electronics

A McGRAW-HILL PUBLICATION

MAY · 1955

PRICE 75 CENTS

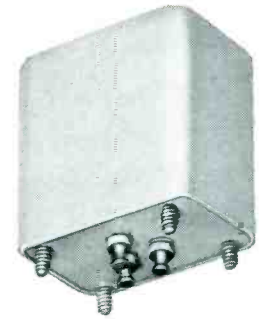
STRAIN-TESTING NEW PLANE

Hydraulic cylinders apply calculated forces to tail structure while 200-channel automatic recorder prints readings of strain gages on individual cards. Portable servo motor zeroes each circuit automatically

OUR 10 MILLIONTH MILITARY UNIT SHIPPED THIS YEAR

Military Components
FOR EVERY APPLICATION

A HUNDRED STOCK UNITS in our catalog B . . . 30,000 special designs

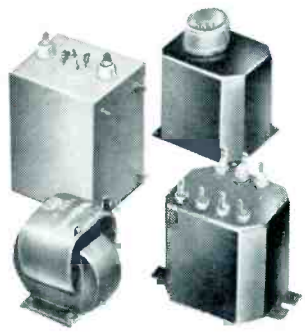


FILTERS

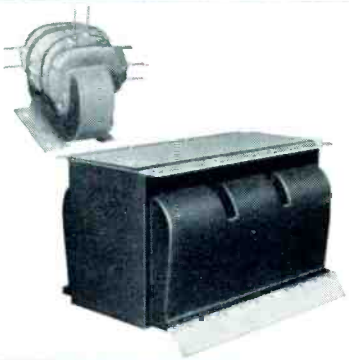
UTC filters, equalizers and discriminators are produced in designs from .1 cycles to 400 mc. Carrier, aircraft and telemetering types available in standard designs.

POWER COMPONENTS

The scope of military power components produced at UTC ranges from 500 lb. plate transformers to miniaturized 2 oz. units . . . hermetically sealed and encapsulated . . . molded types.



UTC



ENCAPSULATED UNITS

8 years of encapsulation experience assure maximum reliability in this class of UTC material.

MOLDED UNITS

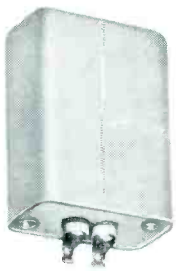
UTC molded units range from ⅓ oz. miniatures to the 100 lb. 3 phase unit illustrated.

PULSE TRANSFORMERS

UTC pulse transformers cover the range from molded structures weighing a fraction of an ounce to high power modulator applications.

AUDIO COMPONENTS

UTC military audio units range from 1 ounce subminiatures to high power modulation transformers. Standard, high fidelity, sub-audio, and supersonic types.



HIGH Q COILS

Unequalled stability is effected in UTC high Q coils thru special processes and materials. Toroid, mu-core, and variable inductors are available to military standards.

MINIATURIZED COMPONENTS

UTC H-30 series audios are the smallest hermetic types made. Class A, B, and H power components of maximum miniaturization are regular production at UTC.

MAGNETIC AMPLIFIERS

In addition to a stock line of servo motor magnetic amplifiers, UTC manufactures a wide variety to customer specifications. Saturable reactors are supplied for frequencies from 1 cycle to 40 mc.

WRITE FOR UTC CATALOG B

. . . includes complete line of hermetic audios, reactors, magnetic amplifiers, filters, high Q coils, pulse transformers, etc.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

MAY • 1955

STRAIN-TESTING NEW PLANE—Use of Beckman recorder enables Convair to obtain readings of 200 strain gages in five minutes while stressing plane for final airframe check. Details on p 186 ..... COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

IN THIS ISSUE—The new symbols for electronics diagrams that have been approved by the American Standards Association appear on pages 176, 178, 180. We are adopting the new symbols for all diagrams as of now, although the change may not be readily apparent since there is little change in those most often used.

OFFICIAL—In the normal course of business we receive mail from all parts of the world. But it was with a bit of surprise that we signed for a letter delivered to us by diplomatic pouch from Europe. The subject? Sorry, classified for reasons of commercial security.

MUSIC FOR ENGINEERS—The special attraction that music holds for many ELECTRONICS readers showed up in the response to a recent article in Industry Report. A short description of a build-it-yourself electronic organ was sufficient to bring in a flood of letters, including one from Brazil, a lot of phone calls and two visitors to the office in quest of more information.

The interest of the inquirers seemed to be more personal than business, since their job titles indicated fields far removed from electronic music. The reason behind it may have been summed up by one of the visitors who explained, "I like music but I can't play any instrument well. With an organ, I can hold down one key and still get music while I'm hunting for the next."

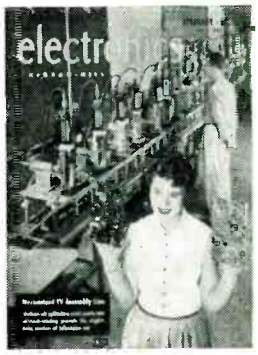
electronics

MAY, 1955 Vol. 28, No. 5

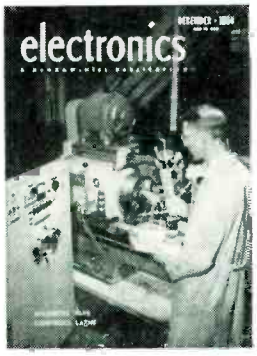
Member ABC and ABP

TALK

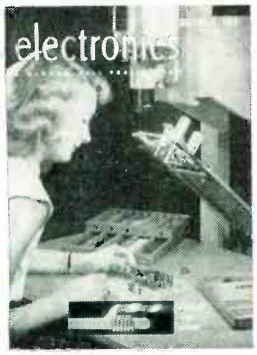
OUR COVERS . . . A History of Electronic Automatic Production Techniques



Mechanized TV Assembly Line Feb. '55

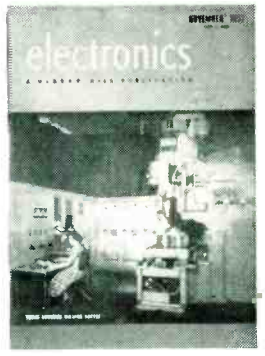


Magnetic Tape Controls Lathe Dec. '54



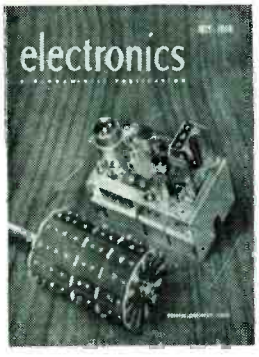
Solderless Circuit Assembly Nov. '53

Components For Printed Circuits Aug. '53

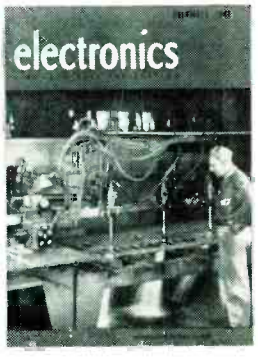


Tubes Control Milling Cutter Nov. '52

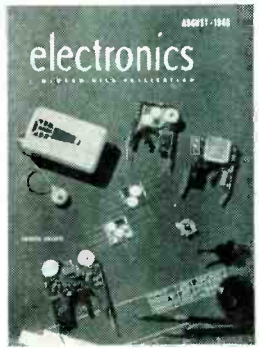
Printed Circuit Techniques Oct. '52



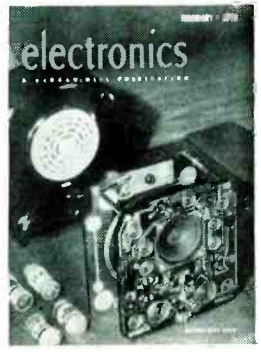
Printed-Circuit TV Tuner July '50



Photoelectric Cutting Machine Dec. '48



Printed Circuits Aug. '48



Machine-Made Radio Feb. '48

EXPENSIVE SURPLUS — ELECTRONICS reprints are made by the photo-offset process, by photographing pages cut from an issue.

Usually, they are ordered within a few weeks of publication, but one recent order called for an article that appeared in 1951. We could find no loose pages of the article in our files, nor a single copy. Even a surreptitious search of editors' desk drawers drew a blank. We do have bound volumes, but these do not permit the pages to lie flat as required by the reproduction process.

A search of second-hand book stores finally turned up the issue needed. But we had to pay $1.20 for it, just 140 percent more than the one-year subscriber pays.

SHADES OF GUTENBERG—Most typographical errors are merely routine, the misspelled word doesn't make sense. But occasionally one does. In January, in the article on recording the radio-tv audience, we caught one that did, a mirror sends light to a group of six apertures, each *mashing* a 931A phototube.

This month we chuckled over a cute one, a phase angel. But a draftsman stopped us cold with a chart, lettered Magnetron Sales Club. We didn't join. It was meant to be Climb.

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Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25.00 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A.

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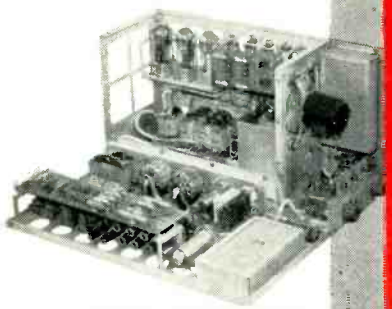
concerning

ELECTRONIC FREQUENCY REGULATION

MODEL FCD250



MODEL DFCD250-2AR.
Typical 3ϕ in, 3ϕ out airborne frequency changer, built to military specifications. Input 360-440cps, output 400cps ±0.1% over wide ambient range.

More than 3 years widespread use in laboratory and industry have proved the reliability, economy, and convenience of SORENSEN *electronic* FREQUENCY CHANGERS

- **45-65cps and 360-440cps output**
- **250VA and 1000VA capacity**
- **1% and 0.01% frequency regulation**

Sorensen electronic frequency changers are now in widespread use as sources of precision 60cps or 400cps for timing applications, for use with servo and gyro motors in design work, and for testing components or complete instruments that must operate over variable frequency conditions. They are used in checking equipment designed for 50cps (foreign) operation; the same instrument converts 50cps line to 60cps source. Many Sorensen frequency changers are also being used with field equipment in connection with motor generator sets, where frequency control is often inadequate.

Portability is an important feature of Sorensen frequency changers. The units can be located right beside the load, making costly wiring and distribution systems unnecessary. Temporary requirements can be taken care of by moving the changer from production line to lab and back, as needs arise.

SPECIFICATIONS

Model	FCD250	FCD1000	FC1000
Input voltage	95-130VAC, 1ϕ, 50-60cps	208 or 230 VAC, 1ϕ, 50-60 cps	
Output voltage	115VAC, 1ϕ, adjustable between 110-120 volts		
Output frequency	400 cycles, adjustable	±10%	45-65 cycles, adjustable
Output voltage regulation	±1.0%	±1.0%	±1.0%
Output frequency regulation	±1.0% in standard models; ±0.01% with auxiliary frequency standard. Frequency fixed at 400cps, 50 or 60cps with standard.		
Capacity	250VA	1000VA	1000VA
Load range	0-250VA	0-1000VA	0-1000VA
Distortion	5% maximum	5% maximum	5% maximum
P.F. range	Unity to 0.5 lagging		
Time constant	0.25 seconds	0.5 seconds	0.5 seconds
Envelope modulation	2% maximum	2% maximum	2% maximum

AIRBORNE FREQUENCY CHANGERS

Sorensen has designed and built a wide variety of frequency changers and inverters for incorporation in military aircraft. These instruments have various specifications and are not standard. For the most part, the changers convert variable (320-1000 cps) input to precision (±0.05%) output frequency, with minimum distortion (5-10%).

Sorensen airborne inverters are built to convert 28VDC input to 400-cycle, 3-phase output, with output frequency accurate to 0.05% over wide ambients.

Sorensen's heavy experience with commercial and military frequency changers is available for application to your precision frequency problems. Your inquiries are invited. Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Connecticut.

SORENSEN

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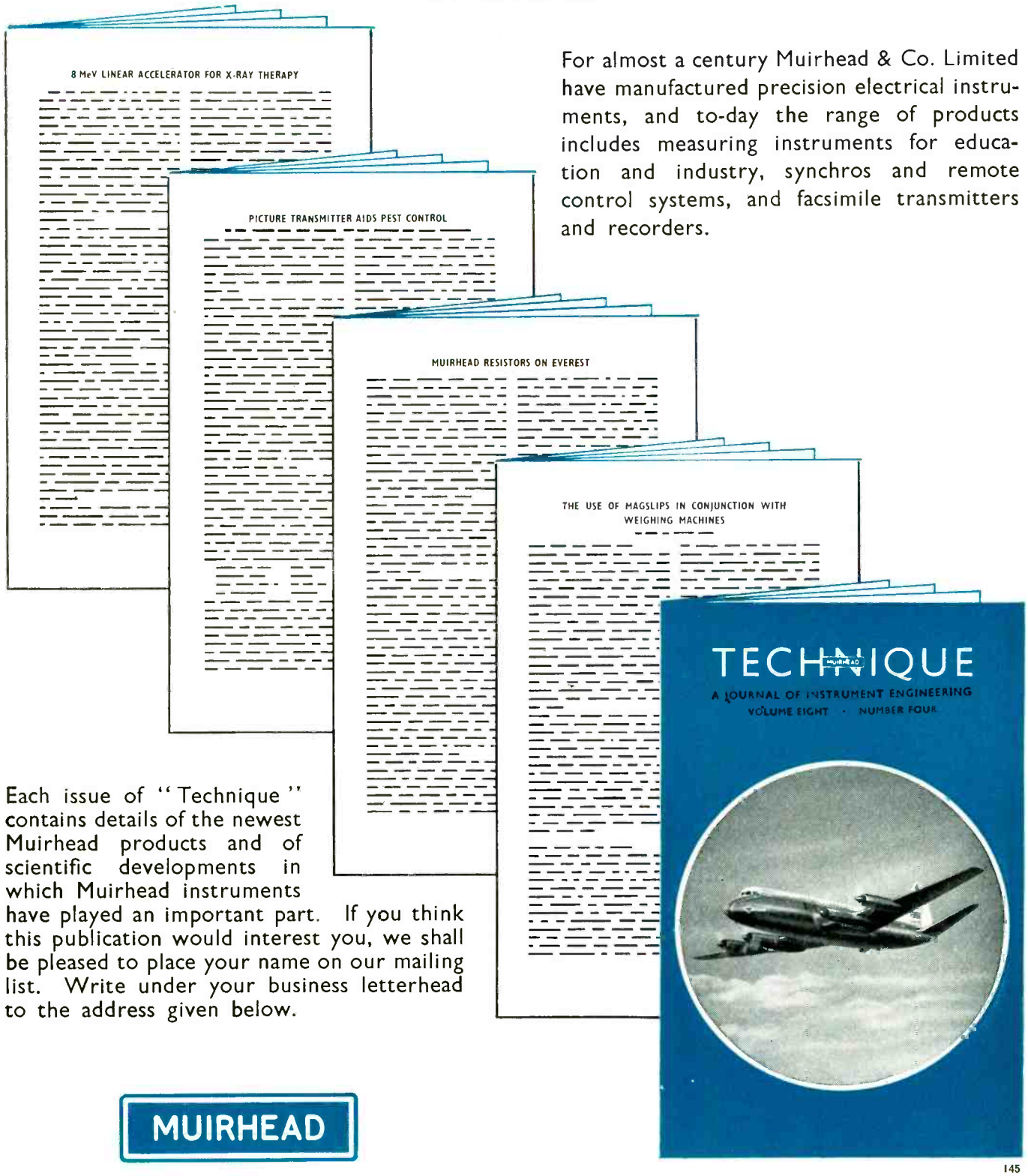

For almost a century Muirhead & Co. Limited have manufactured precision electrical instruments, and to-day the range of products includes measuring instruments for education and industry, synchros and remote control systems, and facsimile transmitters and recorders.

Each issue of "Technique" contains details of the newest Muirhead products and of scientific developments in which Muirhead instruments have played an important part. If you think this publication would interest you, we shall be pleased to place your name on our mailing list. Write under your business letterhead to the address given below.

MUIRHEAD

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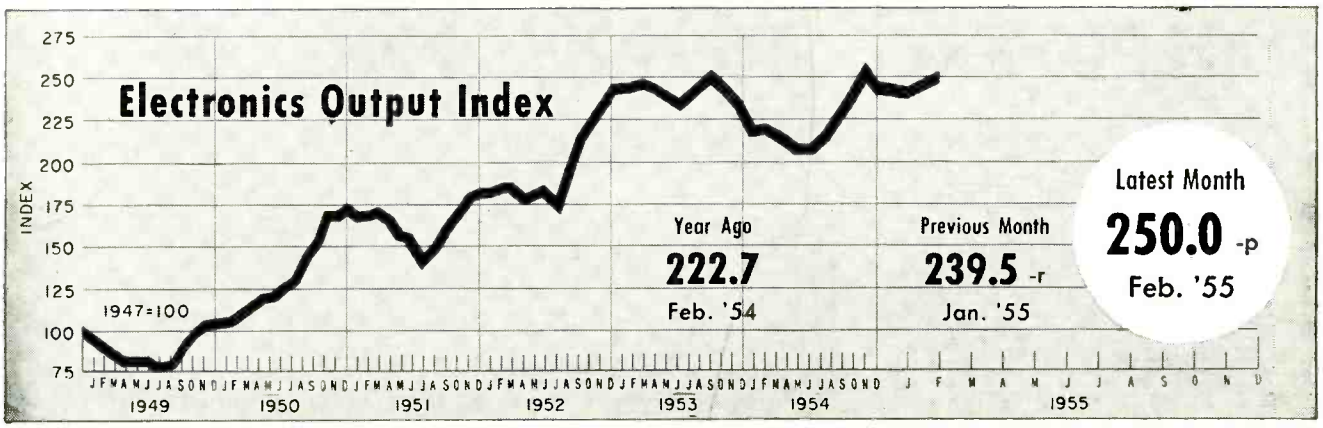


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month: Feb. '55	Previous Month: Jan. '55	Year Ago: Feb. '54
Television sets, total	702,514	654,582	426,933
With UHF	101,217	117,095	92,275
Color sets	nr	nr	.....
Radio sets, total	1,089,724	1,068,146	769,232
With F-M	17,751	16,568	12,298
Home sets	232,831	280,121	233,063
Clock radios	150,031	166,885	105,933
Portable sets	109,120	47,303	98,275
Auto sets	597,742	573,837	331,961

RECEIVER SALES

(Source: RETMA)	Feb. '55	Jan. '55	Feb. '54
Television sets, units	626,613	647,585	536,017
Radio sets (except auto)	320,042	474,947	262,679

RECEIVING TUBE SALES

(Source: RETMA)	Feb. '55	Jan. '55	Feb. '54
Receiv. tubes, total units	38,526,796	37,949,762-r	25,189,147
Receiv. tubes, value	$28,107,186	$26,877,457	$18,319,819
Picture tubes, total units	859,529	866,956	645,715
Picture tubes, value	$17,119,568	$17,661,018	$13,916,478

SEMICONDUCTOR SALES

	Jan. '55	Dec. '54	Jan. '54
Germanium diodes, units Silicon diodes, units	1,403,940	1,464,559	740,445

INDUSTRIAL TUBE SALES

	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
(Source: NEMA)	4th '54	3rd '54	4th '53
Vacuum (non-receiving)	$9,338,181	$8,803,740	$9,467,331
Gas or vapor	$3,498,123	$3,570,586	$4,854,222
Phototubes	nr	nr	$405,000
Magnetrons and velocity modulation tubes	$15,249,651	$13,112,244	$13,073,095
Gaps and T/R boxes	$1,788,780	$1,476,407	$1,707,730

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month: Feb. '55	Previous Month: Jan. '55	Year Ago: Feb. '54
Total sets	34,364,000	33,816,000	28,289,000

BROADCAST STATIONS

(Source: FCC)	Mar. '55	Feb. '55	Mar. '54
TV stations on air	451	448	385
TV stations CPs—not on air	122	130	190
TV stations—new requests	20	17	72
A-M stations on air	2,703	2,692	2,539
A-M stations CPs—not on air	103	101	129
A-M stations—new requests	194	186	163
F-M stations on air	538	542	555
F-M stations CPs—not on air	10	11	15
F-M stations—new requests	6	5	3

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Feb. '55	Jan. '55	Feb. '54
Aeronautical	42,048	41,868	43,682
Marine	48,977	48,751	44,140
Police, fire, etc.	17,289	17,148	15,003
Industrial	23,405	23,223	20,280
Land transportation	7,318	7,289	6,600
Amateur	130,642	129,258	117,427
Citizens radio	9,916	9,579	5,550
Disaster	312	310	257
Experimental	597	649	532
Common carrier	1,822	1,810	1,490

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Mar. '55	Feb. '55	Mar. '54
Prod. workers, comm. equip.	369,700-p	370,100-r	361,900
Av. wkly. earnings, comm.	$70.53 -p	$70.58 -r	$67.55
Av. wkly. earnings, radio	$69.32 -p	$68.28 -r	$66.59
Av. wkly. hours, comm.	40.3 -p	40.1 -r	39.5
Av. wkly. hours, radio	40.3 -p	39.7 -r	39.4

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Mar. '55	Feb. '55	Mar. '54
Radio-tv & electronics	438.0	437.0	301.9
Radio broadcasters	502.9	496.8	302.1

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

TOTALS FOR THE FIRST TWO MONTHS		
1955	1954	Percent Change
1,357,096	847,504	+60.1
2,157,870	1,641,213	+31.5
1,274,198	1,267,934	+ .5
794,989	573,302	+38.7
76,476,558	47,322,147	+61.6
1,726,485	1,203,396	+43.5

Television set production
Radio set production
Television set sales
Radio set sales (except auto)
Receiving tube sales
Cathode-ray tube sales

INDUSTRY REPORT

Transistor Computer Will Hit Market Soon

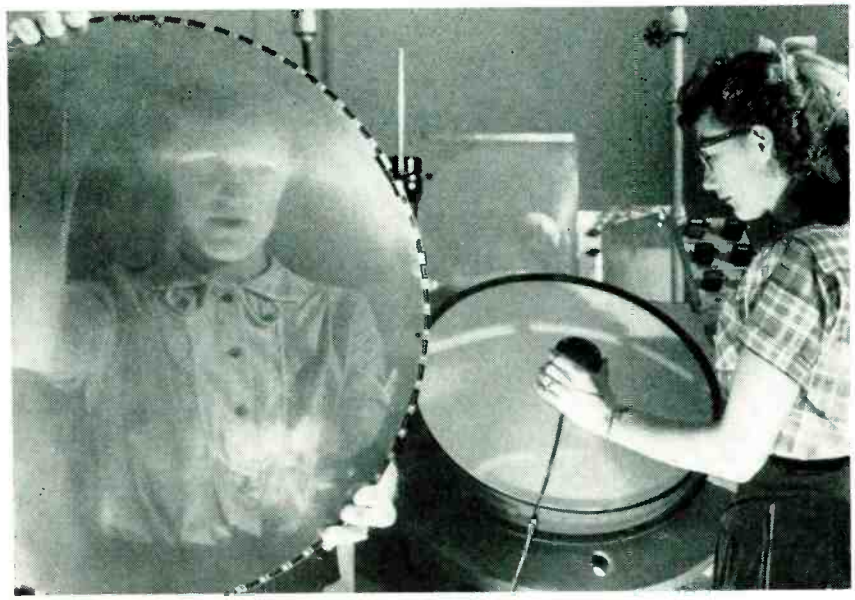
Saves 50 percent in size, 90 percent in power. Unit uses 3,000 transistors

AT LEAST one transistorized electronic computer will be available for delivery early in 1956. Designated as the IBM 608, the machine is similar to electron-tube models 604 and 607. However, it performs 4,500 additions a second, 2½ times faster than the 607.

The machine stems from a developmental machine demonstrated last fall (ELECTRONICS, p 6, Nov. 1954). It achieves a 50-percent saving in space and a 90-percent saving in power required.

More than 3,000 transistors are used—some of them 150-X4 power transistors developed by IBM. The machine uses matrices of ferrite cores as its internal memory. The components are mounted on about 700 plug-in printed wiring boards. This format is adapted to the company's mechanized assembly techniques (ELECTRONICS, p 8, March 1955).

► **More Cores**—Use of ferrite cores is now an accepted thing in large computers. The Remington Rand Univac II, advanced model of the Univac, now contains a high-speed memory capable of retaining 24,000 characters and able to execute 8,000 instructions a minute. The memory is based upon use of ferrite cores. Additional cores can be employed to provide a memory capable of storing 120,000 characters. Univac joins the IBM 705, Raytheon Raycom and RCA Bizmac in using a high-speed ferrite core memory.



CONTINUED REDUCTION of rejects in shadow-mask color tv tubes being inspected with ultraviolet light (right) is a big factor in . . .

Push For Color Tube Output

Standardizing color tube, pushing setmaking and stepping up programming planned

WITH $50 million reputedly already invested in development of color television, RCA has decided to throw in an undisclosed further amount to obtain broad adoption and mass production. The push will be multipronged, involving standardization of the mask type, round metal, 21-inch color kinescope, a less expensive receiver based upon designs released last September and a healthy increase in color broadcast programming.

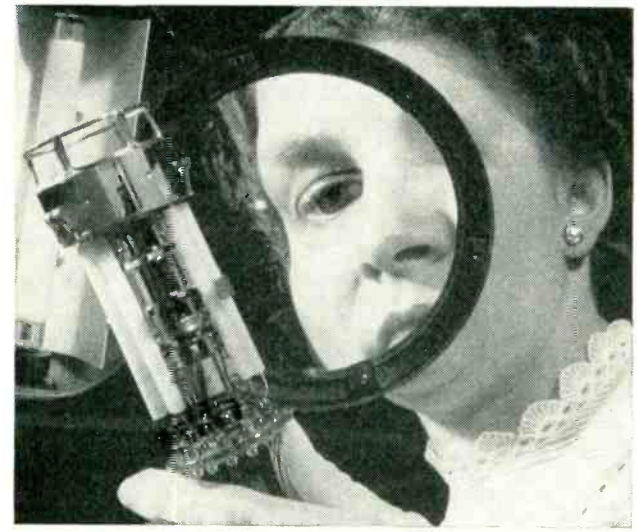
Admitting at the start that it can't do the job alone, RCA expects that after the ball starts rolling it will recoup its initial heavy financial losses.

► **Mask Tube**—First phase of the campaign is the decision to concentrate manufacturing effort on the 21-inch round tube. Facilities at the Lancaster, Pa. plant presently occupy about 50,000 square feet of floor space. By August, new construction and relocation of offices will up the area to 132,000 square feet. Output is about 2,000 color tubes a month at present. Many of the operations are manual.

More efficient handling methods, including conveyor lines, now being installed, will make possible an output of some 30,000 tubes a month. RCA is confident that its projected cost of $100 (reduced from an initial $175) is realistic. As an example, shrinkage (rejects) of black and white picture tubes run between 10 and 20 percent. Recently the Lancaster plant reduced its spoilage on color tubes to 16.2 percent.

► **Color Set Design**—Crux of general color acceptance is reasonable

Completed color tv picture tubes undergoing final inspection at RCA plant in Lancaster, Pa.



Three-gun assembly gets careful scrutiny before being sealed into color kinescope tv tube

set cost. W. W. Watts, executive vice president for electronic products, says that a new simplified set will be announced soon. There is not yet any indication as to its price.

Consensus of those who have observed the pattern is that RCA will probably reveal a design to serve as bellwether, much as the famous model 630 did for mass production of black and white sets. With smaller manufacturers competing against the increasing production lines of the bigger outfits, set prices can be expected to fall eventually below the $500 level that marketing experts feel is the magic borderline for general public acceptance. RCA officials agree with the prediction that color sets at $300 may well be possible when production reaches 5 million annually.

► **Color Programming**—Through its NBC broadcasting affiliate, RCA can help beef up sales by providing interesting color programs. There will definitely be more color on the air, including a daily strip that can be used for demonstrations and adjustments.

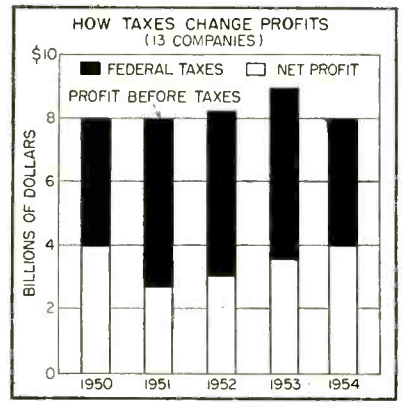
Spreading interest in color will take more than network broadcasts. Local color pickups will undoubtedly lag color film programming owing to high studio costs for the former. Although all major broadcast equipment suppliers have color film equipment designs, only about 65 units have been placed on firm order or delivered to date.

Electronics Profits Gain As Taxes Slide

Net profits after taxes hit new high for many firms in 1954 when excess profits tax died

MANY firms in the electronics field showed greater net profits last year than for any year in the industry's history. This was due in part to tax savings as a result of the expiration of the excess profits tax and to the changes in the new tax law.

However, manufacturers may have to amend returns and repay for some deductions taken in 1954. The government is in the process of changing the provision in new tax law that allowed manufacturers to deduct estimated future expenses such as product warranties in the year that the products are sold. Under the old law such expenses were not deductible until they were actually spent.

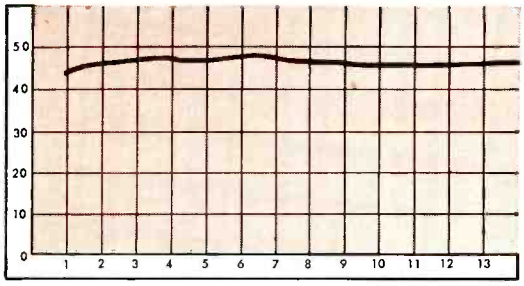


Another provision in the new tax law which has aided net profits permits more of the cost of a new plant facility to be deductable in its first years with lower deductions in its later life. This part of the law applies only to facility additions made in 1954. Other equipment continues under the longer depreciation method.

► **Effect**—Expiration of the excess profits tax was the main factor responsible for tax gains in 1954. The other provisions mentioned were much less effective. GE in 1953 provided $308.5 million for federal taxes on income and renegotiation while in 1954 the amount provided was $178 million for a decrease of $130.5 million or 42 percent.

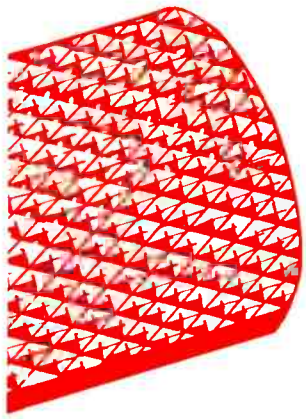
Sylvania's federal taxes on income in 1953 amounted to $14.9 million including $2.3 million in excess profits tax. In 1954 total taxes were $8.9 million representing a drop of $6 million or over 40 percent. As a result of the new tax law, the company's federal tax provision for

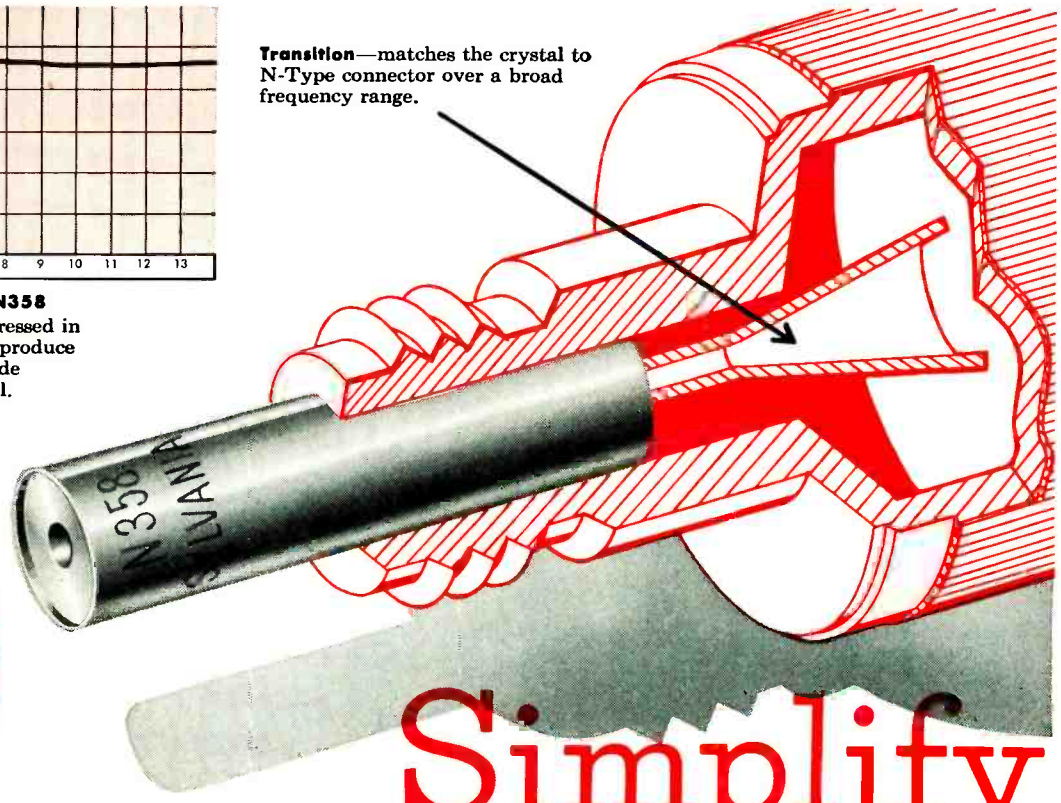
(Continued on page 10)



Tangential Sensitivity of IN358
The input signal level, expressed in db below 1mw required to produce an output pulse of amplitude tangential to the noise level.

Transition—matches the crystal to N-Type connector over a broad frequency range.





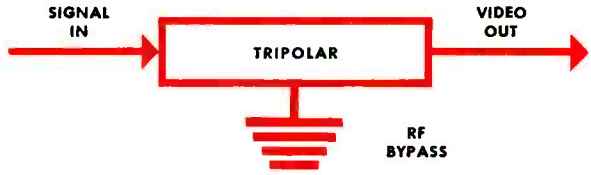
Simplify front-end design

over a BROADBAND microwave frequency range

NEW TRIPOLAR CRYSTAL DIODE

offers these five advantages

- Simpler, broadband crystal mount
- Signal goes in one end—is taken off the other
- No extra plumbing is required
- Built-in rf bypass capacitor
- Available with or without built-in dc return



By matching the inherent broadband characteristics of coaxial cable, the Tripolar crystal diode introduces an entirely new concept in broadband microwave circuitry and opens a fresh, simplified approach to front-end design.

The IN358 video detector is the first of these new broadband crystal diodes. In a simple holder, it covers the frequency range from 1 to over 12 kmc. The IN358 is connected in series with standard coaxial cable between the signal source and amplifier.

Other broadband video types are available now and broadband mixer types will be ready soon.

SPECIFICATIONS

Frequency Range:	1,000—12,400 Mc
Figure of Merit: (1)	10 min. at 6750 ± 10 Mc
Tangential Sensitivity:	−40 DBM over frequency range @ 25°C
Video Resistance:	450 ohms—18000 ohms @ 25°C
Ambient Temperature:	−40—70°C

Note 1. Measured in untuned broadband holder

ANOTHER REASON WHY IT PAYS TO SPECIFY SYLVANIA

SYLVANIA

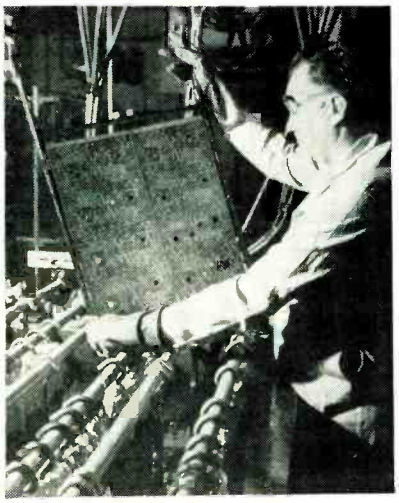
SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., Montreal, P. Q.

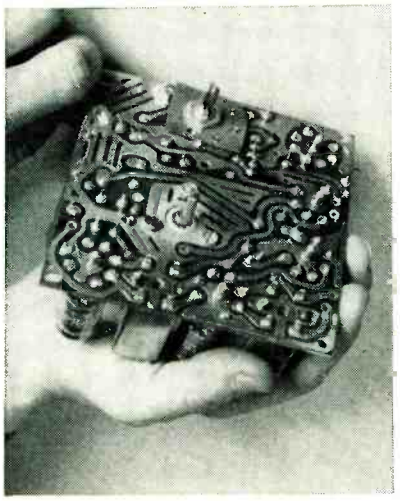
LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

1954 was reduced by $800,000.

For Westinghouse the changes in the tax code and a change in computing current federal income tax costs had the effect of increasing the firm's 1954 net income by about $4.5 million. The company paid a total of $78.6 million for federal income taxes compared to $75.9 million in 1953.

► **Future**—Not all companies had lower taxes in 1954 as a result of tax law changes. However, many that d.d pay higher taxes did so as a result of higher net sales which in some cases moved them to a higher income bracket. Despite tax relief in 1954 total taxes for many firms still amounted to over 50 cents on each pretax profit dollar.





PRODUCTION of "Thru-Con" boards for table model radios is stepped up at GE as . . .

Wiring Boards Hypo Plastic Sales

Laminate manufacturers see their business volume tripled this year by printed wiring

GROWING use of printed wiring in electronic equipment means rising business volume for laminated sheet manufacturers. There are about two dozen firms in the laminate field although not all sell printed wiring boards. Last year these companies sold close to $1 million worth of boards for printed wiring use. This year total printed wiring board sales may be somewhere between $3 and $5 million.

One major set manufacturer recently placed a $54,000 order for one month's supply of copper-clad laminates and may spend a total of over $500,000 this year on the material. One board manufacturer estimates that 10 percent of total laminate production is accounted for by printed circuit boards.

Big computer manufacturers such as IBM and Remington Rand are volume users of printed circuits. One of the firms has already ordered over 200,000 boards.

► **Cost**—A 3 by 4-foot sheet can cost about seven or eight dollars.

The copper foil thickness used in almost all present day applications is one to two ounces per square foot, and the increasing use of the boards has caused a tightness in electrolytic copper supply.

At present, there is only one source for the copper but one laminate maker indicates this may change soon.

► **Thru-Con**—GE, which manufactures its own laminates, recently announced that it will concentrate its production of printed wiring circuit boards on a through-connecting type which will eliminate production steps and reduce the cost of mechanized assembly. The company will curtail production of etched board types and will step up production of "Thru-Con" boards to replace them. These have the copper wiring pattern plated not only on the board, but through its holes to make the front-to-back circuit connections.

They do not require staking pins since the holes have eyelets plated as integral parts of the wiring. GE expects that about one million radios will be produced this year using printed circuit boards.

Magnistors Promise to Supplement Transistors

New circuit element acts as amplifier or bistable storage device

MAGNISTORS are small saturable reactors having unique shapes and flux paths. They are divided into two general classes described as transient and permanent. The transient type has no memory while the permanent or two-state class will remember its set or reset condition indefinitely even if all power is removed.

Magnistors are used to gate, switch, amplify, count and record. They also form logical arrays for adding, subtracting, shifting and other computing functions.

Such a circuit element has an indefinite shelf life according to Potter Instrument Company who developed the magnistor. They are undisturbed at temperature ranges attained in commercial and military equipment. (See p 280, this issue).

The simplest form contains two windings wound on special ferroceramic material. One winding, the signal coil, is used to carry a sine-wave signal in the range from 100 kc to 15 mc or pulses having a repetition rate from 0 to 10 mc. By varying the d-c current applied to the second winding (control coil), the impedance of the signal winding to the carrier frequency or pulses can be varied over a

(Continued on page 12)

A SNAP FOR WIRING BOARD ASSEMBLIES

NEW Sprague Type 28D Push-Lok* Electrolytic Capacitors Give Fast, Fool-Proof Mounting

HERE'S THE BEST APPROACH yet to electrolytic capacitors for printed wiring board assemblies.

It's Sprague's new Type 28D Push-Lok Electrolytic. Just insert the connecting lugs through the slots in the wiring board, and the capacitor is held securely in place until the chassis is ready for dip soldering . . . so securely that solder gaps are eliminated. Spring action of the Push-Lok lugs is strong enough to hold relatively heavy capacitors in place, even when the board is carried sideways, or upside-down on a conveyor. Tab connections are always in close contact with the printed conductors. Yet, unlike other designs, no secondary operations are required for this fast and secure mounting.

Other advantages include:

Fool-Proof Positioning—A Push-Lok can only be inserted the right way. A wide index terminal is provided in the mounting ring to index the assembly on the chassis or other surface if desired.

The Ability to Print Wiring Boards on Both Sides—Shoulders on the Push-Lok lugs plus additional prongs keep the capacitors clear of the chassis.

Safety—Circular shield conforms with suggestions of Underwriters' Laboratories, Inc. Tools cannot be inserted easily between the bottom of the capacitor and the chassis.

FOR COMPLETE INFORMATION on these new Type 28D Push-Lok electrolytic capacitors, write for Engineering Bulletin to Sprague Electric Co., 35 Marshall Street, North Adams, Massachusetts.

**Push-Lok is a Trademark of the Sprague Electric Company*

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of electrolytic capacitors.

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE SPREXINT

ratio as high as 500 to 1 if desired.

Power levels in the range of microwatts to tens of watts can be controlled.

U.S. Urged To Increase Surplus Disposal

THE Hoover Commission, in its report to Congress on surplus property, recommends that the Armed Forces get rid of obsolete stock or stock that is rapidly becoming unsuited to military needs. From $10 billion to $25 billion of supplies now in government warehouses could be eliminated with proper inventory control and more realistic stock levels.

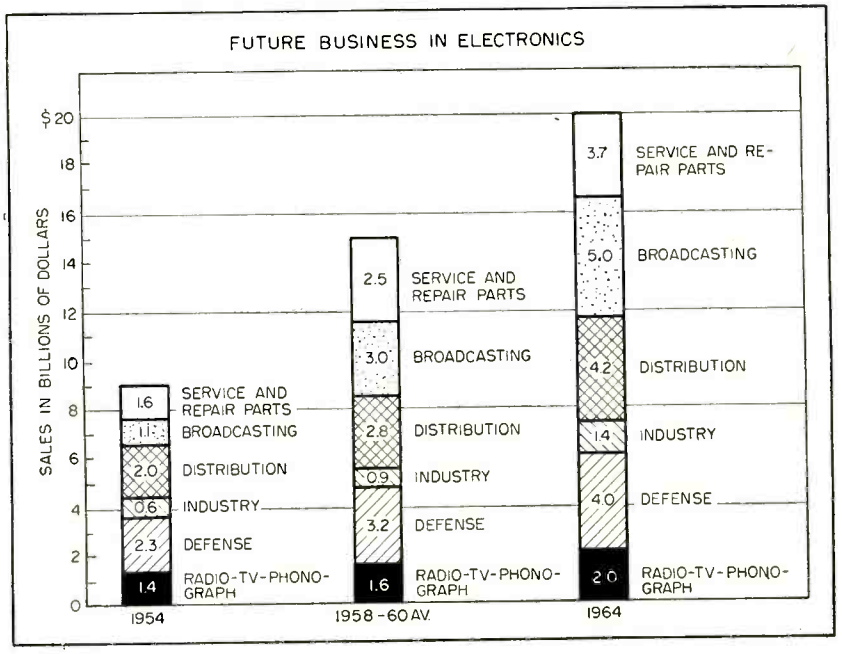
The government would have to dump surplus stock at an annual rate of $2 billion, original cost, for the next several years.

▶**Return**—The average return from surplus sales is now running around 6 percent of original cost. Returns from electronic surplus equipment are as low as 3 percent. This is due to many factors including high obsolescence of some equipment.

Tubes Show Tubes On Closed-Circuit TV

ENGINEERS attending the IRE convention in New York were introduced to a new GE tube, the GL-6442, via a closed-circuit telecast originating at the company's tube plant in Schenectady, N. Y. The new tube promises to raise the power-handling capability of low-power radar, beacons and navigation aides at frequencies up to 4,000 mc.

The hour-long program was produced by Box Office Television. The cameras picked up live sequences demonstrating the manufacture and use of new tubes. A two-way audio system was used so that the audience could ask on-the-spot questions of design and production officials at the plant.



Industry Future Holds $20 Billion

Realistic appraisal of the field's future potentials yields increasing volume figures

THE NEXT ten years in the electronics industry will see the present annual volume of $9 billion rising to $20 billion in the year 1964 according to an appraisal of the industry's business prospects by Sylvania Electric.

▶TV—The report indicates that the long-term potential for tv will range between 6 million to 7.5 million sets per year throughout the next decade. In 1955 unit sales of tv sets will probably fall off to 6.4 million with a total factory value of around $1 billion. During the three year period, 1958-60 combined unit sales of black-and-white and color sets are expected to average 6.9 million, with dollar volume averaging around $1.2 billion a year. At the end of the decade, about 7.4 million sets will be sold at a factory price level of $1.5 billion.

It is expected that no more than about 150,000 color tv sets will be produced this year with only 100,000 of these being sold to the public. About 34 percent of all sets produced in 1958-60 period however will be color sets and by 1964 color is seen accounting for 61 percent of total set production.

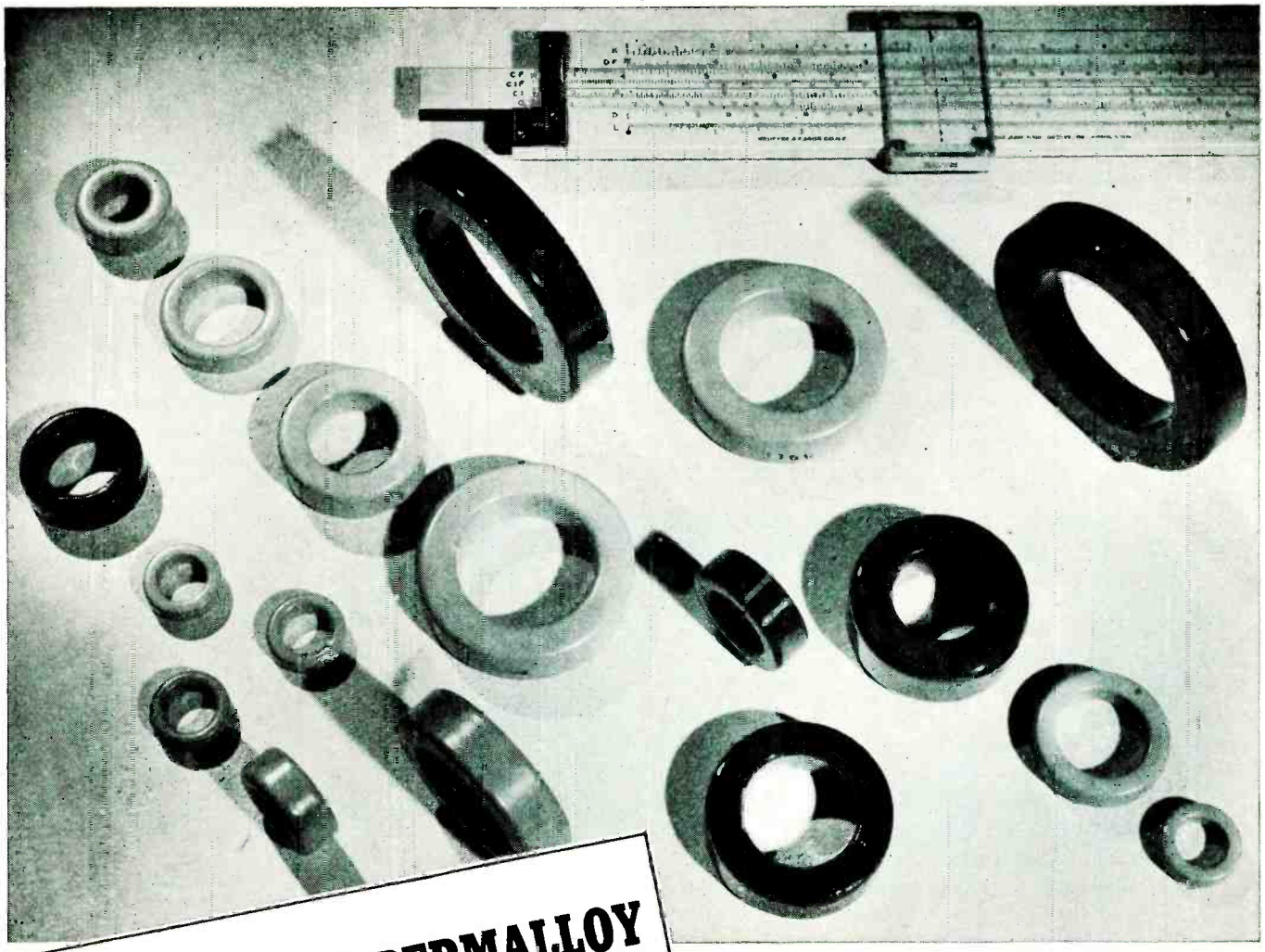
▶**Radio**—The study estimates that 7 million home radio sets grossing around $147 million will be sold in 1955 and that by 1964 8.5 million home radio units will be sold at a dollar total of near $162 million. Annual auto set sales are expected to reach 5.6 million by 1964 with a dollar volume of $140 million.

Records and phonographs were seen maintaining a fairly level volume of sales of between $120 million and $140 million over the next decade.

▶**Defense**—Government purchases of electronics equipment might reach $2.5 billion in 1955 according to the report. A volume of $3.2 billion a year was seen for the 1958-60 period reaching $4 billion a year by 1964.

▶**Industry**—Sales of equipment for industry and commerce were estimated at $570 million for 1954 and were expected to increase to around $640 million this year. By 1958-60 annual sales of industrial-commercial equipment are expected to reach $900 million going to between $1.3 billion and $1.4 billion

(Continued on page 14)



MOLYBDENUM PERMALLOY POWDER CORES*

(New technical data now available)
Write for Bulletin PC-104A, dated March 15, 1955

HIGH Q TOROIDS for use in Loading Coils, Filters, Broadband Carrier Systems and Networks—for frequencies up to 200 K C

COMPLETE LINE OF CORES TO MEET YOUR NEEDS

★ **Furnished in four standard permeabilities—125, 60, 26 and 14.**

★ **Available in a wide range of sizes to obtain nominal inductances as high as 281 mh/1000 turns.**

★ **These toroidal cores are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.**

For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability ($\pm 0.1\%$) over a specific temperature range.

*Manufactured under license arrangements with Western Electric Company

W&D 4744

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

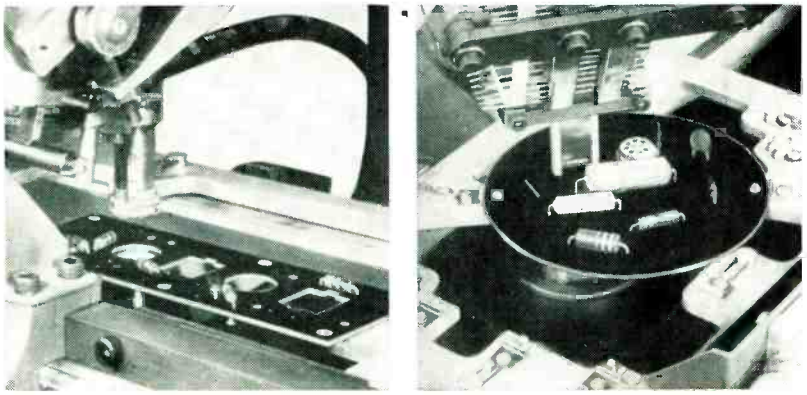
by the decade's end in 1964.

► **Tubes**—Sales of radio receiving tubes, tv picture tubes, special electronic tubes and other components for repair purposes will be near $800 million in 1955, according to the study. In 1958-60, the total is expected to reach $1.2 billion and by 1964 is expected to aggregate $2.3 billion for a 250-percent gain in a decade.

► **Markup**—Added to the factory prices of the foregoing estimates are the revenues of distribution which exceeded $2 billion in 1954 and will be on the same level this year. By 1958-60, markup is expected to pass $2.8 billion and rise to about $4.2 billion in 1964.

Repairmen's service charges are expected to show a gradual increase from $925 million this year to $14 billion ten years hence.

Broadcasting revenues are expected to rise to $5 billion for 1964.



TUBE sockets and other components are automatically inserted by . . .

Robot Assemblers Coming Soon

Machinery maker begins production and schedules delivery of assembler

LIMITED production has been started by United Shoe Machinery on its conveyor type machines for automatic assembly of electronic equipment. (ELECTRONICS, Sept., 1954, p 6 and 232) Delivery will begin in early summer.

The machines are already in daily operation in major radio and tv factories such as Emerson, GE and RCA. The machines have already been used to insert components in well over 500,000 printed wiring boards which have been put into commercial sets, mainly radio and tv receivers.

The equipment has a capacity of over 9,000 boards a day. Parts of the sets that utilize mechanized assembly vary from subassemblies for tv receivers to virtually complete chassis for table radios. Reliability of more than 99.5 percent for equipment under actual production conditions has been reported by users.

► **Development**—The company is continuing development and production evaluation of a complete line of inserting units designed to handle components such as one and two-watt resistors; mica, tubular and disk capacitors jumper wires; tube sockets; and i-f transformers. Included in this system is an advanced method of automatic dip soldering.

Magnetic Amplifier Sales Increase

WITH total sales in 1952 represented as one index point, volume increased for one manufacturer of magnetic amplifiers to 6.5 points in 1953, and to 113 points last year. The firm, which entered the field on the assumption of industry wide sales of at least 600,000 units a year, estimates that their sales index this year will be 114.

Glass Makers Push Parts Field Invasion

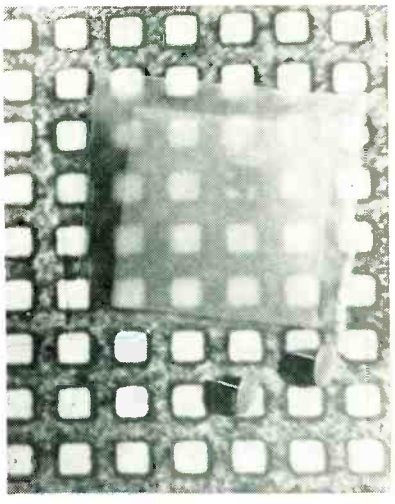
Glass components for mass radio-tv market debut as tube consumption grows

VALUE of glass envelopes used by the electron tube industry is in the neighborhood of $75 million annually. Billings have increased as tv picture tubes have grown in size and number.

So far use of glass in components has been limited. However, increasing activity in the low-cost radio and tv components field is planned.

Corning Glass recently concluded an agreement for the marketing some of its electronic components through the distributors of Erie Resistor Corp. It also reduced prices in certain lines and introduced a number of low-cost components especially designed for commercial radio and tv applications.

► **Military**—Glass makers are continuing research and manufacturing of electronic devices for the military services. Recent developments include fused silica delay lines, and precision glass screens for c-r tubes which contain 200,000 accurately formed holes per square inch. In addition glass makers are working on the design of glass ra-



Newly developed screen of glass, shown against an enlargement of itself, contains 200,000 holes so small they cannot be threaded with a human hair

(Continued on page 16)

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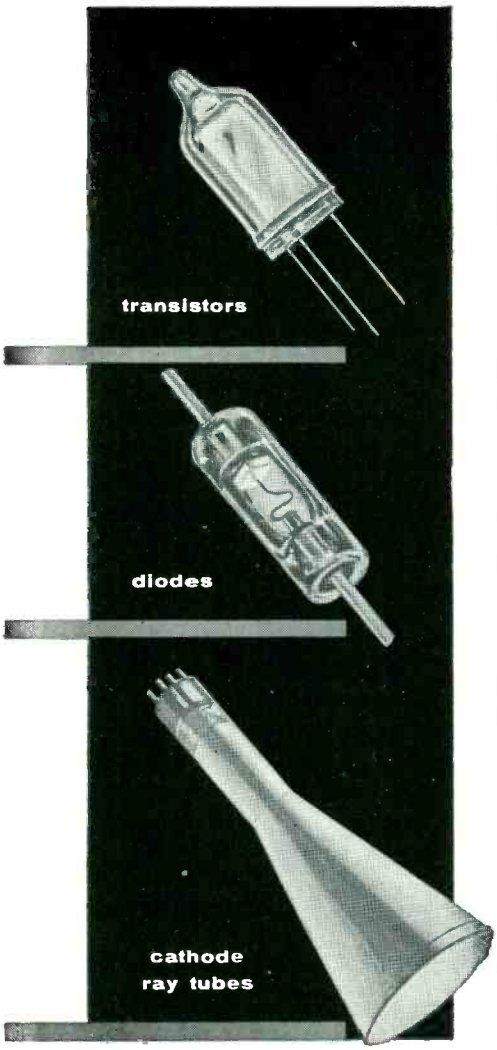
profitable
automatic production...

call on KAHLE



...world's leading exclusive manufacturer of production machinery for the electronics field

If you're making (or plan to make) *diodes, transistors, sub-miniature, miniature, cathode ray tubes, or other electronic tubes or component parts,* take full advantage of Kahle's invaluable experience.

With Kahle methods and "know-how" you're sure of getting exactly the right machinery to produce exactly what you want...accurately, dependably, profitably.

For more than a quarter of a century the leaders in the electronics field have relied on Kahle for production machinery. Typical production steps automatically performed by Kahle equipment include sealing, bulb making, stem making, exhausting, grid winding, filament coil winding, lead wire welding.

Write today for additional details, equipment specifications, production data, and quotations.

Write for information on special experimental and research services offered by Kahle.

Get first hand information at our conveniently located plant—
15 minutes from Times Square, 5 minutes south of Lincoln Tunnel

Kahle ENGINEERING COMPANY

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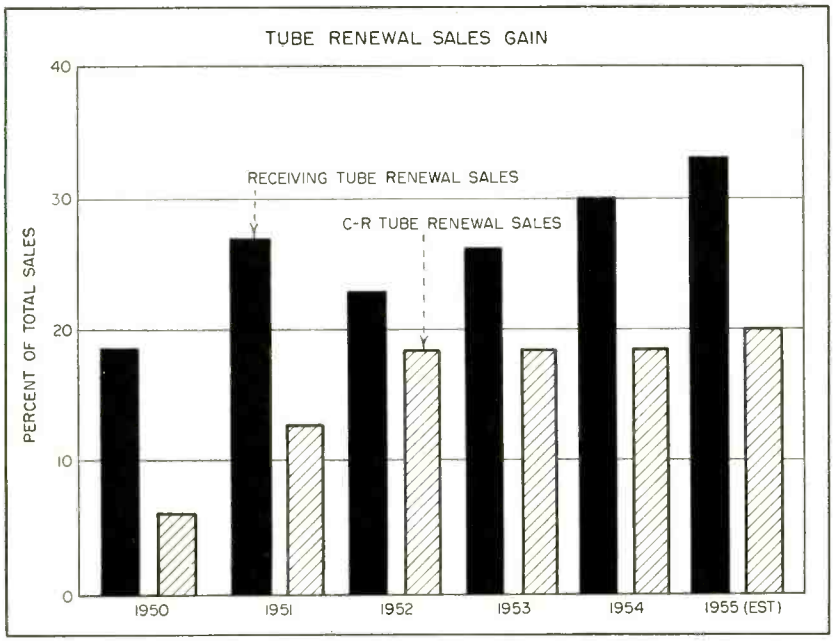
domes for aircraft and guided missiles.

▶**Tubes**—A 22-inch rectangular glass blank for color tv picture tubes is now being shipped in limited quantities by Corning Glass. The new tube is approximately the same length and height as a 19-inch round bulb and is designed to fit into the same size cabinet.

It is designed for a shadow mask tube and is constructed so the mask can be mounted by either of the two methods now in use, the flat land or the pin method. The bulb is adaptable to either the three-gun or single-gun system. Sampling of the tube began last fall. The company is also making small shipments of 21-inch round glass bulbs.



Renewal Market Gains Prominence

One-third of receiving and cathode-ray tube sales are accounted for by renewals

REPLACEMENT market for electron tubes is steadily edging into greater prominance. Last year over 30 percent of total receiving tube sales were for renewal representing a dollar volume of $89.6 million out of total sales of $275.9 million. This year total receiving tube renewals are running at 33.1 percent. In 1950 receiving tube replacement accounted for only 18 percent of total production.

▶**Types**—The bulk of receiving tubes for replacement in the past few years have been entertainment types for home receivers. Receiving types for uses other than home entertainment sets have increased but accounted for less than 1.5 million units of total renewal sales last year.

Most of the $89.6 million in receiving tube renewal factory sales last year were made to parts distributors who annually do approximately $100 million in tube sales including crts. Tube sales account for about 25 percent of total parts distributors' sales.

▶**C-R Tubes**—Although unit volume of renewal sales of cathode-ray tubes is far below that for receiving tubes, dollar volume represented by the tubes is significant. Last year renewal sales of 1.8 million c-r tubes amounted to $43.7 million equal to over half the renewal dollar volume for receiving tubes. This represented an increase of 6,000 units over 1953 sales. The big volume in cathode-ray tube replacement sales was done in the 19 through 21-inch sizes. A total of 810,000 out of the 1.8 million sold last year were in this size. The 17-inch tube was next largest in renewal sales accounting for about 785,000 of total renewal unit volume. The 12 through 15-inch c-r tubes accounted for 148,651 units of total volume. All other sizes has unit sales below 35,000.

▶**Future**—Raytheon, in appraising the future of replacement sales of receiving tubes, tv picture tubes and industrial tubes expects that by 1965 there will be a twofold or even greater increase in sales. This would bring total annual renewal sales for these tube types close to $150 million in 1965.

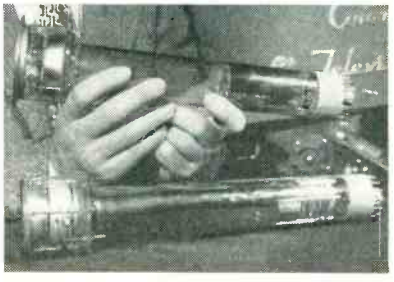
Economy Forecast For Color Camera

AIMING towards a color television camera no more complex than present monochrome devices, RCA engineers have developed a tricolor Vidicon that generates red, green and blue signals simultaneously.

It has been used successfully to televise color slides and motion pictures where high light levels are employed. Further refinements are expected to achieve greater sensitivity.

▶**Color Strips**—Heart of the tube is a color-sensitive target evaporated onto the tube face. The target comprises 900 vertical strips of alternating red, green and blue color filters covered by three sets of semi-transparent signal strips. All the strips of the same color are electrically connected.

As the target is scanned by a single electron beam, the filters permit



Developmental color Vidicon would replace three of the image orthicon type shown below to save expense and bulk

(Continued on page 20)

Type 874-MD Sweep Drive . . . for G-R Slotted Line

This device represents an important advance in the field of automatic instrumentation. In conjunction with the Slotted Line, it makes possible accurate, truly *rapid* measurements of VSWR, complex reflection coefficient or impedance of antennas, termination filters, pads, cables and other network elements.

The Drive can be attached easily to one end of any of the new improved Type 874-LBA Slotted Lines. Sweep speed and length of line swept are completely adjustable, even while the carriage is traveling. Optimum settings for various measurements may thus be made.

For CRO horizontal deflection a sawtooth voltage is provided, the magnitude of which is accurately proportional to carriage position. This feature permits easy calibration of the horizontal scope axis. If the driving oscillator is square-wave modulated, a base line is made available for the scope and VSWR can be measured directly on the scope face. Positions of voltage minima can also be determined in this manner. Where preferable, a standing-wave meter can be used in place of the scope at slow speeds.

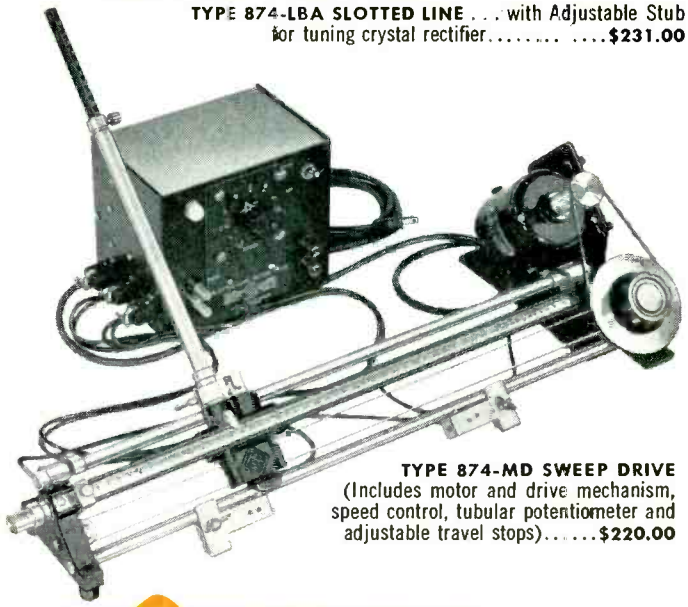
This Drive has no backlash problems whatever, because the Sweep is determined by the *position* of the carriage. Consequently, both forward and backward sweeps are used.

SWEEP SPEED — continuously adjustable from one full sweep (46 cm) in more than 10 seconds, to one full sweep in less than one second.

SWEEP RANGE — continuously adjustable from 1 cm to 46 cm.

SIGNAL FOR CRO HORIZONTAL PLATES — voltage divider with sliding contact on carriage provides d-c output.

TYPE 874-LBA SLOTTED LINE . . . with Adjustable Stub for tuning crystal rectifier..... ....**$231.00**



TYPE 874-MD SWEEP DRIVE
(Includes motor and drive mechanism, speed control, tubular potentiometer and adjustable travel stops).....**$220.00**

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

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8055 13th St., Silver Spring, Md. WASHINGTON, D. C.
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1915-1955
40 Years of Pioneering
in Electronics

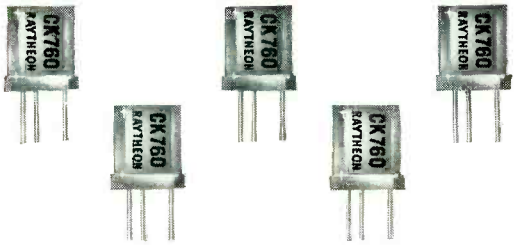
another RAYTHEON *first!*

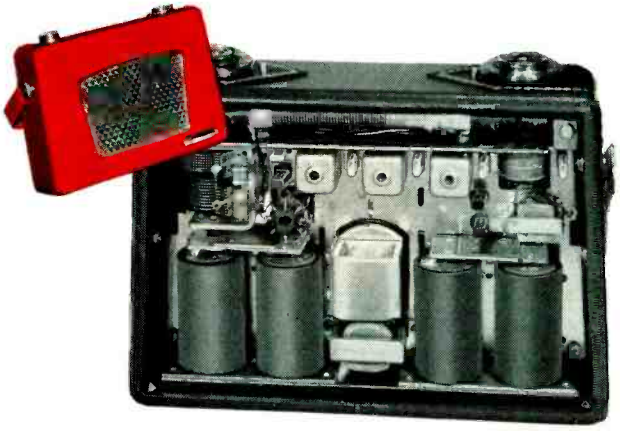
GENUINE

RF TRANSISTORS

that make possible this

ALL-TRANSISTOR 455 kc I. F. PORTABLE





- *completely interchangeable*, without selection of components
- *successfully field tested for an entire year*
- available in production quantities
- hermetically sealed
- equipped with standard military lead spacing
- made by the Raytheon-perfected *fusion alloy* process that has already produced nearly *two million* transistors

- 455 kc performance matching highest industry standards for portable radios
- *operates for 500 hours from 4 standard flashlight batteries*
- delivers 120 milliwatts UPO
- ENSI (equivalent noise sideband input) comparable to vacuum tube portables

HIGH FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

TYPE	Collector		Emitter	Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Max. Junc. Temp. °C	Temp. Rise °C/mW	Coll. Capac. μμf
	Volts	Cutoff μA	MA						
CK760	−6	1	−1.0	75	40	5	85	0.62	14
CK761	−6	1	−1.0	75	45	10	85	0.62	14
CK762	−6	1	−1.0	75	65	20	85	0.62	14

Note: above characteristics are average except where noted

RAYTHEON TRANSISTORS

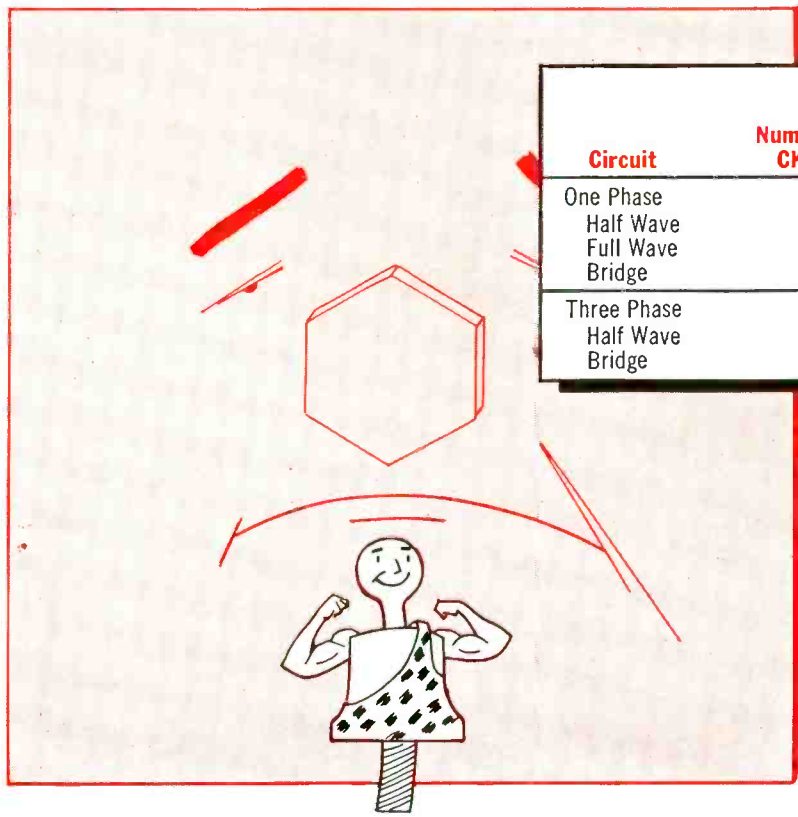
— more in use than all other makes combined

RAYTHEON

SILICON POWER RECTIFIERS

to 175°C to 15 amps. to 200 volts

$$\frac{R_{REVERSE}}{R_{FORWARD}} > 100{,}000$$



Circuit	Number of CK776	Watts Output at Case Temperature† of 30°C	70°C	170°C
One Phase				
Half Wave	1	700	530	265
Full Wave	2	1600	1070	530
Bridge	4	3050	2040	1020
Three Phase				
Half Wave	3	3200	2150	1070
Bridge	6	6800	4550	2270

† Maintained with heat radiator

At maximum power handling capability of CK776, an equivalent selenium rectifier could occupy as much as 100 times the volume.

RAYTHEON SILICON POWER RECTIFIER CHARACTERISTICS

	MAXIMUM VOLTAGE RMS VOLTS	MAXIMUM VOLTAGE PEAK VOLTS	MAXIMUM CURRENT PEAK AMPERES	MAXIMUM CURRENT AVERAGE AMPERES	TYPICAL DISSIPATION WATTS
TYPE CK775					
CASE TEMP. 30°C*	40	60	50	15	40
CASE TEMP. 170°C*	40	60	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	40	60	6	2.0	3.0
AMBIENT TEMP. 170°C	40	60	2.0	0.5	2.0
TYPE CK776					
CASE TEMP. 30°C*	125	200	50	15	40
CASE TEMP. 170°C*	125	200	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	125	200	6	2.0	3.0
AMBIENT TEMP. 170°C	125	200	2.0	0.5	2.0

*maintained by external heat radiator

ACTUAL SIZE

At 25°C both CK775 and CK776 have maximum drop at 5 amperes of 1.5 volts.

Maximum reverse current is 25mA for CK775 at −60 volts, CK776 at −200 volts.

RAYTHEON®

Excellence in Electronics.

RAYTHEON MANUFACTURING CO.

RELIABLE SUBMINIATURE AND MINIATURE TUBES
SEMICONDUCTOR DIODES AND TRANSISTORS
NUCLEONIC TUBES • MICROWAVE TUBES
RECEIVING AND PICTURE TUBES

Semiconductor Division — Home Office: 55 Chapel St., Newton 58, Mass., Bigelow 4-7500
For application information write or call the Home Office or: 9501 Grand Avenue, Franklin Park (Chicago), Illinois, TUxedo 9-5400
589 Fifth Avenue, New York 17, New York, PLaza 9-3900 • 622 South La Brea Ave., Los Angeles 36, California, WEbster 8-2851

the signal strips to produce appropriate electrical signals. Since the beam moves in a fashion similar to the scanning of ordinary camera tubes, the tube generates directly and simultaneously the three primary color signals required for the composite broadcast signal.

Private-Plane Market Boosts Airborne Sales

Multiengined craft require much electronic gear and outnumber airliners

MANUFACTURERS of airborne electronic equipment are looking to the private-plane field as a rapidly growing market for instruments. There are 70,000 active privately owned aircraft of which 40,000 carry some kind of electronic equipment. About 25,000 firms use one or more aircraft in their business—usually for chauffeuring executives.

There are 1,500 multiengined private aircraft as against 1,000 planes operated by the airlines.

▶ **Market**—Electronic equipment currently installed in light planes is valued at nearly $500 million. Value of electronic equipment installed aboard airliners is about $50 million (considering each plane's equipment worth about $50,000).

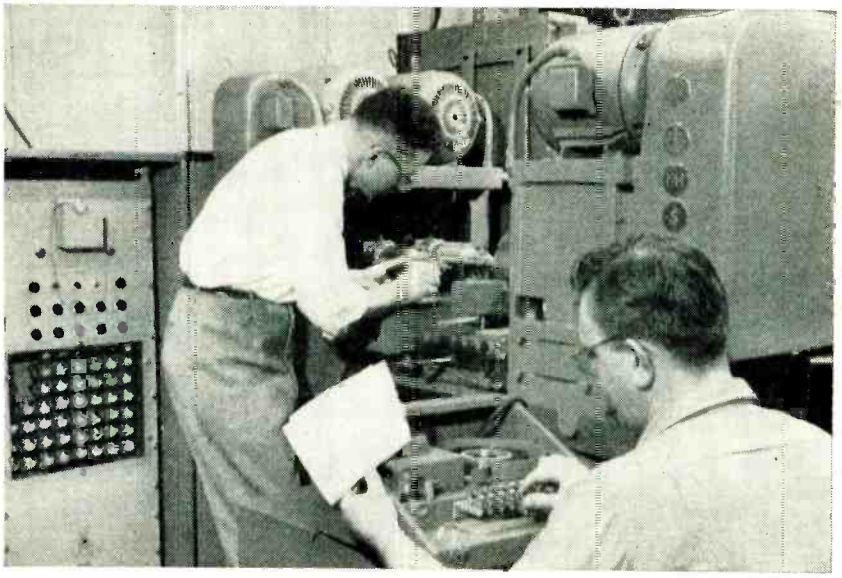
Annual business supplying airborne electronic equipment to the airlines amounts to about $5 million against an estimated $1 billion for military aircraft. Yearly expenditure by light-plane owners is about $30 million.

▶ **Requirements**—Minimum requirement for a private plane is a vhf receiver with broadcast and navigation-band reception and a two-watt transmitter. This can be bought for $437.

Electronic equipment for a light twin-engined executive plane may cost $20,550.

This includes:

2 automatic direction finders	$4,000
1 vhf omnirange receiver	700
1 36-channel vhf receiver	2,000
1 marker-beacon receiver	600
1 3-axis autopilot with ILS	6,000
1 distance-measuring equipment	7,000
1 isolation amplifier	250
	$20,550



BORING work is guided by electronics at Minneapolis-Honeywell as . . .

Tubes Infiltrate Metal Trades

Companies apply electronics to milling and drilling machines for more efficient production

ELECTRONICALLY controlled milling machine capable of producing aircraft dies or parts of any shape will be developed by Convair under a $1.1 million Air Force contract. The 200-ton milling machine and the electronic system that directs it will be completed in about 18 months.

Minneapolis-Honeywell has developed a punched paper tape controlled automatic boring machine for producing instrument gear trains.

▶ **Milling**—The control system for the Convair milling machine will include an input system, computer, director and control console. Signals will guide the milling machine's four cutting heads, its bed and turntable. Control system design will be based upon work done at MIT under Air Force auspices.

▶ **How It Works**—Punched cards of a keyboard may be used to write in the dimensions of the part. The computer prepares numerical commands for the machine and transcribes them on punched paper tape.

The commands are fed to the electronic director and transferred to magnetic tape. The director can either control the milling machine directly or the magnetic tape can be fed to a control console designed solely for controlling machine operation.

In this way the computer-director is freed for other problems. It can support many different machines such as rolling mills, stretch presses and special-purpose profilers.

▶ **Savings**—The numerical or digital control concept eliminates the human error that may be introduced in analog control schemes where a machinist makes the first part with a control unit recording his movements.

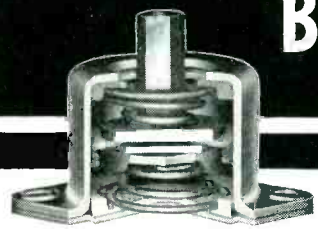
On some parts, savings of as savings of as much as 85 percent of the present lead time are expected with the new method. On parts having greater complexity, the lead time savings may not exceed 15 percent over present methods. Savings of $50,000 or more will be possible in the elimination of some toolings for just one part.

▶ **Drilling**—The system worked out by Minneapolis-Honeywell includes a standard four-spindle Ex-

(Continued on page 22)

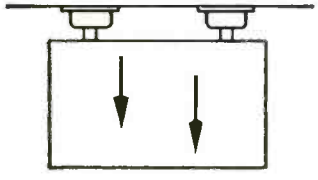
NEW

ALL-ANGL BARRY MOUNT

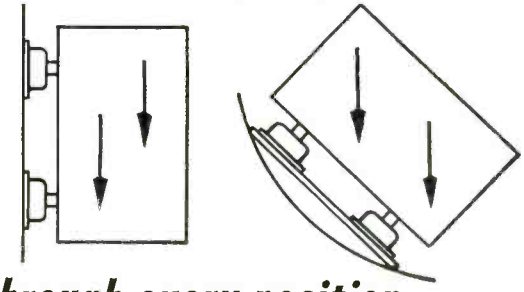


ALL-ANGL **BARRY MOUNT**

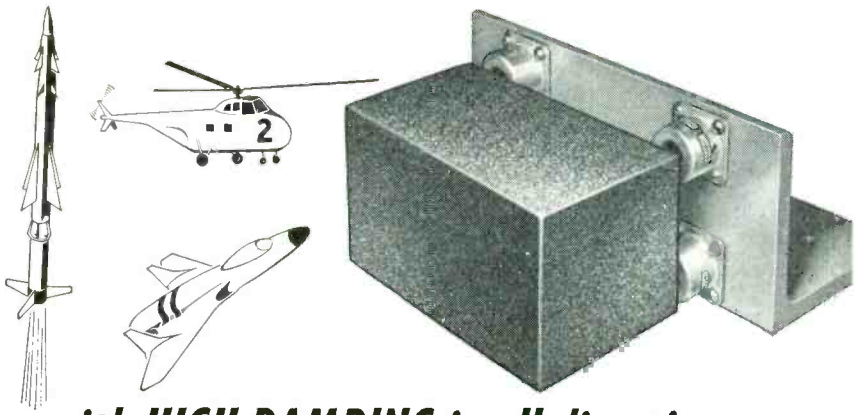
Cup diameter	1 inch
Maximum load	3 pounds
Weight	less than 1 ounce



Works at any angle



...in maneuvers through every position



...with HIGH DAMPING in all directions

Now you can forget all limitations on mounting positions for delicate apparatus. You can design for easiest installation and best space utilization, because the new Barry ALL-ANGL vibration isolator works in any position. Upside down, on a bulkhead, at any slant — position means nothing to this new BARRYMOUNT.® Damping is exceptionally high in all directions; transmissibility at resonance is less than 3. The ALL-ANGL mount is interchangeable with other miniature BARRYMOUNT isolators.

This isolator is the answer to your toughest vibration-protection problems. Let us show you what it will do for you; or write for Bulletin.

BARRY CONTROLS
INCORPORATED
Formerly The Barry Corporation
707 PLEASANT STREET WATERTOWN 72, MASS.
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

cello precision boring machine modified with built-in electronic controls and circuitry and a tape reader housed in a control cabinet.

Hole coordinates and feed instructions are punched on the tape by a perforating machine similar to a typewriter. Electronic signals from the tape regulate the linear travel of the boring machine's hydraulic cross slide and the rotary motion of a holding fixture mounted on the cross slide. Tape preparation requires approximately five minutes per hole and complete changeover from one part to another can be accomplished in about 30 minutes.

► **Future**—Use of electronic control in metalworking operations will be much in the news next fall when nearly every large machine tool builder introduces an electronically controlled machine.

Tool builders have been busy under wraps for some time. Some of the development work has been done by electronics companies under contract while other tool builders have established their own electronics departments.

Electronics Booms In The West

Industry leaders anticipate increasing level of military, radio-tv and industrial sales

UNQUALIFIED optimism is the outstanding characteristic of the electronics industry in the Los Angeles area.

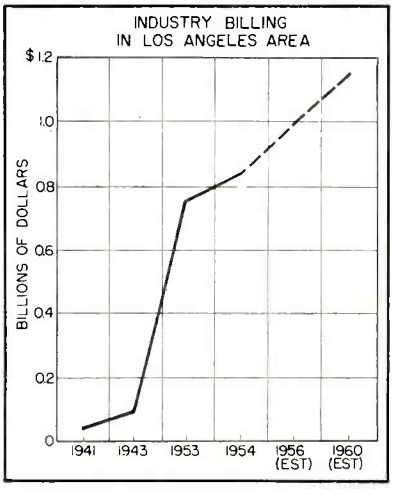
With 15 firms in 1943, the industry now encompasses 440 firms operating 506 plants with a total area of 9,750,281 sq ft and employing 69,637 persons. Gross billing for 1956 is expected to top $1 billion (ELECTRONICS, April, 1955, p 20) and may reach $1.1 billion in 1960.

► **Patterns**—The industry is made up largely of small firms (less than 500 employes) some of which started when handfuls of engineers left the electronics departments of large aircraft plants and founded organizations to exploit their individual talents.

More than half the firms are engaged in engineering and design. Products are characterized by short production runs and a high creative content per dollar.

Items manufactured include military electronic equipment, industrial and scientific instruments, test gear, computers, radio and tv sets and audio equipment.

► **Trends**—Aircraft firms entered the electronics business by way of the weapons-system method of procuring military aircraft and guided missiles. However, the aircraft industry has been noted for subcontracting much of its specialized work in the past and even the firms best staffed electronically continue to buy off-the-shelf items from electronics manufacturers.



Precision wire-wound resistors are important to guided missiles and for specialized instruments. Units cost from 64 cents to $64 dollars depending upon the accuracy required.

Magnetic tape is playing an increasingly important part in the film industry. Sound for the movies is recorded first on magnetic tape then put on optical sound track. Vocals, accompaniment, dialog and special effects are often recorded separately. Some tape used is 35 mm wide and has sprocket holes like film.

Guided missile expenditures are expected to increase 35 percent this year and comprise a big chunk of the $650 million super-weapons budget. One company specializing in field support equipment which includes go-no-go control system testers expects to do a $60 million business this year.

► **Future**—Eight-year time table for tv development includes the following: automatic production of monochrome sets resulting in a 10-percent saving in direct labor together with increased quality and product uniformity; production of color sets selling for under $500; manufacture of transistorized sets using picture-on-the-wall tubes. Immediate objective of set manufacturers is a second or third monochrome set in every home.

Microwave Ovens To Enter Home Kitchens

Units for home use that brown as they cook may be available late next year

ORDERS will be taken by GE next year for household electronic ovens that use magnetron-produced high-frequency radio waves to cook foods. The new ovens probably will not be available before the end of 1956. Built-in models will be displayed during the coming year, according to the company.

No price has been set for the units but they are expected to cost more than conventional built-in ovens. While it will cook faster than today's standard ovens, the current cost for electronic oven cooking will be about the same as for conventional methods.

► **Features**—Electronic ovens have been used experimentally for many years and have been produced for use in commercial establishments. Feature of the GE unit is that it browns food as it cooks.

(Continued on page 24)

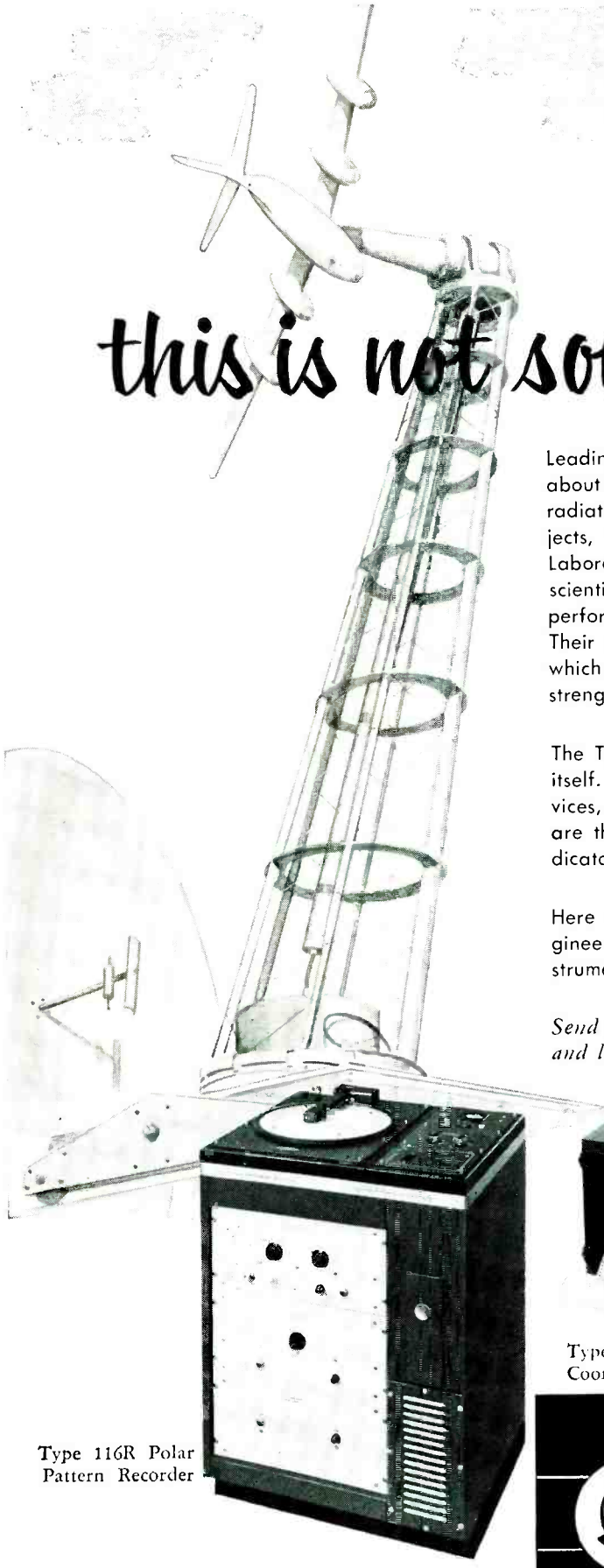
this is not something new!

