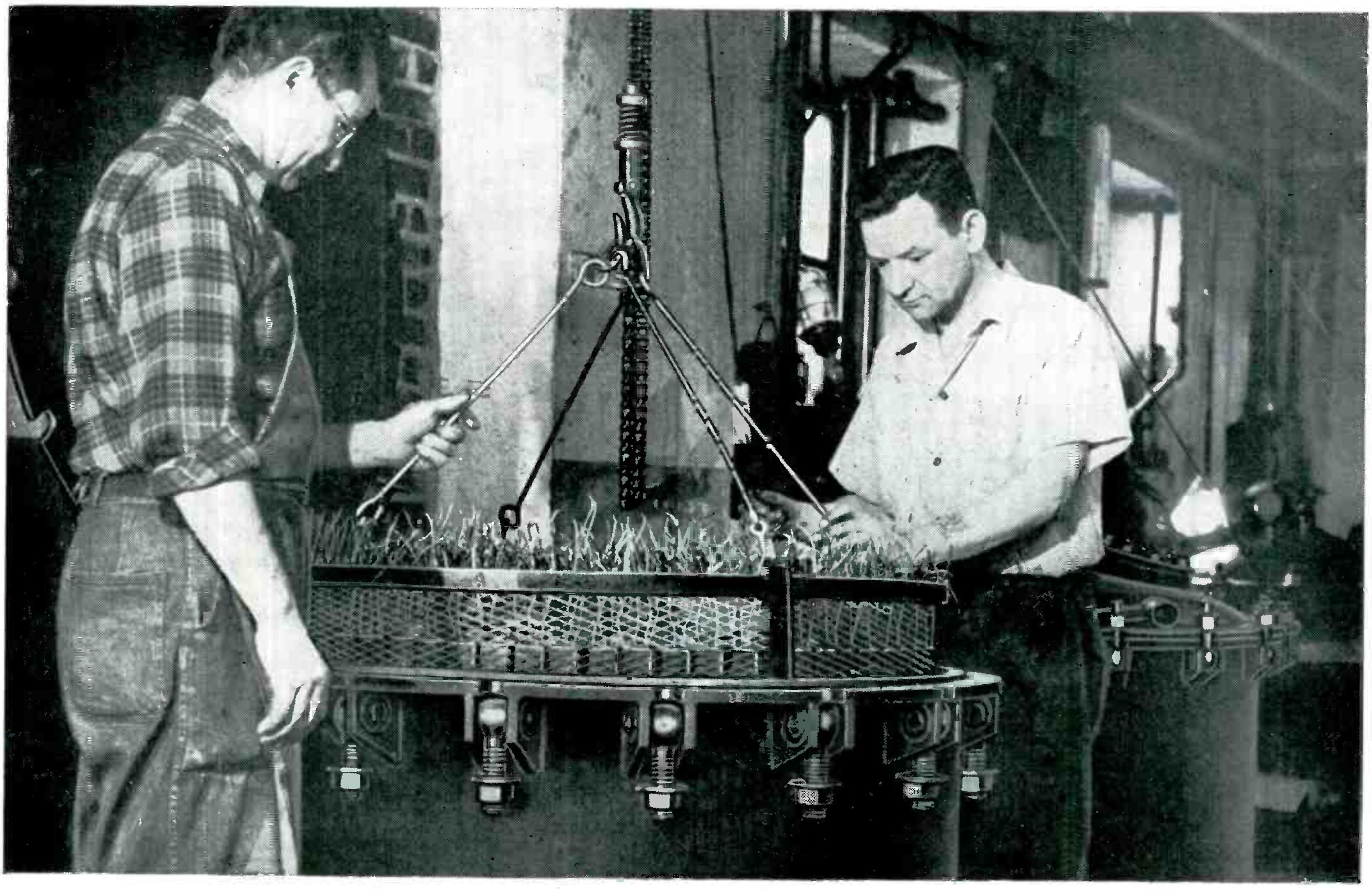
The high frequency limit of the regulating action depends on the bandwidth of the carrier amplifier system. To keep the output impedance of the whole power supply low at frequencies above a few thousand cps, a capacitor C_1 is provided across the output.

Design Considerations

No untoward tendencies to instability were observed in trying out the circuit of Fig. 3. Hum averaged around 5 mv.

To permit lowering the d-c output voltage all the way to zero under conditions of light load, the carrier-rectifier system must be capable of producing enough negative bias to cut off the series tube V_4. About 150 volts is required. The high rectified voltage makes a thermionic diode advisable for V_3, rather than germanium diodes.

An attractive feature of this type of regulator is that the control ratio can be made extremely high by merely providing a lot of ampli-



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fication at the carrier frequency. When this is done, the carrier level at the modulator diode should be lowered proportionately. The low limit for diminishing returns has not been well investigated, but is probably of the order of 50 mv.

Stability of contact rectifiers is considered somewhat better than that of thermionic tubes, so that this type of regulator may well be capable of holding to within a few tens of millivolts with respect to the reference voltage under a wide range of conditions.

REFERENCE

(1) E. L. C. White, U. S. Patent 2,268,790, Jan. 6, 1942.

Aircraft Communication System

ENGINEERS of the Air Materiel Command's Electronics Lab at Wright-Patterson Air Force Base have redesigned all the audio components of an aircraft communication system in one coordinated project which, they say, has achieved better integration of parts than was possible in the projects of the past.

One of the most important changes is the use of small amplifiers at each station instead of the one large central amplifier used in current sets. This serves as a preamplifier when the crew member is talking into his mike and as a booster for his earphones when he is listening. It is built into the crew station control panel.

Voice distortion and instability have been cut down by 95 percent by increasing the frequency range and using a moving coil dynamic microphone and earphones instead of the carbon mike and magnetic diaphragm earphones now in use.

Earphones, the source of sore ears after several hours of flight, were redesigned to be more comfortable. They are of plastic with a nylon cap. The uncomfortable leather-covered metal bands that now form the headband will give way to a netting that snaps on easily. The two plugs and cord used for the earphones and mike have been cut to one plug and one cord.

The new system will replace all sets now in use on bombers, fighters and transports.

THE ELECTRON ART

(continued from p 140)

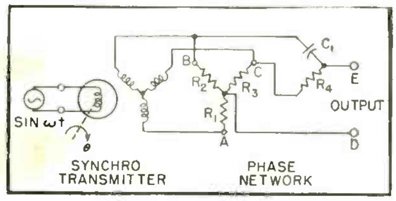

FIG. 1—Basic circuit of synnchro data telemetering converter

a common reference signal for all data channels. Various means of multiplexing these channels onto a single radio or wire transmission have been devised by the writer and others.

Converter Circuit

An extremely simple circuit has been devised to convert three-wire synchro data to a single, phase-shifted signal.

The first portion of the circuit consists of a conversion from three-phase to two-phase data. We refer here to space-phase rather than time-phase voltages. Referring to Fig. 1, three resistors R_1, R_2 and R_3 are connected in wye between the synchro output lines A, B and C. The values of the resistors are so chosen that the space-phase vectors of the voltages BD and CD are at right angles. It may be seen from Fig. 2 that the magnitudes of the vector voltages across these resistors must then be related as follows:

$$\left|\frac{e_{AD}}{e_{BD}}\right| = \frac{\sin 15^\circ}{\sin 30^\circ}$$

and

$$|e_{BD}| = |e_{CD}|$$

Because current vectors i_{BD} and i_{CD} are perpendicular in space phase, and the sum of currents

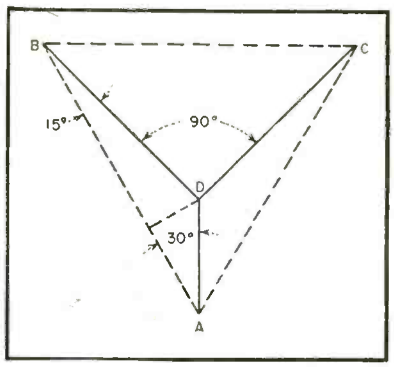

FIG. 2—Space-phase vector diagram of voltages appearing in Fig. 1

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3. **Stronger core**—gives greater resistance to **excess** vibration and shock test.
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5. **Resistive element**—finest quality wire free from impurities that could cause weakness.
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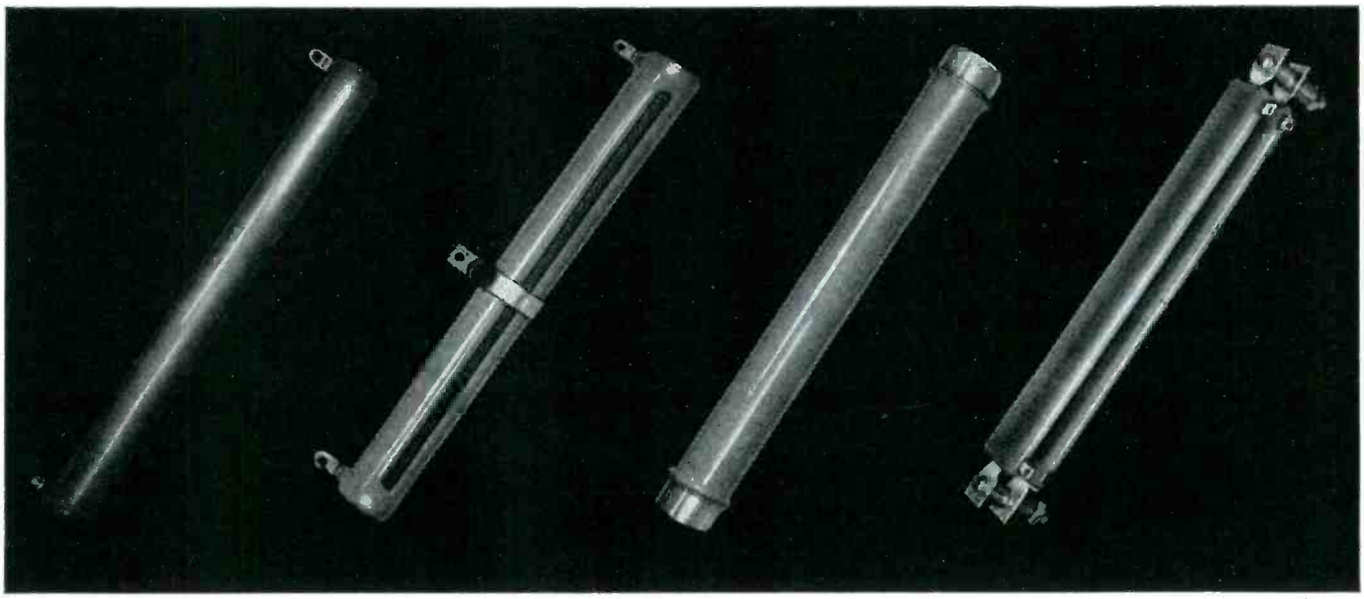

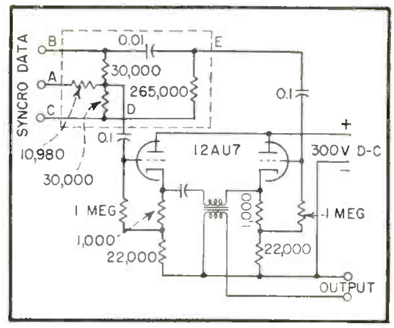

FIG. 3—Complete circuit which employs additional components to avoid loading of phase network by output circuit

entering point D must be zero, the relative magnitude of the currents must be

$$|i_{AD}| = |\sqrt{2}\, i_{BD}|$$

and

$$|i_{BD}| = |i_{CD}|$$

Using these expressions, the ratio of the resistances is:

$$\frac{R_1}{R_2} = \frac{e_{AD}}{e_{BD}} \times \frac{i_{BD}}{i_{AD}} =$$

$$\frac{\sin 15^\circ}{\sin 30^\circ} \times \frac{1}{\sqrt{2}} = 0.366$$

and

$$\frac{R_2}{R_3} = \frac{e_{BD}}{e_{CD}} \times \frac{i_{CD}}{i_{BD}} = 1$$

The above values have been verified experimentally.

The second portion of the circuit of Fig. 1 converts the two-space-phase voltages, BD and CD, into a phase-varying output voltage, ED. The voltages BD and CD are related as follows:

$$e_{BD} = E \sin \omega t \sin (\theta + 45^\circ)$$

and

$$e_{CD} = E \sin \omega t \sin (\theta - 45^\circ)$$

If R_4 is chosen equal to $1/\omega C$ at the synchro supply frequency, then the output voltage is:

$$e_{ED} = \sqrt{2}\,(e_{BD} \angle 45^\circ - e_{CD} \angle -45^\circ)$$

$$\begin{aligned} e_{ED} &= \sqrt{2}\,E\,[\sin(\omega t + 45^\circ)\sin(\theta + 45^\circ) \\ &\quad - \sin(\omega t - 45^\circ)\sin(\theta - 45^\circ)] \\ &= \sqrt{2}\,E\,[\sin(\omega t + 45^\circ)\sin(\theta + 45^\circ) \\ &\quad + \cos(\omega t + 45^\circ)\cos(\theta + 45^\circ)] \\ &= \sqrt{2}\,E \cos(\omega t - \theta) \end{aligned}$$

The latter is seen to be a constant-amplitude carrier of frequency ω whose phase is proportional to the synchro shaft angle θ. It is convenient that any load applied across terminal ED be a negligible load on the network. The

load consisting of R_4 and C is directly across two synchro output terminals and must, like R_1, R_2 and R_3, be high enough in impedance to avoid a voltage drop through the synchro. In certain cases, if the output load is not negligible, network constants can be adjusted to compensate therefore.

Accuracy

By careful selection of the five circuit elements mentioned above, angular inaccuracies as small as a fraction of a degree may be attained.

Figure 3 shows a complete circuit which employs additional components to avoid loading of the phase network by the output circuit, and to allow grounding of one side of the output. The photograph shows a manufactured plug-in assembly of two such circuits.

A New Analog Computer

By S. Bosworth
*Computer Corp. of America
New York, N. Y.*

An inexpensive desk-size electronic differential analyzer has recently been developed by the Computer Corporation of America. Although it is housed in a cabinet which is only 36-¾ in. high, IDA (for Integro-Differential Analyzer) contains 20 d-c computing amplifiers, 23 precision ten-turn potentiometers, 8 of which may be used for setting in initial conditions, 8 integrating capacitors, a control panel, a highly stable regulated power supply, and a setup board for wiring in the analog.

The top panel of the main cabinet shown in Fig. 1 contains the 23 coefficient-setting potentiometers. Any of the eight potentiometers in the upper row may be used to set initial conditions into the integrating capacitors mounted behind them. For this purpose, the switch directly below each one is thrown either to left or right for positive or negative initial conditions respectively. With the switch in the center position, the corresponding potentiometer may be used as a coefficient-setter.

The eight 1-μf $\pm$1 percent herme-

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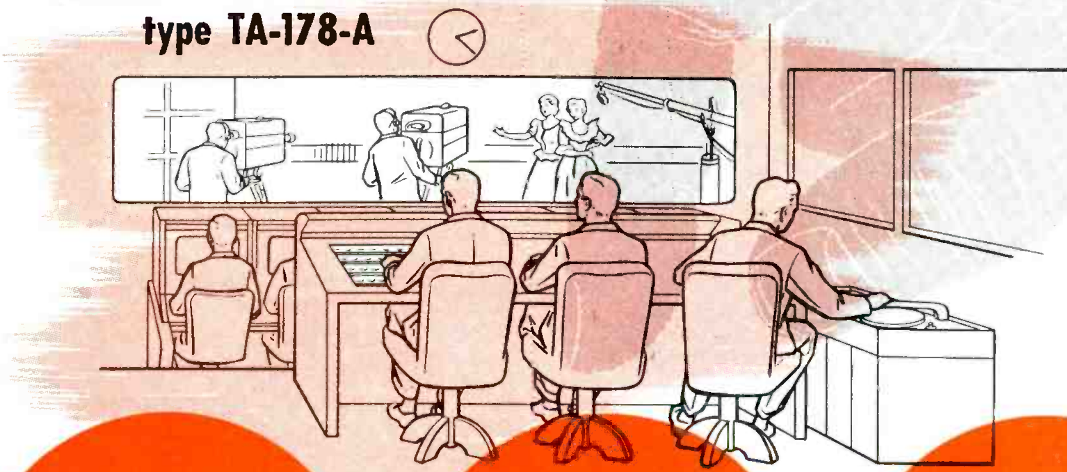

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While main line is feeding transmitter, the mixer amplifier output can be used to feed, simultaneously, a different mixed studio show to an audition circuit. The Mixer Amplifier has three identical program outputs which may be fed to transmitter, network cable and master line monitor.

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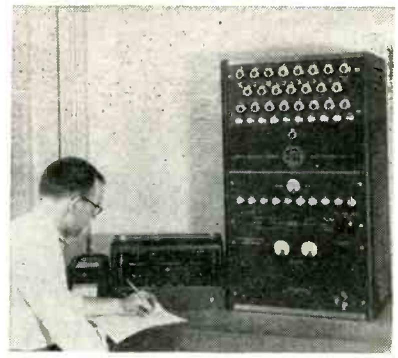


FIG. 1—Compact computer which is capable of solving eighth order differential equations

tically sealed capacitors permit the solution of problems describable by an eighth-order differential equation.

The second panel is hinged to permit plug-in and removal of the set-up board shown in Fig. 2. Use of set-up boards makes possible almost continuous operation of the computer, since problems may be changed in the few seconds required to remove one board, and insert another. Since all interconnections are made on the set-up board, the necessity for patch-cords is eliminated, and once the board is in place, it is virtually impossible to disturb the problem set-up accidently.

The boards consist of two panels mounted back to back on an aluminum frame. On the panels are 266 spring-type binding posts. All computer elements are terminated at these posts through three 50-contact connectors at the rear of the frame which mate with receptacles in the cabinet. The remaining uncommited posts may be used as junction points, and to support resistors. By connecting jumpers, which may be ordinary hook-up wire, and fixed resistors of any desired accuracy, between the proper binding posts, all the elements of the computer are interconnected to form the analog of the problem.

Directly below the hinged panel in Fig. 1 are the balance meter and balance controls of ten amplifiers. The balance controls of the other ten appear just above this panel. Each control incorporates a balance switch. Pushing inward on the knob throws this switch and simul-

taneously engages a potentiometer. The inherent stability of the amplifiers makes balancing necessary only once or twice a day, while the operation itself requires only a minute.

The twenty computing amplifiers, one of which is shown in Fig. 3, are miniaturized plug-in units. The direct-coupled circuit incorporates a positive feed-back loop which is adjusted to give infinite gain. When used with an external negative feed-back loop, as it is in a computing circuit, the amplifier is stable, and has zero output impedance.

By virtue of the fact that the input and feedback impedances that determine the transfer functions of the amplifiers can be selected and connected on the set-up board, each amplifier may be used as a summer, integrator, sign-changer, or constant multiplier.

Just beneath the lower row of balance knobs and to the left in Fig. 1, are the two controls which select the forcing function and adjust its amplitude. Either a positive or negative internally generated step function may be chosen, at a level of zero to 50 volts monitored on the meter below. Special functions, such as sine or exponential, may be internally generated and applied in the same manner. One position of the selector switch also permits an externally generated forcing function to be introduced through the socket just below this switch.

On the right-hand side of this panel are the two operating controls. A spring-loaded switch allows the application of the forcing function either momentarily or

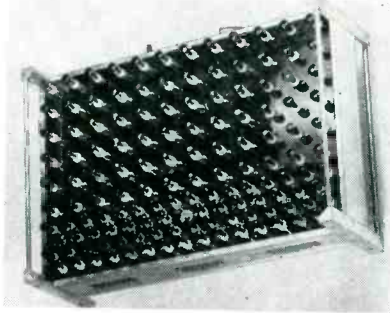


FIG. 2—The analog of the problem is constructed on this set-up board. Use of several boards makes possible storage of problems and continuous operation of the computer

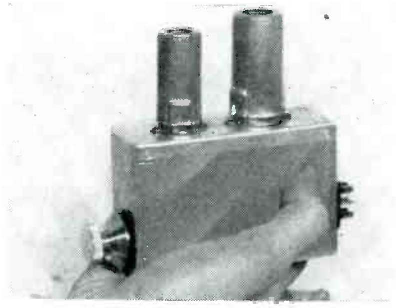
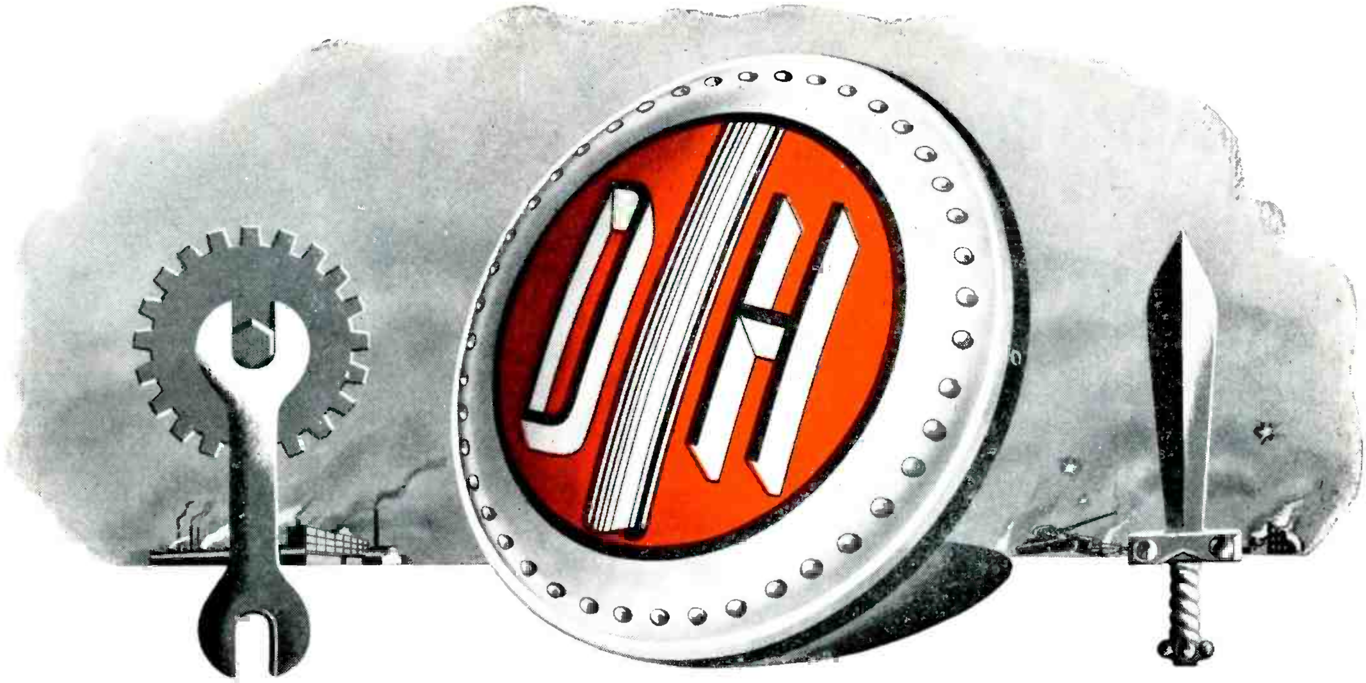


FIG. 3—Twenty computing amplifiers of the type shown are used. These interchangeable units can operate as integrators, summers or sign changers

continuously, before the start of, or during, the computing process. The large knob alongside it is marked OFF-RECORD-COMPUTE. With this switch in the OFF position, the recording oscillograph motor is turned off, and each computing capacitor is maintained in either a discharged condition, or at some preset initial condition voltage. Under these circumstances, the computing process is, in effect, clamped to correspond to conditions in the system at time $t = 0$. When the switch is turned to RECORD, the computing process remains clamped, but the recorder chart drive is turned on. This permits the chart to reach full speed, and allows the pens to be zeroed mechanically. Rotating the switch to COMPUTE removes the capacitor clamps, and allows the computation to proceed.

Below the control panel is the regulated power supply. Positive and negative B voltages are furnished to the amplifiers, as well as to the integrating capacitors for initial condition charging, and to the forcing function circuit. These voltages are regulated to better than 0.1 percent for simultaneous variations in load from zero to full, and line from 105 to 135 volts. Power supply voltages and currents are monitored by the two meters on this panel.

Figure 4 is a close-up view of the recorder and its control unit. Amplifiers for driving the magnetic oscillograph are contained in the control unit, as well as switches to select the input to each channel. This cabinet also contains circuits for controlling and calibrating the gain of the recording channels, and for monitoring any of the amplifier



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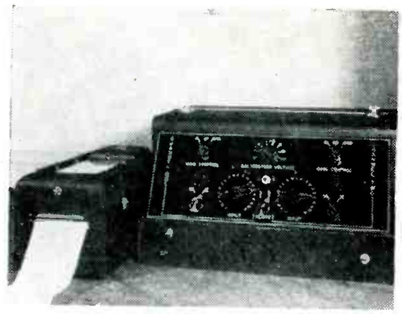


FIG. 4—Solutions appear graphically on the magnetic oscillograph (left). The control unit (right) selects the computed quantities to be recorded

outputs or the forcing function by means of a meter or cathode-ray oscilloscope. For those applications requiring simultaneous recording of more than two quantities, a six-channel recorder and control unit is available.

To increase the usefulness of the computer, 44 terminals on the set-up board are brought to connectors at the rear of the main cabinet. This makes possible interconnection of two or more computers, and permits the introduction of special function generators, servo multipliers, additional integrating capacitors and other auxiliary equipment.

Measuring Power Factor of Low-Loss Dielectrics

BY J. L. DALKE AND R. C. POWELL

National Bureau of Standards Washington, D. C.

ACCURATELY MEASURING the power factor of low-loss materials is frequently difficult with equipment that is usually available. The smallest power factors determined by most commercial bridges is hardly better than 10^{-4}, whereas materials such as polystyrene and teflon have power factors only two to three times this value. When resonance methods are used, the smallest detectable power factor is inversely proportional to the Q. For a circuit with a Q of about 200 and the usual voltmeters and generators the sensitivity of power factor measurements is of the order of 10^{-4}. The sensitivity can be increased by introducing negative resistance into

Original paper given at the 1950 Conference on Electrical Insulation, the abstract of which appears in the 1950 Annual Report of Conference on Electrical Insulation, National Research Council.

the resonance circuit to compensate for the energy dissipated in the circuit, thereby obtaining a much higher Q. In fact, radio engineers have for many years used regenerative circuits to improve the selectivity of tuning circuits. Apparently Towsley[1] was the first to apply regeneration to dielectric measurements. The approach and the circuit described in this paper are different and the apparatus is simpler making accurate measurements possible up to three hundred megacycles.

Circuit Diagram

Figure 1 shows the circuit which has been in use for over a year. It is composed of a conventional coil, a micrometer electrode system shunted by a voltmeter and a negative resistance in series. The negative resistance is supplied by the real component of the input impedance of a cathode follower circuit with a capacitative load and certain values of grid-to-cathode capacitance. A negative resistance in parallel with the electrode system will also produce satisfactory results, but the value of negative resistance necessary and the dependence of the resonance frequency on the vacuum tube circuit make such and arrangement more unstable than the series circuit. The familiar susceptance variation or Hartshorn technique is used to evaluate the dielectric in terms of micrometer readings, the width of the resonance curve and the voltages with the specimen in and out. The expression for the input impedance to the cathode follower circuit is

$$Z_{in} \cong \frac{g_m}{\omega^2 C'_K C'_{gK}'} - j\left(\frac{1}{\omega C'_K} + \frac{1}{\omega C'_{gK}}\right)$$

provided $r_p >> X_K$, $X_{gK} >> R'_K$,

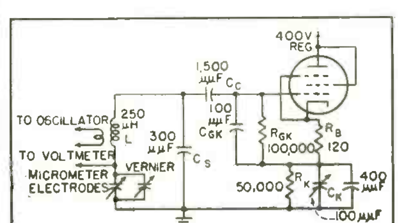
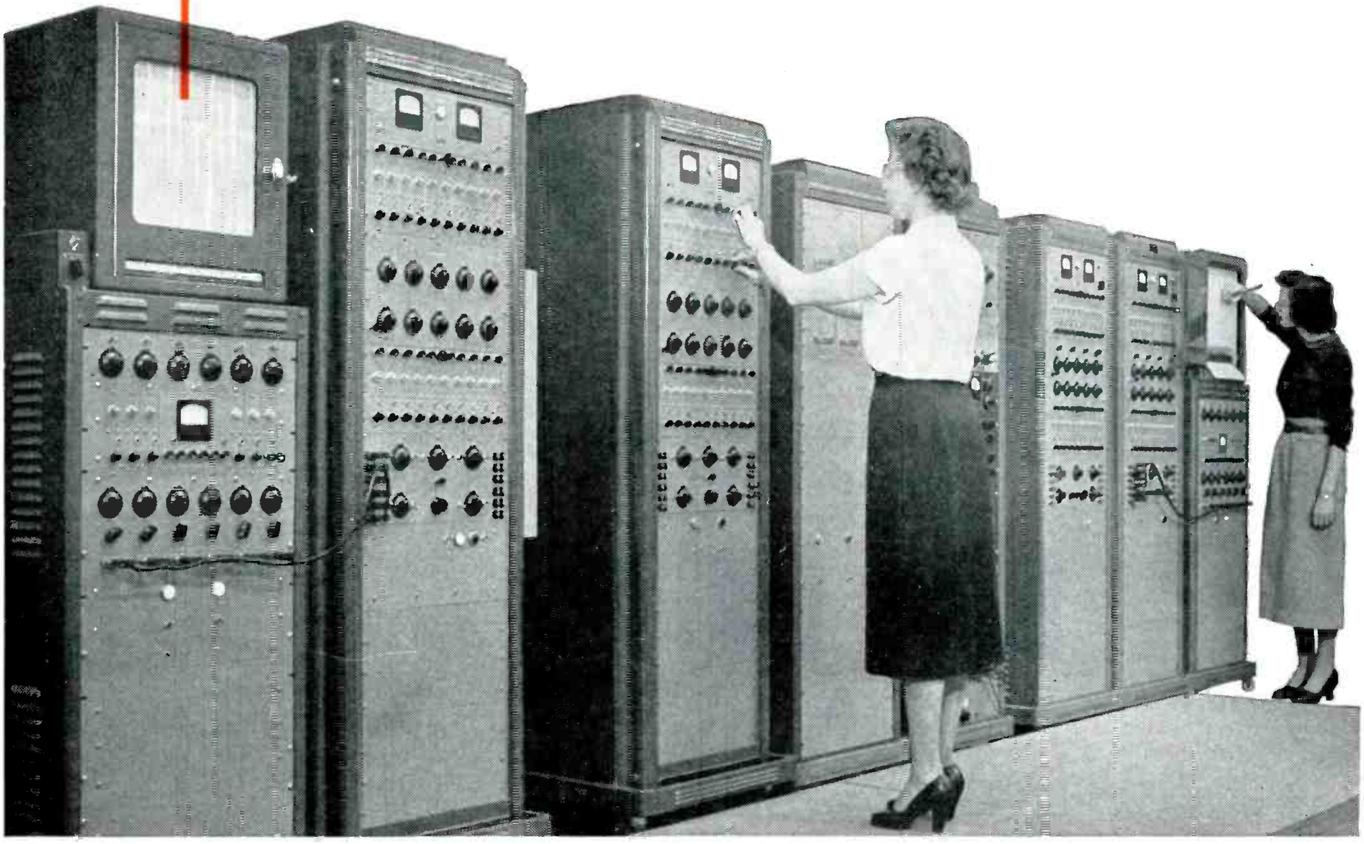


FIG. 1—Circuit used for making low-loss measurements at 1 mc

Brush recorder



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R'_{gK} and $\mu >> 1$; g_m, r_p and μ are the transconductance, plate resistance and amplification factor of the tube and X_K, R'_K, X_{gK} and R'_{gK} are the series equivalents of the corresponding elements in Fig. 1. If Z_{in} is shunted by C_s such that $X_s << R_{in} >> X_{in}$ then

$$Z_{in} \cong - \frac{C'_K C'_{gK}}{g_m C_s^2} - j\frac{1}{\omega C_s}$$

These equations are only approximations but they represent the operating conditions accurately for all practical purposes. Thus, to a very good approximation, the negative resistance is $-C'_K C'_{gK}/g_m C_s^2$. The reactive component of Z_{in} offers no difficulty since it can be

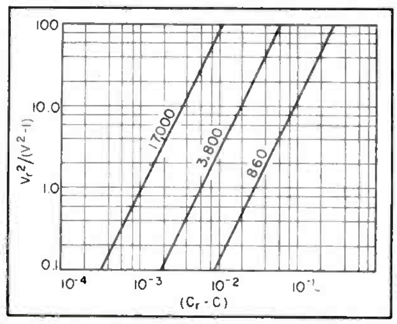

FIG. 2—Curves demonstrate closeness of fit of measured curves to conditions for theoretical resonant curves

made small in comparison to the reactance of the inductance and electrode and remains constant during a measurement. The equation for the resonance curve in terms of the voltage V and the total equivalent conductance G_t across the electrode system is

$$2 \log (C_r - C) = \log \left(\frac{V_r^2}{V^2} - 1 \right) + \log \left(\frac{G_t^2}{\omega^2} \right)$$

where C_r and V_r are the capacitance and voltage at resonance. Thus if

$$\left(\frac{V_r^2}{V^2} - 1 \right) \text{ is plotted versus}$$

$(C_r - C)$ on log log paper a straight line with slope 2 should be obtained. Figure 2 illustrates that this requirement is met by the high-Q circuit under consideration. Figure 3A shows the familiar resonance curves obtained for the corresponding data, using a voltmeter with

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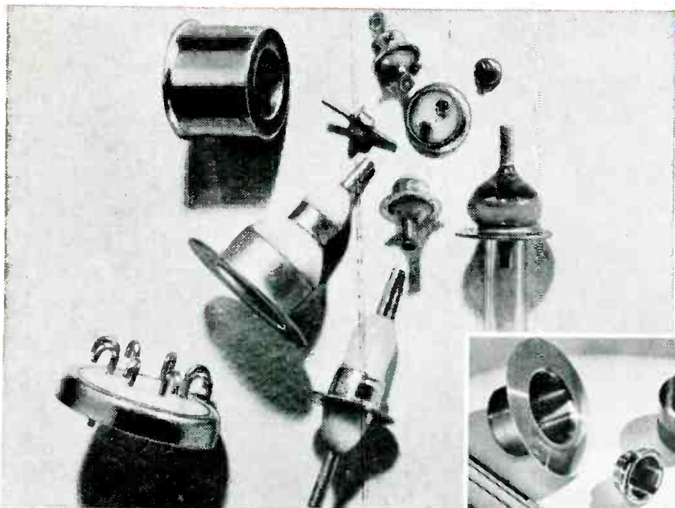

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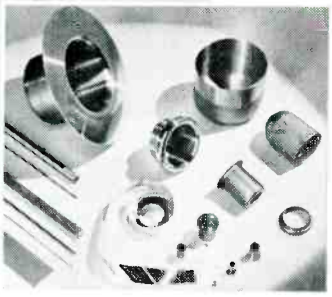

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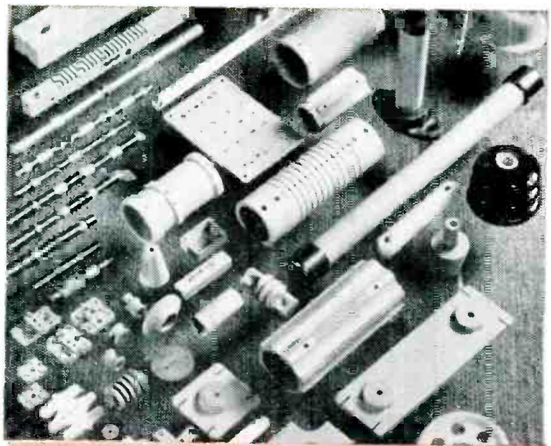

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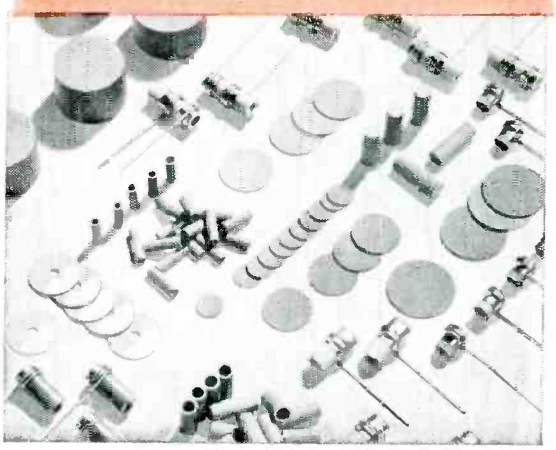

linear input impedance.

Stable Q's as high as 170,000 have been obtained. With a commercial generator and power supply, Q's of the order of 100,000 were found to have random fluctuations and drift of the voltage at the resonance peak of about 5 percent over a period of five minutes. The stability obviously improves as the Q is lowered. At 1,000 the voltage peak was stable to better than ±1 percent over a period many times longer than the time required to make a set of measurements. The stability of the circuit was found to

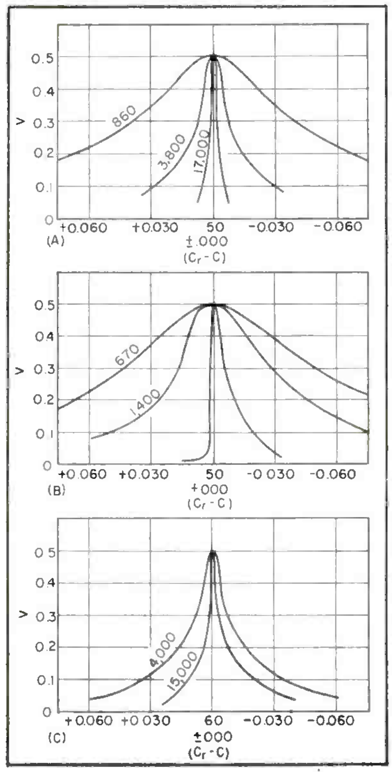

FIG. 3—Curves show voltage across electrodes plotted against vernier capacitance. Numbers on curves represent the approximate $C_r/C = Q/2$

be better than the commercial generator and power supply employed. With such a device the power factor of materials such as polystyrene and teflon can be measured to three significant figures from one kilocycle to 300 megacycles. An extremely low-loss fused-quartz specimen was found to have a power factor an order of magnitude smaller than polystyrene and teflon.

When operating the circuit at Q's

above a few hundred, effects due to nonlinear elements become noticeable in the distortion of the resonance curve. The negative resistance circuit itself produces no observable nonlinearity, because low amplitudes are used and a large amount of stabilizing negative feedback is provided. However, if a voltmeter with a nonlinear input impedance is connected directly across the electrode system, effects such as those illustrated in Figs. 3B and 3C are easily obtained. To eliminate this difficulty, which obviously makes accurate resonance-curve measurements impossible, it is necessary for the voltmeter input impedance to be linear or to isolate the voltmeter from the system by means of an amplifier with a linear input impedance.

The micrometer electrode system and associated equipment used at the National Bureau of Standards are shown on the opening page of this department.

In the center is located the micrometer electrode and coil mounted on the negative resistance circuit. Power supplies are shown in background.

REFERENCE

(1) 1948 Annual Report of Conference on Electrical Insulation, National Research Council.

Self-Erecting Weather Station

COMPLETE and accurate weather predictions can only be obtained by studying meterological information taken at a large number of widely spaced stations. The accompanying photographs show a weather station that is designed to be dropped from an aircraft by parachute. Upon hitting the ground, the weather station goes into action quickly and automatically, and it transmits weather information by radio to appropriate recording instruments in a main station.

As shown in Fig. 1 the station as it is dropped from the plane resembles a bomb. When the unit is released over a desired location,

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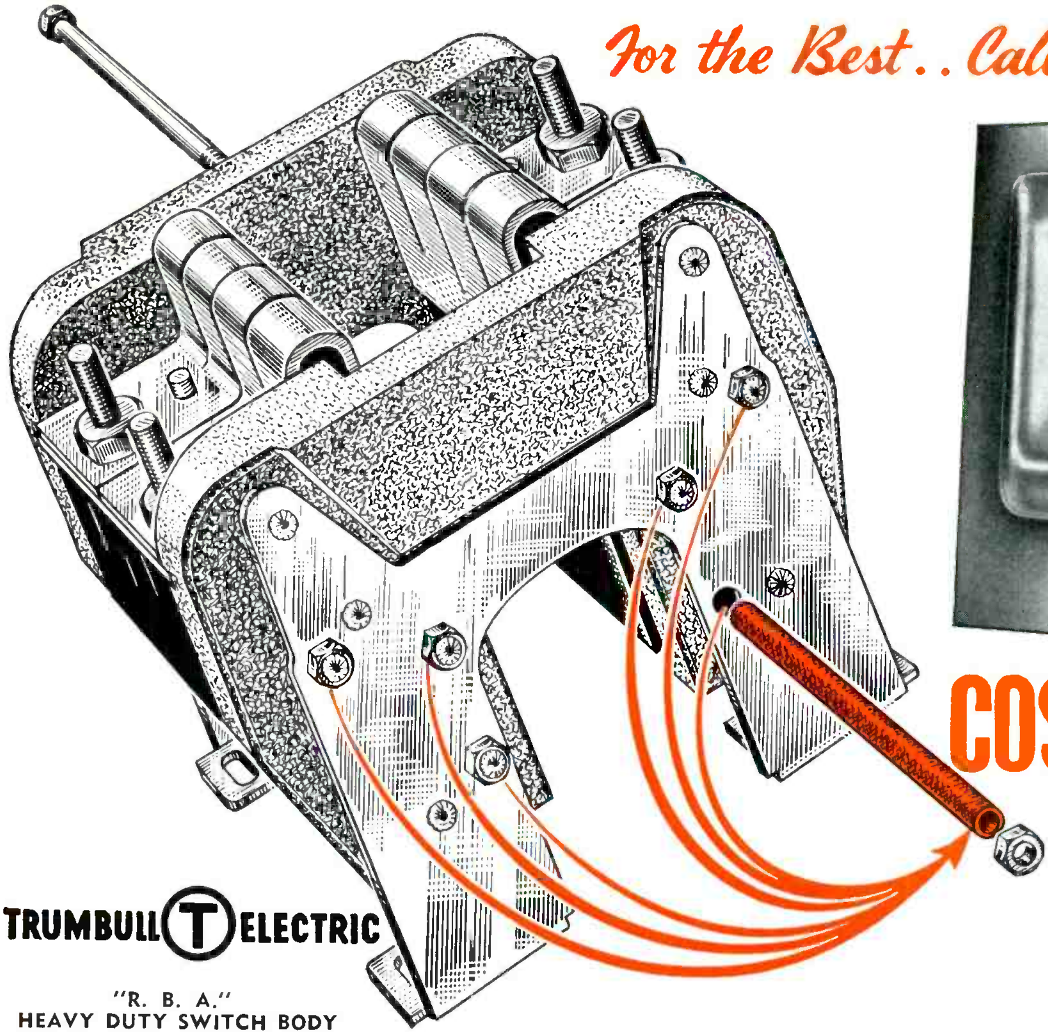

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the parachute is automatically opened by a line rigged from the plane. Simultaneously, an electric clock, which controls subsequent operations of the station, is turned on.

The impact of the landing sets off a small explosive charge which disengages the parachute and prevents the station from being pulled along the ground. Either immediately or after a pre-set dormancy period, another explosive charge causes the station to rise to an upright operating position. This is done through an arrangement of six legs to which springs are attached. The explosive charge operates a release, permitting the

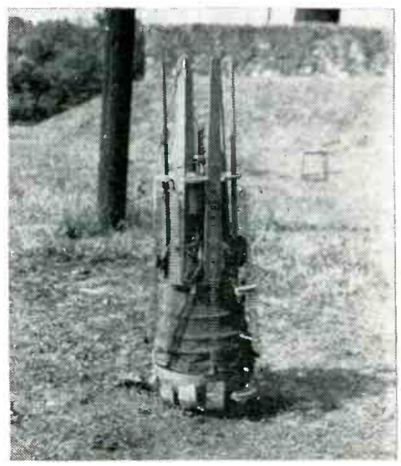

FIG. 1—Experimental model of the air-launched automatic weather station developed by the National Bureau of Standards for the Navy Bureau of Ships. The station has landed, but the leg-release device has not yet functioned

springs to pull the legs into position. A third explosive charge extends a telescopic vertical antenna to a height of some 20 feet. The erected station is shown in Fig. 2. The station is then ready for automatic transmission at intervals predetermined by the built-in timing mechanism.

The automatic station could be adapted to transmit various kinds of information, but in the standard design only temperature, pressure, and humidity data are reported. Separate mechanisms responsive to changes in these atmospheric conditions each cause an associated resistor to vary. At predetermined intervals the timing mechanism

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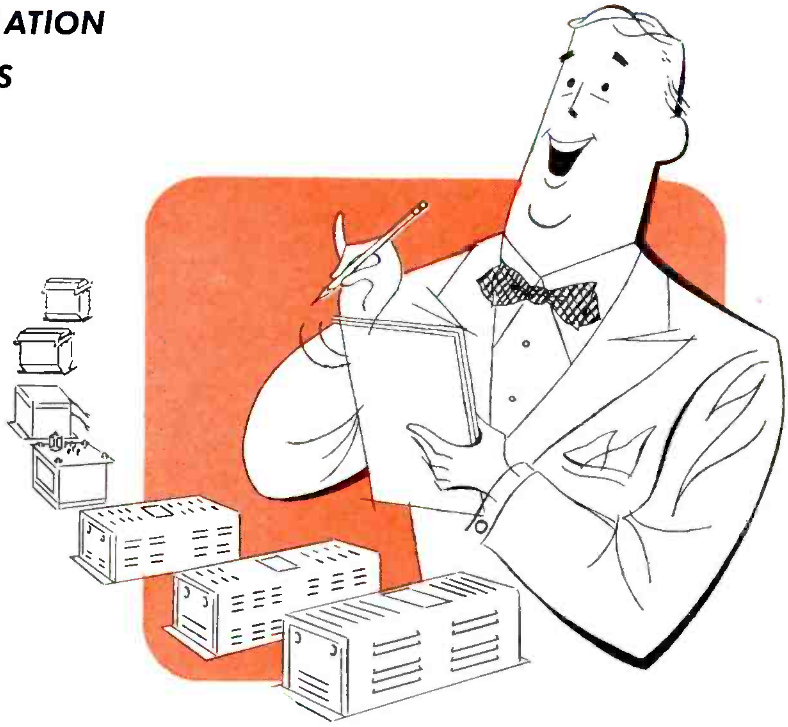

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turns on the radio transmitter and connects one resistor after another to a critical point in the transmitter circuit. The transmitter is designed so that the emitted radio signal pulses on and off at a rate proportional to the value of the resistor so connected. The station is calibrated before use by subjecting it to known temperatures, pressures, and humidities and measuring the resulting pulse rates. At the receiving station the transmitter pulse rate can then be read as tempera-

FIG. 2—After the station lands, explosive charges disengage the parachute, raise the station to an upright position, and erect a telescoping antenna

ture, pressure or humidity, depending on the phase of the predetermined clockwork cycle.

The radio transmitter proper consists of a crystal oscillator followed by a radio-frequency amplifier stage. A relay in the plate circuit of a separate relaxation oscillator turns the crystal oscillator on and off at a rate proportional to the value of whatever resistor is temporarily inserted (by the clock mechanism) into the relaxation oscillator circuit. When the station is to be used as a beacon, the radio transmitter and its control mechanisms may, of course, be simplified.

The clock, in addition to inserting the several weather-responsive resistors into the circuit in a predetermined sequence, connects two other resistors at appropriate intervals. These are a reference

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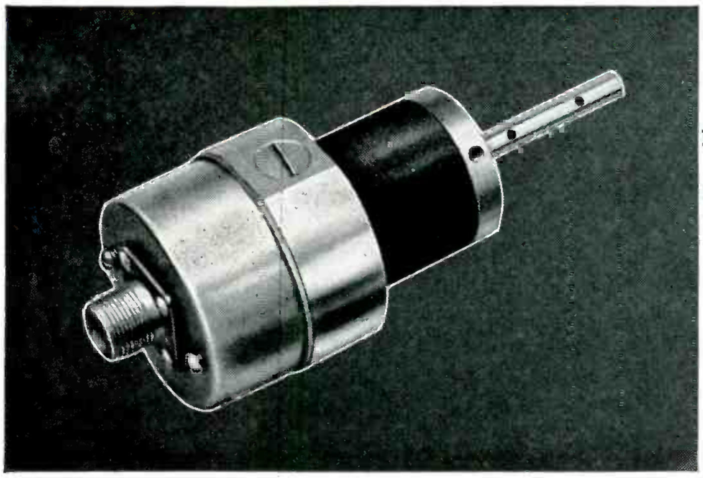

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FIG. 3—Inner view of experimental model of the air-launched automatic weather station

resistor and an identification resistor, both of constant value. The pulse rate produced by the fixed reference resistor is observed during initial tests of the transmitter. Any subsequent deviation in the reference resistor pulse rate warns the receiving station that a correction factor must be applied to the pulse rates of the weather-responsive resistors. Such deviation could arise from transmitter damage or aging. The identification resistor is of a value selected to produce a pulse rate characteristic of the particular station; this enables the receiving station operator to identify the station.

A special technique is used to insure maximum accuracy of the transmitted data despite possible deformation of the weather-responsive mechanisms due to landing impact: a buzzer vibrates each weather-responsive device for a short time before its associated resistor is inserted in the relaxation oscillator circuit. This forced vibration counteracts friction, which may have been increased by landing-impact deformation, and thus aids in the attainment of a true equilibrium condition.

The developmental model of the weather station had an output of the order of 5 watts. Operating on a frequency in the neighborhood of 5 megacycles, it performed reliably over land at ranges of more than 100 miles. The dry batteries used provided power for transmission of weather reports at 3-hour intervals

for more than 15 days.

The station, called the Grasshopper, was developed at the National Bureau of Standards for the Navy Bureau of Ships.

Zero-Impedance Power Supply Termination

JORDAN J. BARUCH
Acoustics Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

IN THE DESIGN of regulated power supplies, the regulator must perform two functions. One of these is to hold the output voltage constant despite small changes in the input voltage. The second is to hold the output voltage constant despite changes in load current. In general, the series-regulated power supply does both of these jobs with a single regulator section. In many cases, however, it will prove advisable to relegate these two functions to separate sections of the regulator system. The second section, then would provide a low-impedance output for the system.

Much has already been written on the regulation of series-regulated power supplies. In most of these papers, however, a single section is used for both voltage regulation and for the provision of a low output impedance. In the proposed system, a simple regulator section will be described which provides the necessary low output impedance although it is not primarily intended to operate as a regulator for changes in input voltage. Consider the circuit shown in Fig. 1.

We can perform a differential analysis of the output impedance by solely concerning ourselves with the

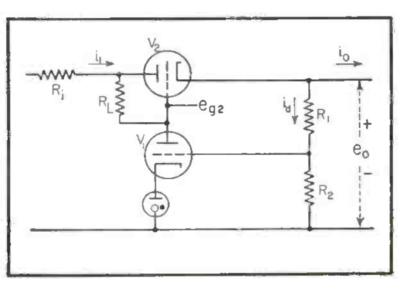

FIG. 1—Basic circuit of zero impedance power supply termination

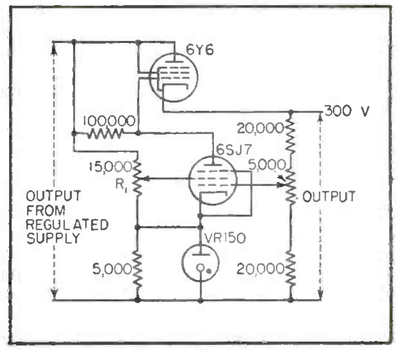

FIG. 2—Complete schematic of zero impedance circuit used in conjunction with conventional series voltage regulator circuit

voltage regulation. All the quantities we express will be considered differentials. In addition, we will assume that the plate current drawn by tube V_1 is insignificant compared with that drawn by V_2 and hence:

$$i_o = i_1 - i_d$$

If the power supply does have a zero internal impedance however, $i_d = 0$ and $i_1 = i_o$. We will assume this to be the case. A differential analysis of the supply can then be made as follows:

$$Z_o = e_o/i_o \quad (1)$$

$$i_o = i_1 = g_{m2}\, e_{g2} \quad (2)$$

$$e_{g2} = \mu_1 \frac{R_L}{r_{p1} + R_L}\, e_o \frac{R_2}{R_2 + R_1} - i_o R_1 \frac{r_{p1}}{r_{p1} + R_L} \quad (3)$$

$$\frac{i_o}{g_{m2}} + i_o R_i \frac{r_{p1}}{r_{pi} + R_L} = - e_o\, \mu_1 \frac{R_L}{r_{p1} + R_L} \frac{R_2}{R_2 + R_1} \quad (4)$$

$$Z_o = -\frac{1}{g_{m2}} + R_i \frac{r_{p1}}{r_{p1} + R_L} \Big/ \left(\mu_1 \frac{R_L}{r_{p1} - R_L} \frac{R_2}{R_2 - R_1} \right) \quad (5)$$

and hence for $Z_o = 0$

$$r_{p1} = - \frac{R_L}{1 + R_i g_{m2}} \quad (6)$$

Thus, for the zero-impedance condition, the amplifier tube should be operated in the region of negative plate resistance. We see that it is essentially possible, by this means, to obtain a zero-impedance power supply. The analysis holds true, of course, only if the input voltage to the system is constant and may be represented as being in series with a fixed resistance. An additional way in which the behavior of this

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system can be analyzed is to consider that V_1 operates as a resistor in the voltage divider network comprised of R_L and V_1. A change in load current causes a voltage drop equal to i_1R_i and this must be compensated for by a change in e_g such that

$$g_{m2}\, e_g = i_1$$

which is the differential current. It is evident that e_g is given by

$$-e_g = \frac{r_{p1}}{R_L + r_{p1}} R_i i_1 \qquad (7)$$

Since $g_m\, e_g = i_1$, we can write

$$g_{m2} R_i \frac{r_{p1}}{r_{p1} + R_L} = -1$$

Which is equivalent to Eq. (6).

It is interesting to note that the negative resistance characteristic required of V_1 can often be obtained through the suitable use of a pentode such as a 6SJ7. When using a pentode, it will be possible to obtain and control the value of this negative resistance by tapping the screen voltage off a potentiometer between the plate of V_2 and ground. The output impedance of the power supply regulator section will then in turn be varied. This has proved an extremely useful characteristic in recent laboratory work. A power supply having an impedance which can be varied from approximately plus 500 ohms to minus 500 ohms continuously is now in use in this laboratory for testing the troubles arising from power supply coupling of circuits. The zero impedance termination circuit diagram is shown in Fig. 2.

Its value in this work is enhanced because the ground may be made continuous throughout the power supply, a factor which has been missing in many previous zero-impedance supplies.

Stress-Strain Recorder

AN ELECTRONIC stress-strain recorder to record automatically stress-strain or load deflection characteristics of intricate parts and mechanisms of aircraft armament equipment, has been developed at the Naval Gun Factory in Washington, D. C.

The device consists of a measuring head or transmitter and a re-

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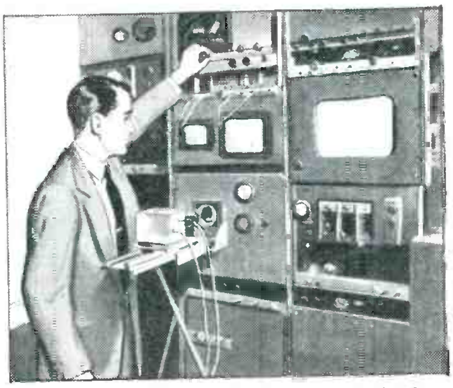

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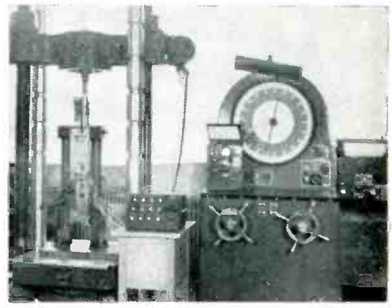

FIG. 1—Close-up view of measuring head fixed to test specimen

corder. The measuring head (see Fig. 1) consists of a dial indicator (range depends on deflection to be measured) coupled to a 26-volt, 400-cycle aircraft autosyn. A five-conductor cable connects the transmitter to the recorder, which consists of a servo system and recording drum.

Rotation of the drum is proportional to the deflection of the piece being tested and the load component being recorded by a pen which is controlled by the weighing system of the tension-compression machine. The unique feature of this device is the measuring head which can be installed to the test fixture so that linkages that are small and difficult to measure with other devices can be tested for deflection. The electronic stress-strain recorder at present is equipped to record deflections from 0.0001 inch to 10 inches simply by interchanging dial indicators.

Figure 2 shows a test arrangement of a subassembly of a machine gun mount on the tension-compression machine. Strain data of component parts of the machine gun subassembly were also taken during the test.

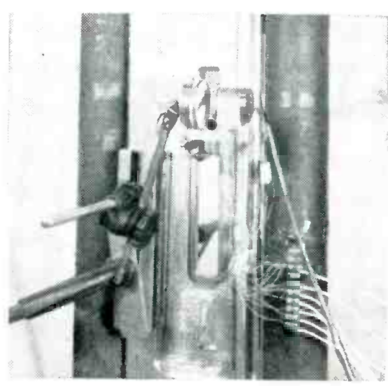

FIG. 2—Test arrangement for recording deflections and measurements of strain with electronic stress-strain recorder

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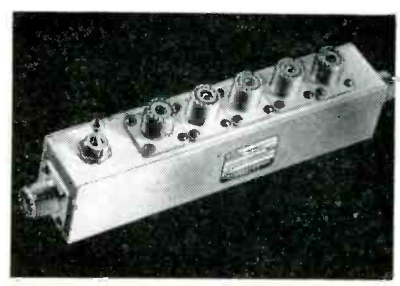
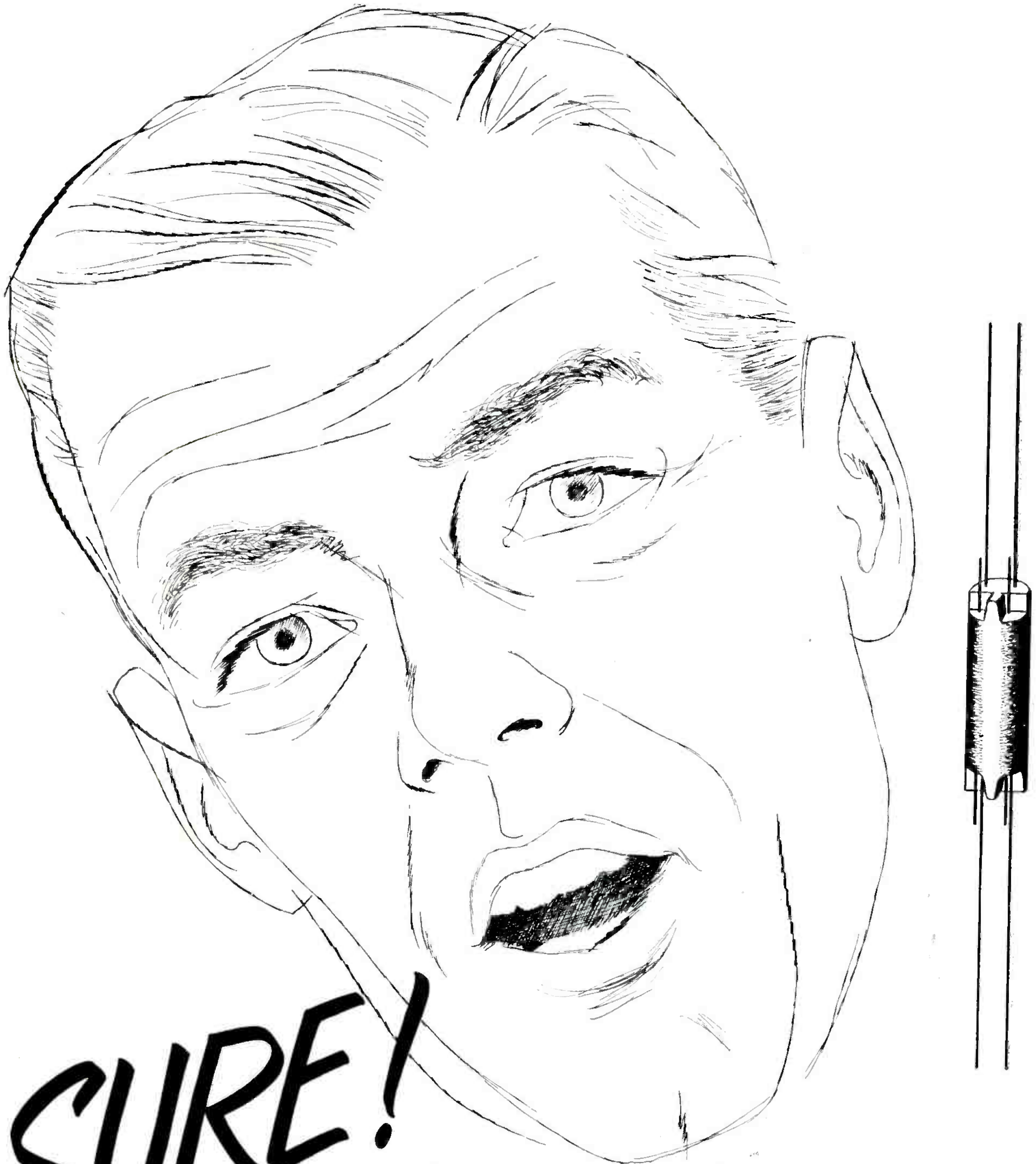
Tiny Geiger Counter

PRECISION RADIATION INSTRUMENTS, INC., 4113 W. Jefferson Blvd., Los Angeles 16, Calif., has introduced the Snooper, a Geiger counter for use as a civilian defense instrument as well as for prospecting and school use. A miniature amplifier gives a loud audible signal whenever the counter comes near radioactivity whatever the source. The snooper measures $1\frac{1}{2}$ in. × 3 in. × 5 in. and weighs $1\frac{1}{4}$ lb. Price is $24.95.



Video Distribution Network

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., announces availability of its type V-101 video distribution network. The unit provides a ready means of dividing the output of a single source into from one to five bridging amplifiers for video program distribution. In



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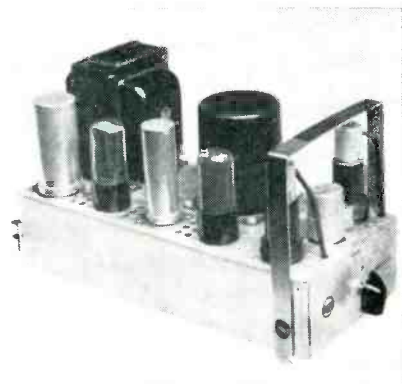
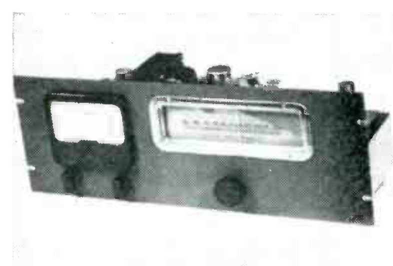


Line Amplifier

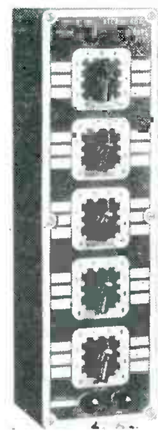
RADIO CORP. OF AMERICA, Camden, N. J. Type MI-12160 plug-in line amplifier with self-contained power supply may be used as a master mixer for up to four preamplifiers, a booster amplifier for supplying zero level to a telephone line, a line amplifier capable of operating from a telephone line, a driver amplifier supplying driving voltage for up to 500 power amplifiers, a monitor amplifier supplying two watts of audio power to a speaker, or a bridging amplifier for bridging a low impedance line. It provides excellent frequency response from 30 to 15,000 cycles with low distortion.



F-M Tuner

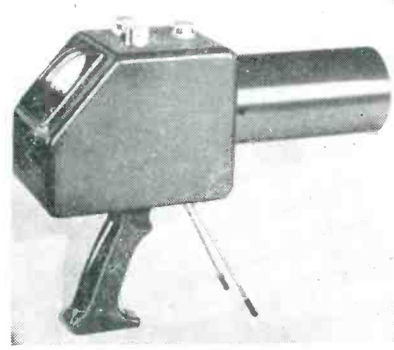
COLLINS AUDIO PRODUCTS CO., INC., P. O. Box 368, Westfield, N. J., has

announced the model HP-14 f-m tuner. Its output circuit may be operated directly into any load from 500 ohms to ½ megohm. The output level is approximately 3 volts, depending upon what load the tuner operates into. Power source is 110 volts a-c, 60 cycles; power consumption, 100 watts; sensitivity, between 5 and 10 microvolts. Audio response is flat to beyond 15 kc.



Resistance Decade Box

ELECTRONIC INSTRUMENT CO., INC., 276 Newport St., Brooklyn 12, N. Y., has announced the model 1171 resistance decade box in factory wired and kit form. It supplies resistance values from 0 to 99,999 ohms with 0.5-percent precision. Dimensions are 3½ in. × 12 in. × 3 in. In kit form the unit is priced at $19.95; factory wired, it costs $24.95.



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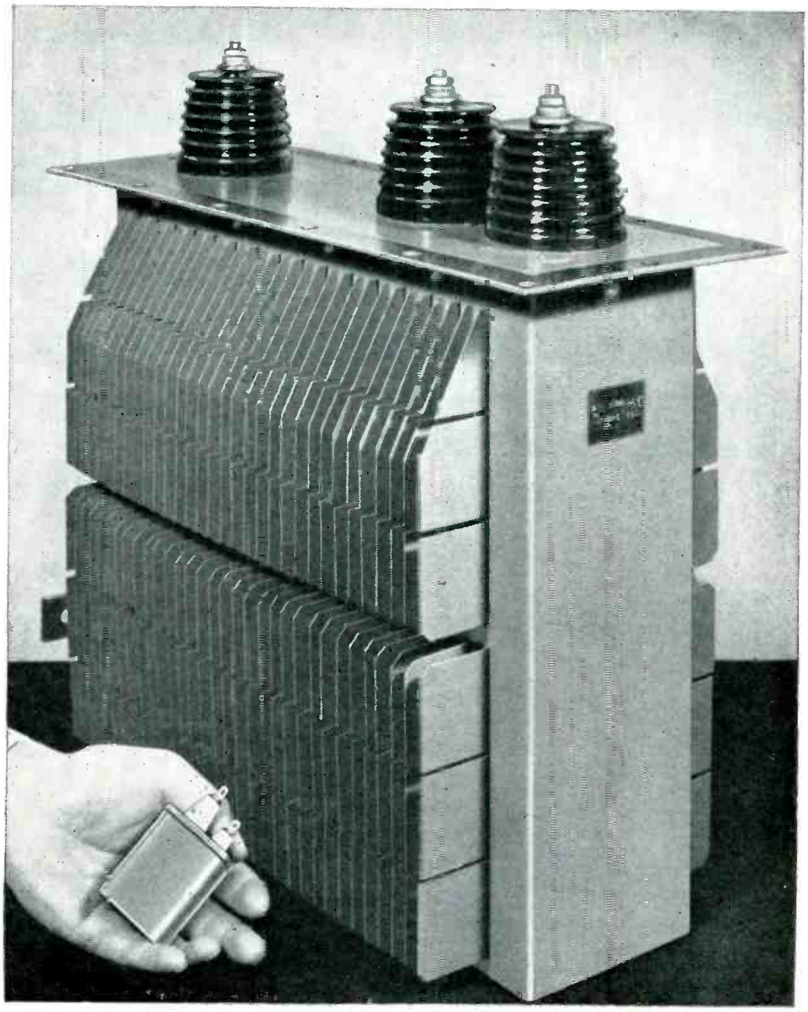

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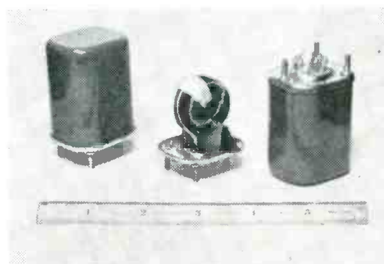

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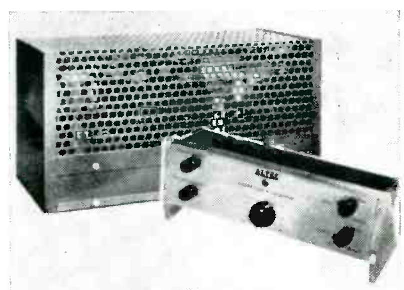
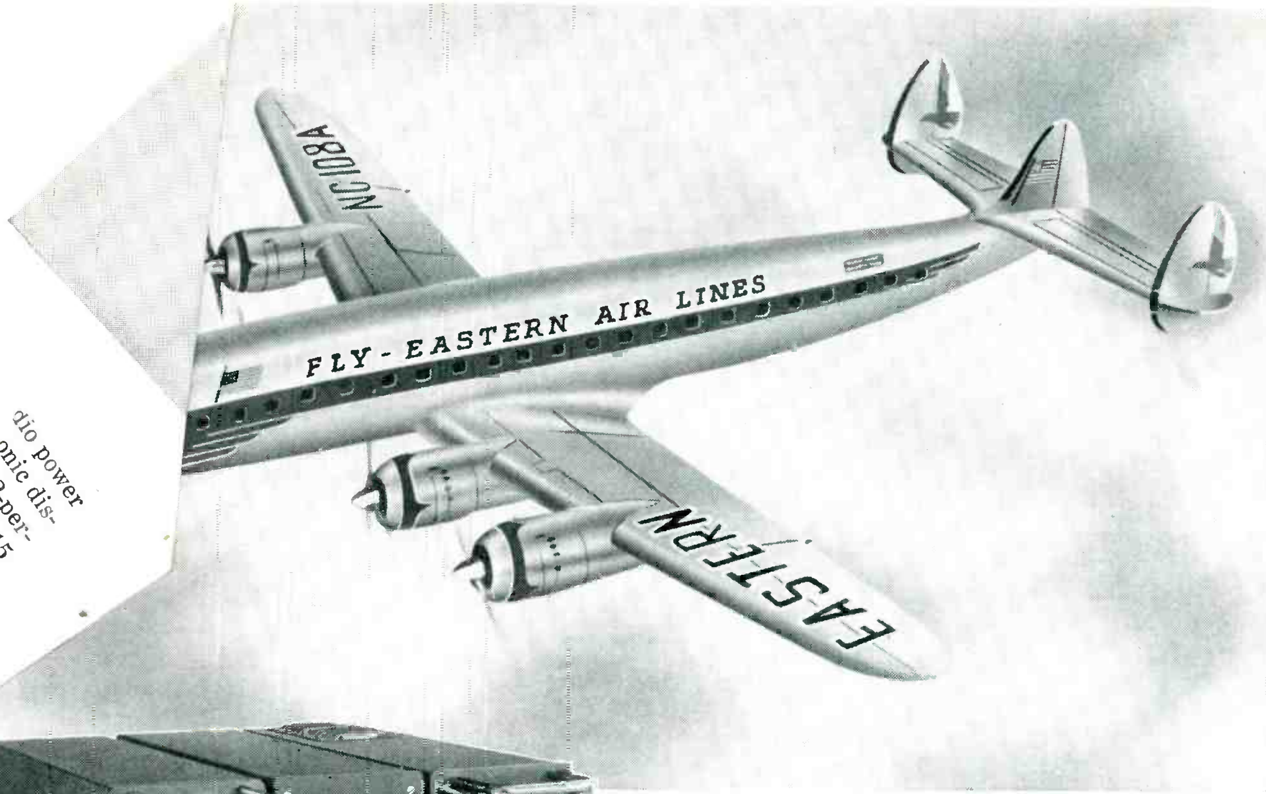
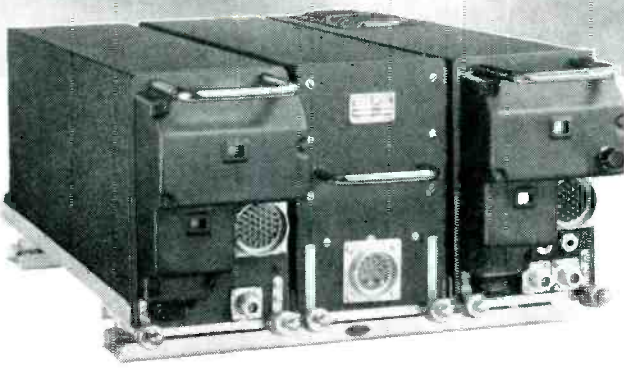
C. G. S. LABORATORIES, INC., 391 Ludlow St., Stamford, Conn. The Increductor is a new type of electrically controlled variable inductor with no moving parts. It is variable over a useful inductive range of 100 to 1, 200 to 1, or even more in some applications. It is low in loss, maintains high Q even at megacycles, is controlled with minimal power, and is compact and light in weight. These characteristics are attained by the use of separate control and signal windings, specially arranged on a ceramic core having unusual magnetic properties.



Amplifier System

ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif., announces a new amplifier system





WILCOX ...*Choice of*

EASTERN Air Lines

180 Channel WILCOX Communications System Chosen for Eastern's Entire Fleet of SUPER CONSTELLATIONS and MARTIN 4-0-4's

Eastern Air Lines demanded the finest communications equipment available to match the advanced, efficient operation of their modern new fleet. No greater compliment could be paid to Wilcox radio equipment than to be selected for this challenging assignment.

The Wilcox 440A VHF Communications System covers all channels in the 118-136 Mc. band. It is light in weight, small in size, and easy to maintain.

UNIT CONSTRUCTION FOR EASY HANDLING

The 50-watt transmitter, high sensitivity receiver, and compact power supply are each contained in a separate JAN A1-D case. Any unit may be instantly removed from the common mount.

FINGER-TIP REMOTE CONTROL

All transmitter and receiver functions are available by remote control. A new channel selector system assures positive operation and minimum maintenance.

DEPENDABILITY AND EASY MAINTENANCE

Simple, conventional circuits minimize the number and types of tubes and require no special training, techniques, or test equipment.

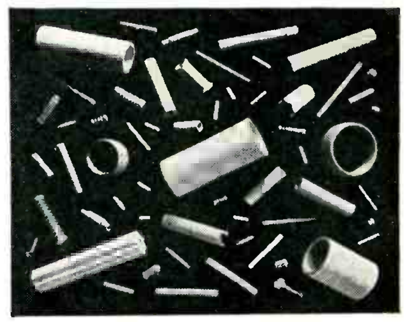
Write Today FOR COMPLETE INFORMATION ON THE WILCOX 440A 180 CHANNEL VHF COMMUNICATIONS SYSTEM

WILCOX ELECTRIC COMPANY

FOURTEENTH AND CHESTNUT KANSAS CITY 1, MISSOURI, U.S.A.

(continued)

designed es music syste A-433A prea power amplifie trols are located which connects to home fier by 6-foot flexi quency response is minus 1 db from 20 t and is within 3 db of up to 100,000 cycles. The deliver full 27 watts of au at less than 5-percent harm tortion; 20 watts at less tha cent harmonic distortion; a watts at less than 0.5-percent monic distortion.



Precision Ceramics

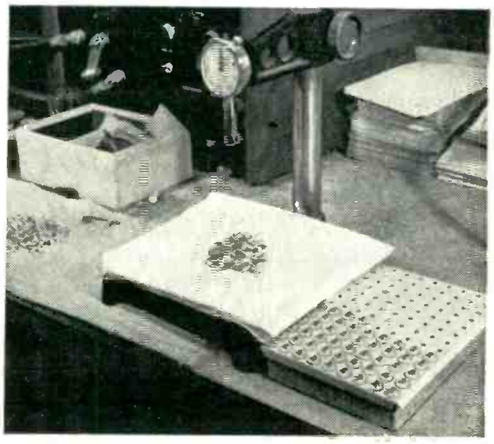
THOR CERAMICS, INC., 225 Belleville Ave., Bloomfield, N. J., has developed a new steatite insulating ceramic which can be milled, drilled, pressed, planed, lathe-turned, ground or worked by any other process applicable to metals. The new ceramics combine the advantages of close-tolerance production with ideal electrical characteristics. Their hardness—crush resistance factor of 100,000 lb psi—facilitates high-speed precision production to meet JAN specifications or manufacturers' requirements at low unit cost.