Leading members of the aviation industry have long known about this means of measuring aircraft and missile antenna radiation patterns. In the course of various engineering projects, they have come repeatedly to Airborne Instruments Laboratory with antenna test problems. As always, Airborne's scientists sought to create equipment, singularly perfect in performance yet flexible enough to meet many specific needs. Their efforts resulted in the Type 105 Model Range System, which automatically records polar plots of the relative field strength of aircraft radiation patterns.

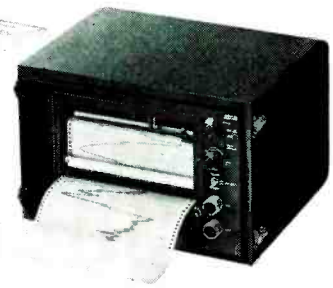
The Type 105 System, however, is not only important within itself. Out of its totality have emerged several significant devices, designed for many recording purposes. Among these are the 116R Polar Pattern Recorder, the Type 20 SWR Indicator, and the Type 373 Rectangular Coordinate Recorder.

Here again is an example of creative initiative, by AIL engineers, providing a continuous succession of advanced instruments for America's industrial progress.

Send for information about the 105 Model Range System and literature on other recording devices.



Type 116R Polar Pattern Recorder



Type 373 Rectangular Coordinate Recorder

Type 20 SWR Indicator

AIRBORNE INSTRUMENTS LABORATORY INC.

160 OLD COUNTRY ROAD • MINEOLA, NEW YORK

Heretofore, electronically cooked food has lacked the appetizing browned surface achieved in a regular oven.

Test data on a developmental sample of the new range shows that it cooks meats in from one-sixth to one-eighth the time required by conventional methods.

Financial Roundup

Over two-thirds of the firm's reporting show gains in 1954 net profit over 1953

YEAR 1954 was one of the best on record profitwise for the industry. Following are the net profits for 26 firms for the 12 months of 1954 or the fiscal period indicated, compared to 1953:

Company	Net Profit 1954	1953
Admiral	$6,547,974	$8,213,165
Aircraft Radio	576,127	390,611
Am. Cable & Radio	1,890,072	1,656,659
ACF Industries 9m	4,305,949	5,742,949
Burroughs	7,796,065	7,206,655
Electronic Assoc.	244,557	130,685
Electronic Corp. Of Am.	162,106	
Gen. Dry Batteries	529,301	403,358
Gen. Prec. Equip.	5,488,090	3,436,349
Globe Union	569,280	1,682,276
Hallicrafters 6m.	275,241	*949,337
Hoffman Electronics	1,485,513	1,199,655
Indiana Steel	587,854	335,925
Minnesota Mining	24,624,225	17,977,771
Motorola	7,572,000	7,076,000
National Union	1,289,264*	166,458
Norden-Ketay	1,002,922	
Oxford Electric.	93,983	99,886
Raytheon 9m	3,592,000	2,703,000
Robertshaw-Fulton	3,677,709	2,649,181
Sprague Electric.	3,333,408	2,888,281
Standard Coil	2,871,290	2,972,481
Texas Instruments	1,200,000	1,270,000
Trav-ler Radio	241,000	
Triad Transformer	52,111	
Zenith	5,676,264	5,631,701

* Loss.

▶ **Securities**—American Electronics of Los Angeles filed with SEC covering $1,250,000 of 5-percent convertible debentures due 1967 to be offered at 100-percent of their principal amount. Net proceeds are to be used to retire loans and debts and for general corporate purposes.

Collins Radio registered with SEC covering 122,500 shares of $50 par convertable preferred stock. Proceeds will be used to redeem outstanding preferred and for working capital.

Norden-Ketay registered with SEC covering stock purchase warrants and/or 22,500 shares of common stock issuable pursuant to stock warrants. Net proceeds will be used for corporate purposes.

What It Takes To Be An Executive

Varying views are held on technical management qualifications

WHAT it takes to be a successful technical manager was one of the main discussion points in the engineering management sessions at the 1955 convention of the Institute of Radio Engineers.

▶ **Job**—An effective technical manager, as described in one paper, is able to organize and direct the activities of others for greater productivity. He is also effective in representing to higher management the ideas, points of view and needs of his own people in such a way that they can have a bearing upon company plans.

A technical manager is badly handicapped if he attempts to manage scientific and engineering people without a thorough understanding of their tasks. Thus it is necessary to convert some technical people into administrators and executives.

▶ **Qualities**—However, the very qualities that make a man outstanding as a creative engineer are likely to be disqualifying for managerial responsibility. Five important qualities in which the typical engineer differed from the typical executive are:

- The *engineer* is primarily proud of his intellectuality while the *executive* is primarily proud of his practicality.
- The *engineer* is spontaneously interested in physical things and physical processes while the *executive* is spontaneously interested in people.
- The *engineer* is more thoughtful than active, introverted, while the *executive* is more active than thoughtful, extroverted.
- The *engineer* is less able to use his own emotions as drives. He finds it hard to accept emotion in himself or others. The *executive* can accept his own emotions and use them as drives to accomplish results with himself and others.
- The *engineer* may be limited in both fluency and clarity of verbal expression while the *executive* must be superior at both points and must be effective in verbal communications.

U.S. Cues Electronics At German Trade Fair

Thirty firms send equipment abroad for U. S. exhibit in Hanover

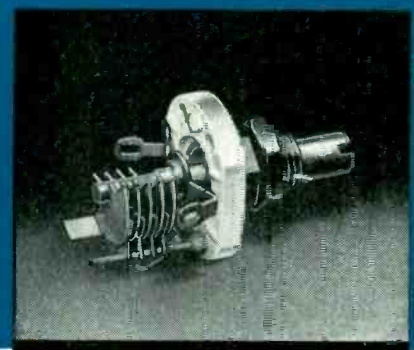
AMERICAN electronics will play a major role in the U. S. Department of Commerce's exhibit at the German Industries Fair, April 24 to May 3, at Hanover, Germany. At least 30 U. S. manufacturers of electronic equipment will display their products at the Fair as part of the U. S. Government exhibit. The Hanover Trade Fair is one of a series of international exhibits in which the U. S. is officially to participate as a means of acquainting Europeans with U. S. products and facilities.

Robot Op Takes Code At 600 WPM

All-electronic Morse code converter developed at C.G.S. Laboratories is viewed by company and military officials. It automatically translates Morse signals at any speed from 10 to 600 words per minute to finished form as a printed message on a standard teletype printer

(Continued on page 26)

To help you meet the Tolerance Squeeze



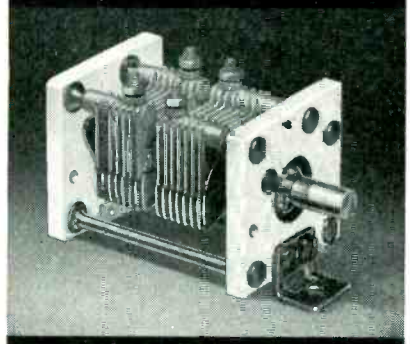
Miniature "MAC" Variable Capacitor

QUALITY CAPACITORS BUILT BY HAMMARLUND

Performance requirements for electronic products — commercial, industrial and military — are becoming more difficult to meet. Specifications call for the finest quality components available to fulfill exacting equipment tolerances.

Hammarlund variable capacitors have been designed and built for more than 25 years to meet the most demanding of requirements. Check the general characteristics of these outstanding variables:

- Rotor and stator plates of brass stock soldered, *not staked*, to their supports to permanently insure perfect contact and prevent loosening of plates.
- Stator supports soldered into eyelets assembled to steatite insulators.
- Terminals hot-tinned for ease in soldering.
- Insulators of low-loss steatite, impregnated with DC 200 silicone fluid to prevent absorption of moisture.
- Rotor and stator assemblies nickel or silver-plated.
- Rotor contact springs of beryllium copper or phosphor bronze, and nickel or silver-plated.
- Precision soldering fixtures and assembly jigs used in fabricating to assure absolute uniformity of plate spacing.

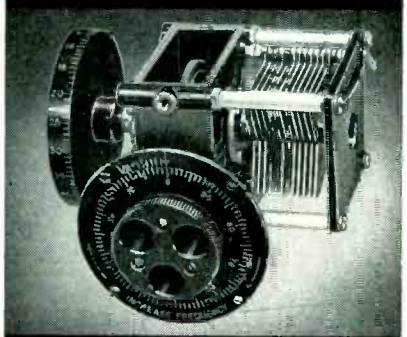


"VU" Capacitor For Up to 500 Mc

These are basic reasons why Hammarlund capacitors should be used where highest dependability is required. Convince yourself in your engineering models and you will specify them for production.

Special 3-Gang Precision Capacitor

For detailed information on Hammarlund variable capacitors write for this latest catalog. It includes complete drawings and specifications on all standard units. Ask for bulletin E-5.



Precision Frequency Meter Capacitor

HAMMARLUND

THE HAMMARLUND MANUFACTURING COMPANY, INC.
Main Plant and Offices: 460 W. 34th ST., N. Y. 1, N. Y.
Midwest Sales Office: 605 N. Michigan, Chicago 11, Ill. • Export Sales Office: 13 E. 40th St., N. Y.

Military To Give Navaids Business

SOME TWO YEARS after the end of the war, systems of electronic aids to air navigation were generally agreed upon. Loran, the long-range aid developed for Navy ships, was agreed to be the best compromise until something better came along. For short ranges, VOR/DME was chosen to guide aircraft across the continent.

At present, the North Atlantic, the Gulf of Mexico and the area off the Pacific Coast are blanketed with an invisible network of hyperbolic lines generated by transmitters that are, mostly, run by the Coast Guard. The Civil Aeronautics Administration is pushing forward a program that will total 436 vhf omnirange and 241 distance-measuring stations across the country by the end of fiscal 1955.

► **Speedup**—Korean hostilities and the development of fast aircraft have caused some big changes in navaids thinking. To counter loran's lack of overland coverage during daylight and extend its nighttime service, Navarho has been proposed. Operating on a low radio frequency, it is expected to extend a usable beam out to 2,500 or 3,000 miles. An experimental Air Force installation will go in soon at Camden, N. Y., using three 15-kw transmitters precisely phased.

In doubt is the future of VOR/DME. Despite a large CAA investment in ground equipment as well as a healthy amount in private aircraft, the military are pushing for adoption of another system known as Tacan. Basically, Tacan is said to do more things better than VOR/DME but the system is still under security wraps. It is known to require some of VOR/DME frequencies.

Policies mapped by the Air Navigation Development Board will be carefully scrutinized by House and Senate committees before final acceptance of the Tacan system.

FUTURE MEETINGS

MAY 2–5: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.
MAY 2–5: Joint Meeting URSI, IRE, National Bureau of Standards, Washington, D. C.
MAY 3–5: First National Flight Test Instrumentation Symposium, ISA, Wichita, Kansas.
MAY 10–12: Eleventh Annual Meeting and 1955 Metal Powder Show, Bellevue-Stratford Hotel, Philadelphia, Pa.
MAY 13: Automation, Engineering For Tomorrow, Symposium, Engineering School, Michigan State College, East Lansing, Mich.
MAY 16–19: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.
MAY 17–19: Communications Section, AARR, St. Francis Hotel, San Francisco, Calif.
MAY 18–20: Annual National Telemetering Conference and Exhibit sponsored by IRE, AIEE, IAS, ISA; Hotel Morrison, Chicago, Ill.
MAY 19–21: Global Communications Conference, sponsored by AFCA; Hotel Commodore, New York, N. Y.
MAY 23–25: Ninth Annual Convention of the American Society for Quality Control, Hotels Statler and New Yorker, New York, N. Y.
MAY 24–26: Ninth Annual NARTB Broadcast Engineering Conference, Washington, D. C.
MAY 25–27: Ninth Annual Frequency Control Symposium, Signal Corps, Hotel Berkeley Carteret, Asbury Park, N. J.
MAY 26–27: Electronic Components Conference, Los Angeles, Calif.
JUNE 2–3: IRE Materials Symposium, U. of Penn. Physics Bldg., Philadelphia, Pa.
JUNE 3–5: ARRL Hudson Division Convention and Amateur Radio Equipment Show, Hotel Adelon, Long Beach, N. Y.
JUNE 6–8: Fourth Annual Convention and Trade Show, National Community Television Association, Park Sheraton Hotel, New York, N. Y.
JUNE 14–16: First Magnetics Conference and Exhibit, AIEE, APS, AIMME, William Penn Hotel, Pittsburgh, Pa.
JUNE 20–25: Symposium on Electromagnetic Wave Theory sponsored by URSI and the University of Michigan, Ann Arbor, Mich.
JUNE 27–29: Radome Symposium, Ohio State University and Wright Air Center, Columbus, Ohio.
AUG. 22–23: Symposium on Electronics and Automatic Production sponsored by Stanford Research Institute and NICB, San Francisco, Calif.
AUG. 24–26: 1955 WESCON, Civic Auditorium and Fairmount Hotel, San Francisco, Calif.
AUG. 26–SEPT. 4: Great German Radio, Gramophone and TV Exhibition, Dusseldorf, Germany.
SEPT. 12–16: Tenth Annual Instrument Conference & Exhibit, ISA, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.
SEPT. 19–20: RETMA Symposium "Electronics For Automation and Automation For Electronics, Philadelphia, Pa.
SEPT. 28–29: Industrial Electronics Conference, AIEE, Rackham Memorial Auditorium, Detroit, Mich.
OCT. 3–5: National Electronics Conference, Hotel Sherman, Chicago, Ill.
OCT. 24–25: First Annual Technical Meeting, IRE Professional Group On Electron Devices, Shoreham Hotel, Washington, D. C.

Industry Shorts

► **Juke Box** type of storage system using magnetic disks instead of tape or drum provides fast high-capacity random-access memory for a soon-to-be-announced business computer.

► **Number** of fused junction transistors for low frequencies manufactured by Raytheon that are now in use totals nearly two million.

► **Experimental** auto radio that uses nine transistors has been developed by RCA. It requires no vibrator, power transformer or rectifier and uses about one-tenth the power needed by conventional sets.

► **Net** recovery to the U. S. Treasury under the Renegotiation Act of 1951 for the period between 1951 and 1954 was $39 million.

► **Total** attendance at the 1955 IRE National Convention was 40,093.

WIDE RANGE WIDE SWEEP- Sweeping OSCILLATOR

The KAY CALIBRATED *Mega-Sweep*

SG-92/U

- ***Continuously Tunable Thru Video VHF and UHF Frequencies, 50KC-950MC Range***
- ***Sweep Widths to 40 MC***
- ***Single Dial Tuning***

Used with a standard cathode ray oscilloscope, the Kay Calibrated *Mega-Sweep* will display the response characteristic of wide band circuits over the frequency range of approximately 50 kc to 950 mc. It features a calibrated dial indication of the approximate output frequency. The center frequency of the sweeping output voltage may thus be set to an accuracy of about 10%. The calibrated *Mega-Sweep* is the ideal instrument for use in alignment of amplifiers and filters . . . also as an FM source of wide range for instructional and lab purposes.

SPECIFICATIONS

Freq. Range: 50 kc to 1000 mc.

Freq. Sweep: Sawtooth, adjustable to 40 mc. Repetition rate, 50 to 100 c/s.

RF Output: *High*, approx. 100 mv max. into open circuit. *Low*, 5 mv into open circuit.

RF Output Control: Microwave attenuator continuously variable to 26 db.

Output Waveform: Less than 5% harmonic distortion at max. output.

Meter: Provides crystal detector current for peak output.

Regulated Power Supply: 105-125 v., 50 to 60 cps. Power Input, 100 watts.

Send for Catalog 110-A

$495 f.o.b. factory

Dept. E-5

KAY ELECTRIC COMPANY

14 MAPLE AVENUE PINE BROOK, N. J.

KAY SWEEPING OSCILLATORS for every application

KAY

Mega-Sweep

Widest range of the Kay line of sweeping oscillators. Provides continuous frequency coverage up through UHF-TV bands – 50 kc to 1000 mc. Widely used in radar system development and in alignment and testing of TV and FM systems and components, as well as wide band IF and RF amplifiers and filters. Freq. range, 10 mc to 950 mc. *Write for Catalog 100-A.* Price, **$465** f.o.b. factory.

KAY
111-A CALIBRATED

Mega-Sweep

Higher output model calibrated *Mega-Sweep*, with zero level baseline. Higher output facilitates frequency response testing of UHF converters or tuners. Wider sweep width permits multi-channel response viewing. Zero level baseline is convenient means of measuring gain of test circuit.

SPECIFICATIONS

Frequency Range	Output Impedance	Output Voltage (Into Load)
1. 10 mc—950 mc	70 ohms unbalanced	0.15 Volts
2. 450 mc—900 mc	300 ohms balanced	0.3 Volts

Sweep Width: Continuously variable to approx. 40 mc max.

Write for Catalog 111-A Price, **$575** f.o.b. factory

KAY 112-A CALIBRATED *Mega-Sweep*

Same as 111-A, except total frequency range is 800 mc to 1200 mc. *Catalog 112-A.* Price, **$575** f.o.b. factory.

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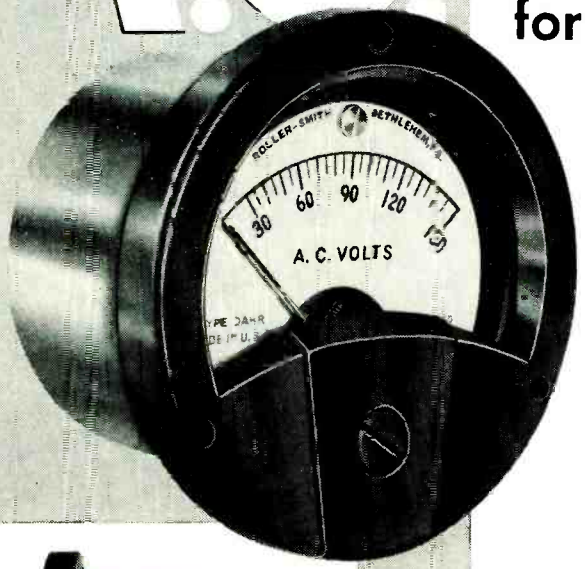
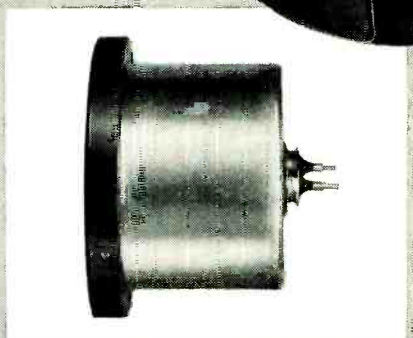
Provides One Source for All Your Instruments





An extra feature—new "wrap around" shroud with gasket seal makes these meters as modern in appearance as they are dependable in performance. Precisely built, their neat functional form expresses the forward thinking of our engineers.

With the introduction of A.C. Ruggedized panel instruments, Roller-Smith has made their famous precision instrument line one of the most complete ever offered . . . one which provides you with a single source of supply for *all* your instrument needs.

Styled by leading industrial designers and featuring an eye-appealing "New Look," the A.C. Ruggedized line matches other Roller-Smith panel instruments and provides maximum readability, accuracy, and maintenance simplicity. Available in 2½" and 3½" hermetically sealed cases, these instruments conform to specification MIL-M-10304 (Sig. C). These A.C. Ruggedized instruments, like all other Roller-Smith products, are produced by master craftsmen with nearly 50 years of precision engineering and manufacturing experience. Whatever your instrument problem, consult us for a practical, economical solution.

Instrument Division
CORPORATION
1825 WEST MARKET STREET BETHLEHEM, PENNSYLVANIA
Precision Products Since 1908

CONTROLLED WELDING

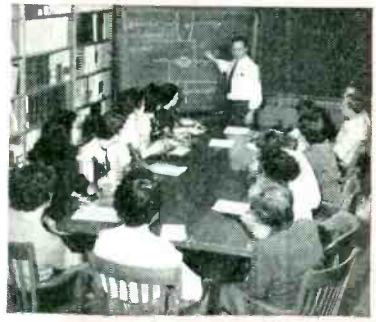
is an important part of

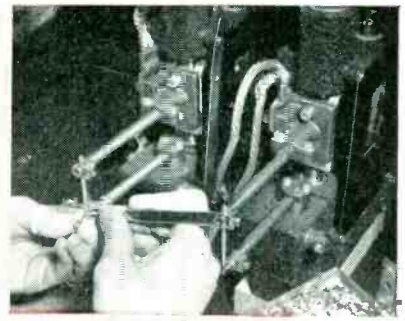
QUALITY CONTROL

in the manufacture of all RAYTHEON

RELIABLE SUBMINIATURE TUBES

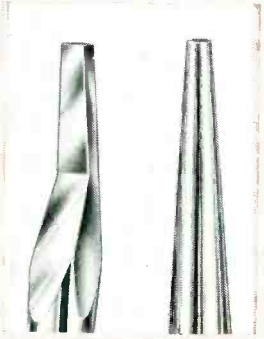
Employee Training Program in welding techniques, welder maintenance and defect detection greatly reduces the incidence of operator-caused weld defects.

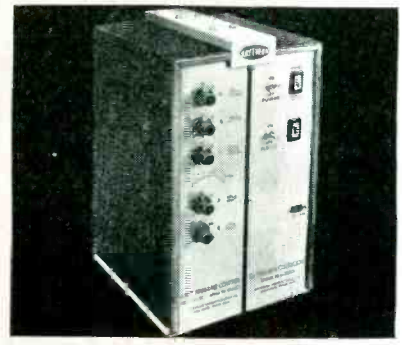




Standardized Work Place Setups for each material combination and geometric configuration to be welded, including specification of welder head, electrode material and design, welding current, time and pressure insures optimum welding conditions at all times.

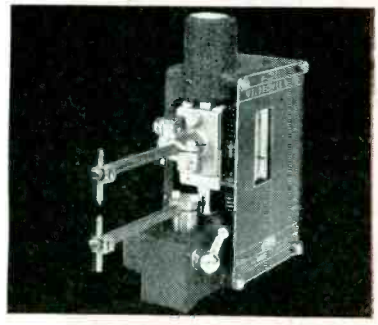
Specially Designed Precision Produced Electrodes eliminate need for hand dressing of welder points thus providing uniform contact with material to be welded.

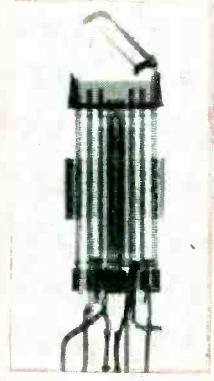




New Electronic Heat Program Controls developed by RAYTHEON permit splash free welding of coated and oxidized materials.

New Raytheon Designed Welding Heads have many unique features including precision controlled forging pressure insuring high weld strength, simplified design for easier maintenance, and small size which permits use of multiple welder heads by one operator.





Radiographic Inspection of Welds permits precise Quality Control through non-destructive inspection techniques.

These production and testing techniques and equipments have been developed by RAYTHEON under Bureau of Ships sponsorship to improve the weld quality of guided missile tubes.

FLAT PRESS SUBMINIATURE TUBES ★ THE SEAL OF RELIABILITY ★ RAYTHEON SEAL OF RELIABILITY

RELIABLE SUBMINIATURE AND MINIATURE TUBES
SEMICONDUCTOR DIODES AND TRANSISTORS
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Want more information? Use post card on last page.

MICROWAVE FIELD INTENSITY RECEIVER

BROAD BAND 950—11,260 mcs

- Four interchangeable RF Tuning Heads
- Uni-Dial Tuning
- Double Tuned RF Pre-Selection
- Signal-Lock Automatic Frequency Control
- All purpose AM, FM, Pulse

The new Polarad Model R Receiver is a fully integrated unit which combines reliability, ruggedness and simplicity of operation. Characterized by high sensitivity, low noise figure and excellent gain stability, this versatile instrument is ideal for communications, laboratory measurements, field intensity measurements, production testing, and automatic monitoring.

Range 950 to 11,260 mc with four (4) interchangeable, plug-in RF tuning units featuring direct reading UNI-DIAL control.

Low noise figure.

Excellent gain stability.

Automatic frequency control.

Direct reading output in db with provision for external metering and recording.

Separate audio and video channels.

Connectors for external IF attenuators.

High sensitivity and broadband tuning achieved with double tuned cavity preselector which tracks automatically with the local oscillator.

External type cavity klystron with non-contacting chokes. Klystron voltages regulated and automatically tracked with the oscillator.

SPECIFICATIONS:

Basic Receiver: Model R-B

Tuning Unit Frequency Ranges:

Model RL-T:	950 to 2,040 mc
Model RS-T:	1,890 to 4,320 mc
Model RM-T:	4,190 to 7,720 mc
Model RX-T:	7,260 to 11,260 mc

Signal Capabilities:
CW, AM, FM, Pulse

Sensitivity:
—80 dbm or better throughout range on all models

Frequency Accuracy:
1%

IF Bandwidth:
3 mc

Image Rejection:
Greater than 60 db

Gain Stability with AFC:
2 db for 24 hour period

Automatic Frequency Control:
Pull-out range 10 mc off center

Recorder output:
1 ma full scale

Trigger output:
10 v. pulse across 100 ohms

Audio output:
5 v. undistorted across 500 ohms

FM Discriminator
Deviation Sensitivity:
.7 volts/mc

Skirt Selectivity:
60 db to 6 db bandwidth ratio less than 5:1

IF Rejection:
50 db

Input AC Power:
105 to 125 v., 60 cps., 460 watts

Input Impedance: (ANT)
50 ohms

POLARAD
PROVEN RELIABILITY

ELECTRONICS CORPORATION
43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

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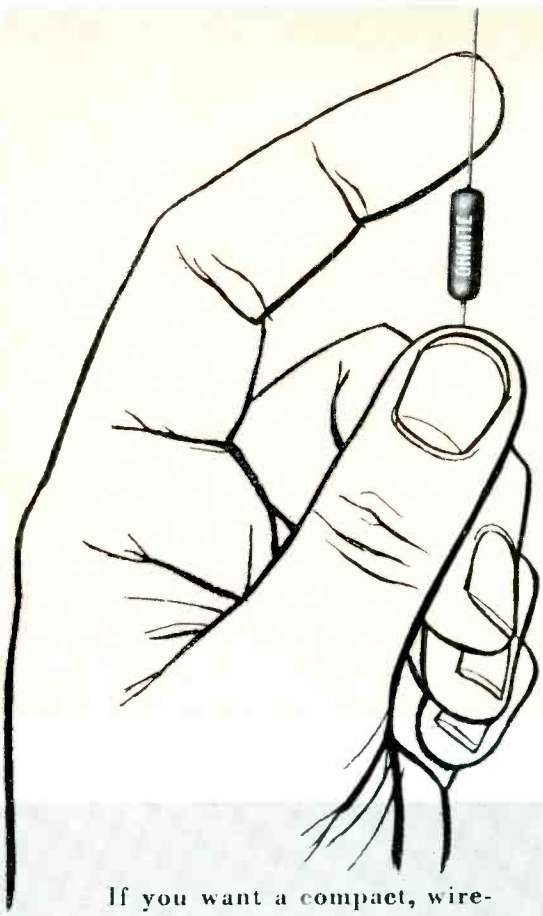
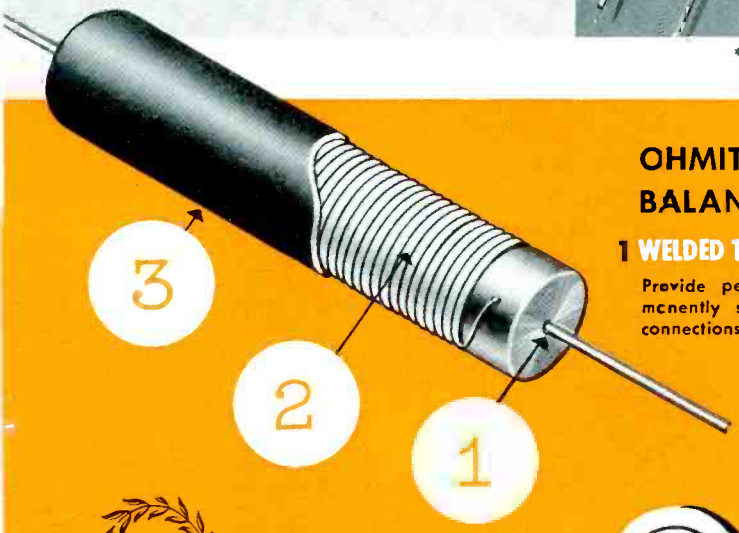


OHMITE® axial-lead vitreous-enameled resistors

18 SIZES—1 to 15 WATTS*
3/16″, 1/4″ and 5/16″ diameters—1/2″ to 1-3/4″ lengths

If you want a compact, wire-wound resistor for your tough jobs, specify Ohmite axial-lead resistors. These power-type units are designed to stand up under high temperatures. All parts—core, resistance wire, vitreous-enamel coating, and terminal bands—are "thermally balanced" to expand and contract as a unit. Terminals remain firmly anchored, cracking is eliminated, and moisture cannot enter the resistor.

*The rating for any one size is determined by the maximum operating temperature as specified by Underwriters' Laboratories, RETMA, or MIL-R-26B.



OHMITE RESISTORS HAVE BALANCED THERMAL EXPANSION

1 WELDED TERMINALS— Provide perfect and permanently stable electrical connections.

2 STEATITE CORE— Its thermal expansion closely matches all other materials in the resistor.

3 VITREOUS ENAMEL— Exclusive Ohmite formula thermally matches core, terminals, and wire.

Write for Bulletin 147

OHMITE MANUFACTURING COMPANY
3610 Howard St., Skokie, Illinois (Suburb of Chicago)

30th Anniversary
1925-1955

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

FOR HIGH CURRENT

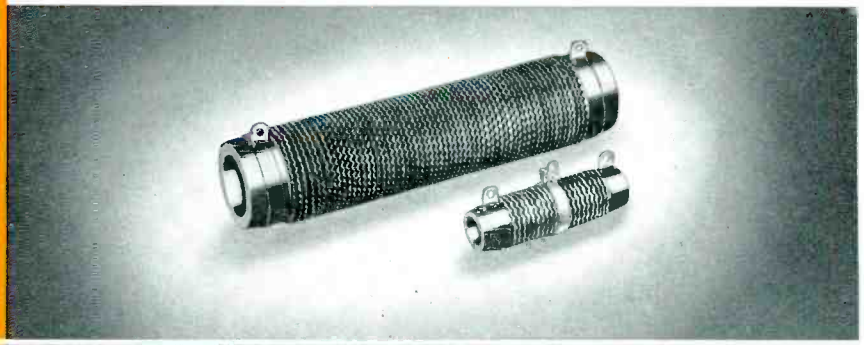
LOW RESISTANCE APPLICATIONS . . .

OHMITE® Power Type RESISTORS

CORRIB®

Vitreous-Enameled, Corrugated-Ribbon Type

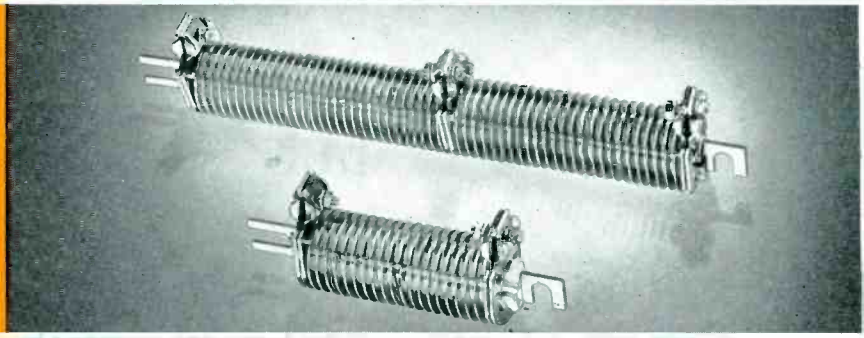
Special Ohmite vitreous enamel locks the edge-wound ribbon alloy to a sturdy ceramic core. Fixed, tapped, and adjustable types. Available in 22 sizes from 90 to 1500 watts. Resistance values range from .04 to 70 ohms.



POWR-RIB

Edgewound-Ribbon Type

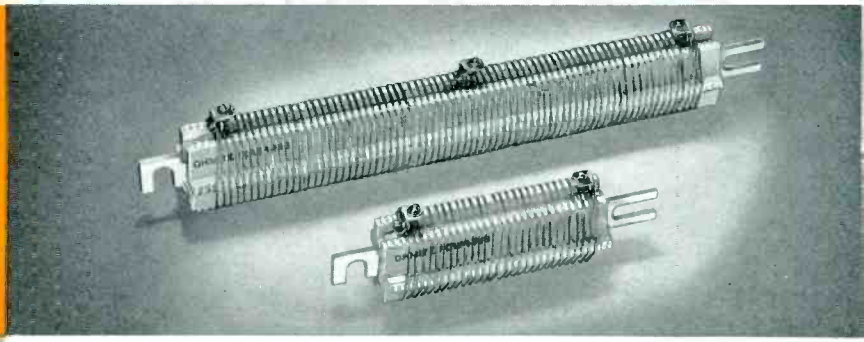
Has a heavy ribbon of resistance alloy, edge-wound on a ceramic core. Core is sectionalized for flexibility and shock resistance. Terminals and brackets are plated to prevent oxidation. Four sizes in resistances from .043 to 1.6 ohms; and from 24 to 95 amperes.



POWR-RIB

Round-Wire Type

Similar in construction to Ribbon-Wire type shown above, but with round resistance wire. Sturdy ceramic core is made in two to five sections. Available in four sizes. Resistance values from .69 to 25 ohms. Current ratings from 5.1 to 18.4 amperes.



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Available in fixed or adjustable "DIVIDOHM®" Types.

Be Right with OHMITE®

30th Anniversary 1925-1955

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3610 Howard St. • SKOKIE, ILLINOIS (Suburb of Chicago)

Battery Of Leesona No. 108 Coil Winders installed in the plant of Acme Electric Corporation, Cuba, N. Y. The most advanced hand-feed coil winders ever designed, Leesona No. 108's wind 4 to 30 paper insulated coils in stick form simultaneously. Note how conveniently the controls are located for quickly changing to a new coil spec — one of many advantages for speeding production on long or short runs. Inset shows an Acme Electric precision-wound luminous tube transformer which features coils that provide 18 MA 12000 volt secondary.

At ACME ELECTRIC...Leesona coil winders provide new production advantages

Manager credits No. 108 machines with vital share in increasing output

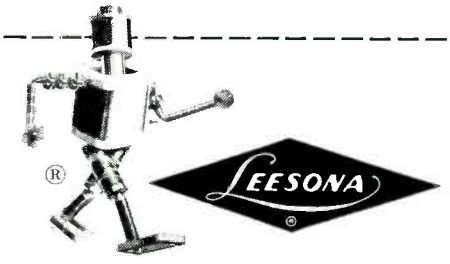
Transformers made by Acme Electric Corporation are used in a wide range of equipment, including radio, TV and other electronic apparatus, rectifiers, neon signs and fluorescent lighting. To meet increased demands for its products, Acme Electric recently replaced old hand-feed coil winding equipment with new Leesona No. 108 Hand-Feed Coil Winders. Plant Manager W. F. Koubek of Acme Electric sends the following report:

"Leesona No. 108 Winders are doing a great job of expanding our production. For short runs on a wide variety of coil types, the quick-change features of these machines are unequalled. We're getting excellent results in both quality and quantity from the accuracy, easy operation and fast winding speed of our new 108's."

Many similar reports prove how Leesona No. 108 Coil Winders — the most accurate, flexible and economical hand-feed winders ever developed — are bringing important benefits that can save *you* time and money, too.

Get the Whole Story

The coupon below will bring you complete facts on Leesona No. 108 Coil Winders, together with other helpful coil winding information. Why not check and mail it today?



FOR WINDING COILS
IN QUANTITY...
ACCURATELY...USE
LEESONA WINDING MACHINES

23B.4.6

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 15

Please send me

- ☐ Bulletin on the Leesona No. 108 Hand-Feed Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name.....*Title*.....

Company.....

City.....*Zone*....*State*.....

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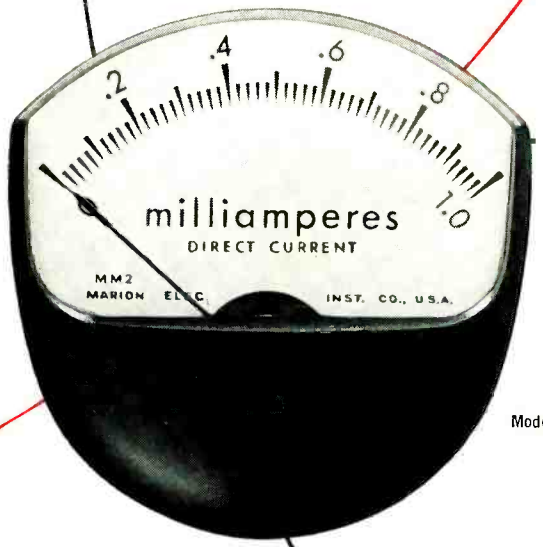
marion

advancement in instrument design

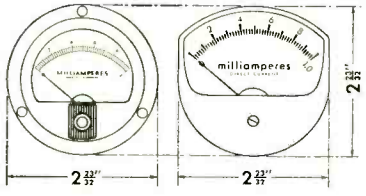
new marion *MEDALIST** meters



Model MM2 MEDALIST
Actual Size

Greater readability and modern styling in minimum space. Interchangeable with ASA/JAN 2½ and 3½ inch sizes. Up to 50% longer scale in same space as ordinary type. Available in various colors.

Comparison of Medalist and Standard Style



marion electrical instrument company

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Manufacturers of Ruggedized and "Regular" Panel Instruments & Related Products

*Trademark Patents Pending.

marion meters

ANNOUNCING

...the Eimac 4X5000A

Ceramic Radial-Beam Power Tetrode

The Eimac 4X5000A ceramic radial-beam power tetrode, with a 5kw plate dissipation rating and 16kw power output in typical Class-C telegraphy operation fills a power gap in the tetrode field. Rugged ceramic replaces glass, increasing immunity to damage by thermal and physical shock, and stack type production techniques assure uniform quality characteristics. Straightforward coaxial structure allows the advantages of low lead inductance. An integral finned anode permits improved cooling with low air pressure. Especially suitable for Single Sideband operation, the versatile 4X5000A handles high inputs without going into the positive grid region and delivers 10kw peak envelope power output with zero driving power in typical Class-AB_1 operation. High power gain, low inter-electrode capacitances, simple circuit needs and non-emitting grid wire, inherent Eimac tetrode features resulting from over 20 years of transmitting tube specialization are, of course, maintained.

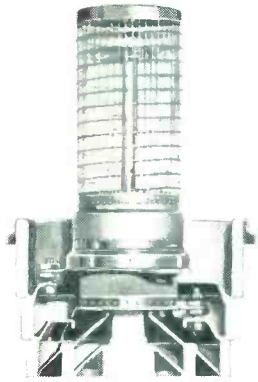
TYPICAL OPERATING CONDITIONS

Frequencies up to 30 Mc

	Class-C Telegraphy	Class-C Plate Mod.	Class-AB_1	
D-C Plate Voltage	7500	5000	7500	volts
D-C Screen Voltage	500	500	1250	volts
D-C Plate Current	2.8	1.3	1.9	amps
D-C Screen Current	.500	.170	.200	amps
D-C Grid Current	.250	.045	0	amps
D-C Grid Voltage	—350	—400	—300*	volts
Peak R-F Grid Voltage	590	520	300	volts
Driving Power	150	25	0	watts
Screen Dissipation	250	85	250	watts
Plate Power Input	21	6.5	14.2	kilowatts
Plate Power Output	16	5.5	10	kilowatts

**In the Class-AB_1 operating conditions listed, adjust grid bias to obtain 500 ma d-c plate current with zero driving voltage.*

The above operating conditions show approximate grid driving power and plate power output. Allowance must be made for r-f losses in practical circuits.



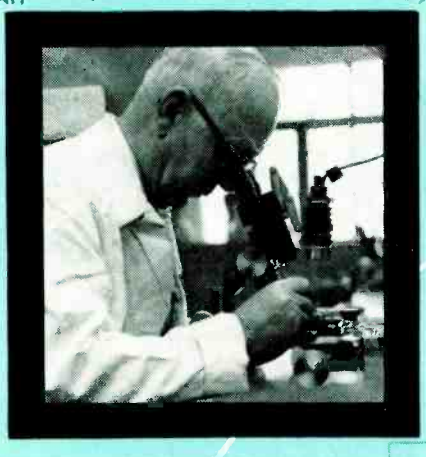
For further information, contact our Technical Services department.

Eimac

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

The World's Largest Manufacturer of Transmitting Tubes



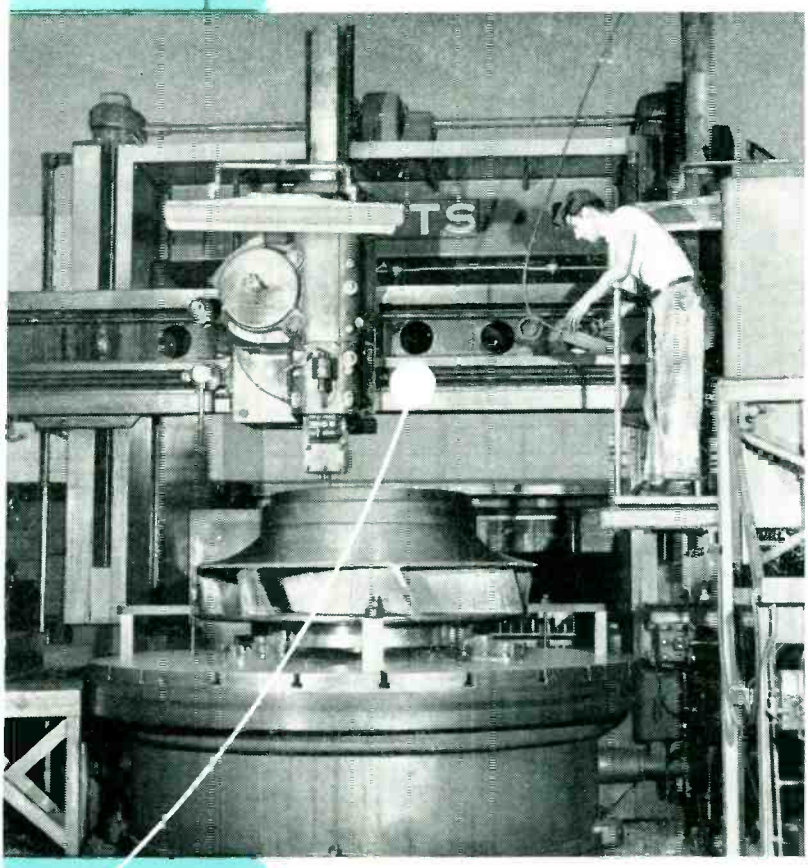
Byron Jackson Co.

and

The Rollin Co.

combine

Now electronic ingenuity combined with **heavy industrial facilities**



Experienced electronic engineering . . . backed by diversified heavy industrial facilities . . . gives the Byron Jackson Co. Electronic Division an unusual ability to pioneer precision electronics in practical form.

The engineering nucleus of this Electronic Division has, since 1944, been engaged in the development and manufacture of high power signal generators, precision slotted lines, miniature digital type transducers, and other precision electronic equipment. Now these electronic skills are teamed with the metallurgical, hydraulic, mechanical, chemical, nuclear, electrical and petroleum specialists and scientists of Byron Jackson Co. In addition, a multi-million dollar investment in plants and production equipment supports our specialized electronic manufacturing and testing facilities.

This unique combination of engineering talent and production abilities is ready to work for you in the field of measuring and testing instruments, complete systems, or an entire development production project.

BJ
SINCE 1872

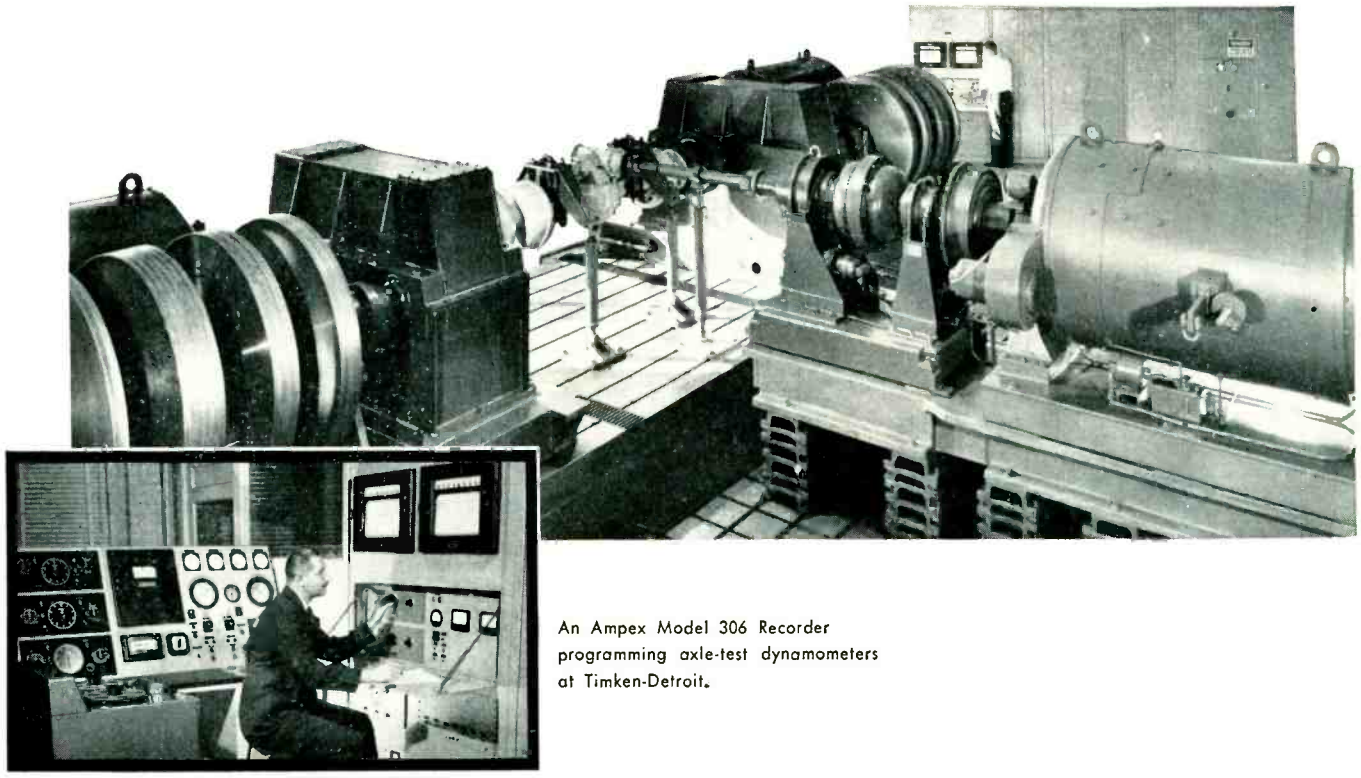
Byron Jackson Co.

ELECTRONIC DIVISION

2010 LINCOLN AVENUE, PASADENA 3, CALIFORNIA • TELEPHONE: RYAN 1-7134

MAGNETIC TAPE RECORDING

helps ***Road-Test*** *Timken Truck Axles*



An Ampex Model 306 Recorder programming axle-test dynamometers at Timken-Detroit.

Magnetic tape recordings are now being used to duplicate rugged road-tests at the Timken-Detroit Axle Division of the Rockwell Spring and Axle Company, Detroit, Michigan. A four hour tape cycle is made of actual road surface and driving conditions . . . then played back through torque and speed dynamometers — repeatedly — until a test axle breaks down.
Result: more realistic and efficient testing — better axles for today's trucks, buses and trailers.

WHY TIMKEN CHOSE AMPEX

Timken engineers required a recording and playback medium that could give near-perfect reproduction of the original road test phenomena . . . and would playback indefinitely without introducing errors through wear and speed irregularities. They found that the Ampex F-M recorder best met these exacting requirements. Its extreme stability of tape motion, precise timing and consistent accuracy produced laboratory "road-test" results within 1% of actual conditions.

LET AMPEX STUDY YOUR REQUIREMENTS

Ampex manufactures the most complete line of magnetic recorders for complex and sensitive automation, communication and data-handling systems. Why not let Ampex application engineers determine what magnetic tape recording can do for you?

For further information, *send for our 16-page illustrated bulletin, "Data Recording, Machine Control and Process Regulation." Contact your nearest Ampex representative or write to Dept. E-1897*

AMPEX CORPORATION

ANOTHER APPLICATION BY THE INSTRUMENTATION DIVISION OF

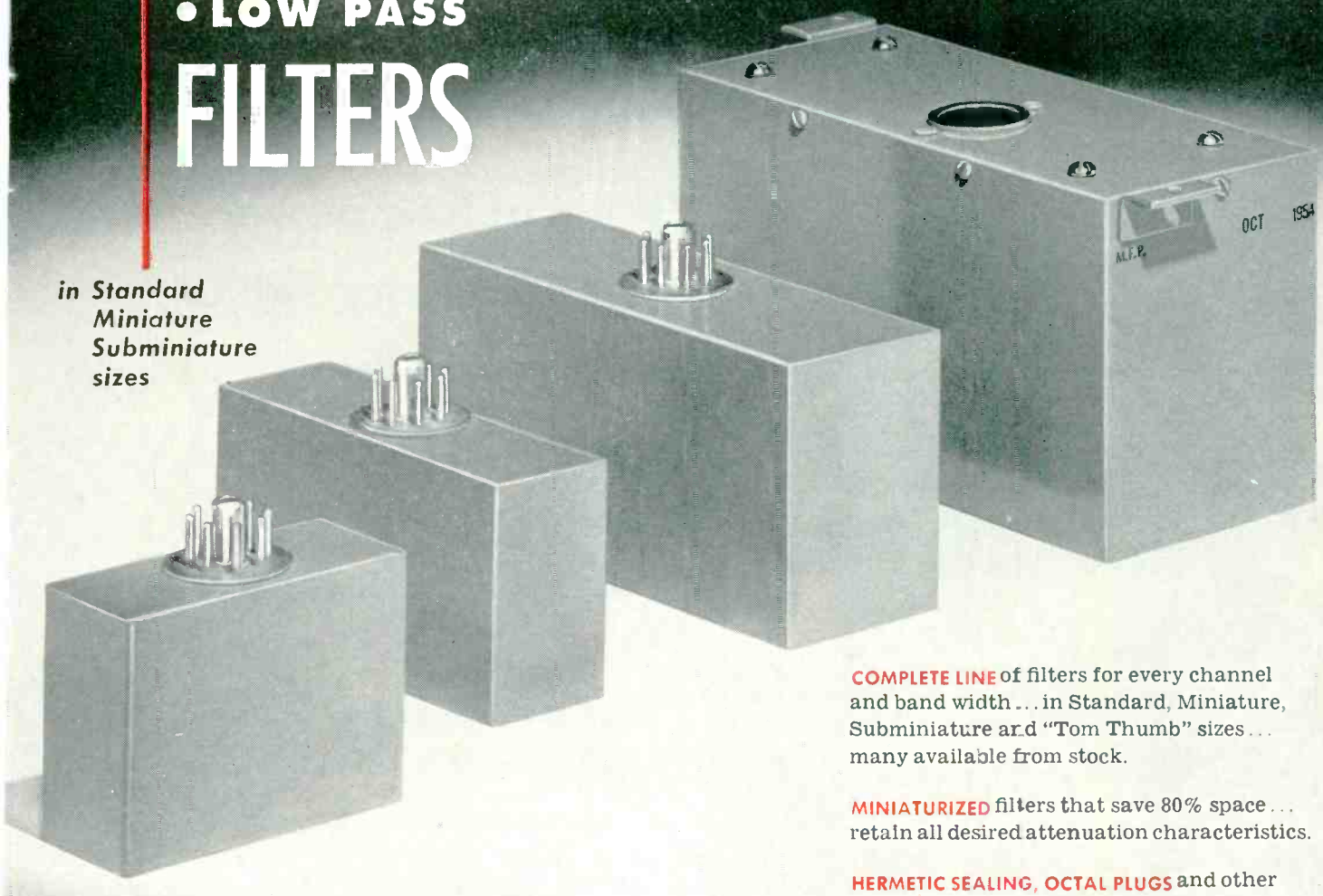
AMPEX CORPORATION • 934 CHARTER STREET, REDWOOD CITY, CALIFORNIA

Branch Offices: New York; Chicago; Atlanta; San Francisco; College Park, Maryland (Washington D.C. area).
Distributors: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company, Canada.

TELEMETERING

• BAND PASS
• LOW PASS
FILTERS

in Standard
Miniature
Subminiature
sizes



COMPLETE LINE of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

MINIATURIZED filters that save 80% space . . . retain all desired attenuation characteristics.

HERMETIC SEALING, OCTAL PLUGS and other new features.

only Burnell offers you . . .

SPECIAL PHASE LINEARITY characteristics to conform to new concepts of high accuracy telemetering practice.

SPECIFICALLY DESIGNED for telemetering, these filters have found great utility in a wide variety of communications and control applications.

APPLICATION ENGINEERING service plus complete technical literature. Write Dept. C, for Catalog 102A.

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

Channel Freq.	15% Band Width	30% Band Width	Case Size	Approx. Weight	Attenuation	
	Type No.	Type No.	W- L- H-		15% B. W.	30% B. W.
400 CPS.	S-15456					
560 "	S-15457	S-15477	2 x 6 x 2¾	3 lbs.	4DB — 15% 20DB — 23% 40DB — 27%	4DB — 30% 20DB — 46% 40DB — 54%
730 "	S-15458	S-15478				
960 "	S-15459					
1300 "	S-15460					
1700 "	S-15461		1⅜ x 4½ x 2¼	1 lb. 7 oz	3.5DB — 15% 20DB — 23% 40DB — 27%	3.5DB — 30% 20DB — 46% 40DB — 54%
2300 "	S-15462					
2570 "	S-15463					
3000 "	S-15464					
3900 "	S-15465	S-15479				
4500 "	S-15466					
5400 "	S-15467	S-15480				
7350 "	S-15468	S-15481				
10500 "	S-15469	S-15482			3DB — 15% 20DB — 23% 40DB — 26%	3DB — 30% 20DB — 46% 40DB — 52%
12300 "	S-15470	S-	1⅜ x 3 x 2¼	9¾ oz.		
14500 "	S-15471	S-15483				
22000 "	S-15472	S-15484				
27000 "		S-15485				
30000 "	S-15473	S-15486				
40000 "	S-15474	S-15487				
52500 "	S-15475					
70000 "	S-15476	S-15488				

OPTIMUM OPERATING IMPEDANCES	SOCKET TERMINAL CONNECTIONS
INPUT	OUTPUT
Terminals 1 & 2 500 ohms	Terminals 1 & 6 500 ohms
Terminals 1 & 3 10000 ohms	Terminals 1 & 7 50000 ohms

Teletype: Yonkers, N. Y. 3633

BURNELL & CO., INC.
YONKERS 2, NEW YORK
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First in Toroids and Related Networks

Direct, automatic power readings

CW or pulsed power

Wide frequency range

No calculations

Assured accuracy

Operates with wide variety of bolometers

New! -hp- 430C
Microwave Power Meter

Here is the newest, finest, most dependable source of instantaneous microwave power readings available today. The new *-hp-* 430C gives you power readings direct in db or mw and completely eliminates tedious computations or troublesome adjustment during operation. The instrument measures either pulsed or CW power on either waveguide or coaxial systems. Operation is entirely automatic, stability is extremely high, and the meter may be used with a wide variety of bolometer mounts having either positive or negative temperature coefficients. The broad nominal measuring range can be extended to higher powers by means of directional couplers and attenuators.

For measurements of CW or pulsed power, *-hp-* 430C uses either an instrument fuse, barretter or thermistor as a bolometer element. Operation may be at either 100 or 200 ohms. Power is read direct in milliwatts from 0.02 to 10 mw, or in dbm from —20 to +10 dbm.

SPECIFICATIONS

Power Range: 5 ranges, front panel selector. Full scale readings of .1, .3, 1, 3 and 10 mw. Also continuous readings from —20 to +10 dbm. (0 dbm = .001 watt). Power range may be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency range depends on bolometer mount. Bolometers can operate at resistance levels of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. Dc bias current is continuously adjustable and independent of bolometer resistance and power level range.

Suitable bolometers are:

Instrument fuses: *-hp-* G-28A 1/100 amp fuse:

Barretters: Sperry 821, Narda N821B or N610B, PRD 610A, 614, 617 or 631C.

Thermistors: W. E. D166382 and 32A3, V. E. Co. 32A3, 32A5, Narda 333, 334.

Accuracy: ±5% of full scale reading.

Power: 115/230 v ±10%, 50/1,000 cps, 75 watts.

Dimensions: Cabinet Mount: 7⅜" wide, 11½" high, 12¼" deep. Rack Mount: 19" wide, 7" high, 12½" deep.

Weight: Net 20 lbs. Shipping 32 lbs. (cabinet mount).

Price: $250.00.

Data subject to change without notice.

hp ELECTRONIC TEST INSTRUMENTS for

Use these precision -*hp*- instruments with -*hp*- 430C for greater coverage, convenience

-*hp*- 752 Multi-Hole Couplers—For measuring average power 1 watt to 1 kw (with attenuator) in waveguide systems. Models cover all frequencies 2.6 to 18.0 KMC. Coupling factors of 3, 10 and 20 db available most bands. Directivity better than 40 db full range; accuracy within ±0.4% full range. Primary guide SWR less than 1.05. $260.00 to $100.00.

-*hp*- 750 Cross-Guide Couplers—For measuring powers up to 1 kw (with attenuator), where precision accuracy of -*hp*- 752 not required. Comprises two waveguide sections joined on broad faces, providing 4-terminal network. Models cover frequencies 2.6 to 12.4 KMC; coupling factors 20 or 30 db, coupling accuracy better than ±1.7 db, directivity 20 db or more. $100.00 to $50.00.

-*hp*- 382A Precision Attenuators—For measurements up to 5 and 10 watts, this revolutionary new broad band instrument may be employed. -*hp*- 382A attenuates from 0 to 50 db, full range, independent of frequency. Phase shift constant with attenuation. Accuracy within ±2% of db reading. Models cover frequencies 3.95 to 18.0 KMC, maximum dissipation 5 to 10 watts. SWR less than 1.15. $450.00 to $250.00.

-*hp*- 370 Waveguide Attenuators — Waveguide sections providing fixed amounts of attenuation. Used to extend power range of -*hp*- 430C. Models calibrated for frequencies 3.0 to 15.0 KMC, power dissipation 1.0 watts (1 kw peak), SWR 1.15, 6, 10 or 20 db attenuation. $75.00 to $55.00.

-*hp*- 487A Thermistor Mounts—Simplify setups, save time and insure maximum accuracy in waveguide power measurements. Models cover frequencies 3.95 to 12.4 KMC with full range SWR of less than 1.5. Permanently installed 200 ohm negative temperature coefficient thermistors. No tuning, large overload factor makes burnout virtually impossible. Maximum power level 3 mw. $95.00 to $75.00.

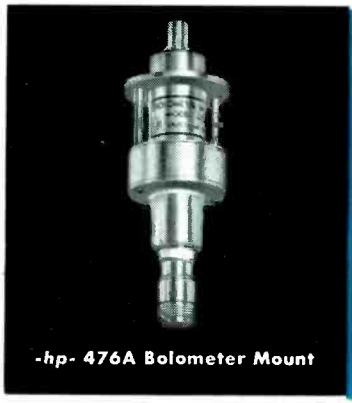
-*hp*- 477A Coaxial Mount — Thermistor mount providing full frequency coverage 10 MC to 10 KMC with SWR less than 1.5. Requires no tuning, uses long time constant elements for accurary even on low duty cycle pulses. For use with 430C or other bolometer bridges providing negative temperature coefficient operation at 200 ohms. Requires 13 ma bias. Power range 0.02 to 10 mw. Uses Type N rf connector. $75.00.

-*hp*- 485 Detector Mounts—Single tuning control accurately matches waveguide section to bolometer element; instrument also detects rf energy with crystal substituted for bolometer element. Models for frequencies 2.6 to 18.0 KMC, SWR 1.25 to 1.5. All models employ crystal or barretter except P485 (12.4 to 18.0 KMC), which uses permanently installed thermistor. $125.00 to $75.00.

-*hp*- 476A Bolometer Mount—Universal bolometer mount requiring no tuning, no adjustment. Frequencies 10 to 1,000 MC, instantaneous, automatic power readings 0.02 to 10 mw. SWR less than 1.15, 20 to 500 MC; less than 1.25, 10 to 1,000 MC. Uses four 1/100 amp fuses. Uses Type N rf connectors. $85.00.

-*hp*- 485 Detector Mounts

-*hp*- 382A Precision Attenuators

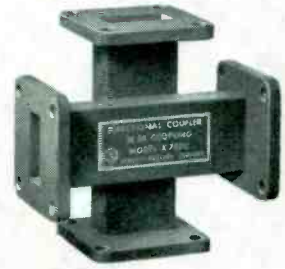


-*hp*- 476A Bolometer Mount

-*hp*- 752 Multi-Hole Couplers

-*hp*- 487A Thermistor Mounts

-*hp*- 477A Coaxial Mount



-*hp*- 750 Cross-Guide Couplers

Prices f.o.b. factory. Data subject to change without notice.

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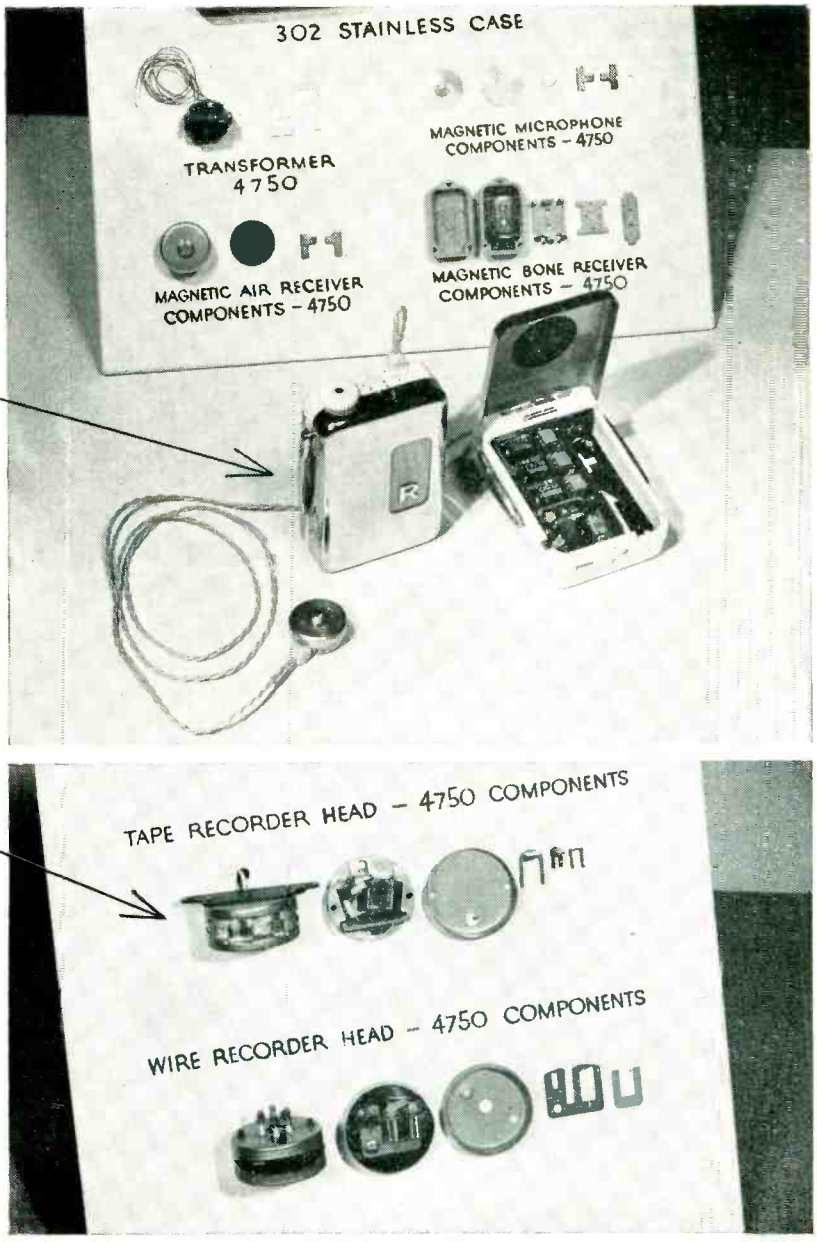
COMPLETE COVERAGE, HIGHEST QUALITY

for
HEARING AIDS

or
RECORDING HEADS



or *ANY* MAGNETIC MATERIALS JOB . . .

Write for your Copy

"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.

ADDRESS DEPT. E-65

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

W&D 5335

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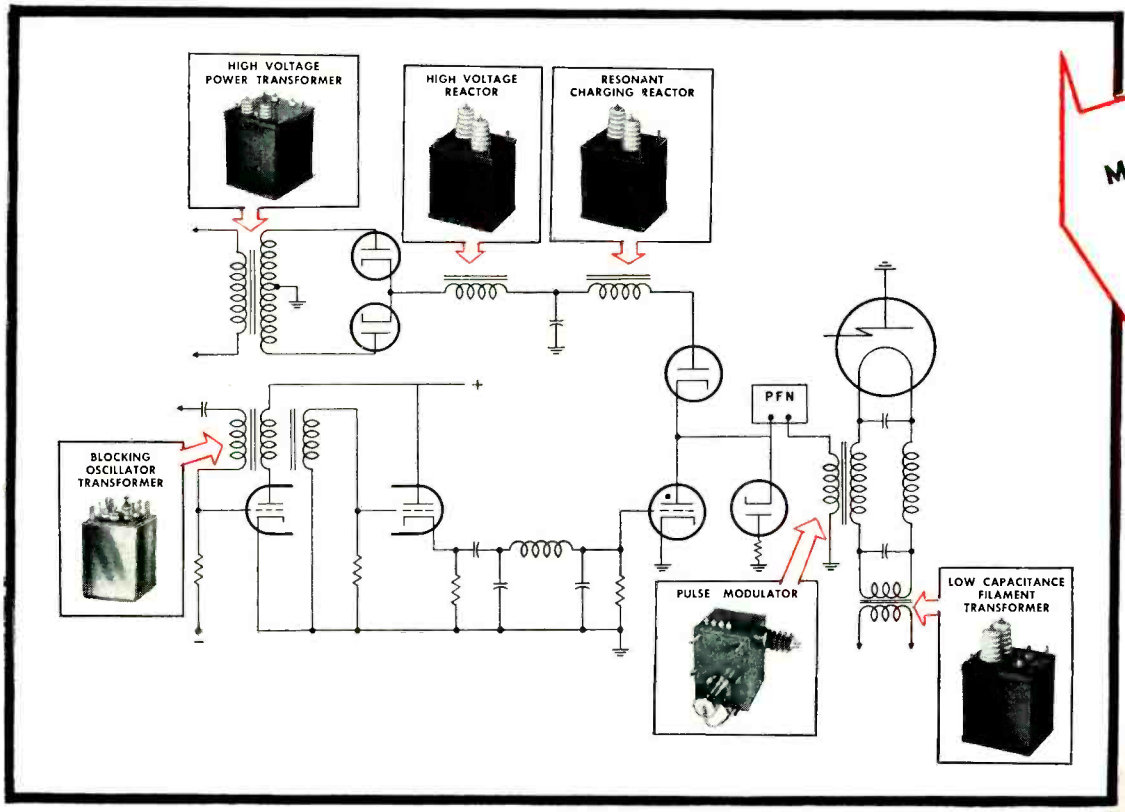
THESE FREED COMPONENTS CONTRIBUTE EFFICIENT, RELIABLE PERFORMANCE IN RADAR, LORAN AND SONAR DEVICES.



TYPICAL PULSE MODULATOR CIRCUIT SHOWS APPLICATIONS OF FREED COMPONENTS

How well our detection and warning services will function in time of emergency will depend upon the performance of each individual component. Imaginative engineering, selected materials, careful inspection and constant quality control make Freed products the ultimate in the industry.

OTHER FREED PRODUCTS

TRANSFORMERS

- High Fidelity
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- High Q Toroids
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- Hermetically Sealed
- Step-down
- Magnetic Amplifiers
- Miniature Transistor
- High Q Reactors
- High Temperature
- Miniature Audio
- Charging Reactors
- Sub-Miniature
- Precision Reactors
- Precision Filters

INSTRUMENTS

- Comparison and Limit Bridges
- Low Frequency "Q" Indicators
- Incremental Inductance Bridges
- Universal Bridges
- Null Detectors and V.T. Voltmeters
- Power Supplies
- A.C. Bridges and Accessories
- Differential Voltmeters
- Harmonic Distortion Meters
- Wide Band Amplifiers
- Decade Amplifiers
- Decade Inductors
- Decade Capacitors
- Megohmmeters
- Filters
- Magnetic Voltage Regulators

Send for further information and catalog

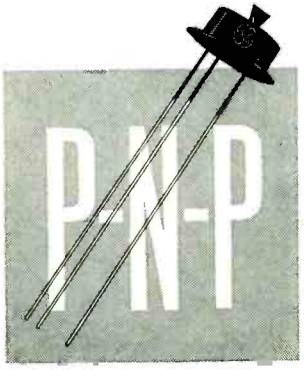
FREED TRANSFORMER CO., INC.

1722 Weirfield St., Brooklyn (Ridgewood) 27, N. Y.

G.E. MECHANIZED PRODUCTION AT LOWER COST...ASSURES

Both types offer high reliability at temperatures

Take a close look at the transistor values G.E. now offers. Because production lines are now mechanized, these transistors are made in *less time* at *reduced cost.* Machine methods today assure strictest adherence to the top quality standards demanded of all General Electric Germanium Products.



TYPE 2N43A

Mechanization results in CONTROLLED CHARACTERISTICS, removing any inaccuracy on the part of the operator. Narrow limits are built into production transistors giving a more uniform produc

In military and commercial applications these G-E transistors offer precision quality, topmost reliability at mass-volume prices!

General Electric's P-N-P junction transistor, 2N43A, is the first to be written into Air Force specifications! MIL-T-25096 (USAF) was actually written around this G-E product which was developed for the military. Now it serves an ever-increasing number of commercial as well as military applications.

APPLICATIONS AND SPECIFICATIONS

TYPICAL USES: Audio and Intercom Amplifiers, Servo Amplifiers, Carrier Current Amplifiers, Test Equipment, Fuel Gauges.

SPECIFICATIONS OF THE 2N43A and USAF 2N43A

Absolute Maximum Ratings:

Collector Voltage (Referred to base)	−45 volts
Collector Current	−50 ma
Collector Dissipation	150 mw
Storage Temperature	100° C
Collector Cutoff Current (−45 volts)	−10 microamps

DESIGN FEATURES:

STURDY CONSTRUCTION... meets critical military tests for shock, vibration, humidity, life.

SEALED JUNCTION... contamination gases permanently eliminated!

HIGH POWER OUTPUT... case design makes possible a collector dissipation of 150 mw.

HERMETIC SEAL... unaffected by moisture.

LONG LIFE... no change in characteristics during life of equipment.

MAKES TRANSISTORS AVAILABLE CONTROLLED CHARACTERISTICS

up to 100°C...are now available in production lots!

TYPE 2N78

HIGH FREQUENCY TRANSISTOR

A new, revolutionary manufacturing technique, the exclusive G-E rate-growing process, coupled with the all-welded hermetic seal, now makes possible extra long life, and noticeably-reduced manufacturing costs by—

- Making 2000 or more transistors from one rate-grown crystal.
- Achieving uniform characteristics in all 2000 transistors—*eliminating wasteful rejects.*

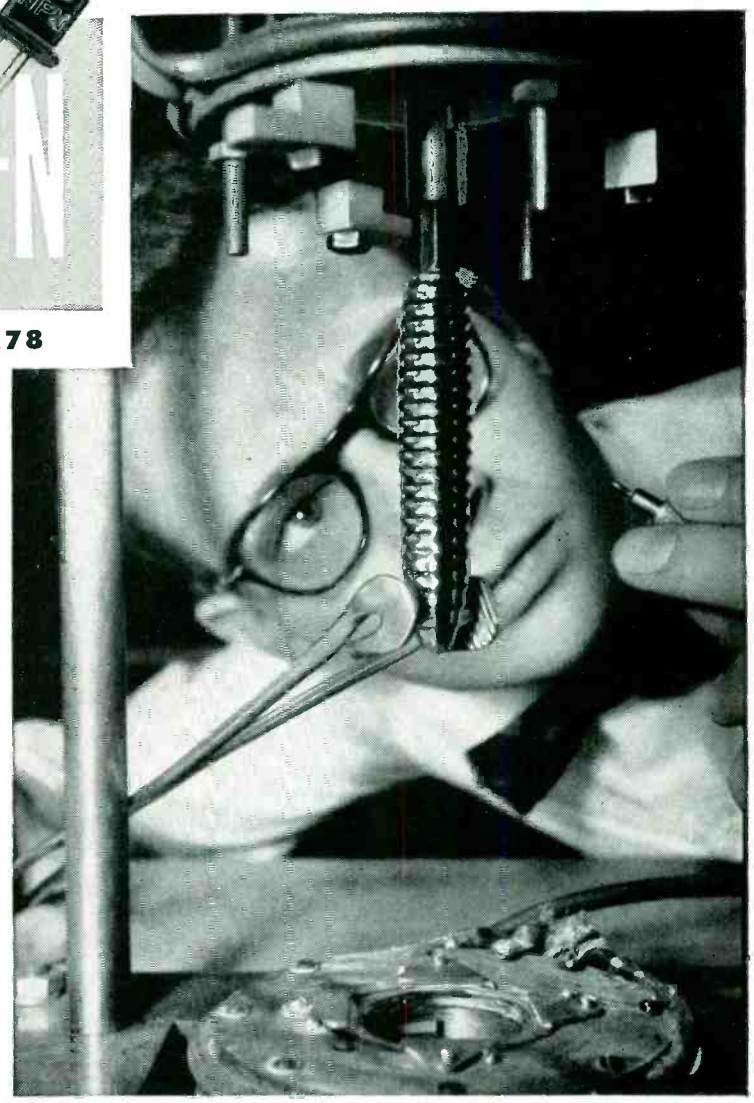
APPLICATIONS

For pulse and switching circuits, RF and IF amplifiers; high-frequency test equipment; telephone repeaters.

SPECIFICATIONS

Collector Voltage (Referred to Base)	15 V
Collector Current	20 ma
Emitter Current	−20 ma
Storage Temperature	100° C.
High Frequency Gain at 2 mc	13 db

● For further details on specifications and prices, write *General Electric Co., Section X455, Germanium Products, Electronics Park, Syracuse, N. Y.*

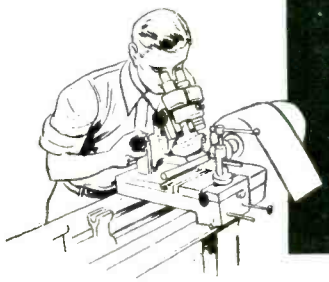


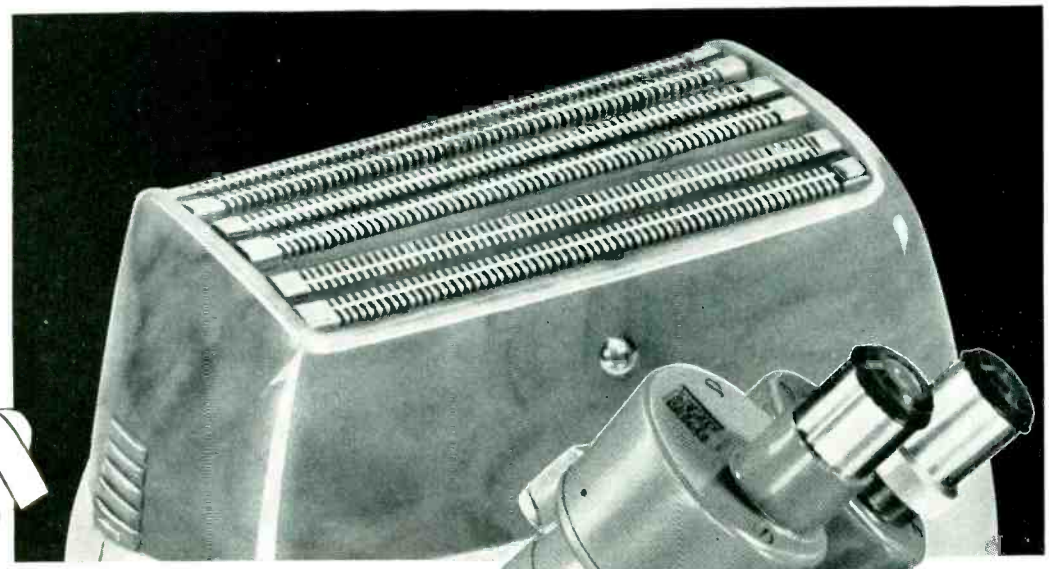
Billet of germanium is removed from furnace, prior to cutting into enough tiny pellets for 2000 transistors.

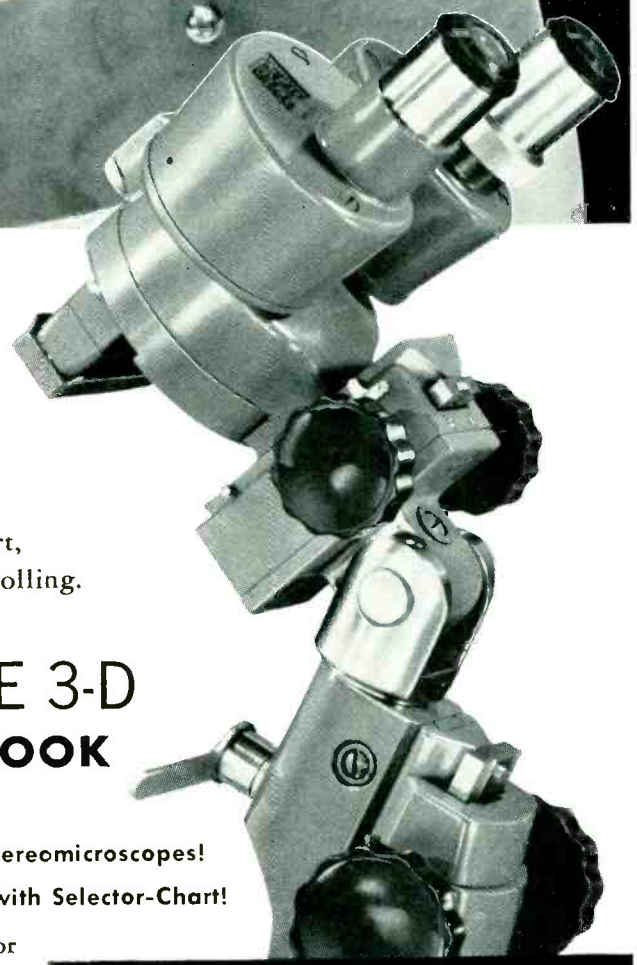
Progress Is Our Most Important Product

GENERAL ELECTRIC

How *REMINGTON RAND* uses 3-D Micro-Vision to maintain peak shaver production



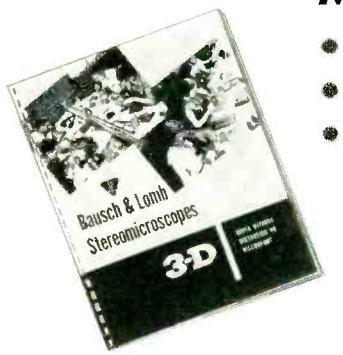




Remington Rand has solved the problem of critical inspection with Bausch & Lomb Stereomicroscopes. And it's done with an increase in production.

Clear, sharp, magnified views of shaver head—with natural depth perception—quickly reveal flaws such as tiny cracks, bent blades, burrs, contact between cutter and head. Increased operator comfort, higher efficiency, keep peak production rolling.

Write for NEW! EXCLUSIVE 3-D MICRO-VISION BOOK



- See actual stereo views!
- Know how and where to use Stereomicroscopes!
- Fit exact model to job needs with Selector-Chart!

WRITE FOR FREE COPY. Ask for Manual D-15. Bausch & Lomb Optical Co., 61441 St. Paul Street, Rochester 2, New York.

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STEREOMICROSCOPES

New

MARCONI EQUIPMENT

Marconi are specialists in the design of instruments to aid electrical engineers in making accurate observations of the more intricate electrical functions.

Their instruments—more than seventy specific designs—are widely used throughout industry and civil telecommunications. Full details are freely available if you will write, stating your requirements.

OUTPUT POWER METER Type TF 893

Ideal for accurate audio frequency power measurements, ideal for optimum load matching, the TF 893 has an input impedance variable in 48 steps from 2.5 ohms to 20,000 ohms, and a power measurement range extending from 20 μW to 10 watts. The input circuit is centre-tapped for push-pull working. The frequency range extends from 20 cps to 35 kc; at 50 cps the response relative to 1 kc is 0.5 dB down, at 20 kc 1 dB down.

100-dB STEP ATTENUATOR Type TF 1073

Variable in 1-dB steps over its 0- to 100-dB range, the Marconi TF 1073 Attenuator is a particularly useful and versatile instrument. It has a characteristic impedance of 75 ohms and a frequency response flat from d.c. to 100 mc. Using the full 100 dB at 100 mc the maximum error does not exceed 0.6 dB; even at 150 mc the TF 1073 has a most acceptable performance.

MARCONI INSTRUMENTS

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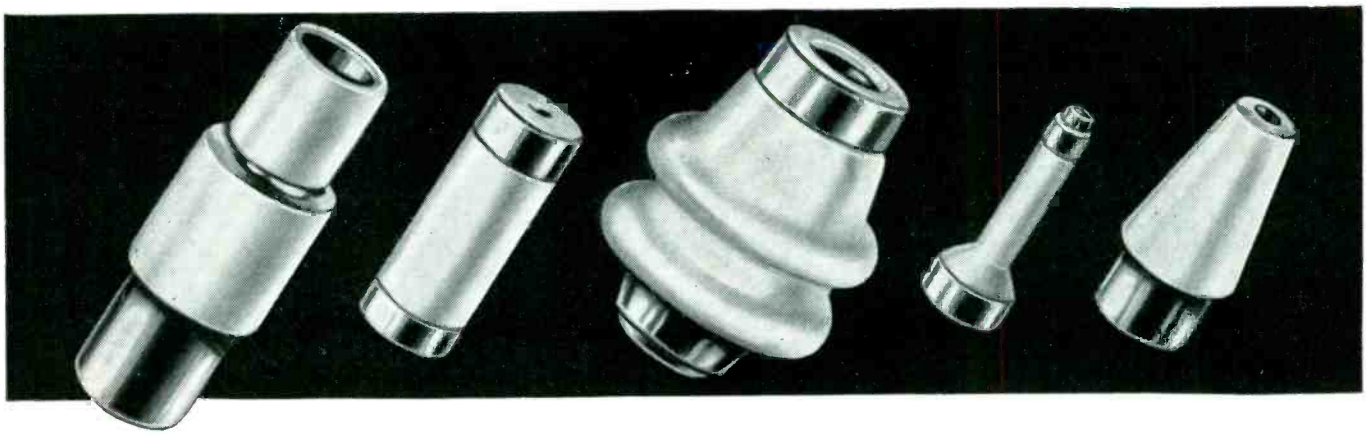
TC 65

Here's an exciting new development in metallized ceramics!



NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

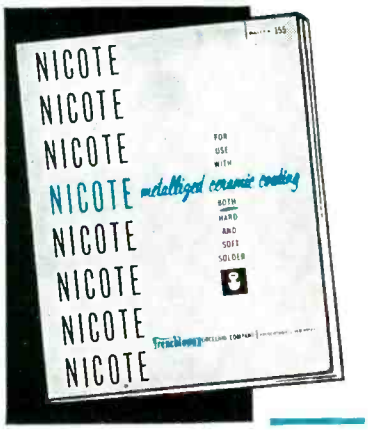
Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.



This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with **both** hard and soft solders. Ask for Bulletin 155.

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86 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

ALSO KNOWS HIS OSCILLOSCOPES

Government of Canada among many purchasers of the new ultra-versatile LFE 411

The 411 is a specialized Oscilloscope made versatile by 6 X-axis plug-in units. Great flexibility is now yours at quite reasonable cost. Check every feature — compare against competitive makes. And whatever your research problem, before you buy a new scope, call the nearest LFE Engineering Representative or write LFE direct about the matchless 411.

Specifications:

X-AXIS PLUG-IN UNITS

• Model (s) 1400, BASIC, with 0.5 to 5000 cps trigger generator • 1401, SWEEP DELAY, continuously variable from 1. μsec. to .1 sec. • 1402, VIDEO SWITCH, time sharing circuit, BW 5 cps to 8mc. • 1403, GATED MARKER GENERATOR, 0.1 to 10,000 μsec. timing markers • 1404, TV TRIGGER SHAPER, triggers on composite video signal • 1405, LONG SWEEPS, from .1 sec./cm. to 5 sec./cm.

BASIC SCOPE

• *Y-Axis Amplifier*

• Deflection Sensitivity — 15 mv./cm. p-p for both d-c and a-c (max.) • Max. Signal Voltage — 500 volts, peak • Frequency Response — d-c to 10 mc. (3 db. point) • Transient Response — Rise time (10%–90%) — 0.035 μsec. • Linearity of Deflection — Max. deflection, 5". At 2" unipolar deflection, maximum compression is 10% • Signal Delay — 0.25 μsec. • Input Termination — 52, 72, or 93 ohms • Input Impedance — 1 megohm, 30 μμ f.