Power Amplifying Tube

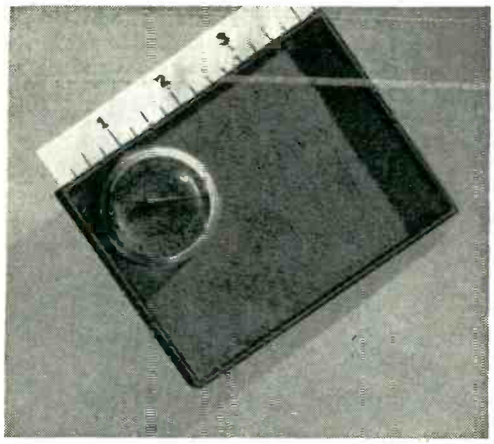
BRITISH INDUSTRIES CORP., 164 Duane St., New York 13, N. Y. The KT66 tetrode was designed especially for use in the output stage of quality audio amplifiers. It is also used as an oscillator or r-f power amplifier for frequencies up to 30 mc. The tube is a high-slope indirectly heated beam

Disc Cathode Speeds Assembly-Improves Performance

Expanded Facilities . . . more space, equipment and trained co-workers help to meet growing demand.



Inspection and Gaging . . . equipment for checking "E" dimensions of Disc Cathodes.



52,600 Seamless Nickel Cathodes, compared under a lens with an ordinary pin.

● Electronics manufacturers find it pays to be a customer of Superior. They receive good service, quality products and the benefits of Superior's methods and metals research that constantly improves upon already good products.

An example is the new, improved Disc Cathode. Investigation proved that a slight flaring of the open end minimized the danger of heater cathode "shorts" caused by scraping of the heater wire coating during insertion, while speeding the operation.

This feature added to an already excellent cathode, resulted in a part that does a better job at a lower cost.

The Disc Cathode is only one of the hundreds of products which Superior supplies . . . but the same program of product improvement is applied to all of them. That's why most manufacturers in the electronics field are already friends and customers. If you are one of the exceptions, it will pay you to find out more about Superior and Superior products. For information, consultation about production problems, design help or research assistance, write today to Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.

Which Is The Better For Your Application . . .

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

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

Superior
THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.
Certain analyses (.035″ max. wall) Up to [illegible]″ O.D.

**Mfd. under U.S. Pats.—Superior Tube Company • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800* tetrode suitable for either single or push-pull audio operation and may be employed as a triode with screen connected through a 100-ohm resistance to the anode. It can work interchangeably with the American-type 6L6 tube in any circuit.

Five-Inch Scope

GENERAL ELECTRIC Co., Syracuse, N. Y., has announced the type ST-2C five-inch oscilloscope designed especially for use in microwave installations. The vertical sensitivity a-c input is 0.075 volt rms per inch; the vertical amplifier frequency response is 20 cycles to about 3 mc. The entire vertical amplifier, sweep and low-level horizontal stages are supplied with d-c operating potentials from an electronically-regulated power supply which allows the oscilloscope to be used under unusually severe power-line fluctuations. To aid in amplitude measurements of voltages under test, a voltage calibrator is included which may be varied in seven steps, from 0.3 volt to 300 peak-to-peak volts.

Galvanometer Shunt

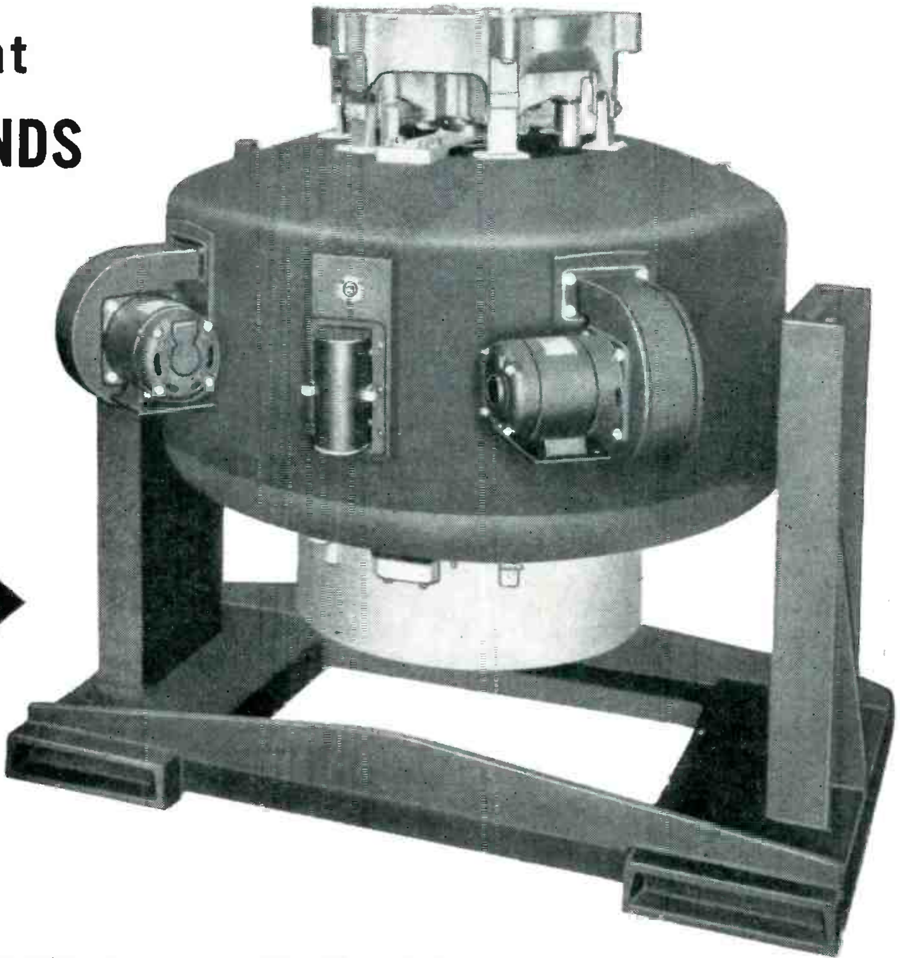
AUDIO INSTRUMENT Co., 133 W. 14th St., New York 11, N. Y. Model 170 galvanometer protector increases the speed and convenience of use of a Wheatstone bridge by adjusting itself automatically and continuously during bridge balancing operation. The galvanometer retains enough sensitivity to indicate balancing effect at all settings, yet is completely protected against

Big New MB Shaker!

...rated at

2500 POUNDS

force



20-inch shake table!

15g at 100 lb table load!

Electrically interlocked control!

No foundation needed!

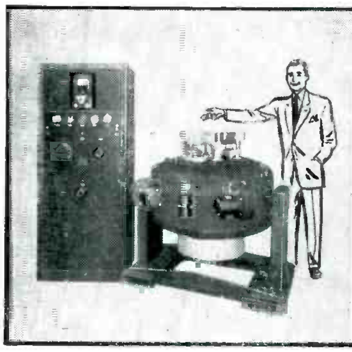
Here's heavy duty capacity for your vibration testing to military specification MIL-E-5272 and 41065-B

Vibration testing reveals *in advance* how your products will behave in service. It's a "must" for military equipment. This new MB model C-25 shaker, one of the largest developed, provides large "brute force" for meeting military vibration testing specifications. Rated at 2500 pounds continuous vector force, it has capacity to produce 15g with 100 lb table load or 20g with 58 lb table load.

An electromagnetic exciter, MB model C-25 features accurate, continuous, easy control of force and frequency. Electrically interlocking controls assure proper operation.

Whether your own vibration testing requirements are of large order or small, you can get the answer to your problem at MB. Models start at 10 pounds force output. Resonant beams for special problems also available.

Make MB *your* headquarters for help and advice on vibration problems. You'll save yourself time and work. *Write for new Bulletin No. 1-VE-5 on vibration exciters.*



MB's C-25 shaker with control panel. Available with built-in meter to read directly acceleration, velocity or displacement.

THE MB MANUFACTURING COMPANY, Inc.

1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION... TO MEASURE IT... TO REPRODUCE IT

damage. The protector uses a network of nonlinear and linear resistors.

Ion Trap

THE INDIANA STEEL PRODUCTS CO., Valparaiso, Ind. The E-Zee-On ion trap possesses a uniform field pattern and can be adjusted in a matter of seconds with one hand. It is a slip-on, grip-snug beam bender made of one piece, permanently magnetized Cunife that cannot be put on backward and requires no manual clamping. Because of its uniform weight distribution it will not jar loose, slip or come out of adjustment.

Literature

Flat Ceramic Capacitors. Sprague Electric Co., North Adams, Mass. Ratings and sizes of standard Bulplate flat ceramic capacitors are shown in engineering bulletin 602. The capacitors discussed are made in six different physical sizes in single and multiple capacitance combinations with voltage ratings up to 5,000 volts.

Air-Cooled Transmitter. Allen B. DuMont Laboratories, Inc., 1000 Main Ave., Clifton, N. J., has published a 16-page bulletin on its 5-kw Oak air-cooled transmitter. Bulletin TTD-T102 contains illustrations, block and circuit diagrams, chief features and specifications of the unit.

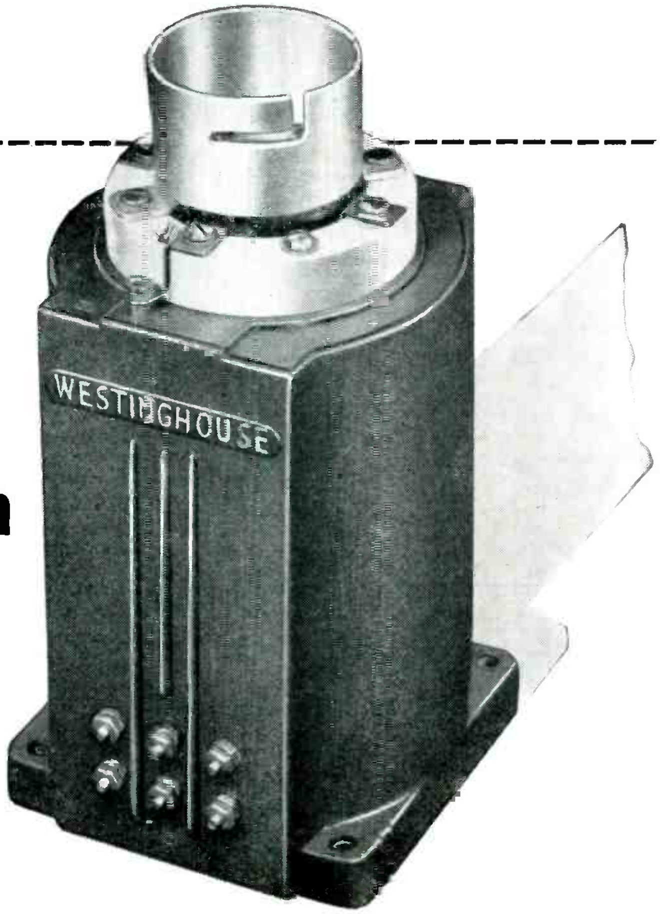
Potentiometer Controller. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Specification sheet

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

Westinghouse

Transformer Space-saving problem

SOLVED



Here's a space-saving problem . . . and another example of how Westinghouse applies engineering experience to handle all types of transformer problems.

The problem: To build a more compact filament transformer for use with Phanotron rectifier tubes.

First, the transformer case, core and coils had to be made smaller.

Second, the large standoff insulator between the transformer case and tube socket had to be eliminated. Because the previous case was metal, a large standoff insulator had been used to keep the tube socket, mounted on top of the transformer case, 11,000 volts from ground.

The Westinghouse solution: MOLDARTA and Type C HIPERSIL cores, two Westinghouse engineered products.

Westinghouse Type C HIPERSIL cores, ⅓ smaller than ordinary cores, easily fit the smaller MOLDARTA transformer case.

MOLDARTA, a low power factor, low loss material, also served as the perfect insulator. Thus the large standoff insulator was eliminated . . . the desired compactness was attained . . . and a difficult space-saving problem was solved.

If you have a tough transformer problem, take advantage of the facilities of Westinghouse for quick, practical solutions. Transformers specially designed for all types of electrical and electronic circuits, as well as a wide selection of standardized designs . . . produced in quantity . . . with quality. Call your nearby Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70569

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SPECIALTY TRANSFORMERS

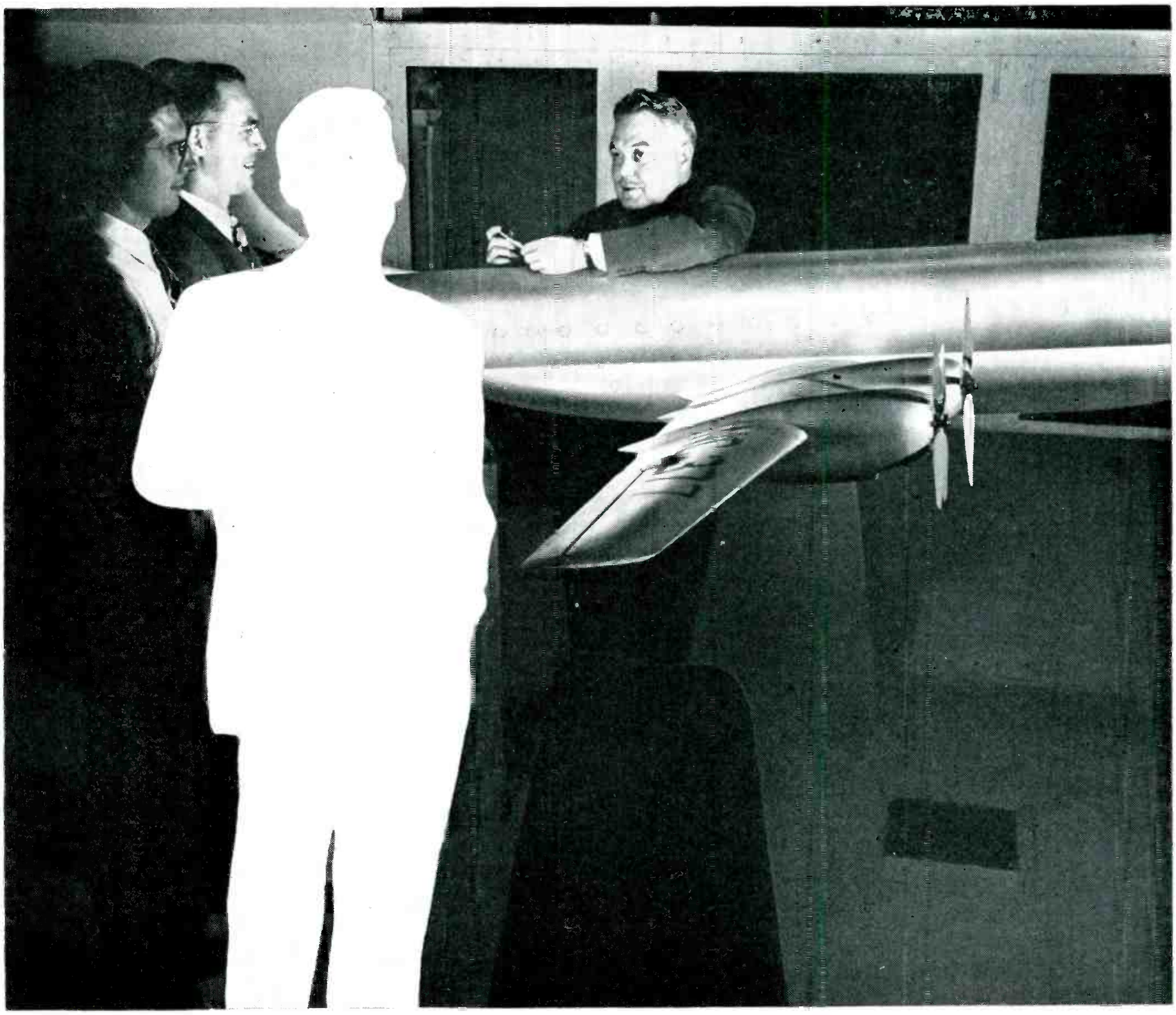
No. 175 gives engineering data on the new ElectroniK strip chart pneumatic control potentiometer. Illustration, specifications, dimensional diagrams and ordering information are included.

Engineering Bulletins. Melpar, Inc., 452 Swann Ave., Alexandria, Va., has available for the asking three engineering bulletins, the start toward monthly recordings of the company's developments. Volume I, No. 1 deals with potting resin for subminiature assemblies and subassemblies; No. 2 gives instructions for use of Melpak IV-M and Melcoat I casting resins; No. 3 describes the model MP-1539 miniature radar beacon.

Retaining Rings. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. A new series of engineering bulletins covering all types of Truarc retaining rings, grouped by specific ring function, was recently issued. All charts give complete engineering specifications including allowable thrust loads, force required to flatten bowed type rings, gap widths, rpm limits and many other helpful data.

Tapes for Television. Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn. An illustrated 8-page folder is devoted chiefly to the Scotch electrical tape No. 22, designed for tv deflection yokes because of its high dielectric strength and heat resistance with thin caliper. Description of the No. 33 tape that protects against moisture, corrosion and abrasion is also included.

Strip Chart Recorder. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 9.1-7 describes the Brown ElectroniK strip chart recorder which, when coupled with a Kelvin bridge measuring circuit, comprises a modern method of measuring rotor temperatures. Besides describing the instrument and its method of installation, it discusses the Kelvin bridge prin-



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Boeing's world-wide reputation for sound engineering achievement is founded on *men*. Boeing engineers and physicists are graduates of many universities and technical schools. They come from every state in the Union. Under inspiring leadership they have been welded into one of the most potent forces in any field of scientific advance.

If you can measure up to Boeing standards, there is an attractive future for you in this renowned group. In addition to the prestige which attaches to being a member of the Boeing engineering team, there are other definite advantages:

1 The challenge of working on such vital programs as the B-47 and B-52 jet bombers, guided missiles and other revolutionary developments.

2 Stability of career opportunity with an engineering division that is still growing steadily after 35 years.

3 The invigorating atmosphere of the Pacific Northwest—hunting, fishing, sailing, skiing, temperate climate all year around.

4 The availability of housing. Newcomers to Seattle are able to get accommodations—and that's unique in a great aircraft manufacturing center.

5 Good salaries. And they grow with you.

6 Moving and travel expense allowance.

Boeing's immediate needs call for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees.

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JOHN C. SANDERS, Staff Engineer—Personnel
DEPT. H-8
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

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BOEING

ciple and lists the required instrumentation, system benefits and other technical data.

Tube Characteristics. Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass. An 8-page booklet is filled with tabular material giving complete characteristics for a wide variety of special purpose tubes. It includes information on subminiatures, magnetrons, klystrons, rectifiers, voltage regulators, radiation counters, transmitting tubes and transistors.

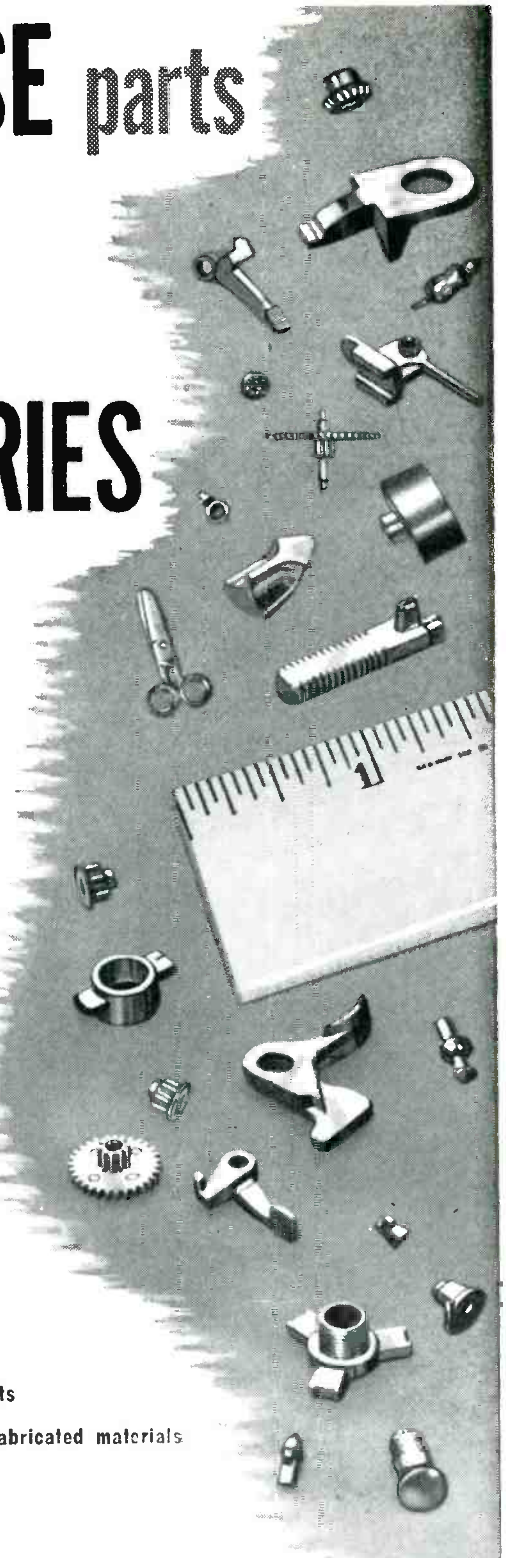
Paper Tubulars. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin NB142 gives the outstanding features, uses and dimensions of the Pup general-purpose metallized paper tubular capacitors that may be used over a temperature range from −40 to +60C without derating. The capacitors described are particularly suitable for portable equipment where space is limited.

Laboratory Instruments. Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y., has issued a 10-page catalog describing a line of laboratory instruments including its all-band spectrum analyzer, microwave signal sources, video amplifier and laboratory power supplies. Illustrations, chief features and specifications of each are given.

Civil Defense Communications. General Electrical Co., Syracuse, N. Y. A new brochure pictorially presents typical communications systems now in use which can be co-ordinated into a dependable emergency communications network in any community. The brochure also describes the company's technical advisory service for civil defense radio communications. It lists GE specialists in 22 district offices throughout the country who are available without charge to analyze existing communications systems and recommend methods of forming them into a single network to operate in any peacetime or wartime emergency.

Strain and Stress Studies. Electronic Tube Corp., 1200 E. Mer-

how to get small DEFENSE parts in a HURRY...without prefabricated metal WORRIES



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COMPARE:

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When it comes to turning out *really small* parts speedily and economically—Gries has a wealth of experience in meeting both civilian and military requirements. Gries' exclusive production facilities make simple or intricate parts in 1 automatic operation—completely trimmed, ready for use, from 100,000 pieces to many millions.

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Max. Wt. ½ oz.
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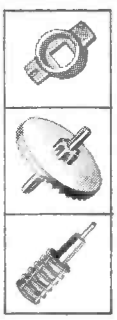
COMPARE! Parts made by old methods:

SPRING WASHER Formerly stampel; die casting permitted design improvement.

Cup Gear Originally a 3-piece assembly stamping, screw machine & wire form.

Puncturing Pin. Was aluminum screw machine part.

COMPARE! GRC Improvements:



GRIES REPRODUCER CORP. 100 Willow Ave., New York 54 • MOtt Haven 9-2476

maid Lane, Philadelphia 18, Pa., has issued a single-sheet bulletin on the H-42A Strainalyzer for dynamic strain and vibration studies from 0 to 50,000 cps. The unit described is designed especially for stress studies of rockets, jet engines, aircraft and the like, and permits simultaneous observation and recording of electronic traces of four phenomena in correct time and phase relationship. General uses, specifications and components are shown.

Temperature-Compensated Strain Gages. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. A new 2-page bulletin, No. 174, describes, shows graphic performance and gives specifications for ten new type SR-4 resistance wire strain gages. The gages covered are only slightly affected by temperature variations within certain ranges when bonded to steel or aluminum.

Picture Tubes. Zetka Television Tubes, Inc., 131-137 Getty Ave., Clifton, N. J., has announced a two-color, 12-page catalog covering thoroughly its 16, 17, 19 and 20-in. round and rectangular picture tubes. Every tube shown is detailed with descriptive copy, diagrammatic drawings and technical descriptions.

Stabilized Crystals. The James Knights Co., Sandwich, Ill. A full line of modern stabilized crystals for every electronic application is illustrated and described in catalog 51. Dimension drawings and general specifications on all the company's crystals and holder types, old replacement types as well as new, are included in the publication, the chief purpose of which is to provide busy engineers with complete data on new crystal advances.

Parts and Components. The Muter Co., 1255 South Michigan Ave., Chicago 5, Ill., has prepared a new catalog of radio, tv and electronic parts and components. The three sections already completed include: Form 100 on Ceramicaps—temperature compensating, general purpose, disc and variable

PERMANENT CAREERS

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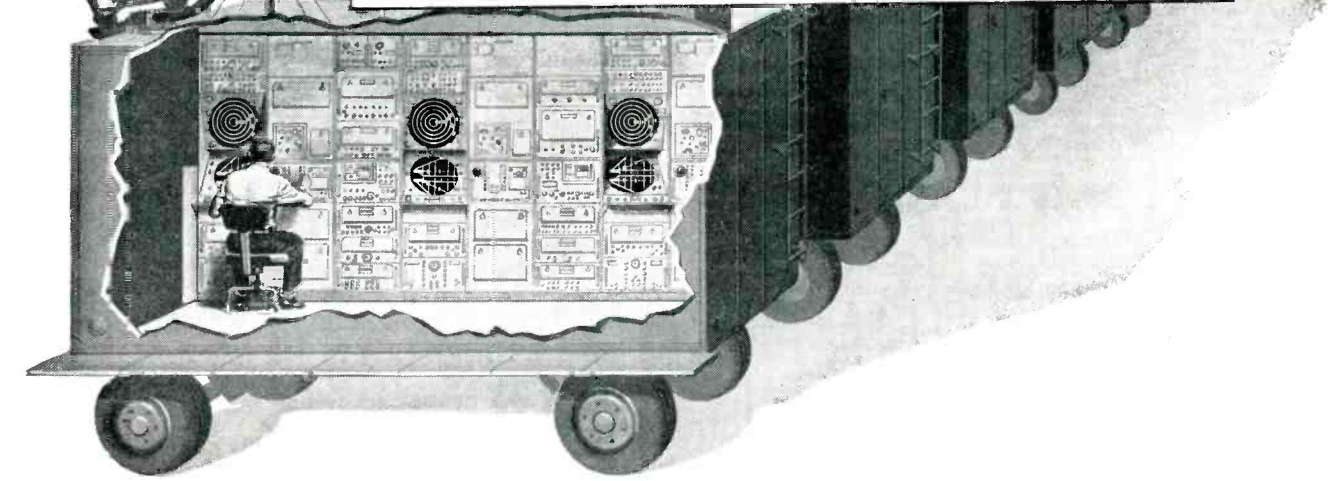
- the company that pioneered development of GCA radar equipment for the USAF, the CAA, the USN and the USMC



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- advancement in both pay and responsibility according to ability.

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General radar and computing systems
Servo mechanisms *Indicator systems*
Radar transmitter modulators and high voltage power supply systems
Wide band IF amplifiers and receivers
General pulse circuits

MICRO-WAVE ENGINEERS...Having design experience in transmission line components, micro-wave antennas and feeds.

PHYSICISTS...Having practical experience in analysis of radar and radar control systems.

DEGREE NOT ESSENTIAL but applicants should have minimum of five years' experience and familiarity with design requirements for military specifications.

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ceramic capacitors; Form 200 on resistors—wire-wound Candohms, Zipohms and sensitivity controls; and Form 300 on Spirashield—the wiring shield for critical r-f and a-f circuits. Copies of these and other sections still to be released may be had without charge by a request on a company letterhead.

Soldering Flux. Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass. A four-page bulletin deals with Solderux fluxes, a group of very effective soft-soldering agents based upon sound chemical principles not used previously in soldering practice. Complete description and a price list of the pastes, creams and liquids are included.

Crystal Probes. United Technical Laboratories, Morristown, N. J., offers a folder describing the many uses of its Klipzon high-frequency germanium crystal probes. Of special interest is the description of use as a means of one-man orientation of tv antennas for best directional characteristic. An additional folder is also available describing Klipzon self-holding test prods, Mini-Prod connectors and Mini-Prod adapters.

Components Booklet. Citation Products Co., 233 E. 146th St., New York 51, N. Y., has issued a booklet containing dimensional diagrams and technical data on a line of products including terminal lugs, terminal boards, cable assemblies, metal stampings, plastic fabrication and screw machine parts.

High-Voltage Capacitors. Sprague Electric Co., North Adams, Mass. Engineering bulletin 212B gives complete sizes and ratings for a line of Hypass three-terminal network feed-through capacitors. The capacitors described are especially suited for suppression of radio interference and harmonic generation in high-voltage circuits in transmitters and industrial electronic equipment.

Vacuum-Sealed Transformers. The Halldorson Co., 4500 Ravenswood Ave., Chicago 40, Ill. Catalog No. 18 lists a complete line of radio

and tv transformers. Many items are listed that are of interest to a wide range of industries. Among such items are isolation, stepdown, filament and voltage-regulating transformers.

Electric Control Potentiometers. Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa. Catalog 15-15 is a 36-page booklet covering ElectroniK potentiometers for both contact and proportional control. Engineering and constructional data, types of control, partial list of available ranges, application data and accessories are described.

Broadcasting Brochure. Radio Corp. of America, Camden, N. J. A new brochure provides complete description and specifications for the model BTL-1A studio-transmitter link equipment that may be used in the 890 to 911-mc band for tv aural channels, by a-m stations in the 925 to 940-mc shared service band and by f-m stations in the 940 to 952-mc band. Copies are available to broadcast station engineers requesting it on their letterhead.

Replacement Needle Chart. Electrovox Co., Inc., 60 Franklin St., East Orange, N. J., offers a colorful 11-in. × 17-in. chart showing not only all of the phonograph needles in use by leading record-player manufacturers, but cartridge makers as well. Name of maker, needle model by maker's number, illustration of actual needle, and replacement number and list price are given.

Engineering Bulletin. Schaevitz Engineering, Camden, N. J. A four-page bulletin illustrates and technically describes the company's linear and rotary variable differential transformers, linear and angular accelerometers, pressure transducers, rotary accelerators, slip rings and recorder systems.

Subminiature Capacitors. Sprague Electric Co., North Adams, Mass. Bulletin 213A shows new ways of mounting subminiature metal-en-

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STRIPPED CLEAN IN SECONDS

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IN

1. DIP WIRE in X-VAR for 3 seconds.

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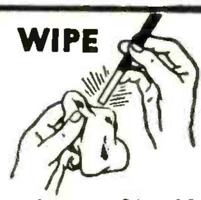

3. WIPE CLEAN. Operation completed in seconds.

X-VAR is non-corrosive, non-creeping — leaves wire ready for soldering. Now in use by leading manufacturers of electrical products. ***Write for FREE SAMPLE for testing.***

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472 Frelinghuysen Avenue, Newark 5, New Jersey

Superior's *new* TELEVISION BAR GENERATOR

THROWS AN ACTUAL BAR PATTERN ON ANY TV RECEIVER SCREEN!!

TWO SIMPLE STEPS

1. Connect Bar Generator to Antenna Post of Any TV Receiver.
2. Plug Line Cord into A.C. Outlet and Throw Switch.

RESULTS — A stable never-shifting vertical or horizontal pattern projected on the screen of the TV receiver under test.

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- Flight Test Instrumentation

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Box No. K-4, 12214 S. Lakewood Blvd.
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cased paper capacitors as well as a complete line of subminiature 125-deg C capacitors. The latter type described may be had in voltage ratings from 100 to 1,000 volts d-c in both inserted tab and extended foil constructions. The bulletin giving complete details is available upon letterhead request.

Products Catalog. The Astatic Corp., Conneaut, Ohio. Catalog No. 51 covers all the company's products manufactured for civilian markets. Printed in three colors, it includes illustrations of all items, as well as full descriptive and performance data on all models of tv and f-m boosters, microphones and stands, phonograph pickups and cartridges, needles, recording heads and related equipment. The index is cross-referenced.

Analog Computers. Geo. A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass., has published a catalog and manual on a line of high-speed all-electronic analog computers for research and design. Included are illustrated descriptions of a wide variety of components, a table of operators and responses and a selected bibliography.

Selenium Rectifiers. Sarkes Tarzian Inc., Bloomington, Ind., recently issued a 64-page handbook on Centre-Kooled selenium rectifiers for radio, tv and electronic applications. Included are circuits, characteristics curves, illustrations, application notes and stack connection information. Price is 25 cents.

Logarithmic Amplifier System. Kalbfell Laboratories, Inc., 1076 Morena Boulevard, San Diego 10, Calif. A recent mailing piece shows how a line of plug-in amplifiers connected together can constitute a convenient system having good sensitivity, high input impedance and low output impedance for driving a rectifier type meter. Units described are the model 104A preamplifier, model 105A Logaten driver amplifier and model 106A detector amplifier. A price list is included.

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SERVOTHERM PRODUCTS

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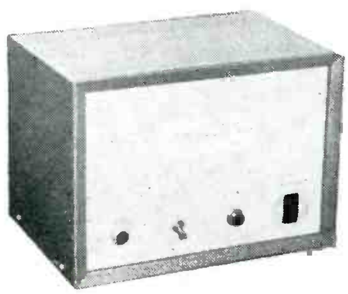

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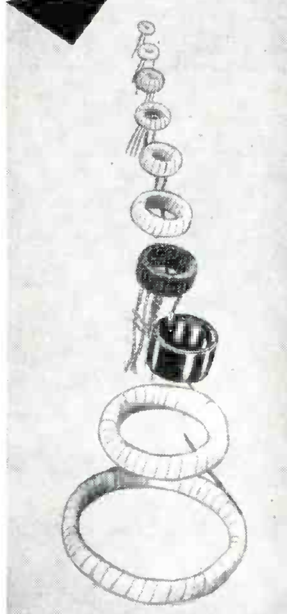

Where a circuit calls for an efficient coil of a high Q factor—when space and weight are limited, specify *DX TOROIDS*.

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DX TOROIDS have a wide application in a number of electronic equipments—particularly airborne radar and miniature assemblies. Toroidal "off-center" and focus coils; band pass, high and low pass filters; inter-stage and output transformers improve performance with substantial savings in space.

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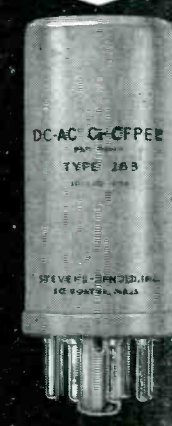
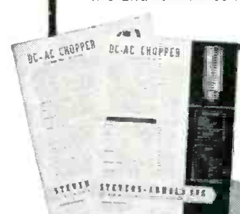


These Choppers convert low level DC into pulsating DC or AC so that servo-mechanism error voltages and the output of thermocouples and strain gauges, may be amplified by means of an AC rather than a DC amplifier.

They are hermetically sealed, precision vibrators having special features which contribute to long life and low noise level.



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NEWS OF THE INDUSTRY

(continued from page 148)

new color television system (see p 90), has reorganized and established nine new panels. Chairman W. R. G. Baker also announced the appointment of Elmer Engstrom, vice-president in charge of research at RCA Laboratories, as vice-chairman of the NTSC. Other vice-chairmen are Donald G. Fink of ELECTRONICS and David B. Smith of Philco Corp.

The nine new panels, their chairmen and vice-chairmen are as follows:

Subjective Aspects of Color—A. N. Goldsmith of New York, chairman; D. E. Hyndman of Eastman Kodak Co., vice-chairman.

Color System Analysis—D. G. Fink of ELECTRONICS, chairman; A. G. Jensen of Bell Laboratories, vice-chairman.

Color Video Standards—A. V. Loughren of Hazeltine Electronics Corp., chairman; W. T. Wintringham of Bell Laboratories, vice-chairman.

Color Synchronizing Standards—D. E. Harnett of General Electric Co., chairman; M. R. Briggs of Westinghouse Electric Corp., vice-chairman.

Compatibility—D. E. Noble of Motorola Inc., chairman; R. DeCola of Admiral Corp., vice-chairman.

Field Testing—T. T. Goldsmith of Du Mont Laboratories Inc., chairman; G. E. Gustafson of Zenith Radio Corp., vice-chairman.

Network—F. Marx of American Broadcasting Co., chairman; R. E. Shelby of National Broadcasting Co., vice-chairman.

Coordination—D. B. Smith of Philco Corp., chairman; I. J. Kaar of General Electric Co., vice-chairman.

Definitions—R. M. Bowie of Sylvania Electric Products Inc., chairman; M. W. Baldwin, Jr. of Bell Laboratories, Inc., vice-chairman.

The entire NTSC is composed of twenty organizations. These units with their representatives and alternates (in parentheses) are as follows:

Admiral Corp.—R. DeCola (Joe Marty, Jr.); Bendix Radio Div.—A. C. Omberg (John Miller); Color Television, Inc.—Samuel Smith (A. S. Matthews); Crosley Division

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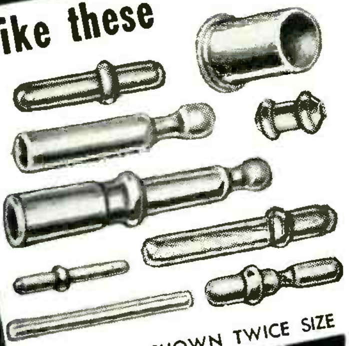

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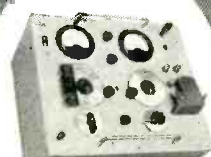

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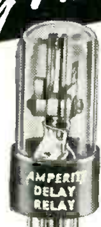

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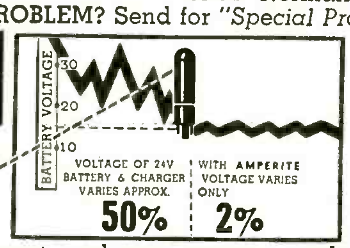

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AVCO Mfg. Corp.—L. M. Clement (P. F. G. Holst); Allen B. Du Mont Lab., Inc.—Allen B. Du Mont (T. T. Goldsmith); ELECTRONICS—D. G. Fink (G. R. Towne); Federal Telecommunications Laboratories, Inc.—Emile Labin (N. H. Young); General Electric Co.—I. J. Kaar (J. E. Keister); Alfred N. Goldsmith—A. N. Goldsmith (D. E. Hyndman); The Hallicrafters Co.—H. J. Adler (L. R. Mead); Hazeltine Electronics Corp.—A. V. Loughren (K. McIlwain); Hogan Laboratories, Inc.—J. V. L. Hogan (F. A. Hester); Motorola, Inc.—D. Noble (E. B. Passow); National Association of Broadcasters—E. K. Jett (Neal McNaughton); Philco Corp.—D. B. Smith (F. J. Bingley); RCA Laboratories—E. Engstrom (G. L. Beers); Sylvania Electric Products Inc.—R. M. Bowie (B. F. Tyson); Tele-Tone Radio Corp.—M. L. Levy (R. S. Mautner); Westinghouse Electric Corp.—M. R. Briggs (R. Harmon); Zenith Radio Corp.—G. E. Gustafson (J. E. Brown).