• *X-Axis*

• Sweep Time Range, calibrated — 0.1 μsec./cm. to .1 sec./cm. • External Sweep Sensitivity — 2 volts/cm., p-p. • Frequency Response — DC to 1 mc, (3 db. point) • Triggers — Internal ±; External ±; 60 cps; Internal Trigger Generator 5000 cps • External Trigger Sensitivity — 1.0–100 volts for Triggers having a slope of greater than 40 volts per second.

OTHER FEATURES

• Flat-face CRT Type 5ABP-1 (P7 or P11 optional) — Accelerating Potential 3000–4000 volts • Deflection Plates Accessible • Power Requirements: 105 — 125 V., or 210–250 V., 50–60 cycles. 385 watts • Dimensions: 13" w, 17¾" h, 21" d.

HEAVY DUTY, PRECISION REGULATED POWER SUPPLIES

FOR LESS THAN THE COST OF BUILDING THEM YOURSELF

Bench Model 50
0-500 VDC @ 0-500 MA $415.00

LAMBDA'S TWO WIDEST RANGE, MOST VERSATILE POWER SUPPLIES

Rack Model 50-R
0-500 VDC @ 500 MA $395.00

These general purpose, heavy duty power supplies save you time, money and experimentation. They are tested, fully guaranteed, now in use in many leading research and industrial laboratories and manufacturing plants. You get quick delivery, dependable equipment ready for immediate installation.

SPECIAL FEATURES

- **Hermetically sealed oil filled condensers**
- **Stable 5651 reference tubes**
- **Easy-to-read 4" meters**
- **Overload circuit breakers (magnetic type)**
- **Vernier high-voltage control**
- **Time-delay tube protection**

SPECIFICATIONS

INPUT ..... 105-125 VAC, 50-60 C, 800 W (max)

DC OUTPUT NO. 1: (regulated for line and load)
Voltage ..... 0-500 VDC (continuously variable)
Current ..... 0-500 MA (over entire voltage range)
Regulation (line) ..... Better than 0.15% or 0.1 V
Regulation (load) ..... Better than 0.5% or 0.3 V
Internal Impedance ..... Less than 2 ohms
Ripple and Noise ..... Less than 8 millivolts rms
Polarity ..... Either positive or negative may be grounded

DC OUTPUT NO. 2: (regulated for line only)

Voltage Ranges	Internal Impedances:
a) 0-50 VDC (no load)	3,300 ohms (max)
b) 0-200 VDC (no load)	17,500 ohms (max)

Regulation (line) ..... Better than 0.1%
Ripple and Noise ..... Less than 5 millivolts rms
Polarity: Positive terminal connected internally to negative terminal of DC output No. 1

AC OUTPUTS (unregulated):
Two outputs, isolated and ungrounded. Each is 6.5 VAC at 5A (at 115 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6 V (nominal) at 5A, or in parallel for 6.3 V (nominal) at 10A.

SIZES AND WEIGHTS:

Bench Model 50	Size: 12½" H x 22" W x 15" D Weight: 110 lb. net; 175 lb. shipping
Rack Model 50-R	Size: 10½" H x 19" W x 14¼" D Weight: 89 lb. net; 143 lb. shipping

LAMBDA ELECTRONICS CORP.
103-02 NORTHERN BLVD. CORONA 68, NEW YORK

KOCH ...*World's largest fabricator of moulded Fiberglas products*

PRONOUNCED "KOKE"

How to insure valuable equipment against damage

In the test illustrated above, a Koch Fiberglas carrying case was loaded with three times its weight and dropped 250 feet into the sea. The case was undamaged.

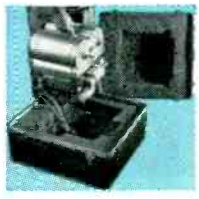
This remarkable case, made only by Koch, is revolutionizing the whole concept of protecting valuable equipment of all kinds in shipping, handling and long term storage.

The case will not dent. It will not corrode, so painting is unnecessary. It safeguards against shock, vibration, fungus, mildew. No outer crating or other protection is required for shipment or storage. The Koch Fiberglas case is absolutely airtight, and under severe tests has maintained a vapor and moisture transmission rate of zero.

Cushioning material inside the case is moulded to fit perfectly the contours of the equipment, giving maximum protection against vibration and shock.

Sixty thousand Koch Fiberglas cases are now in service with the U. S. Air Force and BuAer all over the world. To date there has not been a single unsatisfactory report, or casualty to a case or the valuable equipment it contains.

If you manufacture equipment that needs this kind of protection, we will be glad to confer with you about your problem. Address Dept. EK.



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produces waveguide assemblies of a quality higher than your specifications at *about half the cost.*

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wide temperature range

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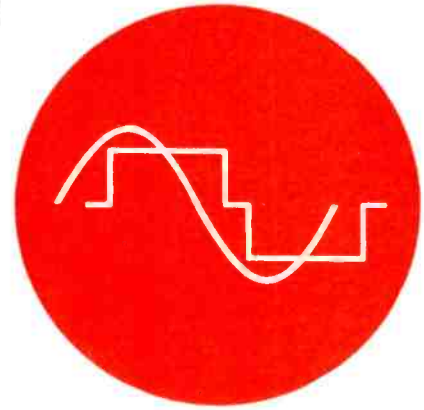

Phase Angle at 6.3v, 60 cycles is 21° ± 5°, at 30 cycles is nominally 20°, at 100 cycles 26°.

Contacts are SPDT, break-before-make, and are rated up to 100 volts maximum, 1 ma maximum.

Dwell Time is approx. 170°. The nominal value of dwell time changes only slightly from 30 cycles to 100 cycles.

Coil demand at 6.3 volts, 60 cycles, is approximately 37 milliamperes, coil resistance approximately 165 ohms D.C.

Noise with all 3 contacts at one megohm impedance, and with wide band amplifiers, will have an effective value of 50 microvolts or less. The offset of narrow band amplifiers will be very much less. The specification of noise requires careful definition, users should refer to the detail specifications and bulletin 103.

Temperature may be any value from —65°C to 85°C. The nominal phase angle will vary from about 17 degrees at —65°C to 25 degrees at 85°C.

Vibration from 10 to 55 cycles will not damage the chopper up to as high as 30 G. At these higher G values there will be some modulation of the phase angle.

Frequency of operation may be any value from 25 to 110 cycles, to maintain full performance, balance, etc.

Humidity may be any value, except of course for external condensation on the header.

Shock values as high as 50G will not damage the chopper.

Altitude may be any value, as the unit is hermetically sealed.

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DESIGNERS ENGINEERS

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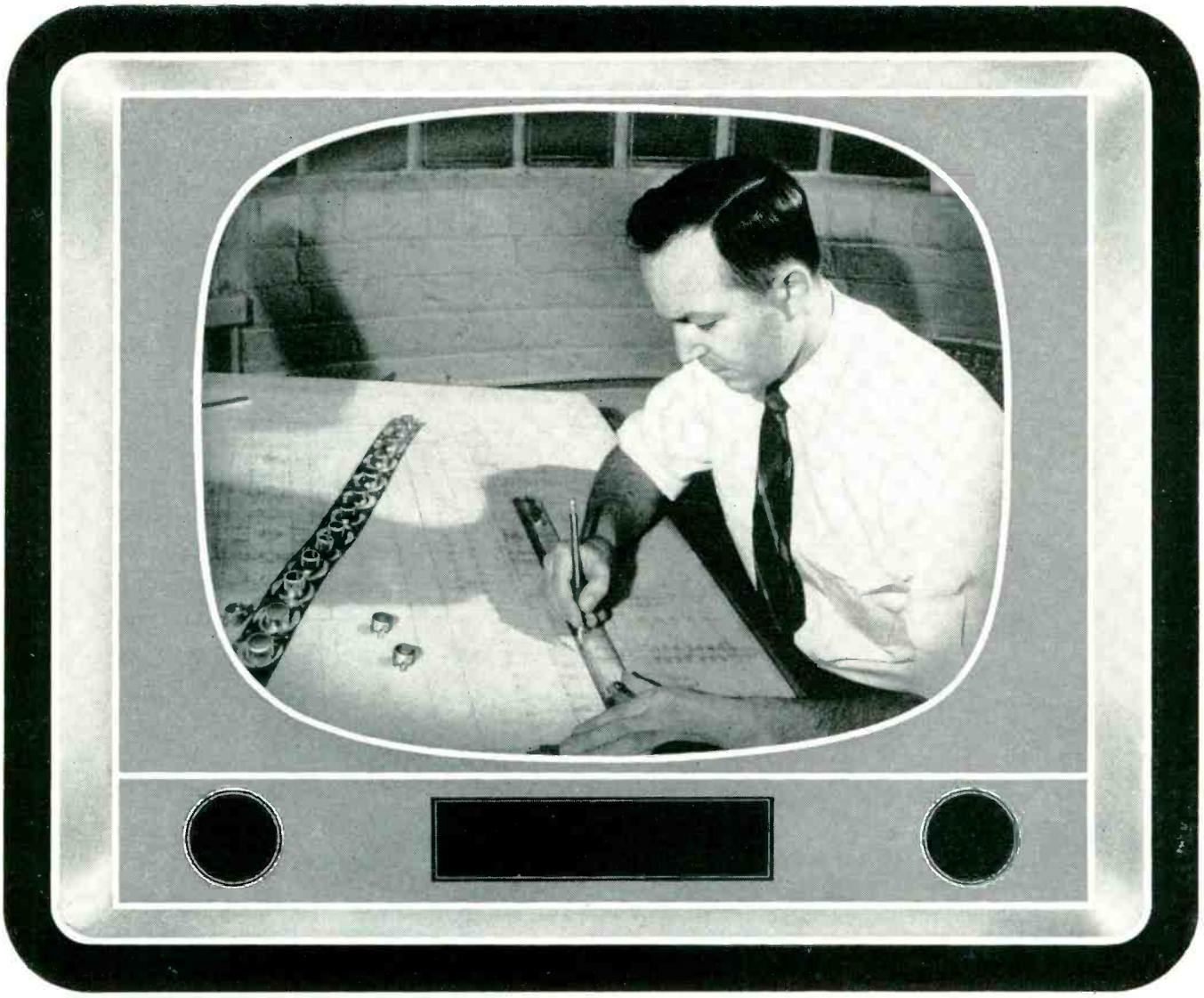


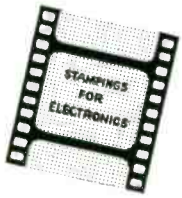
Picture of Your Set Being Improved by Volkert Stampings Research

At Volkert, as in your TV set manufacturing operations, research is an unending process.

Whether it's electron-gun parts for black-and-white or color, receiving-tube components, or shadow masks for color TV, Volkert research sees to it that the stampings you require are more economical in assembly...more efficient in performance.

Volkert serves as engineering consultant and confidential experimental laboratory for the electronics industry, as well as its No. 1 source for precision stampings. A consultation with Volkert at the *development* stage assures you dependable stampings at the *production* stage.

Here are two easy ways to learn more about precision stampings



The Volkert View quarterly keeps you up-to-date on electronic stamping developments. Just drop us a line and you'll be put on the mailing list.

Stampings for Electronics, our color film, tells how Volkert daily produces 2,000,000 precision parts. Arrange for a group showing in your plant.

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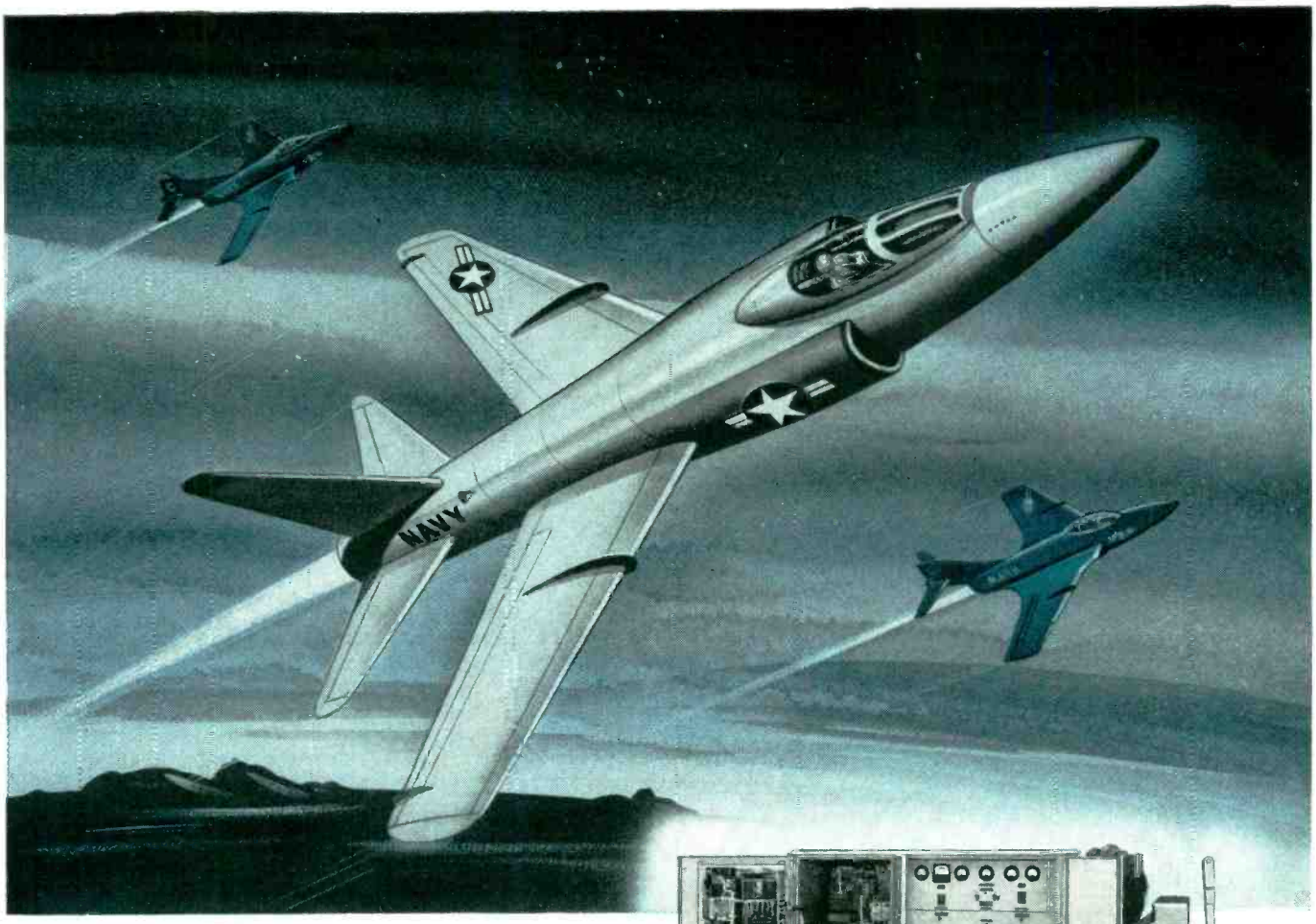

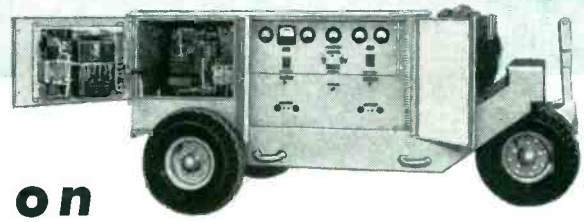

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Grumman Aircraft Engineering Corporation, designers and builders of quality Naval aircraft from the FF-1 of the thirties, the famed World War II Hellcats, to the present day swept-wing Cougar and Supersonic Tiger Jets, has selected Bogue Electric power supplies for laboratory, production and flight-line testing.

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Bogue Electric Manufacturing Company
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The Authority on High Cycle Precision Power

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And yet the challenge is not all military. It is inevitable that the application at Ramo-Wooldridge of these advanced modern theories and new techniques will lead to significant accomplishments in the field of commercial communications as well.

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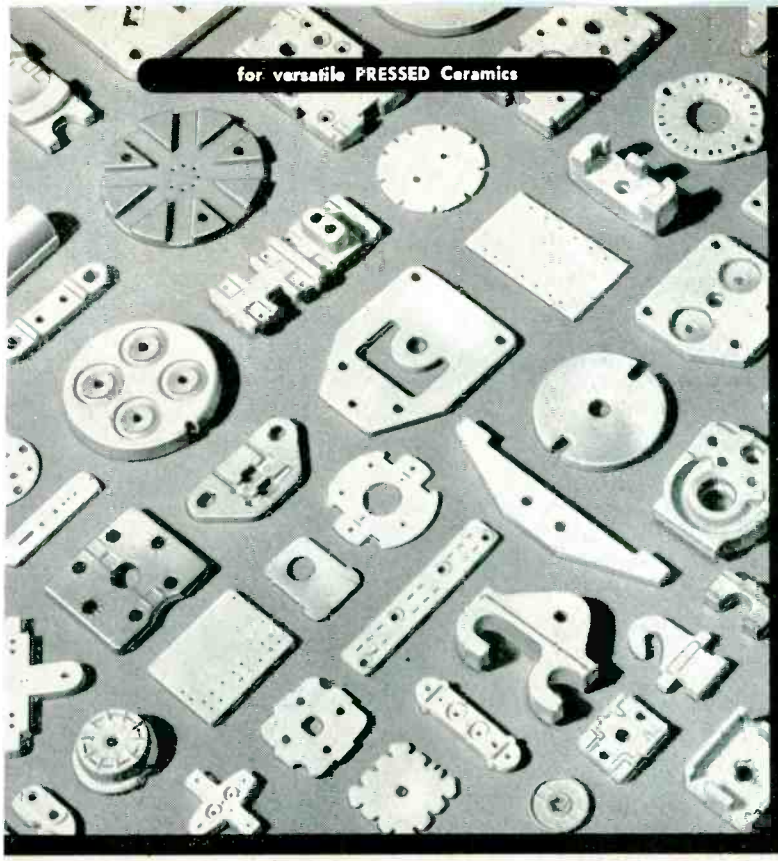

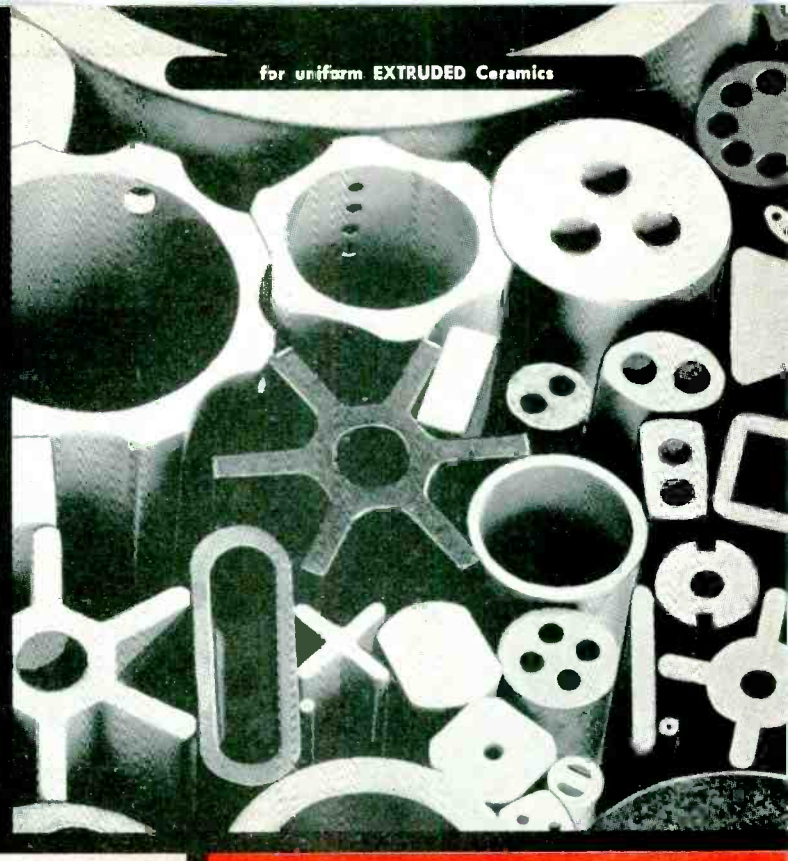

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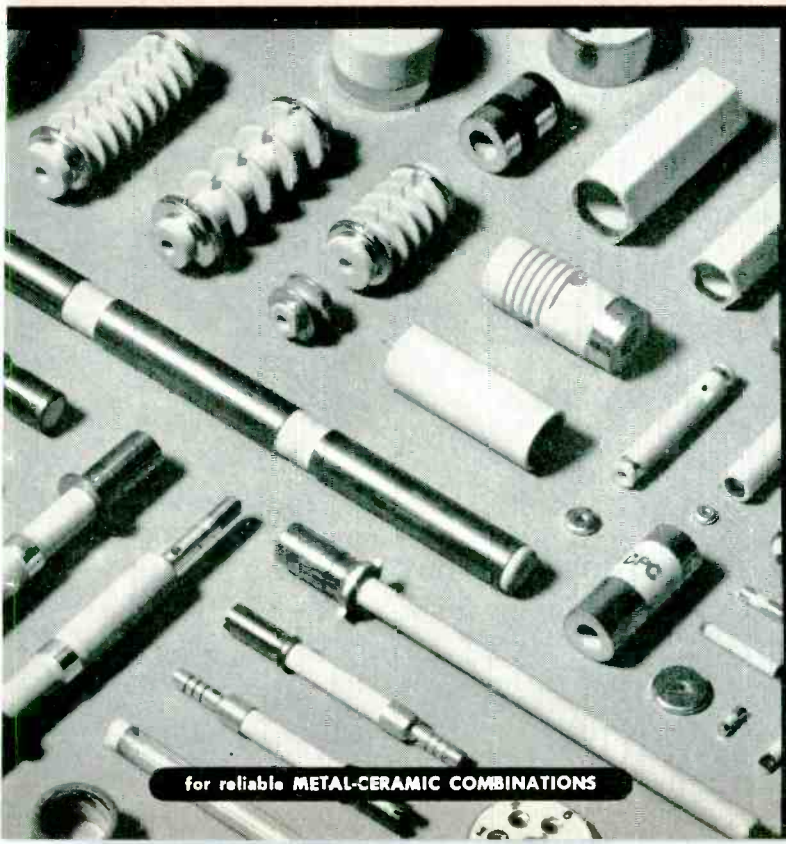

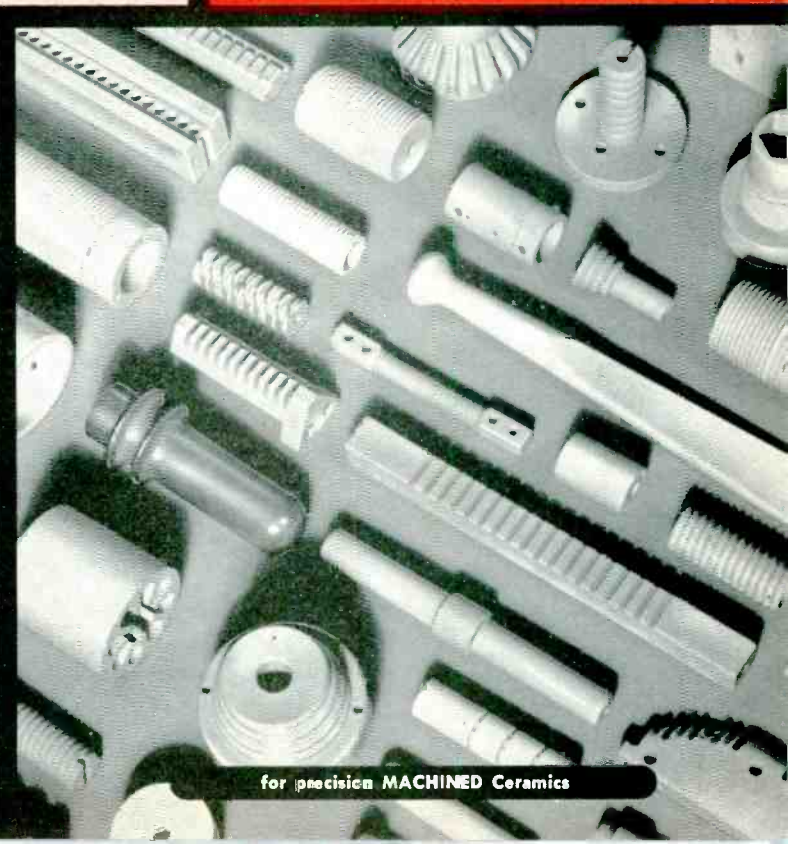

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Here are the facts about "U. S." molded rubber as a basic material:

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3) "U. S." molds rubber that has achieved new standards in resistance to oil, water, cold, heat.

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"U.S." Research perfects it..."U.S." Production builds it...U.S. Industry depends on it.

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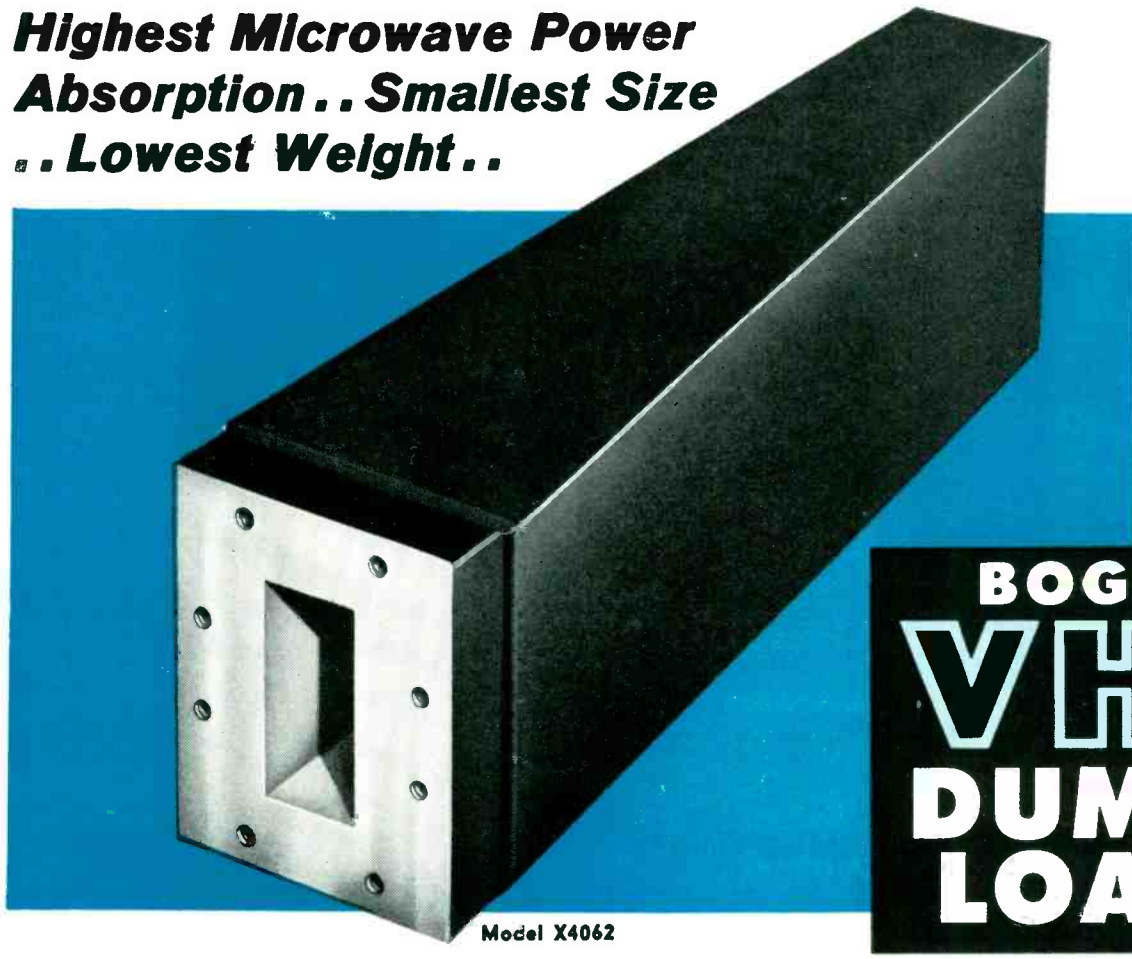

Model X4062

BOGART VHP* DUMMY LOADS

No Cooling Fins Required

In laboratory, in field testing, in production — wherever extremely high microwave power is used—Bogart VHP* Dummy Loads do the job of much larger and heavier units. Even at the full peak power rating of rigid waveguides, no cooling fins are required.

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The lossy material is uniquely designed to present a minimum reflection coefficient, while permitting only negligible absorption of moisture.

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All-Aluminum construction and black enamel finish help reduce weight and resist heat. All models are available with either choke or cover flanges.

Special Applications

We invite your engineers to consult with our own staff. We will be pleased to discuss your particular problems with you, without any obligation on your part. Write today.

*Very High Power!

MODEL NO.	FREQUENCY RANGE (KMC/S)	MAX. PEAK POWER (MEGA-WATTS)	MAX. AVERAGE POWER (WATTS)	MAXIMUM VSWR	LENGTH (INCHES)	WIDTH (INCHES)	HEIGHT (INCHES)	APPROX. WEIGHT (LBS.)	WAVEGUIDE AN TYPE
X4062	8.20-12.4	0.29	750	1.10	4¾	1¼	1½	¾	RG-52/U
B4062	7.05-10.0	0.46	850	1.10	5¾	1¼	1¾	1	RG-51/U
C4062	5.85-8.20	0.71	1000	1.10	6⅞	1½	2¼	1¾	RG-50/U
H4062	3.95-5.85	2.0	2000	1.10	9½	1¾	2¾	3	RG-49/U
S4062	2.60-3.95	3.2	2500	1.10	13¾	2¼	3¾	6½	RG-48/U
L4062	1.12-1.70	17.2	4000	1.10	30	4¾	8	48	RG-69/U

Above data subject to change without notice.

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FREE! A graphic chart illustrating and describing the performance properties of the complete line of "SCOTCHCAST" encapsulating, dipping and impregnating resins will be sent on request. Write Minnesota Mining and Manufacturing Co., Dept. EE-55, St. Paul 6, Minnesota.

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● Flexible, semi-flexible and rigid varieties. ● Filled and unfilled types. ● Available for dipping, impregnating or encapsulating. ● Pot viscosities from 50 to more than 20,000 centipoise. ● Cure temperatures range from room temperature to 325°F. Cure time: 5-10 minutes and up.

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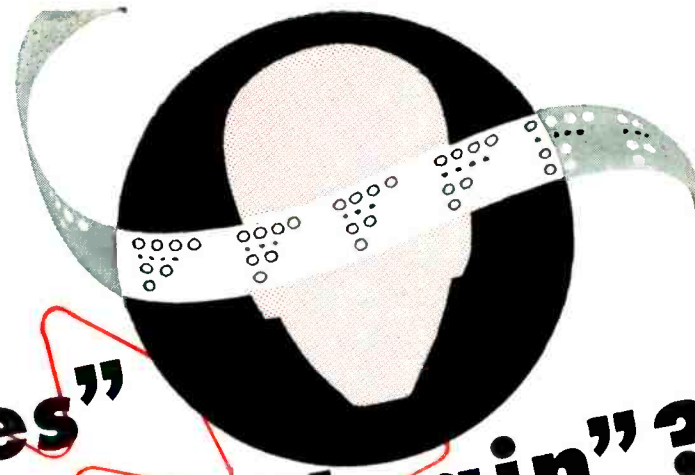
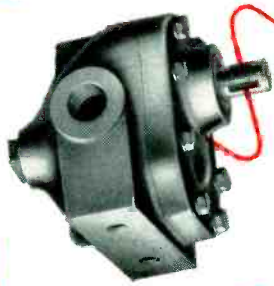
SCOTCHCAST RESINS

BRAND



need "muscles" for your "brain"?



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Gear-type Hydraulic Pumps are built with single or multiple elements in wide range of capacities for pressures up to 3000 psi. "Pressure Loaded" bearings for higher efficiency and longer service life. Can be furnished with Pesco Electric Motor as a Motor-Driven Hydraulic Pump; or with motor, reservoir and controls as a complete Pesco Power Package.

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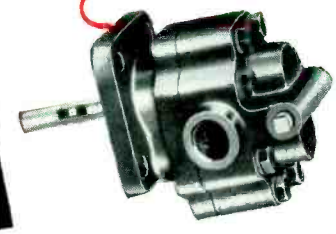
Precision-built Pesco motors provide maximum power for minimum size and weight. Many types available for special needs; models with rigidly exact performance for servo applications.

Both DC and high frequency AC motors built in 5 coordinated frame sizes from 1/100 to 11 hp permitting use of standard parts to expedite design. Many superior features to meet any requirement on humidity, temperature, vibration, duty cycle or altitude.



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Gear-type, positive displacement fluid motors to provide highly efficient, rotary, variable speed hydraulic power. Lightweight and compact, motors operate in either direction without mechanical adjustment. Starting torque efficiency is over 90%. Models available for operation at pressures to 1500 psi.

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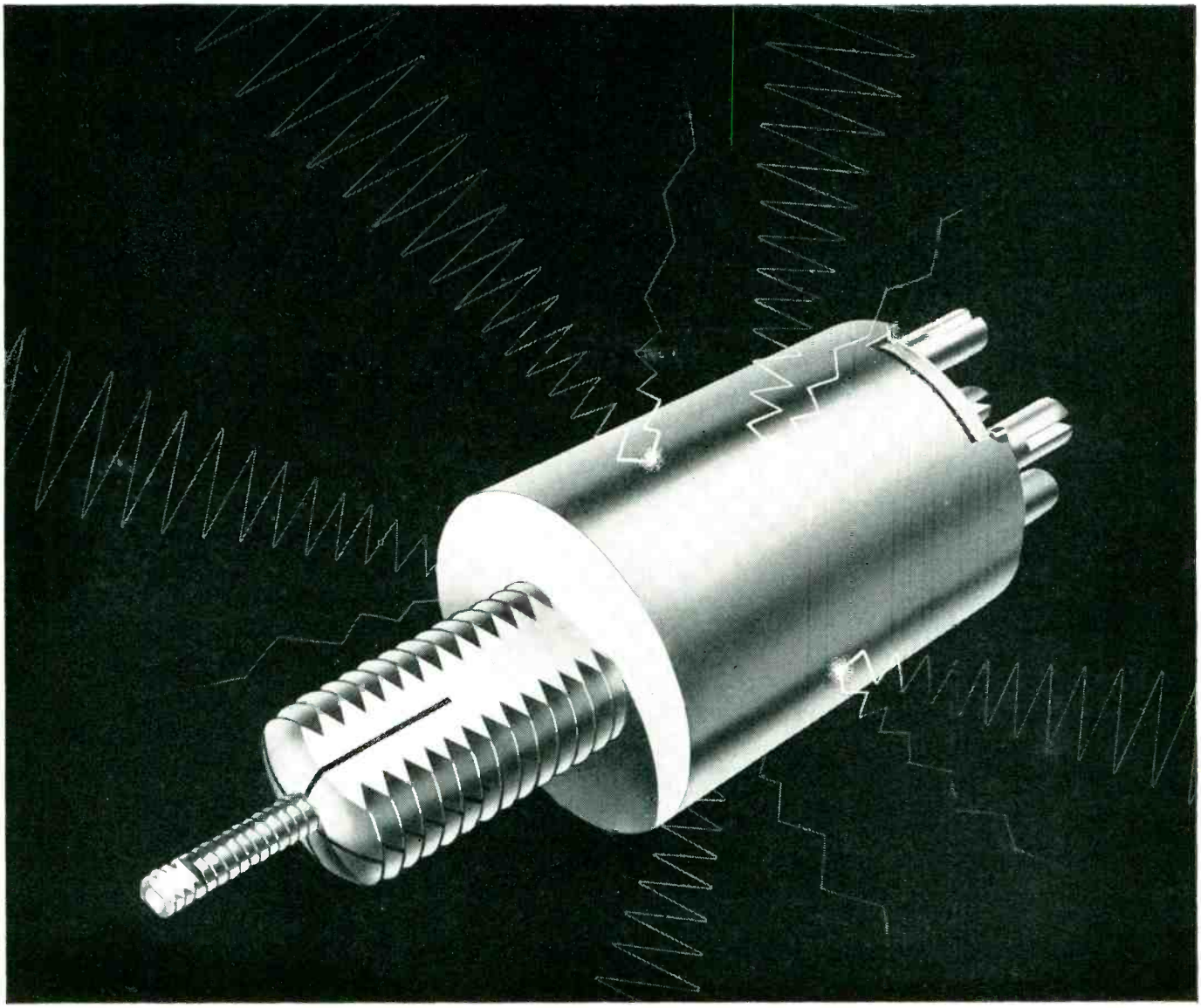


Built for close "combat" in tight spots

Into the construction of this coil form goes C.T.C.'s rigid *quality control* to highest production standards.

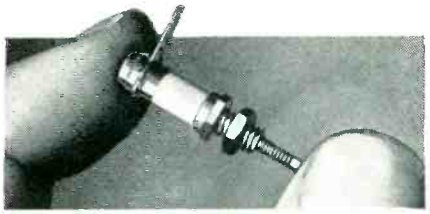
The result is another C.T.C. *first* — a miniaturized coil form (1/16" diameter by 1/2" high when mounted) that is shock-resistant and exceptionally rugged — shielded against radiation, electrically, and therefore ideal for "close quarter" use in I.F. strips and numerous designs where adjacent mounting is necessary.

C.T.C.'s policy of continuous step-by-step quality control in the manufacture of every component means guaranteed performance. Already certified materials are doubly checked before manufacture.

Whatever your component need — let C.T.C. solve your problem — with either custom or standard designs of *quality-controlled, guaranteed* components — including insulated terminals, coil forms, coils, swagers, terminal boards, diode clips, capacitors and a wide variety of hardware items.

Put *your* component problem up to C.T.C. now. For samples, specifications and prices — write today to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge, Mass. On West Coast, contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, California.

Coil Form Data: C.T.C.'s LS-9 coil form has a brass shell enclosing a powdered-iron cup-core, tuning slug, phenolic coil form and silicone fibreglas terminal board. Three terminal boards are available with choice of two, three or four terminal layout. Forms, unassembled, may be had *without windings . . .* or *wound and assembled to your specifications.*



Capacitor: New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 19/32" high when mounted, is less than 1/4" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

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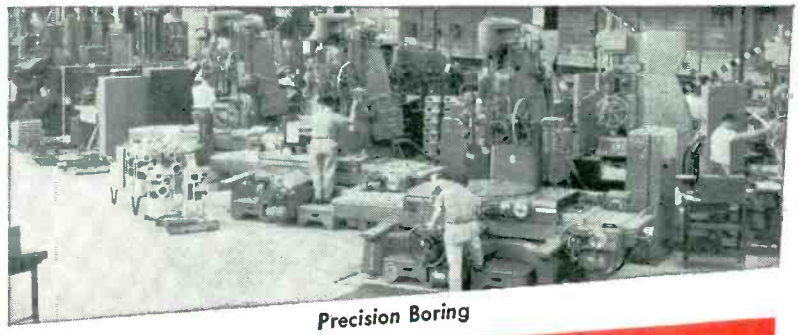

Precision Boring

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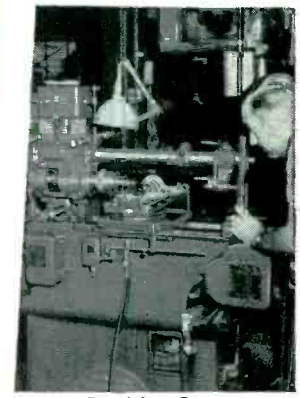
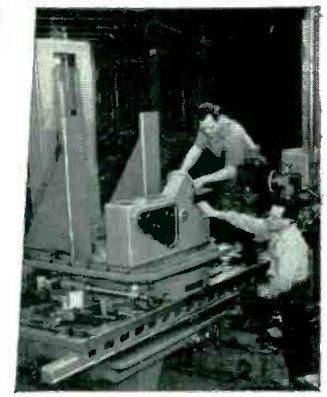


Precision Gear Cutting

Hobbing 56" Ring Gear



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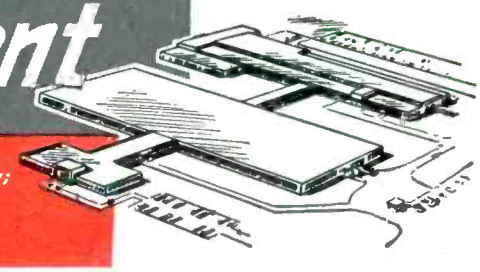

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Many characteristics of a specific alloy can be improved by vacuum melting and casting . . . for impurities that limit an alloy's potential are removed. Tensile and impact strength, stress rupture strength at elevated temperatures, and fatigue life can all be substantially improved . . . and creep and brittleness minimized by vacuum melting.

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VMC

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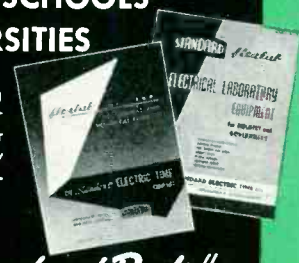

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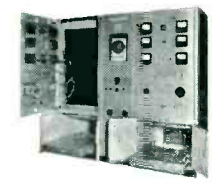
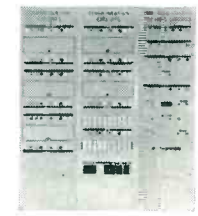


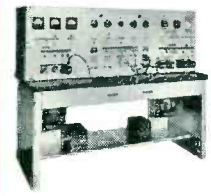
McClellan Air Force Base

Aberdeen Proving Grounds

Naval Air Development Station



Frankford Arsenal



Pensacola Naval Air Station

White Sands Proving Grounds

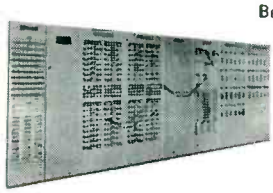
Naval Research Laboratory

IN SCHOOLS and UNIVERSITIES

Bell Vocational School

Bell Vocational School

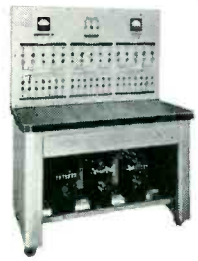
Iowa State College



Princeton University

Bergen County Vocational School

Technical School



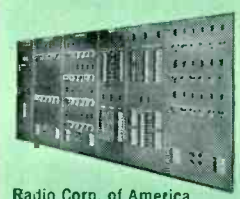
Bell Vocational School

IN INDUSTRY and RESEARCH

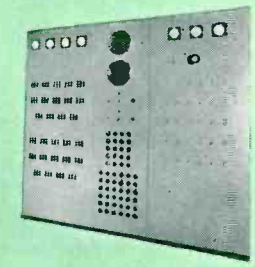
Westinghouse Electric Co.

Monsanto Chemical Co.

Ford Motor Co.

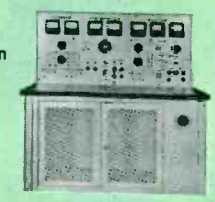


Radio Corp. of America

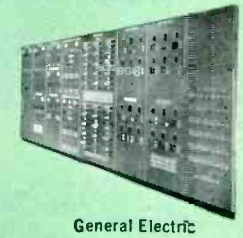


Glenn L. Martin Co.

Commonwealth Edison



Packard Motor Co.



General Electric

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THE STANDARD ELECTRIC TIME COMPANY

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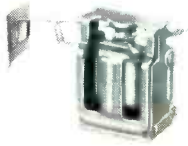
from the World's foremost builder

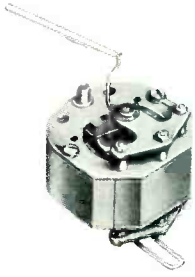
Whether the instrument system requires mechanisms combining miniature size with high torque, or great deflection with high sensitivity, or 'most any other combination of specific instrument characteristics... more than likely there's a WESTON mechanism already available which meets the requirements *exactly*. But for new or unusual needs, Weston engineers are available to assist at the drawing board stage. In either case, Weston's long leadership in instrument design... *since 1888*... offers best assurance of getting mechanisms *specifically designed for*, rather than merely adapted to, the system. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Model 9934—Miniature, self-shielded core magnet mechanism designed for operation of warning flags where space requirements are critical. Capable of 90° total deflection.

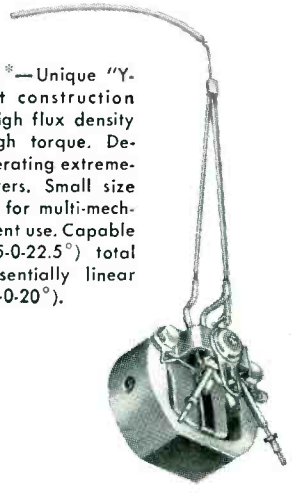


Model 9889—Small self-shielded core magnet mechanism featuring spring-backed jewels for ruggedness and the requirements of vibration and shock; suppressed characteristics if desired; optional location of mounting. Capable of 90° total deflection and can be used for both warning flags and indicator.

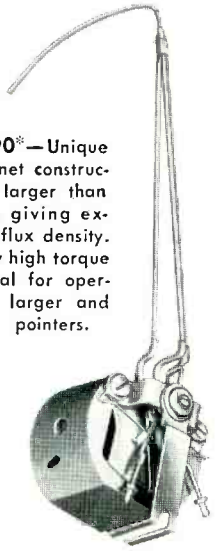
Model 9897—Long scale, 250° self-shielded movement, linear motion for operation of pointers where great deflection is a requirement. Capable of sensitivities in the order of 1½ microamperes per degree deflection.



Model 9891*—Unique "Y-Cor" magnet construction giving very high flux density with very high torque. Designed for operating extremely long pointers. Small size makes it ideal for multi-mechanism instrument use. Capable of 45° (22.5-0-22.5°) total deflection, essentially linear up to 40° (20-0-20°).



Model 9890*—Unique "Y-Cor" magnet construction, slightly larger than Model 9891, giving extremely high flux density. The extremely high torque makes it ideal for operation of the larger and heavier type pointers.



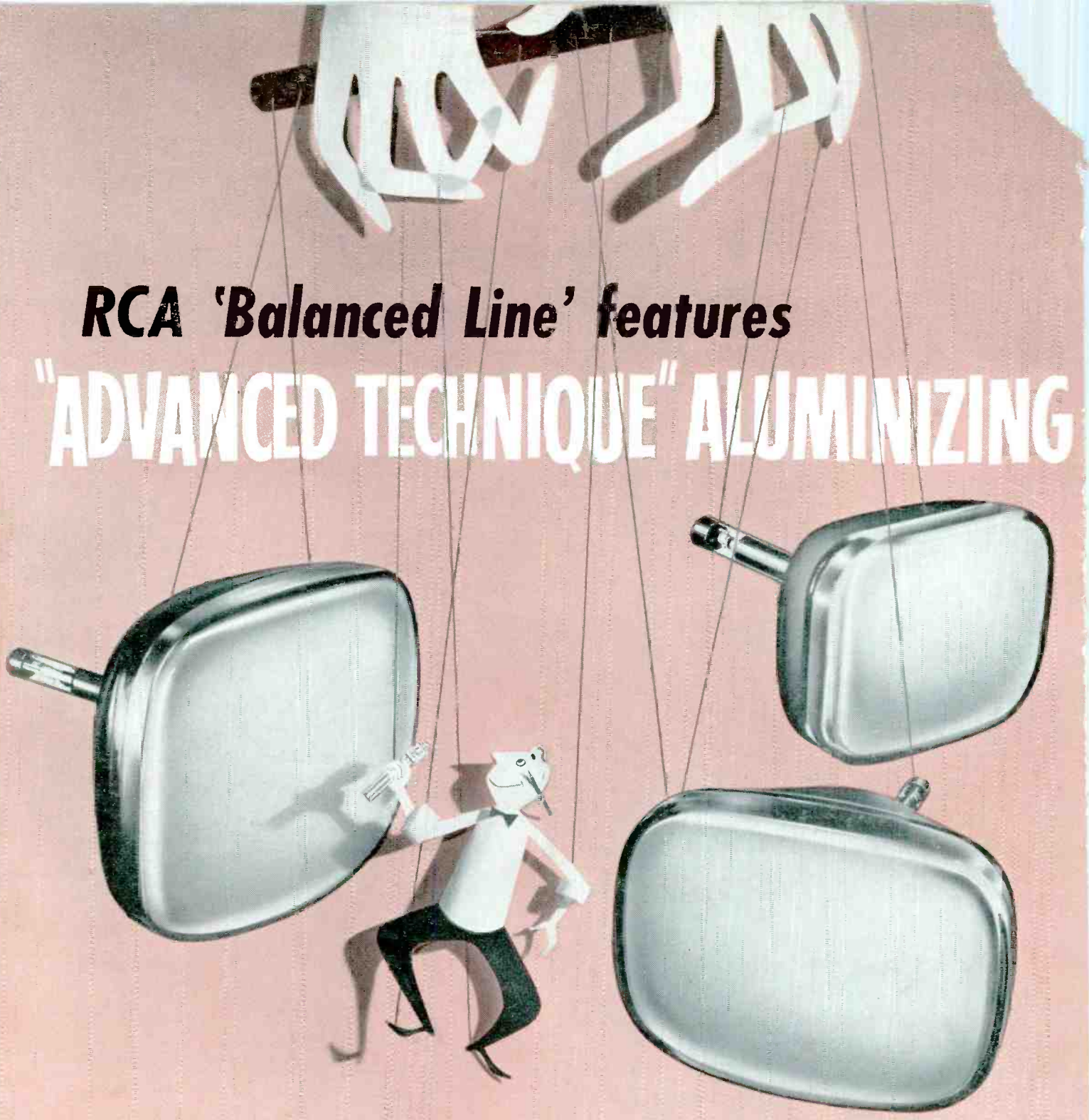
Model 9929—Self-shielded core magnet mechanism of high flux density. Designed for operating pointers with high moments of inertia. Total deflection up to 120 degrees available. Also available in miniature size (Model 9892).

**These Models useful as sensitive, self-shielded galvanometers.*

WESTON Instruments

RCA 'Balanced Line' features

"ADVANCED TECHNIQUE" ALUMINIZING



NEW 24-INCH Aluminized Picture Tubes—RCA-24CP4-A, RCA-24DP4-A, and RCA-24YP4—round out the RCA 'Balanced Line' for the new look in *your* receiver line.

These new tubes bring you the advantages of RCA "Advanced Technique" Aluminizing—an example of the forward thinking, planning, and engineering that make RCA Tubes famous for quality.

See for yourself how RCA top-quality aluminized picture tubes emphasize clarity and sharp detail in your new set designs. See your RCA Field Representative for your needs.

For technical data, write RCA, Commercial Engineering, Section E19Q Harrison, N. J.

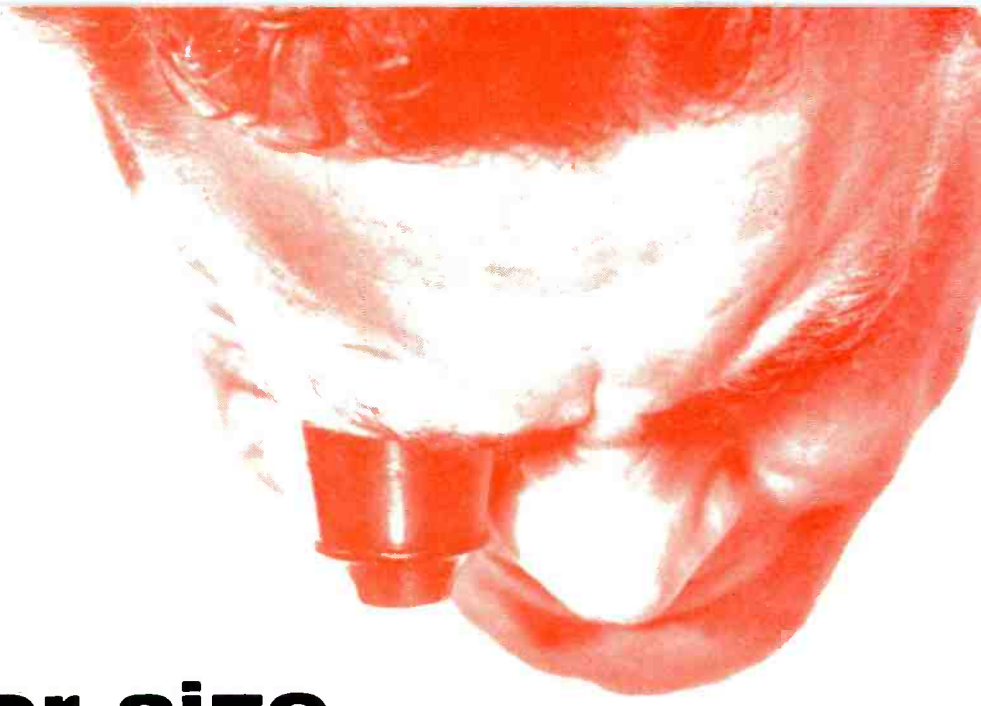
RCA "Advanced Technique" Aluminized Picture Tubes

type	diagonal deflection angle	focus
21ALP4-A	90	E
21AMP4-A	90	M
21ATP4	90	E
21AVP4-A/21AUP4-A	72	E
21AWP4	72	M
21YP4-A	70	E
21ZP4-B	70	M
24CP4-A	90	M
24DP4-A	90	E
24YP4	90	E

E = low-voltage electrostatic M = magnetic

RADIO CORPORATION of AMERICA

ELECTRON TUBES HARRISON, N.J.



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For guided missiles, airborne equipment, portable and mobile ground equipment

Miniature Ceramic Switch... Series M

In these and related fields, where lack of space is the problem, manufacturers have turned to miniaturization. Daven's **new ceramic switch** occupies a panel area of **less** than 1½ square inches—incorporates features that ensure long life and trouble-free operation.

Despite its small size, this switch is extremely rugged and has been designed to withstand all types of field service. Coin silver contacts, rotors and slip rings are provided for low and uniform contact resistance and excellent electrical characteristics. Ceramic parts are silicone impregnated to function under extreme humidity. Sturdy solder terminals are supplied for wiring.

Single pole style has 18 shorting type contact positions available. 2 or 3 pole types may also be obtained. Several sections may be "ganged" by adding supplementary wafers. Flash-over voltage at 60 cycles is 1000 volts peak . . . current carrying capacity is 2 amperes.

This sturdy, high-quality switch is precision produced . . . will give years of service in fine commercial and military equipment. DAVEN's expert engineering staff is at your service for help with special problems or orders to your specifications. Write today for further information.

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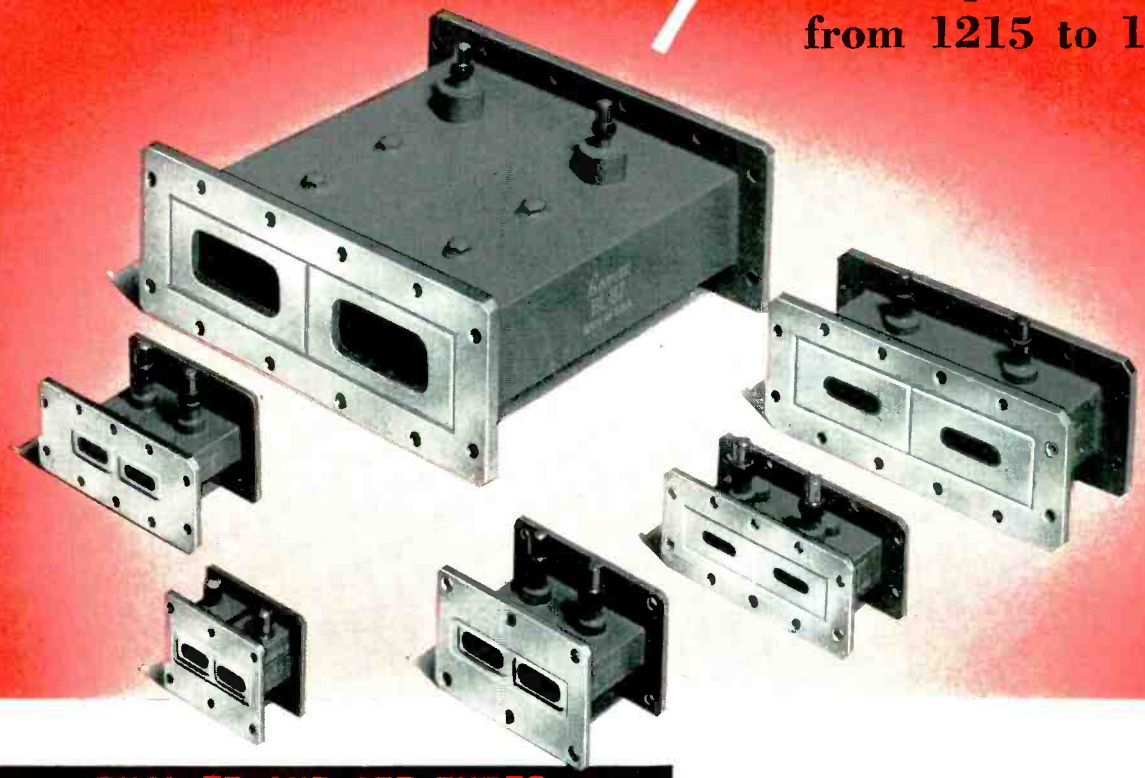
NOW... Bomac

dual TR MICROWAVE tubes covering the frequencies from 1215 to 17,000 mc.



PAT. APPLIED FOR

DUAL TR AND ATR TUBES

Band	Frequency	Center Frequency	Power Level (KW Max.)	Type	Description	Tube Designation
L	1215-1355	1285	2000	TR	Dual, Band Pass	6634/BL90
S	2600-3000	2800	750	TR	Dual, Band Pass	6636/BL87
S	2650-2950	2800	750	ATR	Dual	BL92
C	5400-5900	5650	700	TR	Dual 5865	6640/BL60
C	5400-5900	5650	3000	TR	Dual 6568, Band Pass	BL613
C	5400-5900	5640	300	ATR	Dual, Fixed-Tuned, Contact Mount	BL63
X	8490-9578	9000	200	TR	Dual 1B63A	6334/BL27
X	8490-9578	9000	200	TR	6334 tapped Flanges Both Ends	BL78
X	8490-9578	9000	200	TR	6334 plus Separate Channel 1B63A	BL81
X	8490-9578	9000	200	TR	6334 with Recovery Time 1 μsec at 1 db	6643/BL84
X	8490-9578	9000	200	TR	BL84 with Heater	BL84H
X	8490-9578	9000	200	TR	6334 with Large X Flange Input and Small X Flange Output	6642/BL600
X	8490-9578	9000	200	TR	Dual 1B63A, 2 μsec Recovery Time	6646/BL604
X	8490-9578	9000	200	TR	BL604 with Heater	6647/BL604H
X	8490-9578	9000	200	TR	6334 with Special Hole Dimensions for Aluminum Flanges	BL607
X	8490-9578	9000	200	TR	6334 with Special Saddle Type Flange	6648/BL615
X	8500-9600	9050	250	TR	Large X Guide	6501
X	8500-9600	9050	250	TR	Four-Element Tube for Large X Guide	6564/BL71
X	8490-9578	9000	250	—	Integral 6334 Hybrid Duplexer	BL507
Ku	15000-17000	16000	100	TR	Dual, Band Pass	6560/BL35

Unlimited design possibilities are now afforded the systems engineers with Bomac's complete line of dual TR tubes.

Bomac dual tubes are designed for use with suitable short-slot hybrid junctions to provide balanced duplexers of utmost simplicity.

In operation, the balanced duplexer is similar to magic-T or rat race duplexers. The very low coupling between the transmitter and antenna eliminates the necessity of employing one or more ATR tubes and reduces the losses introduced in radar systems by these tubes. The features of compactness, weight and excellent performance with respect to both transmission and reception characteristics offered by these dual tubes hold many advantages for microwave systems designers and engineers.

Bomac offers a complete line of hybrids to be used in conjunction with these dual tubes — the tubes can be supplied with integral shutters, offering continuous crystal protection.

We invite your inquiries regarding
- ENGINEERING
- DEVELOPMENT
- PRODUCTION

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NEW Tektronix Portable Oscilloscope

gives you Laboratory Performance ...in the FIELD!

The Tektronix Type 310 is fully capable of performing much of your laboratory work, yet has the physical characteristics desirable for work away from your bench. It handles easily and fits into tight spots, simplifying field maintenance of complex electronic equipment. The high performance of the Type 310 can help you speed up your field work... its low weight and small size can ease your equipment handling problem.

Complete accessibility to tubes and components is maintained by a unique step-chassis construction, hinged at the rear. Accurate calibration and excellent linearity permit reliable quantitative measurements—you read time and amplitude directly from the screen. Functional panel design and versatile control system contribute to operator convenience, making this new oscilloscope an easy-to-use field and lab instrument.

IN THE FIELD

IN THE LAB

TYPE 310 CHARACTERISTICS

Portability
Overall dimensions—6¾" wide, 10" high, 17" deep.
Weight—only 23½" pounds.

Transient Response
Risetime—0.09 μsec.

Sensitivity
DC to 4 mc—0.1 v/div to 50 v/div in 9 calibrated steps, 0.1 v/div to 150 v/div continuously variable. AC-Coupled—3 db down at 2 cycles. AC-Coupled only, 2 cycles to 3.5 mc—0.01 v/div to 0.1 v/div in 3 calibrated steps.

Versatile Triggering
Internal, external, line... ac- or dc-coupled, and AUTOMATIC TRIGGERING.

Flat-faced CRT
3WP with 1.8-kv accelerating potential. Edge-lighted graticule with ¼" divisions.

Wide Sweep Range
0.5 μsec/div to 0.6 sec/div, continuously variable. 18 calibrated sweeps from 0.5 μsec/div to 0.2 sec/div. Accurate 5-x magnifier extends calibrated sweep range to 0.1 μsec/div.

Horizontal Input
Sensitivity—1.2 v/div.

Voltage Calibrator
Square wave, approximately 1 kc—0.05 v to 100 v in 11 steps.

Jewel Warning Light
Indicates when controls are at non-calibrated settings.

Power Requirements
105 to 125 v, 60 to 800 cycles, 175 watts.

DC-Coupled Unblanking

All DC Voltages Electronically Regulated

Type 310 Cathode-Ray Oscilloscope—$595
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Tektronix, Inc.

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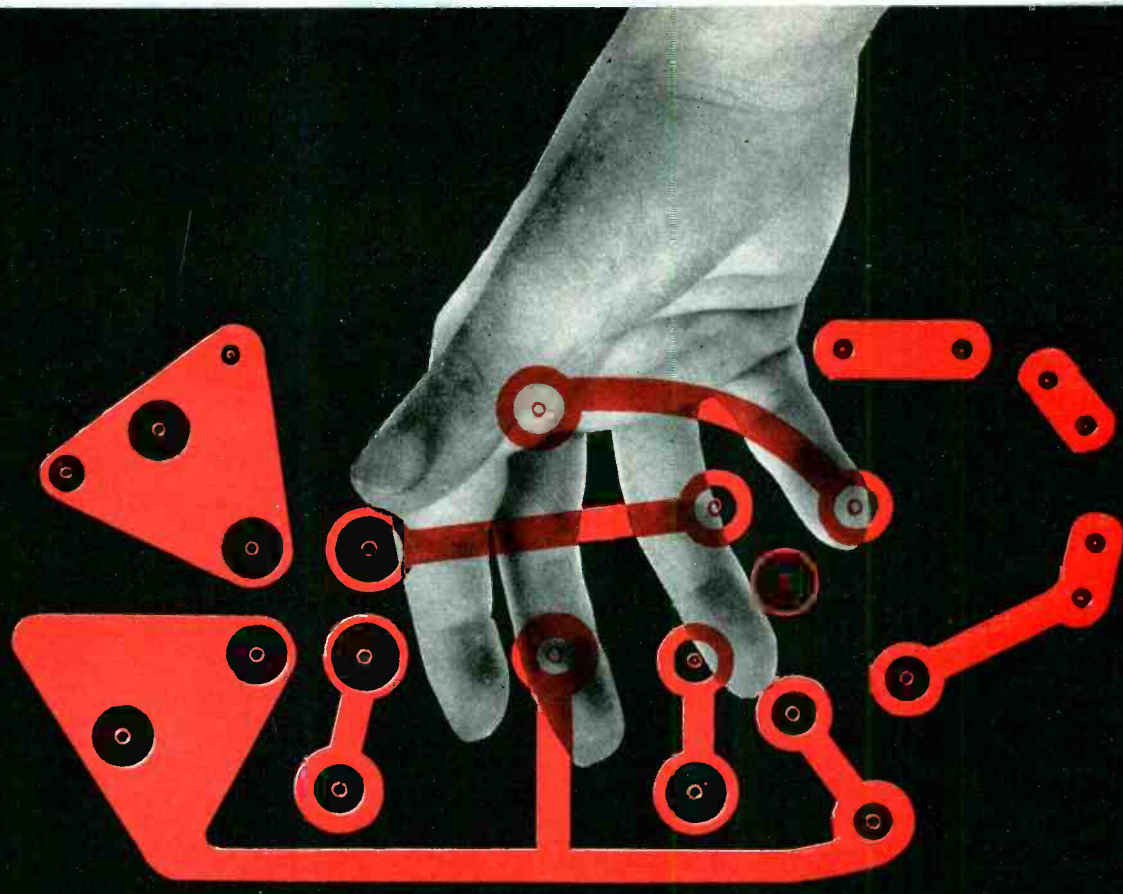

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Plants in South Plainfield, N. J.; New Bedford, Worcester and Cambridge, Mass.;
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THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

GENERAL ELECTRIC ANNOUNCES

Vac-u-Sel RECTIFIERS

New Line of G-E Component Rectifiers Achieves 3 Performance Highs

- **63 VOLT PEAK INVERSE**
- **130 C AMBIENT OPERATION**
- **60,000 HOUR LIFE EXPECTANCY**

General Electric's new line of Vac-u-Sel Component rectifiers offer greater application flexibility than any other rectifiers in history. You can now obtain a rectifier cell with a peak inverse rating of 63 volts, or a rectifier which will operate up to 130 C ambient temperature, or a rectifier which has a life expectancy of 60,000 hours.

New G-E Vac-u-Sel rectifiers now make it possible to match performance requirements for life expectancy, ambient operating temperature, and atmospheric protection, as well as electrical characteristics.

THREE NEW RECTIFIER CELLS make up the new line of Vac-u-Sel rectifiers; a 26-volt low temperature cell, a 26-volt high temperature cell, and a 45-volt high temperature cell. All three are produced by the vacuum evaporation process described at the right, but special variations in the manufacturing give them distinctly different electrical characteristics.

26-VOLT LOW TEMPERATURE CELL is the standard industrial cell, used on applications where ambient operating temperature will not exceed 55 C. Rectifiers using this cell have a life expectancy of 60,000 hours at normal current rating.

26-VOLT HIGH TEMPERATURE CELL can meet operating requirements up to 130 C at full voltage. Current need not be derated where shorter life is acceptable. Life expectancy at 130 C is 1000 hours.

45-VOLT HIGH TEMPERATURE CELL has a 63-volt peak inverse voltage. Unlike most 45-volt rectifiers, this is a true, long-life industrial cell. Frequently this rectifier may be substituted for ones employing 26-volt cells. Since fewer cells are required, savings of up to 30% in cost, and up to 35% in the size of the stacks are possible. Life expectancy of this 45-volt cell is 40,000 hours, and the cells can be used at ambient temperatures up to 110 C.

ALL VAC-U-SEL RECTIFIERS operate with exceptionally low forward voltage drop and low reverse leakage, and their margin of superiority in these characteristics increases in service. All Vac-u-Sel rectifiers undergo extensive testing and grading, and matched cells are used in assembling stacks. A variety of finishes and mounting arrangements are available to meet virtually any requirements.

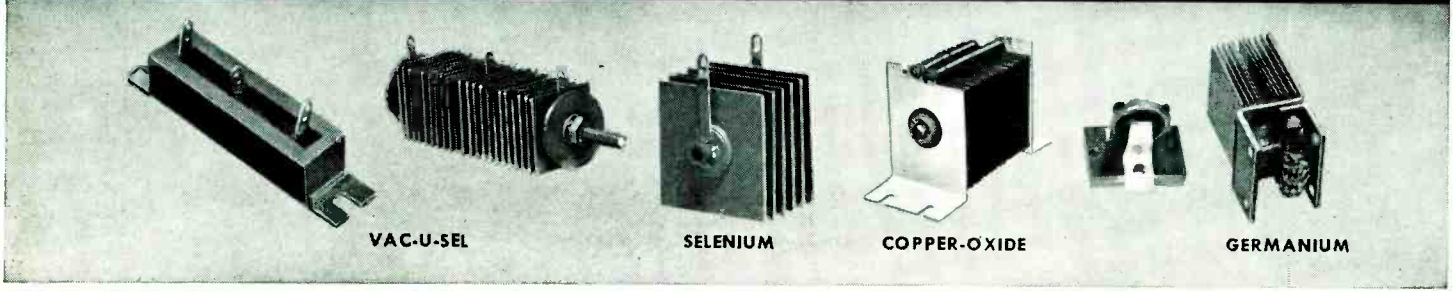
MORE INFORMATION on these new Vac-u-Sel rectifiers is available from your nearest General Electric Apparatus Sales Office, or by writing Section 461-36, General Electric Co., Schenectady 5, N. Y.

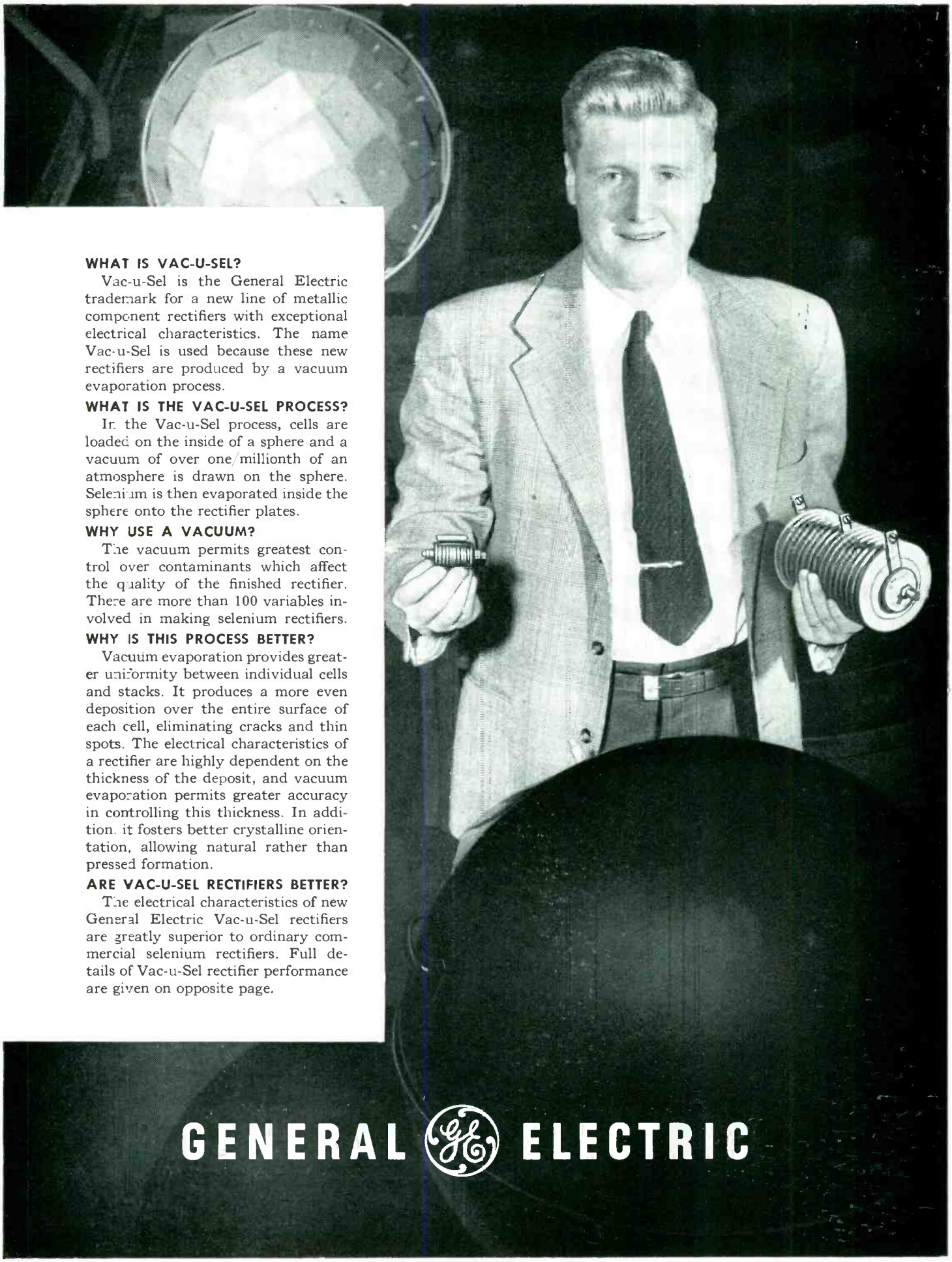
Progress Is Our Most Important Product

GENERAL ELECTRIC

RECTIFIER DEPARTMENT

METALLIC RECTIFIER COMPONENTS FOR PRACTICALLY EVERY DC REQUIREMENT





WHAT IS VAC-U-SEL?

Vac-u-Sel is the General Electric trademark for a new line of metallic component rectifiers with exceptional electrical characteristics. The name Vac-u-Sel is used because these new rectifiers are produced by a vacuum evaporation process.

WHAT IS THE VAC-U-SEL PROCESS?

In the Vac-u-Sel process, cells are loaded on the inside of a sphere and a vacuum of over one millionth of an atmosphere is drawn on the sphere. Selenium is then evaporated inside the sphere onto the rectifier plates.

WHY USE A VACUUM?

The vacuum permits greatest control over contaminants which affect the quality of the finished rectifier. There are more than 100 variables involved in making selenium rectifiers.

WHY IS THIS PROCESS BETTER?

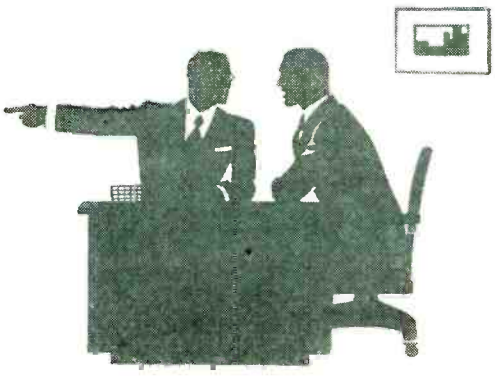
Vacuum evaporation provides greater uniformity between individual cells and stacks. It produces a more even deposition over the entire surface of each cell, eliminating cracks and thin spots. The electrical characteristics of a rectifier are highly dependent on the thickness of the deposit, and vacuum evaporation permits greater accuracy in controlling this thickness. In addition, it fosters better crystalline orientation, allowing natural rather than pressed formation.

ARE VAC-U-SEL RECTIFIERS BETTER?

The electrical characteristics of new General Electric Vac-u-Sel rectifiers are greatly superior to ordinary commercial selenium rectifiers. Full details of Vac-u-Sel rectifier performance are given on opposite page.

GENERAL ELECTRIC

YOU CAN RELY ON BUSS . .



for Fuses of Unquestioned High Quality

Here's why—Millions upon millions of BUSS fuses have given dependable electrical protection in homes, on farms and in industries over the past 40 years, thus establishing the unquestioned high quality of BUSS fuses.

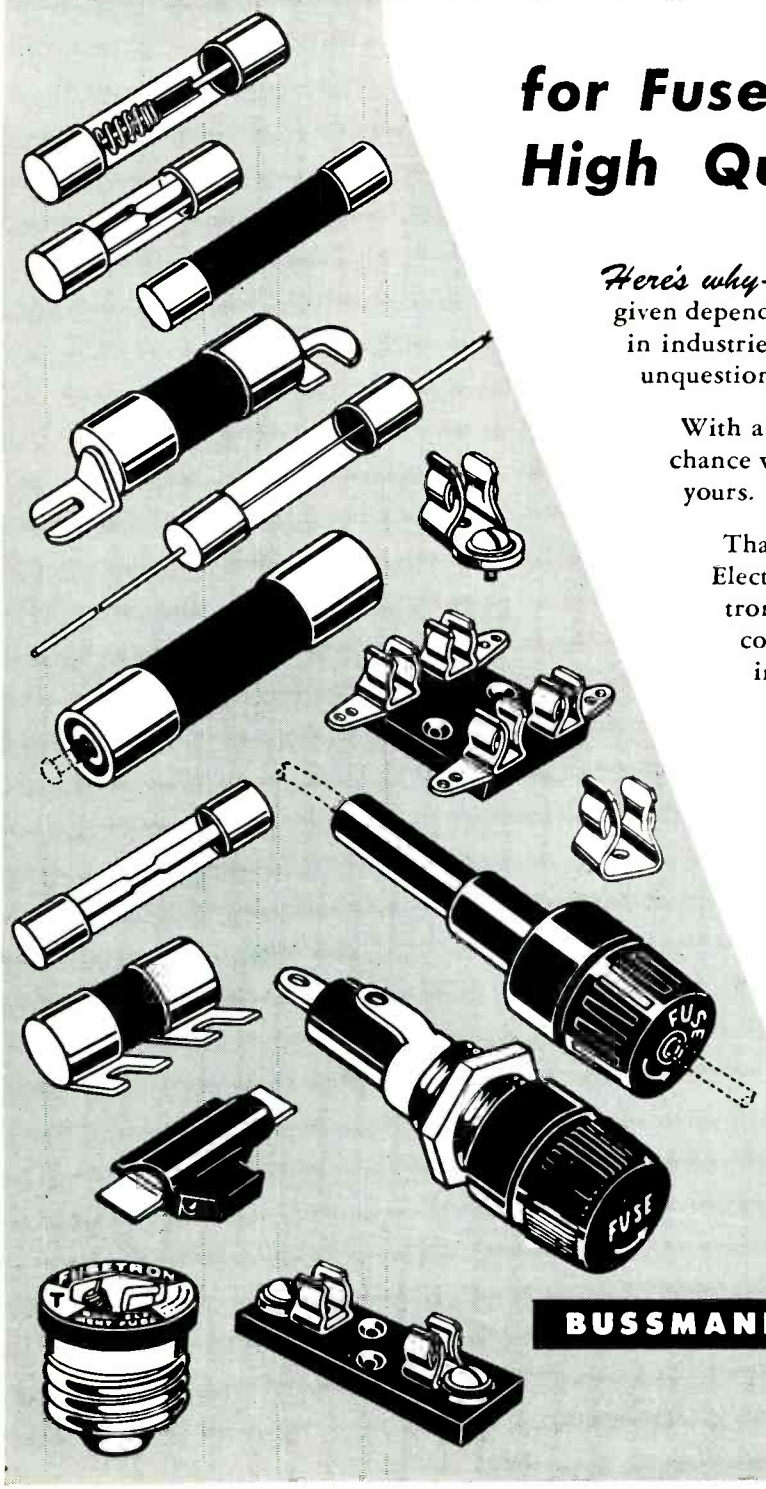
With a reputation like this, BUSS can't afford to take a chance with faulty fuses that could injure its business and yours.

That's why every BUSS fuse, normally used by the Electronic Industries, is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Fuses that give you double protection against loss of user goodwill are the result. Not only are users guarded against damaged equipment when there is trouble on the circuit, but they are also protected against irritating shutdowns caused by needless blows.

Then why not be sure your buying and stock records specify BUSS and FUSETRON fuses . . . you'll save time and trouble by using BUSS as the one source for all your fuse needs.

Makers of a complete line of fuses for home, farm, commercial, electronic and industrial use.



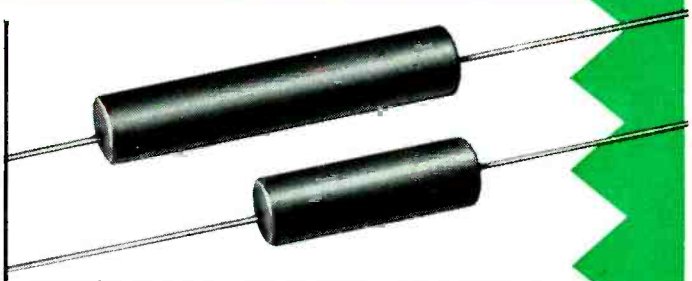
BUSSMANN MFG. CO. FUSETRON / BUSS — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — Div. of McGraw Electric Co.

ELRC 555

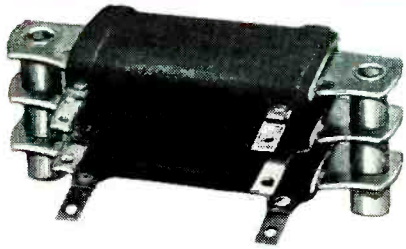
University at Jefferson, St. Louis 7, Mo.

STAND PAT WITH CLAROSTAT Wire Wound POWER RESISTORS

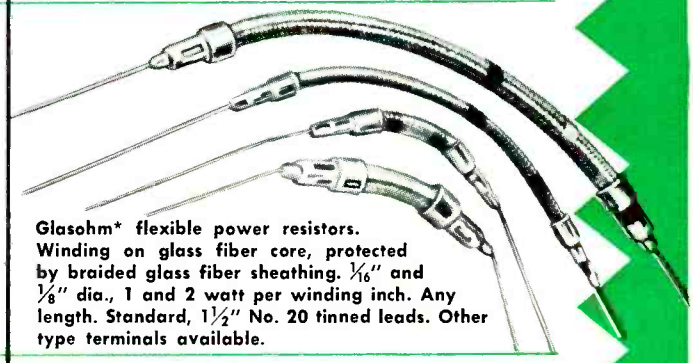
Fixed or adjustable "Greenohm" power resistors. 5 to 200 watts.



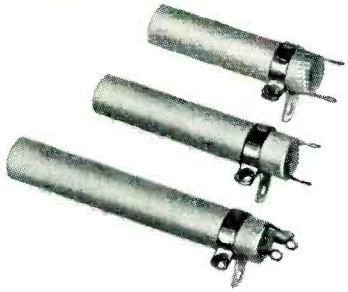
Greenohm Jr.* cement-cased tubular power resistors for point-to-point wiring. 5, 10, 14, 15 and 20 watts.



Series ZT Stack Mounting resistors, 30 to 75 watts. Approved for RW-20 through RW-24 characteristics G and J of MIL-R-26A specifications.



Glasohm* flexible power resistors. Winding on glass fiber core, protected by braided glass fiber sheathing. 1/16" and 1/8" dia., 1 and 2 watt per winding inch. Any length. Standard, 1½" No. 20 tinned leads. Other type terminals available.



Standee* power resistors. 10, 15, 20, 25 and 30 watts.

Power Resistor Decade Box.

Consider these three good reasons why your power resistor requirements are best met by specifying CLAROSTAT...

1. Adequate choice of types, wattages, resistance values, terminals, mountings. No need to improvise. No wasted time and effort trying to make the wrong thing do. Rather, you can get the correct Greenohm*, Glasohm*, Standee* or Series ZT Stack Mounting resistors **for your exact needs.**
2. And you can make sure of the exact resistance value and wattage rating by using the **Clarostat Power Resistance Decade Box.** It inserts in the actual working circuit and under actual working conditions, any resistance value from 1 ohm to 999,999 ohms, at the mere flip of knobs. When best operating conditions are attained, you read the inserted resistance value right off the six dials. No guessing. No calculating. Rather, the **correct** resistance value.
3. Install the "Greenohm" or "Glasohm" or other Clarostat power resistor. You can now "Stand Pat with Clarostat." For the millions of Clarostat resistors in daily use, month after month, year after year, in all kinds of radio-electronic and electrical assemblies, are proof sufficient that **no tougher power resistors are available today.**

WRITE **for Engineering Bulletins. Let us collaborate on your resistor problems and needs, whether standard or special.**

CLAROSTAT®

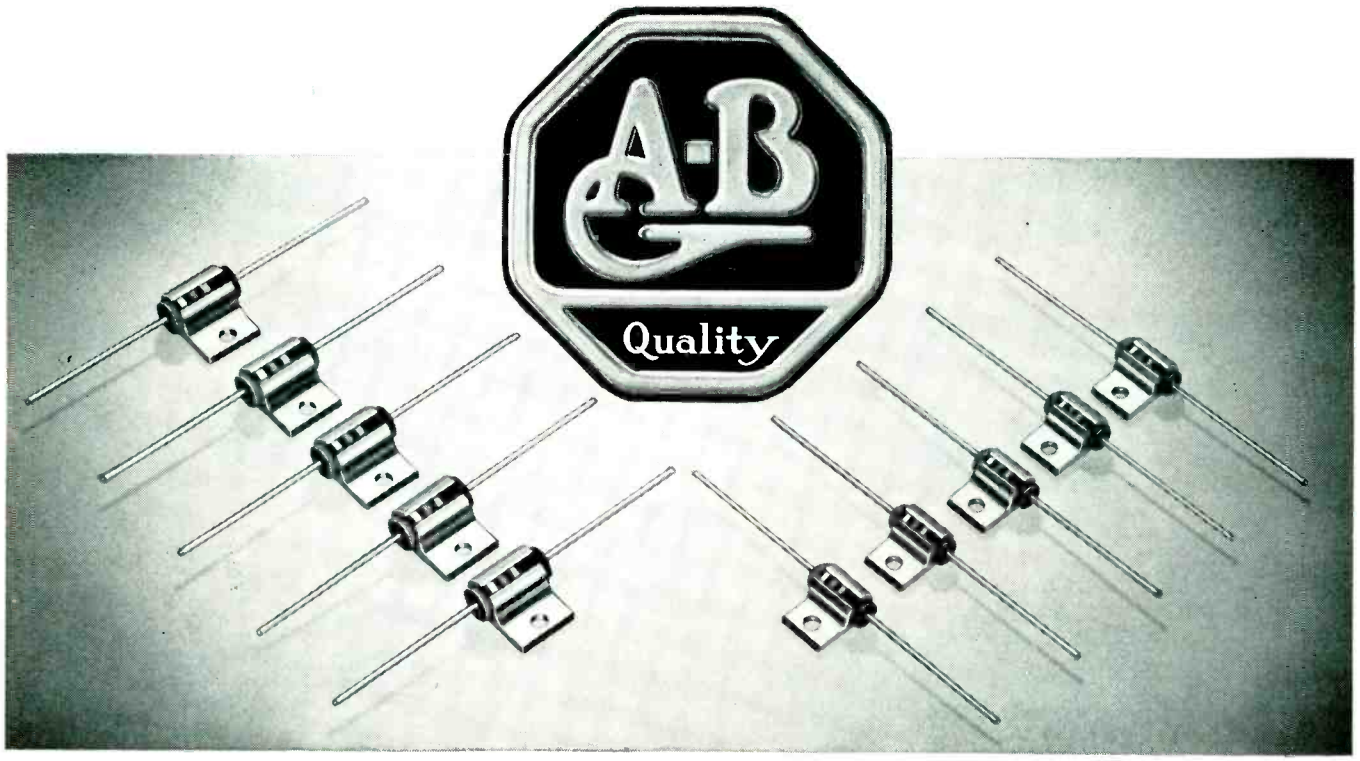
Controls and Resistors

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE

***In Canada:* Canadian Marconi Co., Ltd., Toronto 17, Ont.**

Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W. 1, Concessionaires for British Commonwealth except Canada.

*Reg. U.S. Pat. Off.



ALLEN-BRADLEY COPPER CLAD MOLDED RESISTORS

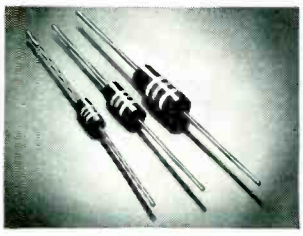
rated at 3 and 4 watts at 70C Ambient Temperature

A new and important addition to the Allen-Bradley line of radio, electronic, and television components are these Types GM and HM copper clad Bradleyunits, each fitted with a heavily tinned copper clamp. These new resistors are designed to be attached to a metal panel or chassis with rivets, bolts, or self-tapping screws. If attached to a metal panel four inches square and 0.050 in. thick at an ambient temperature of 70 C, the maximum continuous wattage rating of the Type GM Bradleyunit is 3 watts; the Type HM Bradleyunit is 4 watts. At 40 C ambient temperature, the ratings are 4 and 5 watts, respectively. However, if these copper clad Bradleyunits are suspended by their leads without being bolted to a metal panel, their respective ratings are 1 and 2 watts.

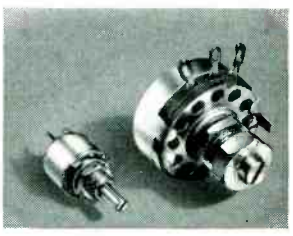
The copper clamp does not completely encircle the Bradleyunit, thus leaving a slot through which the color-code bands are plainly visible. Type GM Bradleyunits are available in all RETMA values from 2.7 to 22 megohms and Type HM Bradleyunits from 10 ohms to 22 megohms.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

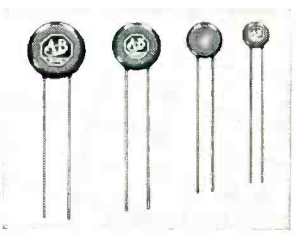
OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



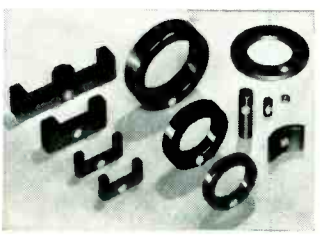
BRADLEYUNITS
½, 1, 2, 3 & 4 WATT



BRADLEYOMETERS
½ & 2 WATT



CERAMIC CAPACITORS
0.00001 to 0.022 MFD

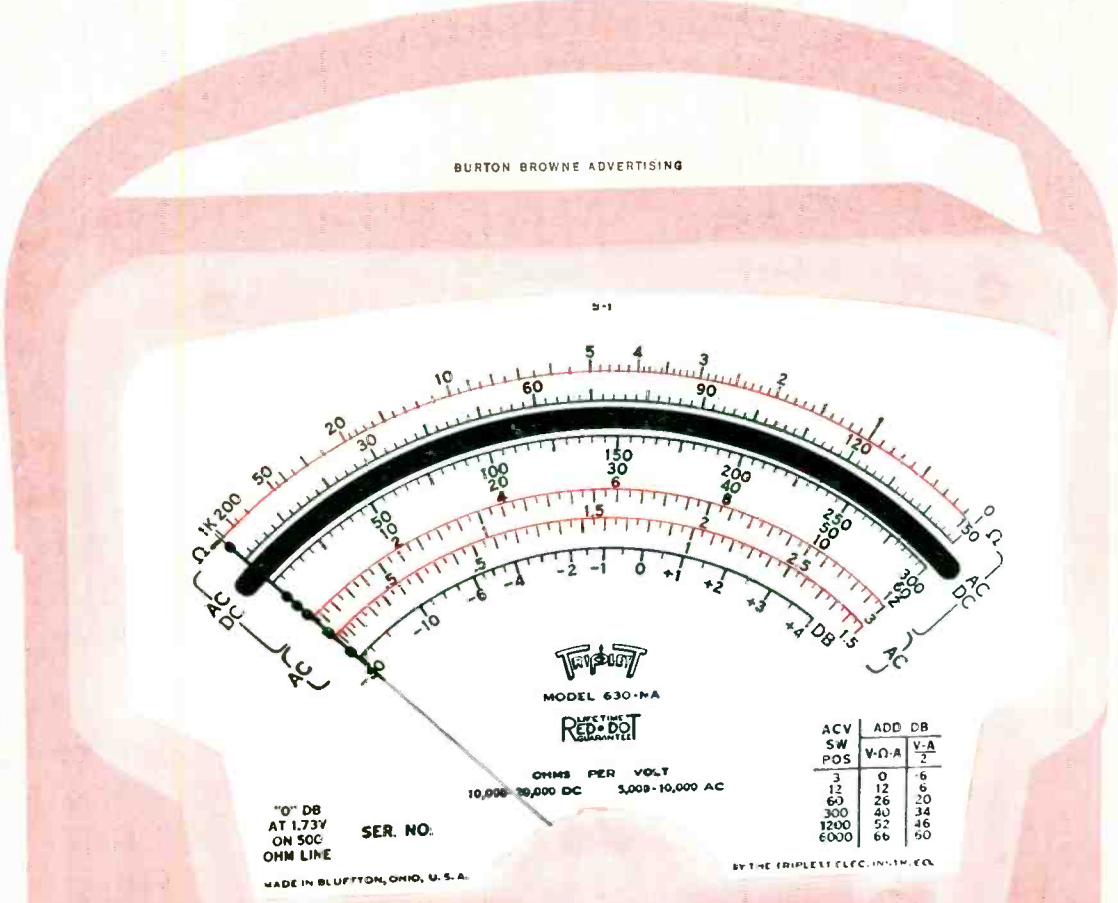


FERRITE COMPONENTS
HIGH EFFICIENCY

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

FIRST V-O-M with ALL in ONE!



actual size

70 RANGES . . . nearly double those of conventional testers
FREQUENCY COMPENSATED . . .
for accurate readings over entire audio range
HIGH AC-DC ACCURACY ON SAME SCALE
ACCURACY: 1-1/2% DC to 1200 Volts, 3% AC to 1200 Volts
METER PROTECTION AGAINST OVERLOADS
TEMPERATURE COMPENSATED . . .
Accurate within a wide range of ambient temperatures
SIX RESISTANCE RANGES Including 100 Megohms
COMPLETELY INSULATED Black Molded Case
MIRROR SCALE And Knife-Edge Pointer

ALL TRIPLETT
TESTERS APPROVED FOR COLOR
see them at your distributors

TRIPLETT HAS THE MOST COMPLETE V-O-M LINE

TRIPLETT

MODEL 630-NA
Volt-Ohm-Mil-Ammeter
DEALER Net Price . . . $69.50

MODEL 630 Famous
Volt-Ohm-Mil-Ammeter $39.50
33 ranges and many other features making this the favorite in a popular V-O-M line

MODEL 630-A Laboratory Type
Volt-Ohm-Mil-Ammeter with mirror scales, 1-1/2% DC accuracy and special 1/2% resistors for greater accuracy. Found in the best laboratories and production lines. $49.50

MODEL 631 Combination
V-O-M and VTVM $59.50
This sensational 2-in-1 battery operated combination saves you money — will do all your work easier at half the price.

MODEL 666-R Pocket size
V-O-M. Practically a portable laboratory with self contained snap-in type batteries. $26.50

The above are examples of the complete Triplett V-O-M line in which 10,000 ohms per volt AC sensitivity has been featured for 10 years.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio

TAYLOR Laminated Plastics Vulcanized Fibre

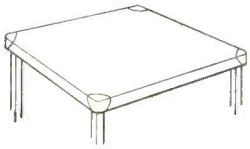
Shop Talk

TAYLOR FIBRE CO.

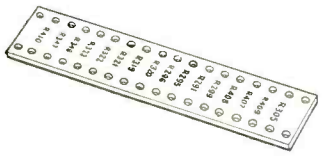
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

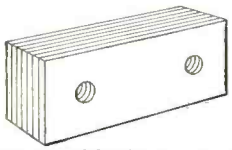
Tips for designers



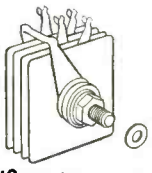
Furniture can make good use of the mar-resistant, tough surface afforded by Taylor Vulcanized Fibre plywood combination table tops.



Terminal strips for high-precision electronic instruments benefit by the excellent insulating properties of Taylor XXXP-301 hot-punch phenol laminate.



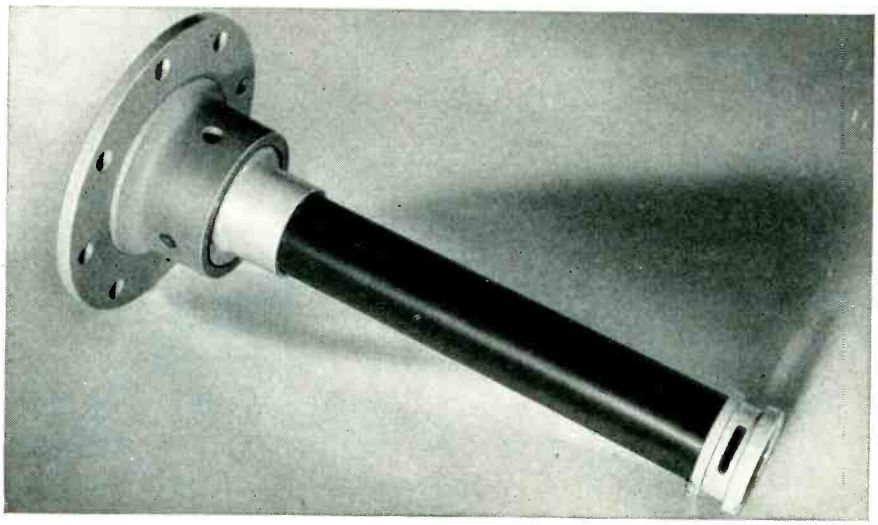
Heavy bumper blocks for steel mill use, made of Taylor Built-Up Fibre several inches thick, give long service under severe shock and abrasion.



Selenium rectifier plates are insulated by washers made of Taylor Grade 353 phenol laminate . . . chosen for its dimensional stability and mechanical strength.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



High strength, light weight, excellent insulating and corrosion-resistant qualities make Taylor Epoxy Glass Base Laminate the ideal material for tubing in an aircraft fuel gage tank unit made by Avien, Inc.

When service conditions are tough— *use Taylor special-purpose laminates*

Designing for severe service? Then take a look at what Taylor special-purpose laminates can do. Taylor's resin chemists have developed special formulations of melamine, silicone and epoxy resins . . . for combination with a variety of base materials. The result is a line of laminates which offer the plus performance that your new designs may require.

Taylor epoxy laminates. Retain superior mechanical properties after exposure to high temperatures (above 430 F) . . . have outstanding electrical characteristics, moisture resistance and resistance to corrosive chemicals . . . setting these laminates apart as a means of solving difficult design problems.

Taylor melamine laminates. Excellent resistance to arcing, electrical corona, flame and chemical attack characterizes these materials . . . useful in many electrical applications.

Taylor silicone laminates. These withstand temperatures up to 500 F . . . provide insulation where other laminates thus far cannot be used. They also possess high mechanical strength, low power factor and low moisture absorption.

Sheets, tubes and rods of these materials are available in a range of sizes that will give you maximum economy of material in your manufacturing processes.

To help you in the application of these specialized materials to your specific product, Taylor offers the service of its experienced engineering staff. Call on Taylor for a consultation on your individual requirements.

Here's the New

PHILCO

SB

(Surface Barrier)

TRANSISTOR

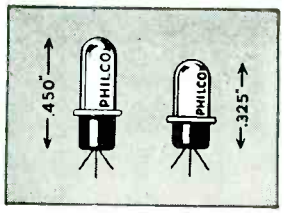
Industry's First High Frequency Transistor

...Available Now!

See Next Page For Details ▶

For the First Time...

High Frequency Circuits Can Be COMPLETELY TRANSISTORIZED



Philco SB Transistors are available in the sizes shown here—standard and miniature.

Today, Philco's new SB Transistor opens up a completely new field of commercial, industrial and military applications for the electronics design engineer. With vastly superior performance assured to 50mc and above, many basic circuits can now be *completely transistorized.* Video bandpass amplifiers, wide band low-pass amplifiers, high frequency oscillators and high speed switching are only a few of the innumerable circuits which the design engineer can produce quickly, easily, efficiently with the revolutionary new SB Transistor.

UP TO 10 TIMES BATTERY LIFE

The Philco Surface Barrier Transistor operates efficiently with power consumption of less than *one* milliwatt! This extremely low power drain results in up to *ten* times the battery life obtainable with junction transistors, vastly reducing operating costs. Hermetically sealed, the SB Transistor has greater inherent characteristics of stability, longer life and higher efficiency than any other type of transistor.

HIGHEST UNIFORMITY YET ATTAINED

Due to Philco's unique design and precision production methods, the SB Transistor reaches a degree of uniformity and unvarying quality never before achieved with transistors. This remarkable quality permits design engineers to specify the Philco SB Transistor with full assurance of superior performance.

Now being produced in quantity this new Philco SB Transistor is available for your current projects and immediate shipment can be made to you.

For complete technical information on the PHILCO SB Transistor write Dept. E

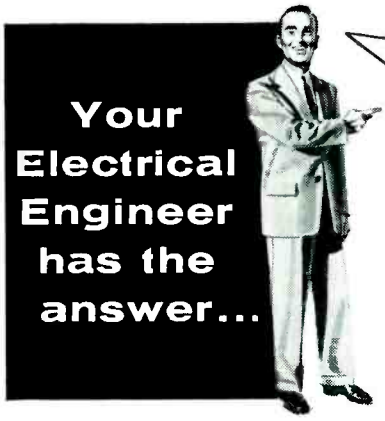
PHILCO CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA

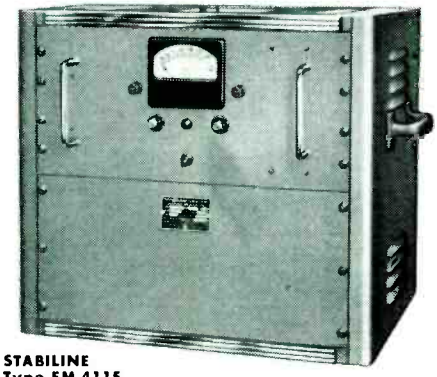
In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario

V.V.T.*

the "Phantom Saboteur" of Automation can cause 101 production troubles... rejects . . . without your knowing it!

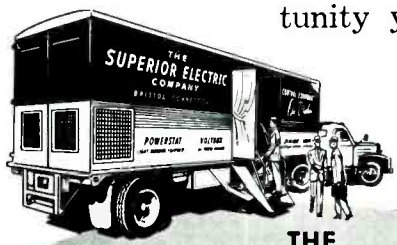


* "Varying Voltage Trouble plays hob with timers, solenoids, and electronic gear in production and inspection departments. A Stabiline Automatic Voltage Regulator prevents this 'sabotage'."



STABILINE
Type EM 4115
Superior Electric offers a complete line of automatic voltage regulators. Send for Bulletin S351.

• Automatic machines and processes . . . inspection department equipment can go "haywire" every time your voltage varies — even within so-called "allowable limits". Given the opportunity your plant Electrical Engineer can spot V.V.T. and help you cure many production headaches you now consider to be "routine trouble" that you have to live with. When he recommends a Stabiline automatic voltage regulator you can be sure *these* troubles are under control.



See Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

BRISTOL, CONNECTICUT

Manufacturers of: POWERSTAT Variable Transformers • STABILINE Automatic Voltage Regulators • VOLTBOX A-C Power Supplies LUXTROL Light Control Equipment • VARICELL D-C Power Supplies Superior 5-WAY Binding Posts

THE SUPERIOR ELECTRIC COMPANY, 205 Reynolds Ave., Bristol, Conn.

Please send me a copy of your STABILINE Bulletin S351.

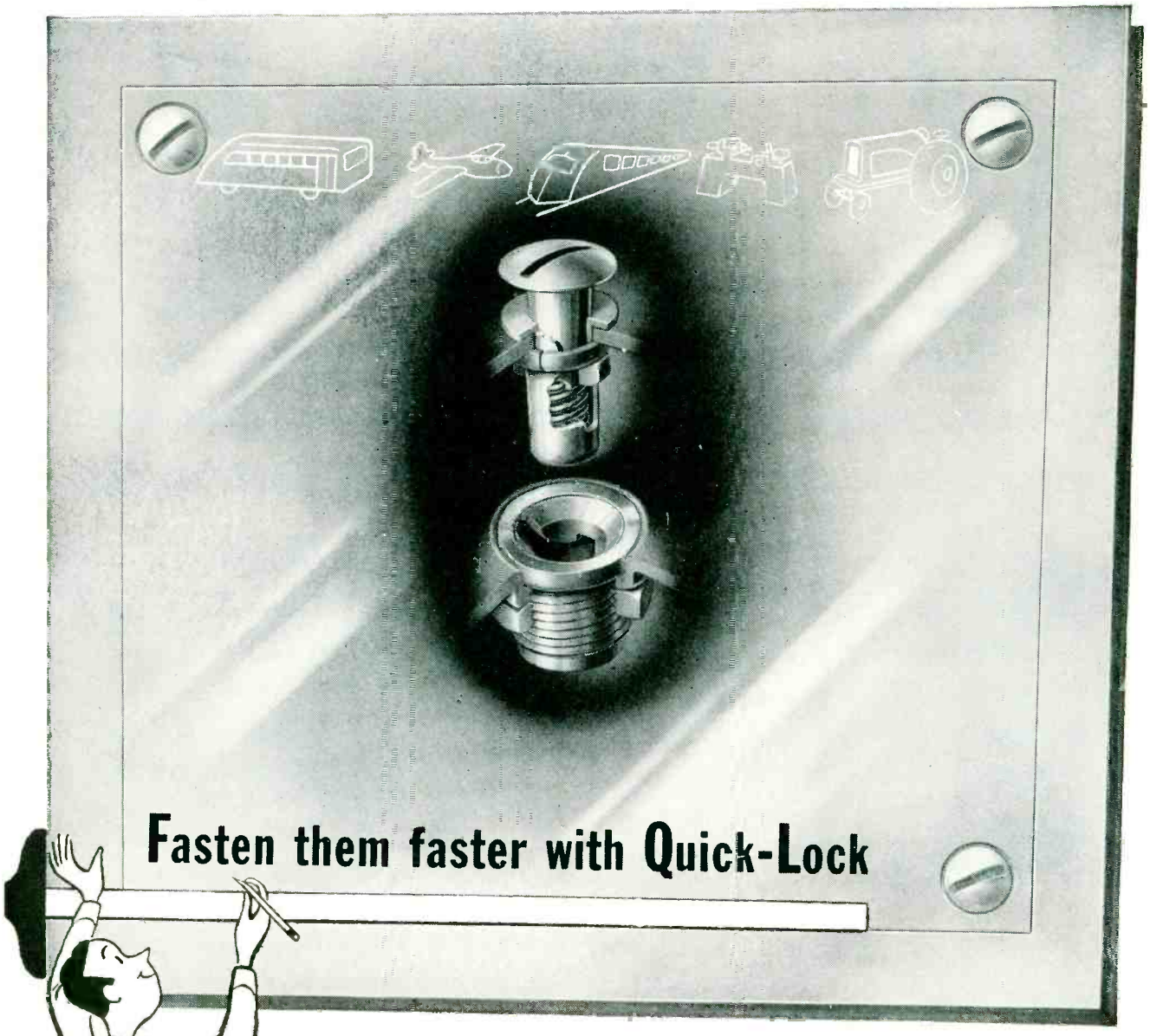
Name.....

Company Name.....

Company Address.....

City.....Zone.....State.....

Simplify Your Access Panel and Door Assemblies...



Fasten them faster with Quick-Lock

Fastening removable access doors and panels need not be a laborious and costly production or assembly operation—not if they're fastened with QUICK-LOCK.

Designed for simple installation, QUICK-LOCK requires no special tools. It speeds up mounting and demounting detachable panels with only a 90° turn required to lock and unlock it *in a jiffy*.

The flexible mounting and tapered stud makes QUICK-LOCK ideal for assembling curved sheets and insures a tight fit when locked. Stud is self-ejecting when unlocked. Minimum deflection is assured—only initial loads are carried by the helical spring. Solid supports take up increased loads.

Industrial and agricultural equipment manufacturers would do well to analyze the cost-saving features of QUICK-LOCK's simple design. A good way would be to call in a Simmons Engineer and discuss the economy of a QUICK-LOCK installation as compared to your present fastening method. Why not send for him today?

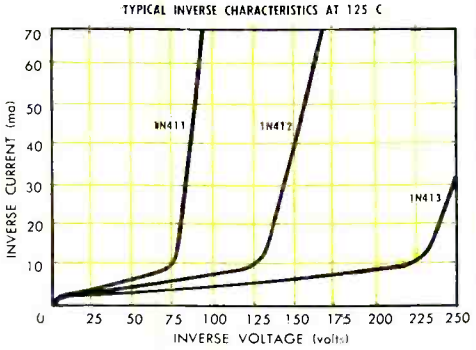
SIMMONS FASTENERS

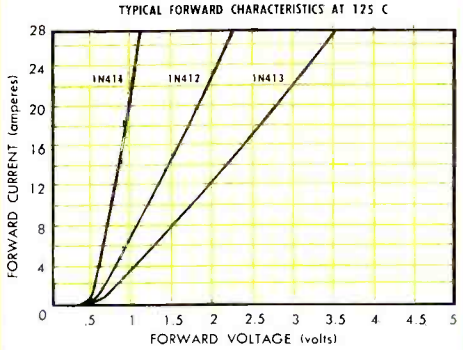
SIMMONS FASTENER CORPORATION • 1750 NORTH BROADWAY, ALBANY 1, N. Y.

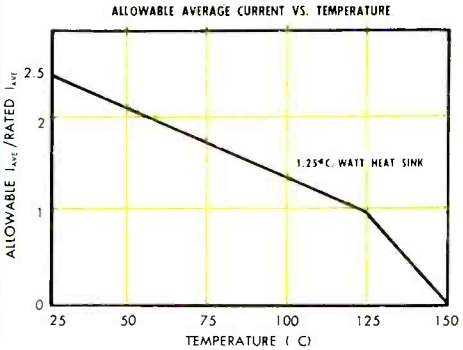
HIGH POWER SILICON RECTIFIERS

UP TO 10 AMPERES AT 125°C

ACTUAL SIZE







- **Reliability at High Temperatures**
- **High Power Handling Ability**
- **Negligible Leakage Current**
- **No Forward Aging**
- **High Conductance**
- **Miniature Size**
- **Hermetic Sealing**

Transitron's high power silicon rectifiers are designed for reliable high temperature operation in power supply and magnetic amplifier applications. Types 1N411 and 1N412 are particularly useful for 28 Volt DC supplies, while type 1N413 is designed for 130 Volt AC bridge rectifier service.

Overcoming the basic limitations of selenium, germanium and the gas-filled tube, these rugged rectifiers also offer major savings in both size and weight. Bulletin TE1321C contains detailed information.

In addition to high power types, Transitron manufactures a complete line of medium power silicon rectifiers and diodes. Write for Bulletins TE1321 and TE1322.

RATINGS AT 125°C				
TYPE	PEAK RECURRENT INVERSE VOLTAGE (VOLTS)	MAXIMUM RMS VOLTAGE (VOLTS)	MAXIMUM AVERAGE FORWARD CURRENT (AMPERES)	
			25°C*	125°C*
1N411	50	35	25	10
1N412	100	70	18	7
1N413	200	140	12	5

*Rectifier mounted in a 1.25°C/Watt heat sink.

Transitron
electronic corporation
melrose 76, massachusetts


Glass Diodes


Silicon Diodes


Germanium Diodes


Transistors


Silicon Rectifiers

Never before!

NOT 2: motor + gear train BUT ONE homogeneous unit

New Power Motor–Gear–Train

1. Unique: *Not* 2 separate units but a single entity. An entirely new principle—another OSTER "first."

2. More Versatile: Any output speed from 10,000 to .3 RPM.

3. Extremely High Torque Capacity: e.g., 100 #-in. at 523:1 and 1600 #-in. at 10,500:1.

4. Lighter-Smaller: e.g., 10-1/2 oz., 1-1/2" dia., 3-1/2" long at 523:1 ratio.

5. Available in 28 V and 115 V DC or in 28 V and 115 V 400 cycle AC

6. 1.50" dia. (Type 3094) illustrated. Variations include 1.25" dia. (Type 3101), 1.062"* dia. (Type 3200) and 1.75"* dia. (Type 2487).
*Available soon.

For a precision speed reducer with low backlash and low composite error at a moderate price specify an OSTER Power Motor-Gear-Train adapted to your individual application. Write for further information TODAY.

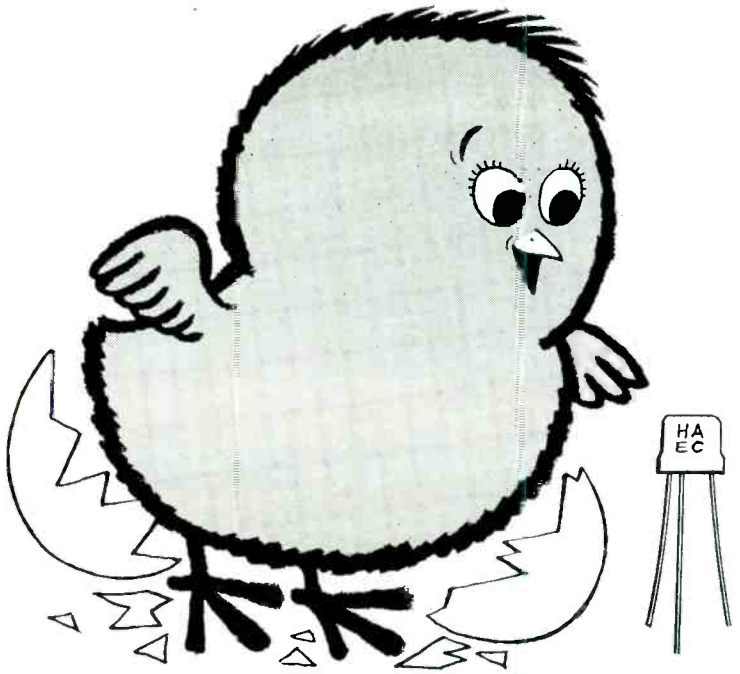
Actual Size
1.50" dia. (Type 3094)

Oster®

JOHN OSTER MANUFACTURING CO.
AVIONIC DIVISION
RACINE, WISCONSIN

Your Rotating Equipment Specialist

Other products include Actuators, AC Drive Motors, DC Motors for Special Applications, Fast Response Resolvers, Servo Torque Units, Low Inertia Servo Motors, Synchro Differentials, Two-Phase Reference Generators, Tachometer Generators and Motor Driven Blower and Fan Assemblies.



hatched by HYDRO-AIRE

a low cost H-F TRANSISTOR you can count on!

THE BONDED BARRIER TRANSISTOR

First dependable H-F Transistor for quantity production

ABSOLUTE MAXIMUM SPECIFICATIONS	Collector Voltage	−12 volts
	Collector Current	−3 ma
	Collector Dissipation	30 mw
	Ambient Temperature	55°C.

AVERAGE CHARACTERISTICS AT TEMP. 20° C., FREQ. 1 kc, COMMON BASE

Collector Voltage	−4.5 volts
Emitter Current	0.5 ma
H 11, input impedance, output short circuit	350 ohms
H 12, voltage feedback ratio, input open circuit	3.5×10^{-4}
H 21, current amplification, output short circuit	−0.75
H 22, output admittance, input open circuit	10 mu ohms
Ico, Collector Cutoff Current	−5 mu a.
Max. Power Gain, Gnd. Emitter	25 db
Freq. Cutoff	5 mc

OTHER HYDRO-AIRE FIRSTS

- Hermetic Sealing
- Transistor Socket Strips
- Packaged line of Transistorized Audio Pre-amplifiers

NOW READY FOR QUANTITY PRODUCTION AT LOW COST

We held off counting this chicken until it was well and truly hatched! And now that time has come.

The Bonded Barrier Transistor has been exhaustively tested, and found dependable in service throughout the frequency range shown at left. Not only that: the Bonded Barrier process is ideally suited for large-scale production. Hydro-Aire's Electronics Division is now completing new mass production facilities to meet the widespread demand for a transistor that offers such great potential in electronic design.

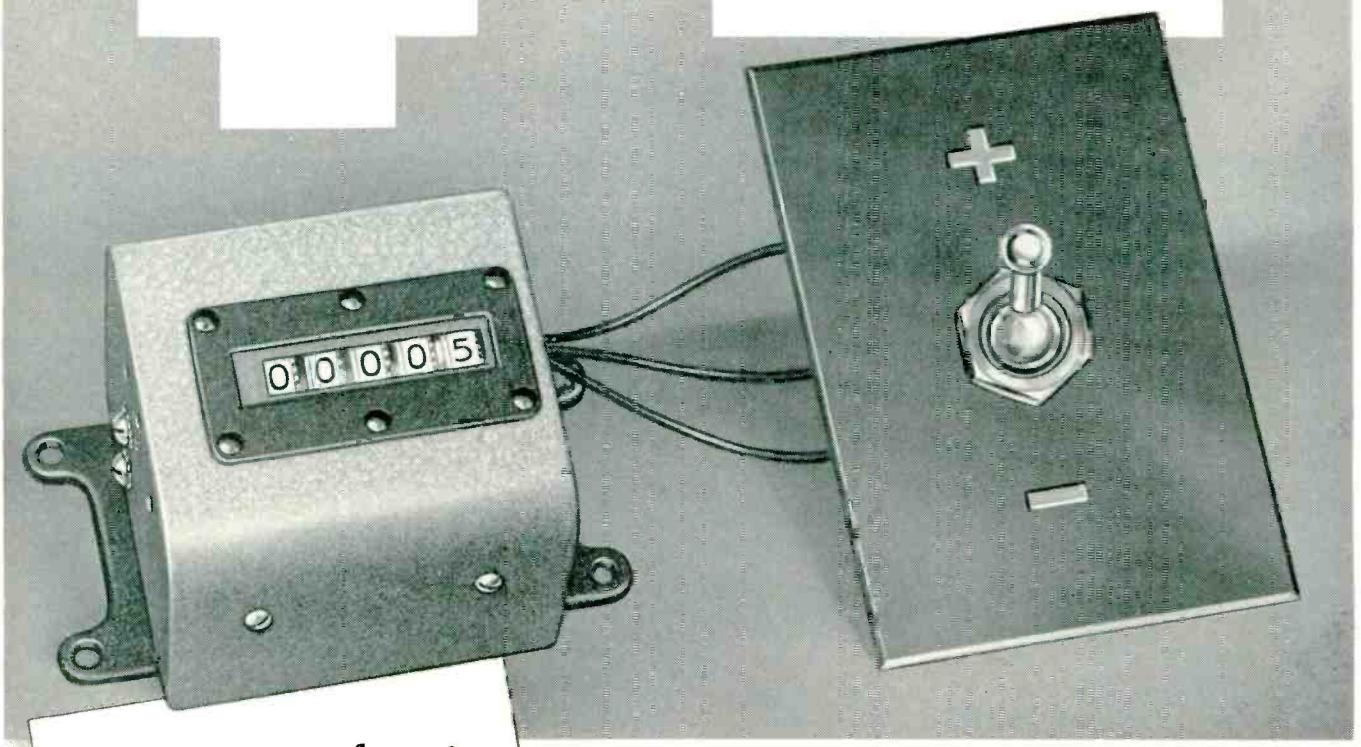
Sample quantities are already being shipped to certain users. You will appreciate that we shall have to hold to certain priorities on such a much-needed item; but we shall deal as fairly as possible with all legitimate inquiries. We can only advise you to contact us right away, so that you may be high on the list, both for test quantities now and production quantities later. Please write on your company letterhead.

ELECTRONICS *Division of* HYDRO-AIRE 3000 VINONA AVENUE, BURBANK *Inc.*

The Aviation Subsidiary of CRANE Co.

This Magnetic Counter

Adds and Subtracts



Added Evidence that —

Everyone Can Count on VEEDER-ROOT

Flip the switch up . . . the counter adds. Flip it down . . . it *subtracts*. And this 2-way countability makes this new counter a distinct asset to modern systems of automation, control engineering and stock control. Readily adaptable, easily installed and connected to existing circuits, the Veeder-Root "plus or minus" counter is a reliable double-check on the operation of machines, processes, systems. And it's just one of scores of standard and special Veeder-Root Counters for every field of reckoning from atomics to electronics to automation. What is *your* counting problem? Let's put a mathematical eye on it . . . write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

Speaking of resistor quality

. . . it is worthy of note that Stackpole Fixed Resistors are one of the most widely used brands in meeting today's exacting specifications.

Speaking of resistor supplier co-operation

. . . the Stackpole record of personal attention to detail in matching resistor requirements and of following through with "on time" deliveries of dependable, fully quality-controlled units, speaks for itself.

Electronic Components Division
STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

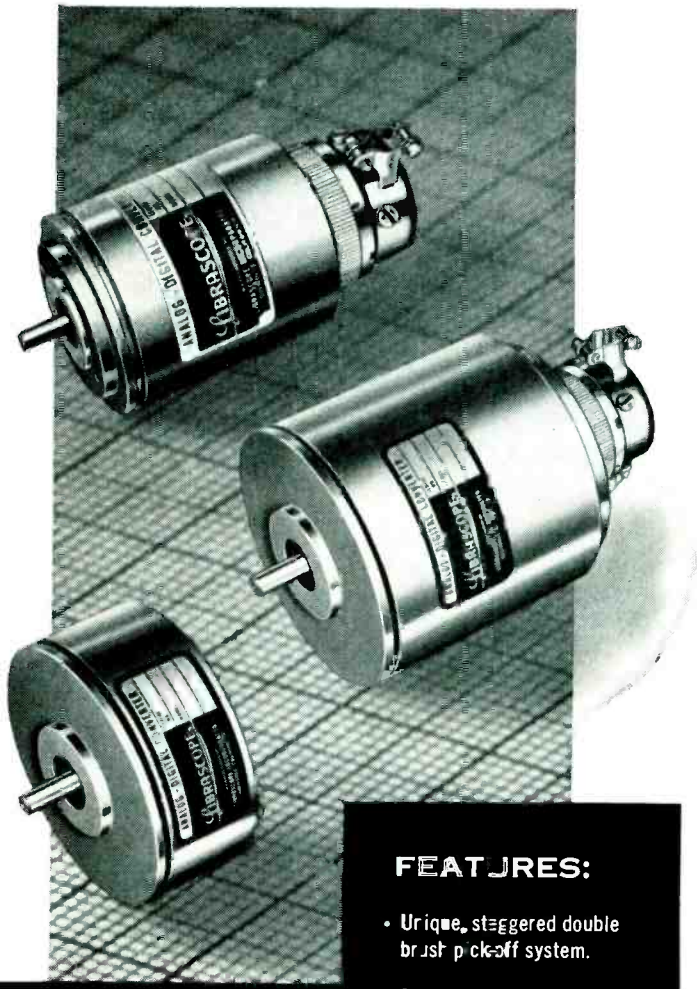
FIXED COMPOSITION

R E S I S T O R S

Backed by the keen personal interest and full co-operation of the specialists who produce them

Flexibility in Application
Versatility in design...

packaged analog-digital converters



Shaft Position to Digital Converters features reliability, long life, non-ambiguity and speed makes these converters ideal for computers or data handling systems where serial read-out is preferred. Librascope converters transmit information at almost any rate desired up to 1 mc and in some cases above, and may be multiple time-shared, holding extra circuitry to a minimum. All units quickly adjustable, syncro-mounted. Available in Binary, Gray code or Binary decimal code as shown in chart below. Special units may be designed to your order.

Write for catalog information.

FEATURES:

- Unique, staggered double brush pick-off system.
- Reads out serially into relays or single or multiple scan matrices.
- Analog-digital or digital-analog operation.
- May be time-shared.
- Syncro-mounted.
- Associated circuitry can be designed to fit your data-handling problems.

CODE	MODEL*	RESOLUTION PER INPUT SHAFT REV.	RESOLUTION OVER FULL RANGE	DIMENSIONS DIAMETER X LENGTH
BINARY	7 digit	128	1 part in 128	2" x 2 49/64"
	13 digit	128	1 part in 8192	2" x 3 19/32"
	17 digit	128	1 part in 131,072	2" x 4 15/16"
	19 digit	128	1 part in 524,288	2" x 4 15/16"
BINARY CODED DECIMAL	0-2000	200	1 part in 2000	3 1/16" x 4 17/32"
	0-3600	200	1 part in 3600	3 1/16" x 4 17/32"
	0-20,000	200	1 part in 20,000	3 1/16" x 4 17/32"
	0-36,000	200	1 part in 36,000	3 1/16" x 6 3/8"
GRAY	8	256	1 part in 256	3 1/16" x 1 1/16"

*SPECIAL UNITS AVAILABLE

Precision gearing
Shaft Speed: 120 rpm continuous
Operating temp: −55° C to +75° C
Shock and Vibration: up to 15 G, 5 to 500 cps.

Life Expectancy: Function of load current. For 13 digit unit @ 2 ma. per brush, life approx. 5×10^8 breaks or makes at approx. 120 rpm.

Engineers, physicists and mathematicians interested in challenging California careers, contact Mac McKeague, Personnel Director.

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Want more information? Use post card on last page.

Don't take gaskets for granted!

Flowed-in gaskets are cutting costs, improving results for many users!

Now electronic parts manufacturers are *flowing* gaskets into place at speeds up to 300 per minute. And they end up with a gasket that is integral with the part and custom-formulated to meet a wide range of problem conditions.

Simple Application. A uniform circular track of "Flowed-in" gasket material is deposited onto a rotating part. Baking or drying transforms the fluid into a solid rubbery gasket.

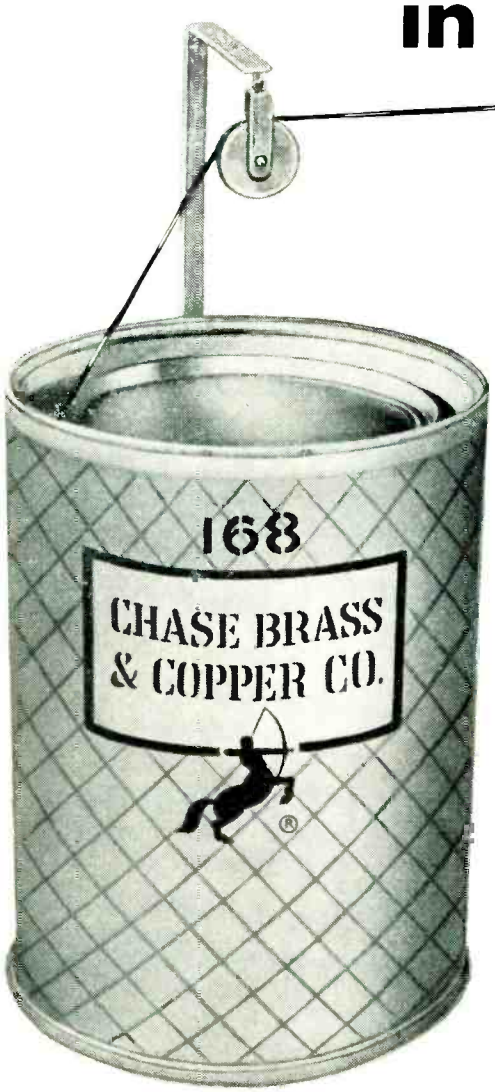
Important Economies. Gaskets are flowed in place automatically or semi-automatically, replacing costly hand operations. Minimum gasket material is needed for full sealing efficiency. Scrap material problems disappear. Inventories are reduced and simplified.

Resistance Properties. Dewey and Almy "Flowed-in" gaskets are formulated with resistance properties to meet the needs of each particular job. They are now being used to create effective seals against weather, gases, solvents, moisture, oils, hydraulic fluids, pressure . . . and to form shock-resistant cushions between component parts.

Fully Proven. The equipment which Dewey and Almy designs and builds for the "Flowed-in" gasket process is based on more than 35 years of field experience. The gasketing compounds are a result of Dewey and Almy industrial research in the chemistry of small particle dispersions . . . a continuing research program that has brought benefits to almost every industry, through such varied products as: Battery Separators • Shoe Materials • Sealing Compounds for Food Cans • Resin Adhesives • CRYOVAC Bags for Food Packaging • Soda Lime • Flowed-in Gaskets for Industry • Chemical Products for the Construction Industry • Meteorological Balloons • Print Blankets and other specialized Belting • Organic Chemicals.

DEWEY and ALMY
Chemical Company
DIVISION OF W. R. GRACE & CO.
Cambridge 40, Massachusetts

CUT Wire forming costs with CHASE® WIRE in new *Payoffpaks*!

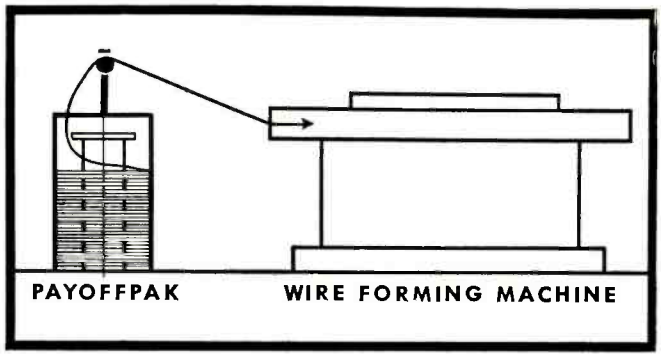


Now, in this compact, easy-to-handle PAYOFFPAK you can get a continuous length of Chase copper alloy wire weighing 400 to 500 pounds!

This new Payoffpak puts an end to frequent set-up of wire-forming machines . . . means *more* continuous, economical operation, *less* costly down time!

You'll like the easy way this Payoffpak handles, the space-saving way it stores . . . and the way it protects the shining surface of Chase copper alloy wire from rough handling in transit and storage.

Ask your Chase Wholesaler or nearest Chase Warehouse about the new Payoffpak the next time you order copper alloy wire.



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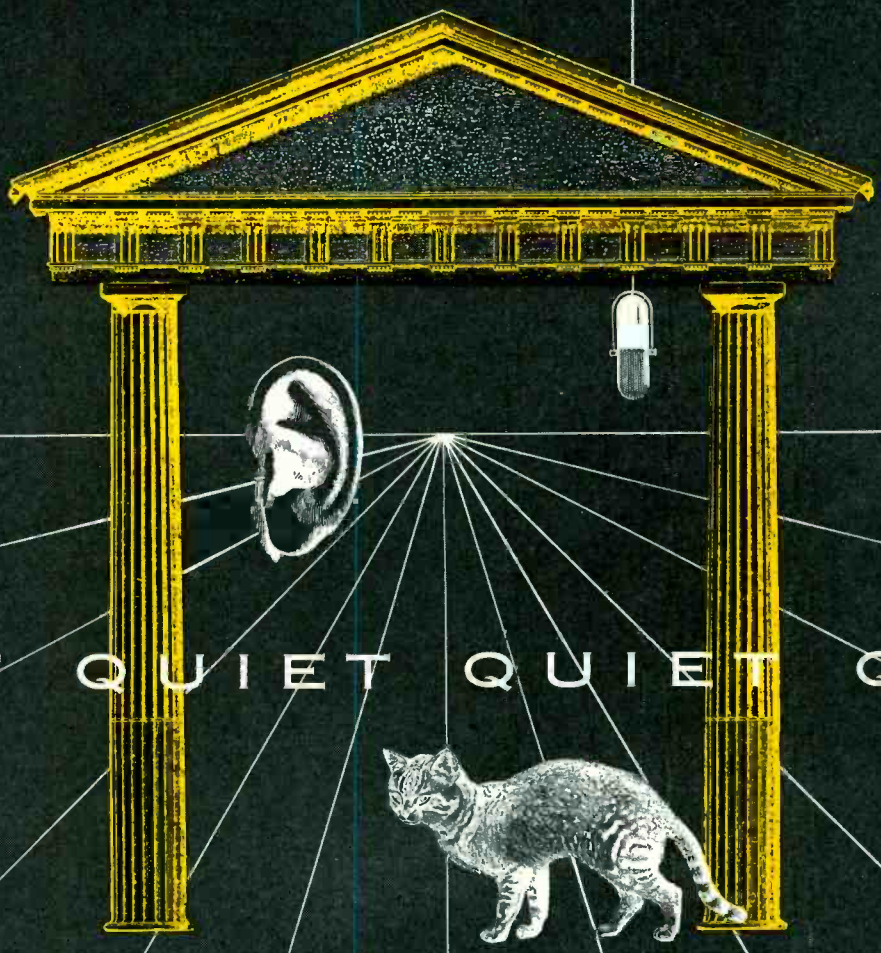
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)



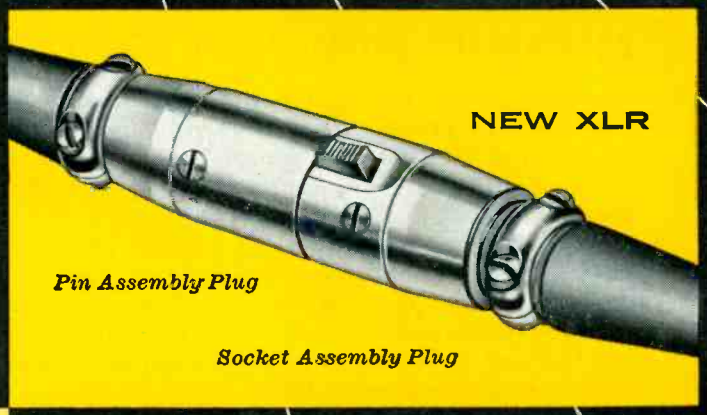
QUIET QUIET QUIET QUIET

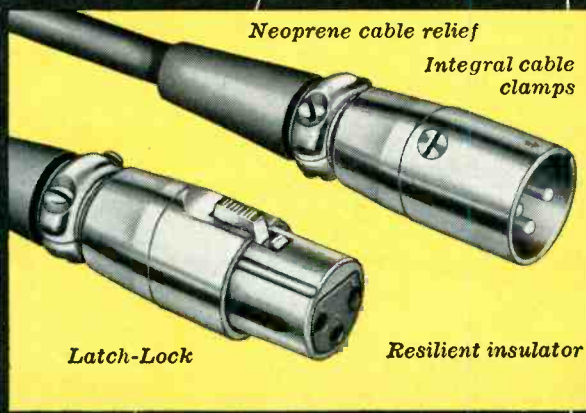
XLR is the designation of Cannon's all new audio cord connector . . . the most modern addition to the long line of distinguished Cannon Connectors featured on all top-quality microphones. It's really quiet, too!

New resilient insulator and specialized construction of socket contact assembly protects against disagreeable mechanical interference . . . noise problems encountered with many other type connectors when their cables are moved, pulled or subjected to shock.

Features streamline design, bright nickel finish, integral cable clamp, neoprene cable relief, and the time-tested Latch-Lock that Cannon pioneered on the first audio connectors. Available with three 15-amp. or four 10-amp. contacts. Available in panel receptacle type, providing same continuous characteristics.

Available from distributors everywhere, or from the factory in production quantities.





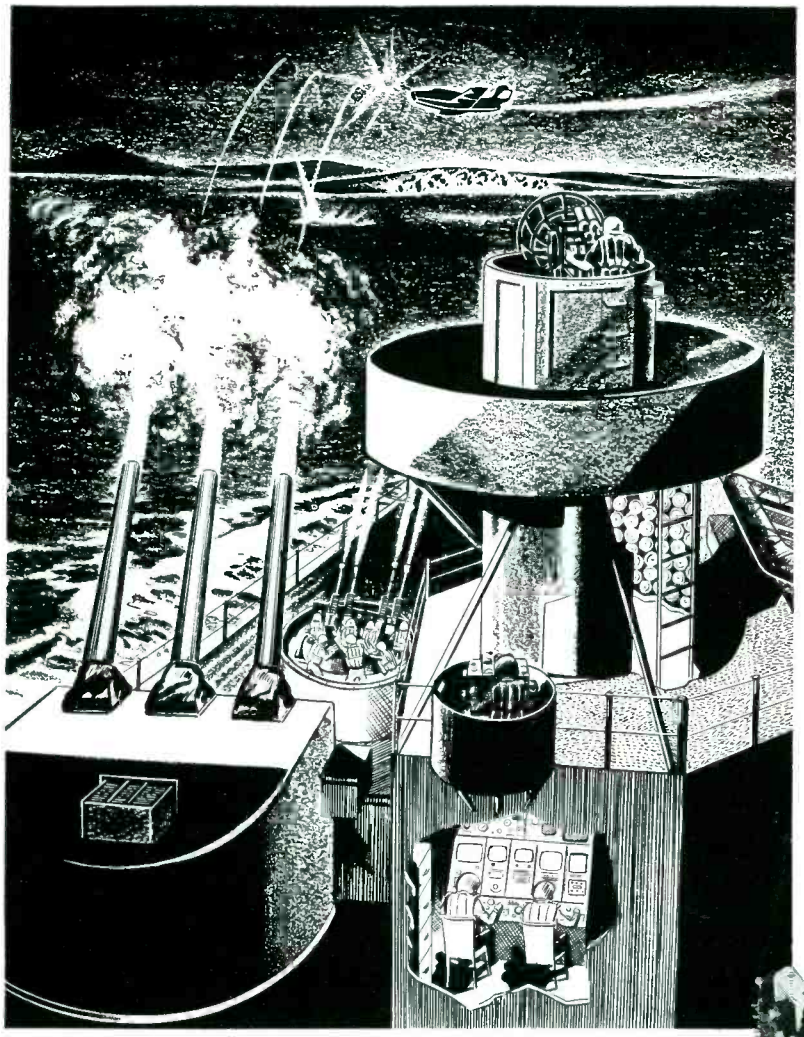
first in connectors

CANNON PLUGS

CANNON ELECTRIC COMPANY
3209 Humboldt St.,
Los Angeles 31, California

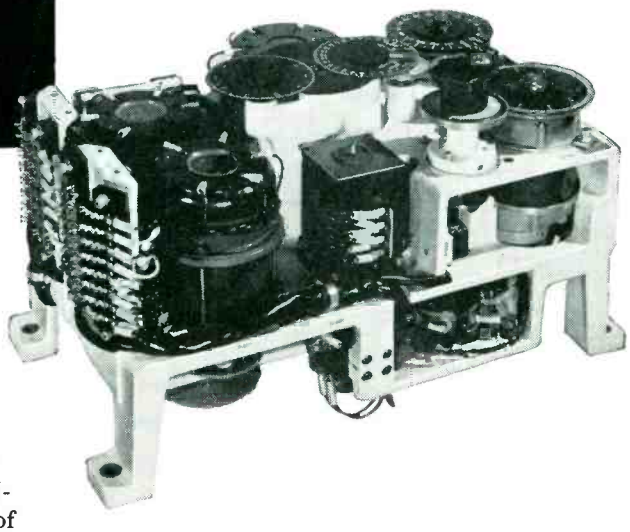
Please refer to Dept. 120

Factories in Los Angeles; East Haven; Toronto, Canada; London, England. Representatives in all principal cities. Distributors everywhere.



Atlas Built Parallax Correcter Helps Keep Guns

ON TARGET IN ANY SEA



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Computers, correcters, radar and sonar systems Atlas develops and "precisioneers" assemblies and components for all types of electro-mechanical devices. Furnishes the practical engineering step between the idea and the production line.

Atlas design, production and methods engineers, toolmakers and skilled mechanics are ready to work on your project on a *job basis* . . . as many men, machines and hours of work it requires and no more. Every up-to-the-minute cost cutting tool and technique is utilized. Atlas metallurgical and electronic technicians thoroughly test your product.

From pilot stage to production efficiency of electro-mechanical equipment the leaders rely on Atlas "creative engineering." Atlas Precision Products Co., Philadelphia 24, Pa. (Division of Prudential Industries).

Write for booklet "Precisioneering Electro-Mechanical Equipment."

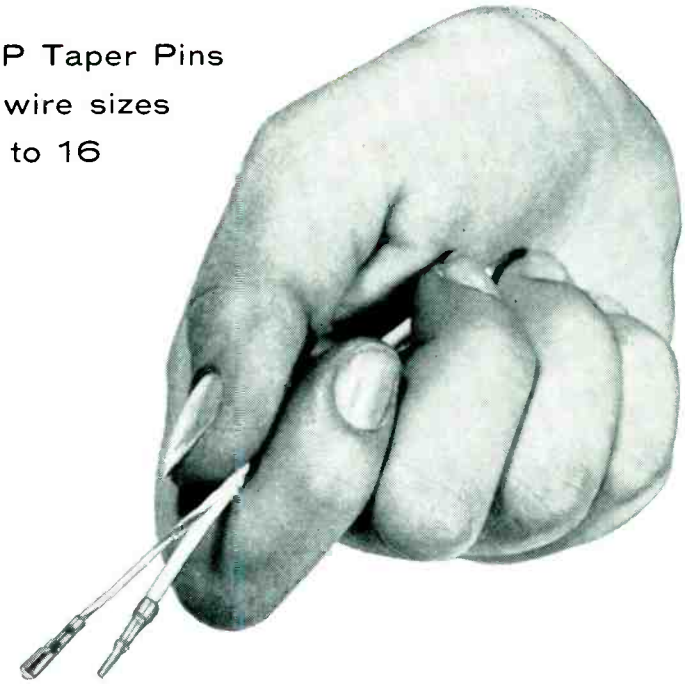
"From Drawing Board . . . to Production Line"

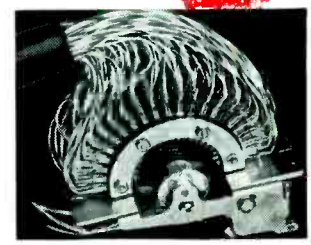
SERVICE ATLAS DEPENDABILITY QUALITY

ATLAS
Precision Products

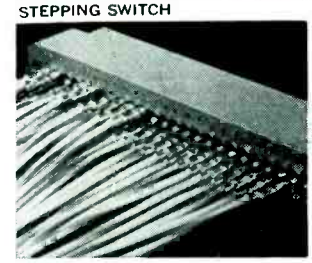
AMP Taper Tab
receptacles for wire
sizes 26 to 18

AMP Taper Pins
for wire sizes
26 to 16



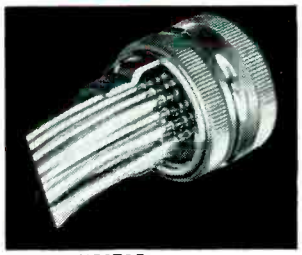


STEPPING SWITCH



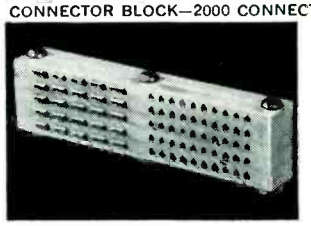
PRINTED CIRCUIT CONNECTOR

TAPER TAB RELAYS



AN CONNECTOR

CONNECTOR BLOCK—2000 CONNECTIONS



A-MP TAPER BLOK

less cube and cost

WITH ADDED RELIABILITY

Cubic restrictions have brought about a whole new concept of wire termination. The AMP Taper Technique with AMP taper pins, tab receptacles, blocks and modified miniature components will help you take full advantage of small wire, small insulation and small space for your wire terminations.

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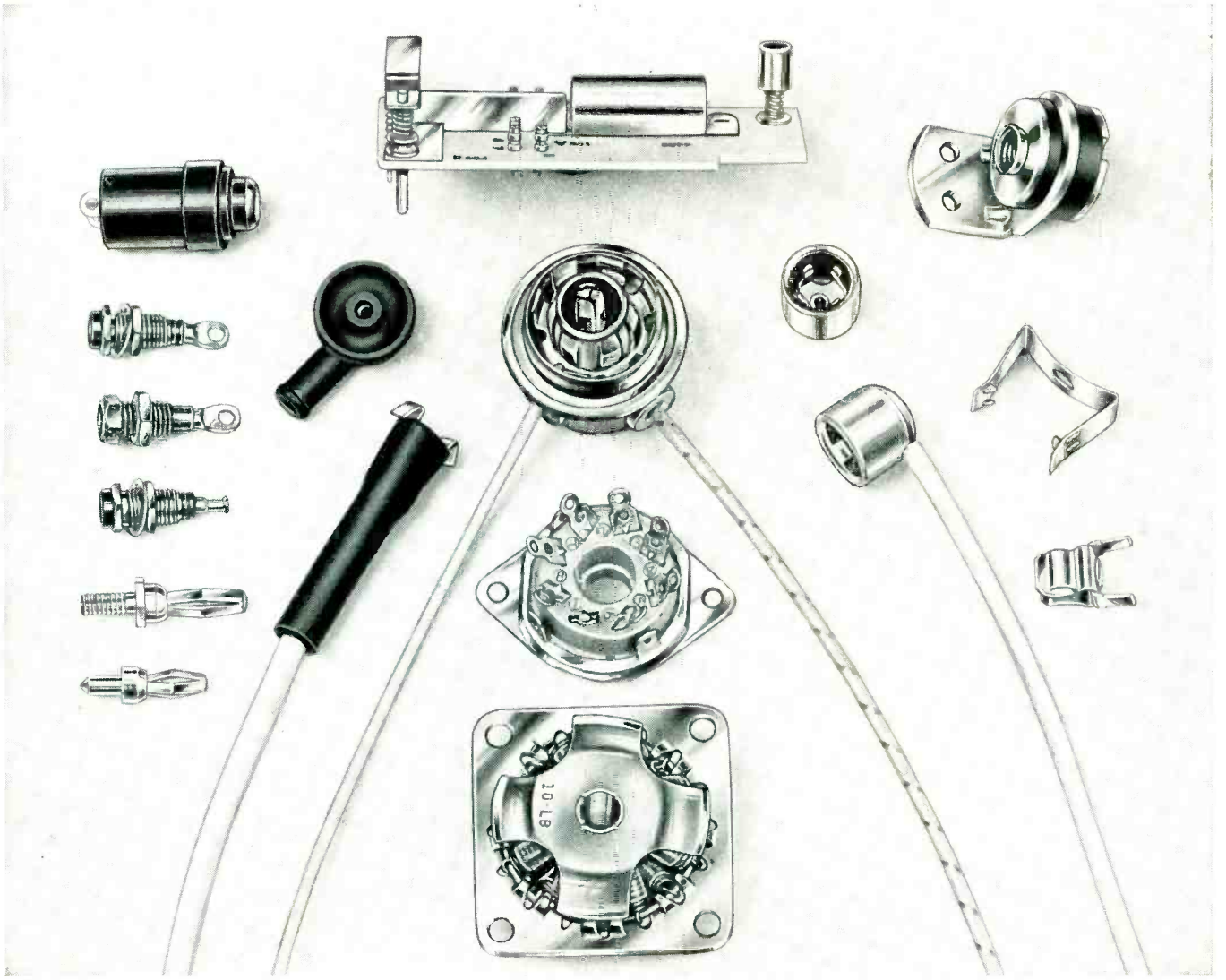

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Switches, connectors (including new clip-on type anode connectors), tube caps, shock mounts, individual stampings and moldings... these and hundreds of other specialized components and assemblies are designed and manufactured by Ucinite for use in electronic equipment of all kinds.

With an experienced staff of design engineers . . . plus complete facilities for volume production of metal parts and the assembly of metal to plastic and ceramic parts, Ucinite is capable of supplying practically any need for small electrical components. Call your nearest Ucinite or United-Carr representative for full information or write direct.

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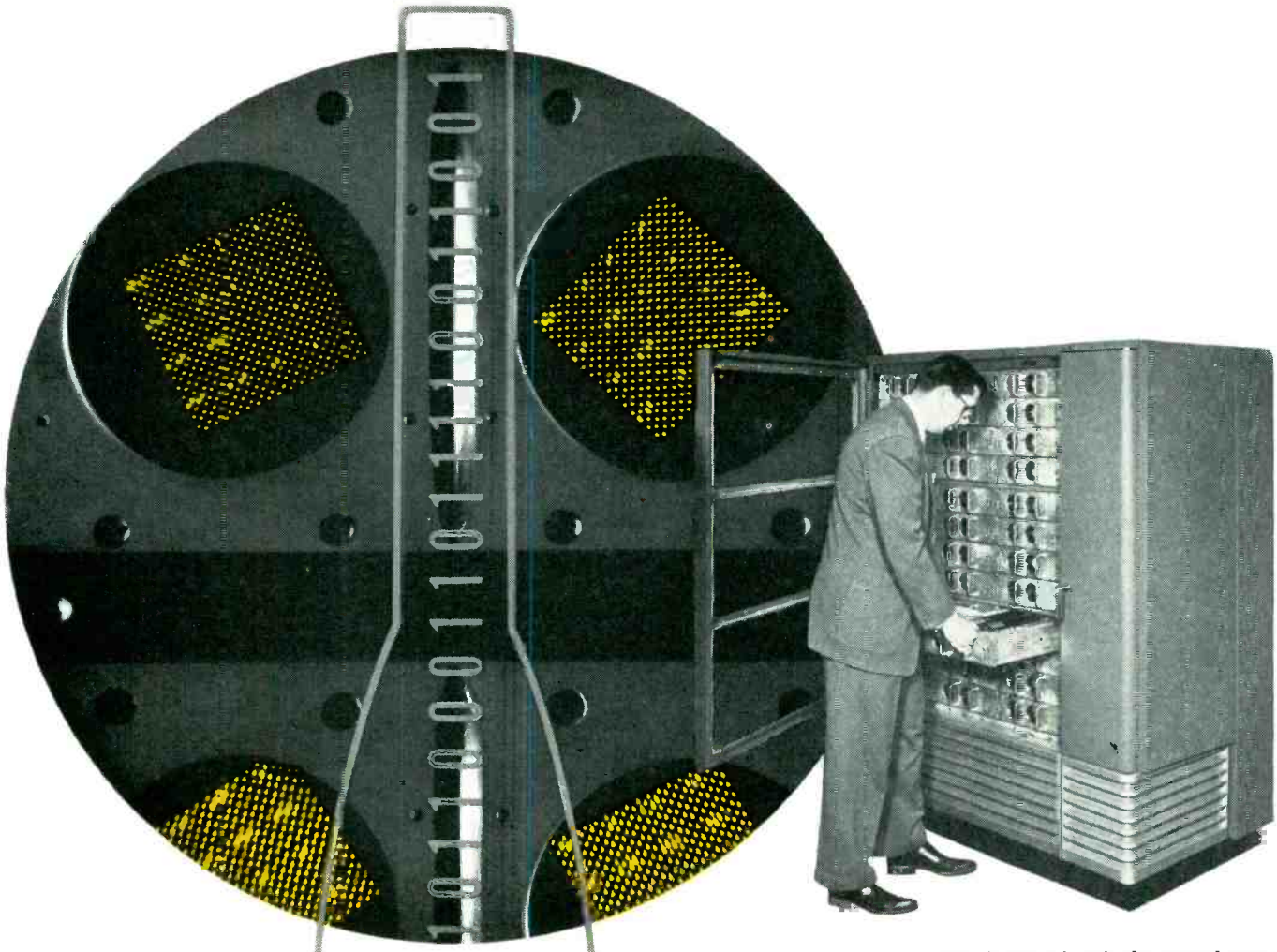

The banks of cathode ray tubes in the IBM Electronic Data Processing Machines are known as Electrostatic Storage Units, one of three "memory" devices.

you can't risk wiring trouble in an electronic **brain**

Out goes your favorite reading lamp, leaving you mumbling in annoyance—even so, it's hardly a calamity. But in the International Business Machines Corporation's incredible electronic calculator, the "701," wiring trouble is simply out of the question. It cannot be allowed to happen.

One of the "701's" three "memory" devices is the Electrostatic Storage Unit. All information to and from other components of this powerful electronic "brain" passes through the Electrostatic Storage Unit which stores data or releases it in 12/1,000,000 of a second. Obviously, this kind of performance demands consistently dependable performance from *all* machine elements.

For users of hook-up wire there is, then, significance in the fact that Rome Synthinol® Hook-up Wire is used in wiring the power supply for this electrostatic storage unit. Rome Synthinol's characteristics of high resistance to heat, flame, acids, oils, plus consistent quality control during production, are what make it dependable.

It will pay *you* to investigate the advantages of this quality Hook-up Wire, Rome Synthinol.

Rome Synthinol Hook-up Wire is used in wiring the power supply for the IBM Electrostatic Storage Unit. The unit shown here is part of the deflection gate and supplies the necessary voltage to it.

It Costs Less to Buy the Best

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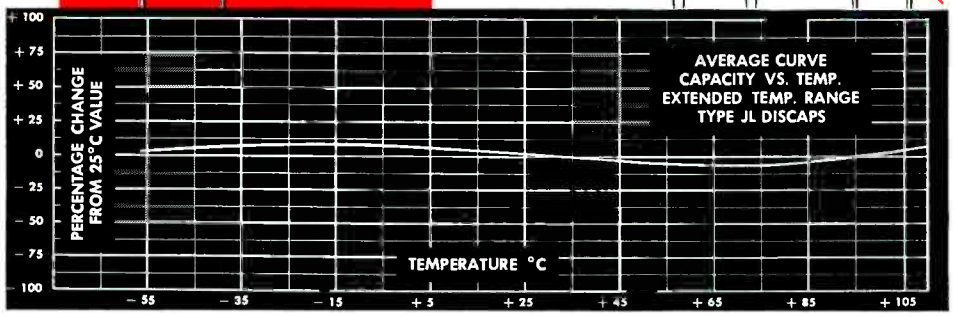
MAXIMUM EFFECTIVENESS AT LOWEST COST...

RMC Type JL DISCAPS

RMC Type JL DISCAPS provide ideal performance over an extended temperature range. The maximum capacity change between −60° and +110° C is only ±7.5% of capacity at 25° C. Lower initial cost, smaller size, and greater mechanical strength combine to effect worthwhile economies in production line operations.

In addition to standard leads, Type JL DISCAPS, as well as temperature compensating and by-pass types, are available with RMC's exclusive "Wedg-Loc" leads or plug in leads for printed circuit applications.

If you have a capacitor problem RMC engineers are prepared to work with you. Your inquiry is invited.



POWER FACTOR: 1% max. @ 1 K C (initial)
POWER FACTOR: 2.5% max. @ 1 K C, after humidity
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C

DISCAP CERAMIC CAPACITORS

RMC

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Two RMC Plants Devoted Exclusively to Ceramic Capacitors

VARO Tuning Fork and Frequency Generator

The VARO Tuning Fork is designed for use as a high accuracy frequency or timing reference in ranges from 300 to 4000 cycles. Highly miniaturized and ruggedly constructed, the VARO Tuning Fork is designed to meet all applicable military environments including temperature extremes and vibration. When used as a signal filter, its high Q provides sharp and consistent characteristics. The VARO Tuning Fork is made to plug in a standard nine pin miniature tube socket.

The VARO Frequency Generator's accuracy is independent of input voltage variations and external loads. No oven or thermostat is required for its accurate operation in any environmental condition. The oscillator circuit of the VARO Frequency Generator uses silicon transistors in place of vacuum tubes. It is designed to plug into a standard octal socket. Special circuit and physical designs may be adapted to any application requirement.

SPECIFICATIONS

TUNING FORK

Accuracy:	0.1% over entire range of military environments. Higher orders of accuracy available on special request.
Frequency:	Available at any frequency within range of 300 to 4000 cps.
Size:	0.875 in. diam.; 2.750 in. high; Standard nine pin tube socket.
Weight:	2.502 oz. (Max.)

FREQUENCY GENERATOR

Input:	28v ± 10%
Output:	2.5v nominal
Accuracy:	0.1% under all military environmental conditions
Size:	1.375 in. diam.; 2.750 in. high; Standard octal socket.
Weight:	4 oz.

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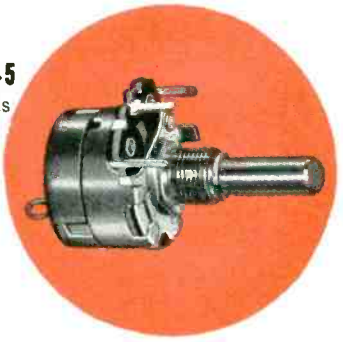
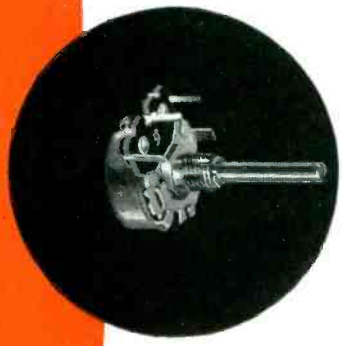
FOR YOUR AUTOMATION PROGRAM

VARIABLE RESISTORS FOR PRINTED CIRCUITS

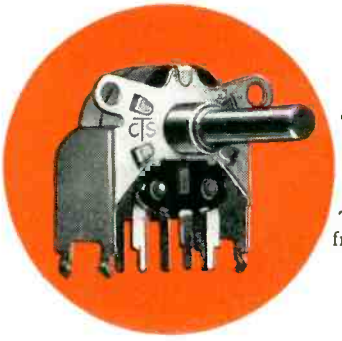
Type UPM-45
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8" knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32" from control's mounting surface.

Type GC-U45
Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.

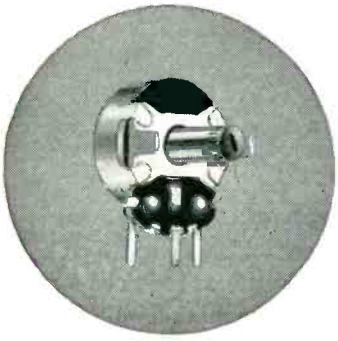




Type U70 (Miniaturized)
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.



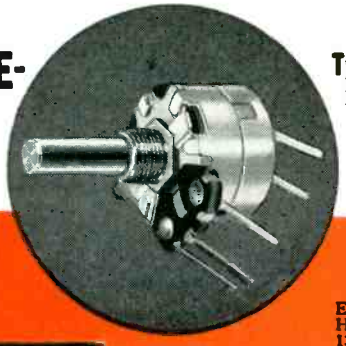
Type YGC-B45
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32" above printed circuit panel. Terminals extend 1-1/32" from control center.



Type XP-45
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.

Type XGC-45
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.

VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



Type WGC-45
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

The controls illustrated are typical constructions. CTS' years of engineering and technical experience makes available many other types for your automation needs.

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Phone: Dixon 9918

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1000 KC to 60 MC

Wire mounted, plated crystals, for use in commercial equipment where close tolerances must be observed. All units are calibrated for the specific load presented by equipment.

Holders: Metal, heremetically sealed.

Calibration Tolerance: ±.0025% of nominal at 30° C.
Tolerance over Temp. Range: ±.005% from −55° to +90° C.
±.002% from −30° C to +60° C.

Circuit: As specified by customer. Crystals are available for all major two-way equipments. In most cases the necessary correlation data is on file.)

Drive level: Maximum—10 milliwatts for fundamental, 5 milliwatts for overtone.

Prices: Available on request.

F-605
Pin dia. .050
Pin lngth. .238

F-609
Pin dia. .095
Pin lngth. .445

F-612
Pin dia. .125
Pin lngth. .620

Pin spacing on each of above is .486

USES:

1. For fast replacement in existing equipment. Replacement crystals are available for all major two-way equipment.

2. To eliminate large inventories of crystals for new equipment. In most cases you can have crystals for a set the day after the customer specifies his channel. This leads to rapid sales of your equipment, and satisfied customers.

3. For development work. Rapid delivery to insure the elimination of bottlenecks in procurement for research and development.

Send for FREE Catalog covering International's complete line. Crystals available from 100 KC to 100 MC.

Delivery: ONE DAY PROCESSING. ***All orders of less than five units of any one frequency in the range 1000 KC to 60 MC will be mailed within 24 hours from the time received.***

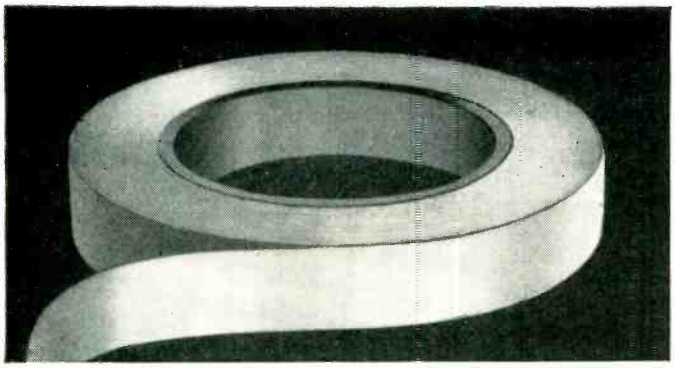
WHEN ORDERING SPECIFY:
(1) Frequency (2) Holder Type*
(3) Circuit Data (32 mmf load, series resonance, etc.) For standard commercial 2-way equipment specify model number and drawing number where available.
(4) End Use (Equipment type & manufacturer, development, etc.)
*Adaptors can be supplied for ¾" pin spacing.

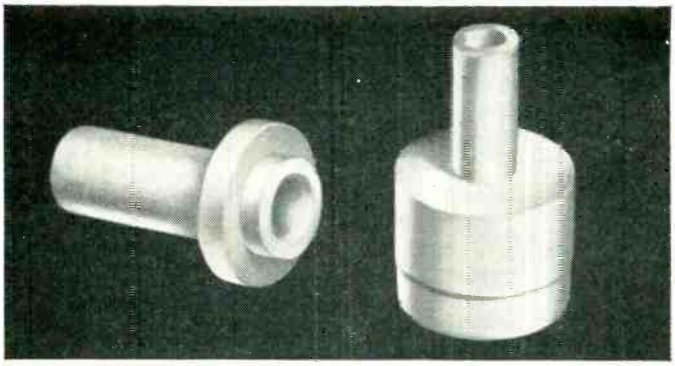
ONE DAY SERVICE

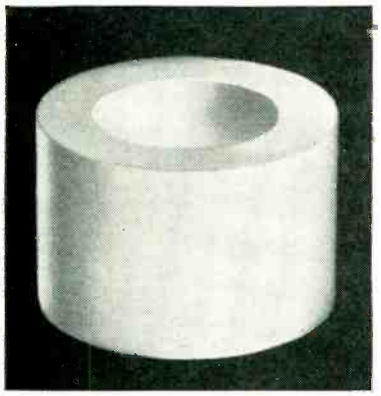
QUARTZ CRYSTALS

ONE DAY SERVICE

International CRYSTAL Mfg. Co., Inc. 18 N. Lee Phone FO 5-1165 OKLAHOMA CITY, OKLA.







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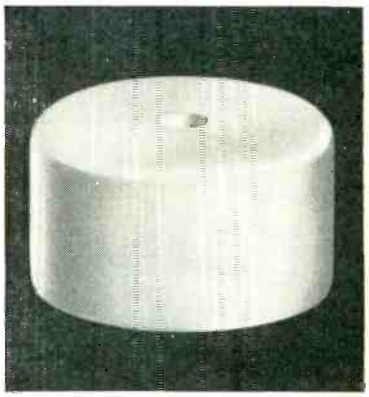

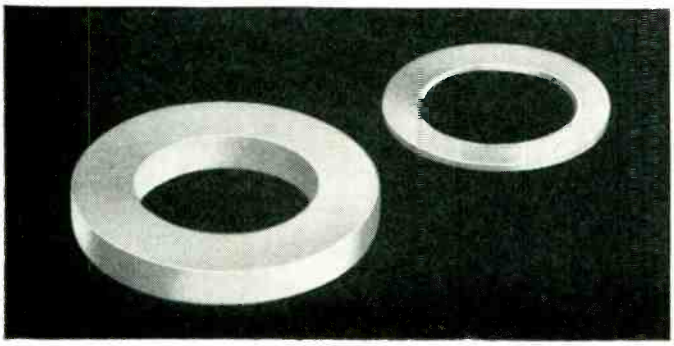

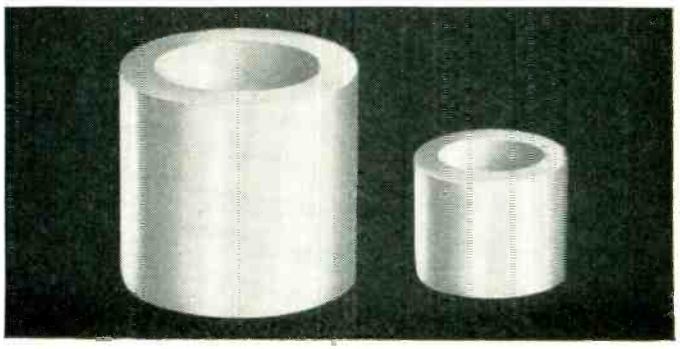

Thousands of engineers have found that "TEFLON" has what it takes to solve some really tough problems in the electronics and electrical manufacturing fields. They have also found R/M, with its unmatched skill, experience and facilities, a tremendous help in solving those problems. For R/M has been working with this plastic ever since it first was produced. If you have a problem the chances are good that R/M has encountered it and already worked out a solution.

The several different products pictured above indicate R/M's versatility in "TEFLON" manufacture. We can fabricate parts to your own specifications or supply you with "TEFLON" in the form of rods, sheets, tubes or tape. For further information, write today.

PROPERTIES OF "TEFLON"

High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

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El-Menco

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Positive Proof of Performance

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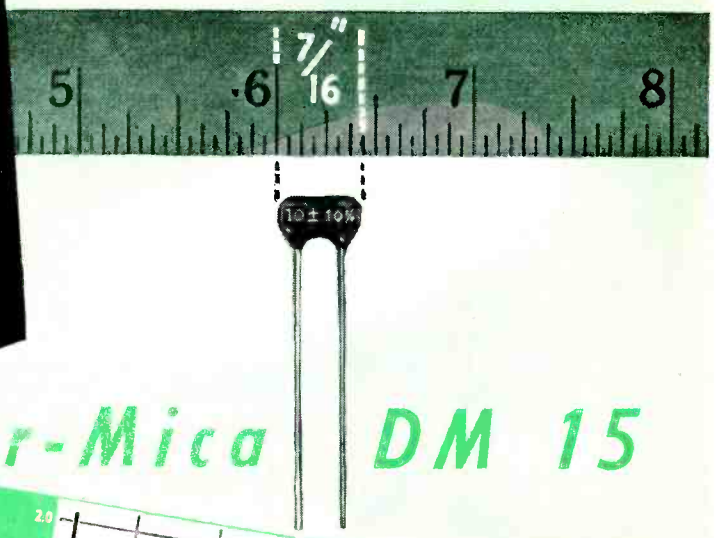


Dur-Mica DM 15

world's smallest mica capacitor

. . . First Miniature Dipped Mica Capacitors with Parallel Leads.

El Menco's Dur-Mica DM15 provides assurance of peak performance in a variety of transistor circuits and other miniature electronic equipment in military and civilian applications.
A new, tougher phenolic casing provides assurance of long-life and stability through wide ranges in temperature.
Parallel Leads provide greater versatility—allow efficient, safe use of the El Menco Dur-Mica DM15 in applications heretofore impractical.
Saves Money—El Menco's Dur-Mica DM15 costs even less than the famous El Menco CM15.
Provides economy of size.

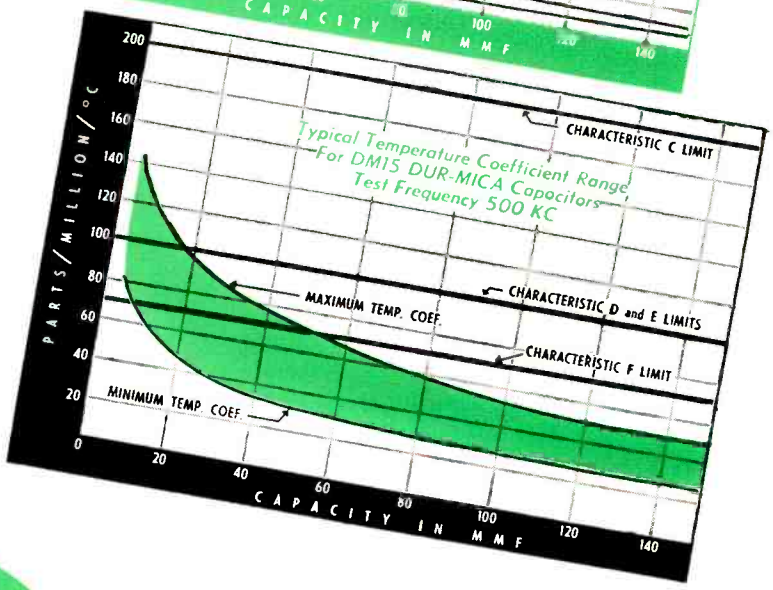
CAPACITIES AVAILABLE:

DM15—Up to 510 mmf at 300vDCw
Up to 400 mmf at 500vDCw
DM20—Up to 5100 mmf at 300vDCw
Up to 3900 mmf at 500vDCw

Available in 125°C operating temperature. Minimum capacity tolerance available—± ½% or 0.5 mmf (whichever is greater).

Test El Menco "Dur-Micas" For Yourself!

For your special requirements—we are pleased to offer information and assistance. Write for free samples and catalog on your firm's letterhead.



El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

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• molded mica • mica trimmer
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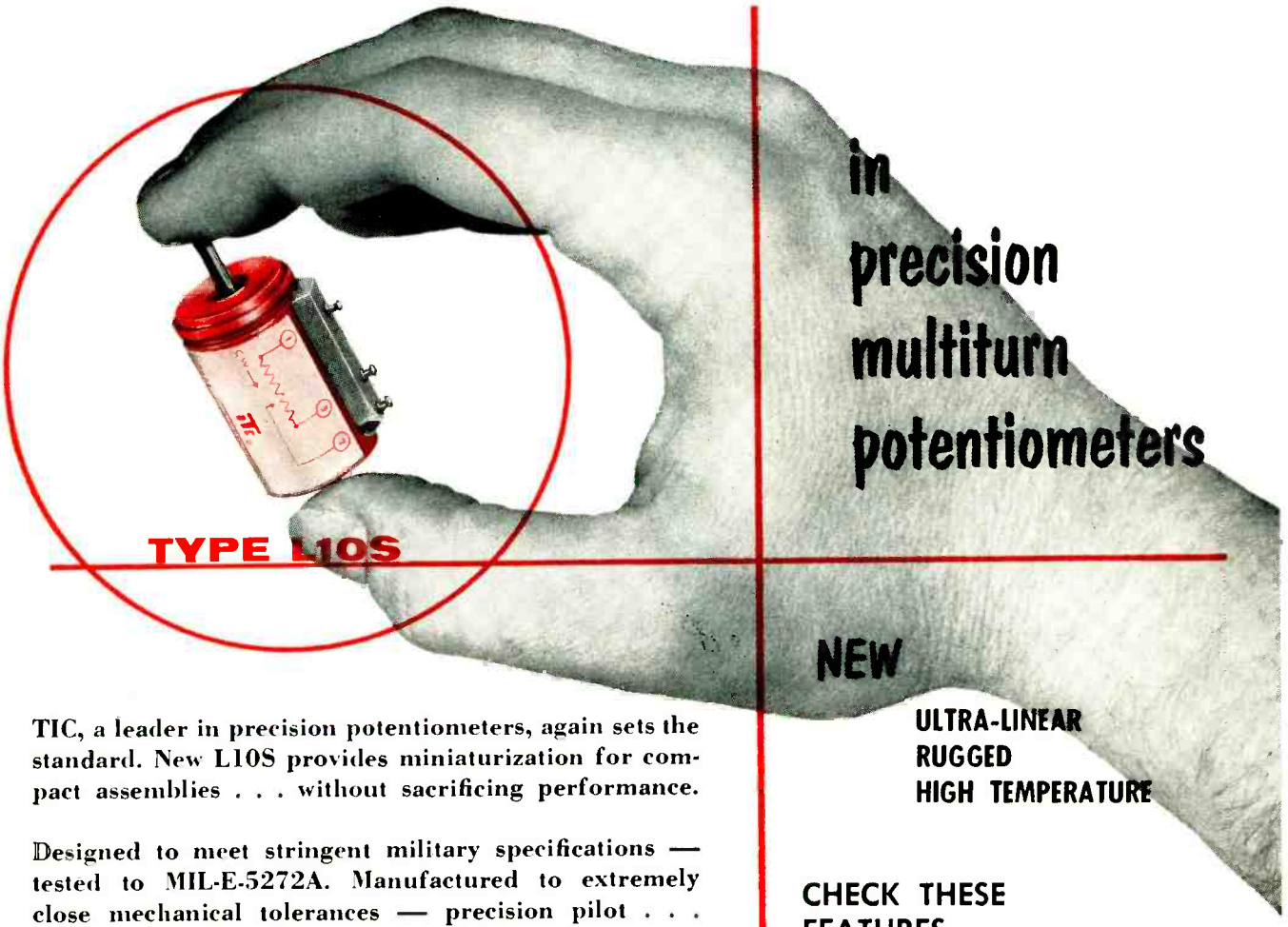
Jobbers and distributors write to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

NOW MINIATURIZATION plus PERFORMANCE



in precision multiturn potentiometers

NEW

ULTRA-LINEAR
RUGGED
HIGH TEMPERATURE

TIC, a leader in precision potentiometers, again sets the standard. New L10S provides miniaturization for compact assemblies . . . without sacrificing performance.

Designed to meet stringent military specifications — tested to MIL-E-5272A. Manufactured to extremely close mechanical tolerances — precision pilot . . . centerless ground shaft . . . precision ball bearings. Made for high electrical accuracy. Type L10S provides rugged construction . . . light weight. . . low torque . . . inherent stability . . . and high resolution.

Wide temperature and resistance ranges of miniature L10S provide greater versatility. Extend its application in servo systems . . . computers . . . control . . . telemetering . . . and measurement systems. Check the L10S features. Then write for free brochure.

CHECK THESE FEATURES

LINEARITY:
±0.05% standard; ±0.025%, special.
TEMPERATURE RANGE:
−55°C. to +130°C.
RESISTANCE RANGE:
1000 ohms to 100,000 ohms.
WEIGHT:
1 ounce.
TORQUE:
Starting .75 in. oz., Running .60 in. oz.