New Anti-Cancer Weapon Planned

THE powerful, supervoltage rays of radioactive cobalt will soon be studied as a new aid to cancer sufferers. A special apparatus for administering the rare isotope will be delivered to the Oak Ridge Institute of Nuclear Studies and M. D. Anderson Hospital by General Electric X-Ray Corporation of Milwaukee within the next several months.

Located in Oak Ridge, Tenn., adjacent to the Atomic Energy Commission plant, the Institute (O.R.I.N.S) will cooperate with the M. D. Anderson Hospital of Houston, Tex., affiliated with the University of Texas, in extensive tests on radioactive cobalt and its effects on cancers.

The radiation emitted by cobalt 60, as it is known, is equivalent to the x-rays produced by high-voltage tubes operating at about 1,200,000 electron volts. Four cobalt wafers, each less than one inch square and less than an eighth of an inch thick, are being irradiated in the Chalk River, Canada, atomic

energy reactor, for use in the new unit. The cost of an equivalent amount of radium ($26,000,000) would be several thousand times greater.

While radioactive cobalt has been tested before on cancer, this has been chiefly in the form of local therapy, usually requiring surgical planting in the tissues, whereas the new apparatus will make it possible to direct the rays at sizeable areas from a distance and to reach deep or otherwise inaccessible cancers.

Manipulating the isotope and adapting it to easy application has posed major problems for GE design engineers. They have now developed a housing and an electrical-mechanical system that makes it possible for doctors and their aides to give treatments by remote control, to limit the radiation to the patient under treatment, and to return the isotope to a safe position automatically in case of power failure.

The cobalt will be encased in a housing made of a special tungsten alloy known as Hevimet, which is considerably more dense and therefore less transparent to radiation than lead. The operator, located in an adjoining room, will be protected by thick concrete walls, but will be able to see the patient through a window consisting of 15 inches of x-ray protective material.

Radio-cobalt takes 5.3 years to lose half of its effectiveness—the rate at which it is said to decay thus making it well adapted to continued use for cancer therapy without frequent correction of calculations by the physicist or radiologist.

The Oak Ridge Institute of Nuclear Studies is a nonprofit educational corporation comprised of 26 southern universities, organized to make AEC facilities available to universities for research and graduate work.

Engineering Positions Available

CIVIL service examinations have been announced for filling electronic engineering positions at the Naval Air Development Center, Johnsville, Pa. The salaries range from $4,600 to $7,400 a year.

To qualify, applicants must have completed appropriate undergraduate college study and, in addition, must have had graduate study or professional experience, or both, in one of the following fields: sonar, radar, radio, control, radiation and engineering evaluation.

Further information and application forms may be obtained from most first- or second-class post offices, from civil service regional offices, or from the U. S. Civil Service Commission, Washington 25, D.C. Applications will be accepted until further notice by the Recorder of the Board of Examiners, Naval Air Development Center, Johnsville, Pa.

Broadcast Bureau Appointments

THE Federal Communications Commission has announced the following appointments in its new Broadcast Bureau, which is headed by Curtis B. Plummer:

Joseph M. Kittner, chief of the Aural Facilities Division; Cyril M. Braum, chief of the Television Facilities Division; Dwight D. Doty, chief of the Renewal and Transfer Division; Frederick W. Ford, chief of the Hearing Division; and Paul Dobin, chief of the Rules and Standards Division.

BUSINESS NEWS

THE INDUSTRIAL CONTROL CO. has moved its facilities from Long Island City to a new location on Straight Path and Arlington Ave., Wyandanch, L. I., N. Y.

CAM-STAT INC., manufacturer of regulators, thermostats and other precision equipment, has moved to new and larger quarters at 11833 West Olympic Boulevard, Los Angeles 54, Calif.

AIR ASSOCIATES, INC. has expanded facilities by leasing additional plant capacity at Orange, N. J., for the manufacture of electronic equipment. The new plant provides 65,000 sq ft of floor area which raises the corporation's total factory area,

including the Teterboro plant, to more than 185,000 sq ft.

THE WILCOX-GAY CORP., Charlotte, Michigan, has leased an 85,000-sq ft plant in Burbank, Calif., for the manufacture of tv, radio and recording products.

MELPAR, INC., Alexandria, Va., has opened a branch plant at 10 Potter St., Cambridge, Mass., to be devoted primarily to applied research and advanced development work on electronic equipment for the armed forces.

COLUMBIA BROADCASTING SYSTEM inaugurated its commercial color television service with a special program over CBS-TV stations in New York, Boston, Philadelphia, Baltimore and Washington, D. C., on June 25, 1951. Approximately 20 hours of color tv weekly was expected to be scheduled by fall.

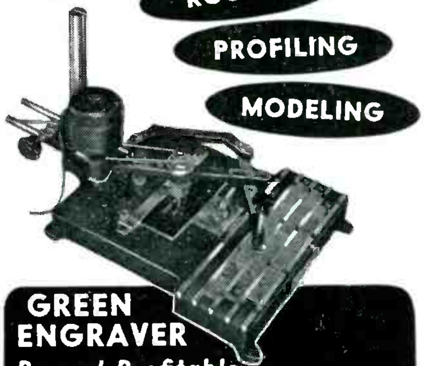
Newest model CBS color tv camera weighs only 29 pounds, against the 100 pounds of a standard black-and-white camera. It is less than ½ cu ft as contrasted with the 3 cu ft of the black-and-white camera

PERSONNEL

LOUIS T. RADER, formerly division engineer of General Electric's Manual and Accessory Control Engineering Division, has been appointed assistant manager of engineering of the company's Control Divisions at Schenectady, N. Y.

HARVEY J. FINISON has been promoted from assistant chairman of

ENGRAVING
ROUTING
PROFILING
MODELING



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electrical engineering research to chairman of the electrical engineering department at Armour Research Foundation of Illinois Institute of Technology.

HARRY F. OLSON, director of the Acoustical Research Laboratory of RCA Laboratories, Princeton, N. J., has been elected president of the Acoustical Society of America for the year 1952.

LUTHER W. HILL, on leave of absence from the post of president of the Carolina Telephone and Telegraph Co., has been named director of the Communications Equipment Division, National Production Authority, U. S. Department of Commerce.

E. C. QUACKENBUSH, previously associated with manufacturers of connectors and wiring devices, has joined Cannon Electric Co. to head the engineering department of its newly created Eastern Division in East Haven, Conn.

JOHN T. HOLLERAN, with General Electric Co. since 1923, has been appointed manager of the Fort Edward and Hudson Falls operations of the company's Transformer and Allied Product Divisions at Fort Edward, N. Y.

JAMES W. MCRAE, formerly director of transmission development, has been promoted to vice-president in charge of the systems development organization at Bell Telephone Laboratories, New York, N. Y.

J. W. McRae

A. K. Wright

ALFRED K. WRIGHT has been promoted from chief radio engineer to vice-president and director of engineering at Tung-Sol Lamp Works, Inc., Newark, N. J.

NEW BOOKS

(Continued from page 150)

cascaded filters, and the last on pulse response of transmission lines.

The material is covered very well for an introductory text on pulse techniques. For engineers who have not had a background in transient analysis and are now encountering pulse equipment in the field the book should prove very useful. For the younger men who have had network and transient analysis in school, the first half of the book should prove to be an interesting brief review.

Chapters 6 to 9 are a little too brief for a complete study of the field but they do give a comprehensive survey of pulse applications. The book should prove very valuable to application engineers who need an introduction to practical pulse techniques.—NATHAN MARCHAND, *Marchand Electronic Laboratories, Greenwich, Conn.*

Electronic Fundamentals and Applications

BY JOHN D. RYDER. *Prentice-Hall, Inc., New York,* 1950, 806 *pages,* $9.00.

THIS BOOK, written by the head of the electrical engineering department at the University of Illinois, is a welcome addition to the Prentice-Hall Electrical Engineering Series edited by W. L. Everitt. The book is intended for instruction of senior and graduate students in engineering and physics who intend to make professional use of electronic techniques. Great care has been used in the choice of symbols; bold-face letters are used meticulously throughout the book to indicate phasors (vectors, having direction and magnitude), but the treatment is not unnecessarily mathematical. Simple differential equations and complex algebra suffice. A good variety of problems of moderate difficulty are appended to each chapter. Numerical answers are not given, and few problem solutions are worked out in detail in the text proper. These omissions detract from the value of the book to the student who must study by himself.

The book follows a three-part

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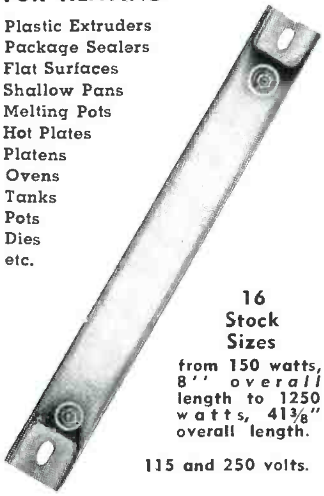

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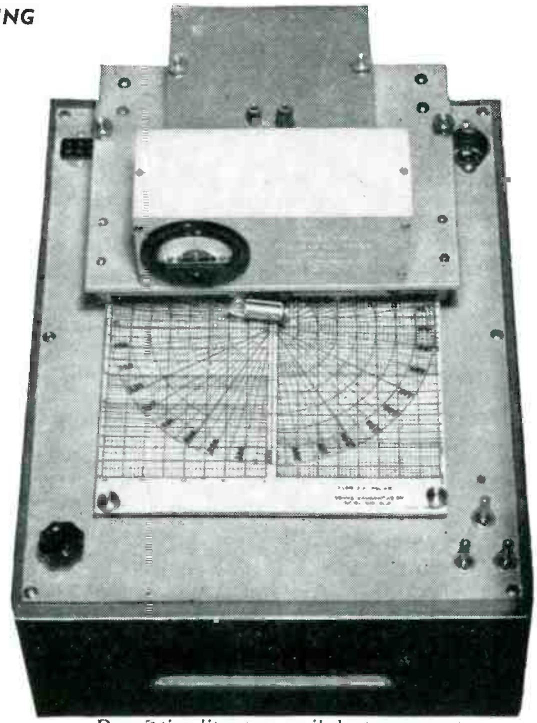

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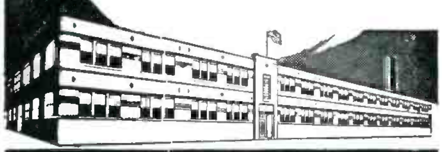

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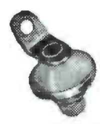

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plan: physical electronics, characteristics of electron tubes, and electronic circuits. In the first category are six chapters on fundamental particles, electron ballistics, cathode rays, emission, space charge and gaseous conduction. Electron tubes are described in chapters on diodes, triodes, multielement tubes, gas diodes and control tubes, and photoelectric tubes. Circuits are described in chapters on small-signal amplification, large-signal audio and radio-frequency amplifiers, oscillators, modulators, demodulators, wave-shaping circuits and gas-tube circuits. The final chapter is an up-to-date summary of solid-state electronics.

The treatment of small-signal and large-signal amplification is comprehensive and particularly well-written. Recent developments are included; the phasitron f-m modulator is briefly described, as is stagger tuning of wideband amplifiers. Throughout the book, tables of performance and figures-of-merit are given, referring to particular tube types and circuit arrangements. There are a few deviations from accepted terminology; for example, "photoemissive cell" is used for phototube. But these are few, and detract little from the general excellence of the book. It should prove a most helpful addition to the growing list of standard texts on electronic techniques.—D.G.F.

Theory and Application of Industrial Electronics

BY JOHN M. CAGE. *McGraw-Hill Book Co., New York*, 1951, 290 *pages*, $4.75.

THE AUTHOR states in his preface that this book is written primarily for college graduate and undergraduate courses in industrial electronics. Since the book comprehensively and broadly covers the subject without being superficial, it will also be interesting to others wishing to gain a general knowledge of the subject.

Although little not previously published material is presented, this is the first book of its kind which has offered an integrated treatment of electronic circuits and devices

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A general discussion of rectifiers and thyratron circuitry includes useful generic curves relating output current in terms of load circuit parameters.

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A discussion of induction and dielectric heating offers a satisfactory introduction to these subjects.

The description of industrial vacuum tube amplifiers is particularly good and may be useful as a reference in many industrial circuit designs. The chapters on electronic measurements and on oscillators and pulse techniques are also excellent and comprehensive.

The book is amply supplied with practical applications, and yet includes substantial basic theory and mathematical background.

Adequate references are included in the bibliography of each chapter so that more complete study may be made of any phase of the subjects covered if desired. Also included are problems which combine an exercise in theory and simpler practical application for use of the student.—JAMES H. BURNETT, *Electrons, Inc., Newark, N. J.*

Electromagnetic Problems of Microwave Theory

BY H. MOTZ. *A Methuen monograph, John Wiley & Sons, Inc., New York,* 1951, 182 *pages*, $2.00.

THIS MONOGRAPH deals with the determination of electromagnetic fields that exist in such microwave components as klystrons, magnetrons and waveguides. This book should be particularly valuable to physicists and engineers doing advanced research and development work on these components. It may not be too useful to the practical

microwave equipment and system engineer.

The subject material of this book, electromagnetic fields in components, concerns probably the most difficult and complex phase of microwaves. It would be impossible to fully cover all fields in all possible component configurations. However, the aim of the book is to illustrate methods of analysis by thoroughly worked-out examples. This is done quite well, and in the process a number of very useful general relationships are developed. In particular, solutions of some of the more complex mathematical equations are given, in some cases with a graphical presentation, which could not readily be found in the literature. This material is of necessity highly mathematical, and the reader should have a thorough knowledge of electromagnetic wave theory, advanced calculus and differential equations to fully absorb it.

The first chapter in the text provides an excellent review of the theory of the basic components used in microwaves, namely velocity-modulated tubes (klystrons), travelling-wave tubes, resonators, cavity magnetrons, crystal and bolometer detectors, transmission lines and measuring equipment (wavemeters and standing wave lines).

In chapter II the basic theory of velocity modulation is covered, with a detailed analysis of electron flow in space (within the klystron) and absorption of energy by a single finite gap (small signals). In chapter II, this basic theory is expanded to include klystron operation using a double-gap system.

Chapter IV deals with the fields in cavity magnetrons, with particular emphasis on mode selection in these magnetrons. Chapter V deals with the basic Maxwell equations as they are applied to waveguides. Chapter VI provides some useful methods of solving the field equations in waveguides containing slotted gap elements. These methods are then used to analyze fields in resonators and corrugated waveguides.

Chapter V and VI continue the analysis of fields in waveguides, covering the effect of coupling ele-

ments (or antennas) and discontinuities. This text contains a large number of references, so that the reader can readily study any particular subject in greater detail by going back to the source material.
—JOSEPH RACKER, *New York, N. Y.*

Quartz Vibrators

BY P. VIGOUREUX AND C. F. BOOTH. *His Majesty's Stationery Office, London, England,* 1950, 371 *pages,* $6.75.

THE PIEZOELECTRIC effect was known for approximately 40 years before the crystal unit became a useful item. It then remained a product of craftsmanship with limited use until about 1938, when demands for large quantities for the Services developed considerable activity in this field. As a result, the past few years have seen rapid advancements in the science of piezoelectricity and its applications. With respect to quartz, emphasis has been given to a study of the modes of motion in plates, evaluation of the elastic and piezoelectric constants, standardization, higher precision, the growing of synthetic quartz, the study of aging, and efforts to render manufacturing techniques well-definable processes. Widespread efforts on all of these phases have created a keen interest and the desire for dissemination of views. Consequently, a book on quartz vibrators by men with as wide a background and experience as the authors should be well received at this time.

Vigoureux's previous book was one of the earliest in this field and was used as a guide and reference in this country in the early stages of crystal unit development. Most of the material in the earlier book has been included but has been almost completely rewritten. Particularly, the notation has been modified to be more in accordance with general usage.

Mr. Booth's experience in the radio laboratories of the General Post Office and his past contact with the quartz processing industry of the United Kingdom has given him a broad experience in the manufacture and application of crystal units. He has also been ac-

tive in the exchange of knowledge with this and other countries.

The principle purpose of this book is contained in the authors' statement, as follows: "It is hoped that the reader interested in the subject will gain a usable knowledge both of the theoretical aspects of piezoelectricity and of its practical applications in the production of crystal units, commencing with raw crystal and finishing with the performance of the equipment in which they function as component elements."

As the title implies, the material is limited solely to quartz. In this respect the book does not cover the field of piezoelectricity or crystallography. However, the treatment of quartz is fairly complete with respect to crystal structure, piezoelectric effects and the electrical, mechanical and optical properties. X-ray effects and the effect of heat on physical properties are comprehensively covered. In the chapter on Piezoelectrical Phenomena in Quartz, a comparison is made between the elastic constants and moduli as given by three well-known exponents, Messrs. Cady, Mason and Voigt. An appendix covers the theoretical treatment of the natural frequency and coupling factor as determined by computing the stored energy. A full chapter is devoted to the theory of the quartz resonator as analyzed by use of the circle diagram, which has proved to be a very useful and convenient method.

While the theoretical aspects of quartz crystals are covered sufficiently to give the reader a well-rounded insight, by far the major contents cover their production and application. The treatment of production begins with the occurrence and examination of quartz crystals and covers in detail all processes, including the testing of the completed unit. Some consideration is given to the design of a production plant. This section is greatly enhanced by the generous use of good photographs. The reader is warned by the authors that not all manufacturers use the same processing methods, but the ones shown have been used in mass production and are therefore considered reliable.

The various applications covered

include ultrasonics, frequency control of radio transmitters, crystal filters, frequency standards and miscellaneous uses such as pressure gages and accelerometers. The description of the Post Office frequency standard, its relation with the Royal Observatory and its comparison with frequency standards of other countries should find wide general interest.

The aging phenomena of quartz elements is given a separate chapter and temperature control of crystal units is generously treated.

This book is as up-to-date and complete as can perhaps be expected in view of the rapid current progress in this field. It most certainly meets the authors' intent in every respect, and an extensive bibliography makes it a convenient reference on the subject.—I. E. FAIR, *Bell Telephone Laboratories, Murray Hill, N. J.*

THUMBNAIL REVIEWS

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, 1950, Vol. VI. National Electronics Conference, Inc., 852 E. 83rd St., Chicago 19, Ill., 564 pages, $5.00. Official record of the 1950 Conference held in Chicago, containing all of the papers, or digests thereof, that were presented. Volumes 2, 3, 4 and 5 are also available at $5.00 each.

ELEMENT VIII-SHIP RADAR TECHNIQUES (Supplement to RADIO OPERATOR'S LICENSE Q&A MANUAL—2nd Edition). By Milton Kaufman. John F. Rider Publisher, Inc., New York, 1951, 32 pages, $0.78. Answers to 69 FCC Study Guide questions suggested as preparation for radiotelegraph operators desiring to qualify by examination for ship radar endorsement to their present licenses.

RAPID TV TROUBLE SHOOTING METHOD. H. G. Gisin, author and publisher, 200 Clinton St., Brooklyn 2, N. Y., 1951, 23 pages, $1.00. Step-by-step classification of symptoms, causes and checks to be made for isolating trouble rapidly in television receivers.

TELEVISION ANTENNAS. Donald A. Nelson. Howard W. Sams & Co., Indianapolis, 1951, Second Edition, 223 pages, $2.00. Expanded and revised to cover recent antenna developments and to place emphasis on the choice of the best and most economical type of antenna installation for a given location. Includes chapter on suppression of interference, avoiding or minimizing ghosts, and solving other common antenna installation problems.

FUNDAMENTALS OF ELECTRICAL ENGINEERING. Fred H. Pumphrey, Univ. of Florida. Prentice-Hall, Inc., New York, 1951, 668 pages. $7.65. For first-year electrical engineering students specializing in some field other than electronics. Of the 28 chapters, 8 deal with electronic topics: Electron Tubes; Rectifiers; Amplifiers and Oscillators; Electron Tubes as Switches; Electronic Instruments; Other Types of Electron Tubes; Heating, Welding and Electrochemical Processes; Electrical Communication.

BIBLIOGRAPHY ON INDUSTRIAL RADIOLOGY, 1948-50. By H. R. Isenburger. St. John X-Ray Laboratory, Califon, N. J., $2.00.

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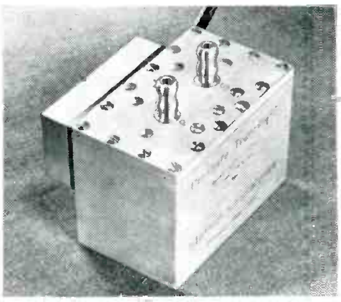

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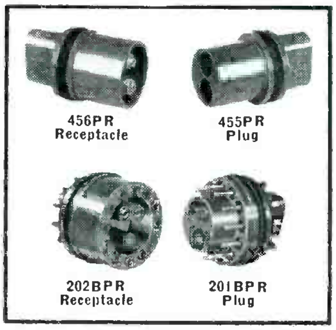

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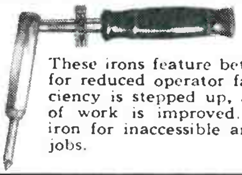

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BACKTALK

(continued from page 152)

maximum efficiency can be achieved.

The field engineer assigned to such a program will find himself confronted with many problems which are nontechnical, and which will arise generally from the relationship of the engineer with the people with whom he works. Roughly, the relationships may be divided into three classes:

(1) Relationship with military
(2) Relationship with co-workers
(3) Relationship with employer

Relationship With Military

In dealing with officers of the military, problems not normally encountered in civilian practice may arise. Because of the complexity of military organizations, armies generally operate with firmly fixed lines of organization known as "chains of command." Fields of responsibility are assigned to each person within the military structure. The engineer will be assigned a field of responsibility within the military organization. Usually, an officer will be designated whose responsibility will include the activities of the engineer. The military field engineer may find that the officer directly in charge of coordinating his activities has a technical background and will understand the complexities of field problems. In other cases, the coordinating officer will be purely an administrator. In this event, the field engineer is faced with the necessity of presenting problems in a clear-cut, nontechnical method so that they will be fully understood.

Often, more than one officer will be concerned with the activities of a field engineer. For this and other reasons, clear, concise reports should be rendered as frequently as conditions warrant, as new field problems arise, or as existing problems are solved. Copies of these reports (consistent with security regulations) will serve as a valuable aid to the employer of the engineer in providing an insight into the problems existing at the field level.

Relationship With Coworkers

In some cases, the personnel with whom the field engineer works will

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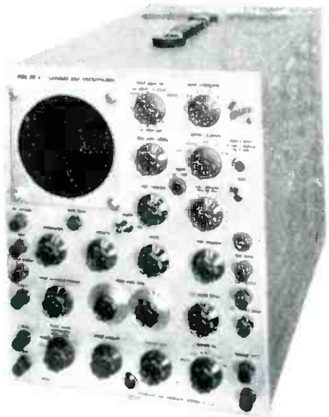

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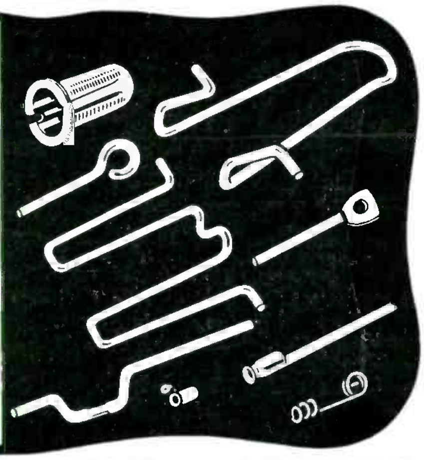

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be American military people. In other locations it may be foreign personnel with whom the field engineer will have everyday contact.

In either event, there will exist a certain unfamiliarity which must be bridged before the engineer is "accepted." The field engineer is a guest of the military unit or the foreign country in which he is working. It is easy to gain entree if the ordinary rules of conduct for a guest are followed.

There are several taboos. The guest who criticizes the method by which his host prepares food is no more welcome than the field engineer who makes unfavorable comparisons between the methods used by the personnel with whom he works, and the method he learned at school or the method HE uses.

Naturally, situations will arise where the experience and knowledge of the field engineer will indicate that a change in technique is advisable. One measure of the engineer's success is the manner in which such changes are suggested. Before suggesting a change, he would be wise to investigate fully the existing situation, and ascertain whether peculiarities of the local scene or requirements of military organization dictate different methods from those which would be used normally.

The military field engineer should not expect preferential treatment by virtue of his civilian status. Certain personal discomforts will be encountered which will be greater than those in comparable civilian positions. These should be accepted with good grace. Because he is a civilian, less grumbling will be tolerated from the engineer than from a soldier. Generally, the field engineer is where he is through choice. The soldiers with whom he is working are there as part of their military duty.

Again, due to the civilian status of the engineer, a certain delicacy of position will result. He will be able to advise only. While some mention has been made of chain of command, the field engineer will find that although he has been assigned a field of responsibility within his chain of command, he has no place directly in the line of

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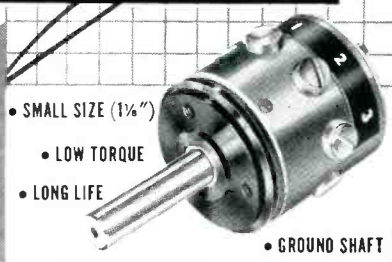

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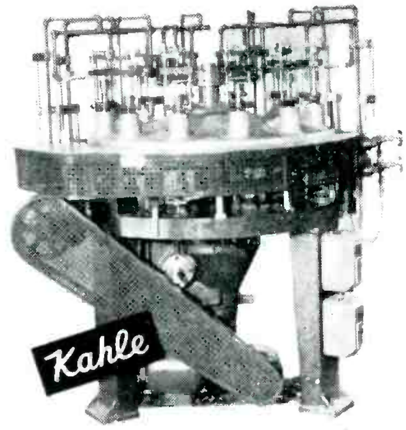

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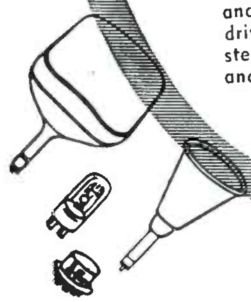

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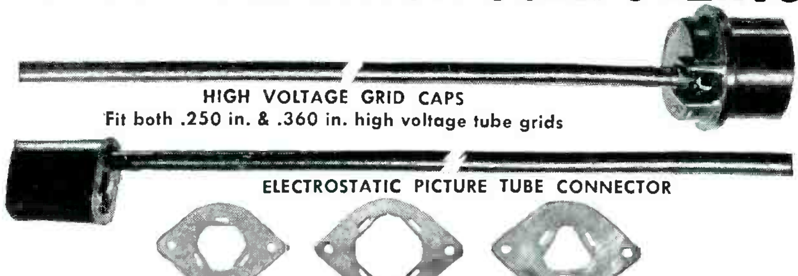

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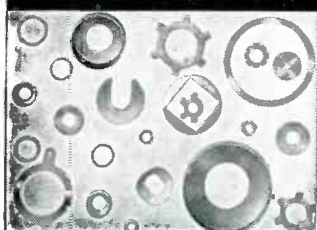

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command. The duties of the engineer, almost without exception, will be confined to those of a technical nature. Any attempt to command on his part will result in a complete negation of his position and create resentment on the part of all concerned. Leadership is best demonstrated by example. It will be difficult for the trained engineer to observe instances of inefficient or incorrect methods and yet refrain from saying, "This is the method which must be used."

The technique of diplomatic suggestion must be employed, particularly when working with foreign nationals. Great care should be taken not to offend personal or national pride. It should be remembered that most of the countries which are friendly to us and have need of our services have suffered greatly during the past war. Education, manufacturing techniques, all the processes which contribute to technical advancement, have been retarded under the pressure of war or occupation. Therefore, while some disparity between American and foreign methods may exist, it should never be attributed to a lack of ability, but rather to a lack of opportunity.

Relationship With Employer

Of equal importance to the success of the engineer's assignment is his relationship with his employer. In many cases, the employer has been selected by the military because the employer is the manufacturer of military equipment and is, therefore, eminently qualified to provide trained engineers familiar with such equipment.

A general corollary which may be drawn is that no engineer can function efficiently without the full backing and assistance of the home office. Correspondence from the field engineer should be answered promptly and correctly whether the problems posed are technical or personal. The term Field Engineer means exactly that—an engineer functioning in the field, independent of the laboratory and administrative facilities normally available. No field engineer can function efficiently if he feels stranded and forgotten, several thousand miles from

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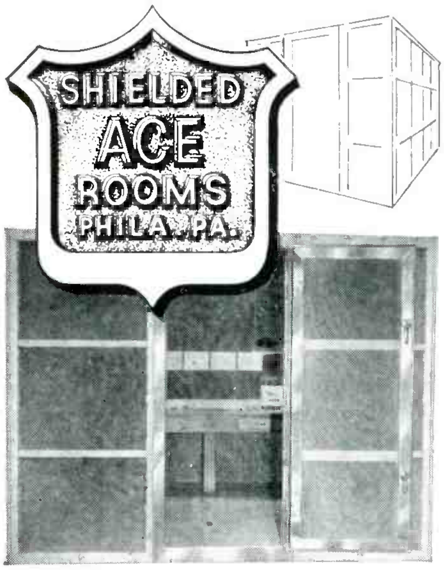

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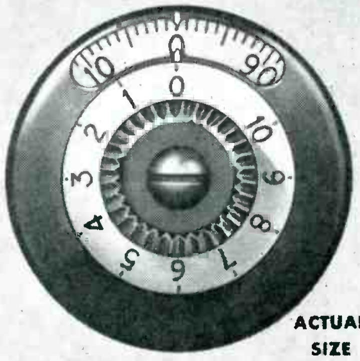

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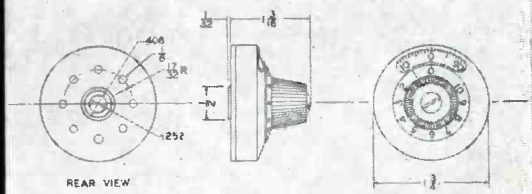

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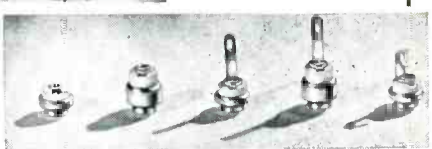

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WILLIAM J. LAPERCH
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Field Engineer Assigned to MDAP
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Mixed

DEAR SIRS:

IN YOUR December 1950 issue under the heading "Mixed" on the *Cross Talk* page you stated: "Unfortunately the mixed-highs technique cannot be used in the field sequential (CBS) system."

I would like to describe a possible method for using the mixed-highs technique in a field sequential system, thereby making more efficient use of the frequency spectrum than the present CBS system. The ideas expressed are solely the opinions of the writer.

The system provides a complete picture in four fields and yet would appear to have better apparent definition than the CBS system which requires six fields. The following information is contained in the four fields that are transmitted:

Field 1—Green plus mixed highs
Field 2—Green plus mixed highs
Field 3—Blue plus mixed highs
Field 4—Red plus mixed highs

As in the present black and white system, line interlacing is employed between adjacent fields.

At the receiving end, a green filter is used for fields 1 and 2. A blue filter is used for field 3, but during this field the scanning spot

on the tube is enlarged (defocused) either electronically or optically so that the resultant line is twice as wide as the line on the previous green field. Thus instead of the normal two interlaced fields required for complete picture coverage the picture is completely covered in one field. The identical procedure is used for field 4 except a red filter is used. By making the scanning spot larger we are essentially reducing the number of elements required for one complete picture coverage. For a compatible system the elements for the blue and red picture would be reduced to approximately 66,750 rather than the 267,000 elements used in a complete black and white frame.

Several independent observers[1] have proved experimentally that the the human eye cannot tell the difference between 267,000 color elements per picture and 66,750 color elements per picture as long as mixed-highs are used to obtain the detail. In this sequential system the persistence of vision phenomena is used to combine the low-definition color with the mixed-highs. The mixed-highs are presented as a green picture in order to keep the number of required fields per complete color picture to a minimum. From experiments that others have made it does not seem to make much difference whether the mixed highs are presented as a green picture or as a white picture. Evidently this is due to the fact that the eye is most sensitive to green colors.

The mixed highs are sent with fields 3 and 4 so that a slightly better black and white picture will result if the system is compatible. If compatibility is not desired then maybe a slightly more realistic picture would result if the scanning spot at the iconoscope were also enlarged when frames 3 and 4 were transmitted.

If each field were transmitted at a 60-cps rate and a line frequency of 15,750 cps were used, then the system would be a compatible. However, for pictures containing large solid areas of one color, there might be a noticeable flicker. It might be more desirable to transmit the fields at a higher rate such as 120 cps. If this frequency were used the actual frame flicker frequency would be

30 cps whereas with the CBS system it is 24 cps. It would also get around the 120-cycle power supply hum problem that exists with the present CBS system.

One possible solution to the whole color television controversy might be to adapt, for the time being, the above-described compatible color system so that present television set owners could still receive the black and white version of the color transmissions on their receivers (without any modifications at all), and yet those who were anxious to receive color could buy an adapter and attach it to their present set. A perfect color picture would result except for the slight color flicker problem previously mentioned. At some later date (say 5 or 10 years from now when more research has been accomplished in both black and white and color television problems) one might consider changing both the black and white and the color standards since it is now apparent that even the black and white transmissions are not using the available bandwidth very efficiently.[2]

REFERENCES

(1) Paper presented by A. V. Loughren of Hazeltine Electronics Corp. at Long Island Subsection of IRE on Nov. 22, 1950.

(2) R. B. Dome, Frequency-Interlace Color Television, ELECTRONICS, Sept. 1950.

P. Mertz and F. Gray, Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television, *BSTJ*, Jul. 1934.

J. M. LESTER
Hempstead, N. Y.

Crossed Bridges

DEAR SIRS:

THE EDITORS of ELECTRONICS and J. F. Graham are to be congratulated on the thought-provoking paper entitled "Automatic A-C Bridges" which appeared in the February issue (p 110) of the magazine.

In it Graham points out the desirability of using a bridge circuit where the contours of unbalanced impedances form a rectangular grid. However, since the contours are arcs of circles, this is just one more of those engineering ideals we are tempted with. Graham neglects to mention that a good approximation can be attained by operating the bridge in the region of a contour of infinite radius. In separating his Fig. 15 into parts B and C, Graham infers that something horrible happens as the radius becomes infinite. Actually the contour system is not merely continuous; it is very favorable for self-balancing bridges in that phase changes are slow and the contours run at right angles when the bridge is resonant. Graham also states that if this capacitive reactance is greater than the inductive reactance, balance cannot be obtained in a normal Owens bridge circuit. This statement is not true near resonance; if the Q of the inductive arm of the bridge is kept low, balance may be obtained without difficulty. In particular, if the Q is adjusted to unity and $X_3 = R$, the bridge will be balanced at resonance. By properly selecting the resonant frequency, the grid system near balance will be so spaced as to give good sensitivity. Because of the low Q involved, the bridge should not be too frequency-sensitive and might well suit applications such as Graham describes.

F. CHOWN
A. V. Roe, Canada Ltd.
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Electronics Quiz

LAST month's problem involved two capacitors connected in series with a switch and a 50-volt battery. Originally the switch is open, but the capacitors are charged to voltages of plus 20 and minus 40 (with respect to the battery voltage). The problem was to find the final voltage after the switch was closed. Robert C. Burns, of Hicksville, N. Y., who submitted the problem, gives the solution as follows:

After the switch is closed the change in voltage on C_1 must equal the change in voltage across C_2. The sum must equal the battery voltage. Thus

$$\begin{aligned}(20 + \Delta E_1) + (-40 + \Delta E_2) &= 50\\ -20 + \Delta E_1 + \Delta E_2 &= 50\\ 2\,\Delta E_1 &= 70\\ E_1 &= 35\end{aligned}$$

Then the final capacitor voltages would be

$$\begin{aligned}E_{c1} &= 20 + 35 = 55\\ E_{c2} &= -40 + 35 = -5\end{aligned}$$

New Quiz Problem

A new quiz problem will be published in this department in next month's issue.

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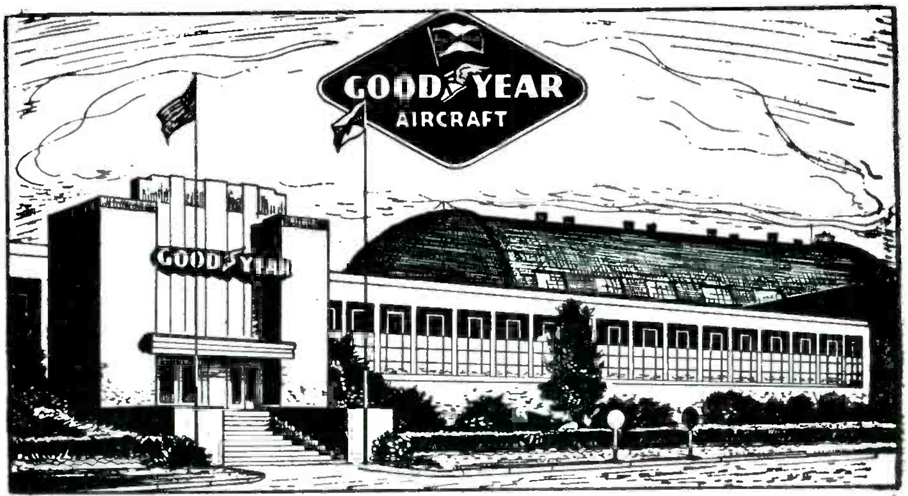

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Two to ten years' experience in research, design, development or test. Patent history desirable but not necessary. A variety of positions open for men, with Bachelor's or advanced degree, qualified in one or more of the following fields:

- RELAYS
- PULSE CIRCUITS
- SERVO-MECHANISMS
- LOW POWER APPLICATION
- TELEMETERING
- UHF TECHNICIANS
- INSTRUMENTATION
- QUALITY CONTROL

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Write Personnel Director
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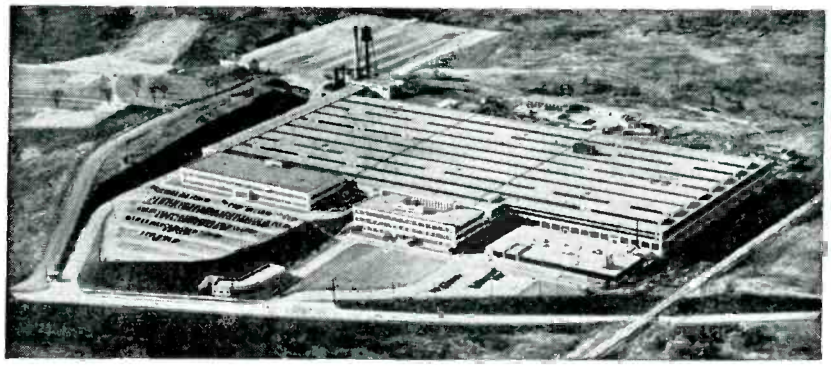

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R-H-S
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APR-4, 5, 7 and tuning units. ARC-1, 3. ART-13, ATC. APS-10, microwave equipment in S, K, X-band. APS-15, APQ-13, APS-13, SCR-300, 284, 694, etc. BC-221, 342, 348, BC-1016 tape recorders. Write, wire or call.