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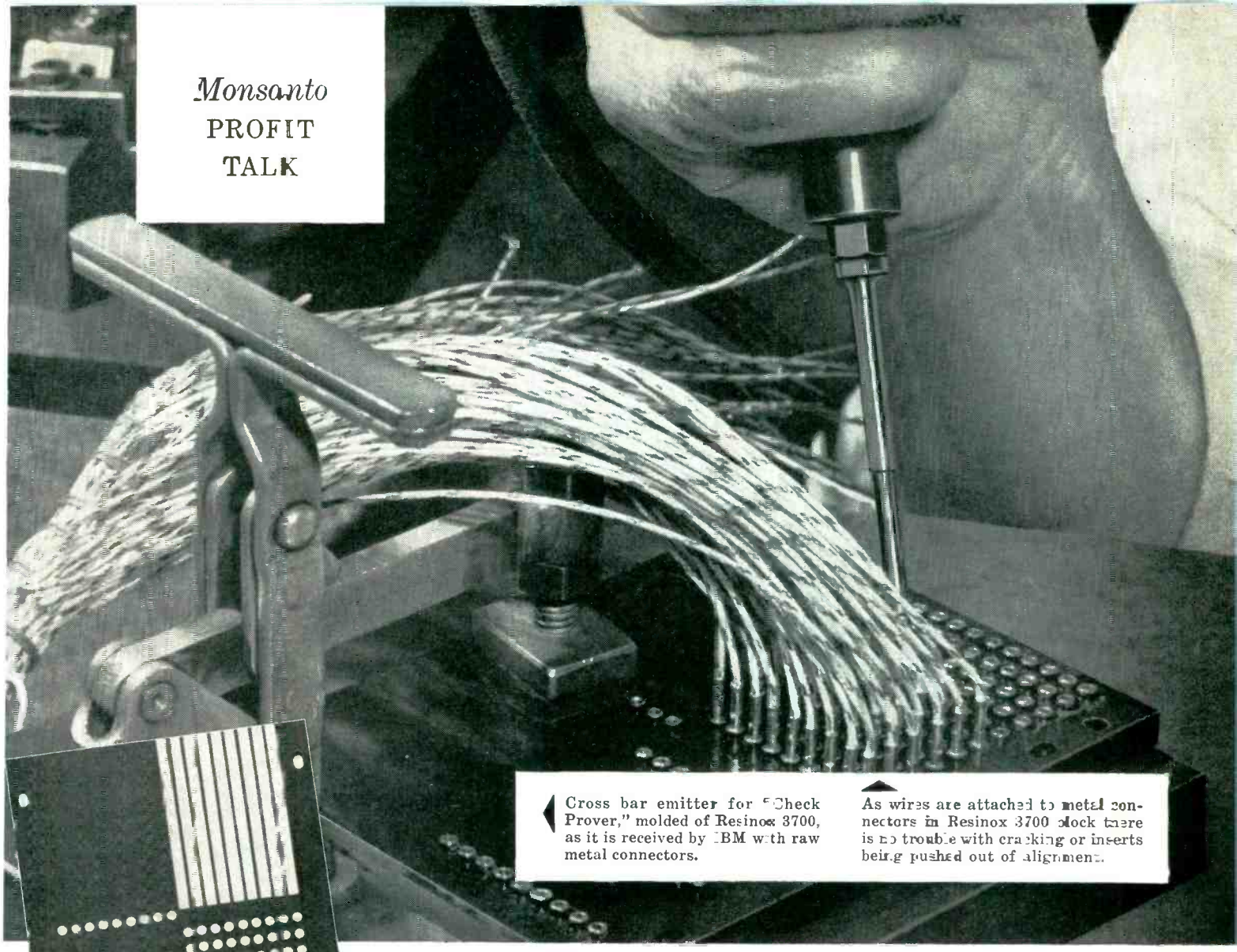

Cross bar emitter for "Check Prover," molded of Resinox 3700, as it is received by IBM with raw metal connectors.

As wires are attached to metal connectors in Resinox 3700 block there is no trouble with cracking or inserts being pushed out of alignment.

IBM SPECIFIES RESINOX* 3700

for cross bar emitter—cuts costs in half!

Monsanto's thermosetting molding powder ends scrapping problem...cuts machining time...speeds production of "Check Prover" part!

An integral part of IBM's famous "Check Prover" is a 4" x 5¼" cross bar emitter which brings together the intricate wiring system of the machine. The block contains over 50 tiny metal inserts through which the various electrical leads pass.

The Plastics Engineers at the IBM plant in Poughkeepsie, N. Y., where the machines are manufactured, say Monsanto's Resinox 3700 has been specified for the molding of these blocks for over two years.

Resinox 3700 has completely eliminated wasteful scrapping and other serious production problems, such as blocks cracking during wire assembly operation, and metal inserts breaking off or pushing out of alignment.

Furthermore, there are no shorting problems. Machining time on the flatter, smoother blocks has been cut 25%. The cross bar emitter is an expensive part and Resinox 3700 has reduced its production cost over $30,000 a year.

Other qualities of Resinox 3700 of special interest to manufacturers of electrical parts are its outstanding arc resistance, its dielectric strength, its excellent dimensional stability, and its moldability.

Perhaps Resinox 3700 is exactly what *you* need to solve an electrical equipment problem. Write today for full information. Monsanto Chemical Company, Plastics Division, Dept. E-5. Springfield 2, Mass.

For outstanding heat resistance and durability, specify **RESINOX 3700**

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*Resinox: Reg. U.S. Pat. Off.

enamel wire

exacting coil designs!

New processes and controls assure uniform quality:

1 **Uniform over-all size—for uniform windings.**

2 **Uniform softness with high tensile strength for tighter windings, reduced breakage.**

3 **Uniform spooling, larger packages for lower-cost windings.**

4 **Uniform property balance for good flexibility, solvent resistance and dielectric strength.**

Any time magnet wire is your problem,
consult Phelps Dodge for the quickest, easiest answer!

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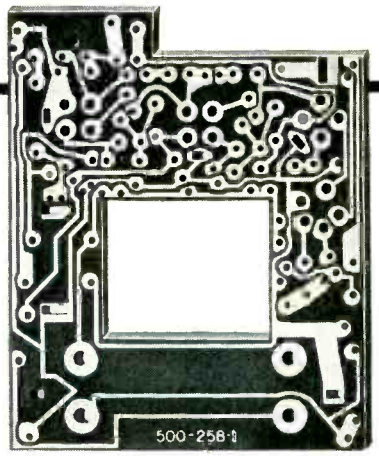
INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

FIRST TRANSISTOR RADIO MADE POSSIBLE

. . by INSUROK® copper-clad printed circuits!

Here's a remarkable example of miniaturization . . made possible mainly through the use of printed circuits and transistors. This diminutive radio weighs a scant 12 ounces, complete with battery. Yet, it has good tone, is selective, and delivers plenty of volume.



Here's the printed-circuit board used in the Regency . . made with Richardson T-725 copper-clad INSUROK. Engineers of I.D.E.A., Inc. of which Regency is a division, laid out the circuit. Croname, Inc.* Chicago, took it from there . . printed the complex circuit on Richardson T-725 copper-clad INSUROK, then etched it. Results: a lightweight, compact, efficient circuit . . tedious, time-consuming wiring eliminated . . faster assembly.

Many grades of Richardson laminate INSUROK are available copper-clad on one or both surfaces. We invite your inquiry.

**Here's what Croname has to say about T-725 copper-clad INSUROK, "Quality is superior . . service good. And Richardson gives us helpful engineering assistance."*

Ask for descriptive bulletin, "INSUROK Copper-Clad Laminates."

RICHARDSON
Laminated and Molded Plastics

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Power Meter Model P-2
DC to 11,000 mc

MICRO POWER METER DC to 11,000 mc

measures microwave power with only one probe

Over the entire frequency range DC to 11,000 MC, Polarad's new Micro Power Meter utilizes only **one** power probe, supplied as an integral part of the instrument. This unique power probe will sustain severe overloads without burnout since it does not contain hot wire barreters or other delicate components.

This new rugged and stable instrument reduces microwave power readings to the simplicity of everyday low frequency measurements. It is a true rms milliwatt indicating meter accurately measuring CW and pulse power, in milliwatts and dbm. Insensitive to line voltage changes.

Because of its wide band coverage, the Polarad Model P-2 is outstanding as a general lab and field instrument, available for power measurements at all commonly used frequencies. The P-2 can be completely calibrated from its own self-contained DC source.

Features and Specifications:

- Single power probe for all frequencies.
- 150% overload without burnout.
- Direct reading.
- Broadband Coverage .....DC to 11,000 mc continuous in single mount.
- Multi-Power Range .....0-1 mw, 0-10 mw, 0-100 mw, 0 dbm, + 10 dbm, + 20 dbm.
- Impedance .....50 ohms coaxial.
- VSWR .....Less than 1.4:1 from 0 to 5000 mc. Less than 2:1 from 5000 to 11,000 mc.
- Accuracy .....± 1.0 db.
- Connector .....Type N plug.
- Input Power Required .....115v ±10%, 60 cps.
- Dimensions .....10" x 8" x 8".
- Weight .....14 lbs.

KLYSTRON TUBE TESTER

tests all klystron tubes

Model K-100
Klystron Tube Tester

Now, for the first time, you can test all commercially available klystron tubes, built-in cavity types as well as those requiring external cavities, just as easily as you make tests on vacuum tubes.

Polarad's new Model K-100 Klystron Tube Tester provides complete metering facilities and control adjustments with a tube data chart to determine settings. Safety features protect personnel at all times when testing tubes requiring high voltages.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

Features:

Performs the following basic tests:

a. Filament continuity.
b. Short circuit tests between all elements.
c. Static d-c tests—measurement of rated d-c currents and voltages.
d. Life test—relation of cathode current versus reduced filament voltages.
e. Dynamic test—provision is made for external modulation so that klystron tubes may be dynamically tested with external r-f measuring equipment.

- Special adapter mount for all commercial types of klystrons.
- Safety features protect personnel during tests.
- Protective devices prevent misadjustment and save tubes from accidental burnout.
- Built-in heavy duty blower provides forced air cooling of the klystron tubes.
- Tester designed to be adapted for future tubes.
- Built-in Universal Power Supply may be used for klystron testing purposes outside the instrument.

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PROVEN RELIABILITY

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Engineering

THE RECORD-SETTING G-12A

This is the JK Glasline unit providing stability of 1 part in 10^9 over a 24 hour period, stability that requires the most accurate methods of measurement available.

TO COMPLETE THE ENVIRONMENTAL PICTURE: THE NEW JK09 OVEN

To the protection JK Glasline design provides against moisture, contamination, vibration and barometric pressure, the JK09 oven adds control of temperature. It is production tooled for economy and uniformity, is small and light (1.28" x 1.70"; 1.5 oz.), and is capable of maintaining a temperature constant to within *±1°C over a range of −55° to +100°C*. Here is an oven that matches the performance of many, massive multi-stage heaters — an example of JK's ultra-stable miniaturization program.

JK-G9: Precision "Glasline" quartz crystals, sealed in evacuated glass for cleanliness and protection, over a complete range of 800 cycles to 5 mc.

PRODUCTS

THE JAMES KNIGHTS COMPANY

Crystals for the Critical - Sandwich, Illinois

Facilities That Measure to 1 part in 10^9 Back JK Research, Production and Certification.

Just a short time ago a crystal offering the extreme stability of the JK G-12A was viewed as a scientific curio. Even its measurement was a scientific effort; its first use limited to laboratory equipment.

But today JK Glasline crystal units in these exacting stability ranges are meeting the demand for ultra stable frequency control in many field applications. They are being production engineered, manufactured, tested, and performance certified in commercial production quantities for use as precision time base units, as long range navigational aids, and for spectrum conserving communications systems. They provide unprecedented stability and reliability, with the compactness and environmental protection that today's field equipment requires.

These advanced research, production and testing facilities are important to everyone concerned with frequency management problems because they are the keys that can unlock tomorrow's door for you. The control of the quartz crystal, so long an art, has become a science.

JK-G4: "Glasline" Crystal Filter Resonator. For broad filter applications such as power line carrier communications and telemetering. Frequency range 50 to 200 kc.

(ACTUAL SIZE)

JK-G3: 10 mc to 150 mc. Miniature size, minimum aging drift, high Q for maximum performance. JK miniaturized "Glasline" crystals meet the growing need for minimum size with maximum stability.

Ultra-Precision frequency control requires that crystal oven, power supply and oscillator circuitry be compatible in design and construction for optimum precision and reliability. The James Knights Company will combine their precision crystals and ovens with tried and proven circuitry in packages that will meet your mechanical layout requirements, at a saving of valuable customer engineering time. Precision frequency signal sources covering the wide frequency range of 60 cycles to 150 mcs can be made available to meet your specific application.

JK "THERMYSTAL"

AN ADVANCED FREQUENCY CONTROL DESIGN

1. Higher Merit Factor: Vacuum enclosure increases Q of crystal.

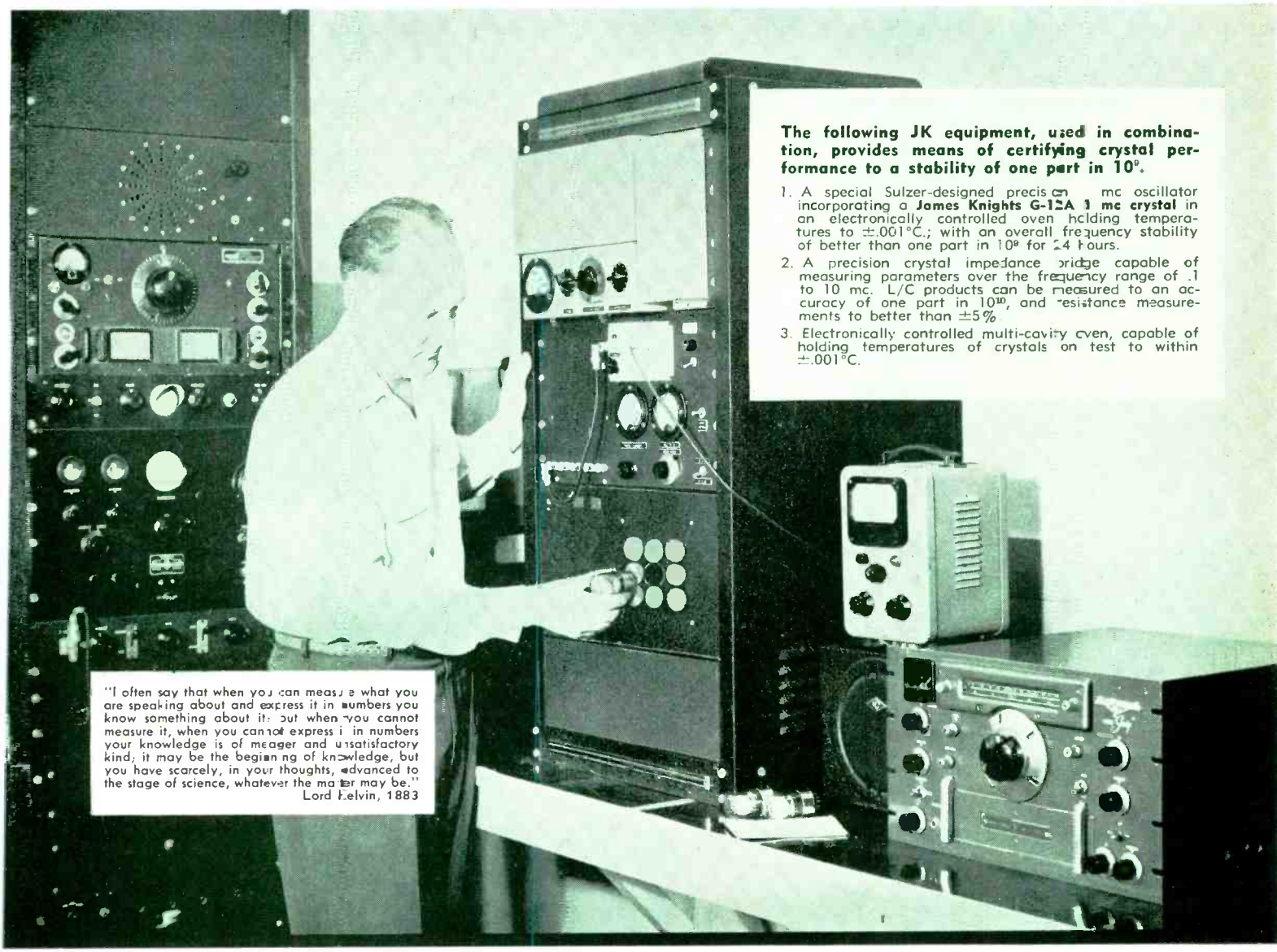
2. Calibration Accuracy: ± (1 cycle + .0001%)

3. Temperature Stability: 30 to 900 kc ± .0001%, 1000 kc to 150 mc ± .00005%. Oven temperature varies less than ± 1°C over ambient range of -55°C to + 85°C.

4. Secular Stability: Less than .001% per year. Crystal is specially processed and sealed in glass enclosed vacuum.

5. Low Oven Power: 6.3 v @ 1.5 amp maximum. Thermostat cycles less than 3 times per minute at room temperature.

that unlocks tomorrow's door



The following JK equipment, used in combination, provides means of certifying crystal performance to a stability of one part in 10^9.

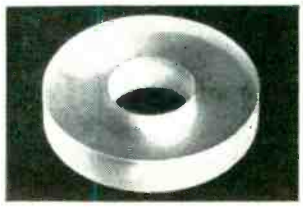
1. A special Sulzer-designed precision mc oscillator incorporating a **James Knights G-12A 1 mc crystal** in an electronically controlled oven holding temperatures to ±.001°C.; with an overall frequency stability of better than one part in 10^9 for 24 hours.
2. A precision crystal impedance bridge capable of measuring parameters over the frequency range of .1 to 10 mc. L/C products can be measured to an accuracy of one part in 10^{10}, and resistance measurements to better than ±5%
3. Electronically controlled multi-cavity oven, capable of holding temperatures of crystals on test to within ±.001°C.

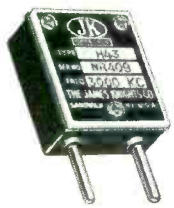
"I often say that when you can measure what you are speaking about and express it in numbers you know something about it: but when you cannot measure it, when you cannot express it in numbers your knowledge is of meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."
Lord Kelvin, 1883

JK STANDARD MILITARY AND COMMERCIAL TYPE CRYSTALS

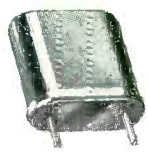
TEMPERATURE CONTROL OVENS: Available for a wide range of applications.

Quality and service are James Knights traditions that apply to the simplest JK crystals as well as to the most complex, and apply to our smallest customer as well as our largest. So whatever your requirements — look to James Knights as a dependable, cooperative source for quality, price and delivery.





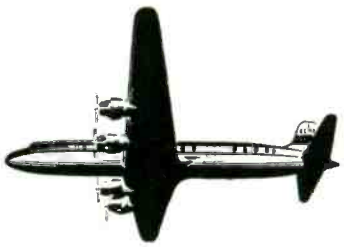
PRESSURE MOUNTED: A complete line of commercial and military types.



MILITARY TYPES: Hermetic sealed, metal cased, in frequency ranges from 16 kc to 100 mc.

ULTRA-SONIC TRANSDUCERS: Carefully oriented and processed to your specifications, in a variety of shapes with holes, dimples, soldered-on leads, and backing plates. Can be plated with a variety of metals.

AEROCOM'S 1046 H.F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

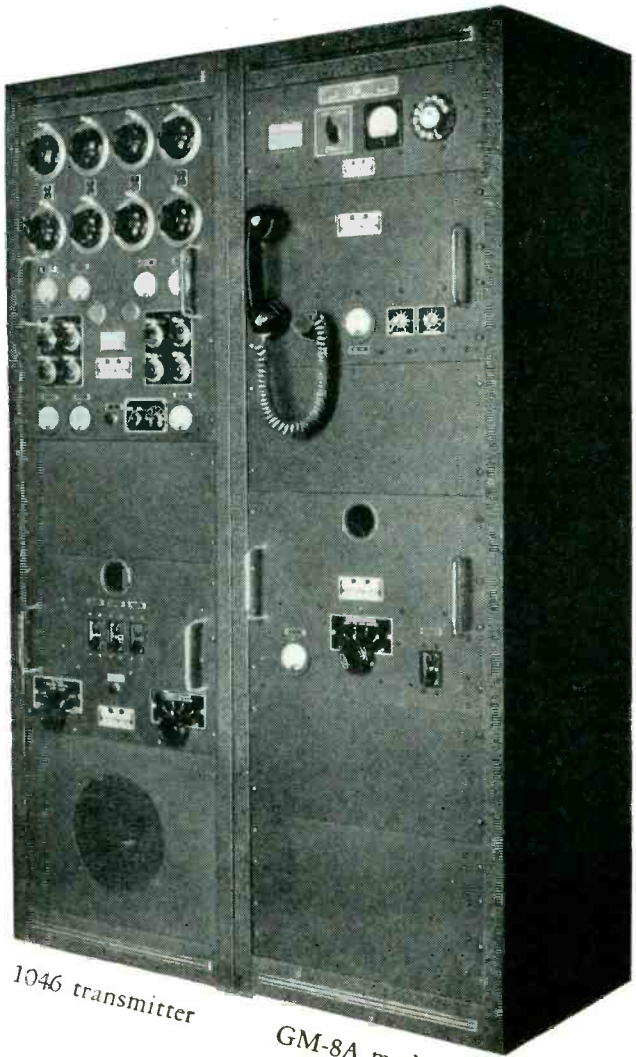
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to + 50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator . . . new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request

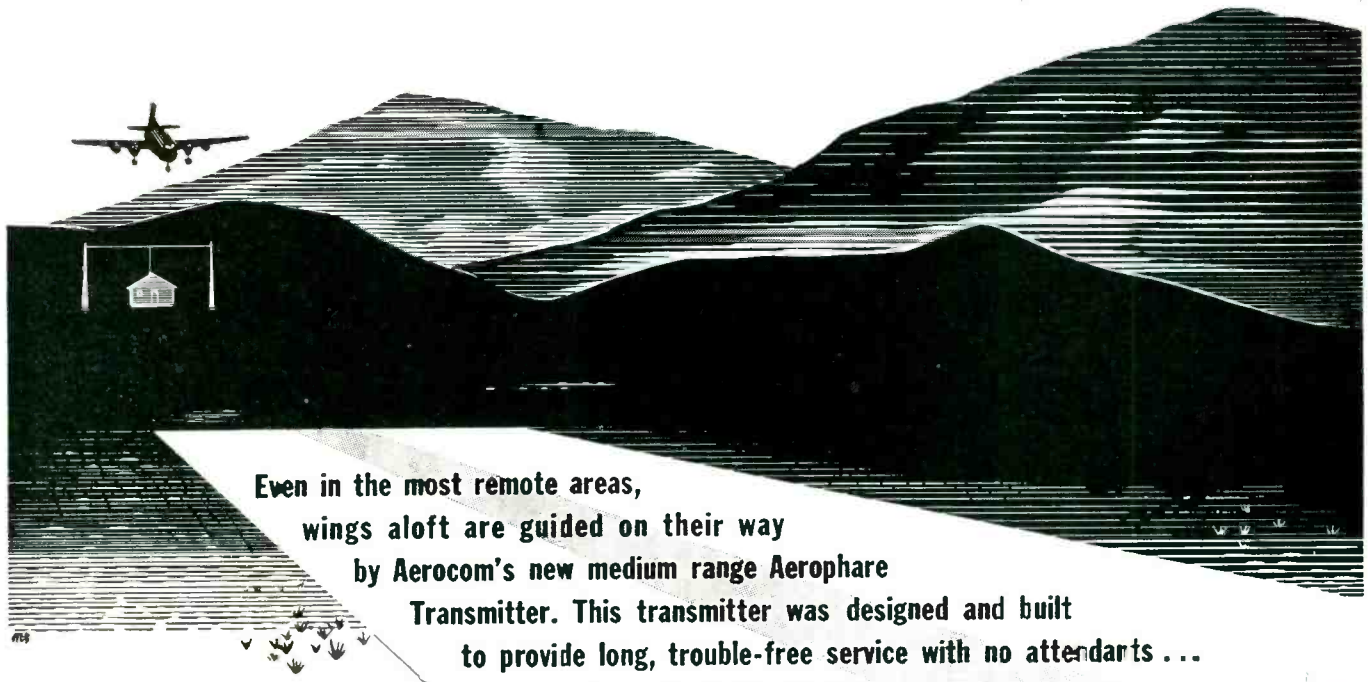


1046 transmitter GM-8A modulator

AER-O-COM

3090 S.W. 37th AVENUE MIAMI 33, FLORIDA

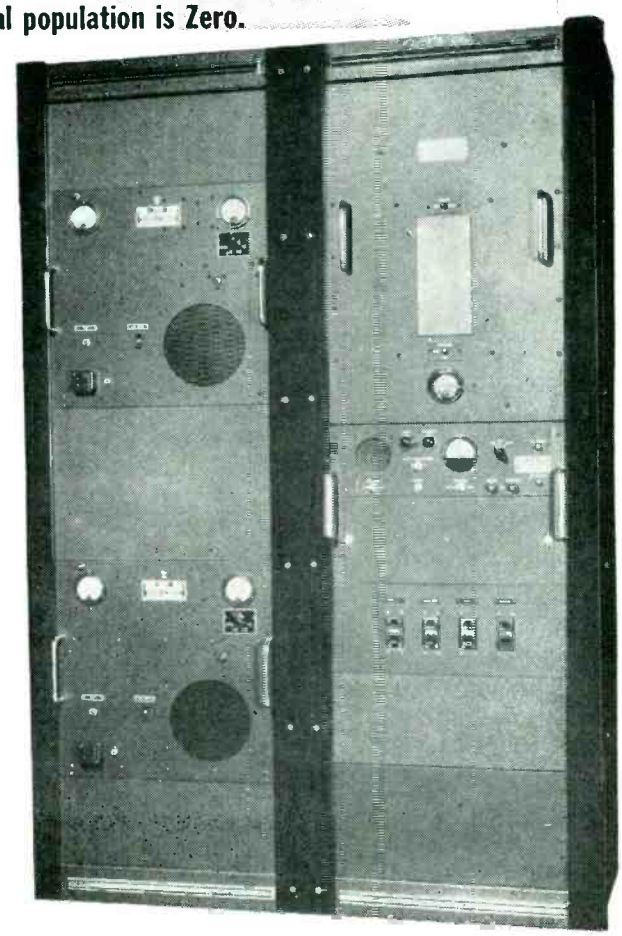
POPULATION-0



Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

AEROCOM'S

Dual Automatic Package-Type Radio Beacon



for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters with keyer, automatic transfer and antenna tuner. (Power needed 110 or 220 volt — 50/60 cycles, 520 V.A. for 50 watt, 630 V.A. for 100 watt.)

Frequency range 200 — 415 kcs.: self-contained P.A. coil and "plug-in" crystal oscillator coil cover entire range. (Self-excited oscillator coils covering 200-290 and 290-415 kcs. are available.) High level plate modulation of final amplifier is used, giving 40% tone modulation in 100 watt transmitter and 60% in 50 watt model. Microphone P-T switch interrupts tone, permitting voice operation.

This unit can be operated in air temperature range 0°C to + 45°C using 866A rectifiers, or from — 35°C to + 45°C using 3B25 rectifiers; humidity up to 95%.

The "stand-by" transmitter is selected when main transmitter suffers loss (or low level) of carrier power or modulation. Audible indication in monitoring receiver tells which transmitter is in operation.

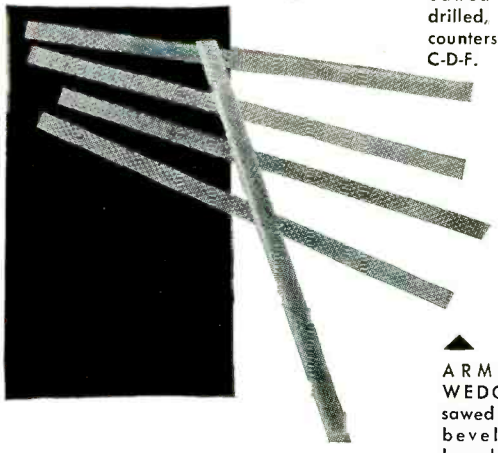
Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.

AER -0- COM
Reg. U. S. Pat. Off.

3090 S.W. 37th AVENUE MIAMI 33, FLA.

For high heat applications C-D-F Melamine Dilecto cleanly machined by C-D-F

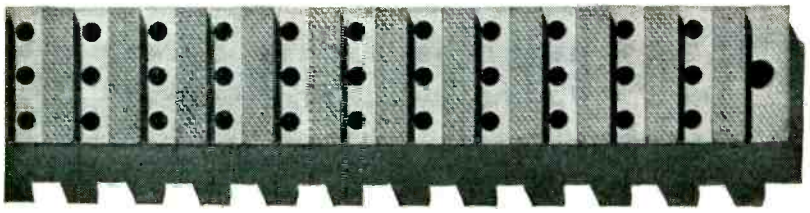
AIRCRAFT PANEL BOARD — GB-28M, ¼" laminate. Sawed to shape, holes drilled, counterbored and countersunk. Machined by C-D-F.



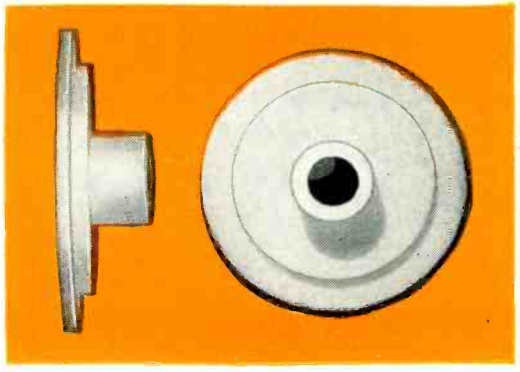
ARMATURE SLOT WEDGES — GB-28M, sawed into strips, then beveled edges were broached to angle of 21° 23', and strips were cut to exact length. Machined by C-D-F.

RF COIL FORM — Natural GB-112M Dilecto rolled tubing, smooth edged. Sawed to length; drilled and burred by C-D-F.

TERMINAL BLOCK—GB-28M. Sawed to shape, grooves milled, corners sanded round. Holes were drilled, counterbored, characters stamped. Machined by C-D-F.



INSULATOR — ML rod. Turned on automatic screw machine by C-D-F. Grade ML is a fine weave cotton fabric base laminate bonded with a melamine resin. Easy to machine.



As operating temperatures rise, melamine laminated plastics can satisfy many requirements for component parts. Glass base melamine grades of Dilecto resist elevated temperatures —up to 300° F. continuously, 350° F. intermittently. They have extremely high impact strength; excellent arc resistance and self-extinguishing properties. C-D-F melamine Dilecto grades are usually specified for many electrical applications requiring high arc resistance, mechanical strength, flame and heat resistance.

C-D-F can supply melamine Dilecto in sheets, tubes and rods in the following grades:

GB-28M—Medium weight glass base laminate with melamine resin. Highest mechanical strength; excellent arc resistance, high heat and flame resistance; self-extinguishing. Dimensionally stable—little affected by temperature and humidity.

GB-112M—Lightweight glass fabric with melamine resin. Substantially same characteristics as GB-28M. Usually produced in thickness less than 1/32".

GM-1—Glass mat base melamine resin bonded laminate. A lower cost product suitable for many applications requiring arc resistance along with good mechanical strength and flame resistance.

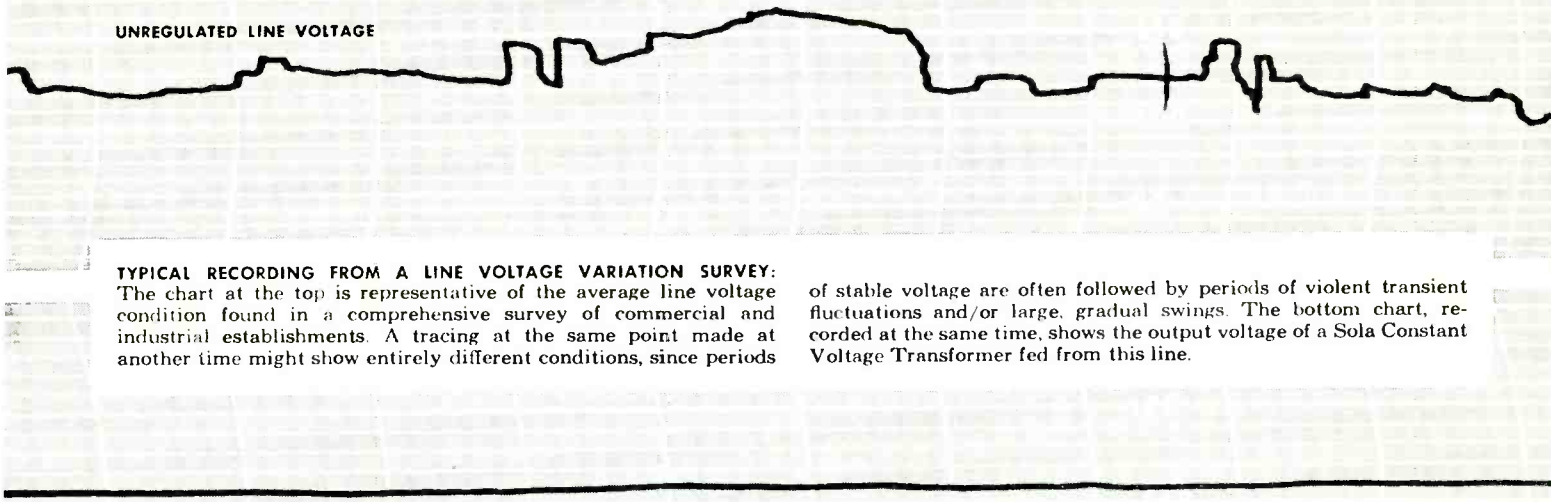
USE COMPLETE MANUFACTURING FACILITIES OF C-D-F. Make us responsible for your complete job . . . from laminates to finish machining of components. C-D-F has the know-how to cleanly machine melamine Dilecto to close tolerances. C-D-F can save you time, money and waste of material. And when you make C-D-F responsible for the complete job, you know what you're getting: components machined to exact specifications; strict adherence to quoted prices; and prompt delivery.

Write for samples and technical bulletins on melamine Dilecto components. Call in a C-D-F sales engineer, tell him your problem. He'll help you.

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for technical bulletin and specific catalog, free test samples, or send us your print for quotation.

C-D-F Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY • NEWARK 28, DELAWARE



TYPICAL RECORDING FROM A LINE VOLTAGE VARIATION SURVEY: The chart at the top is representative of the average line voltage condition found in a comprehensive survey of commercial and industrial establishments. A tracing at the same point made at another time might show entirely different conditions, since periods of stable voltage are often followed by periods of violent transient fluctuations and/or large, gradual swings. The bottom chart, recorded at the same time, shows the output voltage of a Sola Constant Voltage Transformer fed from this line.

End Fluctuating Line Voltage Handicap to Reliable Product Performance

Where line voltage fluctuations impair the performance of voltage-sensitive electronic equipment, Sola Constant Voltage Power Transformers often provide a simple, economical solution. Stock or custom designed units are available.

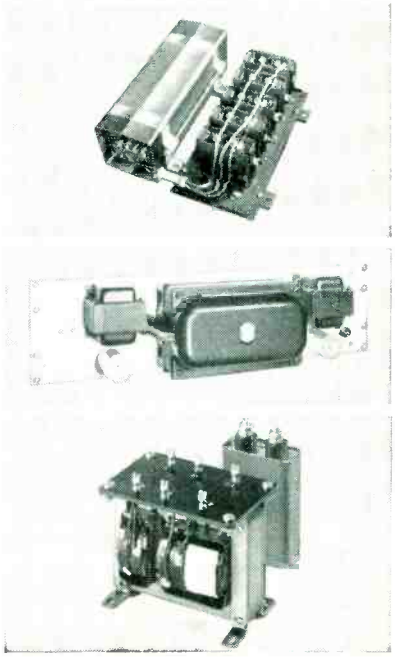
The Sola regulator has no moving parts and requires no manual adjustment or maintenance. Operation is automatic with response time 1.5 cycles or less. Regulates as close as ±1% with line voltage variations as great as 30%.

To meet special load requirements or service conditions, units can be custom-designed for production quantity orders. Variations available for special-order work include:

- *Capacity ranges from a fraction of a va to 30kva*
- *Wide variety of voltage inputs and outputs*
- *Frequencies other than 60 cycles*
- *Provisions for wide ambient temperature ranges*
- *Structural features for installation as a component*
- *Premium mechanical features for military service and other special duty*

The cost of Sola voltage regulation may be far less than you anticipate for two reasons: 1) installation of a Sola unit eliminates the need for the conventional non-regulating power supply transformer and any regulating components which you may currently use . . . 2) your requirements may be satisfied by a stock unit or custom design already on file. A Sola sales engineer is always available to discuss your voltage regulation requirements with you.

TYPICAL CUSTOM-DESIGNED SOLA POWER TRANSFORMERS



SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 7-CVES for facts on the complete line of Sola Constant Voltage Power Transformers.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts • *NEW YORK 35:* 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building • *CLEVELAND 15:* 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *TORONTO 9, ONTARIO:* 617 Runnymede Road
Representatives in Other Principal Cities

Tests show two CATHALOYS most versatile cathode materials

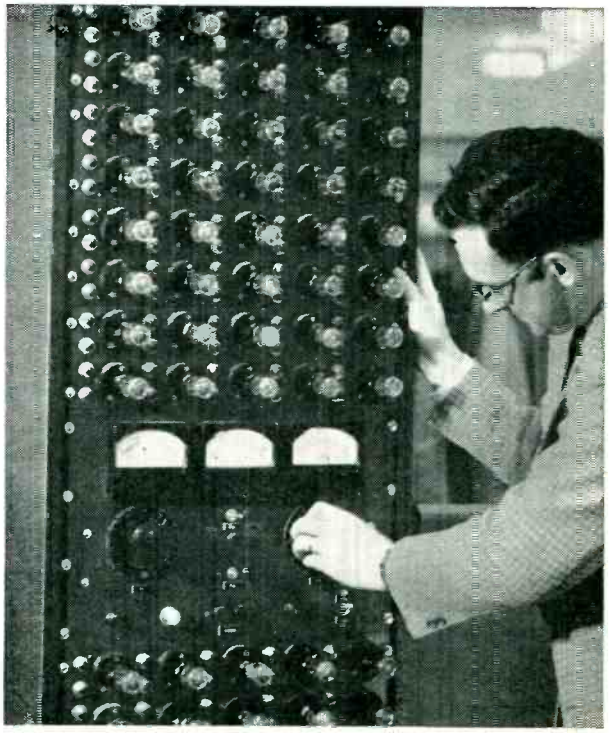
New alloys from Superior Tube simplify selection, prolong tube life

Now the engineer's job of selecting the right cathode alloy for practically any electron tube can be a simple choice between two new CATHALOYS from Superior Tube.

CATHALOY A-32* is an active alloy characterized by rapid activation, high emission level throughout life, very low interface impedance, and absence of sublimation. These remarkable advantages are the result of using aluminum in place of silicon or magnesium as the reducing agent. The addition of a small percentage of tungsten also makes A-32 approximately 50% more shock resistant than cathodes without tungsten. Thus A-32 is suitable for virtually any active alloy application, including ruggedized tubes.

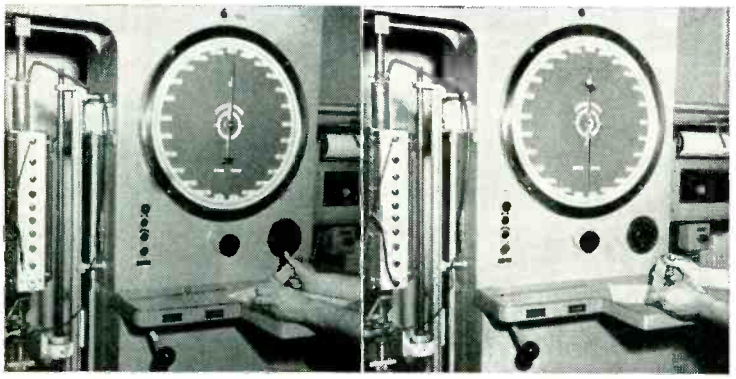
CATHALOY P-50 is a passive alloy of carefully controlled analysis that is commercially available in WELDRAWN† cathodes as well as Lockseam.‡ It can be made in WELDRAWN form because of its capacity to take much more severe reductions in cold drawing without rupture than other grades of passive alloys. P-50 is identical in composition with the well-known ASTM Grade 21. The important difference is in the method of melting which improves the uniformity and completeness with which deoxidation is accomplished. All heats are tested in Superior Tube's laboratory before being approved for production.

Ask for complete technical reports on both these new CATHALOYS. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

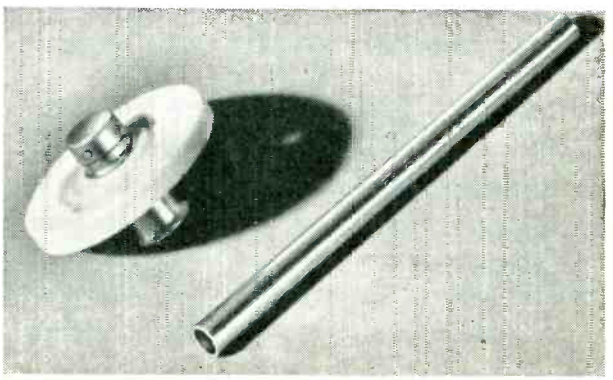


ON TEST. Laboratory photo of test diodes used in Superior Tube's electronic laboratory. Under exhaustive tests, the new Cathaloys display performance characteristics not present in other alloys.

*Patent applied for †TM Reg. U.S. Pat. Off., Superior Tube ‡Manufactured under U.S. patents NOTE. Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.



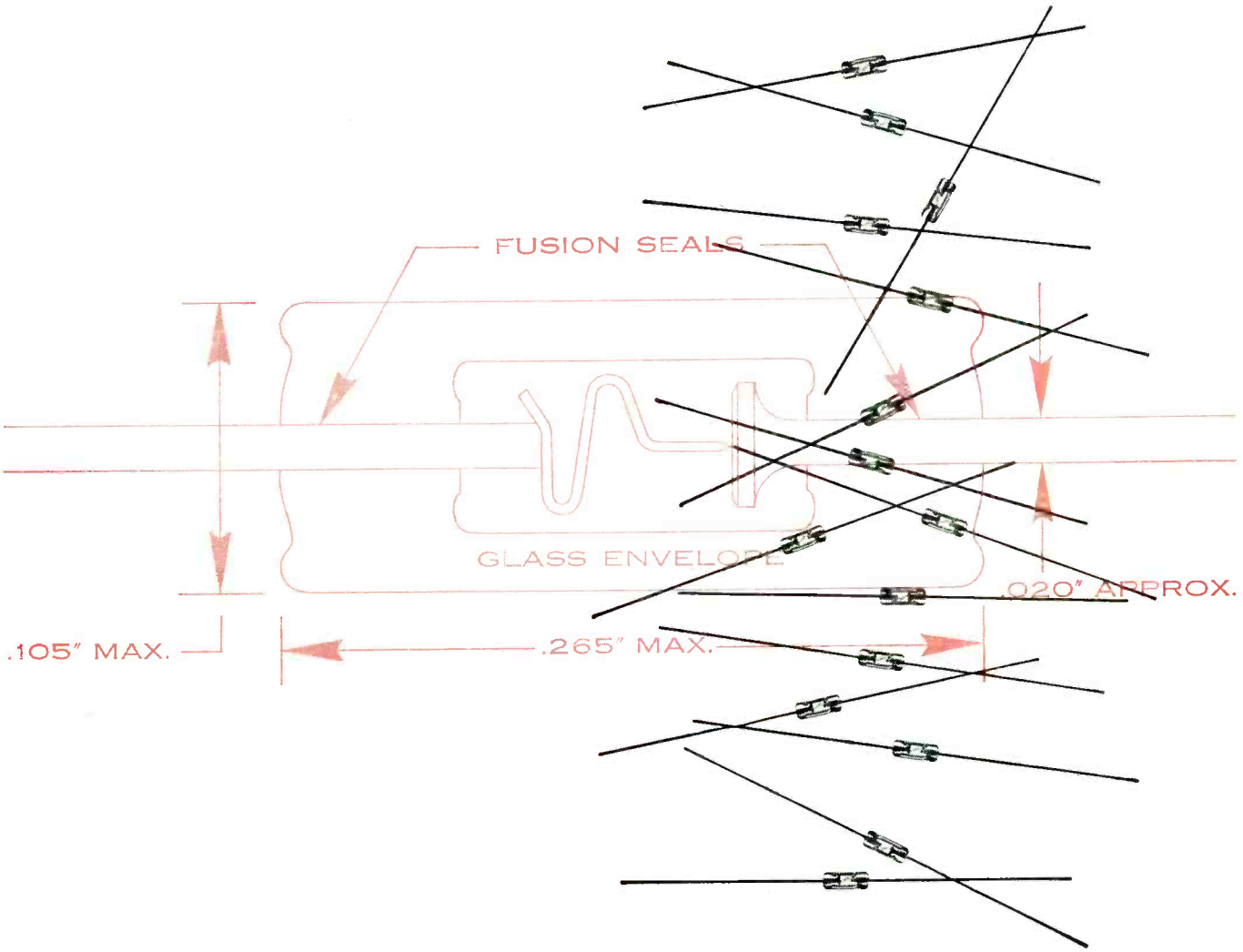
CATHALOY A-32—3750 psi **Tungsten-free cathode alloy—2500 psi**
50% STRONGER. High temperature tensile testing machine proves Cathaloy A-32 approximately half again stronger than tungsten-free cathode alloys.



WELDRAWN PASSIVE ALLOY. Typical uses for Cathaloy P-50 are in Weldrawn cathode sleeve shown at right and in disc cathode shank at left. Heretofore, passive alloys have not been commercially available for these applications.

Superior Tube
The big name in small tubing

All analyses .010" to ⅝" OD. Certain analyses in light walls up to 2½" OD.



FIRST OF ALL FOR **RELIABILITY**

HUGHES SEMICONDUCTOR PRODUCTS

Why should YOU *use Hughes semiconductors? First of all—for reliability. You can depend on these devices to stay within published ratings and specifications under varied and severe operating conditions.*

All diodes made by Hughes are:

MOISTURE-PROOF—Fusion-sealed in a one-piece glass envelope. This construction eliminates a major cause of diode failure.

RUGGED—Small volume and mass enable them to withstand physical shock and vibration.

STABLE—Internal elements are isolated from damage or contamination. Mechanical and electrical characteristics remain stable throughout a long operating life.

THOROUGHLY TESTED—All diodes are tested for electrical and mechanical characteristics. They operate faithfully over wide ambient temperature ranges.

SUBMINIATURE*—In miniaturized circuitry, the high component density possible with these diodes promotes greater volumetric efficiency.

For instance, Hughes subminiature diodes have now been used by many major manufacturers of electronic equipment. Without exception, available performance reports indicate that, in military and commercial installations alike, the Hughes components have maintained an extraordinary record of failure-free service. Today, these same diodes are continuing to add to the reputation for superior reliability synonymous with Hughes Semiconductor Products.

The Hughes line of semiconductor devices is being steadily expanded. It now comprises a wide selection of Germanium Point-Contact and Silicon Junction Diodes, and Photocells. New products, now under development, are being readied for commercial production. Watch for their release. They, too, will embody the same Hughes quality in design and manufacture that spell out unsurpassed stability and reliability. Specify Hughes—with confidence.

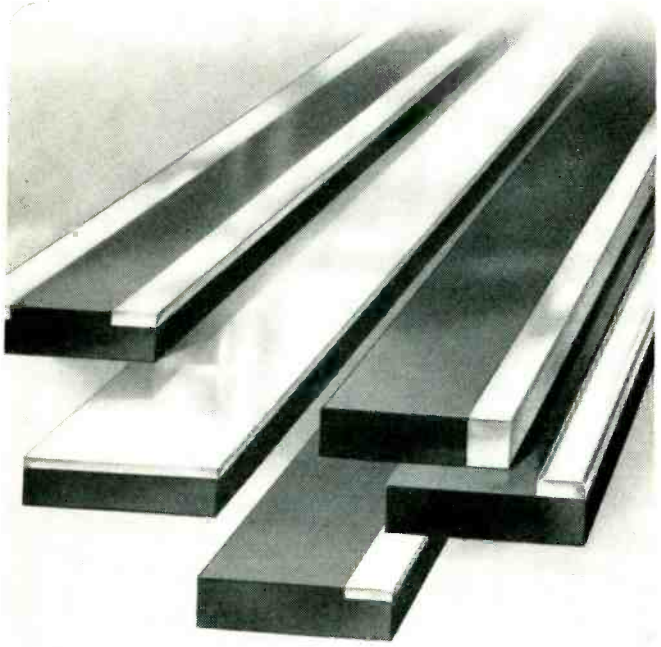
HUGHES SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, California

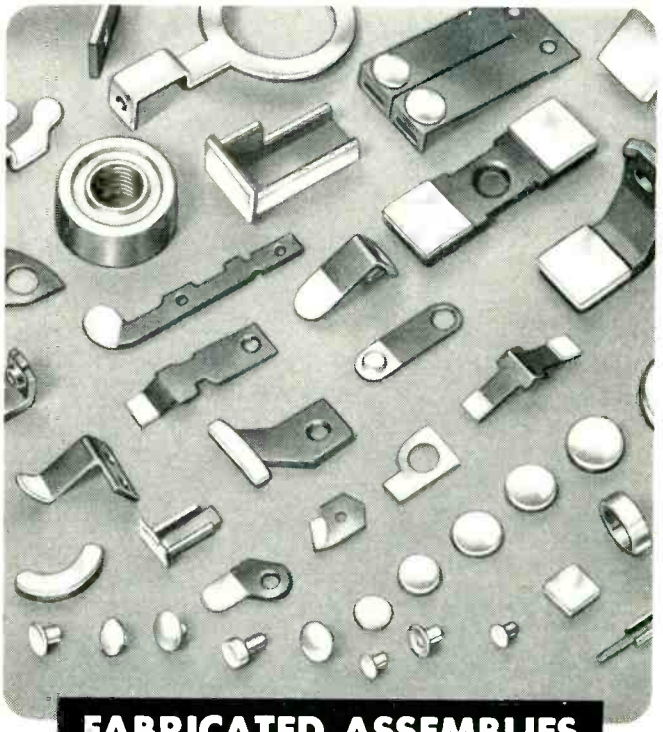
New York *Syracuse*
Philadelphia *Chicago*

**Maximum dimensions, standard germanium diode glass envelope: 0.265 inch by 0.105 inch.*

General Plate
COMPOSITE CONTACTS



COMPOSITE STOCK



FABRICATED ASSEMBLIES

Composite Contact Material
that meets your requirements
Composite Contact Assemblies
that cut your costs!

There are many advantages for using General Plate composite contact materials, processes and facilities. Among the more important are better performance, longer operating life and lower fabricating costs.

But that's not all — here at General Plate you have a single source that can supply your contact requirements be it composite raw stock, contacts or complete assemblies. General Plate stock and contacts are available in a wide range of alloys designed to meet your specific requirements.

General Plate Composite Contact Materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods.

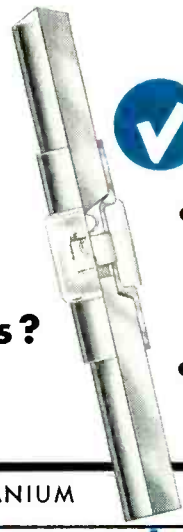
By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

Write for complete information and Catalog PR700.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
35 FOREST STREET, ATTLEBORO, MASS.

what are your diode requirements?



Check these PSI features...

- Versatile lead configurations
- Glass-to-metal fusion seal
- Welded construction

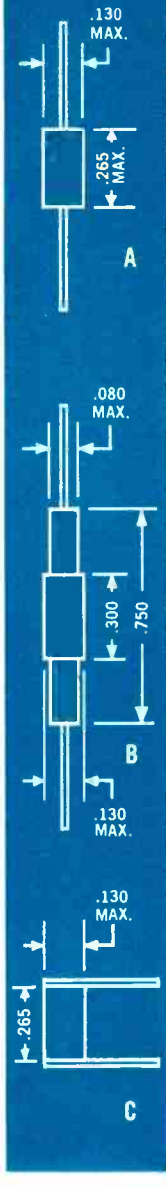
Below, we've listed typical types from PSI's broad *standard* diode line. We also make many special diodes... and if your needs cannot be met by standard types, PSI engineers will be glad to investigate your specific problem promptly. Write us for complete product information.

GERMANIUM GOLD BONDED DIODE SPECIFICATIONS (@ 25°C)

RETMA TYPE	PSI TYPE	OUTLINE 1	MAXIMUM INVERSE WORKING VOLTAGE (v)	MINIMUM FORWARD CURRENT @ +1v (ma)	MAXIMUM INVERSE CURRENT @ SPECIFIED VOLTAGE (ma)
HIGH VOLTAGE TYPES					
	PS200	A/B/C	200	20	0.05 (− 50v) 0.2 (−200v)
1N39A		B	200	3	0.2 (−100v) 0.8 (−200v)
1N55B		A	150	5	0.5 (−150v)
HIGH CONDUCTANCE TYPES					
	PS201	A/B/C	90	150	0.02 (− 10v) 0.18 (− 90v)
		After switching from 5 ma 1μsec forward pulse to −40v, back resistance must equal or exceed 25K in 0.3μsec. Loop resistance = 2000 ohms min.			
	PS202	A/B/C	30	100	0.02 (− 20v)
	PS203	A/B/C	30	100	0.1 (− 20v)
					0.35 (− 20v) @55°C
GENERAL PURPOSE — MEDIUM CONDUCTANCE					
	PS205	A/B/C	80	75	0.05 (− 50v)
	PS206	A/B/C	60	75	0.1 (− 50v)
1N143		B	100	40	0.1 (−100v)
	PS207	A/B/C	80	40	0.05 (− 50v)
	PS208	A/B/C	60	(Note 2)	0.02 (− 10v) 0.12 (− 60v)
		After switching from 5 ma 1μsec forward pulse to −40v, back resistance must equal or exceed 80K in 0.3μsec. Loop resistance = 2000 ohms min.			
GENERAL PURPOSE					
	PS210	A/B/C	100	15	0.02 (− 20v) 0.1 (−100v) 0.15 (− 20v) 0.3 (−100v) @55°C
	PS211	A/B/C	60	30	0.05 (− 50v) 0.2 (− 50v) @55°C
1N63		B	100	4	0.05 (− 50v)
1N67A		A	80	4	0.005 (− 5v) 0.05 (− 50v)

SILICON JUNCTION DIODE SPECIFICATIONS (@ 25°C) 6

PSI TYPE 3	OUTLINE	MINIMUM SATURATION VOLTAGE 4 $-E_s$ (v)	TRANSITION VOLTAGE RATIO 5 E_t/E_s (%)	MINIMUM FORWARD CURRENT @ +1v (ma)	MAXIMUM INVERSE CURRENT @ SPECIFIED VOLTAGE (μa) @ 25°C	(μa) @ 150°C
(D) PS500	A/B/C	300	90	3	0.01 (−150v)	5.0 (−150v)
(D) PS501	A/B/C	150	90	10	0.01 (− 75v)	5.0 (− 75v)
(D) PS502	A/B/C	55	95	30	0.01 (− 30v)	5.0 (− 30v)
(D) PS503	A/B/C	30	95	60	0.01 (− 15v)	5.0 (− 15v)



1. Diodes may be obtained with other configurations to meet special needs.
2. During 0.1μsec 50 ma peak half-sine forward pulse (Maximum PRF = 100 KC), forward voltage ≦ 3v.
3. (D) denotes Developmental Specification.
4. Saturation Voltage (E_s) is measured at 500μa.
5. Transition Voltage (E_t) is measured at 50μa. A high ratio of E_t/E_s indicates a sharp voltage saturation which in turn correlates with reliability of the unit. This ratio is measured for each diode with respect to its E_s.
6. Recovery time: After switching from 5 ma forward current to two-thirds of the minimum E_s, typically each of the diode types reaches a back resistance of 50K in less than 1μsec.

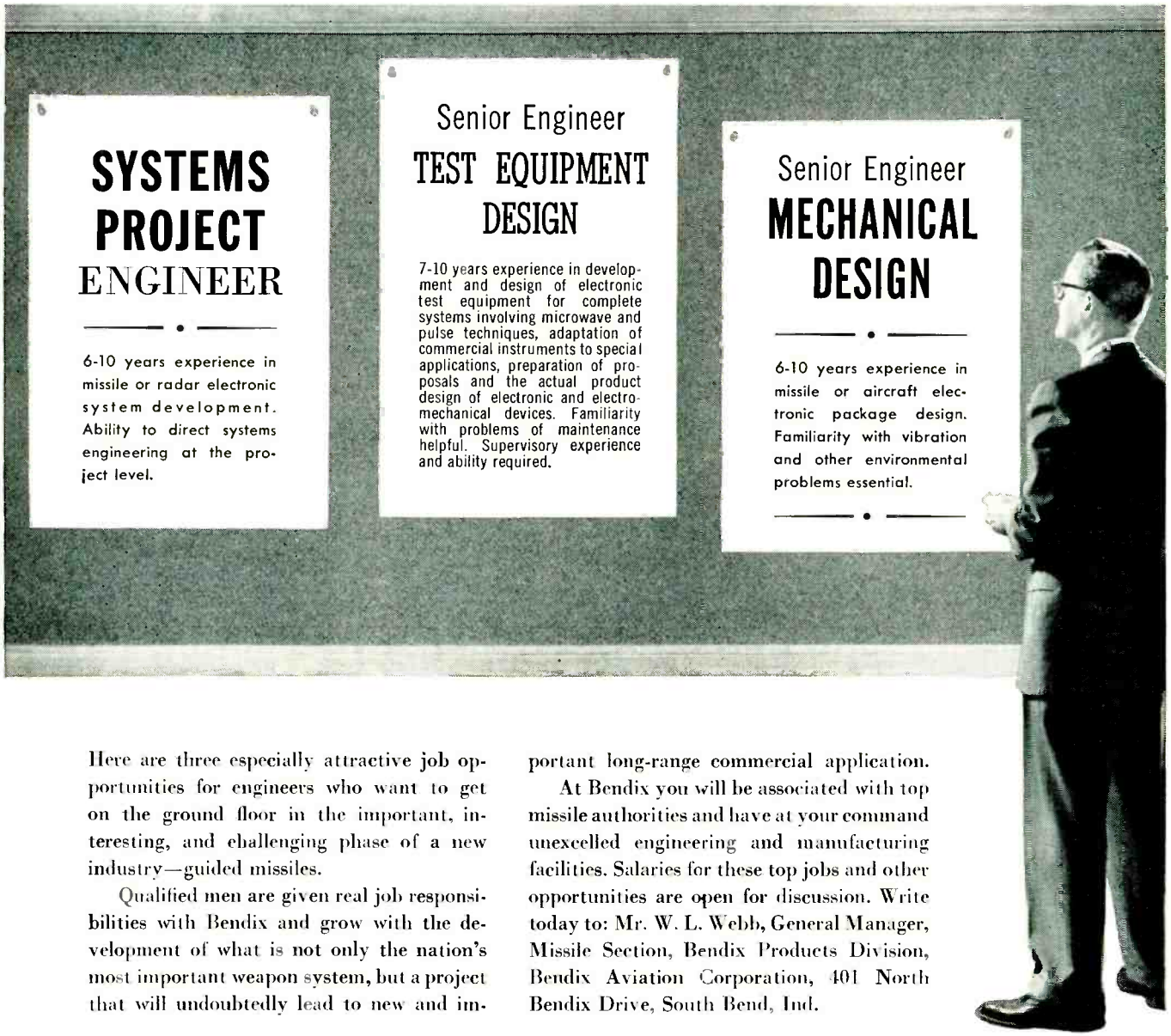
PACIFIC SEMICONDUCTORS, INC.

10451 West Jefferson Boulevard
Culver City, California
3959 Lincoln Avenue
Chicago, Illinois
2079 Wantagh Avenue,
Wantagh, Long Island, New York

THREE SALES OFFICES:

3 SENIOR ENGINEERING JOBS

WELL WORTH LOOKING INTO . . .



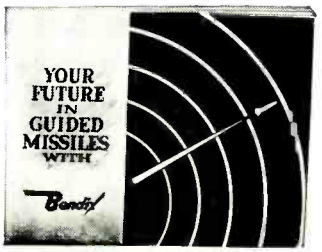
Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

Qualified men are given real job responsibilities with Bendix and grow with the development of what is not only the nation's most important weapon system, but a project that will undoubtedly lead to new and important long-range commercial application.

At Bendix you will be associated with top missile authorities and have at your command unexcelled engineering and manufacturing facilities. Salaries for these top jobs and other opportunities are open for discussion. Write today to: Mr. W. L. Webb, General Manager, Missile Section, Bendix Products Division, Bendix Aviation Corporation, 401 North Bendix Drive, South Bend, Ind.

23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book is bound to interest you. Write for it today.



problem: Electronic Assemblies

Long experience in this highly specialized field enables Makepeace to supply efficiently and promptly electronic assemblies which meet the most unusual and exacting specifications.

Even Tighter Tolerances Than MIL-T-85-B Are Readily Met

When Makepeace supplies such components as rotary joints, antenna feeds, crystal mixers or highly specialized assemblies, manufacturers can be confident that each one will not only exactly meet but often surpass the most rigid specifications. Our engineering staff is always available for consultation on the design and manufacture of prototypes and for projection of production runs . . . and our unusually complete testing facilities are at your disposal. We invite your inquiries.

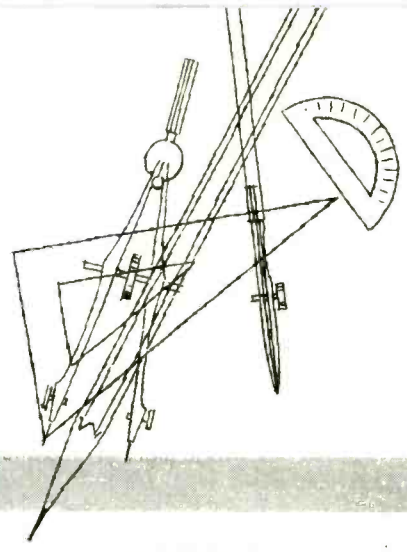
Makepeace Can Meet Your Requirements In Collector Rings and Brushes

Complete self-contained assemblies are available either MAKEPEACE standard 2 to 24 circuit stock ring and brush assembly or units made to meet special requirements for miniature large electro-mechanical rotating devices and systems. New materials and techniques developed in our laboratory and tried in the field provide hitherto unobtainable performance at very high speeds and extremely low noise levels as well as economy of space and weight. Slip rings from .050″ O.D. to 48″ O.D. in solid or laminated precious metals are available in a great variety of alloys. Our unique facilities for designing, testing and engineering are at your disposal.

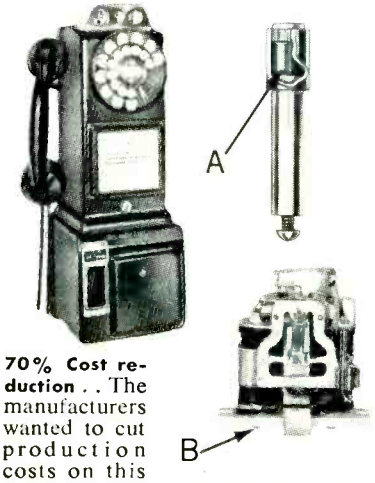
D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
ATTLEBORO, MASS.

Sales Offices: New York • Chicago • Los Angeles • Columbus
Precision Rectangular Waveguide Tubing • Microwave Components • Microwave Transmission Assemblies • Electrical Contact Material • Formed Electrical Contacts • Crossbar Welded Contacts • Slip Ring and Slip Ring Assemblies • Brush Assemblies • Precious Metals Clad To Base Metals • Sheet — Tubing — Wire and Assemblies • Sendzmir Precision Rolling

Creative..Imaginative

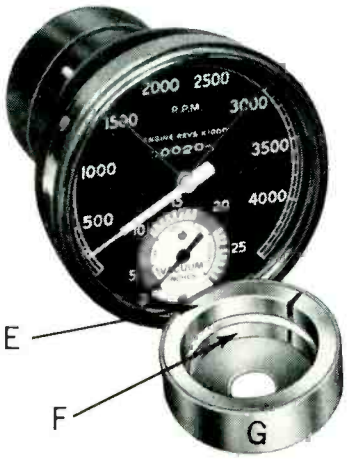


TELEPHONE PAY STATION



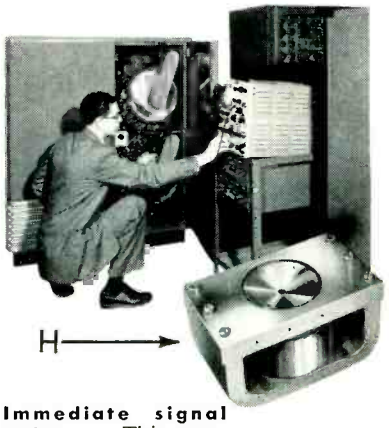
70% Cost reduction . . The manufacturers wanted to cut production costs on this pay station. They wanted more positive mechanical action built into the unit . . to minimize service calls. So their engineers, cooperating with Indiana Permanent Magnet engineers, designed a new magnet assembly using specially designed Indiana Permanent Magnet (A), replacing a conventional type steel magnet. Assembly functioned as a part of coin return assembly (B). Results were (1) flux increase 27% . . from 2750 Maxwells with steel magnet to 3500 with Indiana Permanent Magnet using Alnico III, (2) magnet cost reduced 70%, (3) weight saving, (4) simpler design, (5) fewer service calls required.

TACHOMETER



Improved stability . . This company wanted a permanent magnet assembly that would produce sufficient torque and give added stability to this tachometer. By varying the analysis and heat treatment of the magnet material, Indiana Permanent Magnet engineers developed special Cunife permanent ring-magnets (E) and (F) which, as component parts of permanent magnet assembly (G), provided the necessary torque and improved stability. Results were: (1) the desired torque and improved stability; and (2) the redesigned magnet lent itself better to the limited space resulting from the new design.

ELECTRONIC DATA PROCESSING MACHINE



Immediate signal pickup . . This computer manufacturer required a permanent magnet to build up a magnetic surface of the *drum* used in Magnetic Reader and Recorder . . a unit of its Electronic Data Processing Machine. Indiana Cunife Permanent Magnets were selected. Results: Strong, dependable signals because of the high coercivity and permanence of Indiana Permanent Magnets. Another permanent magnet (Indiana Alnico) was used for the housing (H) in the magnetic *tape* Reader and Recorder unit of the processing machine. Results: Immediate signal pickup . . sensitivity high because of magnet's high efficiency.

Here are six thumbnail case histories of permanent magnet applications. You'll notice they all have one thing in common. *Special engineering and design service* by Indiana Permanent Magnet engineers . . design service that reflects original thinking, creative thinking, imaginative thinking . . was an important part of each story!

This specialized service is available to you without obligation. Indiana Permanent Magnet engineers, with more than 45 years experience in designing permanent magnets for some 40,000 applications, will welcome the opportunity to assist you in the development of *your* permanent magnet designs.

Indiana maintains the *world's largest engineering staff devoted solely to the design and application of permanent magnets* . . and the world's largest and most complete permanent magnet research and production facilities.

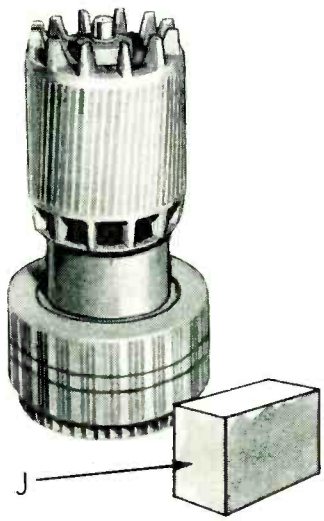
For additional details and a copy of Engineering Design Manual 4-A-5, write The Indiana Steel Products Co., Valparaiso, Ind.

World's Largest Manufacturer of Permanent Magnets

Permanent Magnet Design

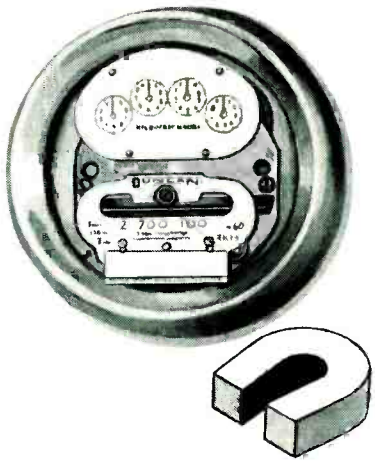
helped these original equipment manufacturers reduce costs . . improve performance . . simplify design

GENERATOR



Permits uninterrupted service . . This permanent magnet generator uses 28 Hyflux Alnico V, bar-shaped Indiana Permanent Magnets. Minimum maintenance and long service are two "musts" in generators . . and Indiana Permanent Magnets help insure these qualities. These magnets (J) eliminate necessity for slip rings and commutators, which in turn eliminate sparking and resulting radio or TV interference. And there's no heat from the field coils . . nor is excitation power needed.

WATT-HOUR METER

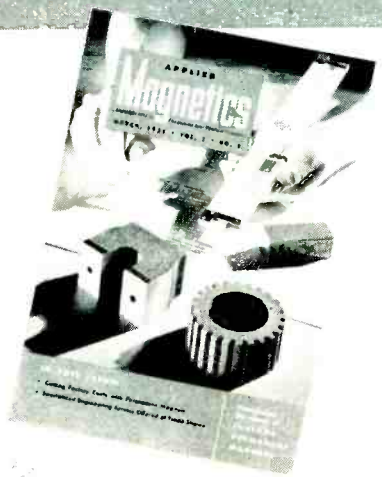


Insures field stobility . . This watt-hour meter is typical of hundreds of different types of instruments and meters using permanent magnets. A single phase, 15-amp, 240-volt unit, it uses an Alnico I Indiana Permanent Magnet weighing only 0.2 lb. Uniformity and stability of field, so necessary for maintaining the initial accuracy of this meter over a long period of years, is provided by magnets of the type shown above. Similar magnets are widely used in mass spectrometers, vibration pickups, galvanometers, medical instruments, speedometers, fluxmeters, etc.

SOUND-POWERED TELEPHONE

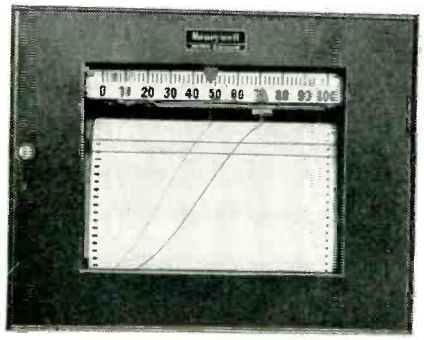
Compactness . . was an important consideration in the design of this electric self-powered telephone. It is powered not by batteries nor other outside power sources . . but rather by sound waves which initiate a series of electrically activated impulses. Working with Indiana Permanent Magnet engineers, the manufacturer, by selecting Indiana Sintered Alnico II, was able to use extremely small magnets while maintaining high performance requirements. "Indiana Sintered Alnico II," reported this company's sales manager, "made possible small magnets of high coercive force, *the greatest single factor in size reduction of transducers* compared to that possible with other alloys."

Free Subscription: Write for your subscription to "Applied Magnetics" . . a bi-monthly publication carrying helpful and practical information about permanent magnets and their application to industrial and consumer products. Please write on your company letterhead.



INDIANA PERMANENT MAGNETS

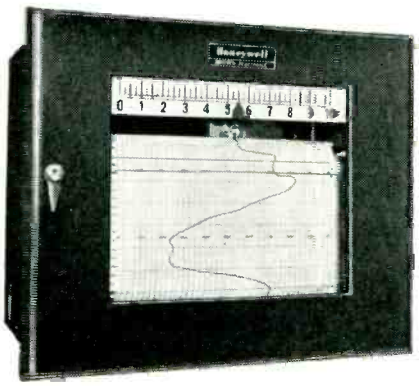
THE INDIANA STEEL PRODUCTS COMPANY, VALPARAISO, INDIANA



DUPLEX RECORDER

Simultaneously plots two continuous data curves vs. time. Has two independent measuring systems, each with any desired range.

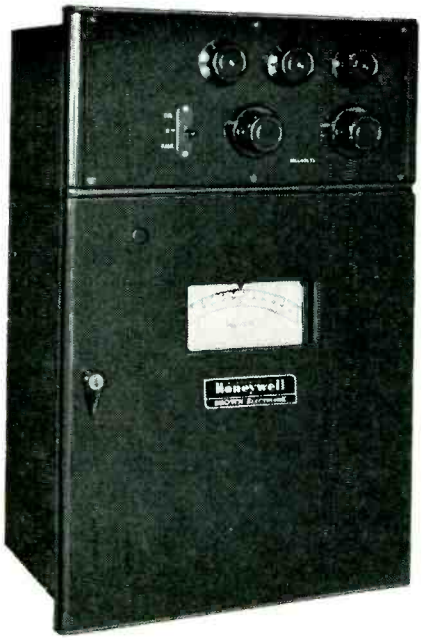
See Data Sheet 10.0-6.



½ SECOND PEN SPEED RECORDER

Pen traverses full 11-inch calibrated width of chart in only ½ second. Precise recording of variable changes without overshoot or hunting. Full accuracy, even on spans as narrow as 3 millivolts.

Request Data Sheet 10.0-13.



BROWN-RUBICON PRECISION INDICATOR

Combination of high-precision potentiometer and automatic *ElectroniK* indicator, for highly accurate small voltage measurements and for calibrating meters, bridges and similar equipment . . . with minimum operator fatigue.

See Data Sheet 10.0-2.

Get *better* test data *quicker* – with *ElectroniK* research instruments

Research men everywhere are finding that specialized *ElectroniK* instruments can save them many precious hours of lab time, by automatically taking over much of the routine burden of gathering, recording and plotting data.

In addition to the models pictured here, Brown instruments for research include *ElectroniK* Function Plotters, in single pen and double pen types . . . *ElectroniK* Extended Range Recorder and Adjustable Span Recorder . . . the *ElectroniK* Null Indicator, modern successor to the galvanometer . . . and a family of precision-made servo components. For a discussion of how these can help in your own research program, call your nearby Honeywell sales engineer.

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BROWN INSTRUMENTS

First in Controls

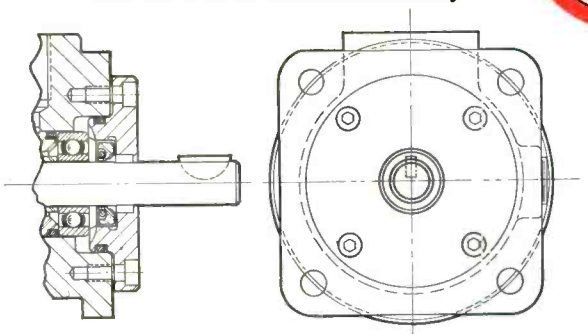
One Waldes Truarc Ring Saves a Pound in Weight Replaces Cast Retainer Plate and Four Screws

Denison Vane Type Pump/Motor

The Denison Engineering Company of Columbus, Ohio uses a Waldes Truarc Beveled Retaining Ring (Series 5002) in their pump/motor to achieve a simpler, lighter, more easily assembled unit and to cut both material costs and production time.

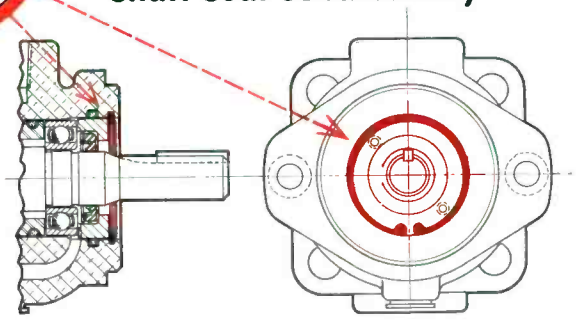
This vane-type power package operates as either a fluid pump or motor without alterations of any kind. Built for 2000 psi continuous duty, rugged construction was essential.

Shaft Seal Subassembly



Experimental Way: One cast retainer plate plus four socket head cap screws hold unit together. Assembly requires skilled labor, machinery, time-consuming careful adjustment.

Shaft Seal Subassembly



Truarc Way: Waldes Truarc beveled retaining ring (internal 5002) retains shaft and bearings, takes up accumulated tolerances rigidly, prevents leakage around shaft. Unit is one pound lighter. Assembly is quick and easy, more economical.

Wherever you now use machined shoulders, bolts, snap rings, or cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble.

More than 5,000 stock-sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

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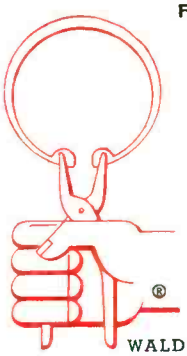

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RETAINING RINGS

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

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

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electronics

W. W. MacDONALD, Editor

MAY • 1955

CROSS TALK

► **TOUGH TRANSITION** . . . One of the major differences between government and commercial business is that in the first case equipment is designed primarily to meet specifications while in the second it is more often designed to meet competition.

This (plus other things widely realized in the industry) further explains why manufacturers who have run across something really exciting while fulfilling a military contract cannot always immediately convert it into civilian dollars.

► **ANOTHER BARRIER?** . . . One of the problems faced by a large and active group studying reliability is the fact that design parameters of such things as guided missiles must embrace not only the requirements of missiles as we know them today but also those likely to be devised tomorrow.

A lively and uninhibited imagination is called for, as well as intimate knowledge of current art. For who, regardless of stature, can be sure how fast or how far or how high a missile can go.

► **CRYSTALLIZING** . . . Gains in transistor production are in large part due to perfection of automatic instrumentation and control for devices that "grow" germanium and silicon crystals.

When making semiconductors a curveless Dior look is one goal of production men. To keep diameter constant, temperature in the crucible must be held constant within, say, 0.1 degree C at the 940-degree melting point of germanium. For silicon, which melts around 1,400 degrees, the control job is still more difficult, particularly when the level of the melt drops continuously.

To do the job, instrument men joined forces with r-f heating engineers. Automatic temperature controllers were modified to provide greater accuracy. The electronic heaters were modified to permit practically instantaneous throttling of power output to the work coil. New circuits were devised, among them one that avoids system time lags by chopping the heating power around a dozen times per second.

► **FUNNY FIRE** . . . Back in February we noted that a remotely operated California tv station burned to the ground before the studio knew there was a fire because there was no telemetering alarm system.

Since then, in the same area, another station has had a serious fire because—of all things—the doorbell shortcircuited.

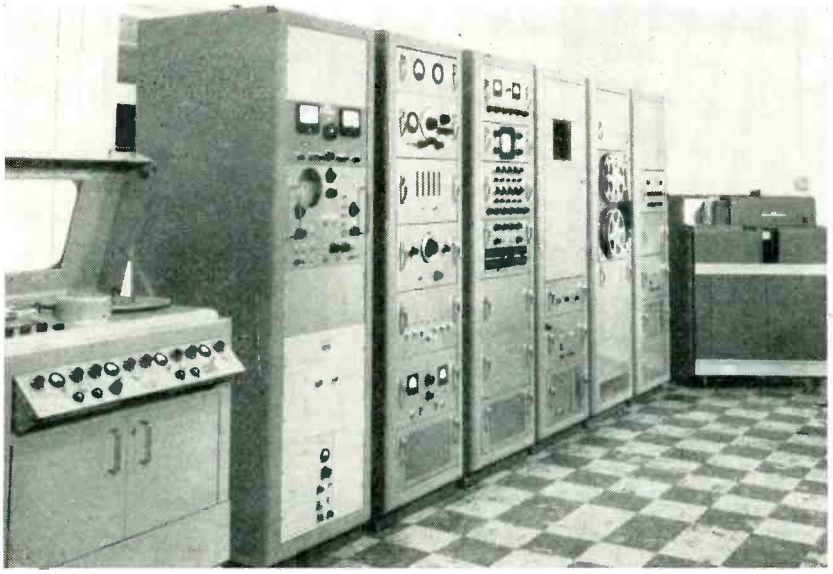
LOOKING AHEAD . . .

Mergers will continue at high level for some time. Among reasons: Desire of big non-electronic companies to diversify, need of expanding small companies for capital, current activity of investment houses

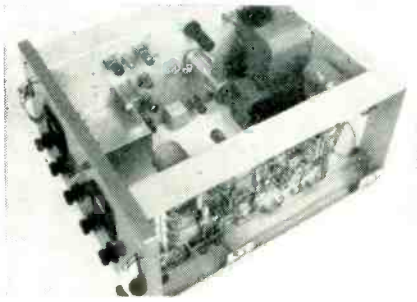
Watch for important but not necessarily last-word improvements in color-tv picture tubes by at least two manufacturers in midsummer or early fall

Business will be good but more highly competitive in period immediately ahead, new products with real advantages moving well, older products or those merely face-lifted not so well

Mechanized assembly trend, rolling up in size like a snowball, will bring some headaches, among them difficulty educating assemblers to specify wanted overall characteristics of packaged parts combinations rather than individual component requirements



Data reduction system including tape recorder, test equipment, f-m data converter and linearizer, data processor and summary punch



Discriminator of f-m data converter

By E. M. McCORMICK
Riverside, California

Data Reduction System

AN AUTOMATIC telemeter data reduction system has been developed and constructed to fulfill some of the data reduction requirements of the Missile Evaluation Department at the Naval Ordnance Laboratory, Corona, California. The input to the equipment is standard f-m/f-m telemeter signals recorded on a ½-inch magnetic tape and played back on an Ampex 500 tape recorder. The output consists of samples of the telemetered function to three decimal digits punched in IBM cards. These samples can occur up to 400 times per second. The system will be used also for other forms of analog-to-digital conversion including pulse-width telemetry and quantizing outputs from analog computers.

The equipment consists of the f-m data converter and linearizer designed and made in the Missile Instrumentation Section of the National Bureau of Standards (now Naval Ordnance Laboratory) Corona, California, and the Millisadic data processing system designed and made by Consolidated Engineering Corp., Pasadena, California. The author is merely reporting on the equipment made jointly by these groups.

General Operation

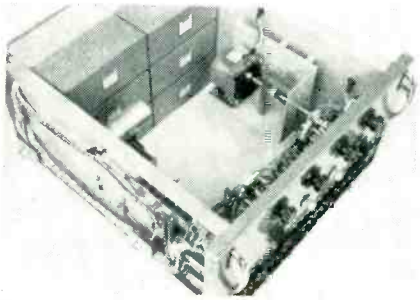
The f-m data converter and linearizer demodulates any one of the f-m subcarriers and produces a pulse train, at each sampling time, whose count is proportional to the original telemetered function. The discriminator is extremely stable. Nonlinearity in the system from missile function to output can be corrected in a built-in inverse function generator. A total of 88 tubes is used.

The data processing system counts the pulses in the pulse trains from the f-m data converter and linearizer and causes the count to be punched into cards by an IBM 523 summary punch. Time count is provided by accumulating in a six-decimal-digit counter the pulses which occur at a rate of 100 per second. Each card contains six decimal digits of time; 5, 10 or 20 samples of three decimal digits each; and 14 arbitrary digits making a total of 80 columns. Since the information can be punched, in interlocking operation, at a rate of only one card per second by using a speeded-up IBM 523, intermediate storage is used. This is provided by an Ampex digital tape recorder (DTR) in which the time-serial digital information is recorded at 20, 10 or 5 inches per second. This results in an effective card rate of 20, 10, 5 or 1 per second. The sampling rates are, therefore, from 400 to 5 per second. About 512 tubes are used in this section.

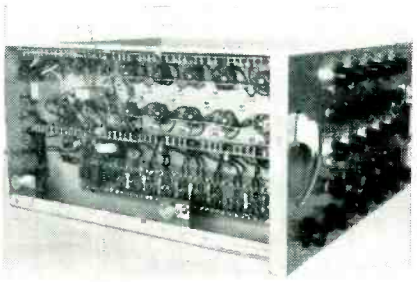
Card Record

The first six columns of a card indicate time to 0.01 second. This time is that of the first sample (columns 7, 8 and 9) whose sign is punched in column 10. The next sample is punched in columns 13, 14 and 15 with its sign in 16. The time associated with each sample is computed by linear interpolation between values on successive cards. Where no signs need be punched, 20 samples can be stored on a card, the first in columns 7, 8 and 9, the next in 10, 11 and 12 etc.

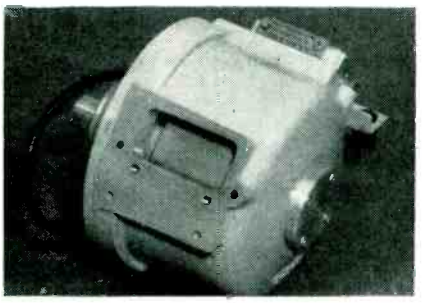
The last 14 columns of the card represent information not on the digital tape but entered directly by manually operated switches on the



Control chassis of f-m data converter



Linearizer chassis of f-m data converter



Two-card drum storage unit

SUMMARY — Flight data telemetered from experimental missiles is decommutated and recorded on punch cards for further study by f-m data converter and data processing equipment. Designed for f-m/f-m telemetering, the system also handles pulse-width signals

for Missile Telemetering

IBM punch control circuitry of the data processing equipment. Generally, these are used only for identification of records.

Telemeter Data Reduction

Reduction of f-m telemeter data involves converting the instantaneous value of subcarrier oscillator frequency to the function which it represents. A hypothetical example is given in Fig. 1. Curve A represents a case where the function varies linearily with frequency s. That is, $f = ms + b$ where s refers to the deviation of subcarrier frequency itself. The operation corresponding to m is referred to as the scale factor and b is the offset.

In this example, scale factor is 0.15 degrees per cycle and the offset is −2.5 degrees. When the function-versus-frequency curve is nonlinear as shown in curve B, it is convenient to consider the difference betwen it and a straight line as A as the nonlinear correction. Hence, in general, a system for reducing telemetered data must include scale factor, offset and nonlinear corrections. In the system described these corrections can be made by either analog or digital means.

The f-m data converter front end is illustrated in Fig. 2. The signal obtained on playback of the telemeter tape contains all subcarriers and the one to be reduced is separated by a band-pass filter. A d-c voltage proportional to the telemetered signal is obtained from the f-m discriminator and converted to a 0 to 400-microsecond signal. This pulse-width signal is initiated each time a sample trigger occurs and is used to gate a train of pulses from the clock pulse generator. The number of output pulses indicates the absolute value of the function at that time. A zero-set arrangement is provided that permits setting the zero function indication to any frequency in the band. This, with a negative function value marker punched into the card permits offset correction. Where nonlinearity correction is required it is accomplished by making the width of the 0 to 400-microsecond gate vary nonlinearly with the input voltage. This is done by a linearizer function generator which produces the nonlinear difference function needed to correct a type B curve to an A type.

The f-m to d-c converter is of the pulse-averaging type. As shown in Fig. 3, the subcarrier frequency is amplified, limited and differentiated to produce a series of pulses, one for each positive-going zero crossing. These pulses trigger constant-amplitude, constant-duration pulses. Normally, their duration is half the period of the subcarrier band center frequency. As the subcarrier frequency increases, the proportion of on time increases. By filtering the pulse waveform, a d-c signal proportional to deviation from center frequency can be obtained.

The discriminator has three provisions to reduce d-c drift below that of other pulse-averaging discriminators. The amplitude of the pulse in both the on and off states is accurately limited in amplitude. A highly stable and repeatable pulse-width signal is used. This is obtained by a phantastron precision delay and dual-triode coupling circuit. Finally, d-c drift is held to a minimum by a chopper-stabilized system. A high-gain operational

amplifier with considerable negative feedback is used. The filtering action is obtained by an R-C network as a part of the feedback path of this amplifier permitting 60-db-per-decade roll-off in the low-pass filter. The nominal cutoff frequency can be set to 35, 100 or 200 cps.

Pulse Train Conversion

The amplitude comparators and the precision saw-tooth sweep generator provide an output pulse accurately delayed from the input sample pulse in proportion to the input voltage. A 0 to 4-v input signal from the d-c discriminator will cause the pulse delay to vary 0 to 400 microseconds corresponding to a maximum count of 999. This is shown in Fig. 4A.

The precision sweep and the signal output from the discriminator are applied to two terminals of the crystal diode bridge null detector. A switching signal of 30 mc is applied to two other terminals. As long as the signal-voltage amplitude differs from the saw-tooth output, there is an output from the null detectors. However, when the amplitudes match, the bridge is in balance resulting in no output. The output is amplified by a 30-mc i-f strip with a gain of 4,000. The change in amplitude at balance produces the desired output from the amplitude comparator.

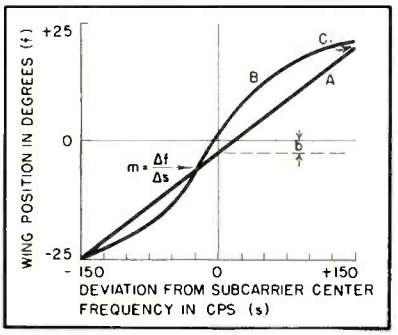


FIG. 1—Reduction of linear *(A)* and nonlinear *(B)* f-m telemeter signals

Zero-Set

One of the amplitude comparators is a part of the zero-set circuit. The input is a presettable d-c voltage which causes the output pulse to occur at a corresponding time in the 400-microsecond range (Fig. 4B). In making offset corrections, it produces a pulse corresponding to the zero value of the telemetered function. When the function value is negative, the signal pulse occurs before the zero-set pulse; if positive, after the zero-set pulse. The electronic switch basically causes the first in time of these pulses to turn the gate on, the second to turn it off. The result will be, for positive values of function, a gate (Fig. 4C), whose leading edge is fixed as it is triggered by the zero-set pulse and whose trailing edge varies in time with the amplitude of the function. When the function goes negative, trailing edge remains fixed, leading edge varies (Fig. 4D).

Total pulse width excursion is limited to 400 microseconds. By adjusting the zero-set d-c input, this pulse can be set to any desired place in the band and can accommodate an all-positive or all-negative function. An automatic servo system is provided which will reduce the pulse width to zero when a frequency corresponding to zero function value is fed into the discriminator.

The output gate duration controls the number of pulses in the train at each sampling time. This is done by switching the clock pulse generator which operates at 2.5 mc or lower depending on the scale factor required.

The zero-set pulse defines the positive and negative portions of the function excursion. Through the electronic switch and the coincidence gate circuits a negative function marker pulse can be obtained (Fig. 4E). However, when the signal pulse follows the zero-set pulse the negative marker pulse causes an X punch in the card. Since the X can not be recorded simultaneously with the sample itself, an additional circuit not shown causes one sample trigger to produce a pulse train. The next results in a recorded sign indication. Similarly, a positive marker may be obtained when desired.

Function Generator

The zero set will provide the offset corrections and the continuously variable clock pulse generator the scale factor corrections. The nonlinearity correction is made by a linearizer function generator. The linear curve would require a linear saw-tooth voltage. The linearizer function generator, however, produces a sweep voltage which, when added as shown to curve *A*, produces a comparison voltage to the null detectors corresponding to curve *B* in Fig. 1. The sample trigger causes this nonlinear sweep, 400 microseconds in duration, to be generated at the same time as the saw-tooth sweep. This is done by starting a 25-kc oscillator which produces 40-microsecond pulses that are counted in a ring-of-ten counter. The amplitude of each of the output pulses (Fig. 5) can be varied by a precision ten-turn potentiometer and the polarity controlled by a switch. It is possible to approximate

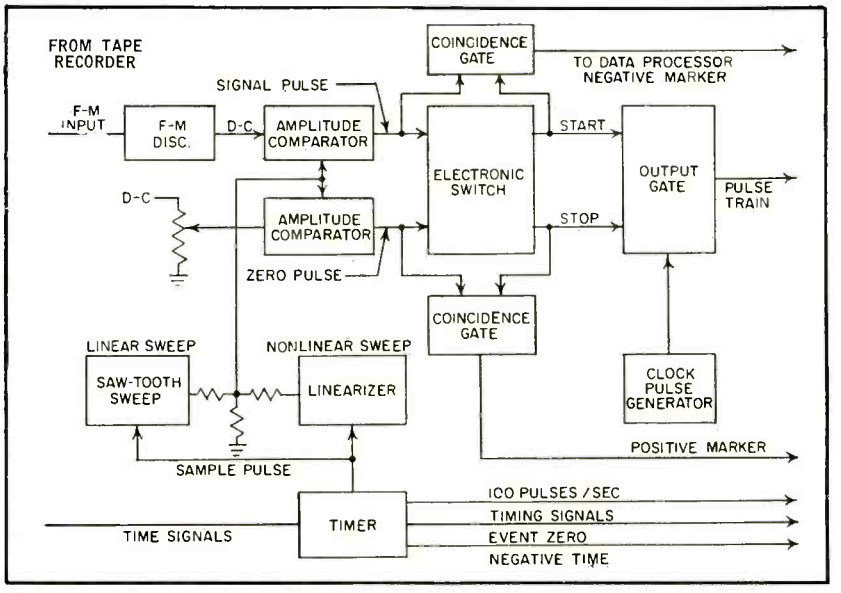


FIG. 2—Frequency-modulation data converter and linearizer

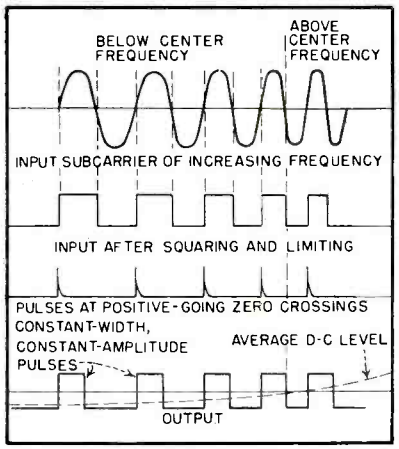


FIG. 3—Operation of pulse-averaging f-m discriminator

most nonmonotonic continuous correction curves by adjusting the pulse amplitudes and polarities. A low-pass R-C filter provides smoothing.

Setup Procedure

For a linear function a plot of the function versus subcarrier frequency would indicate the frequency for which zero function value is desired. After setting the input oscillator to this frequency, the servo on the zero set will automatically make this adjustment. The operator then adjusts the clock pulse generator so that the pulse train count for a point such as *C* (Fig. 1) will correspond to the function value.

When the curve is nonlinear as in *B*, line *A* need not be the best-fitting straight line. It is necessary only that it cross the desired curve *B* at a subcarrier frequency corresponding to the beginning of the sweep from the function generator. Then the range of the function, maximum to minimum, is divided into ten equal parts. The value for the subcarrier oscillator frequency for each is noted. Setting the input subcarrier frequency to the lowest of these frequencies, the potentiometer and switch for the first pulse is varied until the desired count is noted in the data processor counter. Then the subcarrier oscillator is set to the next higher frequency of the ten and the controls varied until the second function value is indicated.

The range time signals are applied to the sync-lock channel of the Ampex 500. The timer circuit (Fig. 2) separates the timing signal from the sync-lock and, when it occurs as a time burst, demodulates it. The exact nature of the timing signals varies from one test range to another. However, for the systems it accommodates, the timer produces 100-pps signals. In addition, the zero-event time signal is extracted and applied separately to the data processor. It resets the time counters at that time.

The timer also produces sampling pulses at the rate of 400, 200, 100, 80, 50, 40, 25, 20, 10 and 5 per second synchronously with the timing signals. This simplifies the problem of associating a time value with every sample.

General Operation

The general data processing operation is shown in Fig. 6. The input data samples would normally be the pulse train from the f-m data converter. However, it can be a pulse-width signal which gates an internal 2.5-mc oscillator to give a 999 count for 399.6 microseconds pulse width.

Digital operations are performed on a binary-coded decimal digit basis in 1-2-4-8 form. Each decimal digit is actually four binary digits. Since decimal digits are handled sequentially, the operation is time series. However, because these serial operations involve parallel transfers of four binary digits, it is actually series-parallel.

After the sample has been counted, the three-decimal-digit number which has been totalized in the counters is transferred in time-parallel to three register decades for temporary storage. Immediately after this, the counters are cleared and are free to count another sample. The count now stored in the registers is transferred in time-series directly, channel *A* Fig. 6, to the magnetic drum memory if the sampling rate is 20 per second or less. Otherwise channel *B* Fig. 6, it is transferred to the magnetic tape (DTR) for playback later at this lower rate, Fig. 6 channel *C*.

This information occurs time-serially corresponding generally to the way it is to be stored longitudinally on a punch card. However, cards are punched or read while being pulled sideways through the punching or reading stations. That is, all the 9's to be punched in each of the 80 columns are punched at the same time, the 8-row next and the 7-row next through to the last row which is the negative indicator row. Hence, a column-to-row transformation must be made. This is done by storing the information temporarily on a magnetic drum

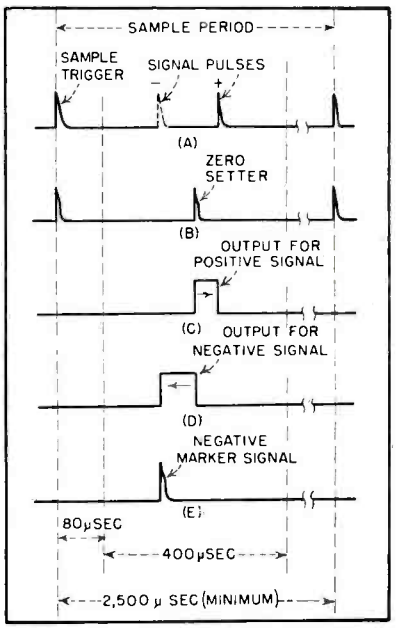


FIG. 4—Time relationships in f-m data converter

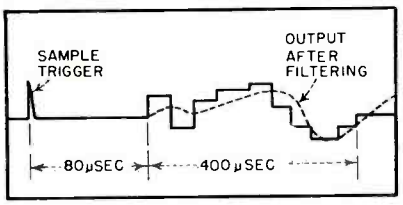


FIG. 5—Correction of nonlinear data

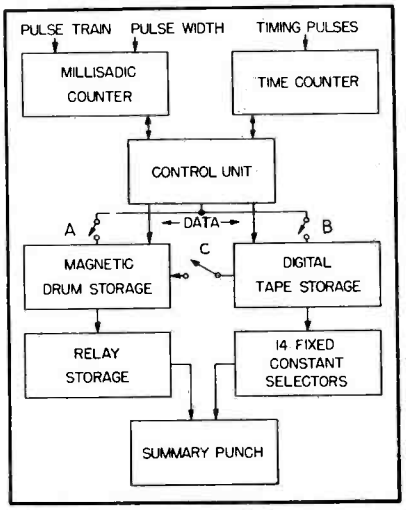


FIG. 6—Data processing system

which holds two cards of information. This is a four-inch drum rotating at 12,000 rpm. While one card is being written on the drum time-serially (column-wise) as it occurs, the preceding card is reading into the summary punch row-wise. The contact closures for the IBM punches are provided by 66 mercury relays, each operated by a thyratron.

Digits are stored in time-series on the drum until 5, 10 or 20 samples have been stored. At this time a summary punch cycle is initiated and the card is indexed through the punch row-by-row. After a row has been punched, the drum is interrogated for numbers equal to the following row number. Coincidence detection circuits set up proper column contact closures while the card is between rows. At the time the card is indexed at the next row, contacts are all set up so that the proper holes will be punched in that row. This is done simultaenously for 66 columns of the punch card.

Range time pulses at 100 per second are accumulated continuously in a six-decade counter. At the beginning of each group of 5, 10 or 20 samples of data, range time information is transferred with the data to the magnetic drum or tape. Provision has been made to indicate negative time by applying a pulse which will cause an excess count in the most significant digit of time. This produces an X punch in the card, leaving five digits to indicate time.

Tape Data Pattern

The magnetic tape data pattern is shown in Fig. 7. This indicates the manner in which the information is handled in combination time-parallel modes. The data pattern shown is for five samples per card. The pattern contains seven parallel tracks. The center track contains the sprocket pulses which indicate where the data is present on the other tracks. The left track contains the card pulse. Its occurrence on read-out causes the drum storage to switch so that the card of information just recorded will now start reading into the relay storage and the part just read-out is switched to recording. Furthermore it causes the summary punch to start its card cycle.

A computer pulse is recorded on the next track. This has no application in the present system but it is intended to facilitate direct transfer of digital information on magnetic tape into the ElectroData 30-203 magnetic-drum computer. This would eliminate the necessity for punching cards and subsequent reading of them. This pulse occurs

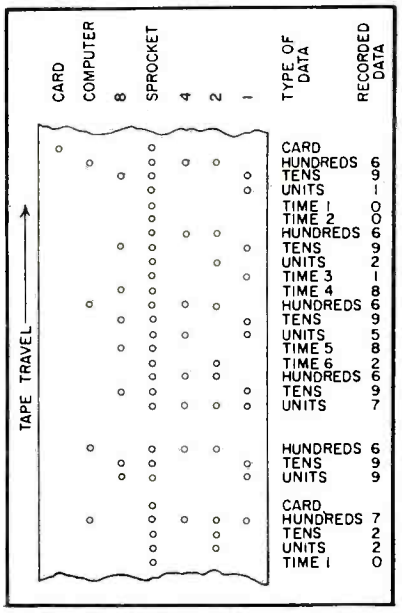


FIG. 7—Magnetic tape data pattern

once every two samples. The last four tracks contain the decimal digit in four-binary-digit form.

The first three sprockets indicate the hundreds, tens and units value of the first sample. This is followed in order by the first two digits of the six digits of time. Next are the three digits of the second sample and the next two digits of time. The third sample is followed by the least significant digits of time. Hence, transferring a sample is a five-step procedure. The fourth and all following samples will be followed by two blanks where no sprockets exist.

A 20-sample card would require 100 equivalent sprocket times. Since the read-back rate is 1 inch per second, the pulse density is 100 per inch. The 2,400-foot roll of 1-inch tape normally used on the DTR will hold over 28,000 cards of information. This, incidentally, would require 8 hours to punch out.

The magnetic tape unit has a skew-corrector circuit. This assures the simultaneity of pulses which should occur in time parallel even though they may not be read at the same time by the seven reading heads. Basically, it causes the pulses on all tracks to be lengthened so that the existence of pulses can be determined by interrogation at a later time after all pulses have had an opportunity to occur.

For independent operation, the data processor has an internal oscillator for control and will provide triggering pulses to an external device. A third mode of operation permits the data processor to function in synchronism with time signals applied to it. This operates only at a one-card-per-second rate. Both the f-m data converter and the data processor have provision for producing a single sample for test purposes.

Evaluation

The linearizing, offset and scale-factor adjustments in the equipment have certain limitations. If the function varied from 1,300 to 1,500 units, these values could not be punched out as this is beyond the range of the counter. Even a function whose count varied from 300 to 500 units could not be accommodated as the zero set cannot be zeroed outside the 0 to 400-microsecond range and, in addition, the counters cannot be preset. Providing for punching signs reduces the sampling rate by one-half. However, these limitations may not be particularly serious in many cases.

Telemetered data is punched into cards to permit subsequent operations while in digital form. If a digital computer is to be used for these operations it can be programmed to do the linearizing, offset and scale-factor adjustments.

The f-m data converter and linearizer was designed by a group at the National Bureau of Standards under the direction of M. G. Pawley. Much of the circuit design is due to E. D. Heberling. The diode bridge comparator was designed by M. L. Kuder of NBS in Washington. The data processing system was designed by a group at Consolidated Engineering Corp. under the direction of H. E. Burke.

UHF Rebroadcasting Cuts Costs

SUMMARY — Exchange of programs between two stations in Maine reduces production costs and gives greater coverage. Parabolic-dish antenna at Lewiston-Auburn end of link picks up Portland channel 53 with 48-db signal-to-noise ratio on video and 50-db ratio on sound. Picture resolution is 350 lines

By HENRY G. ROOT

Chief Engineer
Radio Station WLAM
Lewiston, Maine

OFF-THE-AIR pickup of uhf tv programs for rebroadcasting is being used by two stations to obtain increased coverage without increasing costs. Community-television type equipment and modified home receivers are used to provide reliable high-quality video and audio on an around-the-clock basis.

Station WPMT channel 53 (704 mc) in Portland Maine is 30.5 miles to the south of the twin cities of Lewiston and Auburn where WLAM-TV channel 17 (488 mc) is located. Station WPMT has an erp of 10.8 kw with an 0.9-deg beam tilt and WLAM-TV radiates 15.8 kw with a tilt of 0.5 deg. As shown in the contour sketch, Fig. 1, the Lewiston-Auburn pickup point at a 420-ft ground level is considerably above the main transmitting lobe of the Portland antenna located at a height of 336 ft. As a result of this, rebroadcasting Portland's signal from an off-the-air pickup is more difficult than the converse.

Attenuation between dipoles in free space is

$$db = 10 \log \frac{183.5 \times 10^6 R^2}{\lambda^2}$$

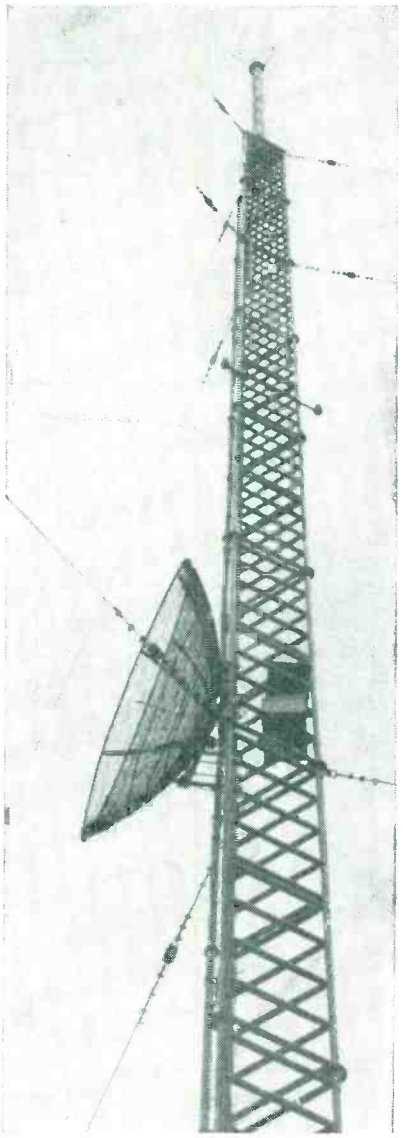
where R is the distance in miles and λ is wavelength in meters.

At 704 mc. λ is 0.425 meter. Since distance R, between Portland and Auburn, is 30.5 miles the attenuation over this distance will be 119.64 db.

The 10.8-kw output of WPMT dissipated across 72 ohms (the Z of a dipole in free space) would give a developed voltage of 880 volts. Across a 72-ohm load connected and matched to a half-wave dipole at the 30.5-mile distance, 880 μv volts would exist.

This is too low a signal strength to contend with mixer loss, lead-in loss and accompanying noise and still provide a good noise figure, especially in the immediate presence of a 1-kw ch-17 transmitter. This is the theoretical situation and of course the practical approach has some shortcomings by direct comparison. The results obtained above however are relative.

To overcome much of the pickup



Dish antenna picks up signal from Portland, 30.5 miles to the south, for rebroadcasting. Station's 488-mc transmitting antenna is at the top of the 250-ft tower

noise of the ch-53 signal from WPMT a parabolic dish shown in Fig. 2A is used. At 704 mc this is of a practical size. With a mouth diameter of 6.85 wavelengths, or 9.6 ft, a gain of 20.68 db is achieved. This type of antenna offers practically a complete null at its rear. This is a useful feature because 0.6 of a mile in this direction lies a 13-kw f-m transmitter and in Bangor 80 miles to the north in the same direction a ch-2 outlet is allocated. The rear null provides more protection than a parasitic array.

The parabola has the focus in the plane of the mouth and thus will not materially affect the impedance of the dipole placed there. A folded dipole is used so that it may be rigidly soldered to the stand-off element without insulators. The impedance is transformed to 72 ohms by a balun. The focal point of the dish bears the relation $F = D/4$. Beam width is given by 137.5 (D/λ) in the vertical plane. In the horizontal plane it is approximately 1.25 times this figure, providing a beam spread 20 deg vertically and 25 deg horizontally. Power gain is 20.7 db.

The output of the antenna is fed to a converter and a 30-db ch-2 amplifier as shown in the block diagram Fig. 2B. The connecting lines ahead of the high-gain amplifier are cut to odd multiples of $\frac{1}{8}$ wavelength at 488 mc. This includes lengths of coaxial cable within the panels of the units. No interaction of the station carrier on the pickup is experienced.

Community television pickup equipment is used. This consists of the ch-2 converter head and a 30-db amplifier.

The following results were obtained in day-to-day operation picking up ch-53 for rebroadcast: There is approximately 200 μv pickup on the 72-ohm take-off from the dipole. Antenna gain is 66.5 db going into the converter. An estimated 11-db mixing loss reduces this to 55.5 db on ch-2 coming out of converter. A 30-db low-noise amplifier raises this level to 85.5 db before entering the coaxial downlead. Approximately 6-db loss is experienced on this down lead. The signal level is 79.5-db above 1 μv or 9½ mv across 72 ohms as it enters the transmitter house. The pickup system contributes approximately 20-db of noise. Signal-to-noise ratio under these conditions is excellent. A 48-db signal-to-noise ratio is obtained at the output of the receiver.

In effect this ch-2 signal is far better than a class-A contour would

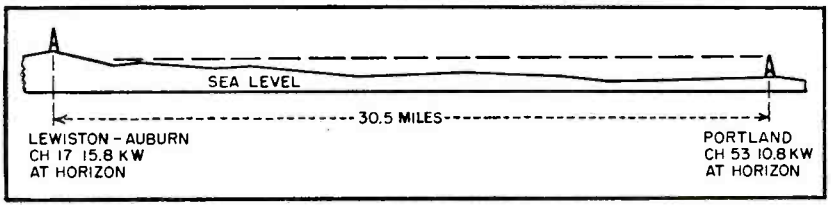


FIG. 1—Pickup antenna at Lewiston-Auburn station is above the main lobe of the Portland radiation pattern

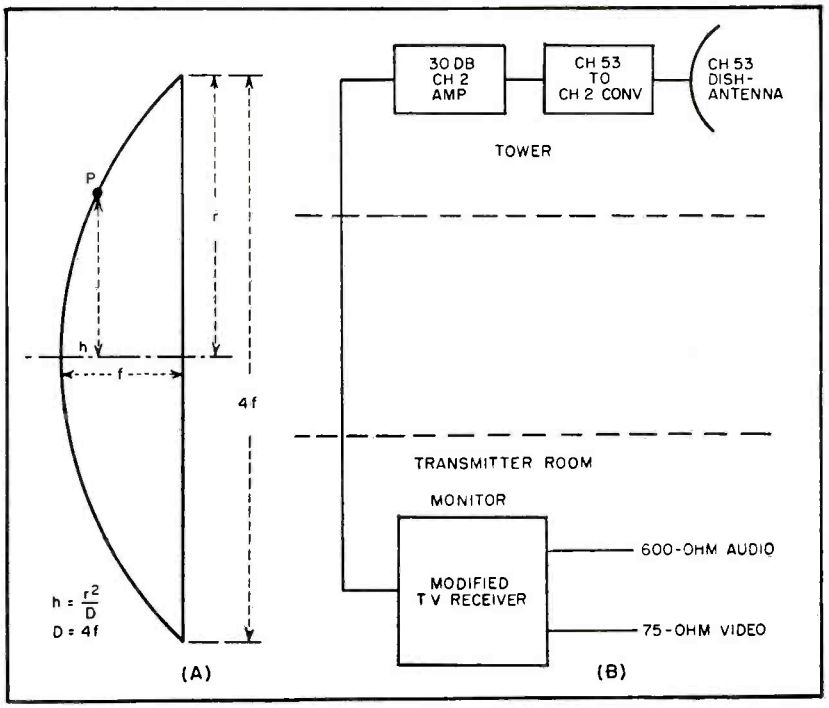


FIG. 2—Design parameters for 704-mc ch-53 dish antenna (A) used in rebroadcast pick up system (B)

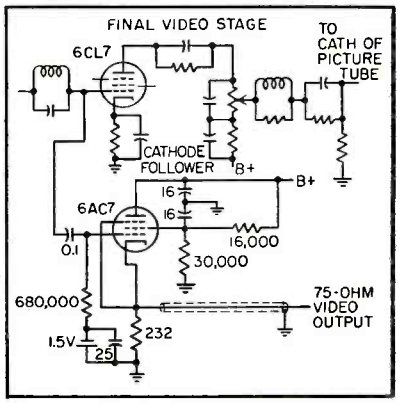


FIG. 3—Modification of commercial tv receiver for rebroadcast monitor

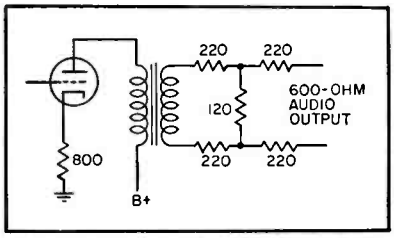


FIG. 4—Receiver audio is modified to match 600-ohm line

offer. In some receivers used as monitors, it might be necessary to disable the cascode front end to accept such a strong signal. This is done by opening up the cathode of the first tube in the tuner leaving the filament on as normal. Conversion will go on as usual within the receiver.

When WPMT picks up a signal from WLAM, two stacked yagi antennas are used. Because WLAM-TV is at a higher elevation and has higher power, less of an antenna is required at Portland. The pickup antenna is well within the main lobe of the WLAM-TV 15.8-kw carrier and does not require much antenna gain prior to conversion. Equipment similar to that at the Lewiston-Auburn end is employed in the system except that the conversion is from ch-17 to ch-2.

Cathode-follower circuits were placed in pickup monitor receivers to feed composite video from receiver output, and the last audio stage was modified to feed low-distortion audio to a 600-ohm load.

An RCA receiver, model 16-S-349U, was selected since the input could accommodate coaxial line. This receiver is built on one chassis with only the picture tube as a separate unit. This simplifies maintenance.

Receiver Modifications

The last video stage, a 6CL6, modulates the cathode of the picture tube. This means that the control grid of this stage has a negative sync signal. This is the proper polarity for feeding to the program switching buttons on the control console. The contrast control in this receiver is in the plate circuit of this last video stage and so does not affect the picture taken off the grid. The picture tube and its brightness and contrast controls still function as normal.

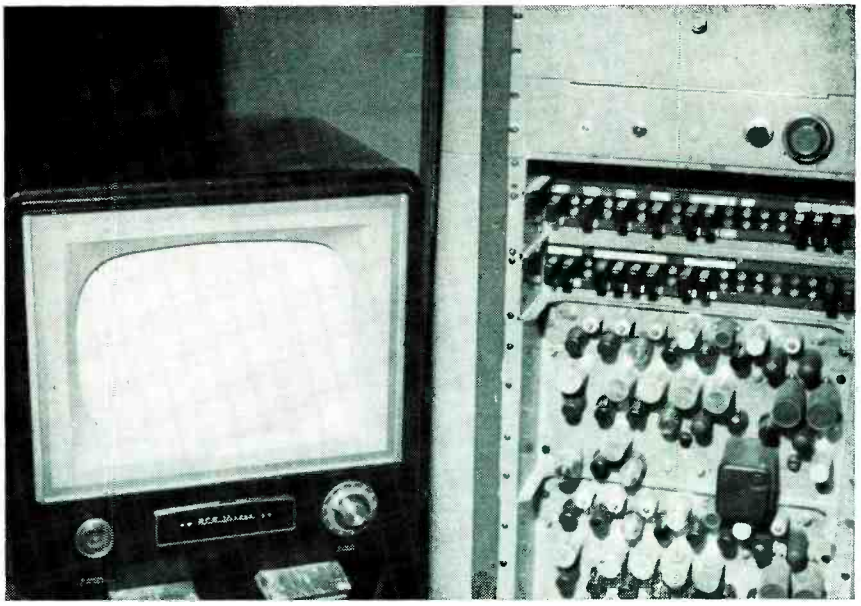
Another advantage is that a power transformer is used in this receiver, making the chassis cold with respect to other racks permiting a heavy copper ground strap to be run to station ground. This is a necessity because of the presence of the tv transmitter in the same room.

Modifications made in the receiver are shown in Fig. 3 and Fig. 4. A cathode follower is coupled to the grid of the last video stage. The bias for the 6CL6 should not pass to the grid of the cathode follower. The choice of coupling capacitor was such as to still have a low value of reactance at 20 cycles. A 0.1-μf capacitor has 80,000 ohms reactance at this frequency. This is adequate provided at least a 680,000-ohm resistor is used in the grid circuit of the follower. Cathode source impedance using a 6AC7 is 111 ohms. Since this is higher than the desired 75-ohm line impedance a parallel 232-ohm resistor is used for matching.

Plate and screen current flowing through the cathode impedance constitute approximately 0.9-v drop and this is added to the fixed bias of 1½ volts already on the control grid. Gain of this cathode follower is 0.4.

Input capacitance of a 6AC7 is normally about 11 μμf. In a cathode follower it is reduced by the factor $[1 - (E_L/E_S)]$ or 0.6. This leaves an input capacitance of 6 μμf which is too low to cause trouble in the 6CL6 grid. The cathode follower is mounted on a small utility box on the top rear of the chassis.

The last audio stage of the receiver is a 6V6. This provides too much power and distortion for broadcast use. The pin connections are identical to those of a 6J5 triode so that by replacing the tube and changing the cathode-bias resistor from 560 ohms to 800 ohms and cutting out the cathode bypass capacitor, distortion and output drop markedly.



Video and audio outputs of modified commercial receiver are fed to patch panel for distribution

600-Ohm Output

The output transformer matched approximately 6,000 ohms when feeding from a 6V6. However, to obtain low-distortion, the plate load for a 6J5 should be approximately 15,000 ohms. A UTC-A25 transformer with a 600-ohm line secondary was used. The power output can easily reach 100 mw with this tube and so a 20-db line pad also was added to attenuate the output.

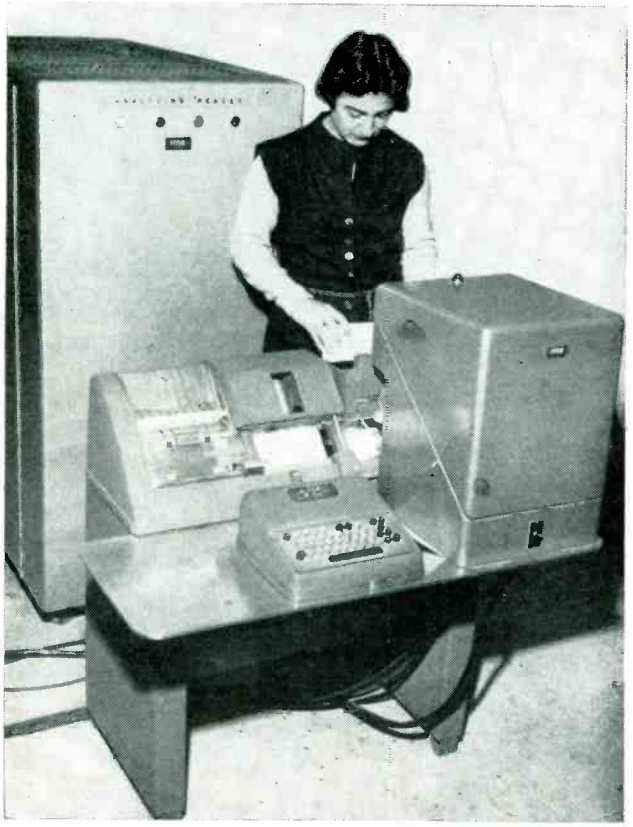
Using the system described the following results were achieved: 48-db signal-to-noise ratios on video; better than 50-db signal-to-noise ratio on voice and frequency response within 3-db from 50 to 12,000 cps.

Video bandpass on the receiver is 3.5 mc. On a regular RTMA test chart, horizontal definition is 350 lines giving a completely acceptable picture. It is planned to expand this response band at a later date.

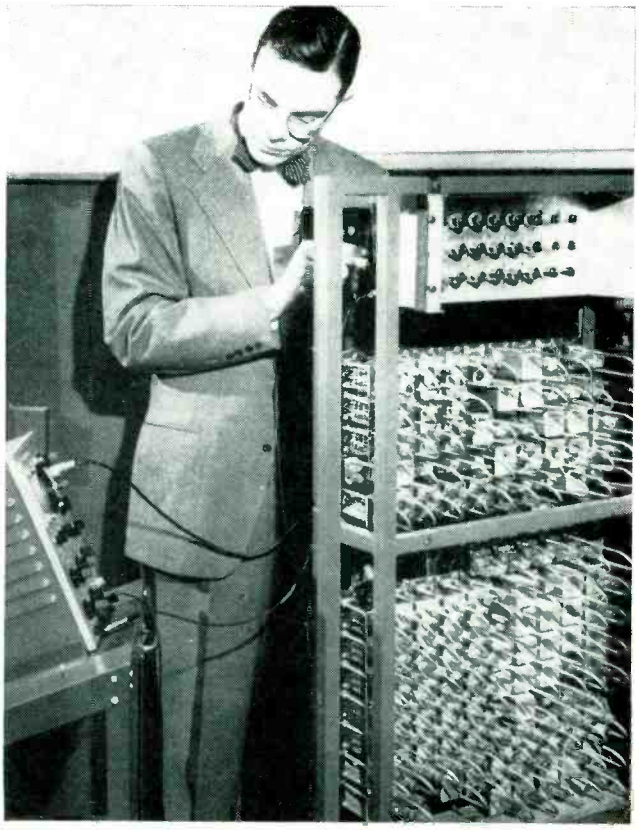
Photoelectric Reader

By DAVID H. SHEPARD and CLYDE C. HEASLY, Jr.

Intelligent Machines Research Corp.
Arlington, Virginia



Model of analyzing reader first developed for Farrington Mfg. Co. reads a ten-digit account number from a Charga-Card sales invoice and punches the number into the same card, using a standard IBM card punch.



Output pulses of the photoelectric scanner are analyzed by this small special-purpose digital computer which recognizes strokes by their unique pulse patterns and recognizes characters by their unique combinations of strokes.

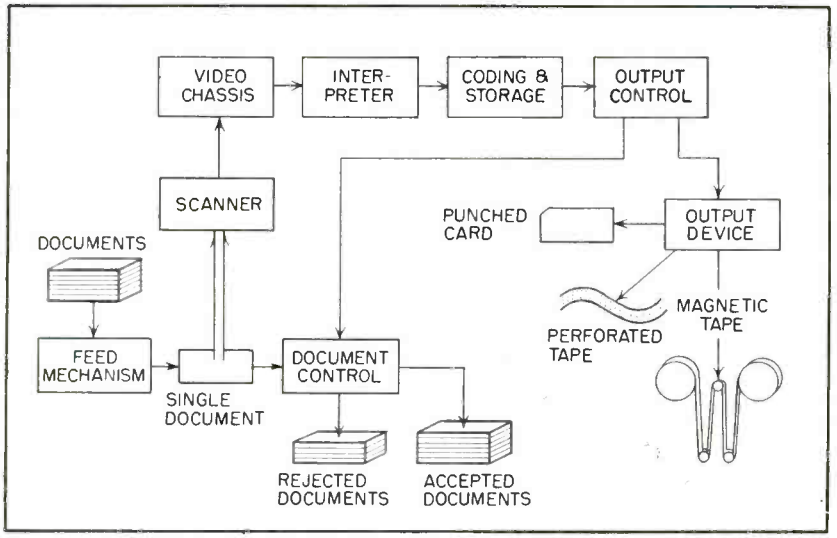


FIG. 1—Complete electronic reading system. Model now under construction will handle over 450 documents per minute, reading printed data on each in turn and transferring it to desired output medium at speeds over 300 digits per second

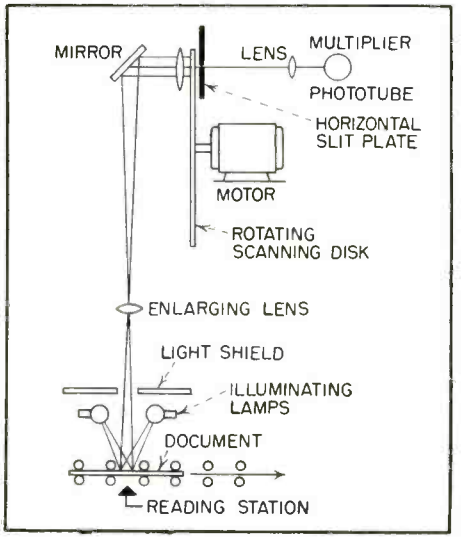


FIG. 2—Optical system for scanning one line of text on document as it moves past reading station

Feeds Business Machines

SUMMARY —— Ordinary printed characters are scanned vertically at rate of 3,600 words per minute, and resulting signals from phototube are fed into a character-recognizing memory for transfer to punched cards, perforated tape or magnetic tape as required for feeding the inputs of electronic business machines

WHILE processing machines for business data are by no means new, their use has largely been limited by the slow speed, high cost and low accuracy of keyboard operations. This is so because the transfer of information from business document to machine record medium has always required the services of an operator to read the information and to manipulate a keyboard of one sort or another.

The analyzing reader eliminates this human limitation on the speed of electronic business machines by reading ordinary typed or printed characters and recording the information on machine mediums such as punched cards, perforated tape or magnetic tape. It is also possible to use information sensed to control sorting, editing and table-lookup operations.

The operation of the reading system is shown in Fig. 1. A feed mechanism passes a single document in front of a photoelectric scanner which scans the characters on the document. Electrical pulses from the scanner are amplified and shaped by the video chassis and then analyzed by the interpreter. The interpreter identifies each character and sends identifying pulses to coding and storage. The storage serves as a buffer to meet the timing requirements of the output device. Information is withdrawn from storage and used to control the output device.

Storage also contains information as to whether or not the document has been successfully read. This decision is sometimes made by the interpreter, which can recognize errors caused by malformation of characters, or can be made by the several self-checking features built into the equipment. If a document has been correctly read, it is placed in the accepted pocket; if not, it goes into the reject pocket.

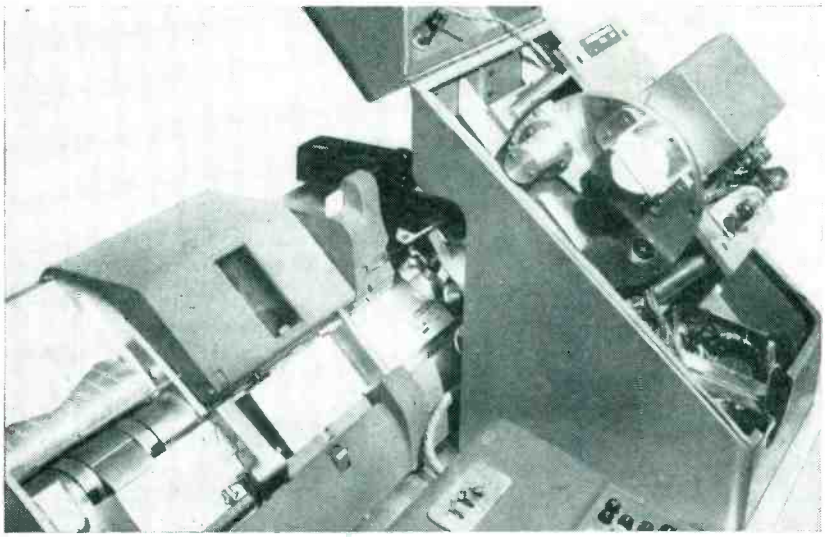
Operation of Scanner

A simplified diagram of the arrangement of the scanner is shown in Fig. 2. The document is fed at uniform rate past the reading station where it is brightly illuminated. The reflected image of the document is projected through a scanning disk onto a multiplier phototube through a series of lenses and a mirror.

The scanning disk, shown in Fig. 3, contains a number of radial slits which pass one at a time in front of a fixed slit. At the intersection of these slits, a point of light from the image passes through and is projected onto the phototube. As the disk rotates, the intersection of the slits moves to give horizontal scanning across the image.

Because the document is moving, the image is also in constant motion, so successive scans fall on successive portions of the image. Since the scan rate is much faster than the document motion, 25 or 30 scans will occur as one character passes the reading station.

As the image of a character is scanned, the output of the phototube will vary. Thus, during a single scan the output will contain positive pulses representating dark portions of the character, with the voltage between these pulses representing the background light in-



Document cards taken from stack move under scanner at right first for reading, then travel to punching position at center and finally to position at left for restacking

tensity reflected from the paper.

The means for producing constant pulse amplitudes in spite of wide variations in ink-paper contrast and light intensity is shown in Fig. 4. The gain of the multiplier phototube is controlled by changing the voltage applied to dynode 9. The output of the phototube is coupled to cathode follower V_2, which drives the cable connecting the scanner to the video chassis. The signal is amplified by a conventional two-stage voltage amplifier V_3-V_4 and fed to cathode follower V_5 which drives contrast control tube V_8 and the first stage, V_6, of the clipping amplifier.

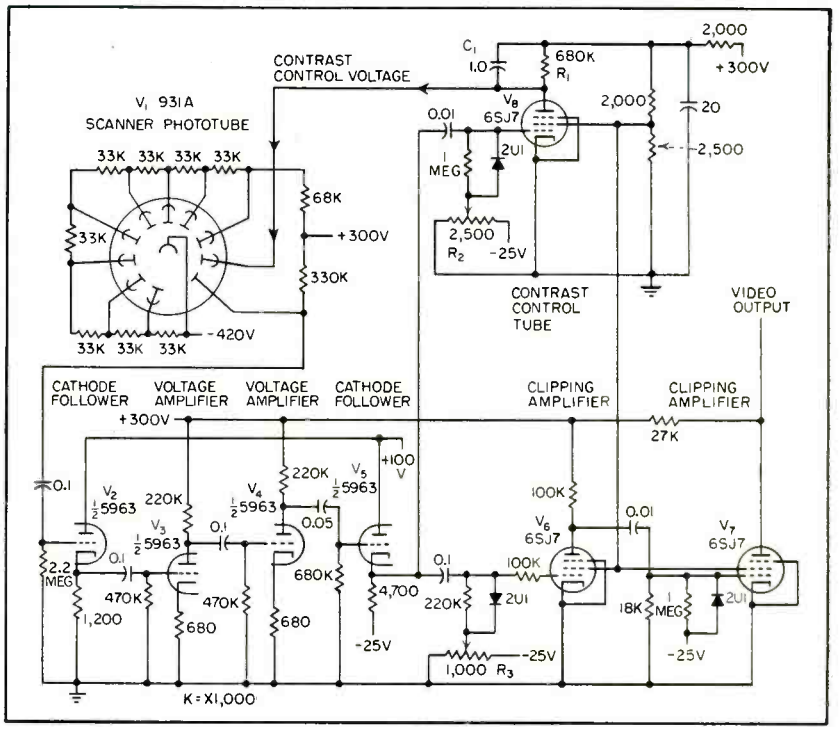


FIG. 4—Contrast control circuit used to compensate for varying degrees of contrast between document paper and characters printed on it

Automatic Contrast Control

The waveform of the amplified video signal fed to V_8 to adjust the contrast control voltage is shown in Fig. 5 for two successive scans. The distance between radial slits is greater than the length of the fixed horizontal slit, so that no light reaches the phototube for about 10 percent of each scan cycle. During this portion of the scan the output reaches its most positive value because the phototube sees true black, or no light. This pulse is, therefore, called the black pulse. The signal pulses which occur during any scan will not be as high as the black pulse since the dark portion of any character will reflect some light. The negative or background portion of this signal, represented by the voltage between the pulses, is clamped through the 2U1 diode to the negative voltage set by potentiometer R_2. The voltage difference between cutoff of V_8 and the setting of R_2 is the pulse amplitude which the contrast control system will seek to maintain.

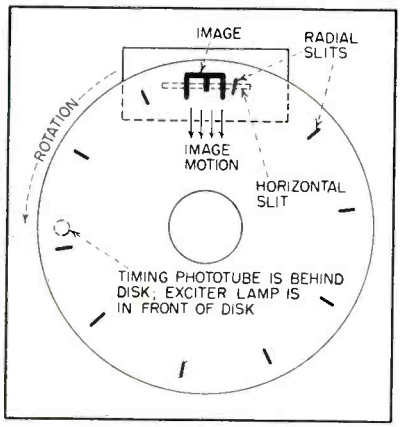


FIG. 3—Details of scanning disk used to obtain 25 to 30 vertical scans per character

When the voltage difference between black pulse and background is greater than the voltage between R_2 and cutoff, the black pulse will rise above cutoff and cause V_8 to conduct. During the black pulse, C_1 will charge through V_8. The higher the black pulse rises above cutoff, the larger the charging current and therefore the greater the voltage change on C_1.

During the interval between black pulses V_8 is cut off and C_1 tends to discharge through R_1. The time constant is the product of C_1 and R_1. This value is such that C_1 will discharge a small amount between black pulses. The charging of C_1 lowers the voltage applied to dynode 9, reducing the phototube sensitivity and thereby reducing the voltage difference between black pulse and background.

Because the second black pulse amplitude is reduced, it does not rise as high above cutoff and so the charging current is decreased and the voltage change on C_1 during conduction is not as great. During each scan the net voltage change on C_1, charging during black pulse and discharging during the balance of the scan, is a net decrease in the voltage applied to dynode 9. But the amount of this decrease gets smaller each scan until finally the black pulse only slightly exceeds cutoff and the discharge and charge during one scan are equal. When the charge and discharge have reached equilibrium, the peak-to-peak voltage between black pulse and background will very slightly exceed the voltage between R_2 and cutoff.

If light intensity or document background changes cause an increase in peak-to-peak voltage, the contrast control tube will conduct more heavily during black time and

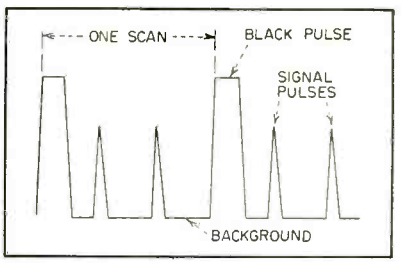


FIG. 5—Idealized scanner output waveform

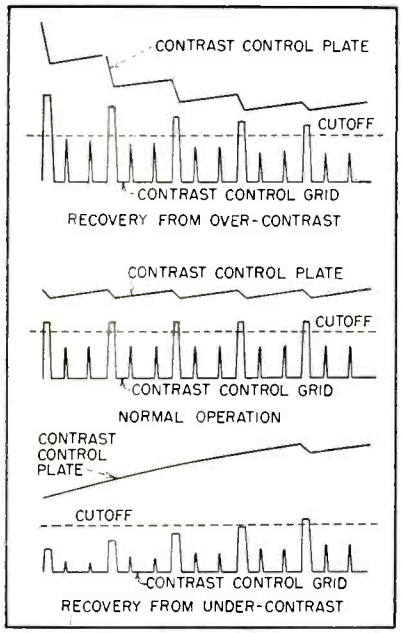


FIG. 6—Plate and grid waveforms of contrast control tube

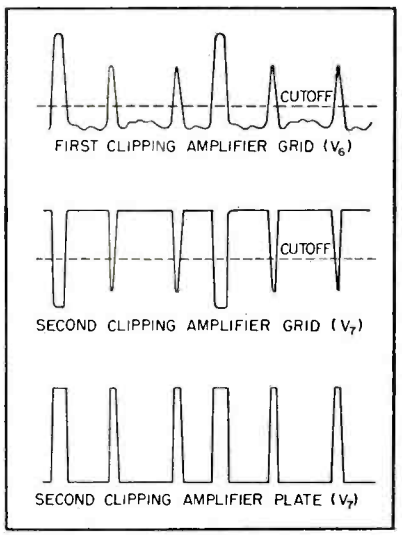


FIG. 7—Clipping amplifier waveforms

further decrease the dynode-9 voltage, thereby decreasing the peak-to-peak photomultiplier signal. After a number of scans a new equilibrium will be reached.

In the event of a decrease in signal, the black pulse will not reach cutoff and C_1 will continue to discharge through R_1. This will increase dynode-9 potential and increase the phototube sensitivity. As the sensitivity increases, the peak-to-peak voltage will increase until the black pulse again just exceeds cutoff and equilibrium is again established. Thus, the contrast control maintains a constant amplitude between black and the background. The grid and plate waveforms during recovery from over-contrast, normal operation and recovery from under-contrast are shown in Fig. 6.

Clipping Action

The regulated signal is fed to the grid of clipping amplifier V_6, where the positive peaks are clamped by the 2U1 to the voltage set by potentiometer R_3. Adjustment of this clamping voltage determines what portion of the signal will fall below cutoff and thereby be clipped. Correct adjustment of R_3 removes background noise caused by paper specks. Figure 7 shows the wave shapes at the grid and plate of V_6.

The clipping is repeated at V_7 where the negative portion of the signal is clamped at −25 volts. Since the signal is inverted at this point one result of the clipping action of the sharp-cutoff pentode is to reduce signal and black pulses (Fig. 7) to the same amplitude.

The video output signal at this point has been compensated for variations in contrast, is free of background noise and is of constant amplitude. It gives a yes-no indication as to the instantaneous presence or absence of a portion of the character.

Identifying End of Scan

To utilize the information in the signal pulses, it is necessary to remove the black pulse from the signal and to identify the end of each scan. This is accomplished by the timing phototube and lamp. The 1P42 phototube is located behind the scanning disk several frames away from the fixed slit. An exciter lamp is located in front of the disk. The exact location is such that the phototube sees a pulse of light just before each radial slit passes off the end of the horizontal slit. This causes a pulse to occur just before the end of the scan. This pulse is called the end-of-frame pulse.

As shown in Fig. 8, timing

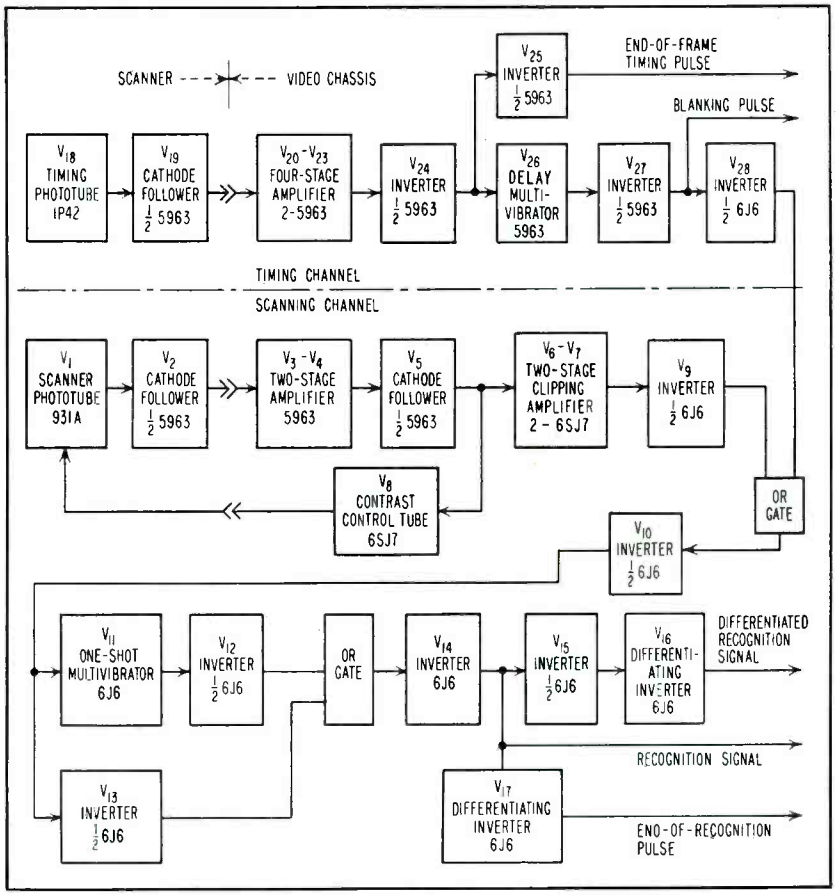


FIG. 8—Arrangement of stages on video chassis which feeds character-recognizing memory

phototube V_{18} feeds cathode follower V_{19}. The resulting negative output pulse is amplified by V_{20}-V_{23}, inverted by V_{24} and applied to the grid of single-shot multivibrator V_{26}. The output of V_{26} is a blanking voltage. It begins just before the end of one scan and lasts until after the beginning of the next scan. The length of the blanking pulse is adjustable and can be lengthened to blank out a portion of the scan where undesired information is being scanned.

The blanking signal is inverted twice in order to get standard voltage levels. This signal is fed into one half of an or gate. The video signal from V_7 is also inverted and fed to the other or gate input. This or gate will cut off V_{10} only when both of its inputs are negative. Since the blanking signal is positive, the negative black pulse and any signal pulses which occur during the blank pulse have no effect on V_{10}. After the end of the blank pulse the voltage goes to a negative value and any negative signal pulses occurring in the video signal will cause positive pulses in the output of V_{10}. These pulses are fed to single-shot multivibrator V_{11} and to inverter V_{13}.

Gate Action

The single-shot multivibrator produces a short fixed-duration pulse which is inverted by V_{12} and fed into one input of an or gate. The output of inverter V_{13} is fed to the other or gate input. The function of this group of circuits is to insure that any video signal will have at least a fixed minimum duration. If a short signal occurs, V_{11} will be triggered and its inverted output will appear at the or gate output. If a longer signal occurs, V_{11} will still cycle, but the output of the or gate will remain down until the signal stops. Thus, short signals are increased to an arbitrary value where as longer signals are unaffected.

The negative pulses from the or gate are inverted and fed to the interpreter and also to inverters V_{15} and V_{17}. The direct signal from V_{14} is called the recognition signal. Inverter V_{17} has a differentiated input and is biased so that it is normally conducting. The differentiated positive pulse does not affect the output, but the differentiated negative pulse at the end of the recognition signal cuts off the tube momentarily and causes a positive pulse. Since this pulse occurs at the end of each recognition pulse, it is called the end-of-recognition pulse and is fed to the interpreter.

The recognition signal is inverted by V_{15} and fed to differentiating inverter V_{16}. This inverter operates like V_{17} and is sensitive to negative changes only. Since the negative change in the inverted recognition signal occurs at the beginning of each recognition pulse, the output pulse from V_{16} will also occur at the beginning of each recognition pulse. This beginning-of-recognition pulse is also brought to the interpreter.

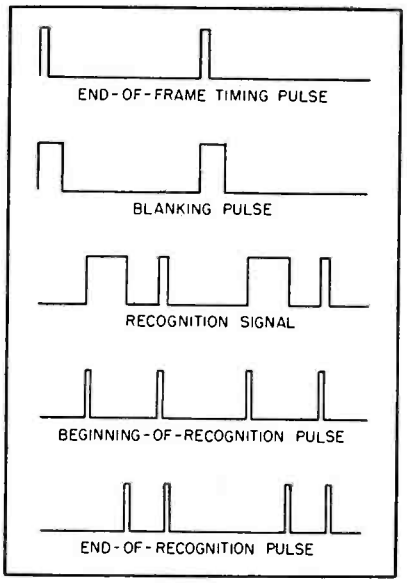


FIG. 9—Video chassis output waveforms

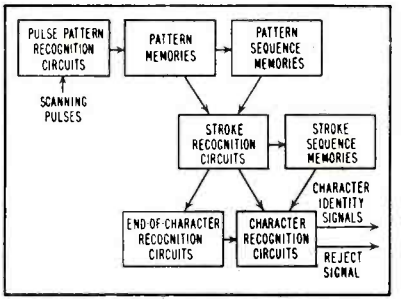


FIG. 10—Functional groups in interpreter

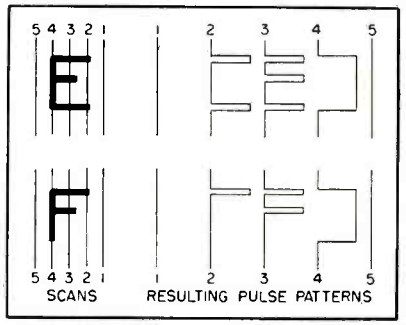


FIG. 11—Characteristic pulse patterns resulting from scanning of capital letters E and F

Recognition of Characters

In addition to the three recognition signals, the end-of-frame timing pulse and the blanking pulse are also sent to the interpreter. The timing relation of these pulses is shown in Fig. 9.

The interpreter which receives pulses from the video chassis is a special-purpose small-scale digital computer (Fig. 10) that examines the pulses and looks for various pulse patterns which are significant in isolating the identity of characters. These patterns and the sequence in which they occur reveal the identity of the characters.

With the letter E as in Fig. 11, the horizontal lines produce identical three short pulse patterns for many scans. The long vertical line on the left side produces a single long pulse during at least one scan. Thus the input signals to the circuit which identified E would be: long-vertical-line-left-side, three-horizontal-lines and nothing-to-the-right-of-three-horizontal-lines.

A similar logical description is set up in the form of signals to circuits representing each of the characters which must be recognized. The outputs of these circuits can be used in any way which is desired. If an impossible combination of strokes occurs, the interpreter recognizes this as an error and sends out a reject signal which can be used to separate the document in question into a reject stack.

If printed characters are well formed and free of interference, the accuracy is equal to the accuracy of punched card reading.

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and W. W. H. CLARKE

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Department of National Defence
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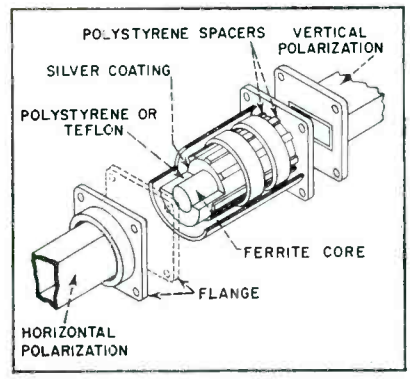

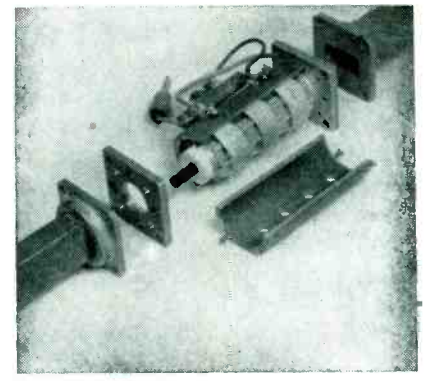

FIG. 1—Exploded view of ferrite gyrator designed to function as high-speed microwave switch

Microwave Modulator Uses Ferrite Gyrator

SUMMARY — Coaxially mounted ferrite slug in a circular waveguide section modulates microwave energy without disturbing power source. Modulating frequencies up to 1 mc or pulses involving 0.6-microsecond transients can be handled

RAPID SWITCHING or square-wave modulation of microwave power without modulation of the power source may be achieved by use of ferrite components to produce rotation of polarization as a switching function. However, failure of these ferrite components to behave rationally or consistently has made it difficult to predict the behavior of such microwave switching systems.

The ferrite circuit component to be described was designed to modulate microwave power to the greatest possible depth in response to a 100-kc square wave having rise and fall times in the order of 0.5 μsec. It was required that the modulator circuits operate with the least possible power dissipation.

Performance indicates that such a microwave switching system is capable of modulating at frequencies of 1 mc or perhaps higher or with pulse waveforms involving transients as short as 0.6 microsecond. This has been achieved by careful design of a current-driving circuit and a magnetizing field coil wound around a section of circular waveguide containing a ferrite core and by cut-and-try experiments with the walls of the circular waveguide and the ferrite core.

Switching Process

Figure 1 shows a cutaway view of the circular section of waveguide in which polarization rotation occurs. A ferrite slug is mounted coaxially inside a cylindrical waveguide section. A rectangular waveguide feeds microwave power into the circular section and this section feeds power to another rectangular section arranged so that the polarization of accepted power is perpendicular to that leaving the input section. The unrotated component is reflected.

Thus the switch is closed when there is no rotation (complete reflection) and opened fully when there is exactly 90-deg rotation. Rotation varies with magnetization of the ferrite and this is controlled by a coil wound around the circular section of guide. Switching speed depends on the quality of the current pulse passed through the coil and the response of the ferrite to the magnetizing pulse in terms of Faraday rotation. Inconsistent behavior in switches is related to hysteresis of the ferrite and to changes of ferrite properties with time and presumably with temperature.

Switch Development

The circuit in Fig. 2 was employed to generate 100-kc square waves which were passed as current pulses through the switch coil by V_4.

At first, attention was given to obtaining square current pulses by making the driving voltage waveform as sharp as possible. The voltage waveform as shown in Fig. 3

is necessary for obtaining square waves of fast current rise in an inductance. The potentials are required only to change the current and must be applied during the rise and fall times. After development of the coil and choice of ferrite, the waveforms in Fig. 4 were achieved in the switching circuit. Figure 4A shows the grid waveform applied to the driving stage; Fig. 4B shows the anode voltage waveform and Fig. 4C shows the current waveform taken across *R*.

The effects retarding the flux rise in the ferrite slug were found to be the capacitance of the coil and its capacitance to ground, the short-circuited-turn effect and the inductance of the coil, which increases with number of turns while the current required for 90-deg rotation decreases.

The brass fittings of the rectangular waveguides (Fig. 1) contribute to the short-circuited-turn effect and the conductor of the cylindrical waveguide is much more closely coupled to the coil. The coupling of the rectangular waveguides must be accepted unless elaborate modifications are undertaken. The effect of the cylindrical conductor may be reduced by slitting it longitudinally or by reducing its thickness or otherwise increasing its resistance to the high-frequency components of the switching waveform. Both precautions were found desirable in producing an optimum switch. The required inductance of the coil was substantially set by the limitation on current magnitude to permit use of a single driving tube. The ferrite is mounted in a Teflon jacket and the cylindrical waveguide section formed by coating the jacket with conducting paint.

The high capacitance to ground, in this case the conductive coating, and the capacitance of the coil itself were reduced by spacing the winding away from the guide on low-loss polystyrene ribs and winding the coil in three pies. These procedures raised the self-resonant frequency of the coil from 100 kc to more than 1.0 mc with the ferrite slugs in place. Wave-wound pies are an advantage where the number of turns cannot be contained in a single layer coil of the required wire size. Subsequent measurements have failed to indicate advantages in multiple wave-wound coils for a 300-turn coil. The ferrite slugs introduce considerable damping and the value of damping resistor to prevent ringing must be found experimentally. Ringing was not a problem before the self-resonant frequency was increased. The short-circuited-turn effect was removed by putting a lengthwise slit with a 90-deg twist in the conductive coating. Later experiments using a paint of slightly higher resistance also proved to be satisfactory without the slit. At present, rotators are being constructed in this manner.

Material for the slug is important and it has been found that Feramic MF 1331 offers the best performance of ferrites tried. Two paints were tried and applied by

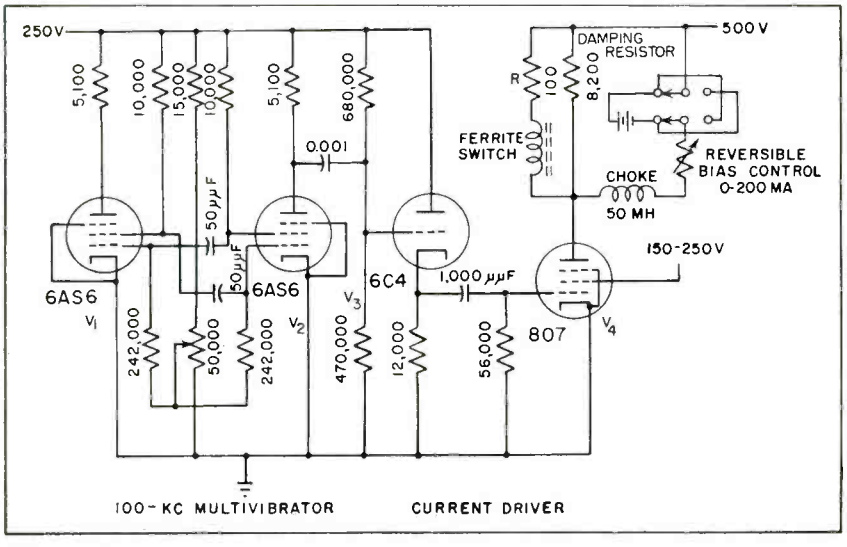

FIG. 2—Multivibrator, pulse shaping and current driving circuits used to produce square current pulses in coil

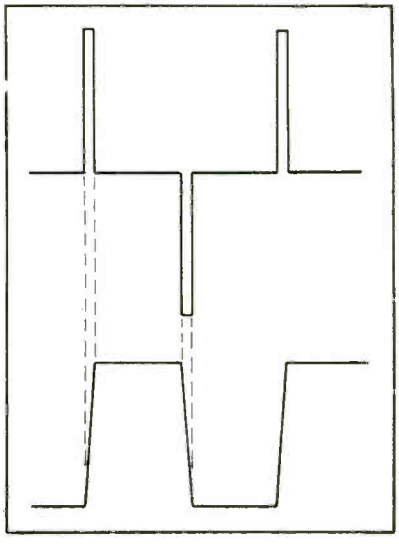

FIG. 3—Applied voltage, top, and resulting current pulse in coil, bottom

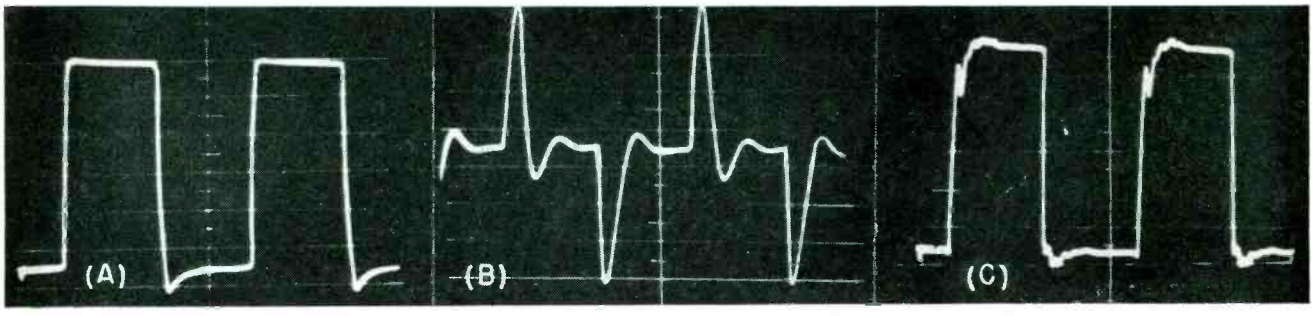

FIG. 4—Driving circuit waveforms illustrating grid voltage (A), anode voltage (B) and switch current (C)

brush. Du Pont Silver 4929, not baked although it is designed for baking on to glass, performed well with a 90-deg twisted slit to reduce the short-circuited-turn effect scribed in the paint when partially dry. Du Pont Silver 4817 had a lower conductivity and it was possible to obtain as high a switching speed with an unbroken film of this paint as with the slit scribed in film of Silver 4929. Since 4817 is not designed for baking and provides a low minimum attenuation through the switch, it is clearly the more desirable material.

Performance

The switches were tested in the waveguide circuit shown in Fig. 5, and the design produced the output waveforms shown in Fig. 6.

The waveforms are for different values of bias current. It may be seen that the bias is quite critical, particularly when very high through attenuation is required in the off switching condition. By critical adjustment this attenuation can be as high as 40 db, but in general operation a much lower figure must be accepted. The waveform even when adjusted carefully, changes to some extent with time. Figure 7 shows the through attenuation of the switch as a function of coil current. The switching requirement may be better understood from examination of this curve, since it is necessary to apply the switching current pulses to work between a maximum and adjacent minimum of attenuation. The hysteresis effect is clearly shown and the separation of the increasing and decreasing current curves is seen to be a function of the size of the closed cycle. To find the maximum of attenuation is a critical requirement for switching, but for modulation there is a good steep slope which proves stable. For consistent switching, saturation of the ferrite core at 90-deg rotation might provide improvement if the shut condition were made to correspond with 90-deg rotation. However, change of saturation rotation with temperature could lead to poor stability.

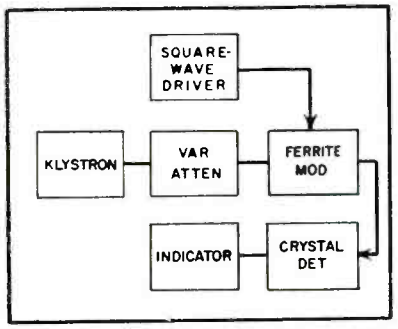

FIG. 5—Test circuit for ferrite switches

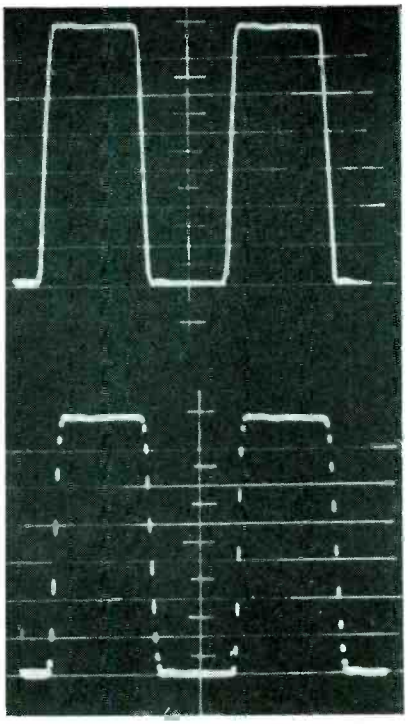

FIG. 6—Switch transmission pulses taken at crystal detector. Bottom trace includes 0.1-μsec brightening pulses

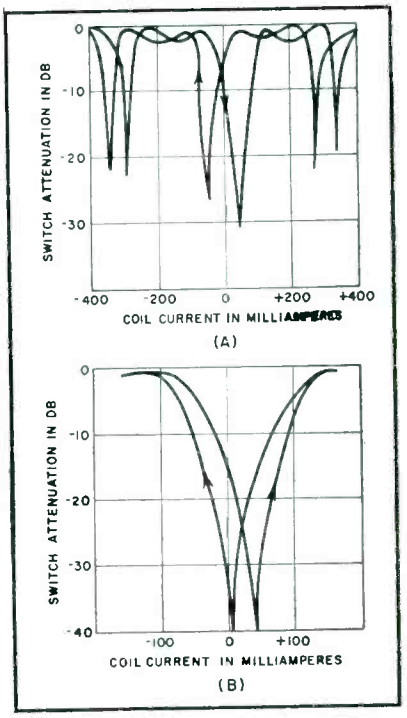

FIG. 7—Effects of ferrite hysteresis for 800-ma (A) and 300-ma (B) closed-cycle switch attenuation

Conclusions

The best waveforms show rise times of 0.7 μsec, fall times of 0.8 μsec and open and shut attenuations of 0.5 db and 40 db respectively. An average performance of 0.7-μsec rise time, 0.8-μsec fall time with open and shut attenuations of less than 1.0 db and 30 db, respectively, can be achieved and the adjustments are not too critical.

The input vswr of the open switch is of the order of 1.2 but when the switch is closed there is a vswr at the input of more than 10. This is a simple reflection of power which may be prevented from reaching the power source by duplexing techniques if such isolation is found necessary.

Faster switching speeds and higher frequencies may be achieved with sacrifice of percentage modulation or with additions to the power in the driving circuits although the latter procedure introduces cooling problems. Slight additional improvement in speed may also be expected from further improvements to the coil design and the dielectric separating it from the conductive film.

The authors thank the Defence Research Board of Canada for permission to publish this paper and B. A. Walker for his interest in the work. The assistance of F. Vail in making the measurements is gratefully acknowledged. The work described was part of a program of modification of ferrite components designed and provided by C. H. Luhrs and Co.

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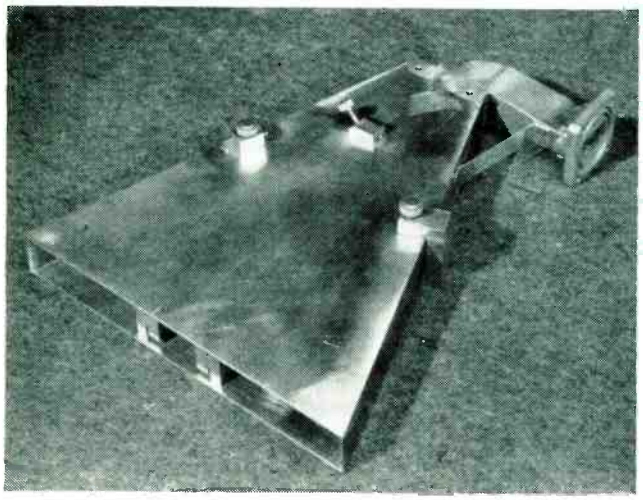

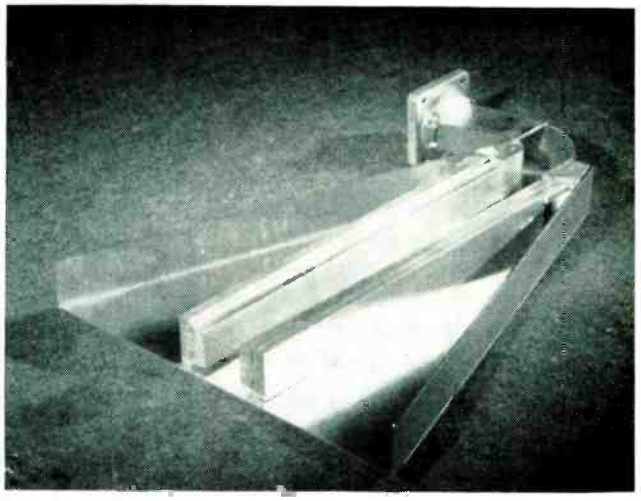

H-plane horn has 100-kw peak output. Choke arrangement and movable side walls are visible in photo at right

SUMMARY — Primary radar feed, used in conjunction with single reflector, gives choice of fan beam for searching or pencil beam for closer examination of target with throw of switch. Antenna consists of flared H-plane horn with movable side walls

Fan-Pencil Antenna

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ANTENNAS providing a choice of a fan beam or a pencil beam of radiation are desirable in many applications. Such antennas permit radar searching with the vertical-fan beam and closer inspection of target objects with the pencil beam.

A primary radar feed has been developed, which in conjunction with a single reflector provides these beam capabilities by simply throwing a switch. The antenna consists of an H-plane flared horn with side walls, which are moved between two fixed positions in selecting the beam.

Design Choices

When an antenna is required to provide a choice of fan beam or pencil beam radiations, one of three designs may be employed: the two feeds may be mounted on separate support arms, one of which is swung out of the way when not in use; the pencil beam may be distorted by displacement of a part of the reflector surface to obtain the fan beam; the two feeds may be mounted adjacently and in the same focal plane, with a resulting angular displacement between beams.

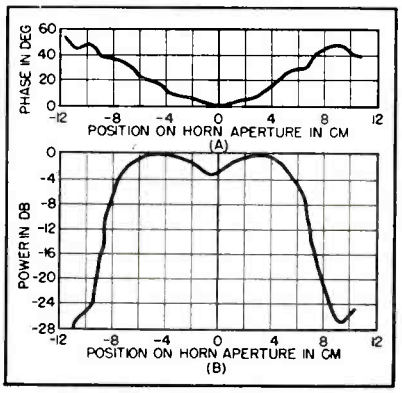
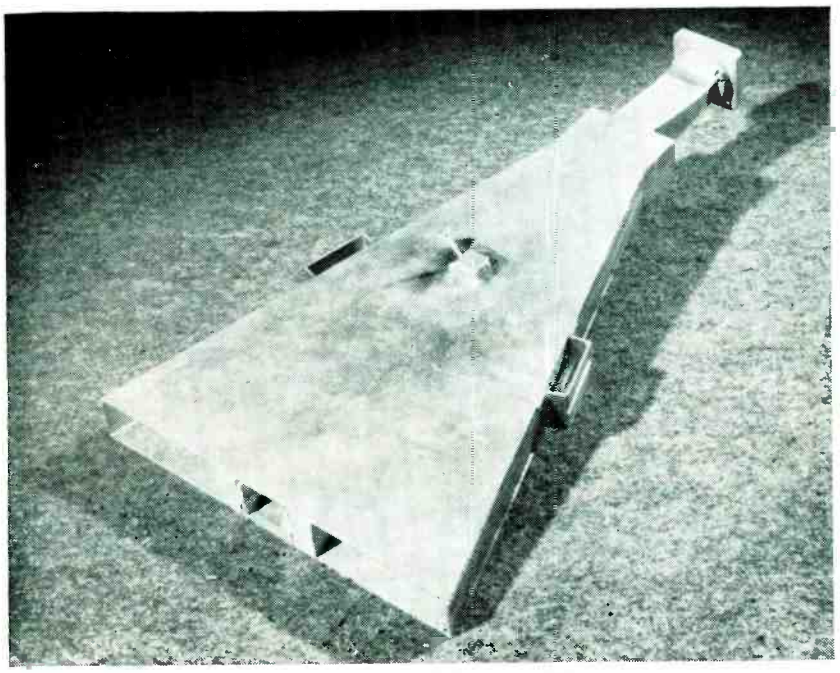


FIG. 1—Phase (A) and power distribution (B) of H-plane horn

A combined feed, mounted in a fixed position in front of the reflector, eliminates these awkward operations. In this combined feed, the effective centers of both the fan-beam and the pencil-beam apertures coincide.

Selection of either of the two beam types is accomplished electrically by a solenoid or by a drive motor. This construction provides greater mechanical stability to the feed and reduces the number of mechanical components required for beam selection.

The reflector employed is a paraboloid of revolution, 60 inches in diameter, with a 19.5-inch focal length. It was desired to obtain a pencil beam 1.5 deg × 1.5 deg and a fan beam approximately 12 deg × 1.5 deg in the vertical plane. These fan-beam dimensions are obtained with a primary-feed aperture of approximately 1 × 7 inches. Polarization of the fan beam is horizontal and a choice of horizontal or circu-



H-plane flared horn has movable walls which give a 7-inch aperture when moved outward and a 1-inch square aperture when inward as shown

for Search Radar

lar polarization of the pencil beam is achieved mechanically.

First attempts to design a feed antenna providing these patterns failed because of phase and amplitude discontinuities in the aperture distributions. These discontinuities were eliminated in the final design of the combination feed by using the H-plane flared horn having movable side walls, illustrated in one of the photographs.

Side-Wall Positioning

The side walls are hinged at the throat of the horn. They may be moved either to the outside, to produce a 7-inch aperture for the fan-beam primary feed, or toward the center to provide a 1-inch square aperture for the pencil-beam primary feed.

Phase and amplitude distribution across the aperture of this feed are shown in Fig. 1. The pencil-beam and fan-beam secondary patterns are shown in Fig. 2. The latter show that the 1.5-deg × 1.5-deg beamwidth requirements for the pencil beam and the 12-deg × 1.5-deg beamwidth requirements for the fan beam are very closely approximated and that the side-lobe levels are low.

Since the power-handling capacity of the first horn was only about 80-kw peak power and because a shorter construction was desired, a second horn was designed as shown in the photographs. This horn is 11½ inches in length, 5 inches less than the first horn. An improved choke design for the movable sides was incorporated, extending back to the centerline of the hinge.

Breakdown tests show that this horn can handle 100-kw peak power at a duty cycle of 0.0015. Although secondary patterns using this combined feed have not yet been measured, the similarity of the phase and amplitude distributions to those of the previous horn indicates similar secondary patterns.

Choice of either linear or circular polarization of the pencil beam is obtained with an adjustable probe, which can be inserted diagonally across the approximately square section of the horn in the pencil-beam position. The proper insertion of the probe, combined with the correct separation of movable walls, changes the linear to circular polarization.

While the movable side walls are held in position by clamps across the two broad faces of the horn, they could be positioned to advantage with solenoids or flexible cable drives, which would move them against fixed stops. Equipment to be mounted in front of the reflector would thereby be kept to a minimum. Pressurization of the feed could be accomplished by a flat window cemented in the aperture or by a rounded radome attached to the sides of the feed horn.

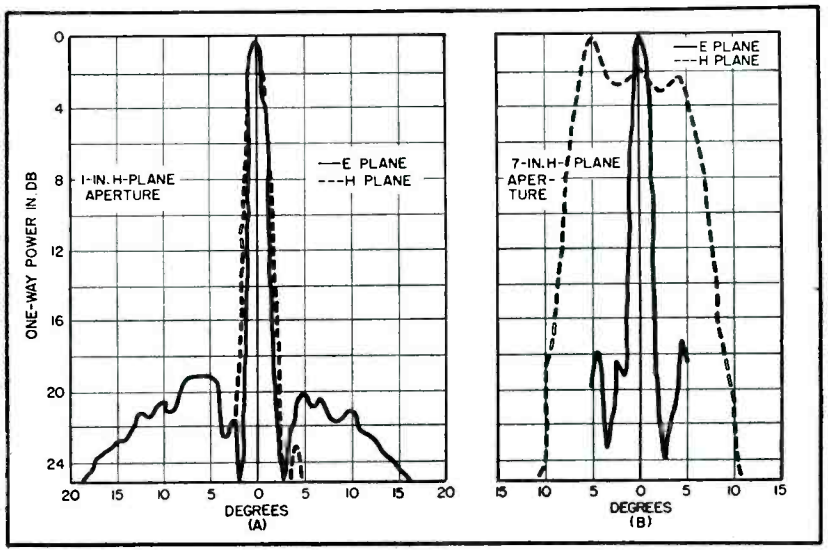
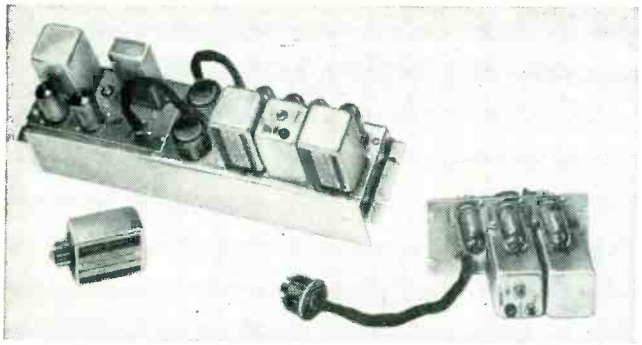
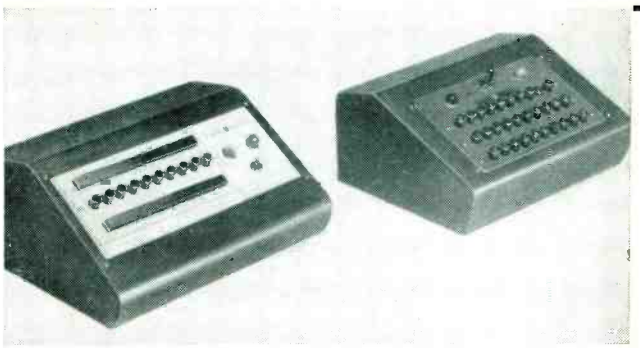


FIG. 2—Pencil beam (A) and fan beam (B) secondary patterns for H-plane flared horn with movable sides and 5-ft paraboloidal reflector with 19.5-in focal distance



Tone transmitter, tone receiver or alternate two-tone receiver can be mounted on chassis for mobile service



Typical control consoles for selective calling. Pushbutton selection of call numbers and transmitter control

Single-Tone Calling

NEED often arises for calling a single vehicle or group of vehicles to the exclusion of all others in a common vhf radio communication system. It becomes increasingly important from the viewpoint of efficient use of personnel and equipment as the system expands and as greater use is made of this medium.

Desirable features to be included are provision for base station selection and dispatching; mobile selection and indication; and mobile dispatching.

Function of Tone

Single-tone systems are generally employed where initial cost is an important consideration and up to ten different calls are required. A momentary burst of tone is used to activate the tone receiver, which may perform a variety of operations. The tone device may unmute the speaker, turn on a call lamp, or operate a beacon or horn on the vehicle.

Multiple tones are employed on systems requiring a large number of different calls. A two-tone system, for example, employs two tone bursts in rapid succession to activate the tone receivers. Combinations possible are equal to the number of tones raised to the second power. Single-tone systems are generally employed in mobile units since a relatively few base stations or repeaters are involved in most practical applications.