RADAR—COMMUNICATIONS AND TEST EQUIPMENT

TS-35/AP X-band Signal Generator, Pulsed and C.W. freq. range, 8400-9600 mcs. This unit will measure power and frequency. 115v 60-2600 cyc.

TS-3/AP S-band Frequency and Power Meter. Portable. Battery operated. Complete with all cables.

TS-33/AP X-band Frequency Meter. 8500-9600 mcs. Contains crystal detector and indicating meter. Output to scope will indicate pulse wave shape.

TS-62/AP X-band Echo Box. 8400-9600 mcs. tuned and untuned input. Will indicate resonance on meter. Complete with pick up antenna and cable.

TS-268/UP Crystal Diode Test Set. Used to check 1N21, 1N22, 1N23, etc. Battery operated. Portable. Complete with spares.

TS-89/AP Voltage Divider. 1:10 and 1:100 ratios. Wide band for true pulse shape. Output to scope.

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TS-45/APM-3 X-Band signal generator. 8400-9600 MCS pulsed & CW output. Used to check APS4 & similar sets.

TS-36/AP X-band Power Meter. Consists of power measuring circuit. Horn antenna, co-ax to wave guide adaptor, connecting cable and probe. Will measure either absolute or relative power. Nominal band of usefulness is approx. 8.5-9.7 KMC. Excellent condition.

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1-185 Signal Generator. L-band search. S-band track. Used with SCR-545 and similar sets. Complete with cables. Good condition.

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TS-226/AP used to measure peak power output of any xmitter in the range of 200-1000 mcs. Has provision for oscilloscopic signal observation and built in calibration. Part of AN/APM-29. Excellent.

TSX-4SE X-band spectrum analyzer. Unit will analyze magnetron & klystron output from 8400-9600 MCS. Double moding, pulling, sparking, etc., can be observed. 115v 60 cyc. input.

TS-14/AP consists of S-band signal generator, freq. meter, wattmeter and cables. Power input is 115v 50-2600 cyc. Used to check various S-band radars and beacons.

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AN-APS-3 Airborne X-band Search and Homing radar. Complete. Contains RF head, modulator, synchronizer, control boxes, plugs, antenna, etc. 115v 400 cyc. Excellent condition...........$875.00

ASB-5 L-band Search and Homing radar. Complete. Contains xmitter, receiver, power unit, control box, plugs, etc. 115v 400 cyc. Excellent condition $125.00

SCR-518 Radar Altimeter. 500 mcs. equipment. Complete with xmitter, receiver, control box, power unit, junction box with all cables, racks, etc. Unit will indicate altitude up to 50,000 ft. Power input is 28v. New condition....$99.50

AN/APS-15 R.F. Head and Modulator. X-band. Complete with all tubes. Good condition..........$99.50

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Type	Input Volts	Output Volts	Output Amps	Price
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PE-125	12v/24v	475	.200	14.50
DM-32	28	250	.060	1.75
DM-33	28	570	.160	2.95
DM-34	12	220	.080	8.95
DY-12	12	275	.110	
		500	.50	
PE-73	28	1000	.350	10.00
PE-94	28	300	.260	
		150	.010	
		14.5	.5	2.25
PE-97*	Vibrator Power Supp			8.95
PE-98	12v	300v		35.00
PE-101	28	400		
		800		5.75
PE-103	6 & 12	500		35.00
PP-18 AR	Vibrapack			15.95
RA-42	(for BC-639 Receiver)			29.95
ATR	Inverter 12v	110v AC 125 watts		14.95

AN/CRT-3 Victory Girl. Dual frequency emergency lifeboat xmitter. Complete with xmitter, kite hydrogen generator, etc. New in knapsack. C.A.A. approved $69.50

AN-APR-5 Radar Search Receiver. Freq. range 1000-3100 mcs. Will detect signals up to 10,000 mcs. with reduced sensitivity. Contains oscillator and mixer cavity, IF strip, power supply. Input 60-2600 cyc. 115v. Excellent condition........$375.00

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AN-APT-5 300-1500 mcs. xmitter cavity oscillator using 3C22 lighthouse tube. Power output 30 watts. Noise modulated. Excellent condition. Complete with all tubes....$149.50

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SCR-183 Airborne Command Equipment. Freq. range 201-398KC and 2500-7700KCS. Complete. Contains receiver, xmitter, dynamotor, antenna switch, control box, coils, etc. Power input 24-28v. Brand new in original cases. Manufacteured by Western Electric $125.00

NAVY RU Command Equipment. Similar to SCR-183 ....$125.00

DU-1 Direction Finding Equipment for SCR-183 and RU Series Equipment. Can be used with any receiver for direction finding in freq. range 200-1600KC. New. Complete....$45.00

SCR-515 (BC-645) contains xmitter, receiver, dynamotor PE-101, control box, manual, etc. New $18.95

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AN/APA-10 Panoramic Adaptor for use with any receiver with following IFs: 455KC, 5 mcs, 30 mcs. Unit will give panoramic presentation (1 mc wide for 455KC input) (100KC for 5MC input) (2MC for 30 mcs input). Power input 115v 400 cyc. but can be changed with the addition of a proper power transformer. Excellent condition......$175.00

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SCR-610 similar to SCR-510 except for freq. range which is 27.0-38.9 mcs. Excellent condition...$79.95

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433 200-1750KC. Good	29.95
ARR-2 234-258 mcs. New	19.95

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TYPE O 5.3-7 mcs. New	9.95
AVT-23 3000-13,000KC complete w/control box, manual, etc. C.W. or phone. 14 or 28v input. Brand new. Original cases	79.50
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BC-433G Compass Receiver, 200-1750KC in 3 bands. Excellent	39.95
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Spares for ARC-5 & 274/N, APX-1, ASG-10. We have a large stock of TS-34A/AP spares.

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OA3	1.50	2J36	105.00	5CP7A	15.00	327A	3.95	724B	6.95	878	1.95
OA4G	1.35	2J38	17.95	5D21	27.50	350A	7.95	725A	9.95	884	1.95
OB2	3.00	2J42	150.00	5JP1	27.50	350B	5.95	726A	6.95	885	1.75
OC3	1.75	2J49	109.00	5JP2	17.50	357A	27.50	726B	56.00	889R	199.50
OD3	1.50	2J50	69.50	5JP4	27.50	368AS	6.95	726C	69.00	913	12.95
C1A	4.95	2J61	75.00	5LP1	18.95	371B	1.95	728AY	27.00	914	75.00
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1B21A	2.75	2K25	47.50	5R4WGY	3.75	388A	2.95	801A	1.00	954	.35
1B22	3.95	2K28	37.50	6C21	29.50	393A	8.95	802	4.25	955	.55
1B23	9.95	2K29	27.50	C6A	3.95	394A	8.95	803	5.95	956	.69
1B24	17.95	2K41	99.00	C6J	7.95	MX408U	.75	804	13.50	957	.29
1B26	2.95	2K45	199.50	7BP7	7.95	417A	17.95	805	5.95	958A	.69
1B27	19.50	2V3G	2.10	7DP4	10.00	434A	17.95	806	25.00	959	.69
1B32	4.10	3B24	5.50	12AP4	55.00	446A	1.95	807	1.69	975A	17.95
1B38	33.00	EL3C	5.95	15E	2.95	450TH	45.00	808	3.50	991	.45
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1N22	1.75	4A1	1.75	RK39	2.95	700A/D	25.00	816	1.45	1620	5.95
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1N27	5.00	4E27	17.50	100TH	9.00	706AY	48.50	830B	11.50	1629	.69
1N48	1.00	4J25	199.00	FG105	19.00	706CY	48.50	832	5.95	1851	1.85
1S21	6.95	4J26	199.00	F123A	8.95	706A	17.95	832A	9.95	2050	1.85
2B22	4.95	4J27	199.00	203A	8.95	707B	27.00	833A	49.95	2051	1.80
2B26	3.75	4J30	395.00	211	.75	714AY	5.95	834	7.95	8012	4.25
2C34	.35	4J31	99.00	217C	18.00	715A	7.95	836	4.95	8013	2.95
2C39	32.00	4J32	99.00	242C	10.00	715B	15.00	837	2.95	8013A	5.95
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GENERAL ELECTRIC TYPE 5BA10AJ37, 27 V., 0.5 amps., 8 oz. in. torque, 250 RPM. PRICE $6.50 EA.

GENERAL ELECTRIC TYPE 5BA10AJ18D, 27 V., 0.7 Amps., 110 RPM, 1 oz. ft. torque. PRICE $6.50 EA.

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TYPE AY14G, 26 V., 400 Cy. PRICE $15.00 EA.

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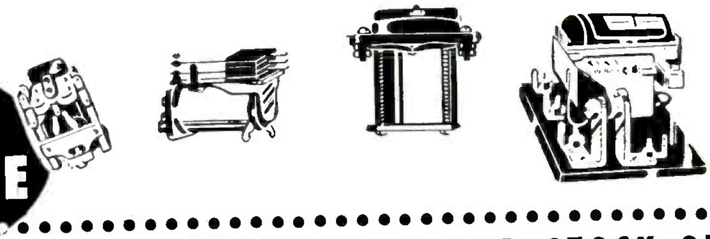

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STANDARD DC TELEPHONE RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-868	30/162 VDC	3300	1C	$1.90
R-873	6	12	3C, 3A Micalex	3.00
R-918	52/228 VDC	6500	1C	3.60
R-852	52/228 VDC	6500	1C, 1A	1.55

SHORT TELEPHONE RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-907	24/32 VDC	3500	1C	2.00
R-914	110 VAC	200	3B	2.50
R-908	6 VDC	15	4A @ 4 amps.	1.50

KEYING RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-850	12 VDC	450	1A @ 1.5 amps.	1.50
R-935	28 VDC	1000	1C @ 1.5 amps.	1.65
R-949	2.4 VAC	...	1A @ 5 amps.	1.95
R-891	24 VDC	475	1C @ 5 amps.	1.45
R-858	27.5 VDC	250	1A Dbl. Brk.	1.45
R-833	6.5 VDC	1300	2C	3.05
R-960	24 VDC	230	3C @ 15 amps.	2.95
R-828	6/8 VDC	42	1A	1.50
R-855	110 VAC	160	1A Dbl. Brk. @ 15 amps.	3.25
R-948	110 VAC	330	3A @ 15 amps.	3.00
R-924	12 VDC	72	1C Dbl. Brk.	1.65
R-950	2.4 VAC	...	1A @ 8 amps.	2.25
R-978	6 VAC	1.7	1A 1B @ 1.5 amps.	1.95
R-979	6 VAC	1.7	2A @ 1.5 amps.	1.95
R-917	18 VAC	31	1A @ 12 amps.	3.25
R-965	24/30 VAC	38	1A 1B @ 1.5 amps.	1.95
R-966	24/30 VAC	38	2A 2B @ 1.5 amps.	2.25
R-967	24/30 VAC	38	2A 3B @ 1.5 amps.	2.40
R-968	24/30 VAC	38	1A 5B @ 1.5 amps.	2.55
R-969	24/30 VAC	38	1A 6B @ 1.5 amps.	2.70
R-974	24/30 VAC	48	1A 1B @ 1.5 amps.	2.25
R-971	24/30 VAC	48	1A 2C @ 1.5 amps.	2.40
R-973	24/30 VAC	48	2A @ 1.5 amps.	2.25
R-970	24/30 VAC	48	2A 1C @ 1.5 amps.	2.40
R-975	24/30 VAC	48	1B 1C @ 1.5 amps.	2.40
R-976	24/30 VAC	48	2C @ 1.5 amps.	2.55
R-977	24/30 VAC	48	3A 1C @ 8 amps.	2.70
R-883	115 VAC	1200	1A 1C 1D	2.00
R-853	6/8 VDC	30	2A @ 10 amps.	1.55
R-875	6/8 VDC	240	1A @ 12 amps.	
			1C @ 1.5 amps.	1.50
R-830	24 VDC	330	2A	1.45
R-832	24 VDC	375 C.T.	1A @ 15 amps.	1.70
R-959	24 VDC	747	2C	1.50
R-929	24 VDC	425	1A Dbl. Brk.	1.25
R-982	12 VDC	24	1A Dbl. Brk.	1.55
R-947	12/24 VDC	320	1C @ 3 amps.	1.25
R-900	24 VDC	95	1A Dbl. Brk. @ 20 amps.	1.55
R-926	24 VDC	95	4C @ 15 amps.	3.55
R-983	24 VDC	265	3A	1.65
R-984	24 VDC	375	1C	1.65
R-878	24 VDC	375	1C Micalex	1.65
R-871	18/24 VDC	2000	2C	1.65
R-936	28 VDC	1000	1C @ 1.5 amps.	1.65
R-829	12/18 VDC	270	1A	1.45
R-905	32 VDC	1500	1C Dbl. Brk. @ 15 amps.	3.25
R-869	115 VDC	600	1A Dbl. Brk.	2.25
R-963	220 VAC	...	2C-1A Dbl. Brk.	7.50
R-928	350 MA	1.75	1C @ 6 amps.	1.25
R-953	12 VDC	65	1A @ 100 amps.	4.95
R-955	12 VDC	65	1B @ 100 amps.	4.95
R-954	24 VDC	160	1A @ 100 amps.	4.95
R-876	12 VDC	175	2A 1B	1.60
R-882	24 VDC	300	1A	3.00
R-860	48 VDC	3000	2A @ 1 amp. 230 v	2.60
R-923	24 VDC	1050	2C	2.75
R-958	60 VDC	1550	2A @ 12 amps.	1.50

W-E TYPE "E" RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-910	...	6/35/35	2A Split Cont.	$3.50
R-904	...	35/175	1A	1.25
R-981	12 VDC	270	2B-2C	1.50
R-870	24 VDC	2600	1A	1.30
R-863	48 VDC	4000	3A	2.00

SLOW ACTING

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-897	6 VDC	150	1A Slow Break	2.65
R-865	24 VDC	200	1C Slow Break	1.75
R-934	24 VDC	3000	2B Slow Break	2.95
R-962	6 VDC	150	1A Slow Make	2.65

DIFFERENTIAL RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-849	220/250 VDC	8000	2C	3.65

SEALED RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-861	32 VDC	8000	1B	4.00

VOLTAGE REGULATORS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-986	6 VDC	...	3 Terminal	2.25
R-886	6 VDC	1	with 15 ohm 50 watt	1.95

CONTACTORS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-890	24 VDC	60	1A @ 10 amps.	3.45
R-916	24 VDC	80	1A @ 25 amps.	2.95
R-885	24 VDC	120	1A @ 25 amps.	3.00
R-845	220 VAC	...	3A	6.95
R-838	90/120 VDC	925	2A	4.50
R-842	115 VDC	925	3A	5.50
R-840	115 VDC	1200	2A—Size 1	5.50
R-843	115 VDC	1200	3A	4.50
R-841	115 VDC	1200	3A-1A (Aux.) Size 2	40.00
R-844	115 VDC	1200	3A-1B (Aux.)	4.50
R-980	24 VDC	6	1A @ 250 amps.	5.50
R-942	24 VDC	80	1A @ 200 amps.	3.95
R-888	115 VAC	32	2A Dbl. Brk. Size 1	7.50
R-903	24 VDC	65	1A @ 200 amps.	5.50
R-938	24 VDC	70	1A @ 200 amps.	5.50
R-939	24 VDC	40	2A @ 200 amps.	7.50
R-854	24 VDC	100	1A @ 50 amps.	4.05
R-933	24 VDC	100	1A @ 50 amps.	4.75
R-881	24 VDC	150	1A	2.50
R-944	115 VAC	40	4A (1B-Remote)	4.50
R-943	115 VAC	100	4A-4B @ 10 amps.	6.75
R-941	14 VDC	12	1A @ 200 amps.	4.05
R-956	28 VDC	160	1A Dbl. Brk. @ 50 amps.	4.05
R-880	18/24 VDC	375 C T	1A Dbl Brk.	2.50
R-889	18/29 VDC	180	1A Dbl. Brk.	2.50
R-899	24 VDC	70	1C @ 50 amp. 1B Aux.	2.50
R-898	28 VDC	8	1A @ 200 amps.	4.50
R-909	24 VDC	11	1A @ 250 amps.	5.50
R-937	24 VDC	150	1A @ 50 amps.	4.75

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Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-831	7.5/29 VDC	6.5	1A @ 250 amps.	$5.50
R-925	24 VDC	100	1A @ 50 amps.	4.05
R-940	24 VDC	132	1A @ 200 amps.	5.50
R-879	24 VDC	150	1A @ 50 amps.	3.75
R-874	24 VDC	140	1A Dbl. Brk. @ 25 amps.	2.00
R-945	12 VAC	1	2A @ 30 amps.	3.25
R-946	125 VDC	3200	2A @ 30 amps.	2.75
R-860	115 VAC	175	2A @ 30 amps.	5.95

MIDGET RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-857	24 VDC	260	1D	1.75
R-912	4/5 VDC	20	3A-1C Ceramic	1.45
R-921	6.7 VDC	18	1A Dbl. Brk. @ 10 amps.	1.45
R-922	12 VDC	75	1A Dbl. Brk. @ 10 amps.	1.45
R-893	14 VDC	150	1A, 1C	2.50
R-895	14 VDC	150	2A, 1B, 1C	2.50
R-896	24 VDC	260	2A	2.50
R-894	24 VDC	260	3A, 1C	2.50
R-856	18/24 VDC	300	1B	1.45
R-913	6 VDC	20	3A, 1C Ceramic	1.45
R-915	12 VDC	70	1A Dbl. Brk. @ 10 amps.	2.00
R-834	6 VDC	20	3A, 1C	1.45

SPECIAL RELAYS

Stock No.	Voltage	Ohmage	Contacts	Unit Price
R-846	5/8 VDC	19	1C Coax	6.95
R-920	6 VDC	18	1A @ 25 amps.	1.25
R-931	Min. 1.5 Ma.	150	1C	7.50
R-927	220 VAC	2500	1A @ 5 amps.	15.00
R-951	115 VAC		3/8" Stroke	1.45
R-887	.5 Adj. 1.5 Amp.	40	2 Pole 2 Pos.	27.50
R-932	6 V. @ 112 amps; 12 V. @ 56 amps.; 24 V. @ 28 amps.			4.25
R-930	25/50 VAC	25 ea. coil	2B-1H @ 8 amps. 1A @ 12½ amps.	3.75
R-972	40/50 VAC		1B @ 12½ amps. 1 MBM @ 1½ amps.	3.25
R-256	26 VDC	65	2B-1A @ 1KW	10.95
R-906	40 VDC	600	1A @ 30 amps.	3.95
R-864	24/24 VDC	95/95	1A,1B,1C/1A,1B,1C	5.50
R-847	10/15 VDC	70	4C	4.75
R-964	220 VAC		2A Dbl. Brk. @ 3 KV.	8.95
R-952	24 VDC	175	1A-Grounded	2.95
R-884	12 VDC; 28 VDC	670; 230	2A; 12 Pos. Rotary	12.95
R-902	115 VAC		1A @ 25 amps. 440 VAC; 1A @ 2 amps 300 VDC; 1A @ 5 amps. 115 VAC	87.50
R-866	Adj. from 1 Ma.	6200	1C	17.50
R-957	12 VDC	.5	1B 2 Aux. Cont.	1.50
R-919	6/8 VDC	50	1C	5.25
R-911	40 VDC	200	1C @ 20 amps. 1A Mom.	7.95

TYPE 82

Stock No.	Voltage	Ohmage	Descriptive Information	Price
R-809	28 VDC	7	360° Rotation in 12 steps with 7" lg. shaft	$2.45
R-766	28 VDC	4/230	360° Rotation in 12 steps with 2½" lg. shaft and 8-6 Terminal Wafers mounted on 12" x 5" Terminal Board with 63 Screw Terminals plus lugs	4.90

ROTARY RELAYS

Type 76-77 14 VDC—2 Ohm Energizing. 125 Ohms Holding Coil 30° Rotation ½" Long Shaft.

Stock No.	First Wafer: Circuit 1	First Wafer: Circuit 2	First Wafer: Circuit 3	First Wafer: Term*	Second Wafer: Circuit 1	Second Wafer: Circuit 2	Second Wafer: Circuit 3	Second Wafer: Circuit 4	Second Wafer: Term	Price
R-877	1 NC	1 NC	....	4	1 NO	1 NO	1 NO	SPDT	9	$2.25
R-892	3 NO	....	....	4	SPDT	SPDT	Ceramic		6	2.40
28 VDC—7 Ohms Energizing, 230 Ohms Holding Coil 30° Rotation ¼" Lg. Shaft With Coupling										
R-711	SPDT	2 pole reversing	....	8	....	....	....	....	....	2.05
R-712	1 NC	1 NC	1 NC	6	....	....	....	....		2.05
R-573	2 pole reversing	....	....	5	....	....	....	....		2.05
R-901	2 NO-1 NC	....	....	4	SPDT	SPDT	3 NC	....	10	2.25
R-616	1 NC	1 NC	....	4	1 NC	1 NC	1 NC	1 NO	8	2.40

* NOTE: Number of terminals excludes those required for operation of relay.

BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION

Form A—"Make" (Single Throw, Normally Open) · Form B—"Break" (Single-Throw, Normally Closed) · Form C—"Break-Make" (Double-Throw) · Form D—"Make-Before-Break" · Form E—"Break-Make-Before-Break"

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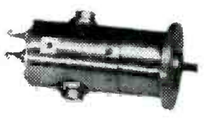
IMMEDIATE DELIVERY — Servo-Tek — FULLY GUARANTEED

ANTENNA TILT INDICATOR

D-C Selsyn type tilt indicator. G.E. 8DJ29AAK. 24 volt. Stock #SA-296. **Price $3.75 each.**

JOHN OSTER MOTORS



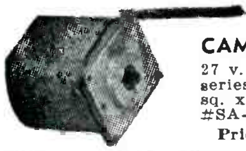
Types B-9-1 & B-9-2 27.5 V DC & 12 V DC. 5600 rpm. Built-in noise filter. Large qty.
PRICES ON REQUEST

BODINE NSHG-12 MOTOR

Constant speed

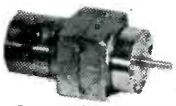
27 v. D-C Governor controlled 3600 rpm. 1/30th hp. Stock #SA-39. **Price $17.50 each.**

REVERE CAMERA MOTOR



27 v. D-C. Split field series. Approx. 2½" sq. x 2½" lg. Stock #SA-315.
Price $6.75 each.

PM MOTOR



Sampsel 27 V DC PM motor. Type S—151273. One in./oz. torque at 7000 rpm. 1½" x 1½" x 2¾" Lg. Stock # SA-283. **Price $12.75 each.**

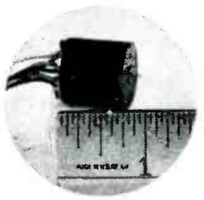
DC MOTOR

High speed 27 v motor with high inertia flywheel. Ideal for gyro demonstrations.
Stock #SA*S-313
Price $9.75 each.

SWEEP GENERATOR CAPACITOR

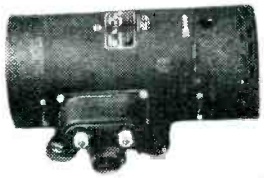
Hi-speed bearings. Split-stator. Silver-plated coaxial type. 5-30 mmf.
Stock #SA-167 **Price $2.75 each**

MINIATURE DC SELSYN INDICATOR



G.E. 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-248. **Price $14.50 each.**

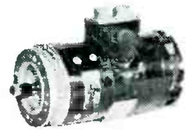
AIRCRAFT AMPLIDYNES



G.E.

5AM31 NJ18A. Input 27 V.D.C. @ 44 amps. Output 60 V.D.C. @ 8.8 amps. max. 530 watts. Stock #SA-111.
5AM31NJ9—Similar to above. Stock #SA-196. **Prices on request.**

Aircroft Generator Eclipse NEA-3



Output 115 VAC; 10.4 amps 800 cycles at 2400 rpm. Also 30 VDC at 6 amps. Stock #SA-306. **Price $49.50 each.**

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

A-5 Autopilot Indicator

Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. **Price $12.50 each.**

¾ HP DC MOTOR

Electric Specialty Co. HCA315T.
24 volts DC. 3800 rpm. Stock #SA-321.
Special Price $24.50 each.

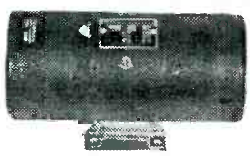
ARMA 5A MOTOR

10 Watt Servo Motor—2 phase 115 v. 60 cycles. 3½" lg. x 3½" diam. 1" shaft ext. 0.250 diam. one end, other ext. ½" lg. 0.250 diam. Stock #SA-231. Limited quantity. **Price $49.50 each.**

400 CYCLE AIRCRAFT ACTUATORS

Manufactured by AirResearch. 115 volt 400 cycle operation. 2½" linear travel. Stat. load 200 lbs. Ten. 75-100 lbs. Comp. 75-100 lbs. Stock #SA-326. **Price $24.50 each.**

WINCO DYNAMOTOR



Model 41S6. 13 v D-C in. @ 13 A. Output 250 v @ 0.60 A and 300v @ .225 A. Stock #SA-323.
Price $9.50 ea.

800 Cycle Inverter

Navy Type CRV-21AAR. GE. 5AS121LJ2. 27 v. DC input @ 45 amps. 120 v. 400 cy. output @ 750 V. A. P.F. 0.90. Wt. 22.5 lbs. Stock #SA-192. **Price $59.50 each.**

Compass Indicator

1-82F Compass Indicator 0-360°-5 in. dial. 26 v 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.
Price $6.50 each

DC SERVO MOTOR

Elinco Type B-64. 1/165 hp at 3100 rpm. Field volts 27.5 Max. armature voltage 80. Ideal for thyratron servo control Stock #SA-211. **Price $16.50 each**

Pioneer Servo Motors

Type 10047-2A. 2ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

PIONEER CK-17

400 cycles 2 phase, 26 v fixed phase. 45 v. max. variable base. Built in gear reduction. Output shaft speed approx. 4 rpm.
Stock #SA-287. **Price $16.50.**

400 CYCLE WESTINGHOUSE FL BLOWER

115 v. 40 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price on request.**

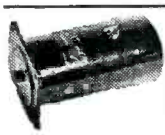
INVERTER

Pioneer 12130-4-B Input 28 VDC at **14 amps.** Output 120 v. 400 cy Single Phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. **Made 1949.** Stock #SA-304. **Price $89.50 each.**

MICROPOSITIONER

Barber Colman AYLZ-2183. Polarized dc relay. Double coil differential current sensitive. Alnico PM polarized field. 24 v. Contacts 0.5 amps 28 v. Use for remote positioning, synchronizing, control, etc. Sens. 1.25 ma. diff. Use to 100 cy. Stock #SA-290.
Price $12.50 each.

JA1 MOTOR (D-C)



Electric Specialty. ¼ hp. 24 v. D-C. (Wing flap motor.) Stock #SA-325. **Price $19.50 ea.**

Synchros - Selsyns

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SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG Set. Diehl Elec. Co. 120V D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New $285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers. 230 DC To 120 AC, 60 cy. 1 Ph. Fully enclosed. Splashproof Ball Bearings, centrifugal starter. New, complete with kit of Spare Parts....$150.00

MG Set. Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy. 1 Ph. Output 115, 480 cy. 1 Ph. 1200W and 26V DC at 4 amps. New......$295.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy. 3 Ph. 1500 VA to 875 DC and 300V DC. New $69.50

DYNAMOTOR. Navy-Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New. $69.50

DYNAMOTOR. Elcor. 64V DC to 110V AC, 60 cy. 1 Ph. 2.04 Amps. New..................$24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph. 0.43 Amps. New..................$17.50

DYNAMOTOR — Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig Corps. U. S. Army MG-27-B. New....................$26.50

AMPLIDYNE—Edison type 5AM31NJ18A. Input: 27 volts 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New.................$22.50

INVERTER—G.E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy. 485 Va. New...$24.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC. 38 Amps. Output, 80V., 800 cy. 485 VA. New $17.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115, 400 cycles at 1.5 KVA...$24.50

GENEMOTOR—Carter 6V DC to 400 V DC at 375 mils. New $39.50

D.C. MOTOR—G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A. Field 60 V D.C. at 2.3A. RPM 4000. H.P. 0.5. New $22.50

MOTOR GENERATOR M.G. 164. Holtzer-Cabot Motor: 440V, 3PH, 60 cy., .90A, 1/3HP, 1750 RPM. Generator: 70V, 3Ph, 146 Cy., .140KVA Exciter: 115DC, 1A. New.................$67.50

BC-348 RECEIVER PARTS
for Models C, E, H, K, L, M, P, R.

Dial Mechanism assemblies. 1st, 2nd, 3rd, 4th I.F. transformers. C.W. osc. and xtal filter trans. with xtals. All R.F. coils. Front panels. Shock mounts. Large quantity misc. hardware sub assemblies, etc. Write your requirements.

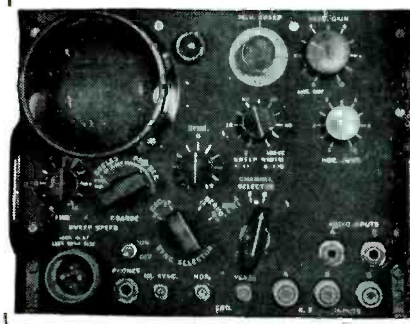
MISCELLANEOUS EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47APR Test Set—40 to 500 MC.
213-A DuMont C.R. Modulation Monitor.
BC1203B APN-4 Test Set.
6255A H.P. Interpolation Osc.
TS-23/APN Test Set.
TS-487/U Peak to Peak VTVM.
BC-221AE Freq. Meter.
LM-13 Freq. Meter.

MICROWAVE RECEIVERS

AN/APR-1 Receivers and tuning units TN-1 (38 to 95 MC) TN-2 (76-300 MC) TN-3 (300-1000 MC).
AN/APR-4 Receivers and tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000 MC).
R111A/APR-5A Receivers. 1000 to 6000 MC Range.

MODEL AN/APA-10 PANORAMIC ADAPTER



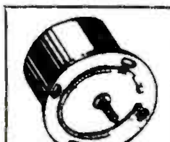
Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I. F. of 455kc. 5.2mc, or 30mc.

SUMMARY OF CHARACTERISTICS:

SENSITIVITY: "A" channel, 400 microvolts or less per ¼" beam deflection. "B" channel, 400 microvolts or less per ¼" beam deflection. "C" channel, 1 volt or less per ¼" beam deflection.
RESOLUTION: 12 kilocycles at 3 db down from peak, sweep control at maximum, using CW signal.
PRESENTATION: Panoramic ("A" & "B" channels): Oscillographic, "C" channel.
SWEEP WIDTH: Channel A, ± 50 kc (100 kc overall) Channel B, ± 500 kc (1 Mc overall) Channel C, ± 1 Mc (2 Mc overall).
CATHODE RAY SWEEP: Oscillatory or non-oscillatory (Servo) Variable Sawtooth Generator, 35 to 40,000 cycles per second.
AUDIO OUTPUT: 50 milliwatts into 600 or 8000 ohm load.
VERTICAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc or higher. Amplifier out position permits direct connection to one vertical plate through coupling capacitor.
HORIZONTAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc. No provision for direct connection to deflection plates.
CATHODE RAY TUBE VOLTAGE: Cathode to accelerating anode; 1200V DC for 115V A.C. input.
SENSITIVITY OF CATHODE RAY OSCILLOSCOPE: Maximum through Amplifier. Horizontal: 10 volts peak to peak per inch. Vertical: 1.5 volts peak to peak per inch.
DIRECT TO VERTICAL PLATE: 150 volts peak to peak per inch.
NOISE: No disturbance in excess of 25,000 microvolts between 200kc to 200Mc generated by equipment.
Overall Dimensions: 19-9/16" x 10¼" x 7⅝".
Weight: 40 lbs.
Power Requirements: 115V. A.C. 60 cycles, 1 phase. With 21 tubes including 3" scope tube, for operation on 115 V. 60 cycle source. PRICE..........$245.00

AN/APA-10 80 Page Tech Manual............$2.75



LINEAR SAWTOOTH POTENTIOMETER
W.E KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.
Brand New $5.50

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier, 115 volts—400 cycles. Dual channel. Employs 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. New $22.50

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No 80G184. KVA .945S—520P. Volts 460/345/230/115. New. $4.95

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $2.95

THYRATHRON POWER. 400/1600 cy. Raytheon UX-8876, 400/1600 cy. Pri: 115, Sec: 50-0-50V at 1.5A, 6.3V at 1.2A. Test r.m.s. 1780. New..$2.75

PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New.................$2.95

Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new............$49.50

SCOPE PL. & FIL. WECO 9556. 400/2400 cy Pri: 115. HV Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New $1.95

PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec: #1=1208VDC at 1.5MA. Sec. #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35V0.8A. (Ins. 1500V)/5V2A/5V2A $4.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core, Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins for 1700V $5.95

High Rectance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New $89.50

High Voltage Trans. Westinghouse Pri: 115, 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up $24.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps.$5.00

PULSE. WECO KS-161310. 50 KC to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New $1.95

RAYTHEON VOLTAGE REGULATOR

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅜" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special.........$14.75

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$26.50
.25 MFD., 15KV	22.50
.5 MFD., 25KV	34.50
1 MFD., 15KV	34.50
1 MFD., 7.5KV	12.50

SOUND POWERED PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. Brand new including 20 ft. of rubber covered cable.......$17.50

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable $10.00

U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new............$13.50

W. E. type TS-10M Handset. New........$16.50

PARABOLOIDS

Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new, per pair........................$8.75

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new........$2.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR. Available in quantity—following frequencies—fundamentals.
5910—6350—6370—6470—6510—6610—6670—6690—6940—7270—7350—7380—7390—7480—7580—9720—Kilocycles.

$1.25 each

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

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27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

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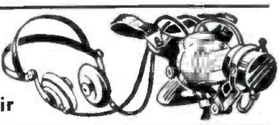
8 RPM 115V 60 cyc
E. Ingraham Co.
$1.95

GEAR ASSORTMENT
100 small assorted gears. Most are stainless steel or brass. Experimenters dream!................Only $6.50

VERNIER DIAL or DRUM (From BC-221)
DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks ....either, 85c

SOUND POWER HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used. $17.60 pr

Sound Powered Chest Set RCA—With 24 Ft. Cord
$17.60 per pair


Variac—General Radio 100W removed from equipment **$10.00**

400 CYCLE INVERTERS
Leeland Electric Co.
#10800 In: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF...............$12.95

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	3.00	6	$3.00
½	4.00	1¼	3.00	10	3.00
¾	$4.00	5	3.00	15	3.00
				20	3.00

DELAY NETWORK—ALL 1400Ω
T 113—Approx. 1.2 micro sec. delay............
T 114—Approx. 2.2 micro sec. delay............
T 115 Similar to T 114 with tap brought out....
95¢ each

BEARINGS

Mfg. No.	ID	OD	Thickness	Price
MRC5028-1	5 1/2	6 1/2"	1"	$3.50
MRC7026-1	5 5/64	6 15/64	9/16	3.50
Timken 37625	4 5/16	6 1/4	29/32	4.25
MRC-7021-200	4 1/8	5 9/32	23/64	2.95
Fafnir B545	2 1/16	2 5/8	1/4"	1.00
MRC 106 M2	1 17/64	2 7/16	25/64	1.75
MRC 106 M1	1 13/64	2 7/16	25/64	1.60
Federal LS 11	1 1/8	2 1/2	5/8	1.75
Norma S 11 R	1 1/8	2 1/8	3/8	1.25
Fafnir B 541	1 1/16	1 1/2	9/32	.55
Hoover 7203	5/8	1 9/16	7/16	.90
Norma 203 S	5/8	1 9/16	7/16	.90
Schatz	3/4	1 3/4	9/16	1.00
N5 5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	1 5/32	11/32	.55
Fafnir S 3K	3/8	7/8	7/32	.45
MRC 39 R1	11/32	1 1/32	5/16	.45
ND CW 8008	5/16	5/16	13/32	.45
MRC 38 R3	5/16	55/64	9/32	.45
Fafnir 33K5	3/16	1/2	5/32	.25

NEEDLE BEARINGS
TORRINGTON B108 1/2" wide 5/8" 13/16" 30¢

Brand New METERS—Guaranteed
0-1 Amp. R.F. 2½"..$3.29 | 0-80 Amp. D.C. 2½".$2.25
0-10 ma D.C. 3½"... 3.95 | 0-7.5V. A. C. 3½"... 3.46

SELENIUM RECTIFIERS
Full Wave 200 MA 115V..........................$1.79
Half Wave 100 MA 115V.......................... .91

SPAGHETTI SLEEVING—assortment—99 feet.....$1.00

TYPE "J" POTENTIOMETERS

150	SD	2000	SD	5000	3/8"	50K	SD*
300	SD	2000	1/2"	10K	3/8"	70K	SD
300	3/8	2000	SD*	10K	SD*	80K	SD
400	3/8	2500	1/2"	15K	1/4"	100K	3/8
500	3/8	2500	SD	15K	SD*	200K	SD*
1000	7/8	3000	3/8	25K	3/8"	250K	SD
1000	SD*	4000	3/8	25K	SD*	500K	1/2"
1500	SD	5000	SD*	30K	SD*	1 Meg	SD

* Split locking bushing $1.50 each

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	4-141W	$0.30	9-141Y	$0.64
3-140¾W	.19	5-141	.26	10-141	.50
6-140	.25	5-141¾W	.37	17-141Y	1.17
10-140¾W	.53	7-141	.36	3-142	.21
2-141	.13	7-141¾W	.49	8-142	.69
3-141¾W	.24	8-141¾W	.58	2-150	.39
3-141W	.24	9-141	.64	3-150	.54

TIME DELAY RELAY

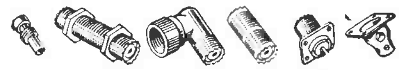
Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully cased • ONLY $6.50

AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

NEW COAXIAL CABLES

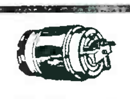
	Ohms	Price per 1,000 Ft.		Ohms	Price per 1,000 Ft.
RG-6/U	76	$150	RG-35/U	71	$450
RG-7/U*	97.5	65	RG-37/U	55	40
RG-15/U	76	160	RG-39/U	72.5	180
RG-21/U	53	100	RG-41/U	67.5	295
RG-22A/U*	95	150	RG-54/U	58	65
RG-24/U	125	240	RG-55/U	53.5	65
RG-25/U	48	575	RG-57/U*	95	100
RG-26/U	48	75	RG-58/U*	53.5	60
RG-27/U	48	290	RG-59/U*	73	70
RG-29/U*	53.5	50	RG-77/U*	48	100
RG-34/U	71	175	RG-78/U	48	80

Add 25% for orders less than 1,000 feet.
*No minimum order—others 250' minimum.