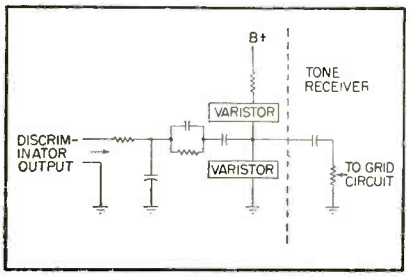


FIG. 1—Type of circuit used to tap tone signal from vhf f-m receiver and apply it to tone device

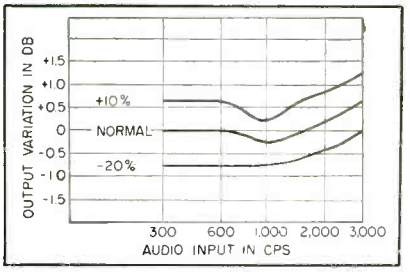


FIG. 2—Variation in tone level with changes in battery voltage at various audio frequencies

The operational requirements for a selective-calling system are exceedingly simple, consisting of an on indication when called and no indication or off at all other times. This extreme simplicity accounts for most of the design difficulties arising from effects of noise, voice and other tone signals. There are two general requirements to be met before a signal operates the tone receivers—tone frequency and tone amplitude. These two factors combine to yield a figure of merit for comparing the quality of signaling equipment.

Input Characteristic

Range of permissible amplitude excursion for operation of the tone receiver must equal or exceed the range of tone amplitude supplied by the vhf receiver under all conditions of operation including the full range of variation of supply voltage and signal strength. Design of the tone receiver must start with the vhf receiver characteristic at the point from which the tone is taken.

The audio volume control and squelch control are usually made available to the mobile operator. Reliable calling service must be provided regardless of the setting of these controls, making it necessary in most receivers to take the tone directly from the discriminator. Disadvantages of using this point include background noise feeding into the tone receiver during absence of carrier—since this point precedes the squelch—and a drooping frequency response characteristic for constant deviation.

The objective in any tone system is to have a maximum signal-to-noise ratio. It is essential from the operational viewpoint to establish a system alignment procedure that permits independent adjustments of the transmitting and each re-

SUMMARY — Increased usage of mobile radio communications has stepped up requirement for selective-calling devices. A new approach in equipment provides plug-in bridged-T selective networks in transmitters and receivers for single or multitone calling applicable to fixed-station or mobile use

By ELMER W. HASSEL

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Simplifies Mobile Radio

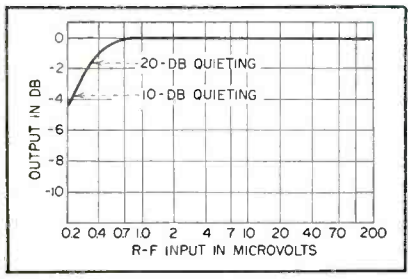


FIG. 3—Typical discriminator output for constant-deviation signal with changes in r-f signal

ceiving equipment. By modulating the transmitter to a fixed degree of deviation for each tone, the vhf receiver requirement is to provide a flat frequency-response characteristic for constant deviation. This yields a one-to-one signal-to-noise ratio for other than the desired tone.

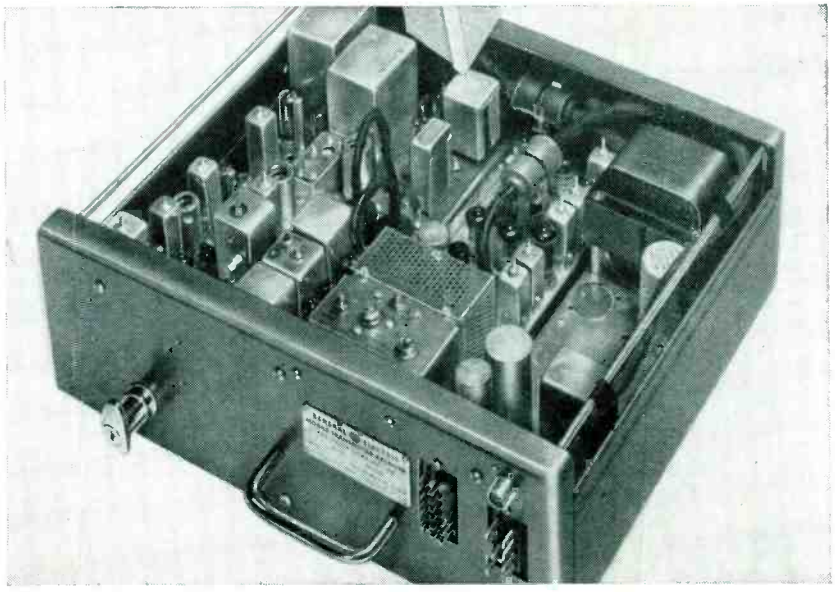
Best Deviation

By selecting a suitable degree of deviation for the transmitter with tone, a workable signal-to-noise ratio can result for voice and noise signals. Although the tone level should be made as high as possible it must be below a level that would cause distortion and noise resulting from the high-selectivity characteristic of the modern vhf receiver. This figure is below 15 kc on wide-band equipment and below 6 kc on narrow-band equipment, particularly on fringe-area operation.

Figure 1 shows a method of coupling the tone signal from the discriminator. Included are an i-f filter, equalizer and tone output level stabilizers. The stabilizers are varistors whose characteristics are selected to help provide a constant output level with variations in the d-c supply voltage. The effectiveness of such a network is shown in Fig. 2. A maximum change in audio frequency, such as will occur in multitone systems, or in supply voltage results in a +1.25-db or a −0.75-db variation for the worst extremes.

Although an f-m system provides an essentially constant output for changes in input signal-strength some variations will occur, particularly when the input level drops below limiting. Most users of selective calling equipment expect it to function at the extreme fringe of voice communication. It will be seen that this is possible depending upon how the system is set with respect to levels and the condition of battery and generating equipment.

Figure 3 shows the variation in vhf-receiver output with r-f input for 10-kc deviation. Combining



Mobile communications chassis comprises transmitter, receiver, power supply and tone equipment for selective calling

Fig. 2 and 3 gives the tone level available to the tone receiver. For example at the −20-percent extreme in supply voltage and at a 20-db quieting level, a 2.35-db drop in tone level can be expected. Applying this information to the tone receiver operating characteristic enables the limits of the selective-calling equipment to be computed.

Single-Tone Receiver

A burst of tone that meets the requirements of the circuit results in the operation of relay K_1 in Fig. 4. The circuit functions around the operation of the selective amplifier, a feedback-type employing a bridged-T selective network[1] as shown in Fig. 5. Signals fed to the input are amplified by V_{1A} and V_{2A} giving a gain of 60 db. The output of V_{2A} is fed back through the selective network to cathode follower V_{1B}, which is cathode coupled to V_{1A}.

Signals fed through the null-type selective network back to V_{1B} have the effect of canceling the input signal, resulting in low output at V_{1B}. Signals of the null frequency are reduced by 100 db, providing little negative feedback and giving full amplifier gain to this frequency. A circuit Q of 150 is obtained with this arrangement.

The selectivity and sensitivity available with the circuit described above can be used as the basis for a selective-calling tone receiver. An added degree of selectivity can be included by the addition of a selective differential amplifier. The signal voltage at the cathode of V_1 will be a minimum at the null frequency and rise for all other frequencies above and below the null. Tubes V_{3A} and V_{2B} insert a gain of 54 db to this cathode voltage. The output of V_{2B} represents the equivalent effect of a notch filter with the desired tone frequency removed. If special care is taken regarding noise, Q's exceeding 1,000 can easily be obtained at this point.

Figure 6 displays the results of rectifying the outputs of both the selective and differential amplifiers. Connecting the rectified output of each amplifier in subtractive series yields the composite characteristic. This connection increases the Q of the circuit to 250. The relay tube grid voltage (Fig. 4) is given by the composite characteristic.

One further factor has been designed into the single-tone receiver. The selective amplifier will limit on signal amplitude before the differential amplifier. A very strong signal on the desired frequency will not operate the relay owing to the subtractive series connection. It requires a tone signal of the correct frequency, of a minimum time duration and of the correct amplitude to operate this tone receiver.

Figure 7 displays the resultant characteristic. In general terms the operating range can be expressed as within a closed area $\pm\frac{3}{4}$-percent of the center frequency and with ±7 db of the nominal input level. A minimum of 200 milliseconds of tone is required. Plug-in type selective networks permit flexible operation over the audio passband down to 3-percent spacing. The operating range in temperature is from −20 to +100 C.

The closed response curve is obtained through the limiting action of the selective amplifier. Fluctuation in supply voltage will affect the limiting point. Figure 8A indicates the changes over the full range of voltage with which this equipment will operate, ±25-percent of nominal.

Since the selective differential amplifier functions to prevent relay operation on all signals but the correct tone, operation of the tone receiver through noise must be considered. Noise will have the effect of canceling part of the tone signal. The extent of this reaction is small. Change in operation for a one-to-one signal-to-noise ratio at the nominal plate voltage of 200 volts is shown in Fig. 8B.

Continuing the example started above, Fig. 8A shows that a permissible drop of 5.5 db can be tolerated at the −20-percent voltage level. Compared to the loss in audio from the receiver of 2.35 db, satisfactory operation would prevail. At 20-db quieting the noise level is

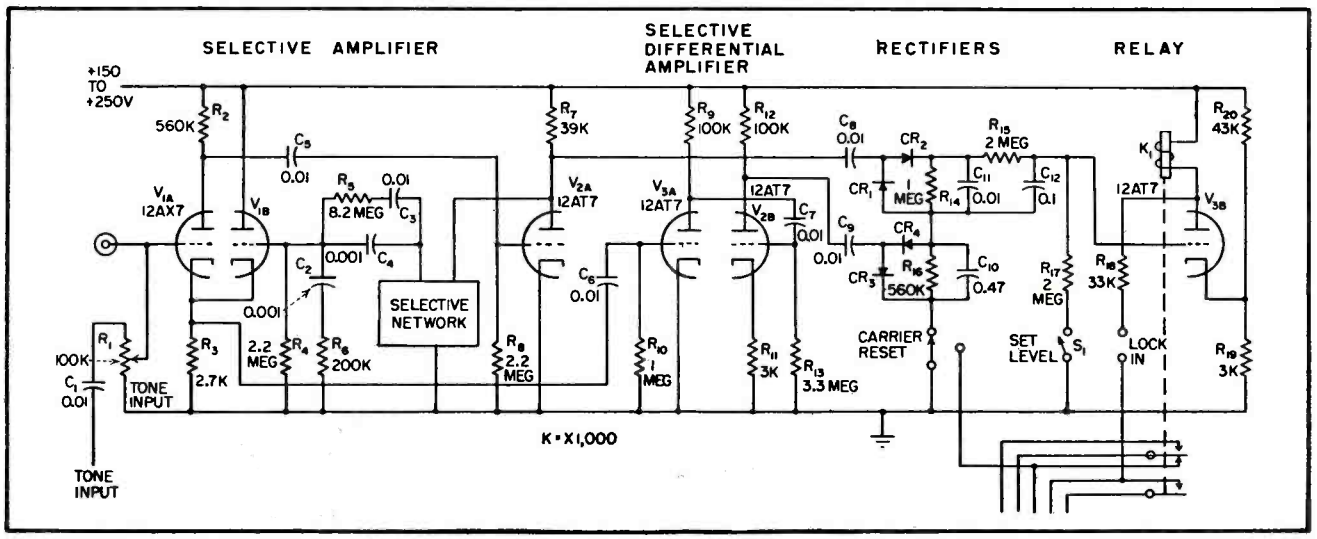


FIG. 4—Receiver for single-tone signaling uses bridged-T selective circuit operating within 0.5 percent of audio tone, reducing voice triggering to bare minimum. Plug-in selective network units are chosen for the desired audio frequency

low thus eliminating the effective loss of signal from the differential amplifier. At —20-percent supply voltage with a signal-to-noise ratio of one-to-one, the tone receiver will tolerate a tone input loss of 4 db.

If operation under extreme conditions of low signal strength, low battery voltage and high noise levels is necessary, greatly improved characteristics can be realized by setting the tone level to the tone receiver under nominal conditions to a level higher than the midrange value used throughout this description.

The input level is set by operating the set level pushbutton (S_1 in Fig. 4) and adjusting the tone input potentiometer R_1 until the threshold of operation is reached. Releasing the pushbutton automatically sets the operating level to the correct value.

A review of the tone-transmitter amplifier circuit in Fig. 9 shows a similarity to that in the tone receiver. Voltage dividers consisting of R_1, R_2 and R_3 form the voltage-feedback loop making the basic selective amplifier a stable low-distortion oscillator. Varistor CR_1 acting on the transfer characteristic of V_{2A} forms the agc circuit. Frequency stabilities of 0.2-percent, amplitude stabilities of 0.3 db and distortion levels of 0.15-percent can be achieved over the range of 150 to 250 volts d-c supply.

The oscillator output is fed to cathode follower V_{2B} providing a 600-ohm output continuously variable up to +5 dbm. For levels up to 0 dbm less than 5-percent total distortion can be obtained. The output level is held within 1.6 db over the full voltage range of 150 to 250 volts.

Three forms of tone output can be furnished: continuous, keyed or pulsed. Continuous tone results in sine-wave output of an indefinite duration. The output may be keyed under the control of a switch or relay contacts by grounding the key-tone lead for no tone and opening the circuit around R_8 for tone.

Pulsed tone provides a tone signal of approximately one-second duration. If B+ is applied to the lead to C_1, CR_2 will momentarily give an open circuit resulting in normal oscillator operation. When C_1 becomes charged, CR_2 again conducts, shorting out the feedback path and thus forming the tone pulse.

The pulsed-tone leads can be automatically controlled by switching contacts in the control head. Tone on each transmission or on the first transmission only may be used by including or eliminating R_4, respectively. Rectifier CR_2 and its related components for pulsed tone are not used for continuous or keyed applications.

Each type of selective calling equipment requires its own sending apparatus to perform the following desired functions:

(1) Select the tone frequency (or frequencies, in multiple-tone systems) under the control of the dispatcher.

(2) Turn on the vhf transmitter and put carrier on the air.

(3) Code and time the calling signal. The length of each tone and the time interval between tones in a multitone system is related to the tone-receiving apparatus and must be designed to unlock it.

(4) Provide for a means of keying the transmitter with or without

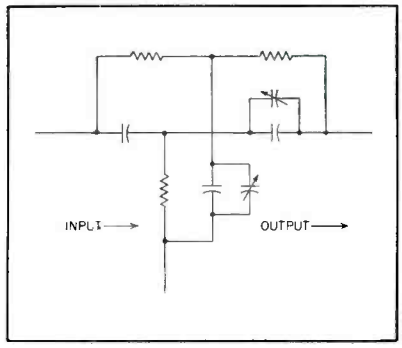


FIG. 5—Bridged-T *RC* network has satisfactory frequency stability from —20 to +100 C

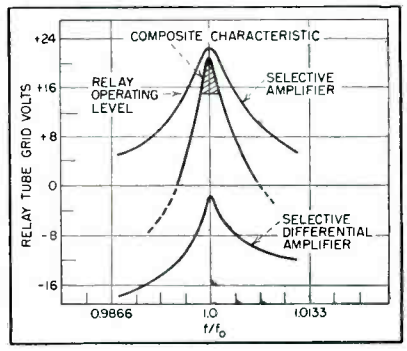


FIG. 6—Differential action of Q-multiplying amplifiers gives resultant Q of 250

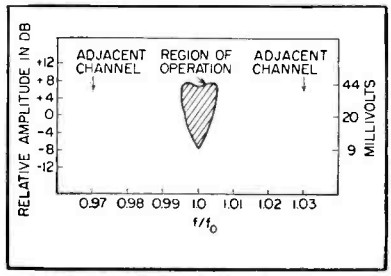


FIG. 7—Selectivity and input level characteristic of tone receiver. Relay operates only if signal falls within shaded area

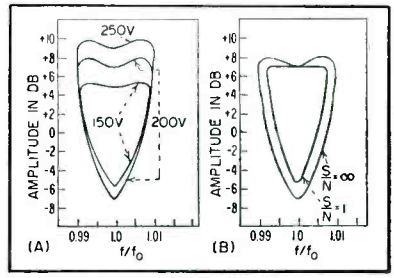


FIG. 8—Effect of plate supply variation without noise (A) and noise superimposed on tone (B) with 1-to-1 signal-noise ratio

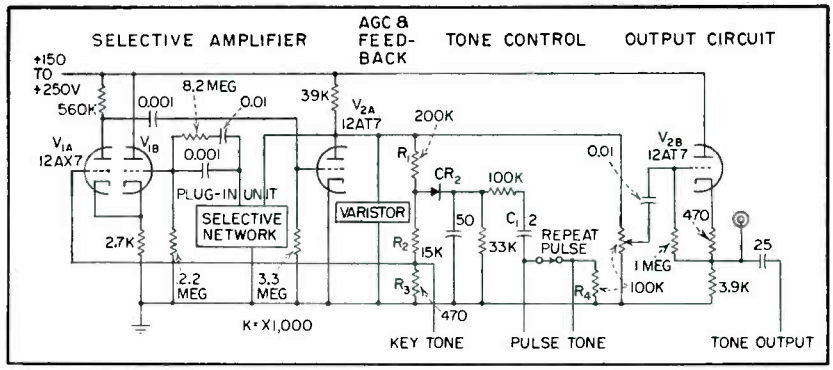


FIG. 9—Tone transmitter uses same plug-in frequency-selective network as receiver. Continuous, keeed or pulsed tone output is available

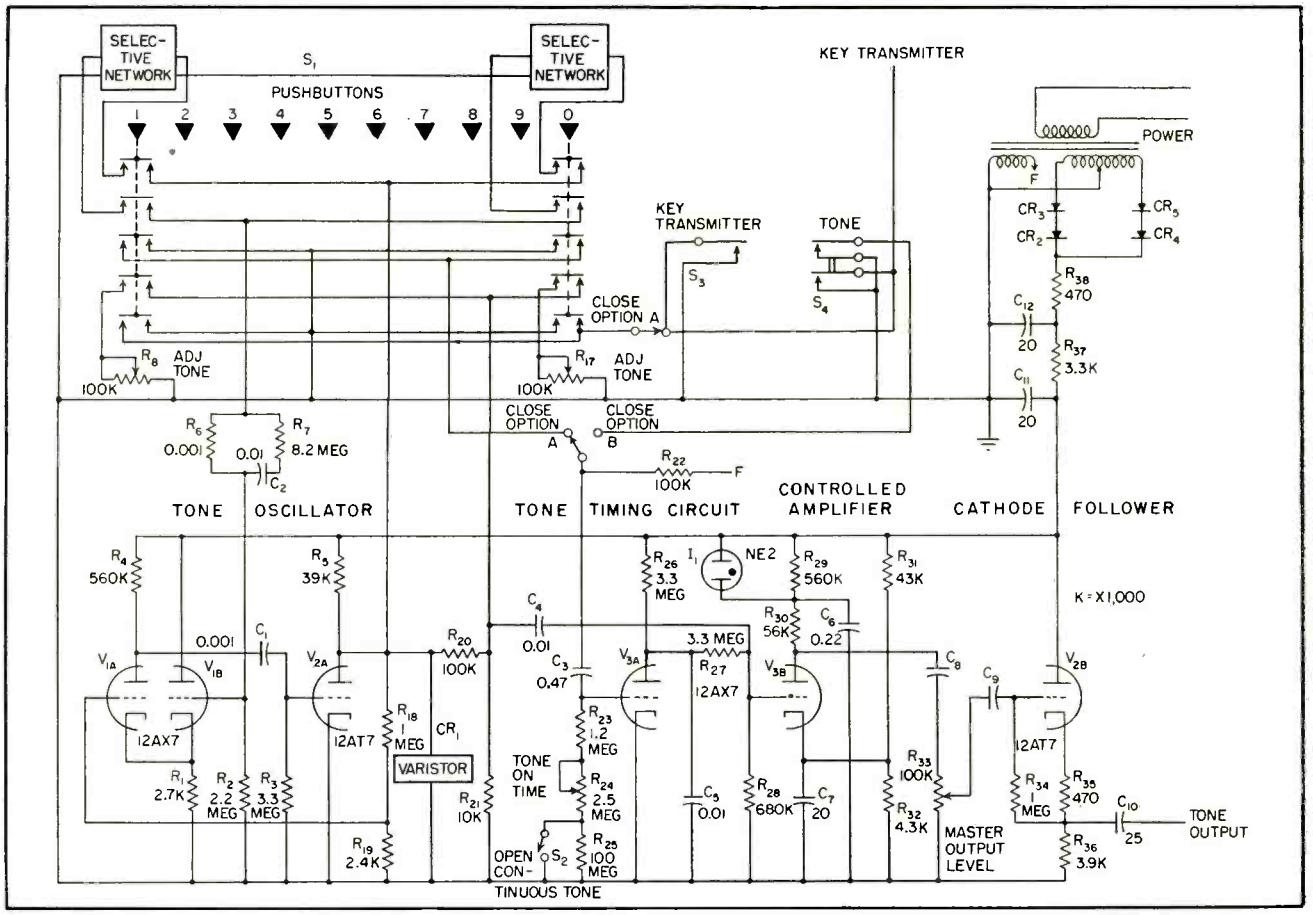


FIG. 10—Dispatching console supplies up to ten different tones for mobile calling. Electronic timing eleminates relays. Tone options A and B are described in text. Gang pushbutton detail is shown for numbers 1 and 0

tone codes, on each transmission or on the first transmission only.

(5) Provide for operation with local or remote control of the vhf transmitter carrier emission.

Tone Dispatcher

Two bar keys and ten pushbuttons form the controls giving two possible types of operation. Spring-loaded pushbuttons can be used to key the transmitter (option A in Fig. 10) pulse the tone automatically and hold the transmitter on the air. Both bars key the transmitter without tone. Rapid dispatching techniques with generally different mobile units or fleets are possible. Indicator I_1 (Fig. 10) shows when tone is transmitted.

Alternatively, equipment can be provided with interlatching pushbuttons (option B) that lock down when depressed. The lower bar keys the transmitter only, the upper bar keys the transmitter with tone, automatically sending the tone pulse. A more convenient but less rapid dispatching arrangement is provided for use on systems that contact a given mobile or fleet successively before changing calls.

Resistors R_8 through R_{17} permit individual adjustment of the level for each tone. This is particularly advantageous on remote-control applications when the wire line connecting to the transmitter does not have a flat frequency response characteristic. Resistor R_{33} is a master output level control for changing the level of all tones simultaneously.

Tone Interval

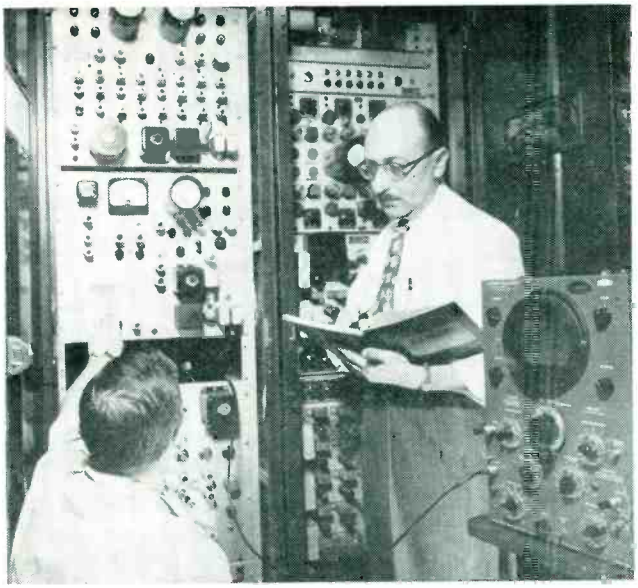
The tone-burst interval is easily adjustable from one-half to two seconds by the setting of potentiometer R_{24}. Adjustment of the tone interval is essential to obtain optimum performance for any system to compensate for delays in the control equipment and repeaters, if used. Switch S_2 permits continuous tone to be sent when making system level adjustments and for special applications such as sounding sirens by tone.

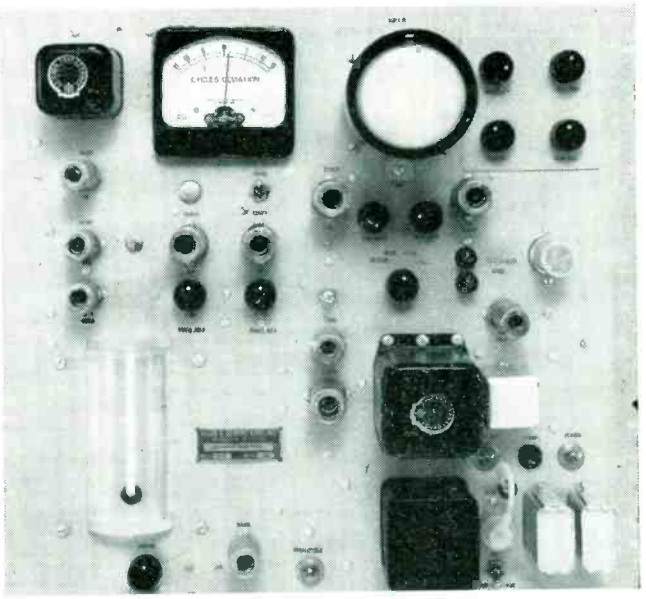
The circuit operation is similar to the tone transmitter previously described, with pushbuttons (S_1) connecting the selective networks to the oscillator circuit. The oscillator output connects through C_4 to amplifier V_{3B}, which normally is biased beyond cutoff giving no output. The timing takes place as follows: the grid-cathode of V_{3A} acts as a diode, rectifying a portion of the heater voltage causing a plate current limited by R_{26}; C_8 develops a d-c voltage of 8 volts.

When S_3 or S_4 grounds one side of C_3, V_{3A} is cut off resulting in a sharp rise in plate voltage controlled by the time constant of $C_8R_{23}R_{24}$. During the period V_{3A} is cut off, V_{3B} becomes a class A amplifier and passes the tone pulse on to the cathode follower. The change in bias of V_{3B} ignites I_1 causing it to glow when tone is transmitted. The output circuit can supply up to 10 dbm; the source impedance is 600 ohms.

REFERENCE

(1) L. Stanton, Theory and Application of Parallel-T Resistance-Capacitance Frequency-Selective Networks, *Proc IRE*, p 447, July 1946.





Color frequency standard undergoing tests in development laboratory. Close-up photo shows direct-reading frequency meter with monitoring-oscilloscope screen alongside. Unit is built on standard rack mounting chassis

Meter Shows Color-Burst Deviation

SUMMARY —— Frequency deviation from 3.58-mc color subcarrier is indicated by direct-reading meter in cycles per second. Simple, yet accurate device, is necessary for tv transmitters in addition to usual visual and aural-carrier frequency monitors

By M. JOFFE

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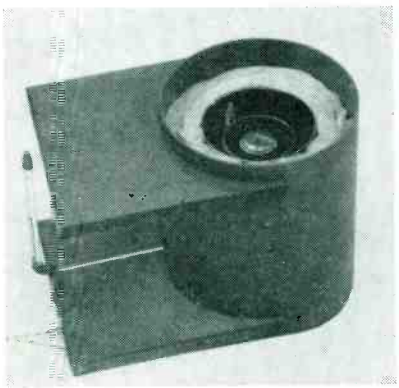
Passaic, New Jersey

TELEVISION STATIONS that contemplate switching from monochrome to color transmission are faced with the initial determination and subsequent monitoring of the color-subcarrier frequency of 3.579545 mc in addition to the visual and aural-carrier frequencies. The tolerance as set forth by the NTSC is ±0.003 percent. Simply using a crystal-controlled oscillator to generate the color subcarrier does not assure that the frequency is within the tolerance specified. It is essential that a monitor or frequency standard be added to check the subcarrier frequency. A relatively simple, yet accurate standard will be described.

The subcarrier frequency standard shown in the block diagram, Fig. 1, consists of a highly stable temperature-controlled 100-kc crystal oscillator and a buffer amplifier followed by a 10-kc multivibrator, which drives a 1-kc multivibrator. A tuned amplifier preceding the mixer reinforces the 3.58-mc harmonic from the 10-kc multivibrator.



Crystal oven consists of Synthane outer cover, Fibreglas insulation layer, heater and heat-distribution shield

After mixing, the beat difference, 455 cps, is filtered, amplified and impressed across a direct-reading frequency-deviation meter. A switch in conjunction with the oscilloscope and its amplifiers selects the following functions: 1-kc multivibrator frequency check; 10-kc multivibrator frequency check; subcarrier versus

standard-frequency beat check with an external interpolation oscillator; interpolation-oscillator calibration check.

Circuits

In the circuit of Fig. 2 a 6AK6 tube operates as the oscillator, with the crystal connected between the grid and screen. Since there are no tuned elements in the plate or cathode circuits, the frequency is that generated by the oscillating crystal. Two variable air capacitors in shunt with the crystal set the frequency and compensate for aging of the quartz plate. One of the capacitors has a range of 2 $\mu\mu$f and is capable of correcting a drift of approximately ± 15 cycles at 3.58 mc.

The oscillator is followed by a 12AT7 buffer-amplifier stage. One tube section feeds a synchronizing voltage to the 10-kc multivibrator. The WWV receiver is also connected to the same point. The other section of the buffer amplifier furnishes a reference frequency for checking the 10-kc multivibrator.

A second multivibrator operating at 1 kc receives its synchronizing signal from the 10-kc stage. To eliminate crosstalk difficulties switch S_{1c} in series with the plate-supply voltage of the 1-kc multivibrator, cuts off the stage while the beat difference is being measured or the frequency of the 10-kc multivibrator is being checked.

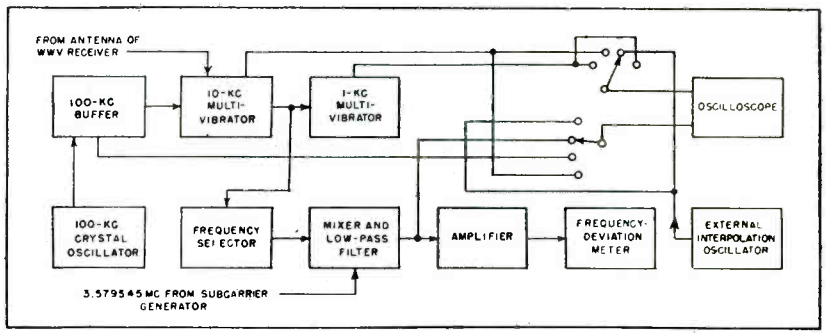


FIG. 1—Tuned-amplifier stage preceding mixer stage reinforces 3.58-mc harmonic from 10-kc multivibrator for comparison with color-burst frequency

The harmonic amplifier that receives the voltage from the 10-kc multivibrator has an L-C circuit in the plate circuit tuned to 3.58 mc. This increases the level of the 3.58-mc harmonic above all others existing in the multivibrator to reduce the possibility of selecting the wrong beat when checking the subcarrier frequency.

The 6BE6 mixer combines the 3.58-mc harmonic and the 3.579545-mc signal from the subcarrier-frequency generator. The resultant audio beat appears in the plate circuit. A low-pass filter rejects all frequencies above 2 kc thus reducing multiple response due to the mixing action.

The voltage amplifier following the mixer feeds the power amplifier, increasing the 455-cycle output of the mixer to a level of approximately 2 watts, which is sufficient to operate the frequency meter. The impedance-coupling choke is tuned to approximately 455 cycles and aids in the rejection of harmonics that cause erratic meter operation.

Deviation Meter

The meter on the panel directly indicates subcarrier-generator frequency deviation in cycles per second. It is a dynamometer-type audio-frequency meter and indicates frequency in accordance with the audio used to energize the instrument.

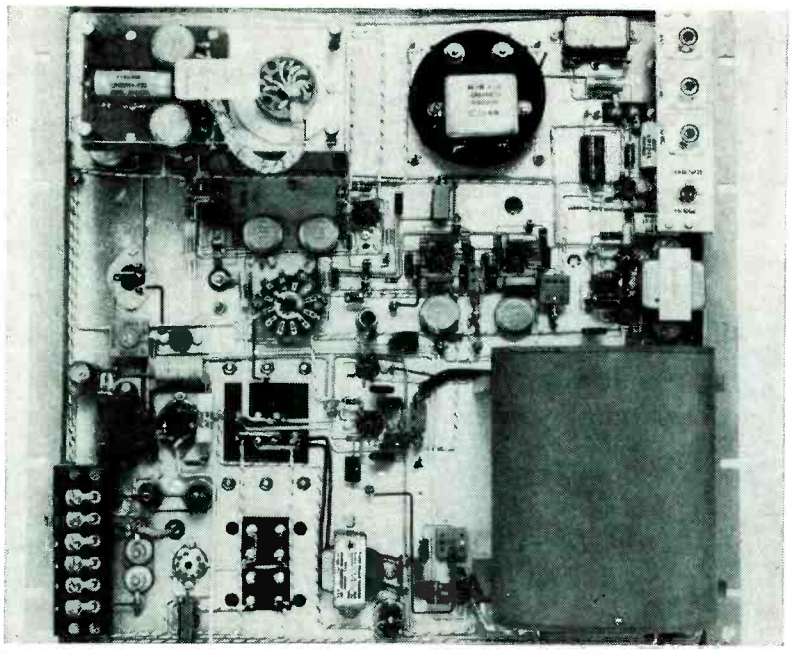
The meter's center frequency is calibrated at 455 cycles and indicates zero deviation, since when a 3.579545-mc signal beats with a 3.580000-mc signal the difference frequency is 455 cycles. A deviation of 5 cycles from 3.579545 mc is shown as a 5-cycle deviation on the frequency-deviation meter.

For example:

3,580,000
3,579,540
460
−455
5 cycles low

3,580,000
3,579,545
455
−455
0 cycle

3,580,000
3,579,549
451
−455
4 cycles high



Rear view of frequency standard shows component locations. Crystal oven is at lower right and oscilloscope monitor at upper left

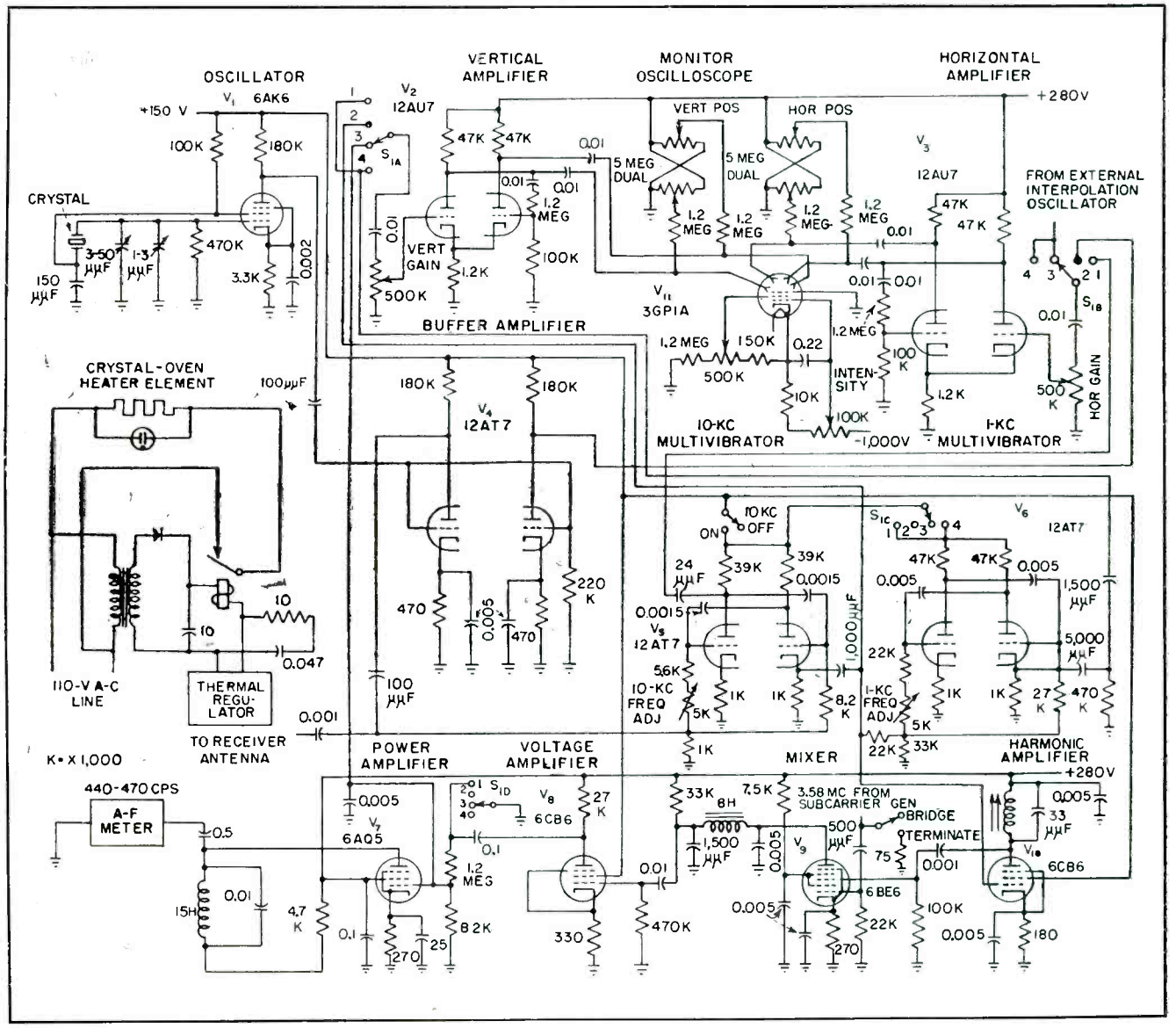


FIG. 2—Crystal oscillator V_1 is followed by multivibrator V_4 through buffer V_5. Harmonic from V_6 is amplified by V_{10} and mixed with subcarrier signal in V_9. Beat output is amplified and applied to frequency meter which indicates frequency difference directly as frequency deviation. The L-C network in the plate circuit of V_7 rejects harmonics preventing erratic meter operation

The 3GP1A tube is the indicator. With its amplifiers and a multiple-deck wafer switch, it allows the operator to use the built-in oscilloscope for checking the functions outlined.

An OA2 regulator tube holds the plate voltage applied to the oscillator and multivibrators at a constant value.

Crystal

The crystal is a parallel-resonant G-cut 100-kc bar. It is contained, as shown in the photograph, in a crystal oven consisting of a Synthane outer cover, a layer of Fibreglas insulation, a heater and a heat-distribution shield. The crystal plugs into a socket fixed to the inner shield.

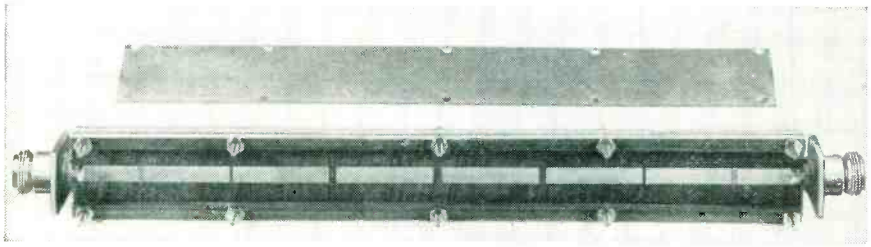
The heater element is wound directly on the heater tube, then cemented in place. A mercury-type thermostat sits in a well soldered to the inner surface of the heater tube and holds the temperature to 60 C $\pm$0.05 deg. The air spaces between the heater and crystal shield and between the shield and crystal reduce this variation still further, so that any temperature change at the crystal is negligible.

The contacts of the mercury-column thermostat cannot carry the current required by the heater in the crystal oven. A sensitive relay operates from the thermostat contacts and in turn applies or disconnects the crystal-heater voltage as required to maintain a constant crystal temperature.

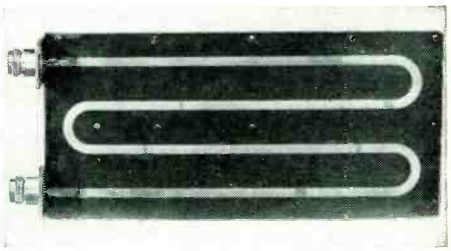
A selenium rectifier furnishes d-c to operate the sensitive relay; the transformer that supplies the voltage for the relay is also used to energize the heater of the oscillator tube and must be left on 24 hours a day.

A receiver capable of being tuned to any of the WWV standard-frequency transmissions must be provided.

Use of an interpolation oscillator is not mandatory, but it may be added if more accurate checks are desired.



Six-stage band-pass filter using air dielectric has a center frequency of 3,350 mc. Note use of dove-tail gap at each end



Solid dielectric band-pass filter designed for operation at 715 mc

Band-Pass Filters Using

SUMMARY —— Design and construction data on filters for insertion in coaxial lines to obtain band-pass filter performance with large savings in space and weight. Use of etched wiring and sandwich construction simplifies fabrication

USING design techniques developed for direct-coupled cavity-type waveguide and coaxial filters, experimental strip-line filters having 10-percent bandwidths in the uhf spectrum have been developed. These units have less than 1-db mid-band insertion loss and provide a rejection of greater than 40 db at frequencies 12 percent from center frequency.

The design techniques discussed in this paper are general and are not restricted to the realization of these filter characteristics. Some limitations pertaining to the realizability of the cavity parameters in different dielectric media and the existence of spurious responses are discussed.

Design Formula

The design procedure for direct-coupled cavity-type strip-line filters can be evolved from synthesis procedures applied in the design of lumped-parameter circuits.

Bandpass filters can be designed from low-pass prototypes through a low-pass to band-pass transformation. The type and complexity of the low-pass prototype is dependent upon the desired frequency-response characteristics (skirt selectivity and ripple tolerances in the pass-band). For example, the maximally flat response fuction is widely used in filter and i-f amplifier designs because of its mathematical simplicity and monotonic characteristic in the pass-band. Other response functions, such as the Tchebycheff function, also have special applications.

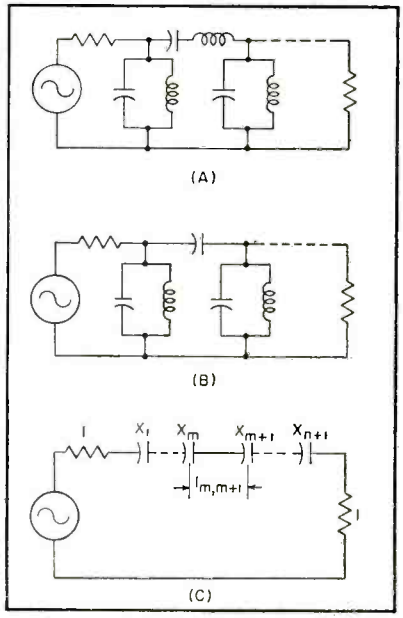


FIG. 1—Conventional band-pass circuit (A) is not as easy to duplicate in strip line as is the capacitive-coupled type (B). Direct-coupled cavity-type filter (C) can be expressed in terms of the lumped parameters of the capacitive-coupled type

A typical band-pass filter resulting from low-pass to band-pass transformation is shown in Fig. 1A. This configuration is not as easily realized in strip lines as is the circuit shown in Fig. 1B. The transfer function of the former network has an equal zero distribution at zero and infinite frequencies in the complex-frequency plane, whereas the filter shown in Fig. 1B has an unequal distribution with $2n-1$ zeros at zero frequency and one at infinite frequency (n is defined as the number of resonant elements).

For this reason, there exists no one-to-one relationship between the response characteristics of these two circuits. However, if the driving-point impedances of the two networks are equated and if the circuit components of one network are expressed in terms of the other, the pole distributions of each network will be identical. Although the zero distributions of the filters differ, the response characteristics are essentially identical in the neighborhood of the pass-band for small filter bandwidths. For large bandwidths, the response of the filter having an unequal zero distribution will be asymmetrical.

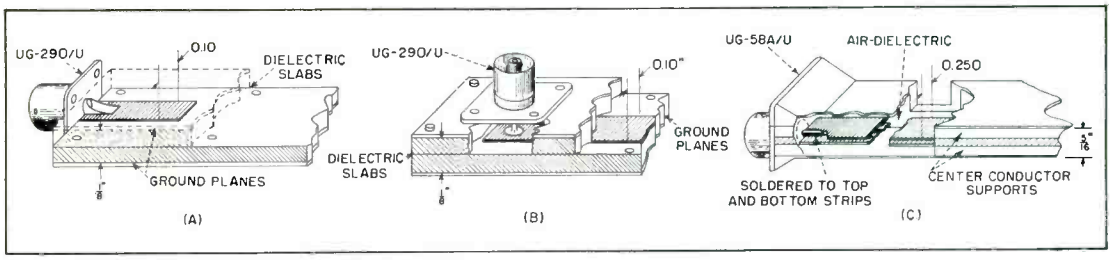


FIG. 2—Coaxial-to-strip-line transition techniques. End transition (A) and normally mounted transition (B) are used with solid dielectric. For air-dielectric strip-line, end transition (C) is used

Strip-Line Techniques

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Using transmission-line theory, the normalized coupling reactances, X_m, and cavity lengths, $l_{m,\,m+1}$, of a direct-coupled cavity-type filter having a configuration shown in Fig. 1 C, can be expressed in terms of the lumped parameters of the capacitive-coupled filter. The general design equations for an n-stage maximally-flat band-pass filter are tabulated below.

The normalized reactance of the end discontinuities is

$$X_1 = X_{n+1} \cong \sqrt{\frac{4}{\pi}\,\frac{f_o}{\Delta f}\sin\frac{\pi}{2n}} \qquad (1)$$

and the normalized reactances of all other discontinuities are

$$X_m \cong \frac{2\sqrt{2}}{\pi}\,\frac{f_o}{\Delta f}\sqrt{\cos\frac{\pi}{n} - \cos\frac{2(m-1)\pi}{n}} \qquad (2)$$

where f_o = center frequency of filter
Δf = filter bandwidth
m = serial number of discontinuity = 2, 3, . . .

The separation of the reactance elements is

$$l_{m,m+1} = \frac{\lambda_a}{2\pi\sqrt{\epsilon}}\left[K\pi + \frac{1}{2}\left(\tan^{-1}\frac{2}{X_m} + \tan^{-1}\frac{2}{X_{m+1}}\right)\right] \qquad (3)$$

where λ_a = electrical wavelength in air
K = a positive integer

Table I—Normalized Reactance Data for Six-Stage Bandpass Filter

Discontinuity m	Normalized Reactance X_m	Gap	Dimensions (d or α) in inches
1	−1.82	Dove-tail	0.070
2	−5.45	Simple	0.039
3	−10.52	Simple	0.097
4	−12.3	Simple	0.116
5	−10.52	Simple	0.097
6	−5.45	Simple	0.039
7	−1.82	Dove-tail	0.070

ϵ = dielectric constant of transmission medium

Physical Construction

The most difficult problem in the development of strip-line filters is their physical realization in the proposed type of transmission line. Prior to fabrication, it is necessary to choose a suitable dielectric medium, develop a broadband coaxial-to-strip-line transition and compile a reference library of normalized reactances versus capacitance-gap spacings for strip line.

For filters requiring high loaded Q-factors and a small insertion loss in the microwave spectrum, the use of an air-dielectric line is recommended. Where physical size is an important consideration at lower frequencies and loaded Q-factors are not large, a high dielectric low-loss material is desired.

A study is being made to establish the availability of dielectric materials having a high dielectric constant, low loss-tangent, a satisfactory degree of homogeneity, properties suitable for copper-cladding and good environmental characteristics. Although not complete, this evaluation program indicates the existence of very few high-dielectric materials available in a suitable copper-clad laminate form.

Since space reduction is of particular importance in many applications, longer filters resulting from the use of materials having lower dielectric constants can be physically accommodated in a relatively small space by forming the transmission line into a spiral configuration. By using a low-loss dielectric such as cementable teflon, a further reduction in size can be obtained over a similar air-dielectric filter.

Having chosen a dielectric medium, a suitable strip-line-to-coax transition is required. To preserve a given filter response, the transition should have a low vswr over the entire operational frequency spectrum. In Fig. 2A, a transition, employing a UG-290/U

BNC connector mounted axially to a strip line having a ground-plane conductor spacing of $\frac{1}{8}$ inch, had a vswr of less than 2-to-1 from 2 to 3 kmc. A normal type transition, similar to those used with most strip transmission lines shown in Fig. 2B, had a narrow frequency response. It should be noted that objects near the edge of this strip line affect the performance of the transition. Asymmetrically located elements in the transverse plane of the sandwich-type strip lines, such as the extended center conductor of the coaxial connector in the transition of Fig. 2B, cause a perturbation of the electromagnetic field resulting in a tendency to radiate.

The first satisfactory design of a broad-band, coax-to-strip-line transition in an air-dielectric structure is shown in Fig. 2C. Similarly, a second broadband transition was designed for a strip line using a teflon-impregnated fibre-glass dielectric medium. Using a cascaded pair of either of these transitions, the maximum vswr over a frequency range from 1 to 5 kmc was less than 1.30, as shown in Fig. 3. It should be noted that the terminating load in these tests had a vswr equal to or less than 1.15 over this spectrum.

The final preparatory step in the realization of a capacitive-coupled strip-line filter is the compilation of normalized reactance data. A series capacitance is easily realized in a strip transmission line by making a gap in the center conductor as shown in Fig. 4A. However, except for very close spacings, it is difficult to calculate the equivalent capacitance of a gap because of the configuration of the fringing field. A reference library of normalized capacitive reactance as a function of gap spacings can be compiled experimentally by making simple tests on one-stage strip-line filters having different gap spacings at a specified frequency. For example, having measured the loaded-Q of a one-stage filter, the capacitive reactance of the gap spacing can be computed from Eq. 1.

In order to realize the required higher capacitances at the lower frequencies without making the gap spacings unrealistically small (<0.010 in.), a dove-tailed gap designed as shown in Fig. 4B was employed.

Typical reference libraries of standard and dove-tailed gaps compiled at 3,000 mc in an air-filled line are shown in Fig. 5. As an interesting by-product of these measurements, the dielectric constant of the medium, for other than very small values of Q, can be computed very accurately using Eq. 3.

Experimental Results

Using the formulas and reference library data discussed above, a six-stage maximally-flat filter having a 10-percent bandwidth centered at 3,350 mc and 40-db rejection at 12 percent from the center frequency can be designed. Given the filter bandwidth, Δf, center frequency, f_o, and the number of resonant elements, n, required for the desired skirt selectivity, the normalized reactances of the end discontinuities, X_1 and X_{n+1} and of the other discontinuities can be computed from Eq. 1 and 2, respectively, and tabulated as shown in Table I. It should be noted that the normalized reactance for a capacitive discontinuity is negative.

Referring to the design data in Fig. 5, all normalized reactances greater than 3 should be realized using simple gaps, whereas smaller values are more conveniently realized with a dove-tailed configuration. The physical dimensions of both the simple and dove-tailed gaps can be read from Fig. 5 and are included in Table I. Dove-tailed gaps are used in the outermost cavities to give the required reactance values. Considering the equivalent dielectric constant, ϵ, of the transmission medium, the separation of the reactive elements can be computed from Eq. 3 to be $l_{1,2} = 1.31$ inches, $l_{2,3} = 1.47$ inches, $l_{3,4} = 1.51$ inches, $l_{4,5} = 1.51$ inches, $l_{5,6} = 1.47$ inches and $l_{6,7} = 1.31$ inches.

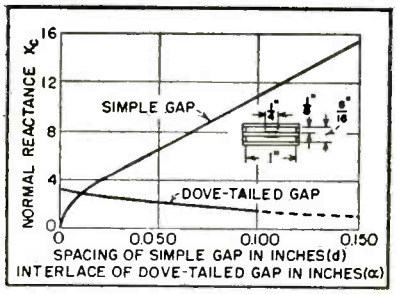

FIG. 5—Normalized reactance plot for simple and dove-tail gaps at a frequency of 3,350 mc

For an air-dielectric structure of the type shown in the photograph, the equivalent ϵ will be slightly greater than unity because of the presence of the dielectric supporting sheet for the center conductor. Using a $\frac{1}{16}$ in. supporting sheet of teflon impregnated fibre-glass, the equivalent dielectric constant of the medium is approximately 1.2 at 3,350 mc. The theoretical and experimental response characteristics of this six-stage filter are shown in Fig. 6.

Filters designed at higher frequencies or having higher loaded-Q factors require smaller coupling capacitors, thus eliminating the need for dove-tailed gaps. At lower frequencies the filters become unrealistically long. To shorten these

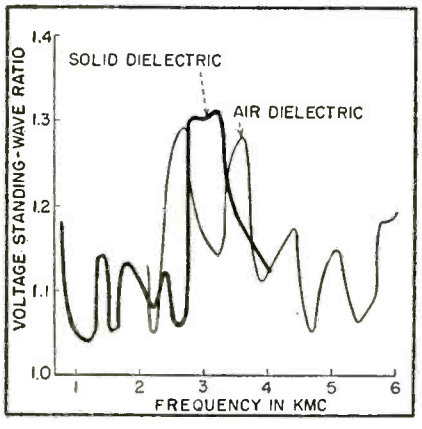

FIG. 3—Impedance match of coaxial-to-strip transitions

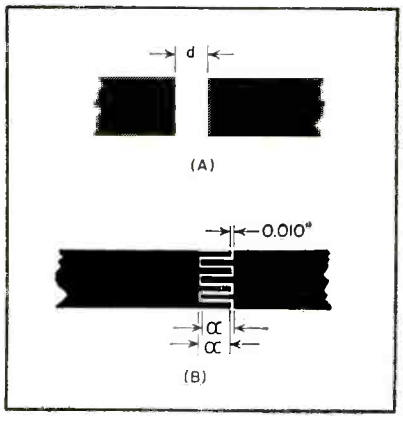

FIG. 4—Simple gap (A) and dove-tail gap (B) used in compiling table I

units, the strip line was photo-etched in a snake-like configuration with the reactance gaps located in a linear portion of the line. A filter designed at 715 mc using a teflon-impregnated fiber-glass dielectric is shown in the photograph. The effect of reflections coming from the impedance discontinuities at the bends is negligible. Theoretical and experimental response characteristics of this unit are shown in Fig. 7.

In many applications, filters must have a large insertion loss over a wide frequency spectrum outside of their fundamental passbands. To examine spurious responses in strip-line filters, response characteristics of a typical unit centered at 3,000 mc were measured from 2,500 to 10,000 mc. The spurious responses, shown in Fig. 8A, were centered at approximately integer multiples of the fundamental, had about the same Q-factor and became less discrete as the frequency increased.

Spurious responses of this type

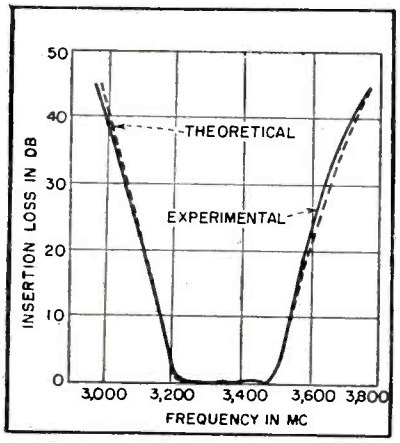

FIG. 6—Response characteristic of six-stage strip-line filter using air as the dielectric

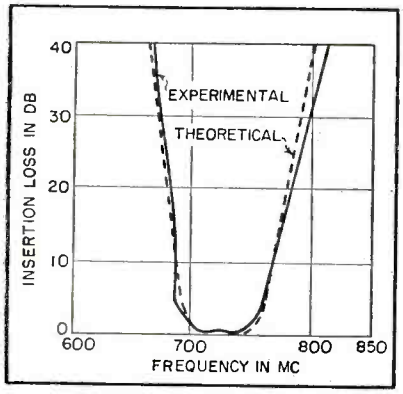

FIG. 7—Characteristic of six-stage strip-line filter in a solid dielectric

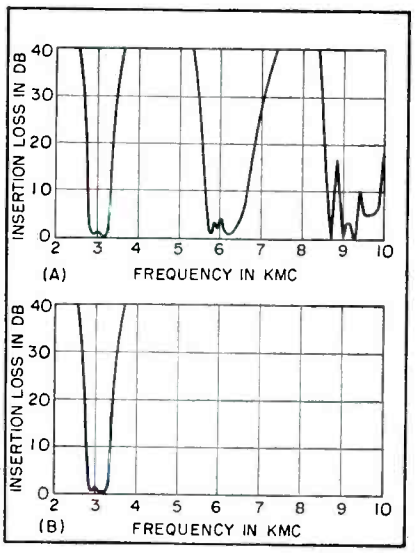

FIG. 8—Suppression of spurious response (A) in band-pass filter by cascaded band-pass low-pass filter (B)

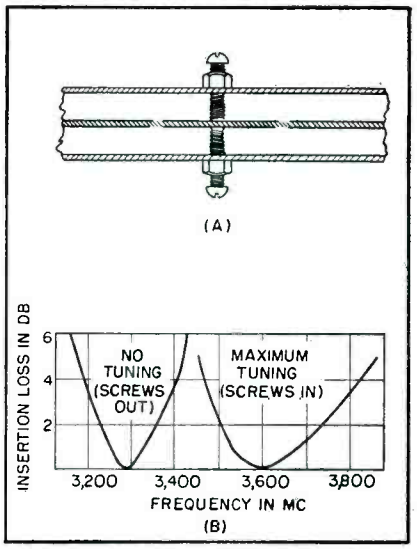

FIG. 9—Effect of capacitive tuning screws constructed as shown in (A) on response characteristic (B)

can be removed with a low-pass filter having a cutoff frequency somewhat less than that of the first spurious response. For example, a low-pass strip-line filter was built with a cutoff frequency of 4,000 mc; when cascaded with the above band-pass filter, the composite response characteristics of both filters had no spurious responses up to 10 kmc, as seen in Fig. 8B. Above 10 kmc, it is possible that TE or TM modes of propagation may exist; this region has not yet been investigated.

Limitations

In designing and building direct-coupled strip-line filters using the above techniques, certain limitations exist. The accuracy of the design formulae is a function of the filter requirements. For filters having a loaded Q-factor of ten, it has been empirically observed that the resulting center frequency and loaded Q lie within a ± 1 percent and ± 4 percent scatter, respectively. This deviation also includes such errors as those introduced by inaccuracies in the capacitive-reactance reference library and the photo-etching facilities. It has been estimated that photo-etching tolerances of ± 0.002 inch should be adequate except where exacting requirements dictate a center frequency location of less than ± 0.5 percent. It is virtually impossible to determine the tolerance requirements since there exist many inseparable variables, each of which is dependent upon the design techniques used and the filter requirements.

Where some tolerances cannot be maintained, an alternate way of realizing filters having exact center-frequency requirements is to make some provision for tuning. Figure 9A shows a longitudinal view of a one-stage strip-line filter with capacitive-tuning screws located in both ground-planes. The symmetrical location of these screws is required to minimize radiation that might otherwise exist. In a one-stage filter, a 10-percent shift in the center frequency was realized with tuning screws located approximately 0.010 in. from the center conductor. However, since the loaded Q of the filter was appreciably changed in tuning, as shown in Fig. 9B, the allowable tuning range is, therefore, restricted in certain applications. To align a multi-stage filter, all stages are completely detuned (capacitive tuning screws touching the center conductor of the strip line); the quarter-wave shift in the standing-wave pattern at the input circuit is monitored as each stage is progressively tuned.

The authors wish to acknowledge the helpful assistance of D. J. Alstadter and C. P. Andrikian in the compilation of the data presented in this paper.

Automatic Micrometer

SUMMARY —— Sensing jaw is linked to mirror that sweeps beam of light across bank of 12 phototubes, each controlling one trapdoor in chute passing over twelve bins, to give precision sorting of punched phenolic resin spacers into thickness groups differing by $\frac{1}{2}$ thousandth inch

By E. T. FEARON

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SPACINGS between contact levels on two-motion telephone selector banks have to be fixed during the assembly of the banks with an accuracy of $1\frac{1}{2}$ thousandths of an inch, but the makers of the phenolic-resin insulating sheet from which the spacing insulators are stamped can only supply sheet accurate in thickness to 3 thousandths. Moreover, this variation does not only apply sheet to sheet; it may occur to a smaller degree from place to place on one sheet.

Former practice was to measure by hand micrometer the centers of the spacing insulators as they were stamped out of the sheet, then segregate them into batches differing by half a thousandth of an inch in mean thickness. These were then used, together with metallic spacers of known thickness, to build up selector banks having the required spacing between contact levels.

When production was found to be flagging because of the laboriously slow manual measurement, an automatic tester-batcher was designed. This machine has a magazine which is filled with 600 insulators every quarter of an hour. Apart from normal maintenance, such as accuracy-testing, this is the only attention it receives; all the machine operator has to do is collect the bins of correctly graded insulators as they become full.

Power for the mechanical operation of the machine comes from a $\frac{1}{3}$-hp electric motor, which operates a feed arm to push the insulators one at a time between the measuring jaws of the micrometer. As each fresh insulator is pushed forward it displaces the last one measured. The movable lower jaw of the micrometer closes the gap and then opens to accommodate the center section of the insulator. Measurement at the center only has been found to be adequate because variations in any sheet are negligible over the area covered by one insulator.

The movement of the lower jaw is transmitted by a second lever under the top deck of the machine, arranged as in Fig. 1, to a small mirror which reflects a narrow beam of light from a slotted light-source onto an arc array of twelve phototubes. The more the jaw of the micrometer moves to adjust itself to the insulator, the further the reflected light-ray travels over the arc. When the beam finally comes to rest it can illuminate only one phototube.

Photoelectric Circuit

A typical circuit element is shown in Fig. 2. The two rotating cams complete one revolution for each test cycle. When the lower cam in the diagram connects ground to the

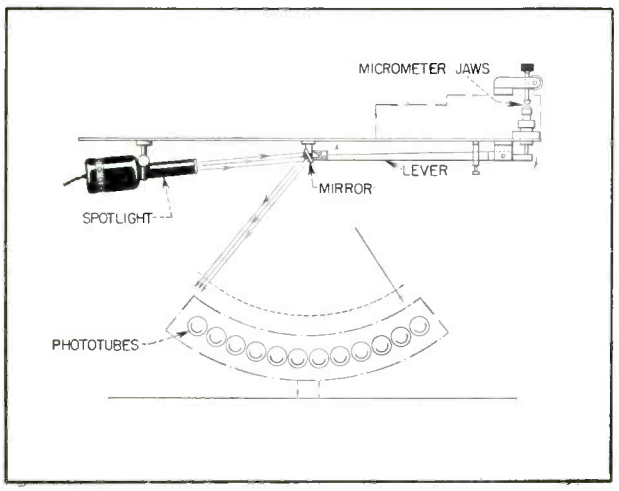


FIG. 1—Movable lower jaw of micrometer pushes down one end of mirror-bearing lever to give optical magnification of thousandth-inch movements

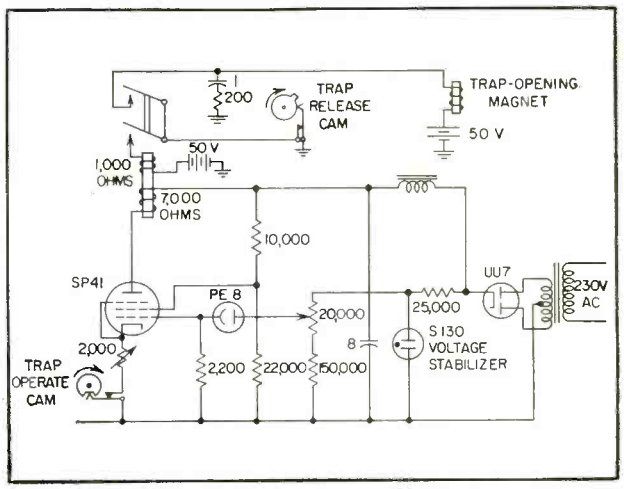
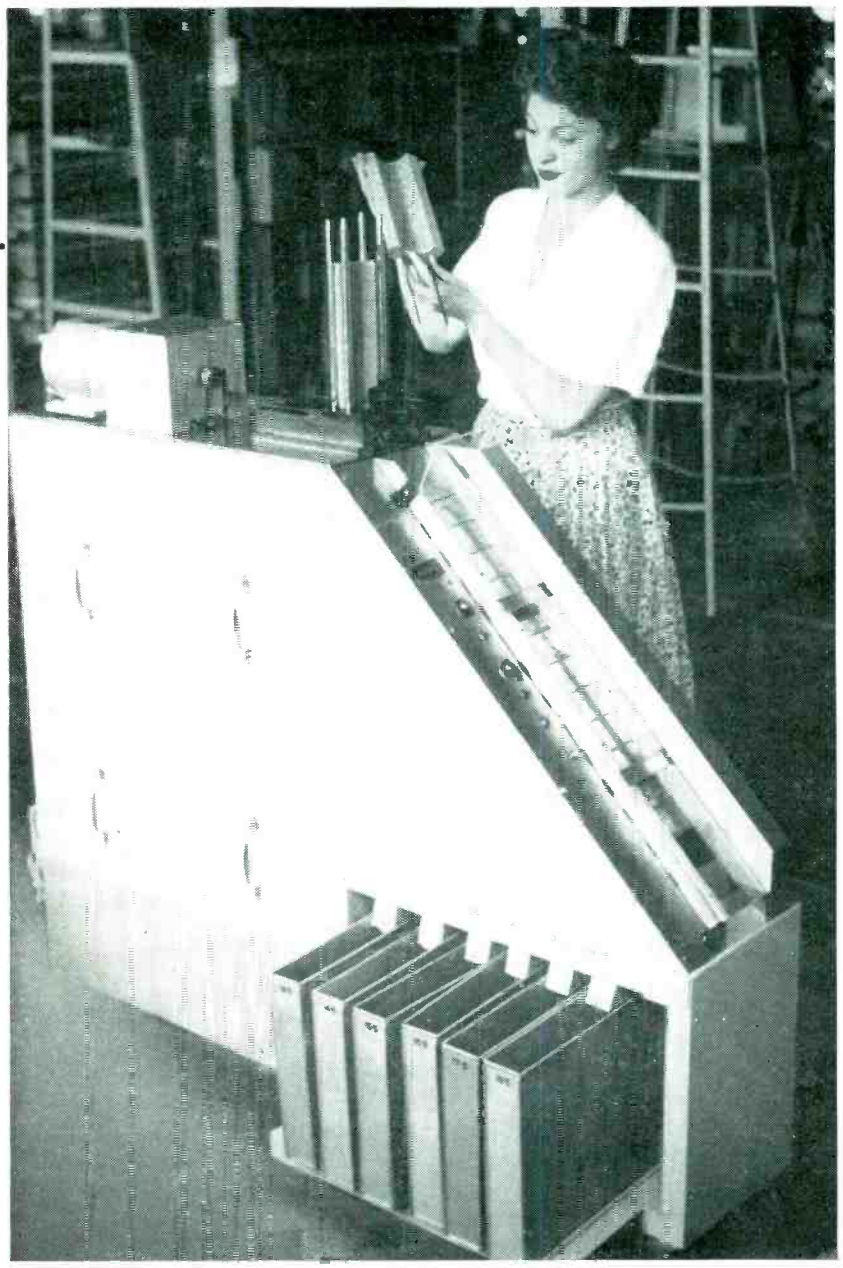
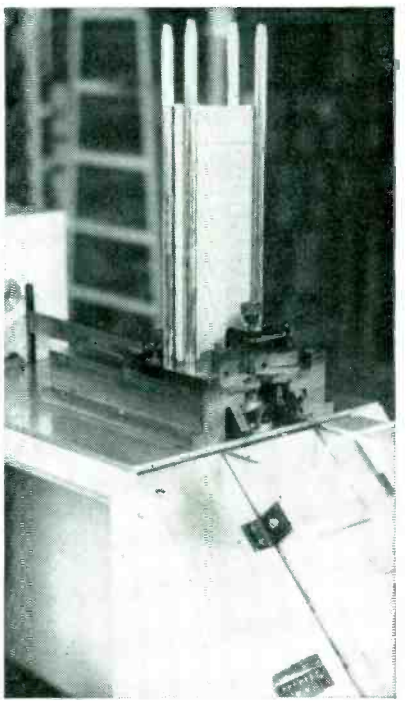


FIG. 2—Circuit used for each phototube. Motor-driven cams make one revolution for each test cycle. Power supplies are common to all twelve phototube stages

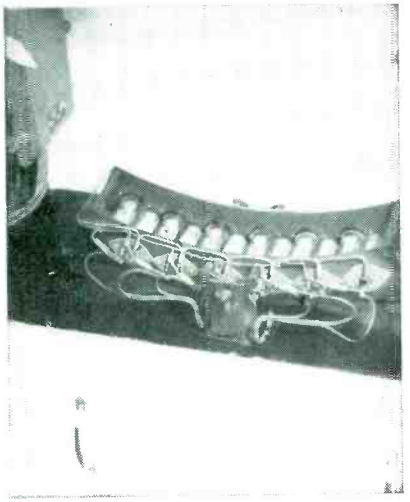
Sorts Insulating Wafers



Loading spacing wafers into sorting machine. After gaging, wafers slide down chute to open trap and drop into correct bin. Six bins are on each side of machine



Micrometer gaging head. Lever behind stack pushes out each wafer in turn



Method of arranging phototubes in arc. Covers of machine give light-tight seal

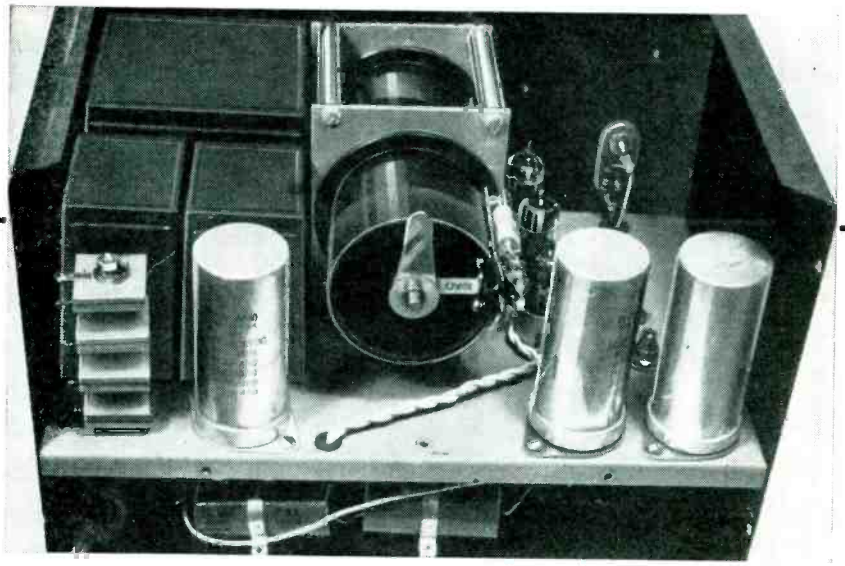
cathode of the type SP41 pentode, the relay operates, assuming that the type PE8 phototube is at that moment illuminated. This relay holds operated through its own contacts and also operates the trap-opening magnet. The trap will be open ready to receive the measured insulator when it is pushed from the micrometer jaws by the next selected insulator from the magazine. The trap lids form a chute down which the insulators slide as they are pushed forward.

After sufficient time has elapsed for the insulator to slide down and disappear into the furthest trap the upper cam disconnects the ground and thereby releases the relay and the trap magnet.

Each trap has its own individual chute leading to a storage bin, which is labeled with the mean thickness in thousandths of an inch of the insulators it holds. The leverage on the optical system is so arranged that there is a tolerance in measurement of plus or minus $\frac{1}{4}$ thousandth. There are twelve bins, labeled in steps of half a thousandth and covering the range from 13 to $18\frac{1}{2}$ thousandths arranged six on each side of the machine.

Audio Oscillator

By PETER G. SULZER
Consulting Engineer
Kensington, Maryland



Rear view of low-distortion audio oscillator showing the two 10,000-ohm square-law potentiometers used for frequency control

RECENT publication of a paper describing a low-distortion transistor audio oscillator[1] has resulted in inquiries concerning the possibility of constructing its vacuum-tube equivalent. This oscillator, covers the frequency range from 10 cycles to 100 kilocycles, with a maximum output of 3 volts to a high-impedance load. Total rms distortion, hum and noise is less than 0.02 percent from 20 cycles to 20 kilocycles.

The desirability of substituting tubes for transistors may appear to be progress in reverse. However, in this application, where small size and low power requirements are not of great importance, tubes are able to supply more output at lower distortion over a wider frequency range than transistors.

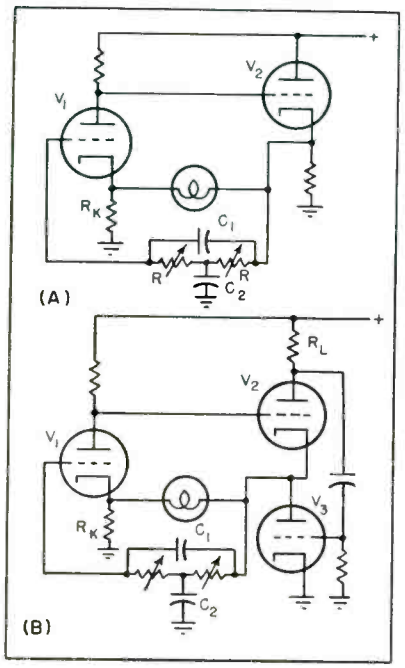


FIG. 1—Basic bridged-T oscillator uses tungsten lamp as amplitude control for linear operation (A); low-distortion bridged-T oscillator employs push-pull arrangement (B)

Basic Circuit

The oscillator[2] shown in Fig 1A contains a voltage amplifier V_1 and a cathode follower V_2. Regenerative feedback is provided to the cathode of V_1 through a tungsten-filament lamp, while degenerative feedback occurs through the bridged-T network[3]. Oscillation takes place at the frequency of minimum degeneration and zero phase shift, $f = 1/2\pi RC$, where $C = \sqrt{C_1 C_2}$. Amplitude control required for linear operation is provided by the tungsten lamp, whose resistance increases with voltage until the attenuation of the circuit containing the lamp and R_k is but slightly less than that through the bridged-T network.

The basic circuit is satisfactory as a general-purpose oscillator; however, the distortion is about 1/2 percent at an output of 5 or 10 volts. Tests of the amplifier alone have shown that most of the harmonic generation occurs in the single-ended cathode follower V_2. This is principally because of the fact that the comparatively low lamp resistance decreases the effective feedback factor of the cathode follower.

If the output is decreased to 1 or 2 volts a distortion of 0.1 percent may be obtained, but only at the expense of serious hunting during the amplitude-stabilization process. This will occur after every adjustment of frequency and the resulting amplitude fluctuations may persist for many seconds, making the oscillator useless except as a fixed-frequency device.

Modifications

A substantial reduction in distortion can be obtained by using the two-stage cathode follower[4] shown in Fig. 1B. Here the control grid of V_3 is driven by the plate of V_2. The tubes are effectively in push-pull, because the plate current of V_3 decreases as the plate current of V_2 increases and therefore a reduction in even-harmonic distortion can be obtained. There is an additional advantage in that the signal currents of both tubes are available for driving the lamp and load. The two-tube cathode follower behaves as a low-impedance source because of its built-in amplified negative feedback.

The oscillator shown in Fig. 1B can be adjusted to produce a distortion of 0.005 percent at 3 volts, but the hunting problem remains. Evidently the lamp temperature and resistance should increase during

Has Low Distortion

SUMMARY — Production testing of high-quality amplifiers simplified by oscillator covering a frequency range from 10 cps to 100 kc in four steps by changing capacitors. Biased diodes eliminate hunting when changing frequency by clipping initial overshoot

build-up until an equilibrium condition is reached in which the amplifier gain is exactly offset by the attenuation through the bridge[5] containing the lamp R_k and the bridged-T network. During the build-up period the lamp temperature will overshoot the equilibrium value, requiring a cooling cycle.

The resulting damped oscillation can be eliminated by any means that will do away with the initial overshoot. Two biased diodes, adjusted to clip both positive and negative half-cycles at slightly over the normal amplitude will accomplish this result. If fixed bias is used, the output-voltage variations caused by circuit changes such as the imperfect tracking of the two sections of the dual potentiometer, will produce excessive clipping and high distortion at some frequencies and insufficient clipping at others.

Fortunately excellent results can be obtained by permitting the diodes to bias themselves, with a long time constant in each diode load. The diode bias will then follow normal, slow output variations, but will permit heavy clipping when the oscillator is first turned on or when transients caused by range switching occur.

Rectification required to maintain the diode bias will produce some distortion even under steady-state conditions. However, this is minimized by the low source impedance of the output stage.

Practical Oscillator

The complete circuit of a practical oscillator is shown in Fig. 2. The frequency range from 10 cycles to 100 kilocycles is covered in four decades by switching C_1 and C_2, whose values are shown on the schematic diagram. Each of the two resistors consists of a 10,000-ohm square-law potentiometer in series with a 1,000-ohm carbon resistor. The two potentiometers are ganged so that the high-frequency end of the tuning range corresponds to the narrow part of the resistance card, producing a nearly logarithmic frequency scale.

A pentode voltage amplifier is used to obtain sufficient voltage gain to permit a large amount of negative feedback at harmonic frequencies. Low-μ triodes are used in the output stage to obtain sufficient plate current with the low effective supply (150 volts) per tube. There

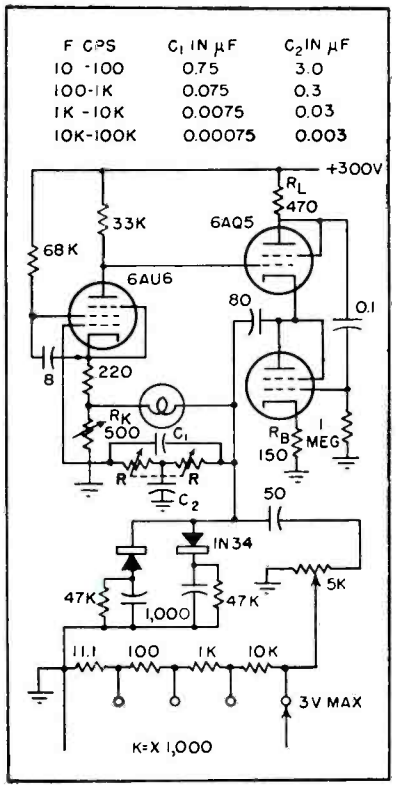


FIG. 2—Complete circuit of a practical oscillator that covers the range from 10 cycles to 100 kc in four decades

is little advantage in connecting these tubes as tetrodes, probably because of the small signal voltages involved. Several extra components would also be required.

Although a buffer amplifier would be desirable to obtain isolation and increased output power, it is difficult to produce an untuned amplifier with sufficiently low distortion. The attenuator is useful for gain measurements and other tests. Output voltage is constant within ±3 percent at all frequencies and therefore an output voltmeter is not required.

Adjustment

The frequency controls should be adjusted to 1,000 cycles on the 1-kc to 10-kc range, and R_k should be increased until an output of 3 volts is obtained. The frequency can then be increased to 10 kc on the same range. If the output voltage is not the same for all settings of the frequency-control potentiometer, the two sections are not tracking properly and one of the 1,000-ohm series resistors should be changed so that the output at the two ends of the frequency range are equal.

With the values given for R_L and R_B a distortion of less than 0.02 percent was obtained with several different sets of tubes.

The work reported in this article was performed for McIntosh Laboratory, Inc., Binghamton, N. Y.

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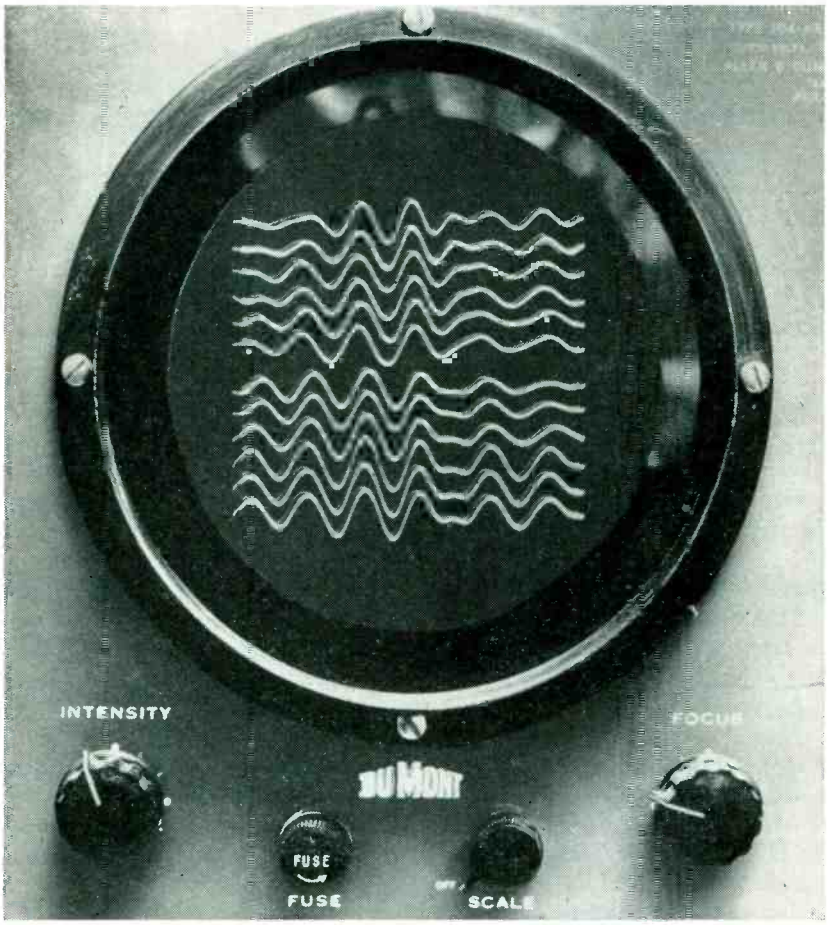
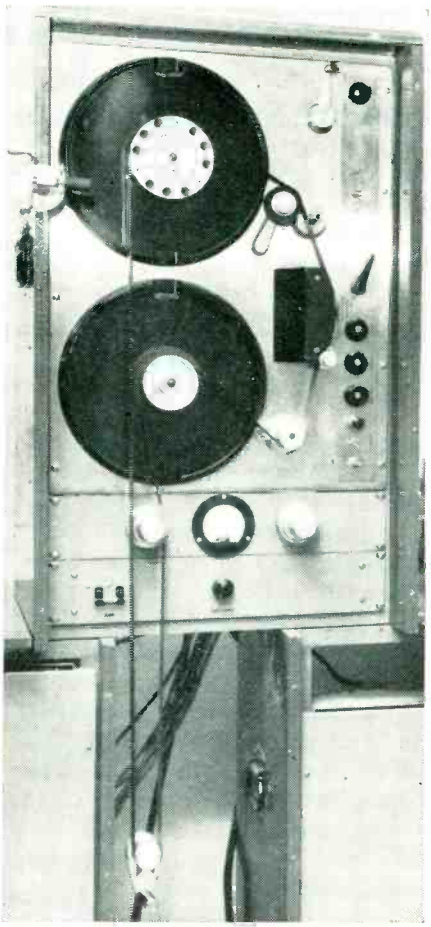


Portion of 12-trace seismogram as seen on 5-inch single-beam oscilloscope using electronic switch to sample all twelve channels from magnetic tape



Tape playback unit, with endless loop of magnetic tape in position

Cathode-Ray Display of

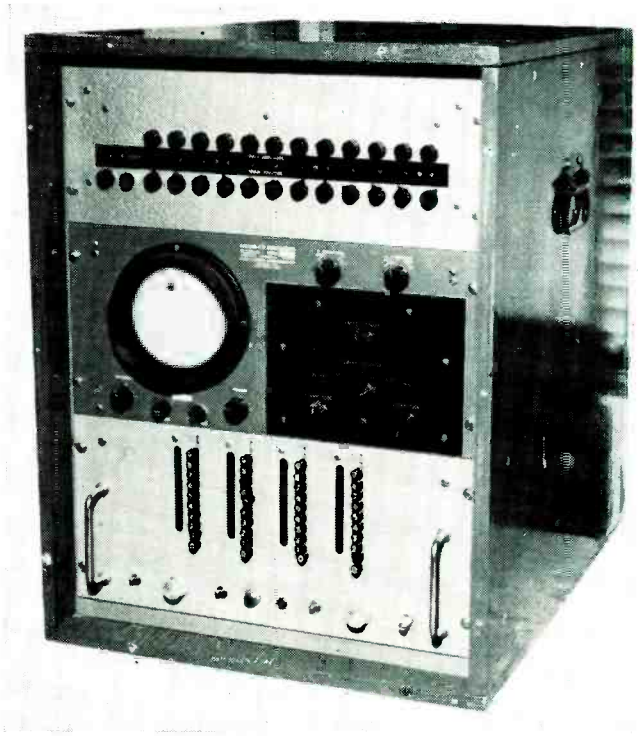
By G. M. GROENENDYKE and G. B. LOPER

Field Research Laboratories
Magnolia Petroleum Co.
Dallas, Texas

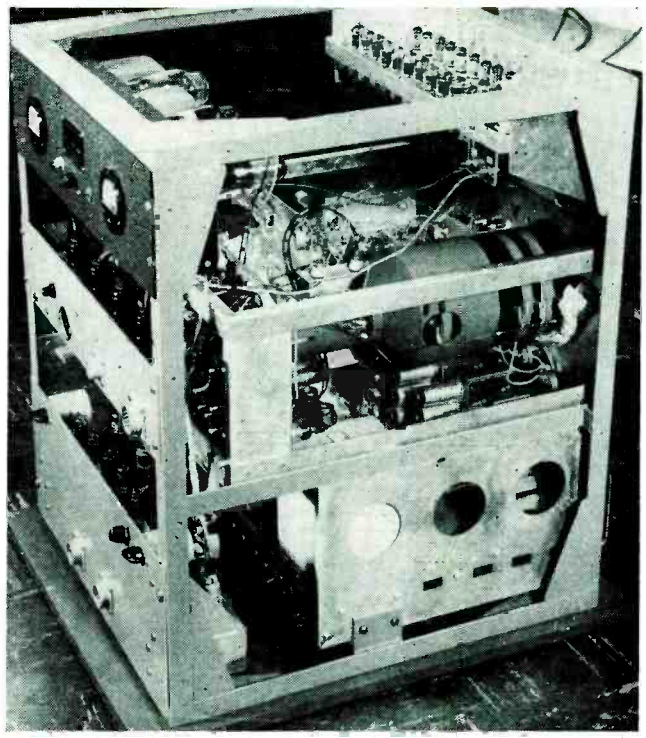
IN THEIR SEARCH for new petroleum deposits in the earth, the major oil companies use practically all known measurements that can be made of the physical nature of the earth. Of the many measuring techniques involved in geophysical prospecting, the one which commands the greatest amount of attention today is the reflection seismograph. This is an acoustic sounding technique wherein the elastic waves generated by the detonation of a small charge of dynamite in a shallow borehole penetrate deep into the earth. These waves reflect from successive interfaces between layers of contrasting materials, as where abrupt changes of acoustic impedance occur.

The depths to the various reflecting layers are computed from the reflection times, after which contour maps are plotted depicting the subsurface structural conditions. This survey is made in the hope of revealing structural conditions favorable for the accumulation of oil.