COAXIAL CABLE CONNECTORS


15¢	$1.30	30¢	80¢	40¢	9¢
UG 175/U	83-1F	ANGLE	83-1J	83-1R	HOOD

83-1AC	$ .42	83-22J	$1.40	UG58/U	$ .63
83-1AP	.30	83-22SP	1.15	UG59A/U	2.25
83-1F	1.30	UG-12/U	.63	UG60/U	2.40
83-1H	.09	UG13/U	.63	UG85/U	2.05
83-1J	.80	UG19B/U	1.95	UG87/U	1.75
83-1R	.40	UG21/U	.67	UG88/U	1.25
83-168	.15	UG22/U	1.10	UG167/U	2.00
83-185	.15	UG24/U	.67	UG175/U	.15
83-2AP	2.00	UG25/U	.60	UG176/U	.15
83-2H	.25	UG27/U	.68	UG201/U	2.05
83-2J	1.65	UG27A/U	2.95	UG206/U	.63
83-2R	1.30	UG29/U	.83	UG281/U	.60
83-21SP	2.10	UG30/U	2.50	UG290/U	1.60
83-22AP	1.10	UG57/U	2.30	UG499/U	1.25

DIFFERENTIAL
115 V., 60 Cyc. **$3.95 ea.**
#C78249
3⅜" dia. x 5⅜" long

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)......$4.50
Mounting Brackets — (Bakelite for selsyns, and differentials shown above...............35¢ pair

2J1G1 SELSYNS $2.95
BRAND NEW 400 CYCLE
Can be used on 60 cycle


POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
4	23	47	85	220	500	910	.003	.0062
5	24	50	90	240	510	.001	.0033	.0065
7	25	51	100	250	560	.0011	.0035	.0068
7.5	26	56	110	270	580	.0012	.0036	.007
8	27	60	120	300	600	.0013	.0039	.0075
8.2	30	62	125	350	620	.00136	.004	.008
10	33	68	130	370	650	.0015	.0044	.0082
15	35	70	150	390	680	.001625	.005	.009
18	39	75	160	400	750	.002	.0051	.01
20	40	80	175	430	800	.0026	.0056	
22	43	82	180	470	820	.0027	.006	

Price Schedule
8.2 mmf to .001 mfd.............................5¢
.0011 mfd to .001625 mfd........................7¢
.002 mfd to .0082 mfd..........................12¢
.01 mfd..22¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	40	82	155	275	430	680	.002	.0039
18	47	100	170	300	466	700	.0023	.004
20	50	110	180	325	470	800	.0024	.0047
22	51	115	200	350	488	875	.0026	.005
23	60	120	208	360	500	900	.0027	.0051
24	62	125	225	370	510	.001	.00282	.0056
27	66	130	240	390	525	.0011	.002826	.006
30	68	135	250	400	560	.0016	.003	.0082
39	75	150	270	410	570	.001625	.0033	

Price Schedule
10 mmf to .001 mfd.............................10¢
.001625 mfd to .0024 mfd.......................20¢
.00282 mfd to .0082 mfd........................50¢

FILAMENT TRANSFORMER
Pri., 115V., 60 Cyc. — Sec. 6 V. @ 35 A. or 12 V. @ 18 A. or 24 V. @ 9 A. **$6.50**

PULSE TRANSFORMERS
UTAH—9262 9278 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9365, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2731, 80-G-5
JEFFERSON ELECTRIC—C-12A-1318
CROSLEY—W-226262-4
DINION COIL—TR1048, TR1049
also 352-7250-2A; 352-7251-2A; T-1-229621-60

PRECISION RESISTORS—¼ WATT—30¢

2	10.48	12.32	14.98	62.54	125	414.3
2.5	10.84	13.02	15.8	79.81	147.5	705
3.5	11	13.52	16.37	105.8	220.4	2,193
5	11.25	13.89	32	123.8	301.8	3,500
6.68	11.74				366.6	59,148

PRECISION RESISTORS—½ WATT—30¢

1.	10.58	70	290	2,230	8,909	33,300
.2	11.1	71	298.3	2,250	9,000	35,888
.25	13.15	75	389	2,500	10,000	36,000
.334	13.3	80	397	2,850	12,000	37,000
.444	13.52	87	400	3,330	13,333	39,000
.502	15	90	500	3,400	14,825	40,000
.557	18.75	97.8	600	3,427	15,000	41,700
.627	20	100	607	3,500	15,750	43,766
.76	21.5	120	705	3,995	15,755	45,000
1	25	123.8	723.1	4,000	15,810	47,000
1.01	30	125	785	4,101	16,000	50,000
1.02	34.75	147.5	800	4,285	16,700	56,000
2	40	148.7	855	4,300	17,000	59,000
2.04	44.73	150	900	4,451	19,860	59,905
2.5	45	178	970	4,750	20,000	68,000
2.54	46	179.5	1,060	5,000	20,150	70,000
3.07	49	180	1,100	5,714	21,300	75,000
3.25	50	210	1,150	5,900	22,500	79,012
3.7	52	220	1,200	6,000	23,300	80,000
3.87	55.1	230	1,264	6,500	25,000	90,000
5.24	60	235	1.375	7,000	26,667	92,000
5.26	61	240	1,400	7,300	30,000	100,000
5.89	65	250	1,490	7,500	31,500	120,000
7	66	260	1,500	8,000	32,700	140,000
7.6	66.6	270	1,573	8,500	32,888	180,000
8	69	286	1,876	8,800	33,000	400,000

PRECISION RESISTORS—1 WATT—35¢

.1	2.58	27.4	179.5	1,700	6,000	34,000
.11	2.6	28	206	1.800	7,000	35,000
.147	2.66	30	215	1.900	7,500	37,000
.2	3	35	250	2.000	7,800	40,000
.25	3.1	38	270	2,200	8,000	45,000
.31	3.39	43.6	300	2,215	8,250	50,000
.4	4.29	45.5	312	2,250	9,000	55,000
.861	4.3	49.75	321.7	2,413	10,000	56,000
1	4.7	50	400	2,500	12,000	60,000
1.01	5.21	54 25	420	3,055	12,420	65,000
1.166	.....	60	425	3,300	12,500	68,000
1.17	10.5	71	.....	3,800	15,000	70,000
1.21	12.8	75	565	4,572	18,000	75,000
1.25	15	80	800	.....	20,000	80,000
2	18	100	1,000	5,221	25,000	84,000
2.5	25	112.8	1,200	5,400	30,000	90,000
2.55	.....	.....	.....	.....	.....	95,000

1 WATT—45c

100,000	175,000	296,000	390,000	550,000
105,000	195,000	300,000	399,000	560,000
120,000	200,000	310,000	400,000	590,000
125,000	220,000	320,000	413,000	600,000
132,000	245,000	340,000	423,400	645,000
145,000	249,000	348,000	450,000	650,000
149,500	250,000	350,000	500,000	700,000
150,000	260,000	375,000	520,000	750,000
166,100	270,000	376,000	522,000	876,457

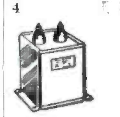
1 MEGOHM 1 WATT 1%—65c; 5%—45c

2 WATT—60c
4,385 5,000 6,000 10,000 23,000


UNIVERSAL JOINT
3/16" hole** 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.125	35,000	$35.95	.5–.1	2,000	1.95
.125	27,000	28.95	.3	2,000	1.75
.25	20,000	19.95	.1–.1	2,000	1.65
.1	12,000	2.95	.02	2,000	.79
1	10,000	12.75	2	1,500	1.79
.15–.15	8,000	2.75	1	1,500	1.50
.02	8,000	1.89	6	1,000	2.25
.1	7,500	1.95	4	1,000	1.89
.05	7,500	1.75	3	1,000	1.59
.03	7,500	1.69	2	1,000	.90
.1–.1	7,000	1.98	1.02	1,000	.65
.1	7,000	1.85	1	1,000	.65
.02–.03	7,000	1.40	7	800	1.98
1	6,000	5.95	1	800	.55
.1	6,000	2.75	8–8	600	1.49
.03–.03	6,000	1.35	8	600	1.95
.01–.03	6,000	1.35	7	600	1.75
2	5,000	5.95	4	600	1.49
.25	5,000	2.95	4 x 3	600	1.95
2	4,000	4.95	2	600	.69
.3 x .2	4,000	2.50	1	600	.49
.1	4,000	2.25	8	500	1.55
.06	4,000	1.45	4	500	.98
.1	3,500	1.95	4	200	.39
.25	3,000	2.25			
.1	3,000	1.75			
4	2,500	4.95			
8	2,000	4.95			
6	2,000	4.65			
4	2,000	4.25			
3	2,000	3.75			
2	2,000	2.95			


2 mfd 4,000 V.D.C. G.E.
$3.95

OILED FILLED A. C. CONDENSORS

MFD.	V.A.C.	Price	MFD.	V.A.C.	Price
.2	750	$ .69	30	330	$6.50
8	660	4.95	25	330	5.95
6	660	4.95	20	330	5.50
5	660	4.50	15	330	4.50
4	660	4.25	10	330	3.95
2	660	3.25	6	330	2.95
1	660	2.35	4	330	1.95
28	440	6.95	3	330	1.25
15	440	4.95	2.5	330	.98
6	440	3.50	2	330	.65
5–3	440	3.95	10	220	2.95
4.4	375	2.15			

1N34 Crystal Diode...........................79¢

Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.
Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

ELECTRO—THE BEST FOR ELECTRONIC SURPLUS

Amertran "TRANSTATS" Voltage Regulator

11.5 KVA 50/60 cy. Commutator range 0-115 V. Max. Amps. 100. Reconnection diagram available for 230 V. 50 A operation. BRAND NEW. Factory Cases $225.00

SUPERIOR POWERSTAT

Type 1126-3Y, Pri.: 230V, 3 ph, 60 cy. Output: 0-270 Volts 7 KVA. May be separated and used as three 0-115V, 1 ph, 60 cy, 2.0 KVA units. Brand New $100.00

Transtat .25 KVA. Fixed winding 115/1/60. Commutator range 103-126 V. Max AMPS. 2.17 ....$9.45

.5 KVA Fixed Winding 115/1/400 Commutator range 92-115 V Max Amps. 5.5 ....$4.50

TRANSFORMERS

All have 115V 60 cy Primary

Hammond RE14032. Sec. #1 thru 4: 5V @ 2A; Sec. #5: 5V @ 6A $4.25

Amertran #7180. Sec. 2. 5VCT @ 25VA $3.95

KV Trans #1523. Sec. #1: 5V @ 20A; Sec. #2: 5V @ 10A $12.50

Thordarson Type T-6F68. Sec. 6.3V @ 2.7A., 5KV Ins. $1.50

Hammond REL10350. Sec. #1: 580VCT @ 55MA; Sec. #2: 5V @ 2A; Sec. 3: 6.3V @ 2A $3.95

Raytheon UX8724. Sec: 0.5V @ 0.5MA $1.35

Federal W15-38. Sec. #1: 300V @ 10MA; Sec. #2: 25V @ 500MA; Sec. #3: 6.3V @ 630MA; Sec. #4: 6.3V @ 450MA $3.95

Thordarson T92R21. Sec. #1: 770VCT @ 200MA; Sec. #2: 6.3VCT @ 3A; Sec. #3: 6.3V @ 1.5A; Sec. #4: 5V @ 3A $5.50

W.E. #KS8606. Sec. #1: 108V @ 177MA; Sec. #2: 5.13V @ 4A; Sec. #3: 6.3V @ 1A; Sec. #4: 2.5V @ 7.5A $3.95

Westinghouse Type GF. Sec. 20V @ 200VA $5.25

Raytheon U7420. Sec. #1: 225V @ 180MA; Sec. #2: 6.3V @ 2.5A $3.2

Bendix 530178. Sec. 1.5V @ .005 MADC $1.25

Raytheon UX6906A. Sec. #1 & #2: 6.3V @ 600MA; Sec. #3: 6.3V @ 2.25A $4.25

The following 115V 400 cy Primary

Raytheon UX8547. Sec. 1000V @ .0025A; Sec. #2: 6.15V @ 700MA $3.95

Sperry 702719. Sec. #1: 700 VCT @ 315MA; Sec. #2: 200VCT @ 100MA; Sec. #3: 18V @ 600MA; Sec. #4: 6.3V @ 15A; Sec. #5: 5V @ 6A $4.35

Raytheon UX8362C. Sec. #1: 6.3V @ 4.7A; Sec. #2: 5V @ 3A; Sec. #3: 6.3V @ .6A $3.50

Sperry #702541. Sec. #1: 1800VCT @ 60MA; Sec. #2: 350VCT @ 120MA; Secs. #3 & 4: 5V @ 3A; Sec. #5: 6.3V @ 5A; Sec. #6: 6.3V @ 2A $5.25

Sperry #702523. Sec. #1: 740V @ 12MA; Secs. #2 & 3: 2.5V @ 3A; Secs. #3 & 4: 6.3V @ 2.25A $3.25

W.E. #SP1035. Sec. #1: 900V @ 410MA; Sec. #2: 875V @ 410MA; Sec. #3: 780V @ 410MA $3.25

Federal #RA6404-1. Sec. #1: 550/0/165/550 @ 200MA; Secs. #2 & 3: 5V @ 3A; Sec. #4: 6.3V @ 2A; Sec. #5: 25V @ 2.2A $4.00

W.E. #KS8986. Sec: 990/875/780VCT @ 420MA $3.25

Raytheon UX8486A. Sec: 5V @ 5A 13.5KV Test $3.50

Raytheon UX7358. Sec: 1-6500V @ .005A $4.25

Stancor Modulation A3871. For single 6L6 (class) A1. Pri: 4500 Ohms; Sec: 8500 Ohms $1.75

Raytheon Output UX7489A. Pri: 3600 Ohm 70MA; Sec: 720 Ohm 0-MA $1.75

Raytheon Pulse WX5137. Pri: 4KV 1 Mu. Sec.: Sec: 16KV 16A $6.75

G.E. #68G457. Pri: 1/1.5/3.6/8/10V; Sec: 50-50V 100W $2.95

Raytheon #U7658B. Pri: 270V 60 cy; Sec: 13.5V @ 450MA $2.00

G.E. #69G500. Pri: 450V; Sec: 6V @ 3VA ....95¢

Federal RA6403-1. Audio. Pri: 8000 Ohm @ 9MA; Sec: 600 Ohm $1.6

Federal RA6408-1. Audio. Pri: 2500 Ohm; Sec: less than 1-Ohm $1.65

Amertran 23882 Audio. Output. Pri: 4000/1000 Ohms @ 0-MA; Sec: 4000 Ohms, DB level: +28 ....$1.95

Raytheon Interstage UX8442. Pri: —40V; Sec: +40V $1.00

W.E. Oscilloscope Input #ES677584-1 SC#4G1670A/T5 ....95¢

Federal Driver RA6407-1. Pri: Tapped Unbalanced 15000 Ohms @ .006A DC; Sec: 1770 Ohms; 200 to 5000 cy. ±1½ DB $1.75

DAVEN SOUND ATTENUATORS

Type 350-A. Network, ladder, linear, imped. 30/30 ohms. 2DB attenuation. 10 W dissipation $3.9

Westinghouse Watthour Meters

Type CS. 240V/60cy/1ph 15 Amp., 3 Wire, new $12.50

Type CS. 120V/60cy/1ph 15 Amp., 2 Wire, new $9.50

Type CA. 120/60cy/1ph 15 Amp., 2 Wire, new $9.50

W.E. Test Set 1-115 ....$9.50

MT/ARC5 Mounting Base provides anti-shock mtg for any 3 units Trans or Rec. of the ATA or ARC5 equip. $1.00

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book, $65.00. Used but like new $45.00

MOTORS AND GENERATORS

G.E. Model 5BA10A522, 24VDC, 0.55A, 10 oz/in torque 1400RPM $5.95

Universal Elec. #523, 115VDC, 1.2A 5000RPM ..$4.95

W.E. #KS5603, 24VDC, 0.6A, 5000RPM, Shunt wound $2.95

G.E. #5BY9E8, Permanent Magnet type, 140VDC. .025A 1800RPM $8.95

EMC. SPN37952. 32VDC, 1/30HP, Gear reduced to 21RPM $12.95

Gen'l Industries, 115VAC, 60cy, .65A 80RPM geared to 20-30RPM $3.95

Elec. Spec. Type JAI, 24VDC, 15A ¼HP, 3800 RPM $14.95

Warren Synch. Type B3. 115VAC, 60cy. 4W, 12 RPM $5.95

Eicor #M24718, 24VDC, 0.32A, 1800 RPM $5.95

Flyer Type 1623, 110VAC, 25cy, 30W 78RPM, gov. cont. $7.95

Dynamic HI-Press Axial Flow Fan. Mod 586SCR4, 24-28VDC, ½HP, 8000RPM, 225CFM. Used $8.95

Lear #COO4, 24VDC, 1.5A 7500RPM 8W $8.95

Oster Shunt Motor. Type E-7-5, 27½ Volts DC. 1/20 HP 3650 RPM ....Price $7.50

Oster Series Motor, Type C-2BP-1A, 27.5 Volts DC 1/100 HP 7000 RPM ....Price $8.50

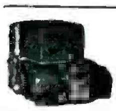
Westinghouse #1171391, 27VDC, ⅛HP, 6.5A, 5000 RPM, Series $9.95

Emerson #1610212. 24VDC. 160 oz/ft torque, 100 RPM $9.9

Elinco F-16 Rate Generator. 2 ph 1.3 volts/100 RPM $17.95

Autosyns, Pioneer AY-59D $24.95

DC SERVO MOTORS



White Rodgers Elec. Co. (6905X-46). 24 VDC @ .65 Amps. Torque 50 in/lbs. ½ RPM reversible, comp. w/limit switch, relays and selenium rectifiers on top of motor, to keep AC out of motor, 5x5x4 ..$12.95

Pioneer Gen-E-Motor Dynamotor #SS2669. Input 18V; Output 450V @ 150MA $3.95

CONVERTERS PU-16/AP, input 28VDC; output 115 VAC 400 cy. 6.5A $59.50

INVERTERS PU-7/AP, input 28VDC; output 115 VAC 400 cy. 21.6A $59.50

INVERTERS PE-218, input 28VDC; output 115VAC. 400 cy at 1.5 KVA $29.9

WIRE WOUND RHEOSTATS

Standard Brands

#241D, 250/250 ohms 50W w/½" shaft ....95¢

#241D, 300/300 ohms 50W w/½" shaft ....95¢

#241D, 400/400 ohms 50W w/½" shaft ....95¢

#50D, 30/30 ohms 50W w/½" shaft ....95¢

Model J, 16/16 Ohms 50W w/½" shaft $1.25

Model J, 0.5 ohms 50W ....95¢

Model J, 5 Ohms 50W ....95¢

Model J, 75 ohms 50W ....95¢

Model J, 150 ohms 50W ....95¢

Model J, 800 ohms 50W $1.25

Model J, 1000 ohms 50W $1.25

Model J, 5000 ohms 50W ....$1.

Model H, 60 Ohms 25W ....75¢

60 Ohms 25W ....65¢

Model H, 100 Ohms 25W ....75¢

Model H, 175 Ohms 25W ....75¢

Type PR, 15 Ohms 25W ....75¢

All size potentiometers and rheostats in stock. Write us your requirements on all carbon or wirewound.

BC-375E Transmitter complete w/tuning units. Brand New $50.00

DECK ENTRANCE INSULATORS

(Bowl and Flange Type)

Mfd. by Ohio Brass Co. heavy galv. metal flange 10½" D., porc. bowl set in rubber gaskets. Top bell 7¾" D. brass feed thru rod 10½" L. Insul. dist. between top bell and flange 6½" $3.9

HEAVY DUTY TRANSFORMERS

G.E. Cat. #7479965. Pri: 230V 60 cy Sec: 16.4/8.2VCT; 11/5.5V @ 60A. 8½H 9½L 6½W $25.00

G.E. Cat. #79G365. Pri: 203.5V 60 cy Sec: 6.3V @ 250 Amperes $39.50

G.E. Cat. #7479971. Pri. 230/208V 50/60 cy; Sec: 1365/1300/1235VCT 735VA. 7½ x 5½ x 8½ $29.50

G.E. Cat. #7479972. Pri: 230/208V 50/60 cy; Sec: 2450/2350/2210VMS. 2.85 KVA $49.5

G.E. Cat #7475695. Pri: 115V 60 cy. Sec: 3530 3720/3910 V. M.S. 1.31KVA $47.50

Maloney Elec. REL10383. Pri: 115/230V 50/60 cy. Sec: 0/21000 Volts @ 100 MA DC, Half Wave. 0.1 Filled. 16"D 16"W 20"H excl. of ins. $125.00

HIGH VOLTAGE REACTORS

Cat. #26F628 rated 0.1 Mu-F @ 12KV DC ....$ 4.95

#7520 rated 2 x .1 Muf @ 7500 VDC 17.50

Cat. #14F64 rated 0.25 Mu-F @ 20KV DC 17.50

Cat. #14F71 rated 0.25 Mu-F @ 32.5 KV DC.. 35.00

Cat. #A7548 rated 2x.25 Mu-F @ 6000 VDC.... 12.50

CD Paper rated 0.5 Muf @ 25 KV DC 45.00

#RC-2151 rated 2x.5 Muf @ 9000 VDC 25.00

Cat. #120063 rated 0.65 Mu-F @ 12.5 KV DC.. 15.00

Type FP rated 1.0 Mu-F @ 10 KV DC 32.50

Cat. #14F63 rated 1.0 Mu-F @ 15 KV DC $37.50

Cat. 15F5 rated 1.0 Mu-F @ 20 KV DC 45.00

Cat. #AE6734 rated 1.0 Mu-F @ 25 KV DC.... 55.00

#TK60020 rated 2.0 Muf @ 6000 V DC 22.50

Cat. #14F338 rated 4.5 Muf @ 7500 V DC.... 35.00

Cat. #14F13 rated 5.0 Muf @ 10 KV DC 45.00

ELAPSED TIME METERS

Mfd. by R. W. Cramer Co. Type RT-2H. 0-10,000 hours by tenths. 115 Volts 60 cycle. Large Quantity Available $9.75

REACTORS AND CHOKES

Raytheon #U11010. Rated 10H @ 1.2 A DC....$49.95

G.E. Cat. #7479974. Rated 2.5H @ 2.3A DC..$37.50

G.E. Cat. #7479964. Rated 50H @ .025A DC..$27.50

Ind. #CK3016. Rated @ 20H @ 60MA DC $2.95

Thordarson #T48853. Rated 6H @ 80MA DC...$1.50

Raytheon #U-7423. Rated 1.2-1.6H @ 0.0MA DC $2.25

Raytheon #U-6313. Rated 0.016H @ 14A DC..$5.50

Raytheon #UX8887D. Rated 30H @ .03A DC..$120.00

Volt Test $5.25

G.E. Cat. #7472403. Rated 5H @ .035A DC 4KV Test $2.35

Thordarson #T45921. Rated 7H @ 0.9A DC 10KV Test $19.50

Raytheon UX9114A. Rated 0.100H @ 1.4A DC..$3.00

Zenith 95G40. Rated 150H @ 1.0 MADC $2.25

Raytheon UX9116. Rated 0.30H @ 2.0A DC....$3.00

Raytheon WX-5148. Dual. Rated 1.75/1.75 @ 0.25/0.25A DC $3.5

W.E. Sine Wave Generator KS5913L02 16V 2 Ph. 1725 RPM, driven by W.E. motor KS5913L01. 115V 60 cy. 1 Ph. 1/50 HP 1725 RPM $17.95

G.E. SIGNAL GENERATORS TVFL EX-1-A, designed for aligning 152-162MC FM receivers. Complete less crystal $24.50

JACK BOX BC-1366, contains plugs, selector switch, potentiometer, etc. ....25¢

G.E. VOLTAGE REGULATOR MODEL 3GVD11B6, for use w/115V 60 cy supply, 23-35KV complete w/10 Tubes $49

RELAYS

G.E. #CR2791- B100J4, 3PDT, 6VDC, 15A Contacts $1.25

Allied DO9D28, 3PDT 6VDC, 15A contacts $1.35

Leach Type 1054ARV, 3PST on make, SPST on break, 20-32 VDC, 15A contacts $1.25

G.E. #CR2791-B100F3, DPDT 24 VDC 5A contacts 75¢

G-M #13013, DPDT, 24 VDC, 15A Contacts ....95¢

Price #311, DPDT, 28 VDC, 10 Amp cont. 1900 ohm coil ....95¢

G-M #13020, DPST on make, 3PST on break, 24VDC, 15A contacts $1.25

Allen Bradley X89309, SPST double make, 24VDC 200 A $2.50

A-B Bulletin X95545, type B6B, SPST Double Make, 24 VDC, 200 Amp $2.50

Dunco Thermal Time Delay 115 VAC 60 Cy, SPST, 1 min delay ....$1.

RECTIFIERS

IT&T Selenium, Bridge, #EE29, 10 plates 1" dia. Input 18VAC Output 14VDC @ .15A $2.25

IT&T Selenium, Half Wave, #FE4, 4 plates 1⅜" dia. Input 18VAC Output 7.5VDC @ .45A $1.00

Westinghouse #103B Copper Oxide, Half Wave, 4 plates 1⅝" D. Input 4VAC Output 3VDC @ .25A. $1.75

G.E. Model 6RS5F10, Selenium, Full Wave, 24 plates 1" D. Input 54VAC Output 36VDC # .2A $3.95

B-L #BL202S1, Selenium, Full Wave, 24 plates 1" D. 220VAC Output 180VDC @ .0075A $3.95

Westinghouse #854029A, Copper Oxide 13 plates 3⅝" D. Bridge, Input 65VAC Output 45VDC @ .32A ..$9.95

HEAVY DUTY COPPER OXIDE RECTIFIERS

FEDERAL TEL & RADIO DC POWER SUPPLY, Input: 220 volts 60 cy 3ph. Output: 28 volts DC 130 Amperes cont. duty. Complete w/meters. Like new $275.00

HAMMETT ELECTRIC RECTIFIERS MODEL SPS-100B. Input: 220 volts 60 cy 3 ph 13A. Output: 15 volts at 130 Amperes. 30 Volts at 65 amperes. cont. duty. Complete w/volt and ammeters. Like new $225.00

MALLORY RECTOSTARTER TYPE APS-20. Input: 230 Volts 60 cycle 3 ph. Output: 12 VDC at 600A for 1 min. 200A for 1 hr., 130A cont. Output: 24VDC at 300A for 1 min., 100A for 1 hr., 65A cont. Complete w/volt and ammeters. Like new $225.00

ALL MERCHANDISE BRAND NEW UNLESS OTHERWISE NOTATED

ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FROM RATED CONCERNS ON OPEN ACCOUNTS NET 30 DAYS. MINIMUM ORDER $3.00

ESCO ELECTRO Sales Co.

Dept. E 110 PEARL STREET BOSTON 10, MASS. LIberty 2-7890

METERS

3 MA DC 2½" R—Simpson black scale........$3.35
500 Microamps, DC—2½" round—Sun.......... 4.30
1 ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric......... 2.95
2 amp. RF 2½" Sq.—Simpson................ 3.15
5 amp. AC 4½" R.—JBT..................... 4.11
10 amp. RF 3½" R.—Simpson................ 4.95
50 amp. AC 3½" R.—General Electric......... 4.11
3 amp. RF 3½" R.—Weston.................. 6.00

MAGNETRONS

2J21A	2J36	2J61	706CY
2J22	2J37	3J31	706FY
2J26	2J38	5J23	706GY
2J27	2J39	5J29	714AY
2J31	2J40	700B	718AY
2J32	2J41	700C	718BY
2J33	2J48	700D	720B/C/DY
2J34	2J49	706AY	725A
		706BY	730A

KLYSTRONS

2K23	2K33	417A	723A/B
2K25	2K45	707A	726A
2K26	2K54	707B	726B
2K29	2K55	723A	5611

OIL-FILLED HIGH VOLTAGE ISOLATION TRANSFORMERS

Pri. 400V 60 cy. Sec. 115V 200VA Insulated for 50KV DC—G. E. Form EIR—36"H x 13"D......$125.00
Pri. 115V 60 cy. Sec. 115V 250VA Insulated for 35KV DC—G. E. Form EIR—29"H x 12½" D....$125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-1 and 9001934G-1 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D.........................$77.50

2ϕ LOW INERTIA SERVO MOTORS

KOLLSMAN Type 936-0240—85/68V 100 cy 5 watts 2650 RPM—new..............................$12.95
DIEHL, Type FPE-25-11 75V 60cy 4 watts—new $34.50

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC	Price
2	600		$ .45	.1	2500	$ .69
4	600		1.65	1–1	2500	3.85
4	600	R'd	1.65	32	2500	15.80
6	600		1.85	3x.2	4000	2.95
8	600	R'd	1.85	1	5000	4.88
10	600	R'd	1.95	.01–.03	6000	1.65
8–8	600		1.95	.1	7000	1.79
1	1000		62	.045	16KV	4.70
2	1000		89	.05	16KV	4.95
4	1000		1.85	.075	16KV	8.95
8	1000		2.45	.25	20KV	18.95
1	1500		.89	50	220VAC	4.95
4	1500		2.95	7	660VAC	4.25
.1–.5	2000		.87	8	660VAC	4.50
1	2000		1.95			

HIGH VOLTAGE TRANSFORMERS

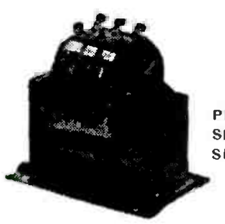
G.E.—Pri. 115V 60 cy
Sec. 6250V 80 MA—12.5 KV Ins............$18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins...........................$18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed...................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	4.00	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

AT-38A/APT (70 to 400MC)..................$13.70
AT-49/APR-4 (300 to 3300MC)................ 13.70
DZ-2 Loop antenna with pedestal............22.50
AN-74B (125 to 150MC)..................... 3.25
AN-65A (P/O SCR-521)...................... 1.50
AN-66A (P/O SCR-521)...................... 1.75
AIA-3CM conical scan......................125.00
ASB Yagi—5 element 450 to 560MC........... 7.00
ASB Yagi—Double stacked 6 element.......... 12.70
ASA Yagi—Double stacked 370 to 430MC...... 29.40



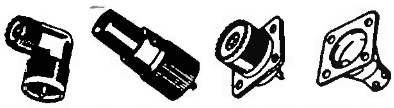
WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$ .45	83-22AP	$1.10
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.50	83-22SP	1.15
83-1H	.10	83-1SPN	.50	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF		N	BN	BNC	
UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-83	UG-106	MX-195	UG-264
UG-21	UG-29	UG-85	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-86	UG-109	UG-201	UG-275
UG-22	UG-34	UG-87	UG-146	UG-206	UG-290
UG-22B		UG-88	UG-166	UG-236	UG-291
			UG-167		UG-306
			UG-171		

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg SS	
2500	SS	40K	SS	2.5 Meg SS	
4K	SS	50K	SS	5 Meg SS	
5K	SS	50K	1/4"		

DUAL "JJ" POTENTIOMETERS

50	SS	500	SS	1 Meg SS
100	SS	1K	SS	2.5 Meg SS
250	SS	2500	SS	5 Meg SS
330	SS	10K	SS	1K/25K 3/8"

TRIPLE JJJ POTENTIOMETERS

100K/100K/100K—⅜" 20K/150K/15K—⅜"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets.....................$8.92 ea.

F. W. BRIDGE SELENIUM RECTIFIERS

AC Volts Input — 18		AC Volts Input — 40	
DC Volts Out — 14.5		DC Volts Out — 34	
1.3 Amps	$3.85	0.6 Amps	$4.60
2.4 Amps	4.95	1.2	5.95
6.6 Amps	7.75	3.2	8.95
13.0	12.75	6.0	15.50
17.5	15.75	9.0	17.50
26	22.75	12	26.95
39	35.50	18	32.50
52	38.50	25	42.50
70	49.50	36	55.50

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400cy. 1 ϕ; DC 30 Volts 60 Amps. Brand New..........................$38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing..$15.50

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
2D23	FG-105	KU-628	2050
3C31	FG-166	KU-634	2051
4C35	FG-172	WL-652	5550
C5B	FG-178	WL-672	5551
5C22	RX233A	WL-677	5552
C6J	FG-235A	WL-681	5557
FG-17			5560
FG-33			

TEST EQUIPMENT

- I-222A Signal Generator..................* $79.50
- I-72K Signal Generator....................$48.50
- Vibrotest Mod. 218 Megger...............* $45.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps. ....* $9.00
- TS-127/U Freq. Meter w/spares.............$69.50
- TS-143/CPN Oscilloscope ....* $95.00
- Dumont 175A Oscilloscope................*$225.00
- LM-20 Frequency Meter....................* 49.50
- Gen. Radio 757-P1 Power Supply..........* $27.00
- I-130 A Signal Generator................* $70.00
- TS-6/AP Frequency Meter.................* $42.00
- L & N KS-7470 Null Volt Test Set........* $60.00
- A.W. Barber Labs. VM-25 VTVM............* $86.00
- TS-10A/APN Delay Line Test Set............$45.00
- TS-19/APQ-5 Calibrator $75.00
- REL W-1158 Frequency Meter 160-220 Mc.$32.95
- CW1-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars..........................$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC..............................$11.75
- 3 CM. Pickup Horn Antenna..................$9.95
- Gen. Radio 736A Wave Analyzer...........* $600.00
- I-138A Signal Generator—10 cm...........* $185.00

All Items New Except Where Noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter.................$ 9.87
Powerstat 1226—115/230V Input—0-270V out @ 9 amp.................................. 37.00
EIMAC 35 TG Ionization Gauge................ 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W.. 22.95
ID-6/APN-4 Indicator 29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
FL-8 1020 cycle filter...................... 1.75
RM-29 remote control unit................... 8.95
RM-14 remote control unit................... 8.95
RTA-1B 12/24 V dynamotor................... 40.00
BC-1206-CM2 Receiver 12.95
CY-230/MPG-1 Radar Console..................575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete................. 69.75
AN/APS-13 less tubes........................ 12.95
T-9/APQ-2 less tubes........................ 16.50
RCA AVR-15 Beacon Recvr..................... 15.50
TBY Trans-Recvr 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used)...................... 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 ϕ.................................. 39.50
Navy SD-3 Radar complete...................1200.00
Navy DP-14 Direction Finder complete..... 385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse PH-1	W.E. D-163325
Westinghouse 132-AW	W.E. D-164661
Westinghouse 139BW2F	

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A. and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW.........................$147.

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 Microsec. 200 PPS. 67 ohms Imped. 3 sections.......$4.30
7.5 E3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS. 67 ohms Imped. 3 sections.......$6.75
7.5 E4-10-60-67P. 7.5 KV, "E" Circuit 4 sections. 16 microsec. 60 PPS. 67 ohms imped........$8.25
15 E-4-91-400-50P, 15KV "E" circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections.......$12.00
15-A-1-400-50P, 15KV, "A" Circuit, 1 microsec. 400 PPS. 50 ohms imped....................$37.50
15 E7-2-200-50P, 15KV "E" Circuit, 2 microsec. 200 PPS, 50 ohms imped., 7 sections......$42.00

SYNCHROS

Size 1, 3, 5, 6, 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

AY-101D	5G	N	C-78248
AY-120D	5N	X	C-78249
AY-130D	6DG	2J1F1	C-78410
1F	6G	2J1G1	C-78411
5B	7DG	2J1H1	C-78415
5CT	7G	C-44968-6	C-79331
5D	A	C56701	C-78254
5DG	B	C-69405-2	C-78670
5F	M	C-69406-1	

SEND FOR COMPLETE LISTING

SYNCHRO CAPACITORS IN STOCK

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715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

RADAR — COMMUNICATIONS EQUIPMENT COMPANY — MICROWAVE

23,000 to 27,000 Mc BENCH TEST PLUMBING
½" to ¼" Waveguide

TR-ATR-SECTION. Choke to cover..............$4.00
FLEXIBLE SECTION 1" choke to choke........$5.00
"S" CURVE CHOKE to cover....................$4.50
ADAPTER, round to square cover..............$5.00
FEEDBACK to Parabola Horn with pressurized window..........$27.50
90° TWIST..........$10.00
"K" BAND DIRECTIONAL COUPLER......$49.50 ea.
LOW POWER LOAD..........$20.00
SHUNT TEE..........$35.00
WAVEGUIDE LENGTHS 2" to 6" long, gold plated with circular flanges and coupling nuts $2.25 per inch
APS-34 ROTATING JOINT..........$49.50
RIGHT ANGLE BEND E or H Plane, specify combination of couplings desired..........$12.00
45° BEND E or H Plane, Choke to cover..........$12.00
MITERED ELBOW. cover to cover..........$4.00

8500-9500 MC BENCH TEST PLUMBING

AN/APS-15A "X" Band compl. RF head and mod. inch 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1B24, TR, rcvr ampl. duplexer, KW apx. input: 115, 400 cy. Modulator pulse duration .5-2 microsec., apx. 13KV. PK. Pulse, with all tubes incl. 715B, 829B, BKR 73, two 72's. Complete pkg..........$375.00
90 DEGREE TWIST. 6" long..........$8.00
BULKHEAD FEED-THRU ASSEMBLY..........$15.00
PRESSURE GAUGE SECTION 15 lb. gauge and press nipple..........$10.00
PRESSURE GAUGE, 15 lbs..........$2.50
DUAL OSCILLATOR-BEACON MOUNT. P/O APS10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields..........$42.50
DUAL OSCILLATOR. MOUNT. (Back to back) with crystal mount, tunable termination attenuating slugs..........$18.50
DIRECTIONAL COUPLER. UG-40/U Take off 20 DB..........$17.50
ROTARY JOINT. Choke to choke..........$10.00
2K25/723 AB RECEIVER local oscillator Klystron Mount. Complete with crystal mount. Iris coupling and choke coupling to TR..........$22.50
TR-ATR DUPLEXER section for above..........$8.50
CU 105/APS 31 Directional Coupler 25 DB..........$25.
723AB MIXER—Beacon dual Osc. Mnt. w/xtal holder..........$12.00
TR-ATR SECT APS 15 for 1B24 w/724 ATR cavity w/1B24 & 724 Tubes. Complete..........$21.0
STABILIZER CAVITY with bellows..........$21.
3 CM 180° BEND, with pressurizing nipple ea. $6.00
3 CM. 90° BEND, 14" long 90° twist with pressurizing nipple..........ea. $6.00
3 CM. "S" CURVE 18" long..........ea. 15
3 CM. "S" CURVE 6" long..........ea. $3.50
3 CM. RIGHT ANGLE BENDS. "E" plane 18" long cover to cover..........ea. $6.50
3 CM. CUTLER FEED DIPOLE. 11" from parabola mount to feed back..........ea. $8.50
3 CM. DIRECTIONAL COUPLER. One way waveguide output..........ea. $15.00
2J42 PULSE MODULATOR, 14 Kw max. rating, 7kw min. Plate voltage pulsed 5.5 kv. 6.5 amp. .001 duty cycle, 2.5 usec pulse length max, filament 6.3v, amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24..........$75.00
3 CM SECTOR SCANNING ANTENNA, 18" dish, cutler feed dipole, 24 vdc drive motor..........$75.0
APS-3 RADAR, new and complete, using 725A magnetron..........$950.00
TS 36 X BAND POWER METER 1½" x ⅝" waveguide; thermistor bridge with indicating meter, complete..........$175.00
"X" BAND PREAMPLIFIER, consisting of 2-723 A/B local oscillator-beacon feeding waveguide and TR-ATR Duplex sect. incl. 60 pic. IF amp....$47.50
15 DEG. BEND 10" choke to cover..........$4.50
5 FT. SECTIONS choke to cover. Silver plated..$14.50
18" FLEXIBLE SECTION..........$17
TR CAVITY for 724 A TR Tube..........$3.
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..$10.00
ROTARY JOINT with slotted section and type "N" output pickup..........$17.50
WAVEGUIDE SECTION 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend..........$4.50
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 w. deck mount..$17.50
3 CM. MITRED ELBOW "E" plane unplated...$12.00
1¼ x ⅝" Waveguide Tunable Termination. Precision adjust..........$65.00
LOW POWER TERMINATION..........$25.00
MAGIC TEE..........$45.00
90 DEGREE ELBOWS, E or H plane..........$12.5
WAVEGUIDE LENGTHS. Cut to size and supplied with 1 choke, 1 cover, per length......$2.00 per ft.
BI DIR-COUPLER WG output calibrated — 25 db nominal..........$17.5
FLEX SECTIONS, 12" Rubber Coated..........$14.50
MITRED ELBOW H Plane UG51-UG52..........$12.0
6" ST. SECT. choke to choke..........$3.50
APQ 13 Constant Z Rotat Jnt..........$22.50
CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD..........$10.00
WAVE GD. RUN 1¼" x ⅝" Gd. consists of 4 ft. sect. w/RT angle bend on one end, 2" 45 deg bend on other end..........$8.00
SLUG. TUNER ATTENUATOR W.E. guide. Gold Plated..........$6.50
APS-10 TR/ATR DUPLEXER section with additional iris flange..........$10.00
WAVEMETER, 8500 to 9400 Mcs., with calibration. Micrometer adjust head. Reaction type......$85.00
90 DEGREES ELBOWS. E or H plane, 2½" radius

APS-4 COMPLETE 3 CM. RADAR SYSTEM. 40 KW peak transmitter, pulse modulator, receiver, using 723AB power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet. Less receiving Type Tubes, but including all others, in used but excellent condition—This price for laboratories, schools and experimental purpose only. See our ad in Electronics for July, 51.

3000 MC BENCH TEST PLUMBING

10 CM RF PACKAGE, using 2J22 magnetron, freq. range 3267-3333 mc, complete with power supply and pulser giving apx. 20 kv @ 30 A. 1 usec, 1000 PPS Power output 265 kw. ⅞" rigid coax plumbing throughout. Uses 417A klystron mixer, 6Ac7 preamp. Pulser is 715 B HARD TUBE. Complete RF unit, pulser unit, receiver front en, new, with tubes. Requires 115v. 400 cy ac primary source..........$38
POWER SPLITTER: 726 Klystron input dual "N" output..........$5.0
MAGNETRON COUPLING FOR TYPE 720 MAG. 1½" x 3" Waveguide..........$35.
10 CM WAVEMETER WE type B43549 Transmission type. Type N Fittings Veeder Root Micrometer dial, Gold Plated W/Calib Chart P/o Freq. Meter X66404-A. New..........$99.50

RC 224-SCR 717 ANTENNA

Radar antenna designed for 10 cm 360 degree rotation, Apx. 15 degree tilt. Heavy base capable of great weight support and high wind stress. Brass gear train. Equipped with 30" parabola, ⅞" rigid coax pressurized, 28 VDC drive motor, position indicating selsyns. New, as illustrated, with 3000 MC pressurized feedback dipole.......... $87.50

MICROWAVE ANTENNA EQUIPMENT

3 CM ANTENNA WITH DISH 14 ". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanisms. Complete. New as shown..........$125.00
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 3'. New......$75.00
Dipole for above..........$12.00
TDY "Jam" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New..........$150.00
10 CM Horn, Rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange $50.00
Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes..........$35.00
Cone Antenna, AS 125 APR. 1000-3200 mc. Stub supported, with type "N" connector (as shown) $4.50
S.F. Radar Antenna. 10 cm. approx. 30" dish comp. with Selsyn and 150V drive motor..........$185.00
With motor driven turntable echo box..........$70.00

MICROWAVE TUBES

MAGNETRONS

Tube	Frq. Range	Pk. Pwr.	Output
2J27	2965–2992 mc.	275 KW	$25.00
2J31	2820–2860 mc.	265 KW	38.50
2J21-A	9345–9405 mc.	50 KW	12.50
2J22	3267–3333 mc.	265 KW	25.00
2J26	2992–3019 mc.	275 KW	37.50
2J32	2780–2820 mc.	285 KW	
2J38 Pkg.	3249–3263 mc.	5 KW	39.50
2J39 Pkg.	3267–3333 mc.	87 KW	39.50
2J49	9000–9160 mc.	58 KW	75.00
2J61	3000–3100 mc.	35 KW	75.00
2J62	2914–3010 mc.	35 KW	75.00
3J31	24,000 mc.	50 KW	85.00
5J30			
718DY	2720–2890 mc.	250 KW	35.00
720BY	2800 mc.	1000 KW	75.00
720CY	2860 mc.	1000 KW	75.00
725-A	9345–9405 mc.	50 KW	50.00
730-A	9345–9405 mc.	50 KW	50.00
700 A, B, C, D			35.00
706 AY, BY, DY, EY, FY, GY			55.00

KLYSTRONS

723A 723A/B—2K25

"CW" MAGNETRONS

QK 62 3150-3375 mc.
QK 59 2675-2900 mc.
QK 61 2975-3200 mc.
QK 60 2800-3025 mc.
New, Guaranteed..........Each $87.50

CR—TR—PULSE TUBES

705A	721	3EP1
3DP1	3FP7	5J30
3GP1	5CP1	15R

MANY OTHER TYPES AVAILABLE. SEND YOUR REQUIREMENTS.

APN-9 SPARES

MFR'S PT#	MFR'S PT#
352- 7250-2	352-7295-2
352-7251-2	352-1554-S

LARGE QUANTITY AVAILABLE

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 ops. 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 Energy 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

VARISTORS		THERMISTORS	
D-167176	$ .95	D-166288	$1.5
D-172155	$2.25	D-167332 (tube)	$1.50
D-172307	$1.	D-170396 (bead)	$1.50
D-167208E	$1.85	D-167613 (button)	$1.50
D-172175	$1.6	D-164699 for MTG "X" band Guide	$2.50
D-168687	$ .95		
D-171812	$ .95		

UHF CRYSTALS IN21 IN22 IN23

140-600mc Directional Antenna

140-310mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency.

New: complete with mast, guys, cables, carrying chest..........$49.50

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L X 4'W X 3'H. Unused....$250.00
Gov't Cost—$4500.00

DBM ANTENNA. Dual back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism..........$65.00

30' SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps #2A289-223-A. New..........$39.50 per set

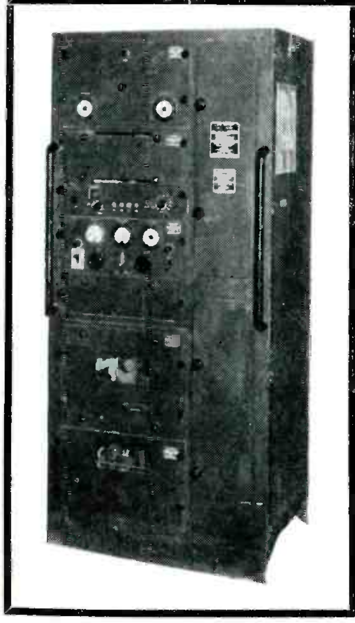
COMPLETE SELECTION OF RADAR REFLECTORS, PEELS UP TO 12 FT. IN LENGTH, DISHES UP TO 10 FT. IN DIAM.

All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E8 — P. I. PLISHNER — Phone: Main 4-8373

MICROWAVE — COMMUNICATIONS EQUIPMENT COMPANY — SONAR



RADAR EQUIPMENT MARK 4

TRANSMITTER SPECIFICATIONS:

Frequency (Mc) . 700.
R-f oscillator . . 700 magnetron.
R-f transmission system . . $\frac{7}{8}$" coax.
Modulator type . Hard tube.
R-f peak power (kw) . . . . 20.
R-f average power (kw) . . 0.046.
Pulse rate (pps) . 1639.3.
Pulse width (μs) . . . . 1.5.
Mounting . . . . . Below deck.

OPERATING CHARACTERISTICS:

Minimum range (yards) . . 1,000
Maximum range measuring capabilities (yards) 100,000
Power supply.—2.7-3 kva, 90-130 volts (adjustable power transformer), 60 cps, single phase.

RECEIVER SPECIFICATIONS:

Type . . . . superheterodyne.
Stages:
Mod 0; 1 r. f. . . . } 4 i. f.;
Mod 1, 2, 3; 2 r. f } 1 video.
Local oscillator . . . . . 316 A.
Mixer . . . . 703 A.
Intermediate frequency (Mc) . . . . 32.
Sensitivity (μv):
Mod 0 . . . . 17.
Mod 1, 2, 3 . . . . . . 4.
Special features . . . . AGC (Mod 1, 2, 3 only).

FREQUENCY

The transmitter uses a magnetron oscillator, the operating frequency being partially determined by the physical dimensions of the tube. Four classes of tubes are available, having nominal frequencies of 685, 695, 705, and 715 megacycles. The receiver is designed to cover continuously the frequency range of 550 to 720 megacycles.

MODULATION GENERATOR

The modulation generator, the top unit in the cabinet, contains a 1639-cycle oscillator, a pulse generating circuit, and a rectifier-doubler and filter network. Nonlinear coils are used for the generation of sharp pulses from the sine wave current output of the oscillator. These pulses, when passed through the pulse amplifier in the transmitter, are approximately 1 microsecond in duration at the toop, and 2 microseconds at the base. Two outputs are used for synchronization of the range-indicating units: one, a 1639-cycle sinewave, is a portion of the oscillator output: the other is a 29.5-kilocycle sinewave obtained from the pulse by doubling and filtering.

RADIO RECEIVER

The receiver employs a converter tuned at the input with coaxial-line sections for maximum power transfer, a beating oscillator, four intermediate-frequency (i-f) amplifier stages, a detector and a low-frequency amplifier for monitoring observation.

POWER CONTROL PANEL

The front panel of the power control unit, contains the LOAD VOLTAGE, PLATE CURRENT, and PLATE VOLTAGE meters, the LOAD, MAG FIL, and PLATE CAP variable transformer controls, the RADIO SET-STANDBY HEATERS and PLATE voltage switches, and the indicator lamps. The variable transformer voltage regulators are mounted on the back vertical panel of the frame.

RADIO TRANSMITTER

Below the power control panel in the cabinet is the radio transmitter. It houses the complete high-frequency transmitting oscillator and the pulse amplifier which controls its operation. The high voltage supply is automatically connected when the unit is fully in place in the cabinet. The transmitter output is connected to the duplexing panel through a coaxial line mounted on the frame.

HIGH VOLTAGE RECTIFIER

The lowest panel in the cabinet is the high voltage rectifier, a full-wave single-phase rectifier employing two high vacuum tubes suitable for low average current drain incident to pulse operation and capable of supplying the plate potential required for transmitter.

DUPLEXING PANEL

To permit the use of a common antenna and transmission line, an arrangement of coaxial transmission line sections and a special gas-filled tube are provided.

PRICE COMPLETE WITH TUBES (AS ILLUSTRATED) $625

SONAR — SONAR — SONAR

Magneto-striction heads - - - High power oscillators - - - Rochelle Heads and hydrophones - - - Training hoist mechanisms - - - Complete Sonar Systems, i.e. QBC, QBE, QBF, QCL, QCQ, etc.

write *write* *write*

TEST SETS

TS 102/AP	TS 250/APN
TS 62/AP	TS 89
TS 35/AP	I-203-A
TS 12 UNIT 2	TS 110/AP
TS 69/AP	BC 438
TS 33/AP	CS60-ABW
CW60-ABM	I-158
LU-1	I-222
LU-3	I-185
TS 159	
TS 226	TS 268/U

SEND FOR FURTHER INFO. & PRICE

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
7.5E3-3-200-6FT, 7.5 KV, "E" Circuit, 3 microsec 200 PPS 67 ohms imp, 3 sections $12.50

MICROWAVE ANTENNA EQUIPMENT

AS 17/APS

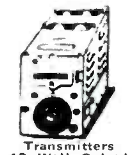
Radar antenna designed for 10 cm 360 degree rotation, Apx. 15 degree tilt. Heavy base capable of great weight support and high wind stress. Brass gear train. Equipped with 30" parabola, $\frac{7}{8}$" rigid coax pressurized, 28 VDC drive motor, position indicating selsyns. New, as illustrated, with 3000 MC pressurized feed-back dipole **$87.50**

SA Radar, 200 MC bedspring array. Complete with drive mechanism, etc., like new $850.00
ASD 3 CM sector scan antenna. Complete with cutler feed dipole. 15" parabola, drive motor, position indicating selsyns, rotary joint $37.50
Bellini-Tossi Direction Finder Cross Loop Assy's for Navy Dav. Radar. New and complete $275.00
AS14A/AP, 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors $3.50
AS46A/APG-4 Yagi Antenna, 5 element array . . $22.50
30" Parabolic Reflector Spun Aluminum dish $4.85

All merch. guar. Mail orders promptly filled. All prices F.O.B. N.Y.C. Send M.G. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E8 P. J. PLISHNER **Phone: Main 4-8373**



Transmitters
40 Watt Output
These Famous
V.F.O. Drivers
Available
4—5.3MC. $5.95
5.3—7MC. 3.95
274N (ARC5)
Used Good Cond.

VARIABLE TRIMMER CONDENSERS

C890	15	MMF
C881	20	MMF
C993	50	MMF
C677	60	MMF

30c ea.

CAPACITORS CERAMICON

MMF.	MMF.	MMF.
3	35	82
3.1	47	125
4	50	200
11	51	240
13	60	250
14	62	345
15	65	350
20	70	500
220		1000
25		

$7 per 100

NEW!! ELECTROLYTIC CONDENSERS

ELECTROLYTICS Prong Mount D. Y. Type

Mfd.	Volt
80	150
60	300
40	250
80	250
80	300
30	300
100	150
20-20	400-25
2x30	25
20-10	150
40-20	150-25
150-50	25
40	150
2x10	150
10-2x20	400-50
Price.....	18c ea.

Mfd.	Volt
2x20(60)	450(350)
2x30(20)	350
80-40(150)	400(50)
2x40(20)	350(25)
20-10(50)	450(50)
50-40	425
Price.....	49c ea.

250-1000	10-6
2x15-1200	150-1.6
10-50-00	350-100-50
1000-500	6
1000	
Price....	69c ea.

50	500
50	400
80	450
100	350
2x4	500
2x8	450
20-80	450-350
15-10	450
80-10	400
80-20	450-350
3x8	150
3x10	150
800	15
30	450
32	450
2x10	350
2x15	350
8	450
20-10	350-300
2x15-20	350-25
2x10-20	450-25
2x8-10	35
Price.....	29c ea.

80	500
40	450
100	400
90	450
2x10	450
2x20	400
2x20	450
20-8	500
2x80	300
40-10	450-350
40-35	450-350
80-20	450
80-10	450
3x16	350

8-50	450-50
40-50	400-300
40-10	475
90-10	350
3x10	450
50-40	450
90-10	350
40-15	450
2x30	350
16	450
2x16	450
20-10 (50)	450 (50)
20 (250-100)	150 (15)
80-50	450-50
2x8 (10)	450 (25)
10-15 (20)	350 (25)
2x16-25	450-50
2x10-20	450-25
10-10-20	450
Price.....	39c ea.

MINICAPS PIGTAIL

Mfd.	Volt	Price
2	50	$0.10
4	50	.10
4	100	.15
4	150	.10
4	220	.18
5	25	.10
5	50	.10
5	150	.10
8	25	.15

8	100	.18
8	150	.18
8	350	.20
10	50	.18
10	150	.20
12	450	.23
16	100	.20
16	150	.22
16	300	.30
16	450	.40
20	25	.10
20	50	.15
20	80	.18
20	350	.30
24	350	.30
25	25	.10
30	300	.25
30	450	.30
40	150	.22
40	450	.40
50	25	.22
50	50	.25
50	150	.30
100	50	.60
250	15	.50
500	8	.60
500	25	.75
1000	6	1.20
2000	6	1.35
1200	1.5	1.10

8-8	450	.60
8-16	450	.65
10-10	150	.30
10-10	450	.35
16-16	450	.70
20-20	150	.40
20-20	450	.50
40-20	450	.55
50-50	150	.40
50-30	150	.35
70-70	175	.85

AVAILABLE
1,000,000
BATHTUBS
250,000
HIGH VOLT
CONDENSERS
WRITE OR
PHONE FOR
LISTS

LARGE ASST. OF PIGTAIL MICAS IN STOCK WRITE

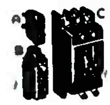
AC COND.
Motor Starting
Fig. C

13-15	220	$1.20
20-24	110	1.00
26-30	220	1.35
43-65	110	1.25
43-48	110	1.25
50-75	110	1.25
53-60	220	1.50
61-69	320	1.60
64-72	110	1.25
72-87	110	1.25
75-84	110	1.25
88-106	110	1.50
107-129	110	1.65
130-157	110	1.75
130-150	70	1.50
130-180	110	1.85
158-191	110	1.85
161-180	110	1.75
189-210	110	1.95
200-220	110	1.95
270-300	110	2.10
324-300	110	2.40
378-420	110	3.00
432-480	110	2.75
485-580	110	2.95

WRITE FOR LISTINGS

EE89A TELEPHONE REPEATER

Used to extend range of field telephones, teleg. & 20 cyc. ringing possible over lines complete w/3Q5 tube & phone. Featherweight. Price $9.95

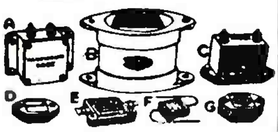


Heineman Ckt Bkrs for AC-DC operation.
AM 1510M 7 Amp
1614 80 Amp
1614 50 Amp
Price each $1.10

932 PHOTO TUBE

Gas Phototube having S1 response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data.
Price 75c

MICA CAPACITORS



THE CONDENSERS LISTED BELOW ARE NEW, UNMARKED, TESTED FOR CAPACITY. MFG BY SOLAR

XQ Lug Type E 1200 VT

MMF	Price
20	$.25
25	.25
28	.25
35	.25
58	.25
85	.25
100	.25
125	.25
130	.25
140	.25
150	.25
190	.25
200	.25
210	.25
225	.25
250	.25
375	.25
400	.25
500	.25
600	.25
750	.35
850	.35
925	.35
1000	.40
1150	.40
1175	.40
1300	.40
1500	.40
1850	.40
2000	.45
2250	.45
2300	.45
2500	.45
2575	.45
3000	.50
3450	.50
3900	.50
4000	.55
4250	.55
4280	.55
4550	.60
5500	.60
6000	.60
10000	.60
11500	.60
13800	.60
15500	.60

XQ Lug Type E 2500 VT

15	30¢
20	30¢
25	30¢
30	30¢
35	30¢
50	30¢
100	30¢
130	30¢
210	30¢
215	30¢
235	30¢
250	30¢
290	30¢
500	30¢
825	30¢
850	30¢
1150	35¢
1175	35¢
1750	35¢
1890	35¢
2000	40¢
2075	40¢
2100	.40
2150	40¢
2250	40¢
2400	40¢
2500	40¢
2550	40¢
2600	40¢
3000	45¢
3500	45¢
4000	45¢
5000	50¢
6000	50¢
7500	50¢
8000	50¢
8500	50¢
10000	55¢

XQ Lug Type E 5000 VT

5	35¢
10	35¢
15	35¢
20	35¢
35	35¢
58	35¢
40	35¢
68	35¢
100	35¢
130	35¢
150	35¢
190	35¢
200	35¢
250	35¢
325	35¢
425	35¢
470	35¢
500	35¢
515	35¢
525	35¢
750	35¢
825	35¢
850	35¢
1000	40¢
1250	40¢
5000	45¢

XM Screw Type D 1200 VT

38	35¢
40	35¢
50	35¢
125	35¢
140	35¢
425	35¢
500	35¢
850	35¢
1300	40¢
1700	40¢
2000	45¢
2900	45¢
4000	50¢
4200	50¢
4800	50¢
5000	50¢
5400	50¢
5500	50¢
6300	50¢
6700	50¢
6900	55¢
8500	55¢
10000	60¢
11500	60¢
16750	60¢
30000	60¢

XM Screw Type G 7500 VT

750	50¢
850	50¢
1000	55¢
1500	55¢
2000	60¢

XM Screw Type D 2500 VT

30	40¢
50	40¢
100	40¢
250	40¢
1000	40¢
1150	45¢
1250	45¢
1700	45¢
2000	50¢
2900	50¢
3000	50¢
3500	50¢
4000	55¢
4450	55¢
4750	55¢
5000	55¢
6000	60¢
6900	60¢
6950	60¢
7000	60¢
7400	60¢
8000	60¢
10000	65¢
12000	65¢
15000	65¢
16750	65¢
17000	65¢
17250	65¢
19700	70¢
20000	70¢
21000	75¢
25000	75¢
30000	80¢

XM Screw Type G 5000 VT

15	45¢
21	45¢
50	45¢
140	45¢
235	45¢
250	45¢
295	45¢
300	45¢
375	45¢
400	45¢
490	45¢
500	45¢
575	45¢
750	45¢
850	45¢
1000	50¢
1150	50¢
1250	50¢
1500	50¢
1700	50¢
1850	50¢

SELSYN TESTER

Magnesyn Instrument Field Tester AAF 43G23330 Spec. 40772. To test individual mag. Ind. & Xmitters, for isolating Faults in magnesyn systems. Brand new $99.00

HEADSETS

Dynamic Mike and Headset Combination. A high quality, efficient unit, used in B-19 tank Xmtrs. Mike and phones complete new $3.75

AUDIO TRANSFORMERS

ITEM		
AT666	Input 6 ohms: 250K ohms..............	$0.79
AT SUB	Multimatch Subonncer 200 ohms 15K ohms C. T.: 100K ohms/20K ohms	.69
AT070	Input to Grid 250 ohms: 60K ohms H1 F1	1.19
AT566	Input to Grid, 500/200 ohms: 50K ohms..	.95
AT353	Output PP 6L6 to 300/20/12/16 ohms 25 Watt..........................	2.95
AT871	UNIV. Output, H1 F1, Pri 20K ohms sec. 15/7.5/5/3.75/1.25/500 ohms...........	2.79
AT554	Interstage. 10K ohms: 250K ohms 15db Level..........................	1.95
AT765	Input 600 ohms to 50K ohms............	.79
AT419	Driver 5K ohm to 4K ohm PP6L6 to PP805 Class B..........................	3.89
AT21	Dual XFRMR 300 ohms: 300 ohms and 600 ohms: 250K ohms..............	1.35
AT415	Output 18K ohms CT to Line 125 ohms 175W..........................	2.95
AT649	Input. Line 500 ohms T grid, 75K ohms..	.79

WHOLESALE ONLY

Phone or Write for Quantity & Price
Digby 9-4124
ATT. MR. C. ROSEN

MICA CONDENSERS
SILVER MICAS
OIL CONDENSERS
ELECTROLYTICS
H.V. MICAS
PRECISION RESISTORS
PYRANOLS
TUBE CLAMPS
TIN. CABLE CLAMPS
DYNAMOTORS
INVERTERS
POWER TRANSFORMERS
FILTER CHOKES
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AUDIO TRANSFORMERS
400 cy. TRANSFORMERS
SHOCK MOUNTS
MAGNETRONS
PULSE TRANSFORMERS
CONTROL BOXES
TUBES
A.C. AND D.C. RELAYS
VIBRATORS
UG CONNECTORS
HEADSETS
MICROPHONES
INSULATORS
BINDING POSTS
WAFER SWITCHES
CERAMICONS
FERRULE RESISTORS
PL 54 PLUGS
JK type PLUGS
BATHTUB CONDENSERS
CIRCUIT BREAKERS
ARC-3 PARTS
BC 375 PARTS
MK. 11 PARTS
EE-8 PARTS
A/C HARDWARE
A/C FITTINGS

INSULATORS

Feeder Support IN81-IN82 Porc. Standoff 1-½ H x 1-3/16 D
10¢ ea., 10 for 75c

Feed Thru IN84-XS1. Complete w/Hdwre
15c ea., 10 for $1.25

Feed Thru Lapp Bowl Sim to XS3 for 2¾" hole. 6¾ L x 3" dia.
$1.25 ea.

ANT Insulators, IN86 3⅝ L x 1 x 1
18c ea., 10 for $1.50

Feeder Spreaders 2-11/16 x 7/16". 2" C to C Holes ....Price 10c

Feeder Spreaders 2⅛" L x ⅝" Sq. 1⅜ C to C Holes .....Price 8c ea.

Locke Suspension Ins Cat # CAL 61249. 18" L x 2" D ......Price $19.95

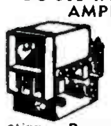
Telephone Knob Insulator Whiteall Tatum # 4. Heavy Glass.
Price $2.29

Many Others—Write

ANTENNA MAST

Are you in a dead spot? If you can't get a good T. V. Picture, here is a Sig. Corp. Ant. mast 30' high of rugged plywood construction to solve your problem. It telescopes into 3 ten ft. sect. for easy storage. Easy to Mnt. Comp. with stakes & rods.
Ea. $19.95

BC 605 INTERPHONE AMPLIFIER



Easily converted to an ideal intercommuincations set for office — home — or factory. Complete w/conversion diagram for 110V operation. **Brand New . . $4.49**

MOBILE MOD. KITS

T-103 Mike to 6J5 grid; T-102 6J5 to Modulators, PP 6V6 or PP 6L6; T-104 Mod. Trans. PP 6V6 or PP 6L6 to 829, 832, or 2E26. COMP. KIT & DIAG..........$2.98

UPRIGHTS

Mfd.	Volt	Type	Cat. No.	Price
.0025	1500	2TT	D164209	30¢
.03	600	2ST	RO3	25¢
2.0515	600	2TT		45¢
.05	400	2BT	616M	25¢
.05	600	2BT	C51481918–20	28¢
.05	600	2BT	7700BR	28¢
3x.05	300	3BT	NJOCA195	30¢
3x.05	300	3BT	CA195	30¢
.125–.05	400	2TT	CMR481380–40	25¢
.1	600	2BT	616M-14842	35¢
.1	600	2BT	R11-616MB	35¢
.1	400	2BT	418CB	30¢
.1	600	2BT	7701BR	35¢
.1	600	2BT	CP69B1AF101K	35¢
.1	400	2BT	XMRBW4–1	30¢
.1	600	2BT	C69B1AF104	35¢
2x.1	600	2BT	P9711	39¢
3x.1	400	3BT	CA255	39¢
3x.1	400	3TT	ROBC	39¢
3x.1	400	3BT		39¢
3x.1	600	3TT	C168B5EF104V	42¢
3x.1	600	3BT	7710BR	42¢
3x.1	600	3BT	CD516	42¢
2x125	400	2TT		
.25	800	2WTT		69¢
.4	600	2BT	M-7725BR	30¢
.25	600	2BT	C168B1EF254K	30¢
.5	600	2BT	SO1	32¢
.5	600	2BT	PO8	32¢
.5	400	2TT	416T	30¢
.5	600	2BT	616MB	32¢
2x.5	250	2TT	A-8B515	30¢
2x.5	400	3BT	418MCB	35¢
2x.875	400	2BT	CWS-P-72076-503	39¢
1	400	2TT	305–1605S	35¢
1	600	2BT	616MCB	38¢
1	600	2BT	YAB6100	38¢
1	250	2TT	CBV48553–15	30¢
1	100	1BT	104M59	25¢
1	600	2BT	616MCB	38¢
1	400	2BT	418MCB	35¢
1.75	50	2TT	CRY48861	45¢

PRECISION RESISTORS

1.01	128	2230	30000
3	150	4300	33000
5	200	5000	35000
5.05	250	7500	40000
10.1	300	8500	50000
18	430	10000	55000
43.5	468	12000	57000
50	800	17000	75000
75	920	17300	We ship
82	1000	20000	type in
120	1100	25000	stock
125	1450		

Above Ea . . . 30¢ Ten For . . . $2.50

100000	150000	200000	
120000	170000	220000	500000

Above Ea . . . 40¢ Ten For . . . $3.50
1,000,000 ohms .... Each 75¢

W. E. PRECISION RESISTORS

D–164886A	2.65 ohms
D–164886AA	3.83 ohms
D–167026	13,500/10,500 ohms
D–162025AT	1400/135/270 ohms
D–164285	40,600/1500 ohms

Price .75c ea.

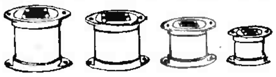
All mer. guar. Mail orders promptly filled. All prices F.O.B. N.Y.C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-8 Chas. Rosen Phone: Digby 9-4124

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

HIGH POWER TR. MICA

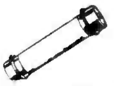


G-1 TYPE		G-2 TYPE		G-3 TYPE		G-4 TYPE	
.0001	6KV	.0001	10KV	.0001	20KV	.0002	30KV
.00015	5KV	.00015	10KV	.00015	20KV	.002	20KV
.0002	6KV	.0002	10KV	.0003	20KV	.0025	25KV
.0008	6KV	.000247	12KV	.0004	20KV	.004	15KV
.0047	6KV	.0003	10KV	.00045	15KV	.005	8KV
.005	5KV	.000375	10KV	.0005	20KV	.01	15KV
.01	4KV	.0004	5KV	.001	20KV		
.032	2KV	.0005	10KV	.0011	20KV		
.04	1KV	.00057	10KV	.0024	15KV		
.051	1.5KV	.00065	10KV	.004	12KV		
.08	1.5KV	.001	6KV	.25	1.6KV		
.09	1.5KV	.003	6KV	.25	6.KV		
		.003	8KV				

OTHER H.V. MICAS

.0001	12.5KV	.01	7KV
.007	15KV Type 75A	.02	8.5KV
.01	5KV		

H.V. GLASS FERRULE RESISTORS



Ohms	Watts	Ohms	Watts	Ohms	Watts
1	15	1000	50	6300	40
2.	20	1000	90	6500	120
2.2	15	1250	20	7500	15
4	90	1500	20	8000	90
5	15	1500	50	8200	40
6.2	15	1500	120	10,000	15
10	15	1600	40	10,000	40
15.	50	1800	15	10,000	90
20	15	2000	15	12,000	15
20	90	2000	20	12,500	15
26.	20	2000	50	12,500	90
32	90	2000	90	12,500	120
40.	90	2000	120	13,000	20
40.	120	2500	15	15,000	120
50.	15	2500	20	16,000	M-O-M
60.	20	2500	50	16,000	50
100	15	2675	38	16,000	90
100.	50	3000	20	20,000	50
125	90	3000	50	20,000	120
150.	50	3100	40	25,000	90
160	20	3100	90	25,000	120
200.	50	3150	15	35,00	120
270	20	3150	90	40,000	90
400	20	3300	20	50,000	MFC
600	40	4000	20	1000,000	120
630	90	4000	50	300,000	MFC
800.	50	4500	20	500,000	M-O-M
1000	13	5000	40	600K	MFC
1000	15	5000	50	4.0 Meg.	MFB
1000	20	6000	50	40.0 Meg.	M-O-M
1000	40	6000	120	100. Meg.	MVP

NOISE FILTERS

MALLORY NF.1-1	SOLAR EB 102
MALLORY NF12-6 EG	SOLAR ED-101
MALLORY NF12-7	SOLAR EF-100
SPRAGUE JX-51	SOLAR EF-102
SPRAGUE JX-55D	SOLAR EF-104
SOLAR EA 107	SOLAR EL-109
SOLAR EA 109	SOLAR EL-111
SOLAR EA 121	SOLAR EL-113
SOLAR EA 142	SOLAR FL 14, EV106
SOLAR EA 125L	SOLAR FL16, EV-125

LEVER SWITCHES

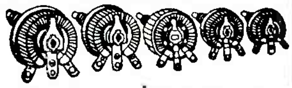
Over 100 Varieties in Stock of Mossman #4101 Series

1% PRECISION RESISTORS

Standard Brand

Ohms	Ohms	Ohms	Ohms
6.	500	5910	72K
24.	636	6000	75K
28.	680	6550	76100
34.6	733	6800	83700
35.7	743	7000	90K
38.6	750	7500	100K
40.	946	15K	110K
47.7	1000	17K	115K
75.	1250	18380	120K
78.8	1260	19500	125K
80.	1280	20K	130K
88.	1477	20500	135K
100	1485	21K	140K
107.85	2000	22K	145K
110	2142	29500	220K
125	2170	30K	235K
200	2500	32K	260K
215	2800	33800	347K
225	3460	37500	390K
248	3500	38140	500K
280	3760	39K	750K
286	4280	40500	800K
300	4500	47710	1.0 Meg.
370	5000	60K	4.0 Meg.
400	5294	61K	10.0 Meg.
450	5470	61430	
	5500	70K	

POWER RHEOSTATS



Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.98	225	50	2.53
.5	50	2.81	250	25	2.23
.5	150	5.93	250	50	2.53
1	50	2.81	300	50	2.53
2	50	2.81	300	100	4.27
2	100	4.68	350	25	1.98
2	225	6.59	350	100	4.26
2	300	8.42	370	25	1.98
3	100	4.67	378	150	6.59
3	225	6.58	400	25	1.98
3x3	300	29.95	400	75	3.90
4	225	6.60	500	25	1.98
5	25	1.97	500	75	3.95
5	100	4.68	500	50	2.53
6	25	2.23	500	100	4.39
6	75	3.90	500	150	4.68
7	25	1.98	585	150	6.60
8	50	2.53	750	25	2.23
10	25	2.23	750	150	5.95
10	100	4.27	1000	25	1.98
12	25	2.23	1000	150	5.93
12	50	2.53	1200	225	7.20
15	25	1.98	1250	50	2.66
15	75	3.90	1250	150	6.59
15	100	4.38	1500	25	2.53
20	50	2.53	1500	50	2.65
25	25	2.23	1800	150	6.24
50	25	1.98	2000	25	2.23
50	50	2.53	2000	50	2.53
60	25	1.98	2250	150	6.24
75	25	1.98	2500	150	6.24
75	75	3.90	2500	25	2.23
75	100	4.39	2500	50	2.53
80	50	2.53	2500	100	4.68
80	500	12.46	3000	25	2.39
100	25	1.98	3000	100	4.68
100	50	2.53	5000	25	2.53
100	100	4.39	5000	50	2.85
125	25	2.53	7500	50	2.85
150	50	2.53	7500	100	5.31
175	25	2.53	10000	50	3.12
185	25	1.98	10000	100	5.51
200	25	1.98	15000	25	3.29
200	100	4.27	20000	150	8.43

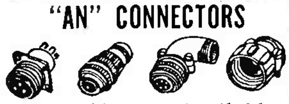
Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES

Pole	Pos	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	Bak-n/shtg	.89
2	2	1	Cer-shtg	.50
2	6	2	Bak-n/shtg	.60
2	11	2	Bak-n/shtg	.75
3	4	2	Bak-n/shtg	.58
5	3	2	Cer-n/shtg	.98
6	11	6	Bak-n/shtg	1.95
10	5	5	Cer-shtg	2.25
16	2	4	Bak-n/shtg	1.35

Many other types in stock

"AN" CONNECTORS



Large Variety Available At Great Savings

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

	FROM	
#926-A		#926-B22
#926-A1		#926-C
#926-A14	35c.	#926-C1
#926-B		#926-C5
#926-B1		#926-C10
#926-B7		#926-C24

MICROSWITCHES

A-#Y2-RS13 SPST "S" plunger. metal housing norm. op....... .59

B-#B-RS10 SPDT Type "S" plunger, 2-circuits: one op and one cl .... .59

#WZ-RL8 (not illus.) SPST leaf actuator, norm. cl......... .59

#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, norm. closed .... .59

C.G.E. SWITCHETTE 10a/115voltsAC

#CR-1070-C103A3 SPST closed.. .59

#CR1070-C103E3 SPST open .... .59

#CR1070-C103R3 SPST closed... .59

#CR1070-C123C3 DPST op/cl... .59

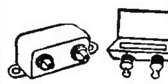
(Many other types in stock)

OIL CONDENSERS

Mfd.	Voltages Avail.
.1	3-6-20K
.25	2-3-3½-4-5K
.5	600-1½-3K
1	600-1-1½-2-5-6
2	400-600-1-1½-2 3-4K
4	600-700-1-1½K
6	400-600-1½-2K
8	600
10	600-2½K
15	600-1K
30	90-vac. 3-ph
100	230-vac. 3-ph
3x4	500
3x8	600
4x3	600
4x8	600
3x10	90-vac

Special Prices on Request

BATHTUBS



Mfd.	Voltages Avail.
.033	400
.05	2-4-600
.1	4-6-1K
.15	600
.25	2-4-600
.35	400
.5	4-6-1K
.75	600
1	1-2-4-6-1K
2	4-600
4	50-100
8	500
25	25-50-75
40	25
50	25
100	15
200	12
300	6
2x.01	2-400
2x.02	6-1500
2x.045	600
.046x.055	600
.2x.05	6-1500
.1x.05	200
.1x.5	400x50
2x.1	4-600
2x.16	600
2x.2	600
2x.25	4-600
.3x.5	500
2x.5	4-600
1.x.05	500
1.x.1	300
1.x.5	200
2x1	600
2x10	25
2x200	9
3x.001	600
3x.05	600
3x.1	4-600
3x.25	4-600
3x.5	100-600
.015x.03x.045x.06x.12/ 600	

Also available CHANNEL Types. Special Prices on request.

SHOCKMOUNTS

100P-1	1 lb.	.15
100P-2	2 lb.	.15
100PR-2	2 lb.	.15
100P-3	3 lb.	.15
100P-6	6 lb.	.20
150P-4	4 lb.	.20
150PH-8	8 lb.	.45
100PL-1	1 lb.	.15
150P-7	7 lb.	.25
156P-6	6 lb.	.35
200PD-15	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112	112 lb.	.98

TERMINAL BOARDS

5 terminal	.98
8 terminal	1.67
12 terminal	2,49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.50 — TYPE "JL" $1.75 — TYPE "JJ" $2.95

ohms (J/JL)	ohms (J/JL)	ohms (J/JL)	ohms (JJ)	ohms (JJ)
50 *	2500 *	100 K *	500-500 *†	130 K-130K *
65 *†	4000†	100 K†	600-600†	150 K-150K†
200†	5000†	125 K *	1500-1500†	250 K-250K†
300†	10 K *†	200 K *	2000-2000 *†	350K-5K†
400 *†	15 K *†	250 K *	2000-50K *	350K-25K†
500†	20 K *†	250 K†	2200-24K†	300K-300K†
600 *†	25 K *†	500k *†	20K-2000†	350K-350K *
750†	30 K *†	1meg *	25K-10K†	800K-75K *
1000 *†	50K *†	1meg†	35K-5000†	1meg-1meg†
1500 *†	80K†	2meg *	50K-50K *	2meg-2meg†
2000 *†		2meg†	100K-100K *	4meg-4meg†

TYPE "JJJ" $4.95

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* 1/8" screwdriver slotted shaft.

† Knob type shaft.

TRANSMITTING MICAS

mfd.	wv	type	ea.	mfd.	wv	type	ea.
.0001	600	4	.36	.0015	600	4	.36
.0003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

(Many other sizes in stock)

"UG" and "UHF" CONNECTORS

UG-9/U	UG-25/U	83-1F
UG-10/U	UG-27/U	83-1J
UG-12/U	UG-27/AU	83-1AP
UG-14/U	UG-57/U	831RTY
UG-15/U	UG-58/U	83-1SP
UG-16/U	UG-87/U	83-1R
UG-18/U	UG-88/U	83-1D
UG-19/U	UG-123/U	83-1SPN
UG-20/U	UG-185/U	83-22R
UG-20/U	UG-206/U	CN 49120
UG-21B/U	UG-260/U	CN 49121A
UG-22/U	UG-290/U	CN 49151
UG-24/U	83-1AC PRICES ON REQUEST	

Jones Connectors

P-101-¼	.25
P-101-⅜	.30
S-101-D-MOD	.33
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.58
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
S-2412-CCE	.87
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52

Jones BARRIER STRIPS

2-140-Y	.13
6-140-Y	.33
10-140-¾W	.53
10-240	.38
18-240	.66
4-141-W	.30
4-141-¾W	.30
7-141-Y	.49
12-141-Y	.82
13-141-Y	.89
15-141-Y	1.02
2-142-Y	.20
4-142-Y	.36
8-142	.48
3-150	.53
4-150-Y	.83
4-151	1.30
5-151	1.60
4-152	1.89
2002	.04
2008	.07
8-54	.22
8-6	.18
4-140-Y	.23
17-240 on 21	.63
20-160-R/L	.51
20-161-R/L	.52

Many other types in stock

MALLORY PUSH SWITCH

#2001	S.P., make cont., non-L	.52
#2003	S.P.D.T., non-lock	.56
#2003L	S.P.D.T., lock	.56
#2004	D.P., make 2 non-L	.64
#2004L	D.P., make 2 lock	.64
#2006	D.P.D.T., non-lock	.78

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APC's	Crystals	Resistors
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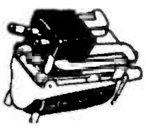
Ceramics	Knobs	Switches
Chokes	Potentiometers	Transformers
Circuit Breakers	(sine-cosine)	Tubes
Coils	Pulse Xfmrs.	And Others



MINIATURE RELAYS

55251 **TELECHRON**, 24VDC, SPST n.o. 300 ohm, #R174 .... $	.90
55340 **PRICE**, 24VDC, SPST n.o. 300 ohm #R170	.90
55342 **TELECHRON**, 24VDC, Makes 3 Breaks One, 300 ohm, Anti-Capacity Arms, Low Loss Bakelite Insulation, #R171	1.25
55526 **COOK**, 24VDC, Makes 2, Breaks One, 300 ohm, Ceramic Insulation, #R107....	.95
55531 **RBM 12**—24VDC, Makes 4, Breaks two, 150 ohm, #R405............	1.25
55589 **RBM**, 24VDC, DPST n.o. 300 ohm, #R245	1.25
55836 **G.E.** 24VDC, SPDT, 250 ohm, #R402 ....ea.	1.25
55837 **G.E.** 24VDC, Double Make, 300 ohm, #R108G	1.00
55837 **RBM**, Same as R108G, #R108R......	1.25
55837 **ALLIED**, Same as R108G, #R108....	1.50
D163221 **AMER. TOTALIZATOR**, 24VDC, SPDT, 300 ohms, Anti-Capacity Arms, #R134	1.25
GUARDIAN, 24VDC, SPST, n.o. 300 ohms, Anti-Capacity Arm, Ceramic Insulation, #R106	.59
23012-0 **RBM**, 24VDC, SPDT, 250 Ohms, #R172	1.25
7251 **ARC** 24VDC SPDT 300 ohm #R406....	1.25
7252 **ARC**, 24VDC, DPST n.o. 300 ohm, Anti-Capacity Arms, Ceramic Insulation, #R354	1.25
A13415 **CLARE**, 12VDC, DPST n.o., 120 ohms, #R246	1.25
A21577 **CLARE**, 24VDC, DPST n.o., 250 ohms, #R352	1.15
P3LEACH (Pair on Bakelite Strip) Each relay: 6VDC, SPDT, 125 ohms, #R353..pr.	2.25
ZH77628-1 **AUTOMATIC**, 12VDC, Make One, Break Two, 640 ohms Dual Telephone Type Contacts #R244	.85
7472679 **G.E.** 3VDC, SPST n.o., 30 ohms, #R59A	.59
2VDC, SPDT, 125 ohms, #R173...........	.69
73A23 **ALLIED**, 24VDC, Make 3, Break one, 300 ohms, #R403 ....ea.	1.25
TB 302 **PRICE**, 24VDC, Make 3, Break one, 300 ohms, #R404............ea.	1.25

PULSE XFMRS

DONGAN TR 1043-A461 Ratio 1:1 high power pulse modulation driver xfmr for final. Ea. winding approx. 8 ohms d-c; 200mh; 260T #30 wire #T152 .... $3.25 ea.

W.E. (coreless type) A quasi-differentiating xfmr. Pri. when tuned with a .01 mfd resonates at 5630 cps. Split wound secondary terminates into 10000 ohms Army SC# 2C2270/T2..... $2.25 ea.

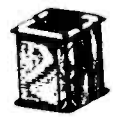
W.E. KS9564 1:1 ratio—high repetition rate $1.19 ea.

FREED #12524 2:1 ratio—high repetition rate $1.49 ea.

HORIZONTAL blocking osc. xfmr........ 69¢ ea.

VERTICAL blocking osc. xfmr............ 69¢ ea.

SERVO OUTPUT XFMRS



PP6L6 to Servo mechanism with 10% feed-back winding. Mu metal core .... $3.50 ea.

DUAL unit PP6V6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism. Both in 1 can. Mu Metal Core.......... $3.95 ea.

AMERTRAN FILTER REACTOR

0.5 hy at 2.5 amps DC, 2.3 ohms, 2.5 KV insul., 5½"x7"x8" overall .... $12.95 each

TS2A VARIABLE CERAMICONS

CAPAC. 1.5 to 7: 1.5 to 7.5: 3.5 to 30; 5 to 40 .28 ea., $25.00/c

FEEDTHRU 55mmf±10% ....10 ea.; 9.00/C

H-F TIE POST

Low-Loss Yellow Bakelite Insulation, pictured actual size (4-40 Thread).... $7.50/C $60.00/M

HI-VOLTAGE GLASS TO METAL SEALS (FEED THRU)

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SCR 625 FAMOUS ARMY MINE-DETECTOR

for prospectors—miners—oil companies — plumbers —etc.,—etc.,—etc.

This unit is being offered now at a considerable reduction in price. Recently advertised at $79.50 it is now available in the same brand new wrappings in suitcase style carrying case (less batteries) at

$59.50

WHILE THEY LAST!

CABINET CH-118

Olive drab in color, this cabinet has a full length interlock access door on the rear. The front takes the standard 19" panels with 60 inches of height and 20 inches deep. It is shock mounted on a heavy steel platform and has a two-inch protrusion fully covering one side to accommodate wave trap and wiring. Louvered vents allow air circulation top and bottom. Each F.O.B. Chicago **$34.50**

RA 52—RECTIFIER

A transtat controlled rectifier to produce high voltage DC from 110 VAC 60 cycle source. Up to 11,500 volts DC at 50 watts. Metered high voltage (0-15KV) and current (0-20 MA). New............ **$74.50**

BC 768

Radio Receiver Chassis Complete except for 13 tubes. This chassis with standard 19" panel front contains the receiver for 493.5 MC complete with power supply and an additional low voltage power supply that originally supplied the keyer BC 770 as described below. 110 VAC 60 cycles is the primary voltage.

Five 10 mfd-600 VDC oil filled GE condensers are used as filters. Five stages of 49 MC IF's.

Two of 10.4 MC, 6.3 VAC Transformer and of course power transformers—chokes and miscellaneous parts. All units are in good condition as removed from new equipment. Even the salvage value is a great deal more than the low price of............ **$9.95**

BC-769 Transmitter P/O RC-100, less tubes..$6.95
BC-770 Keyer P/O RC-100, less tubes.......$4.95

COMPASS INSTALLATION

MN-26 C Remotely controlled commercial type navigation receiver. Freq. range 150 to 1500 KC in three bands. Has twelve 6 volt tubes, 24 V dynamotor and band switch motor, new...	$39.95
MN-28C, Control box for above, new........	9.95
MN-52 Loop control unit, new............	4.45
MN-20E Loop (manually rotatable), new....	9.95
Loop transmission cable 168" long, new.....	9.95
MC 124 Mechanical cabling, new, per length	2.45
IN-4D Left-right indicator, new............	9.95
Plugs, set of three, new............	3.75
Manual, covering complete set, new........	1.95

MISCELLANEOUS SPECIALS!

		New
RA 10 DA Receiver..........	Used $17.50	$24.95
BC 347 Interphone Amplifier............		2.95
BC 442 Less Condenser........	Used $1.49	1.95
APS 13 UHF Antenna, Pair............		.98
I-97 Bias Meter............	Used $3.95	4.95
RL 42 Antenna Gearbox Motor and Reel	Used $4.95	7.50
One Tube Interphone Amplifier—Small compact aluminum case fully enclosed 2¼" x 3¾" x 5¾", Less Tube..........		.79
40 Amps Circuit Breaker............		.59
I 82 F Five Inch 360 degrees compass indicator and Selsyn receiver............		4.95
A-81-2 Transmitters Selsyn for I 82 indicator		2.45
(Both I 82 & Trans. Selsyn for $7.00)		

	New
PE-101 Dynamotor	2.75
Thermal converter Weston Type D, model 507, range .12 amp............	.59
BC-1023 Marker Beacon Receiver, complete with tubes, shock mount and instruction manual	9.95
BC-923 27-38 MC. FM Receiver complete with tubes ....Used $24.50	
BC-924 27-38 MC. FM Transmitter, complete with tubes ....Used $19.95	
BC-684 27-38 MC. FM Transmitter, less dynamotor ....Used $19.95	
10 meter modification kit for BC-610......	3.95
SCR-183 complete 12 volt set with all coils, tubes, dynamotor and control units......	49.50
ARB Control Box............	1.95
ARR2 Control Box............	.89

CATHODE RAY TUBES

3FP7 — $1.95 5BP4 — $3.95 5GP1 — $3.95
4AP10 — 1.95 5FP7 — 1.95

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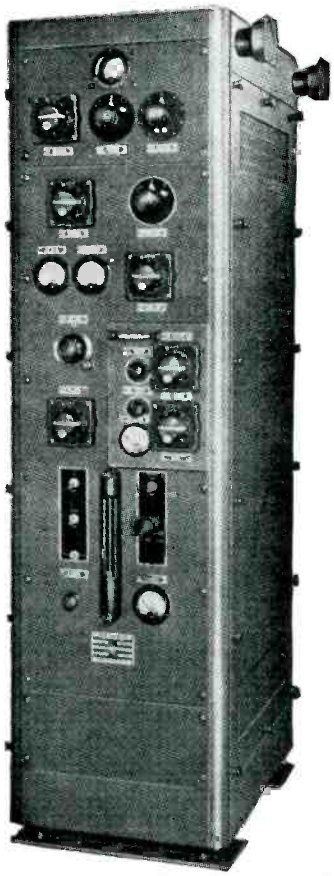

R.C.A. Model MI-8167
TRANSMITTERS

Point-to-point communications

Freq. Range: 2000 to 20,000 Kcs.
Output: 350 Watts C.W.
250 Watts Radiotelephone
Input: 190 to 250 Volts AC 50/60 cps.
Size: 60" high, 17" wide, 27" deep
Tubes: 807s, 813s, 805s, 866s
Master Oscillator unit built-in, fully shielded and stable. All self contained including antenna network. Crystal Multiplier units (available) fits in place of M.O. unit. Speech amplifier is only external unit and has 110/220 v. AC input, four stages, high gain. Total net weight, 625 lbs.

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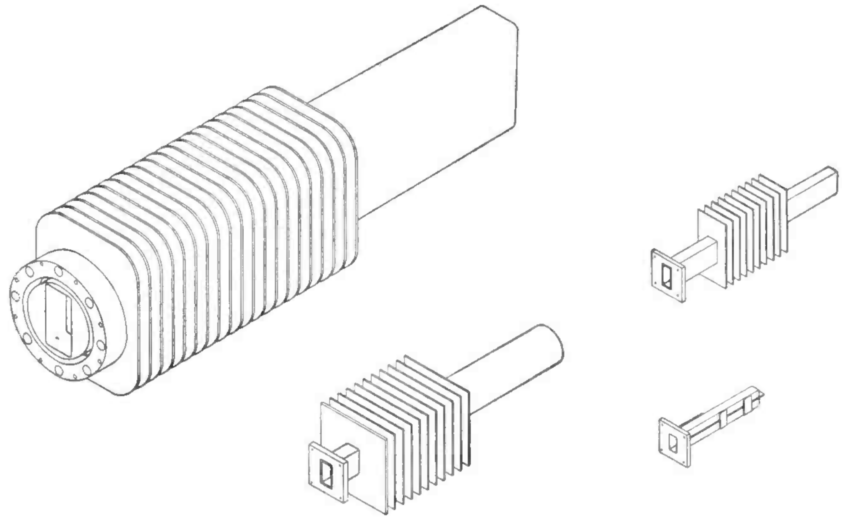
TEST EQUIPMENT



HI POWER X BAND TEST LOAD, dissipates 350 watts of average power for ⅝" x 1¼" waveguide, VSWR less than 1.15 bet. 7 and 10 KMC........$150.00

S Band Test Load TPS-55P/BT, 50 ohms $12.00

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" waveguide. Range 2500 to 3700 MC.

X Band Pick-up Horn, AT-48/UP with coaxial fitting $10.00

TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter. 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-45A-APM-3 Signal Generator. 8700-9500 mc., 110 V. 60-800 cps.

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110-Volt 60-2600 cps POWER SUPPLY. Bandwidth 10 mc; new, part of SPR-2 Receiver.

AMPLIFIER STRIP AM-SSA/SPR-2 contains I.F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps. Send for schematic...$65.00 less tubes

S Band Signal Generator Cavity With Cut-Off Attenuator. 2300-2950 mc., 2C40 tube, with modulator chassis....$30.00

UPN-1 S Band Beacon Receiver-Transmitter $75.00

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

S-Band Mixer, tunable by means of slider, type N connector for the R.F. and local oscillator input, U.H.F. connector for the I.F. output, variable oscillator injection. $30.00

S Band Crystal Mixer, variable oscillator injection $17.50

TS-110 S Band Echo Box 2400-2700 mc. portable $110.00

X Band Thermistor Mounts, VSWR less than 1.4 8500-9600 MC Fixed triple tuned, ½" x 1" waveguide.....$40.00
Fixed triple tuned ⅝" x 1¼" waveguide $50.00

X Band Crystal Mount, ½"x1" waveguide $25.00

UG80/U ½"x1" to ⅝"x1¼" adapter, $5.00

ESTERLINE Angus recording Milliammeter 60 cycles, 110V. AC 1 ma full scale. $160.00

TS-89 Voltage Divider for measuring high video pulses, ratios 1:10 and 1:100 transmission flat within 2 db 150 c.p.s. to 5 mc., with cable for attaching to synchroscope $30.00

Waveguide Below Cut-off Attenuator L 101-A U.H.F. Connectors at each end calibration 30-100db $15.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L 422-32....$3.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc., WE-161310, impedance ratio 120 to 2350 ohms..$3.00

X Band attenuator, 1¼"x⅝" guide, single guillotine type, 0-30 db, V.S.W.R. 1.2 maximum, calibrated $85.00

High Voltage motor operated switch, 18 KV., 5 Amps peak, Schweitzer-Conrad No. QA-35582 ....$50.00

TEST SETS

TS—36	TS—100	TS—126
TS—47	TS—125	TS—226

ELECTRO IMPULSE LABORATORY

62 White Street   Red Bank 6-0404   Red Bank, N. J.

COAXIAL CABLES

"JAN" APPROVED

Available From Stock

RG 11/U

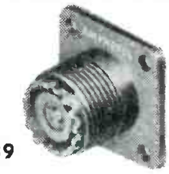
RG. No.	Price Per Thous. Ft.	RG. No.	Price Per Thous. Ft.
RG5U	$100.00	RG27U	$450.00
RG6U	160.00	RG29U	50.00
RG7U	120.00	RG34U	250.00
RG8U	150.00	RG39U	180.00
RG9U	247.00	RG41U	400.00
RG9AU	275.00	RG54U	75.00
RG10U	245.00	RG54AU	60.00
RG11U	150.00	RG55U	110.00
RG12U	245.00	RG57U	125.00
RG13U	225.00	RG58U	70.00
RG14U	300.00	RG58AU	125.00
RG17U	650.00	RG59U	70.00
RG18U	950.00	RG62U	75.00
RG19U	1,250.00	RG63U	175.00
RG20U	1,550.00	RG65U	650.00
RG21U	295.00	RG71U	200.00
RG22U	150.00	RG74U	250.00
RG24U	450.00	RG77U	80.00
RG25U	495.00	RG78U	80.00

Please add 25% to prices shown for length under 500 feet of a type.

"UHF" Coaxial Connectors

NEW "JAN" APPROVED

THIS MONTH'S SPECIAL



SO-239 83-1R

No.	Jan. No.	Description	1-99	100 to 999	1000 and Over
83-1R	SO239	Receptacle	$.55	$.50	$.40
83-1SP	PL259	Plug	.55	.50	.48
83-168	UG176U	Adapter	.18	.17	.15
83-185	UG175U	Adapter	.18	.17	.15
83-1SPN	PL259A	Plug	.60	.55	.50
83-776	UG203U	Plug	.85	.75	.75
83-1RTY	———	Receptacle	.75	.65	.65
83-1H	UG106U	Hood	.12	.10	.10
83-1HP	———	Hood	.27	.24	.24
83-765	UG177U	Hood	.31	.25	.25
83-1AC	———	Cap & Chain	.61	.50	.45
83-1BC	———	Cap & Chain	.35	.31	.30
83-1T	N358	T Connector	1.50	1.40	1.40
83-1AP	N359	Adapter	.35	.30	.28
83-1AP	M359A	———	.80	.75	.70
83-1J	PL258	Junction	1.00	.90	.85
83-1F	PL274	Feed Thru	1.50	1.40	1.35
83-22SP	UG102U	Twin Plug	.90	.90	.90
83-22R	UG103U	Receptacle	.90	.90	.90
83-22AP	UG104U	Adapter	1.40	1.25	1.10
83-22J	UG105U	Junction	1.50	1.40	1.40
83-22T	UG196U	T Connector	1.65	1.50	1.50
83-22F	PL275	Feed Thru	2.00	1.80	1.75
83-2SP	PL295	Plug	1.94	1.75	1.70
83-2R	SO265	Receptacle	1.44	1.30	1.25

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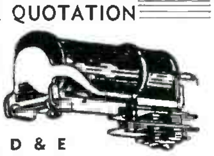

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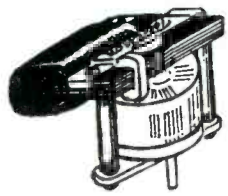

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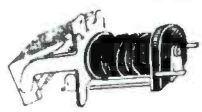

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250 ohms, will drop on 12 volts or more

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400 CYCLE 110V A.C. 1 AMP ¼ H.P. D.C., 110V MOTOR **$49.50**

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With test leads in a leather case.

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Ready to attach to any device that needs turning from remote point. A complete $30.00 unit made by one of the greatest Video Companies. Sorry, can't name it here! $13.95

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TS-10A/APN-1	TS-98/AP	TS-270A/UP	BC-1066/A
TS-12	TS-100	TS-323	BC-1201/A
TS-13	TS-101AP	I-56	BC-1203
TS-14	TS-102/AP	I-95/A	BC-1287/A
TS-15B/AP	TS-108/AP	I-106/A	BC-1277
TS-16/APN	TS-110/AP	I-122	BE-67
TS-19	TS-118/AP	I-145	LAD
TS-27/TS	TS-125/AP	I-177	LAF
TS-32A/TRC-1	TS-131/AP	I-178	LAG
TS-33	TS-153	I-208/A	LU2
TS-34	TS-155A/AP	I-212	LU3
TS-34A	TS-170/ARN-5	I-222/A	OAA-2
TS-35A	TS-173/UR	I-225	TTS-4BR
TS-36	TS-174	I-233	TTX-10RH
TS-45/APM-3	TS-175	IE-21/A	TSS4SE
TS-47/APR	TS-184/AP	IE-36	TSX4SE
TS-51/APG-4	TS-197/CPM-4	IF-12/C	
TS-62	TS-203/AP	BC-221	
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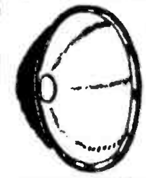

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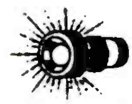

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LABORATORY TEST VOLTAGES—M-G Unit. Motor Single Phase Synchronous 60cyc/1¢/115v/22.5a/1800Rpm. Direct coupled Alternator 3.000 cyc/115v/.1Kw & DC Gen 150v/.1Kw & DC Gen 500v/.125Kw & DC Gen 1000v/.3Kw. Short-time 300% overload. Compact, with controlls. Mfg. F.T.&R. Co. Wt. 485-lb. .... **Ea. $525.00**

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TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
*1A5GT	.75	7G7	1.20	VT62	.50	841	.43
*1LC5	1.25	7H7	.85	VT128	.65	851	75.00
1LG5	1.25	12A5	.90	VU111S	.50	861	40.00
*1Q5GT	.80	12A6	.75	1B24	15.00	864	.73
1R4	.75	12C8	1.05	1N21 XL	.90	869B	29.50
*1T4	.85	12F5GT	.65	1N22 XL	1.60	872A	3.50
3D6	.60	12H6	.75	2C26A	.25	954	.37
*5Z4	1.00	*12K8GT	1.00	2C34	.50	1616	1.98
6AB7	1.10	12J5GT	.65	2C44	1.00	1619	.85
6AK5	1.75	12SH7	.90	2X2/879	.60	1625	.47
6B8	.95	12SJ7	.85	3C24	2.50	1626	.40
*6B8G	.85	12SR7	.80	3E29	14.00	1629	.65
*6C5	.75	14X7	1.15	6C21	25.00	1630	.90
6H6	.75	28D7	1.00	23D4	.60	1631	1.27
*6J8G	1.05	36	.65	211	.80	1632	.75
*6K7	.80	38	.65	215A	.17	*1641	1.50
6K7GT	.70	39/44	.65	307A	4.95	1642	.65
*6L7G	.72	*50	1.00	371B	.75	2051	1.50
6N7	1.00	*57	.65	393A	9.10	*5670	5.90
6R7G	.71	76	.65	471A	2.75	*5814	4.55
6S7G	.75	*77	.65	532A	2.75	7193	.25
6SH7	.75	*85	.75	705A	1.25	8012	3.50
6SH7GT	.80	*117Z6GT	.90	715B	15.00	8020	2.25
6SN7GT	1.05	1005	.45	717A	1.25	9001	1.75
6SN7GTA	1.20	4A21	.75	724B	6.50	9002	1.50
6U7G	.65	615	.15	801	.75	9003	1.80
*7A6	.75	MX408U	.75	805	4.98	9006	.30
7C4	.77	10Y	.55	807	1.75		
7E5 (1201)	.85	VT52	.50	813	8.50		

Items marked * do not have name of standard manufacturer on tube. They are FIRST QUALITY (not seconds) and meet full specifications with our 100% guarantee. Samples to quantity users.

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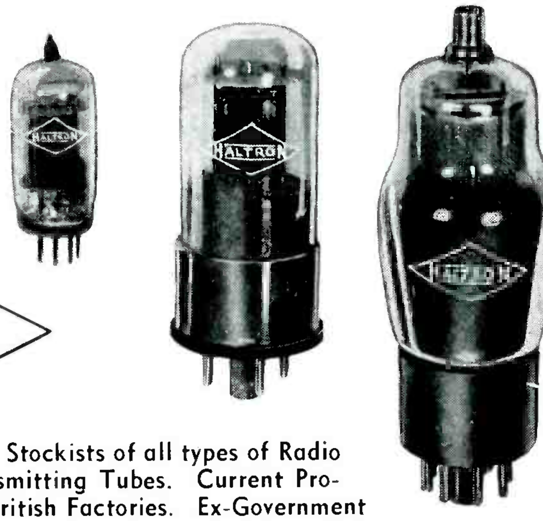

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OB3/VR90	1.25	3B7/1291	.49	10Y	.75	531	7.50	805	3.95	872A	3.75	8020	1.95	3DP1	4.95
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1B22	3.25	3C24	1.95	39/44	.49	700A	24.50	810	12.75	879	1.43	9001	1.50	5AP1	3.49
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1R4/1294	.69	4J22	149.50	250TL	19.95	708A	4.75	830B	3.75	1608	4.95	C6J	5.95	14BP4	26.50
2C22/7193	.35	4J26	159.75	285A	10.95	710A/8011	.98	832A	12.95	1609	4.95	CRP72	1.98	16DP4A	34.00
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2C40	4.95	4J42/700A	27.50	304TL	12.95	715A	6.95	836	5.95	1619	.45	HY114B	.75	19AP4A	62.00
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2E22	3.50	6AJ5	2.25	310A	6.95	715C	24.50	838	4.95	1625	.45	REL5	175.00	20CP4	68.50
2J22	7.95	6B8	.98	316A	1.50	721A	4.95	843	.75	1626	.45	RK25	2.95	TUNGAR BULBS	
2J26	24.50	6C8	.88	329A	8.95	722A	2.49	846	49.95	1629	.35	RK34	.29	6 AMP	
2J36	89.50	6C21	19.95	331A	11.95	723A/B	17.95	851	49.95	1636	3.25	RK72	1.65	#289414	4.75
2J61	37.50	6J4	5.95	353A	4.95	724B	3.49	860	5.95	1642	.98	RK73	1.65	Westinghouse	
2J62	37.50	7A7	.89	371B	.95	725A	12.95	861	24.50	1851	1.75	VT90	.98	Rectigon	
2K25	24.95	7C4	.49	388A	1.50	730A	13.95	864	.75	2051	1.09	VT98	175.00		

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1N21	.80	9005	1.50
1N21-B	3.00	C1A	2.00
1N23-B	4.00	CE25	.75
2D21	1.60	100TH	9.50
2E22	1.25	250TH	19.95
2E24	4.75	304TH	12.95
2E26	3.75	304TL	12.95
2E30	2.20	450TH	35.00
2J26	5.00	F-123-A	6.95
2J32	25.00	HK57-B	5.00
2J36	85.00	HK254	7.00
2J61	22.50	RK20-A	5.00
2K25	24.95	RK28-A	5.00
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211	.65	1A7GT	1.05
300-B	7.00	1B3GT	1.25
310-A	6.75	1X2A	1.60
371-B	.90	3S4	.97
374-A	7.00	5U4G	.80
707-A	10.95	5V4G	1.10
707-B	19.95	5X4G	.90
715-A	6.50	6AH6	1.25
715-B	12.95	6AK5	1.25
725-A	6.95	6AL5	.60
809	2.25	6AU5GT	1.59
810	10.00	6BL7GT	1.59
811	2.35	6BY5G	1.65
812	2.75	6C4	.90
813	8.95	6J5GT	.50
829	9.50	6T8	1.50
829-B	13.50	12AT7	1.35
832	5.95	12AU7	1.10
832-A	10.00	12BH7	1.70
837	1.50	25L6GT	.95
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866-A	1.00	35Z5	.85
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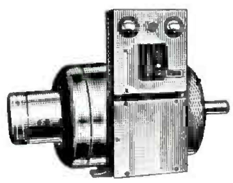
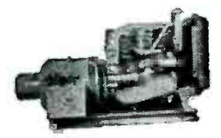


Three 400-cycle, 40 KW, three-phase, AC generators, 120/208 volt, 1714 rpm, $850.00.



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2K45 - -	170.00		14.75
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APR4, APR5A, APR7, TS-34, 804CS2. APA-38, BC-348, ART-13, TS-12, ARC-1
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Variac—General Radio Type 50A O-135V. @ 50 amps	EXCELLENT	95.00
APN-1 Altimeter Indicator 0-1MA. shunt, 250° dial	NEW	2.95
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MG075-G-1 Onan Motor Generator Motor 115/230V. 60 cy. single phase. Generator 115V. AC. 480 cy. 5.3 amps, 26V.D.C. @ 4 amps	NEW	190.00
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H.V. 500-0-500 # 150 Ma. D.C. (2) 6.3 V Ct. # 2.5 Amps. 5 V.Ct. @ 3 Amps. New $5.95

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Herm. sealed Ceramic term. 6.3 V. @ 2 A.
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ML-531 .... $2.95

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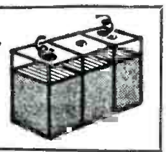

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No. 1 — B & S Hard
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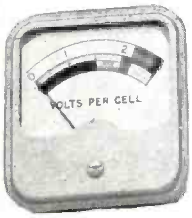

METER. 0-25 ma. Basic Movement d.c. 2¾" sq. 3V scale and blank face reverse. zero adj., mtg. clamp. **$1.25** each.

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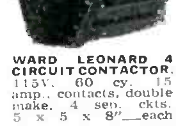

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6SG7 1.39
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12SF5GT .79
12SF7GT .59
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14C7 1.09
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53 .69
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6H4GT .98
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6J4 6.98
6J5GT .59
6J6 1.29
6J7 1.09
6J8G 1.19
6K4 3.49
6K5GT 1.09
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6K8 .99
6L5G .79
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7B5 .79
7B6 .79
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7E7 .89
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7K7 1.29
7L7 1.19
7N7 1.19
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7R7 .79
7S7 1.09
7T7 1.03
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14S7 1.09
14W7 1.09
14X7 1.23
14Y4 .99
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15E 1.98
15R .98
FG17 3.98
18 .98
19 .69
19BG6G 1.79
19J6 1.89
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20 1.17
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22 .99
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25A7 3.17
25AC5GT 1.59
25AV5GT 1.19
25BQ6GT 1.19
25C6 1.18
25L6GT .69
25N6 1.69
25W4GT .89
25Y5 .79
25Z5 .79
NR74 .29
75 .79
HY75 4.59
76 .79
77 .69
78 .89
79 .89
80 .89
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82 1.19
82V 1.39
83 1.89
83V 1.89
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HY114B .79
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117N7GT 1.79
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722A/287 2.75
723A 9.75
723A/B 14.49
724A/B 3.95
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730A 12.98
801A .98
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1644 .95
2050 1.25
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R4340 36.00
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5686 4.23
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5812 2.99
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UX6653 .69
8002R 99.50
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Dual 13000 ohm/20 step 2.98
Dual 25000 ohm/20 step 2.98
100000 ohm/20 step 3.98
Variable Atten. 600 ohm imped/30 step 10.98

COAXIAL CONNECTORS

A. SO239/831R Receptacle 65c
B. PL259/831SPN Plug 65c
C. AN3102-8S-1S Plug 65c
D. M359/CSX48192 Angle Adapter 65c
F. UG22/U Panel Jack $1.49

Write for Connector Listing

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30Amp/250vacdc Csd USN 0.1 to 1000 Mc's $3.98
2 for $6.00
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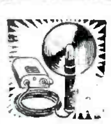

New Thrift-Lite Lifetime Photo-Flash

Complete. Ready-To-Shoot. Not a Kit. Tube rated at twice no. of pix taken in life-time. 1/1000 sec. flash, every 15 sec. True daylite color. Usable all cameras Oper. 115 VAC. w/lite. AC40 $44.50

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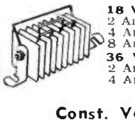

18 VAC Input	14 VDC Output
2 Amps $2.45	12 Amps $7.98
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8 Amps 5.98	
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3000 V/10 ma, Csd H. V. Insul. 4.50

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As we listen to the latest insults from Moscow, we're likely to get fighting mad.

Instead, we'd better use our heads and get *working* mad.

It is clear by now that Stalin and his gang respect just one thing—strength. Behind the Iron Curtain they've been building a huge fighting machine while we were reducing ours. Now we must rebuild our defenses—*fast.*

As things stand today, there is just *one* way to prevent World War III. That is to re-arm—to become strong—and to stay that way!

This calls for better productivity all along the line. Not just in making guns, tanks and planes, but in turning out civilian goods, too.

Arms must come first. But we must produce arms *at the same time* we produce civilian goods.

We can do this double job if we all work together to turn out more for every hour we work—if we use our ingenuity to step up productivity.

All of us must now make sacrifices for the common good. But we're working for the biggest reward of all —*peace with freedom!*

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ADVERTISERS INDEX

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with REDUCED CAPACITANCES

ACTUAL SIZE

NEW!

250 mc. 85 watts output

300 mc. 70 watts output

430 mc. 32 watts output

AMPEREX

AX-9903/5894

UHF and VHF Twin Tetrode for W-I-D-E Band Operation

RF Amplifier, Modulator, Frequency Doubler, Tripler

AX-9903/5894 CHARACTERISTICS

Filament Voltage

Series	12.6 v.
Parallel	6.3 v.

Filament Current

Series	0.9 a.
Parallel	1.8 a.

Maximum

d.c. Plate Voltage	600
d.c. Grid #2 Voltage	250
d.c. Grid #1 Voltage	—175
Plate Dissipation (w.)	2 x 20
d.c. Plate Current (ma.)	2 x 100

COMPARE CAPACITANCES of this tube with its nearest equivalent type.

	AX-9903/5894	Nearest equivalent
Grid to Plate	< 0.08 mmfd.	< 0.12 mmfd.
Input	6.7 mmfd.	14.5 mmfd.
Output	2.1 mmfd.	7.0 mmfd.

MOUNTING POSITION: Base up or down. Horizontal with anode leads in horizontal plane.

Fits 829B Type Socket.

- The AMPEREX AX-9903/5894 is an improved version of the 829B. The design of this tube incorporates features which produce considerably smaller output capacitances and which, therefore, result in higher resonant frequencies (approximately 500 mc. instead of 250 mc.). In addition, because of the low inductances of the connections between the cathode and screen-grid, more stable operation at high frequencies is effected.
- A most desirable design characteristic, also, is the incorporation of internal neutralizing condensers which are connected directly to the control-grids, making impossible self-oscillation in a tuned-plate, tuned-grid transmitter.
- Of importance in this new design are such features as:

  1. Direct and short connection between the pins and the anode, causing lower inductance and resistance.
  2. No insulating parts (mica or ceramics) between anodes, resulting in lower losses at high frequencies.
  3. "Screened" micas, thereby preventing possible losses due to contaminated mica.
  4. Zirconium-coated moly anodes, giving a higher degree of vacuum than possible with nickel anodes and barium getters.

- For the full story on how to use the AMPEREX AX-9903/5894 in your particular application, write to Application Engineering, Department N. Or if you prefer, ask for an AMPEREX representative to call.
- IMMEDIATE DELIVERY* Order from your local electronics parts distributor. If unavailable, write direct to our plant.

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