Because of the extreme inhomogeneity of the earth the significant reflections of acoustic energy from depth are often obscured by noise waves, or the waveforms are frequently so variable that accurate time determinations are impossible. These signals are normally recorded on photographic paper with a conventional oscillograph. In an effort to glean significant information from such recordings a number of the major oil companies and geo-



Modified DuMont 304AR oscilloscope (center) is fed through 12-channel electronic switch (top) and synchronized with magnetic-tape loop by Berkeley 5424 preset counter (bottom) controlled by time-track pulses on 13th recorded track



Rear of cathode-ray display unit, with power supply at top rear and auxiliary control circuits at bottom rear. Each channel of electronic switch has a trace-position control and a sensitivity control for eliminating overlapping of the 12 traces on the screen

SUMMARY —— Magnetic recordings of seismic reflections in petroleum prospecting are viewed on c-r oscilloscope to study effects of filters. Electronic switch and pulse counter present twelve traces simultaneously for any desired portion of endless-loop tape

Seismic Recordings

physical contractors have begun recently to record the seismic vibrations on magnetic tape. This technique affords the means of subjecting the records to a variety of procedures intended to improve signal-to-noise ratio and to clarify correlations based on similarity of waveforms.

The equipment described here was developed to serve as a rapid means of monitoring the played-back seismic records either before or after analytical treatment without requiring the making of a conventional seismogram.

In Fig. 1 is shown a typical re-

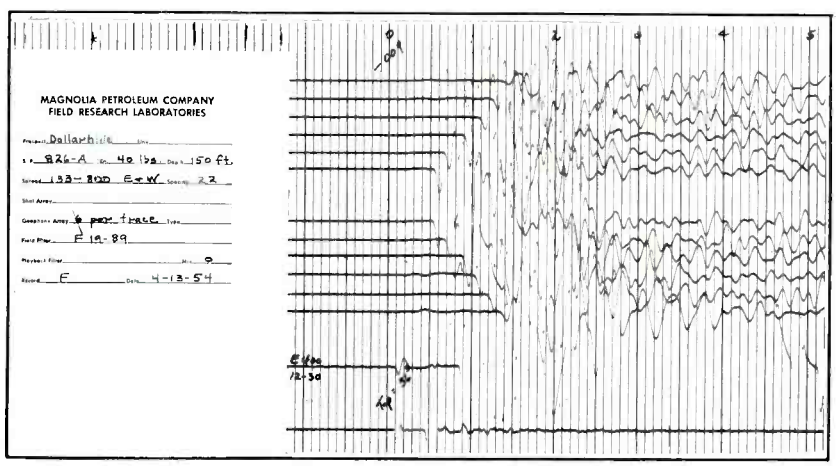


FIG. 1—Portion of typical reflection seismogram, showing signals as conventionally recorded on paper by ink-writing oscillograph. Numbers at top are tenth-seconds

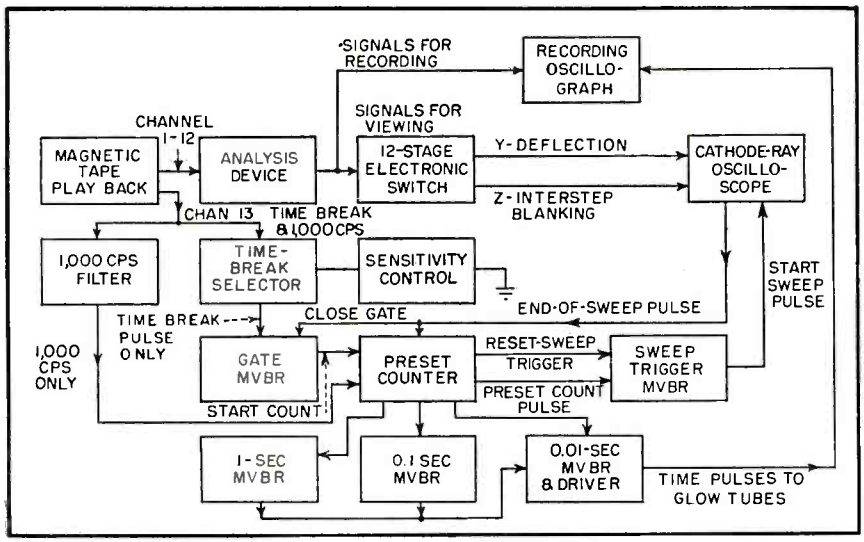


FIG. 2—Block diagram of complete cathode-ray display system used for studying selected portion of all 12 traces

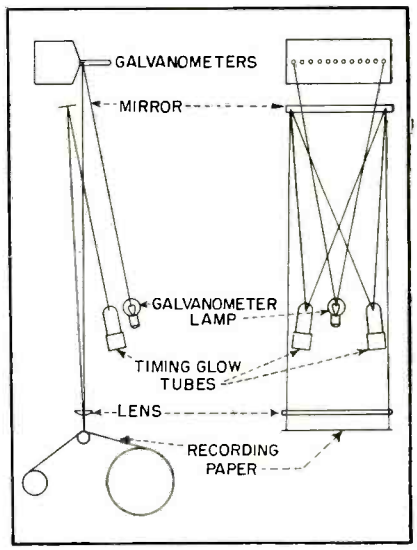


FIG. 3—Optical system used with glow tubes to give accurate time lines

flection seismogram. Time progresses from left to right, with the closest vertical lines separated by 0.01 second. Each of the first 12 traces is a recording of the motion at a point on the earth's surface as picked up by a vibration detector or geophone of the moving-coil, permanent-magnet type. Traces 6 and 7 are signals from detectors nearest the dynamite charge, other traces corresponding to successively greater distances in either direction. The frequencies involved in this record range from 20 to 90 cps. Variable electric filters in the recording amplifier have been preset to pass only this range. Frequencies from 5 cps to 200 cps are sometimes encountered and a pass band anywhere in this range may be selected if the basic channel response is broad enough.

Reflections on the record are distinguished by an increased burst of amplitude common to all traces, a common phase relationship, and similar waveform among all or most of the traces.

The bottom trace shows a sharp break near the zero time line which gives the instant the charge detonated. This is the time break.

To record these signals on magnetic tape, a 13-track recorder is employed. The 12 reflection traces are recorded with a frequency-modulated carrier. The maximum available bandwidth of the overall system is 5 to 300 cps. Time data are recorded in the form of a steady 1,000-cps note on the 13th track with direct recording (no carrier). The 0.01-second timing lines are derived from this signal. The time break is a pulse of less than 1 millisecond duration which is superimposed upon the 1,000-cps tone and exceeds it in amplitude by a factor of 2 or 3. Each magnetic tape record, representing one seismogram of about 5 seconds duration, is spliced in an endless loop and threaded onto the playback machine with fixed pulleys and a weighted, floating pulley to keep it taut. The full record thus repeats endlessly about 12 times per minute.

Block Layout

A block diagram of the cathode-ray display system is given in Fig. 2. The 12 information channels are applied to an instrument referred to as an analysis device. In the simplest form, this may involve only level adjustment or simple selective filtering to vary the frequency responses of the 12 channels. It may also include phase shifting and partial interchannel mixing. Whatever the treatment used, the modified signals then go to a 12-stage electronic switch which drives a cathode-ray oscilloscope for simultaneous viewing of the 12 traces, and to a recording oscillograph for making a permanent paper record. The c-r screen serves as a monitor to show instantly the effects of changes introduced in the analysis circuits and thus reduces the making of paper records to those which are desired for computation and permanent file. The rest of the circuitry of the block layout is required for synchronizing the c-r sweep with the repeating of the tape loop, and for generating the timing lines in the oscillograph.

As it is not practical to use a screen large enough to display the entire seismic record in its proper proportions, the conventional seismogram being 3 to 6 feet in length, it is necessary to preselect a short portion which is to be viewed and to trigger the sweep each time that portion repeats so that the images are always in perfect register. The signals on the 13th track provide synchronizing means. The reference point on the tape loop is the time-break impulse. This is separated from the 1,000-cps tone by amplitude discrimination, shaped in the gate multivibrator and applied to the preset counter to start the count.

The 1,000-cps tone is filtered with a parallel resonant circuit to give it purity and to cause it to sustain during instants of dropout which may occur on the magnetic tape. This is then applied to the counter input. When the time break occurs the counter begins to count the 1,000-cps signal. At the end of the preset count a pulse is delivered to a sweep trigger multivibrator which in turn pulses the sweep circuit of the scope. The sweep trigger

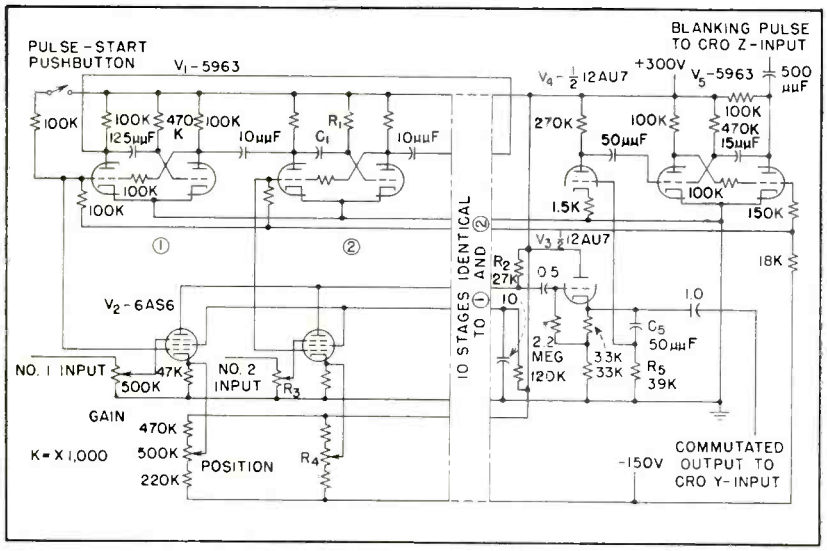


FIG. 4—Ring of monostable multivibrators in electronic switch serves to gate the twelve 6AS6 signal tubes in sequence at 20-microsecond intervals

multivibrator serves also to block subsequent pulses, coming out of the counter, from triggering the sweep.

The sweep circuit of the scope generates a pulse at the end of the sweep which is used to reset the gate multivibrator, the preset counter and the sweep trigger multivibrators. Both multivibrators are bistable units which respond only to the first impulse which hits them, until reset. The counter has four decade units with a total count of 9,999, so that within this limit the sweep may be initiated any selected millisecond after the time break each time the tape loop repeats.

The speed of the sweep is independently adjustable to have any duration from 0.1 second to 10 seconds as desired by the operator. The entire record may be viewed in compressed form if the sweep speed is made slow and the counter is preset on 0000 so that the sweep starts with the time-break impulse. On the other hand, a reflection occurring at 1.5 seconds may be viewed in fine detail if the counter is preset to start the sweep at about 1,490 milliseconds and the 0.1-second sweep duration is used.

The timing lines on the paper record of the oscillograph are derived from the 1,000-cps tone of track 13. Output pulses are taken from three of the decade units in the counter. The first decade delivers a pulse every 0.01 second, the second gives a pulse every 0.1 second, and the third every 1.0 second. These are shaped with monostable multivibrators and combined with a 6AQ5 driver tube to flash a pair of 1131C glow modulator tubes in the oscillograph. These glow tubes have sufficient brilliance to make dark straight lines across the full 8-inch width of the recording paper. The optical arrangement is shown in Fig. 3.

The period of repetition of the endless loop of magnetic tape may be any time from 3 seconds to 10 seconds and is generally made as short as the data will permit so that screen brightness is enhanced by higher repetition of sweeping.

Electronic Switch

The electronic switch is a hard-tube commutator which provides the means for displaying twelve information signals on a single-gun cro. A self-sustaining ring of twelve monostable multivibrators is the source of pulses used sequentially to gate the No. 1 grids of twelve 6AS6 pentode amplifier tubes. The No. 3 grids are used as signal grids. In this manner there is no tube conduction except in the amplifier, which is gated to the on or amplifying condition. Although capable of higher switching speeds, the rate is set at approximately 50 kc to minimize the commutation interval and reduce the power which would be required for a system of greater bandwidth. The resulting sampling rate, in excess of 4,000 cps, is adequate for sweep durations as short as 0.1 second. A blanking pulse is derived from a 13th monostable multivibrator which runs at the 50-kc rate in synchronism with the ring-of-twelve. It is desirable to apply this pulse as a Z-signal to blank the cro during the commutation interval. The definition of each trace on the cro screen then approximates that of the normal single trace.

Figure 4 is a schematic diagram of the electronic switch. For simplicity only two of the twelve identical stages are shown. The multivibrators are coupled by 10-μμf capacitors to form a ring. After warmup the pushbutton is momentarily depressed. Upon release, a starting pulse triggers monostable multivibrator 1. Upon recovery, stage 2 is triggered and a positive gating pulse is advanced from amplifier 1 to amplifier 2. This advance is sustained since the recovery of each multivibrator triggers the one succeeding. Although this ring is not critical of component tolerances, timing components R_1 and C_1 should provide uniform time constants. The brightness of the cro traces would otherwise not be uniform.

The No. 1 grid voltage of the amplifiers is normally −25 volts, representing cutoff. The gating pulse rises to approximately zero volts, being limited by the low grid-cathode impedance of the left half of the multivibrator, which is heavily conducting. As the multivibrator cathodes are tied to ground, the level to which the gating pulses rise is stable and uniform. The plates of the amplifier tubes are connected to a common plate load resistor R_2 across which appear the twelve information signals, sequentially commutated.

Each amplifier has a gain control, R_3, and a trace position control, R_4. The latter is a No. 1 grid bias control which serves to adjust the plate-voltage level when the amplifier is gated. When there are no signals at the No. 3 grids, therefore, the signal across load resistor R_2 will be a repetitive sequence of pedestals, normally adjusted in a uniform stair-step fashion by position controls R_4. The range of these

controls is limited so that linear dynamic operation of the tube as an amplifier is not exceeded.

A positive spike having a sharp leading edge occurs at the trailing edge of each pedestal during the commutation interval when tube conduction is switched from an amplifier to the one succeeding. The switch output is differentiated by C_5-R_5. The leading edge of this spike is amplified and inverted by V_4 and then used to trigger monostable multivibrator V_5. This multivibrator is the blanking pulse generator which supplies negative pulses to the Z-input of the cro.

Cathode-Ray Oscilloscope

The DuMont 304AR scope was chosen for reasons of low cost, rack mounting, response from d-c to 200 kc and full screen deflection on a flat-face tube. Before the development was completed, however, the circuit was modified as in Fig. 5. Two push-pull stages were eliminated to improve stability and cut down noise, power drain and heat. Response to d-c was maintained. This is desirable because if the response is not held up in the low frequencies there will be intercoupling of signals among the 12 traces, or, if one trace is shifted in position, all the others will shift slightly as well.

The sweep circuit was considerably simplified. A phantastron sweep generator was chosen because of its excellent linearity with wide voltage excursion, simplicity and low drain features, and because it delivers an excellent pulse at the screen for beam gating and end-of-sweep indication. A long sweep time of 10 seconds could be provided in this circuit with only a 0.1-μf capacitor.

The sweep function switch has three functions. OFF gives no sweep; spots are centered and steady for focus and position adjustment. TRIG is for an external triggered sweep, with spots blanked just off the left edge of the screen prior to sweeping. RECUR gives a recurrent sweep with no trigger or sync; spots are blanked between traces and on retrace.

The TRIG position is normal when portions of a magnetic tape record are to be viewed with the sweep triggered on each recurrence of the desired data.

The sweep generator is coupled to the horizontal deflection plates with a 12AT7 cathode-coupled push-pull driver. The direct coupling is necessary because of the low sweep speeds and repetition rates involved. The sweep is triggered with application of a short positive pulse to the suppressor grid through the 0.001-μf capacitor.

To hold the beam in blanked condition between sweeps a 1-mc intersweep blanking oscillator was added. It is a conventional circuit with r-f coupling to a rectifier in the No. 1 grid circuit of the c-r tube to provide control of intensity. The oscillator, employing a 6BJ6 pentode, is turned on at its suppressor grid. When the sweep starts, the screen grid potential of the sweep generator goes highly positive. This turns on the r-f oscillator, applying positive excursion to the No. 1 grid of the c-r tube to brighten the traces for the duration of the sweep. At the end of the sweep the 6BH6 screen grid returns to its former potential, turning off the oscillator and blanking the beam. This negative excursion of the 6BH6 screen is differentiated and the resulting pulse serves as the end-of-sweep reset pulse.

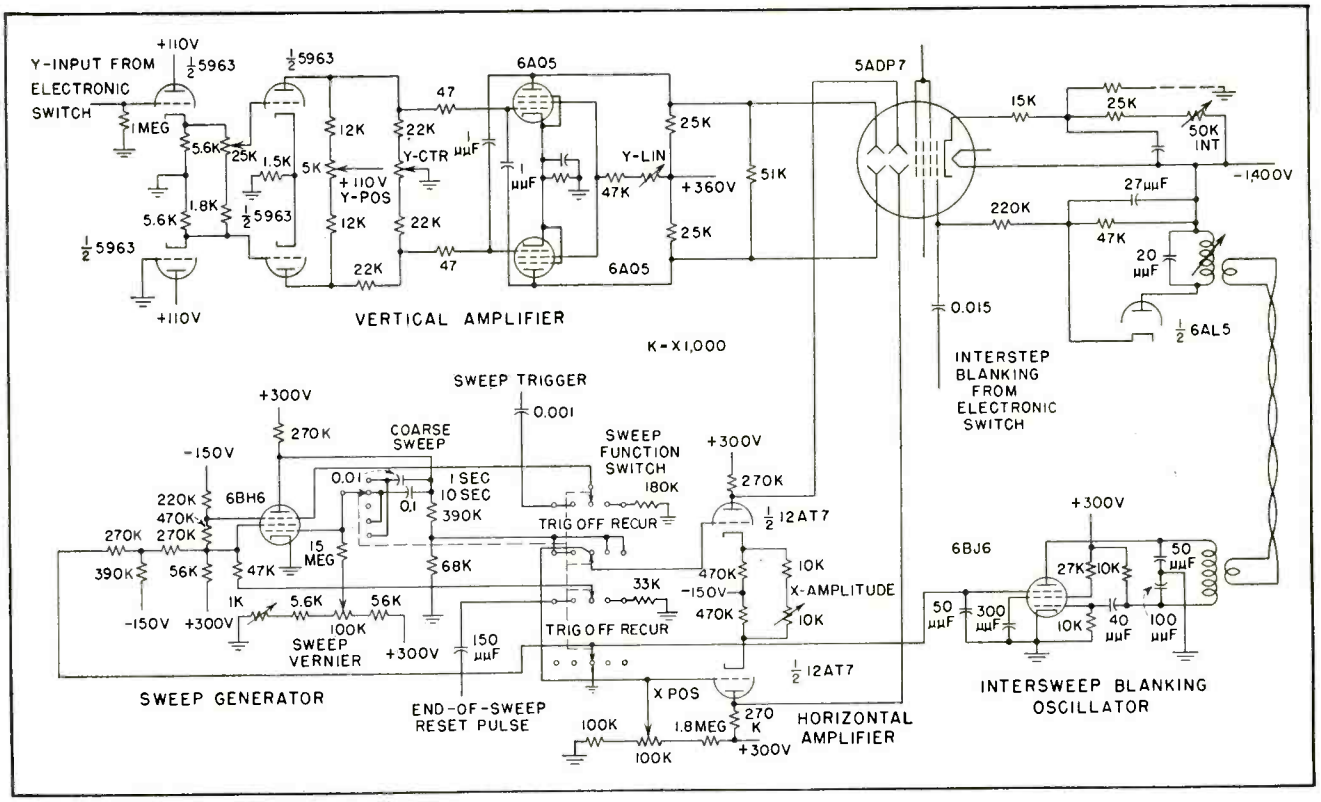


FIG. 5—Modifications made in oscilloscope include simplified vertical amplifier, phantastron generator and r-f blanking stage connected as shown here

The preset counter was modified so that the gating signal is supplied externally by a gate multivibrator as previously described. This signal is applied to the suppressor grid of the regular 6AS6 pentode gate in the counter which feeds shaped pulses to the first preset decimal counting unit. The end-of-sweep transient resets the decimal counting units through the normal circuitry of the counter. However, these counting units are modified to reset on the count of 9 instead of the count of 0. This is desirable since the first count will then clear all counting units, and the first time-line on the oscillogram will be accentuated as are all subsequent 1.0-second lines.

Bistable multivibrators V_2 and V_3, shown in Fig. 6, serve to initiate the cro sweep at the preset time. This time is set by depressing the numbered pushbuttons on the panels of the decimal counting units. Counter gate multivibrator V_2 is triggered by the positive-going time-break impulse which is selected, amplified and inverted in V_1. Selector V_1 is biased near cutoff. The sensitivity control sets this bias, and is found desirable because of track-13 signal-level variation, associated with amplitude modulation. When V_2 is triggered, the gate signal to the counter rises from −30 v to slightly higher than ground potential, being limited by grid-cathode conduction since the left half of V_2 is then heavily conducting. The negative-going end-of-sweep transient which resets the decimal counting units also resets V_2 to its original state and the counter is prepared for the next time-break impulse.

The cro sweep generator is triggered by V_3, which is similar to V_2 in operation. Tube V_3 in turn is triggered by the preset pulse from the counter, at which time the signal to the sweep generator rises to a steady value of approximately 15 v and is coupled to the sweep generator through a 0.001-μf capacitor located with the sweep generator circuitry. Tube V_3 is reset by the end-of-sweep transient simultaneously with V_2.

When the equipment is first turned on, V_2 and V_3 may set up in the triggered state, in which case the counter will not function. A switch actuated by a spring-return pushbutton produces a synthetic end-of-sweep impulse to reset these multivibrators. This pushbutton also starts the electronic switch.

Transfer of Timing to Paper Records

The paper speed during recording is approximately 15 inches per second. Time lines are provided by glow modulator lamps, beginning with the time-break impulse and repeating every 10 milliseconds. Each tenth line is enhanced by a longer pulsing of the glow time lamp. Each 100th line (1-second marker) is further enhanced by a still longer pulsing time.

Figure 7 shows the time-line circuitry. Tubes V_4 and V_5 form a monostable multivibrator which is triggered by the negative pulse output of the first decimal counting unit. The duration of the conduction of V_5 through the glow modulators is determined by the time constant of C_1 and the parallel combination of R_1 and R_2, and also by the voltage level to which the grid of V_4 begins to rise immediately after each trigger. This level is approximately +50 v when V_4 and V_5 are not triggered, and is influenced by the voltage level of the cathode of V_3. The pulse duration is accordingly about 50 microseconds. Tubes V_4 and V_5 form monostable multivibrators triggered by the outputs of the 2nd and 3rd decimal counting units respectively. The outputs of V_4 and V_5 are mixed and applied to the grid of V_3 as shown. The pulse times of V_4 and V_5 are respectively 100 and 250 microseconds. These pulses lower the cathode voltage of V_3 so that the recovery time of driver V_1-V_2 is accordingly delayed to 100 or 250 microseconds.

For permission to publish this article and for their cooperation, the authors are grateful to the Magnolia Petroleum Co. and to the Seismograph Service Corp. of Tulsa, Oklahoma who, under license from Magnolia, are manufacturing equipment of the type described.

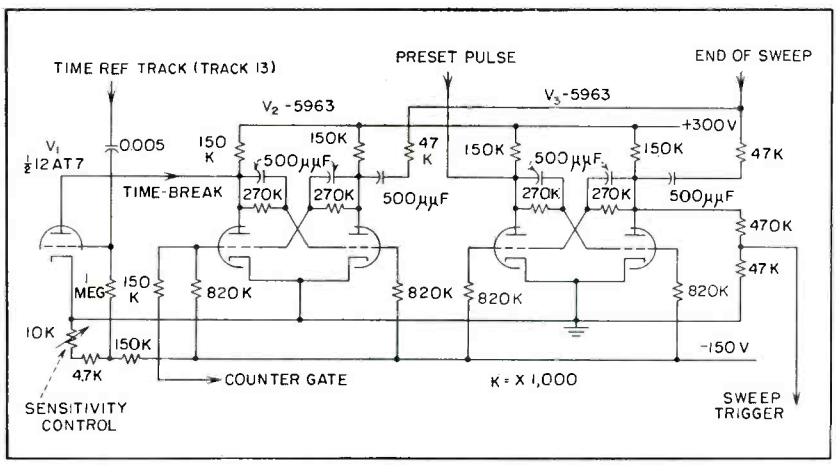


FIG. 6—Circuit of time break selector, counter gate multivibrator and sweep trigger multivibrator

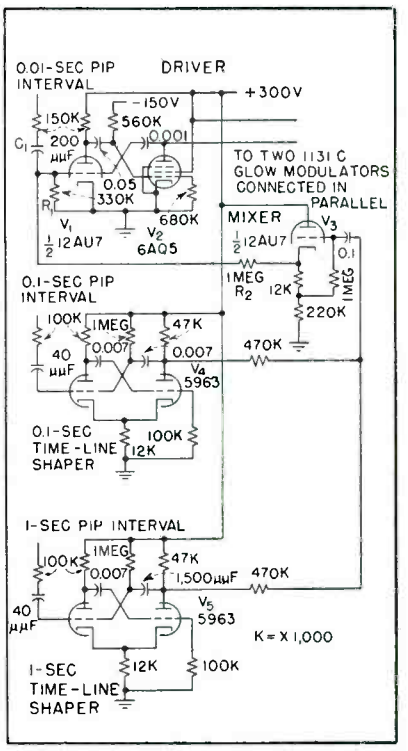
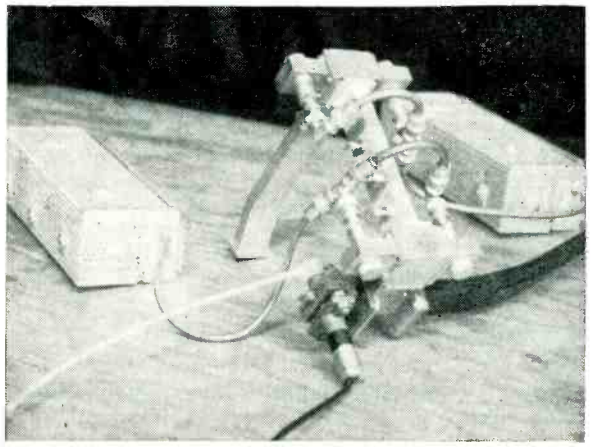
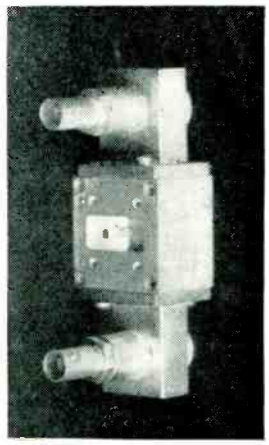


FIG. 7—Outputs of decade units in counter are combined to flash glow tubes used to make time lines





Radar transmitter for X-band has component units arranged in order shown on block diagram. Closeup shows mixer network using magic T

Local Oscillator

By HAROLD B. GOLDBERG

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COMMON RADAR local oscillator design practice involves a loop consisting of a klystron oscillator, afc mixer, some type of frequency discriminator and a feedback amplifier controlling the klystron frequency with respect to the transmitter frequency. This paper describes a system which eliminates the need for a klystron and handles the frequency-control problem without additional components and with a considerable reduction in complexity. The system was designed for an X-band c-w system with a 60-mc i-f but nothing in the theory precludes the use of any other combination of transmitted and intermediate frequencies.

A simplified block diagram of a c-w radar system is shown in Fig. 1A. The c-w oscillator, either a klystron or c-w magnetron, feeds the antenna. Before entering the antenna, a portion of the r-f oscillator output power is diverted to a microwave mixer circuit where it is mixed with 60-mc power from a crystal-controlled oscillator. Assuming a transmitter frequency of 9,000 mc, the modulation products from the mixer will consist of upper and lower sidebands, 9,060 and 8,940 mc, together with some carrier leakage signal of 9,000 mc. The desired sideband can be separated from the other signals by a cavity filter while at the same time removing the noise sidebands of the local-oscillator signal.

If the transmitted frequency changes from 9,000 to 9,001 mc, the sidebands generated by the mixer become 9,061 and 8,941 mc. Either of these sidebands, mixing with the transmitted frequency, will still give an i-f of 60 mc within the accuracy of the 60-mc crystal oscillator.

Mixer System

A diagram of the mixer circuit is shown in Fig. 1B. The circuit consists of a standard microwave balanced mixer utilizing a magic T with crystal mounts on each of the collinear arms. Arm 3 in the figure is the H-plane arm and arm 4 the E-plane arm.

A signal entering arm 3 divides equally between the collinear arms with signals of the same phase in each arm. The signal entering arm 4 also divides equally in amplitude but with opposite phase in the two collinear arms. By reciprocity, if signals of equal amplitude and opposite phase travel down the collinear arms toward the junction of the T, they will add and emerge from arm 3.

In the radar system, a portion of the transmitted signal is sent into arm 3 of the T and a 60-mc signal fed into the two diodes on the collinear arms. The diodes generate sidebands which travel back toward the junction. Since the local-oscillator signal is to be extracted from arm 4, there must be a 180-deg phase difference between the signals returning in the two arms.

If arm 1 of the magic—T mixer is made $\lambda_g/4$ longer than arm 2, the 9,000-mc signal at crystal 1 is 90-deg out of phase with the signal at crystal 2. This will result in a 90-deg phase difference in the sidebands generated by the crystals in the two arms. The sideband from arm 1 will receive an additional 90-deg shift in traveling towards the junction due to the $\lambda_g/4$ difference in line lengths, thus giving the desired 180-deg difference in sideband phase at the junction of the T. This method has the advantage of using the same type of crystal and crystal mount on each of the arms. There is, however, an unfavorable effect on the carrier leakage in the sideband output arm. If the two crystals have the same r-f impedance but are not perfectly matched to the line, the carrier reflections from each arm will be of the same phase, assuming arms 1 and 2 are of equal length. They will add in arm 4 and not appear in the local-oscillator arm. If, however, a $\lambda_g/4$ difference exists between arm 1 and 2, the reflected carriers at the junction of the T will be 180-deg out of phase and they will add in the l-o arm giving poor carrier rejection.

A second method of realizing the 180-deg phase shift is to have arms 1 and 2 of equal length but to feed the 60-mc to the two crystals from a balanced system so that there is a 180-deg phase difference between the signals at the crystals. This results in a 180-deg difference in the phase of the generated sidebands.

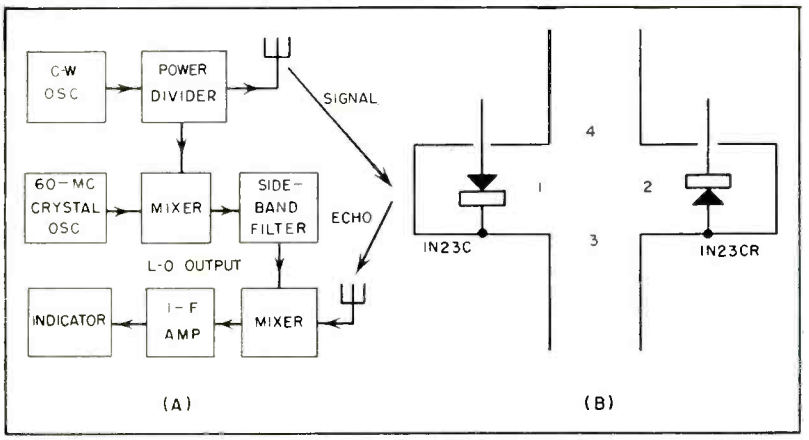


FIG. 1—Arrangement of functional units comprising c-w radar (A) and detail of mixer using magic T with crystal diodes (B)

Pair No.	Power Output (mw)	Pair No.	Power Output (mw)
1	13.6	11	14.7
2	15.6	12	14.2
3	14.7	13	16.5
4	13.6	14	13.6
5	15.4	15	13.9
6	13.0	16	13.6
7	11.8	17	15.9
8	15.3	18	16.1
9	14.2	19	12.5
10	15.9	20	13.6

Table I—Sideband Power Output with Twenty Crystal Pairs

for C-W Radars

SUMMARY —— Design eliminates klystron in local-oscillator of X-band c-w radar. Crystal-controlled oscillator on intermediate frequency beats with r-f output creating sidebands one of which is mixed with received signal to obtain desired i-f

If carrier and i-f signals of the same relative phase are applied to two crystals, one of which has its positive end grounded and the other its negative end grounded, the sidebands generated in the crystals will be opposite in phase. The difference in grounding can be obtained by using an inverted crystal mount or a regular mount and a crystal whose elements are reversed in the crystal package. The use of one regular and one inverted crystal mount, besides adding to the number of different components required in the system also contributes some unbalance to the system due to different i-f input capacitances of the two mounts. This difficulty is eliminated by the use of one regular and one inverted crystal in identical crystal mounts.

Experimental Results

Since it was desired to generate a local-oscillator signal of 10 to 20 milliwatts for the specific application, it was necessary to find a crystal that could stand over 100 mw of incident microwave power together with about the same magnitude of i-f power. As the only crystals available for use at X band are the 1N23 series, designed for a nominal input of 1 mw, tests were conducted using Microwave Associates 1N23C and 1N23CR crystals, to determine the effect of increased power input upon the crystal performance.

Single 1N23 crystals were run for 300 consecutive hours with 150 mw of incident X-band power. After this period, the crystals were checked for conversion efficiency and noise temperature and were still within the JAN specs on the 1N23C.

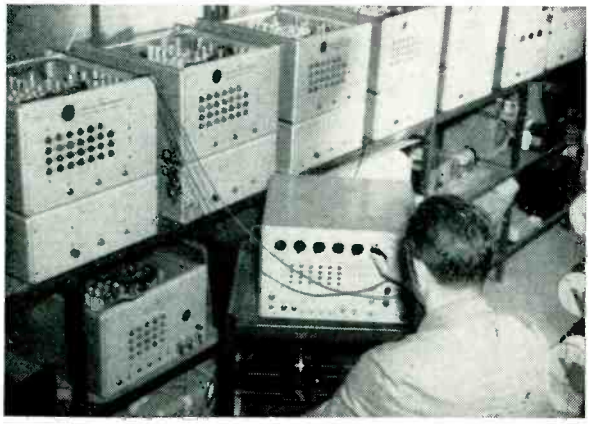
In the local-oscillator generator 150 mw of carrier power was fed into arm 3 of the T, dividing equally between the 1N23C and 1N23CR crystals on arms 1 and 2. Four volts of 60-mc energy was impressed across the two crystals in parallel.

Table I shows the upper-sideband power output for 20 pairs of 1N23CR crystals. These are random pairs and no attempt was made to match the crystals.

The sideband power output as shown in the table ranged from a low of 11.8 mw to a high of 16.5 mw. The average figure of 14 mw corresponds to a conversion efficiency of 10.3 db referred to the carrier input signal. The carrier leakage in the sideband output arm at the T was 10 db down from the sideband level.

The photograph shows the arrangement of components which corresponds to Fig. 1A. The oscillator, consisting of a Varian V-55 reflex klystron, feeds the power divider which sends power to the transmitter and to the local-oscillator generator T. The local-oscillator signal is fed to the receiver mixer through a sideband filter. The filter is a 4-stage, quarter-wavelength iris-coupled waveguide filter. It has the characteristic of passing the upper sideband with only 1.5-db insertion loss and rejecting the carrier by 55 db. Since the carrier output of the local-oscillator arm was already 10 db down from the sideband level due to the balancing action of the mixer, the carrier level into the receiver mixer is 65 db down from the sideband level.

The writer thanks Dr. M. A. Meyer for his many valuable suggestions and overall supervision of this work.



Production testing of high-speed counter chronographs using preset interval generator

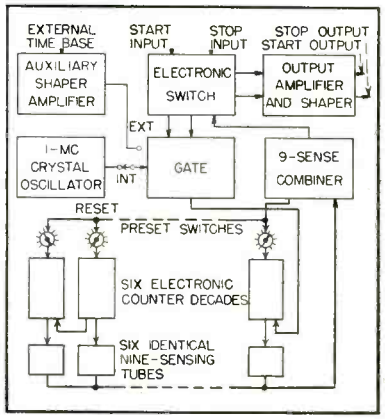


FIG. 1—Interval generator allows timing of intervals as short as 1-mc

Short-Interval Timer

By N. A. MOERMAN

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TESTING and calibrating radar systems, sonar systems and other equipment depending on precise time interval measurements requires a means for measuring and generating exact time intervals. Where the intervals approach the time-base period, the techniques to be described can be employed to preserve the inherent accuracy of the counting system.

Predetermining electronic counters involves setting the complement of the desired number with respect to the count capacity of the instrument. The interval is terminated when the counters reach count capacity. The desired number is set directly on six interval-selector switches, one for each digit. These switches route a single preset pulse to condition appropriate counter stages to the complement number.

Nine Sensing

The start pulse for triggering external equipment coincides with the externally applied start pulse. The stop pulse in a conventional circuit is delayed a few microseconds in the electronic counter stages, thus limiting the minimum obtainable interval to that value.

This limitation can be eliminated by use of the technique illustrated in Fig. 1. As the counters approach count capacity of 1,000,000, each stage must assume a nine condition. The last decade reaches this condition when the count reaches 900,000 or 0.1 second before the end of the interval. Likewise, the next-to-last counter reaches the nine condition at 90,000 or 0.01 second before the end of the interval, and so on.

To avoid the counter delay of the stop pulse, it is possible to electronically monitor each counter decade and bypass the 1,000,000th pulse directly to the output rather than causing it to pass through the counters and be delayed.

Dual Triodes

This technique is referred to as nine sensing. Using binary decades, a nine is represented by the first and fourth tubes being on. A single dual-triode tube with its grids connected to the normally conducting grids of these counting tubes serves as a nine-sensing circuit. The plates of all such nine-sensing tubes are connected through a common load resistor.

The voltage present at the common plate connection is low by virtue of plate current conduction except when all sensing-tube grids are negative as a result of all counter stages registering nines. When this condition occurs, a nine-sense combiner routes the next time-base pulse to an amplifier rather than through the counters.

It is possible to preset any interval from one period of the time base frequency to the count capacity of the instrument. In the case illustrated in Fig. 1, the range is 1 microsecond to 1 second in steps of 1 microsecond.

The nine-sensing tubes are shown in the circuit diagram of Fig. 2. The grids of the six nine-sensing tubes are connected to the grids of the first and fourth binary counter tubes in such a way that all nine-sensing tube grids are negative when each of the six counter decades indicates nine (a total count of 999,999).

At that time (grids negative) conduction through the common 22,000-ohm plate resistor ceases and the resulting voltage rise is capacitively coupled through a 1,000-$\mu\mu$f capacitor to the control grid of a type 5919 gate tube. This positive gate voltage permits the 1,000,000th time base pulse to pass through the gate tube to the output circuit.

The circuit that routes the first time-base pulse to the output is shown in Fig. 3. Application of the external start pulse flips the electronic switch, causing a negative gate to be applied to the norm-

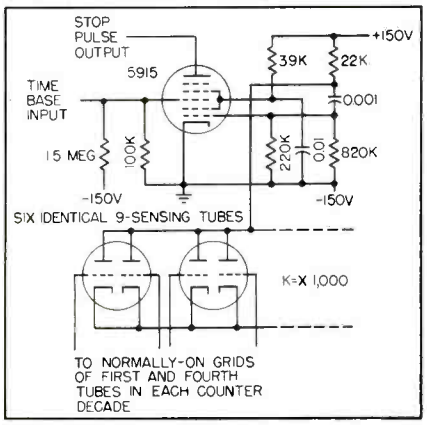

FIG. 2—Circuit bypasses counter so that last pulse goes directly to output

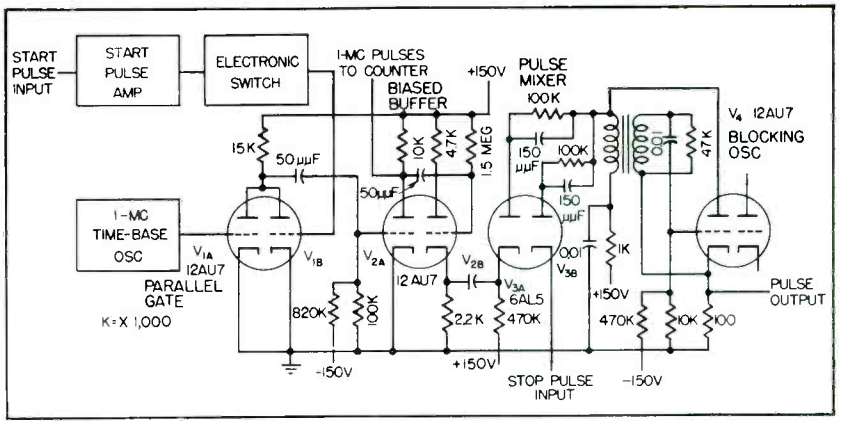

FIG. 3—Circuit eliminates gating error when starting pulse falls between two pulses of count generator

SUMMARY — Nine-sensing technique eliminates usual counter delay by having stop pulse bypass counter so that it goes directly to output and stops external equipment. Gating error produced when starting pulse falls somewhere between two count-generator pulses is also eliminated

ally positive grid of gate V_{1B}. Tube V_1 is connected as a parallel gate in such a way that amplified time-base pulses appear at the common plate connection only when the grid of V_{1B} is negative. Thus the external start pulse opens the gate, allowing 1-mc pulses to pass.

These positive 1-mc pulses are amplified and inverted in V_{2A}. The resulting negative pulses are capacitively coupled to the grid of V_{2B} and the negative pulses appearing across the 2,200-ohm cathode resistor are applied to the cathode of diode V_3. Diode V_3 is normally zero-biased by the connection of its cathode (through 470,000 ohms) to +150 volts. The 150-μμf capacitor in its plate circuit is completely discharged (through the 100,000-ohm resistor). When the negative pulses are applied to the cathode of V_3 it starts conducting and the 150-μμf capacitor quickly charges to the voltage developed across the 100,000-ohm resistor.

The time constant of the 150-μμf capacitor and 100,000-ohm resistor combination is such that the capacitor will not discharge between the 1-mc pulses. The first pulse triggers blocking-oscillator tube V_4, causing a start output pulse to be generated, but subsequent pulses are held down by the charge developed across the capacitor.

The stop pulse is applied to the cathode of V_{3B}, and since the capacitor in the plate circuit of that diode is uncharged, the stop pulse will trigger the blocking oscillator and a second pulse will be formed.

Thus the instrument produces two pulses on a common line and defines a time interval to within a fraction of a microsecond.

Gating Error

In high-definition interval-measuring equipment, the output of the time-base oscillator is gated by an electronic switch that is turned on by a sharp voltage pulse. External equipment being calibrated or tested is actuated by the same pulse that turns on the electronic switch.

Appreciable error may occur when the interval is of the order of a few cycles of the time-base frequency. Accuracy depends on the time a start is initiated with respect to the phase of the time-base pulse. If the start pulse coincides with a time-base pulse, the interval will be the exact number of time-base increments selected. If the start pulse falls between two time-base pulses, the interval generated will be in error since the interval is terminated only after a prescribed number of counts are registered.

It is possible to avoid this gating error by using the first time-base pulse to trigger the external equipment being tested. This starts the interval measurement. This first pulse does not affect the counter stages. The second pulse occurs exactly 1 microsecond later and registers the first count. Accuracy is limited only by the ability of the electronic switch to open and close the gate on corresponding portions of the time-base oscillator pulses and by the oscillator stability.

Interval Measurements

These techniques can be applied to measurement of unknown intervals that can be defined by electrical pulses. The number of 1-mc pulses admitted by the electronic switch during the unknown interval corresponds to the number of microsecond increments in the interval, in the case of the 1-mc time base.

The interval generator gives any desired delay corresponding to exact target range in yards or feet for testing reflection-type ranging equipment. The use of a lock-out circuit permits application of start and stop pulses on a common line when the equipment is used to measure intervals. Pulses other than those intended for starting and stopping are ignored.

Airborne Interrogator

SUMMARY — Distance measuring equipment employs pulse transmitter in aircraft to query automatic ground beacon. Tracking circuits in airplane lock on the return pulses and servo system measures time delay between outgoing and incoming pulses. Distance is a dial reading

AIR NAVIGATION by the long-heralded system known as VOR-DME [1,2] has now reached the stage where both the VOR (vhf omnirange) and DME (distance measuring equipment) are available as packaged items for aircraft installation. The VOR has been in widespread use for several years, but DME with its greater complexity has required more extensive development and has only within recent months become commercially available. This article describes the airborne DME interrogator.

The DME system consists of a bidirectional radio link between an aircraft and any one of some 450 fixed ground stations distributed throughout the U. S. A few are also operating in Europe[3]. The airborne set transmits an interrogation signal comprising a series of narrow pulse pairs at a slow pulse-rate frequency on any of ten channels between 963.5 and 986.0 mc. If the DME ground station receives these pulse pairs and the interpulse time interval is correct, the ground station transmits a reply signal consisting of pulse pairs having a different interpulse time interval on one of ten channels between 1,188.5 and 1,211 mc.

The airborne interrogator, on receiving the reply signals from the ground station, tests to see that the pulse spacing is correct. If it is, one-way distance equivalent to the time interval between the original interrogation signal and receipt of the reply signal is displayed on a distance indicator dial. Since the interrogation-reply process repeats at a rate between 15 and 30 times per second, the distance indicator continuously reads the slant range between the aircraft and the chosen ground station to provide the pilot with distance information as an aid to navigation.

The airborne equipment includes a pulsed transmitter, operating on 10 channels, a pulse receiver, also operating on 10 channels and a range unit. This latter unit is required to key the transmitter with accurately spaced pulse pairs and select only correctly spaced pulse pairs from the receiver output. In addition, it measures the time interval between the interrogation

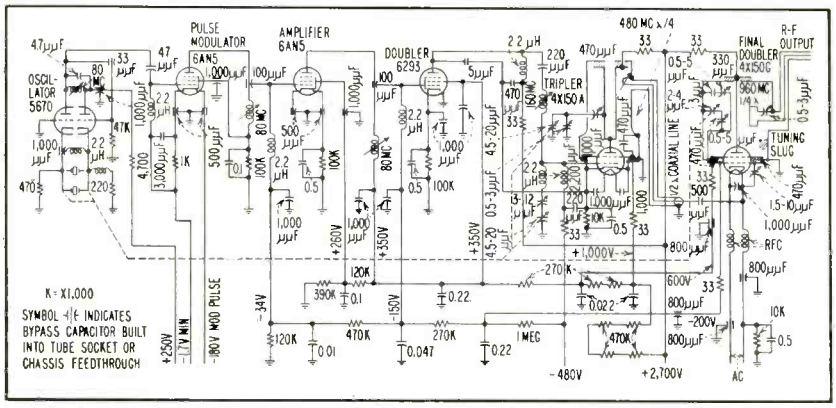

FIG. 1—Transmitter unit is crystal controlled on one of ten channels. Doubler and output stages employ cavities tuned by ganged capacitors

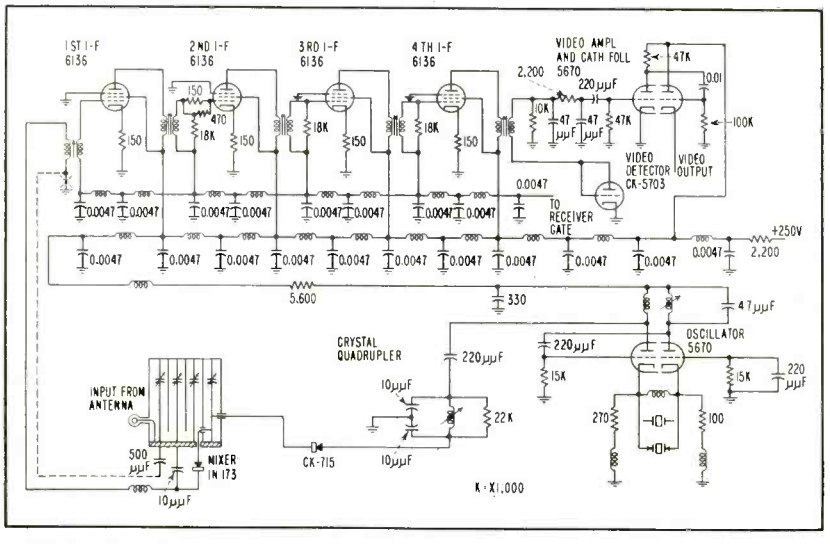

FIG. 2—Crystal-controlled superheterodyne receiver uses resonant-line preselector and semiconductor quadrupler

Spots Location

By A. R. APPLEGARTH
Chief Engineer
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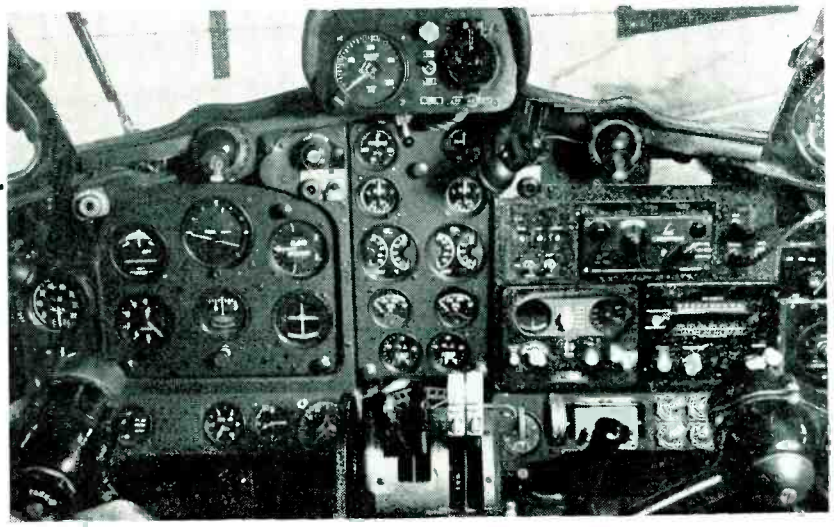

Typical installation of DME controls in airplane cockpit. Mileage indicator is at top left. Selector controls tied in with VOR-ILS facility are tuned to airport frequency

and reply pulse pairs and supplies it to the distance indicator. It also provides an identity signal.

A remote-control device permits remote channel selection.

Transmitter Assembly

The transmitter unit (Fig. 1) employs a type 5670 tube as a Butler-type crystal master oscillator using any one of ten fifth-mode crystals[4] oscillating at about 80 mc. The next stage is a type 6AN5 tube operating as a pulse-modulated r-f amplifier in which negative pulses are applied simultaneously to the grid and cathode elements, while the plate and screen remain at ground potential. This arrangement permits direct operation from the delay-line type pulser without a pulse transformer.

A following 6AN5 tube in a low-level class-C r-f amplifier at 80 mc drives a higher-level frequency-doubler stage using a type 6293 tube. Similar to a 6146, this tube is designed for pulse operation. The 160-mc output from the doubler is fed to a type 4X150A tripler stage mounted in a cavity resonant at about 480 mc.

This signal is coupled through a resonant-line network to a type 4X150G doubler-output stage mounted in a cavity resonant at the final output frequency—about 960 mc. The last three tank circuits including both resonant cavities are tuned by variable capacitors ganged to the crystal selector switch to provide tracking.

Receiver Components

The receiver unit (Fig. 2) is a superheterodyne with crystal control of the local oscillator. The signal from the antenna is passed through a broadband preselector comprising three resonant lines with aperture coupling, having a bandwidth of 32 mc at the 3-db points. A Butler-type crystal oscillator using a type 5670 tube and any one of ten fifth-mode crystals oscillating at about 76 mc has a 152-mc tank circuit[4] to select second-harmonic energy.

This signal is passed through a crystal quadrupler circuit to a 608-mc resonant line, from which it is coupled to a crystal mixer along with the signal from the preselector. The 25-mc heterodyne output from the crystal mixer is amplified by a four-stage i-f strip having a total gain of about 100 db and a 3-db bandwidth of about 1 mc. A type 5703 tube is used as a diode detector, which is followed by a type 5670 serving as a video amplifier and a cathode-follower output stage.

Range Unit

In the range unit (Fig. 3) both sets of transmitter pulses are generated through gas-tube discharge of a pulse-forming network (pfn). The type 5696 tube generating the first pulse is biased to permit self-triggering at about 25 pps. A noise signal is produced by passing a small reverse current through a germanium diode. The noise produced by this method amounts to about 0.5 volt. It is coupled to the grid of the gas tube to cause an irregular jittering of its firing.

Jitter is introduced to avoid possible erroneous distance information that might be caused by receiving reply signals intended for some other interrogator operating simultaneously with the same ground station and pulsing in accidental synchronism. The jitter is sufficient to cause adjacent interrogations to vary at least 400 microseconds. The first pfn has inserted within its coil windings the end of a length of $\frac{1}{8}$-in. diameter nickel tubing.

By the phenomenon of magnetostriction, the magnetic field set up by the pfn during the pulse formation creates a mechanical strain in the nickel that propagates along the tube[5] as a sound wave. Pickup coils are located along the tube at selected distances from the pfn to provide ten discrete time delays at multiples of 7 microseconds from 14 to 77. A selector switch chooses the desired pickup coil, which provides a one-volt signal to a type 5654 voltage amplifier.

The output of the voltage ampli-

fier triggers the type 5696 gas tube second-pulse generator, which is biased to fire only when externally triggered. It discharges a second pfn creating the second pulse, which is precisely delayed with respect to the first one by the magnetostriction system described above. Outputs of both pulse generators feed a common load resistor to provide the pulse modulating signal to the transmitter.

The second portion of the range unit decodes the receiver output signal to determine whether the interpulse interval is correct. A magnetostriction delay system is used, similar to the one described above, but driven by a pulse amplifier. It includes a two-stage output amplifier because of the reduced amount of energy available from the receiver for magnetizing the nickel. The delayed decode output signal is fed to the coincidence tubes along with the undelayed receiver output and the gate signals described below.

Time Measuring System

The time interval between the second pulse of each transmitted pulse pair and the second pulse of the corresponding reply pulse-pair is the basis for distance determination. A phantastron time-delay circuit[6] is triggered by the second transmitted pulse. This stage, which is stabilized by two clamp-diodes and is provided with regulated plate and filament power, generates an output signal in its cathode circuit.

The time delay between the trigger and the output signals is a very linear function of the d-c control voltage applied to the plate clamp diode of the phantastron. It is displayed as the distance indication. The phantastron output signal triggers a monostable blocking oscillator that generates a 10-microsecond early gate. A short time-delay circuit consisting of a diode-damped resonant circuit is shock-excited by the early gate oscillator. The delayed output from this circuit triggers the 10-microsecond late-gate oscillator to provide a 3-microsecond overlap. Each gate signal is applied to the screen grid of a triple-coincidence amplifier tube.

The undelayed receiver output pulses are applied to the control grids of both coincidence tubes and the delayed decode output signal is applied to the suppressor grids. If there is a triple coincidence between the second pulse of the undelayed receiver output signal, the first pulse as delayed in the decoder and the early or late gate signals, one or both of the coincidence tubes will amplify the coincident portion of the signals and pass it to the pulse detector and time discriminator circuits.

Pulse Detector

The pulse detector is a monostable blocking oscillator that responds to the output of either coincidence tube. When triggered, it generates a large negative bias-voltage, which is filtered and applied to the grid of a relay amplifier tube. The presence of the large negative bias cuts off the plate current of this tube and thereby de-energizes the search track relay causing the input to the servoamplifier to switch from the slow repetitive search function to the time discriminator output for tracking.

The time discriminator is a double-diode circuit that rectifies the pulse ouput from each coincidence tube separately. It develops a d-c output voltage that rises or falls depending on which coincidence tube is active. The diodes are biased to allow any existing potential between 0 and −6 volts to remain unchanged in the absence of output from either coincidence tube. A signal present only during the early gate will produce a d-c output voltage that will swing the servoamplifier grid more negative, while a signal present only during the late gate will swing it more positive. Signals occurring during the overlap appear in both gates and cause no change in the d-c output voltage.

The servoamplifier performs a dual function. During search it slowly sweeps the phantastron control voltage (indicated as equivalent miles on the distance indicator) from below 0 miles (115 microseconds) to beyond maximum range (2,255 microseconds). At about 110-percent maximum range a contact closes within the distance indicator that discharges the Miller run-up capacitor coupling the plate to the grid of the servoamplifier and restarts the cycle below 0 miles.

The large grid-plate capacitor serves to increase the natural time constant of the circuit to require about 30 seconds to search through the distance range. During tracking, the search-track relay transfers the servoamplifier grid to the time-discriminator output. This action corrects the grid voltage as needed to change the phantastron control voltage to keep the decoded reply signal within the 3-microsecond gate overlap.

Identity Detector

During certain prescribed time intervals, the DME ground stations add a third reply pulse 10.5 microseconds after the second pulse. This pulse is keyed to provide station identification. The range unit includes an identity detector comprising another monostable blocking oscillator with a gating pulse applied to its cathode, which is obtained by differentiating the late gate signal. Thus a third reply pulse occurring 10.5 microseconds after the second pulse (which is in the overlap during tracking) will coincide with this gating pulse and will trigger the identity detector. The energy from this detector operates a small neon lamp located on the instrument panel of the aircraft.

The distance indicator is a 270-deg, 0-1 milliammeter having a specification accuracy of ±1 percent of the actual current (down to 20 percent of full-scale current). The overall accuracy is specified as ±2½ percent or ±¾ mile, whichever is greater. However, this allows for tube aging and severe environmental conditions. Under normal conditions, the maximum error does not exceed ±1½ percent or ±0.2 mile.

Memory Holds Range

The range is actually determined by the phantastron control voltage, which is measured by the distance indicator milliammeter with an arrangement of multiplier resistors selected by the range switch. The range switch is a part of the distance indicator assembly that simultaneously changes scale numbers as

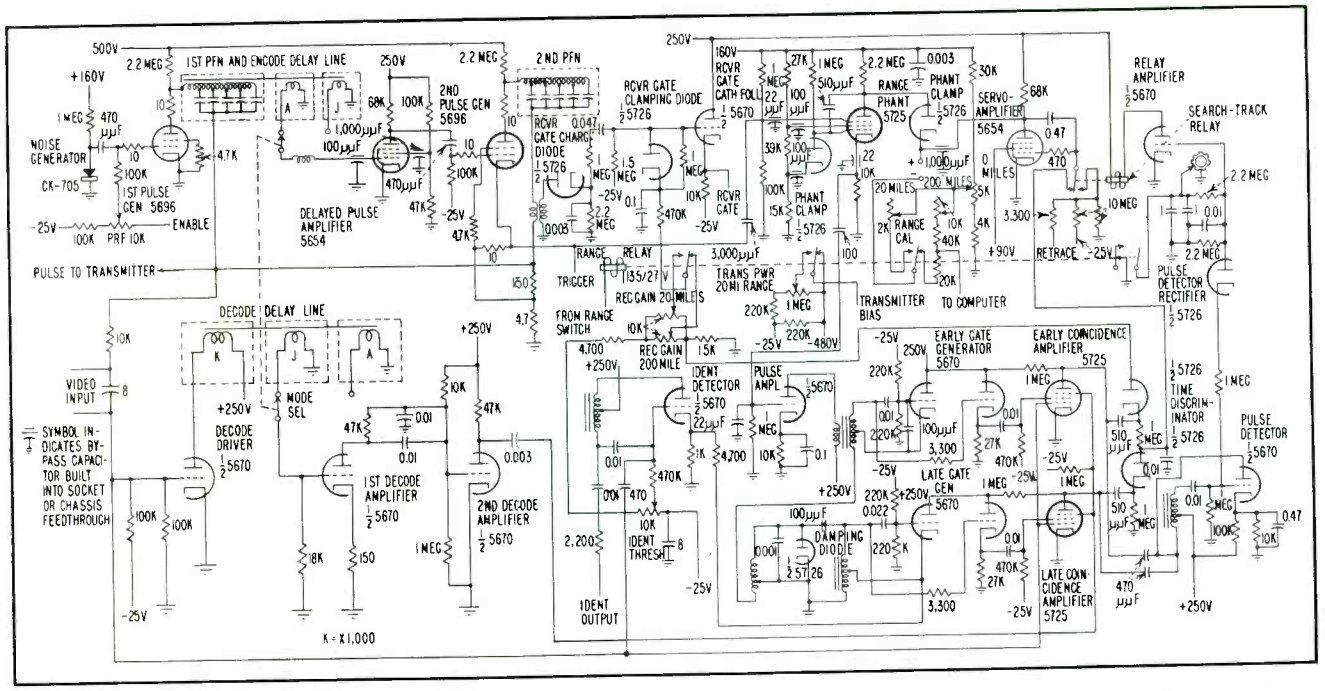

FIG. 3—Heart of airborne interrogator is the range unit that pulses transmitter, measures and identifies time delays and provides memory during periods of weak signal when the aircraft is maneuvered

it selects multiplier resistors.

Because of the prominent shadows characteristic of uhf propagation, reception of DME reply signals is frequently interrupted for periods ranging up to several seconds. This is particularly noticeable during aircraft maneuvers. To prevent the ranging circuits from resuming search immediately upon the temporary loss of reply signals, a simple memory is built into the set.

It consists of an R-C circuit that slows up the decay of the negative voltage built up by the pulse detector prior to loss of signal, thereby delaying the operation of the search-track relay by about 15 seconds. During this memory interval, no change in the d-c output voltage of the time discriminator takes place, so the distance indicator continues to show the reading displayed at the time the signal faded. If the signal returns, even momentarily, prior to the expiration of the 15-second memory interval, tracking is resumed.

To conserve plate current, the four receiver i-f stages are biased to cutoff except during the 3,000-microsecond time interval following each interrogation when replies are possible. The receiver is therefor operative only about 10 percent of the time between interrogations. The enabling gate is formed in the range unit by first generating a large pulse signal that closely follows the second interrogation pulse, then shaping it into a truncated saw-tooth having a flat top 3,000 microseconds wide. This signal is then applied to the receiver i-f grid returns through a cathode follower to lower the impedance level.

Remote Control Unit

The remote channel selector consists of two independent concentric rotary switches arranged to permit selection of any 0.1-mc channel between 108.0 and 117.9 mc. These are frequencies of the VOR or ILS stations that have associated DME stations and are paired to specific DME channels. The 108–109–110 dial actually selects the DME reply channel (1,188.5 to 1,211 mc) while the 0.1–0.2–0.3 dial actually selects the DME interrogation channel (963.5 to 986 mc). The pulse spacings, or mode, are a somewhat complex function of both interrogation and reply frequencies.

The channel-selector mechanisms within the interrogator are powered by rotary ratchet motors that home to the switch positions selected by the remote-channel selector. In addition, the mechanisms also set up the mode as specified by the particular combination of interrogation and reply frequencies. A third ratchet motor sets the pulse spacing switch sections to conform with the mode as set up.

Antennas

Separate quarter-wave ground-plane antennas are used for the transmitter and receiver. Since the individual bands are only 25-mc wide at 975 and 1,200 mc adequate broad-banding can be obtained by using rods of about $\frac{1}{8}$-in. diameter. Each antenna consists of a modified BNC connector having an enlarged flange with a center conductor extension rod serving as the radiator. A cone-shaped Teflon insulator is added along with a circular clamping disk to strengthen the aircraft skin at the point of installation.

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Feedback-Stabilized

By DEAN W. SLAUGHTER

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ATTEMPTS to build a precision transistor amplifier with gain accurately stabilized by inverse feedback have generally failed because the low input impedance of the transistors loads down the feedback network. When the transistors are replaced or when the transistor parameters vary because of aging or changes in ambient temperature, the feedback factor may vary.

A transistor differential amplifier[1] employed in the first stage of a feedback amplifier provides a convenient terminal for feedback which does not load down the feedback network. In Fig. 1, e_1 is the equivalent input signal of source resistance R_{g1} and e_2 is the equivalent feedback voltage of source resistance R_{g2}. The stage gain is

$$e_o/e_2 = -e_o/e_1 \approx R_L\alpha_2/[r_{e1}+r_{e2}+(r_{b1}+R_{g1})(1-\alpha_1)+(r_{b2}+R_{g2})(1-\alpha_2)] \quad (1)$$

if $R_e >> r_e$; R_g, r_b and $R_L << r_c$.

Subscripts differentiate between the two transistors. Equation 1 shows that the amplified signal developed across R_L is proportional to the difference between e_1 and e_2. The presence of a small amplified signal voltage across R_L when $e_1 = e_2$ is due to common-mode effect, usually defined[2] as the ratio of this signal voltage to that which is present when either e_1 or e_2 alone is amplified. Its magnitude increases as the inequalities decrease. Common-mode effect due to signal-source resistance and common emitter resistance is

$$\delta \approx \frac{R_{g1}}{r_{c1}} - \frac{R_{g2}}{r_{c2}} + \frac{r_{e1}}{R_e} \quad (2)$$

Typical values of r_c and r_e for a junction transistor are 1 megohm and 40 ohms. A source resistance R_{g1} of 10,000 ohms results in a common-mode effect of about 1 percent.

The overall amplifier gain (Fig. 1) as determined by the feedback network is

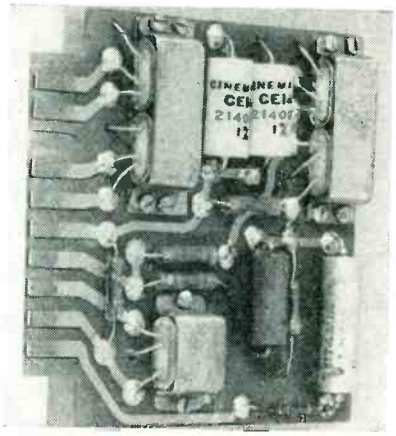
$$A = (R_1 + R_2)/R_1 \quad (3)$$

subject to two conditions. The first requires an amplifier internal gain without feedback A' much greater than gain with feedback A. The variation in A denoted as ΔA, resulting from variations in A' denoted at $\Delta A'$, is

$$\Delta A = \Delta A'A/A' \quad (4)$$

The second condition states that gain A varies in direct proportion to the amount of common-mode effect present in the differential-input stage, that is $\Delta A = \delta$. Variation in gain due to signal-source resistance R_{g1} or feedback circuit-source resistance R_{g2} can be computed directly from Eq. 2. Increasing R_{g1} or R_{g2} also reduces the differential-amplifier gain with a corresponding reduction in internal gain A'. Variation in gain resulting from the factor r_{e1}/R_e can be reduced to negligible proportions by replacing R_e with a constant-current source, as shown in Fig. 2.

Figure 3 is a feedback-stabilized amplifier employing germanium junction transistors. The gain A' without feedback is about 10,000. If R_1 and R_2 are selected for a gain of 10, it is possible to replace either of the transistors in the input circuit with an unselected transistor. The gain of 10 does not change by more than a few tenths of one percent.



Complete amplifier, shown actual size

Low-Drift Amplifier

Variations in base-to-emitter bias and collector cutoff current due to changes in ambient temperature may cause the output of transistorized d-c amplifiers to drift. However, when a differential circuit is employed in the first stage of these amplifiers, equal variations in the parameters of both transistors are not amplified because of the rejection of common-mode signals. For maximum reduction of d-c drift, matched transistors may be selected. They should be mounted in close proximity on a common heat sink.

The use of germanium transistors above room temperature in d-c amplifiers is not recommended. Figure 4 shows a d-c amplifier employing *npn* silicon transistors which perform satisfactory at 200 F or higher. By employing a differential circuit in the second as well as the first stage, a worthwhile increase in common-mode rejection and a decrease in overall amplifier drift is obtained. Power-supply regulation of from 2 to 5 percent is adequate. Amplifier internal gain is about 2,500.

Table I compares drift versus temperature of a differential amplifier employing silicon transistors with other amplifier configurations. Drift is given in terms of equiv-

Table I—Amplifier Drift

Input Stage	D-C Offset*	
	120 F	200 F
Germanium differential amplifier	10 to 25 mv	
Single-ended silicon amplifier	25 mv	120 mv
Silicon differential amplifier		
Pair 1	3 mv	10 mv
Pair 2	negligible	1 mv
Pair 3	2 mv	8 mv
Pair 4	negligible	1 mv
Pair 5	1 mv	3 mv

* Based on initial zero at 70 F

Transistor Amplifier

SUMMARY —— Gain of transistor amplifier is accurately stabilized by inverse feedback to avoid drift, from aging or temperature change. Amplifier can be built with silicon junction transistors for stable operation despite high ambient temperatures

alent input drift, that is that voltage which must be applied to the amplifier input terminal to return the output terminal to zero. These data assume that all the drift is generated by the transistors and none by the circuit resistances. Amplifier zero does not offset by more than a few millivolts over a period of hours or weeks if the amplifier is permitted a 20-minute warmup.

The supply voltages applied to the output stage TR_5 permit an output swing of at least ±10 volts. The 10,000-ohm collector load resistor may be safely decreased to 2,500 ohms without exceeding the collector dissipation rating of 150 mw. Because of feedback, the amplifier input impedance may approach but never exceed the collector resistance of TR_1. The output impedance is approximately equal to the output load resistance divided by the amplifier loop gain A'/A.

The resistor and capacitor connected between the collector of TR_4 and ground provide the phase correction necessary to prevent oscillation. Their values must be determined experimentally.

The values shown were suitable for a gain of 10. The resulting frequency-response curve is essentially flat to 10 kc, rises 3 to 6 db at 60 kc and cuts off at 150 kc.

This paper presents the results of one phase of research carried out under Contract No. DA-04-495-Ord 18, sponsored by the Department of the Army, Ordnance Corps.

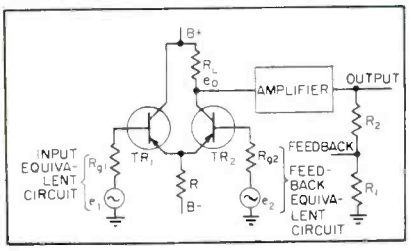


FIG. 1—Transistor differential amplifier

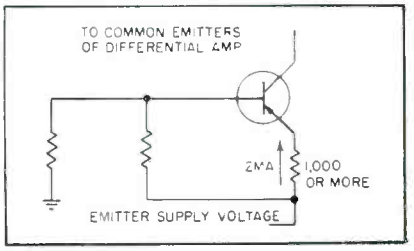


FIG. 2—Emitter constant-current source

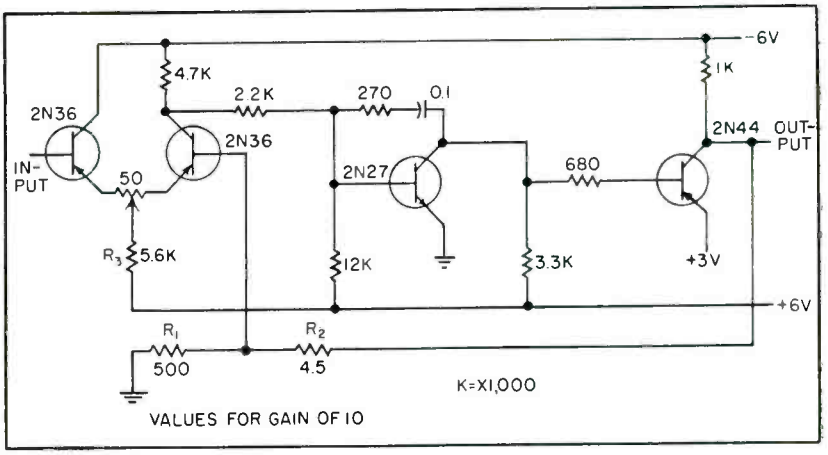


FIG. 3—Feedback-stabilized amplifier using germanium junction transistors

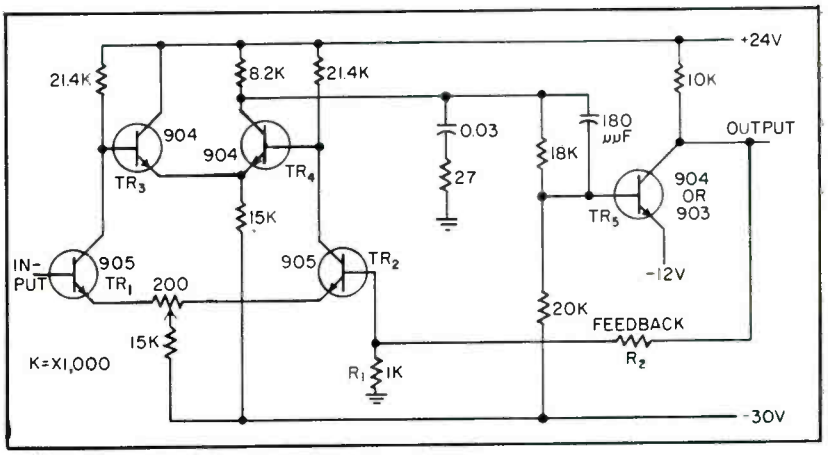


FIG. 4—Low-drift d-c amplifier employing *npn* transistors

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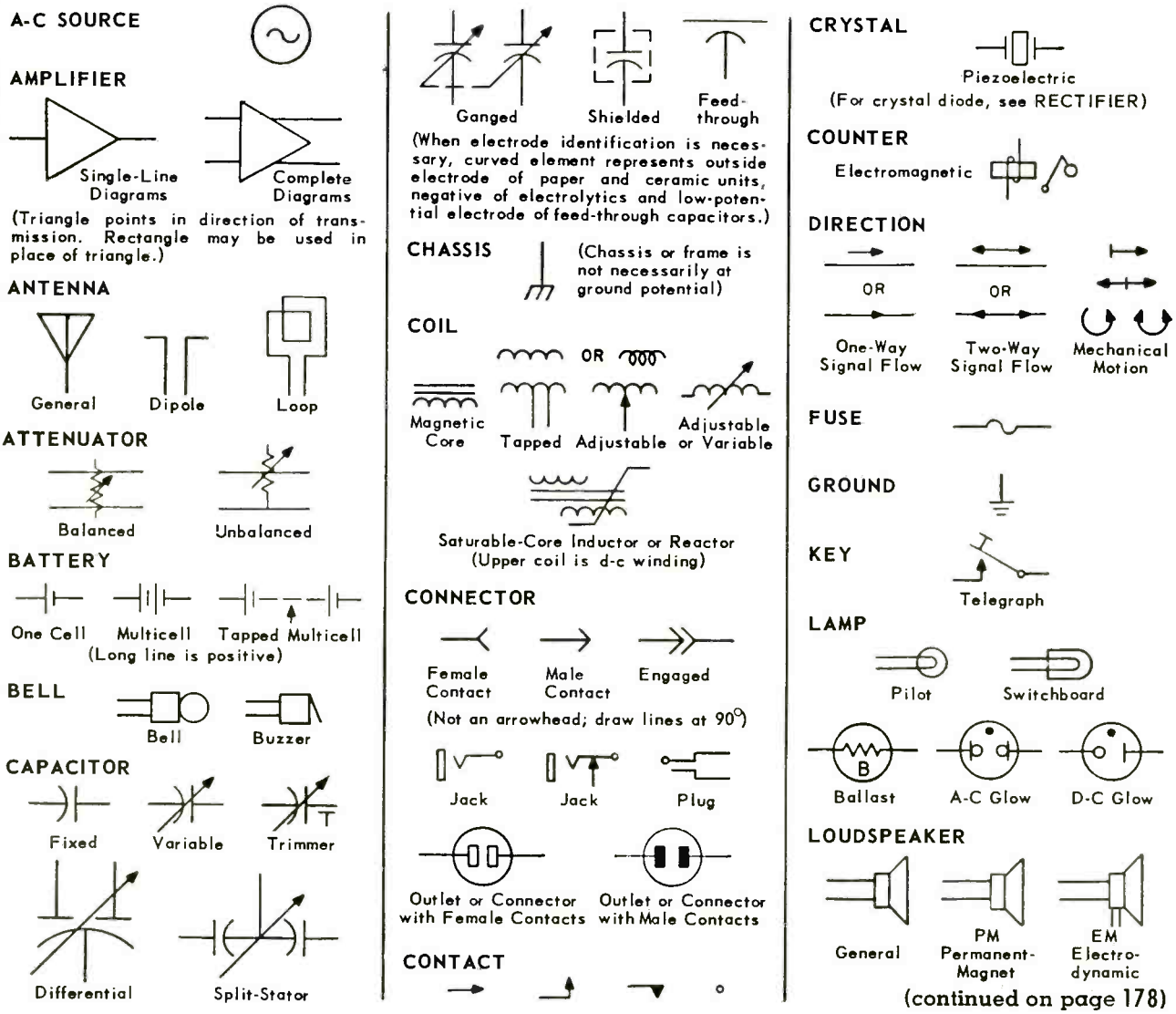
Standard Symbols for Electronics

SUMMARY —— Further simplification speeds drafting and cuts costs. Simple half-circles are now favored for coils. Basic switch loses arrowhead. Metallic rectifier symbol now serves for crystal diodes. Antenna goes back to triangle. Many microwave, transistor and photocell symbols appear here for first time

MOST-USED schematic symbols for electronic components are collected here on three pages for convenient reference, as abstracted from the new 54-page American Standards Association publication Y32.2-1954, "Graphical Symbols for Electrical Diagrams" and (for transistors) from MIL-STD-15A, "Military Standard Electrical and Electronic Symbols".

Symbols may have any orientation, size and line weight. The open-circle terminal symbol may be added to leads if desired. Arrowheads may be either filled or open unless otherwise noted. Electrically actuated devices are normally shown in the power-off position. One-line symbolism has been adopted for waveguide diagrams, as indicated for microwave symbols.—J.M.



(continued on page 178)

ELECTRONICS REFERENCE SHEET

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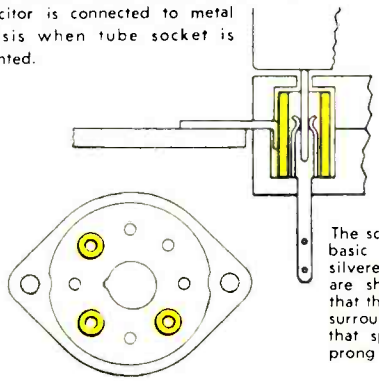
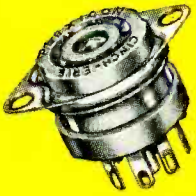
now in universal use, commercial and military types, available in seven pin miniature, nine pin Noval, and Octal

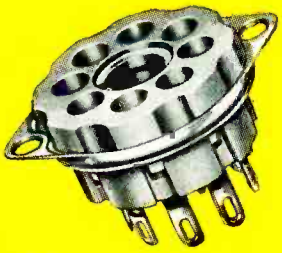
Capacitors built into socket may be either by-passed to ground directly, or left open for coupling applications. On by-pass applications, ground strap contacting outer plate of capacitor is connected to metal chassis when tube socket is mounted.



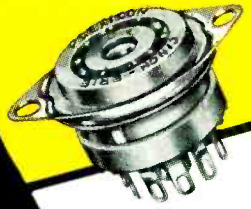
The schematic diagram shows basic design principle. The silvered ceramic condensers are shown in yellow. Note that the condenser completely surrounds the tube pin, and that specially designed tube prong terminals are used.

CINCH-ERIE "Plexicon" VACUUM TUBE SOCKET





With built-in ceramic condensers, Plexicon Tube Sockets, no larger than standard receiver socket, provide the most effective method of by-passing . . . with condenser close to tube element providing shortest path to the ground. . . . capacity up to 1,000 MMF—the tube element may be coupled or by-passed as desired.



Reduces set assembly costs—saves space; permits moving other components closer to tube socket. Where space and weight make compactness mandatory, as in airborne equipment, the Plexicon socket is the solution.

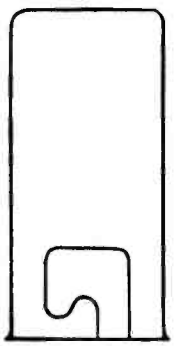
Cinch ELECTRONIC COMPONENTS

CINCH components available at leading electronic jobbers—*everywhere*.

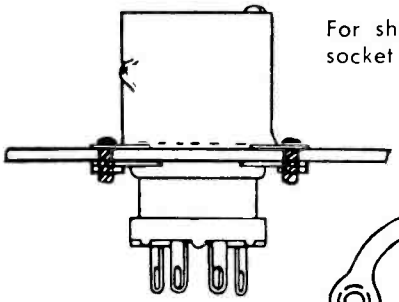
CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

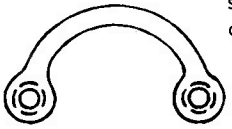
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.



SHIELD



BAYONET SHIELD BASE



MOUNTING STRAP

For shielding tube, two types are available for miniature socket as shown, Bayonet with three lengths of shield cans available and Snap-on, two lengths of shields available. Bayonet type shown here.

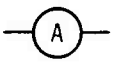
The Mounting strap is a CINCH development for ease and simplicity in mounting miniature sockets. One strap nut takes the place of two conventional type nuts and is generally used in assembling sockets having attached base.

Write for detailed information

Standard Symbols for Electronics

(continued from page 176)

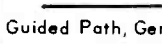
METER

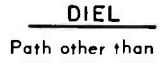


A--Ammeter
CRO--Oscilloscope
G--Galvanometer
MA--Milliammeter
μA or UA--Microammeter
V--Voltmeter

MICROPHONE

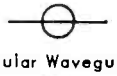
MICROWAVE

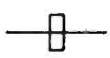

Guided Path, General

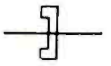


Path other than Air


Coaxial Cable

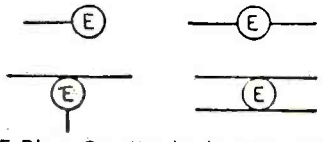

Circular Waveguide


Rectangular Waveguide


Ridged Waveguide


Open Short Movable Short Resistor

Coax and Waveguide Terminations



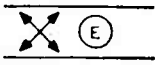
E-Plane Coupling by Aperture, with 1,2, 3 & 4 Path Ends Available


Coupling by Loop to Space


Coupling by Loop to Guided Path

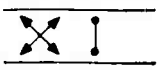
Coupling by Probe to Space

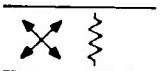

Coupling by Probe to Guided Path



E-Plane Aperture Directional Coupler


Loop Coupling


Probe Coupling

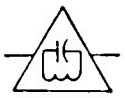

Resistance Coupling

Equivalent Series Element, General


Resistance

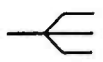

Capacitive Reactance

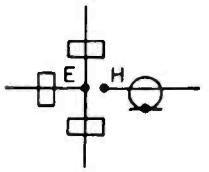

Inductive Reactance


L-C with Infinite Reactance at Resonance

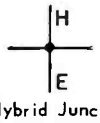

L-C with Zero Reactance at Resonance

(For conductance and susceptance discontinuities in coax and waveguide, rotate symbols 90° clockwise inside triangles.)


Hybrid, General



Hybrid--Rectangular Guide & Coax Coupling



Hybrid Junction

Circular Hybrid

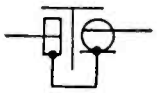
(Use single letter for principal transverse field in plane of ring; use HE for all other cases.)

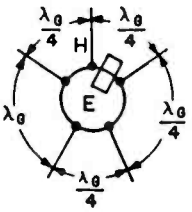

Mode Suppression


Mode Transducer

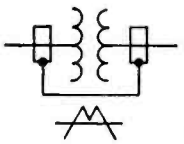

Resonator for Coax & Waveguide

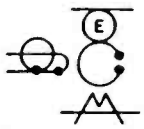
MICROWAVE EXAMPLES


Transducer from rectangular guide to coax, with d-c grounds connected

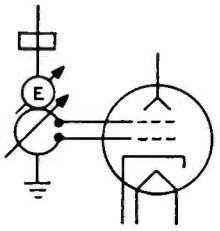


Circular 5-arm hybrid with principal coupling in E plane and 1-arm H coupling using rectangular waveguide

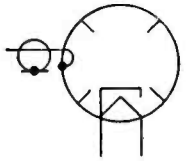

Transformer with d-c grounds and mode suppression between 2 rectangular guides

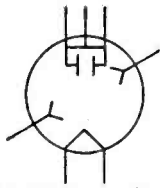


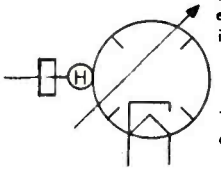
Resonator with mode suppression, coupled by E-plane aperture to guided path and by loop to coax



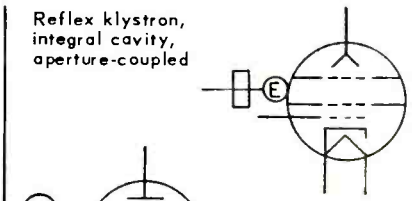
Tunable resonator with d-c graund, connected to electron device and adjustably coupled by E-plane aperture to rectangular guide


Resonant magnetron with coaxial output

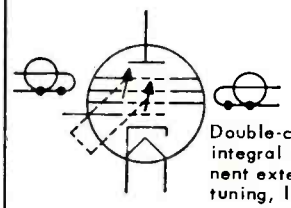

Transit-time split-plate magnetron with stabilizing deflecting electrodes and internal circuit

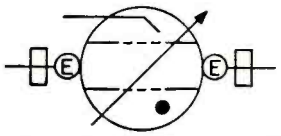


Tunable magnetron, aperture-coupled



Reflex klystron, integral cavity, aperture-coupled


Double-cavity klystron, integral cavity, permanent external ganged tuning, loop coupling

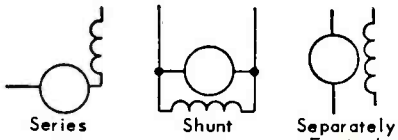


Transmit-receive (TR) tube, gas-filled, tunable integral cavity, aperture-coupled, with starter

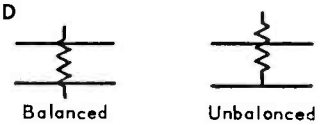
MOTOR & GENERATOR

Motor

Generator


Series Shunt Separately Excited

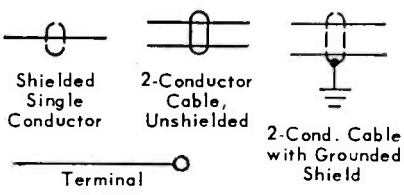
PAD


Balanced Unbalonced

PATH


No Connection Connection Connections

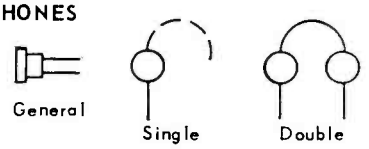

Conductive Path Air or Space Path


Shielded Single Conductor
2-Conductor Cable, Unshielded
2-Cond. Cable with Grounded Shield
Terminal

PERMANENT MAGNET

PM

PHONES


General Single Double

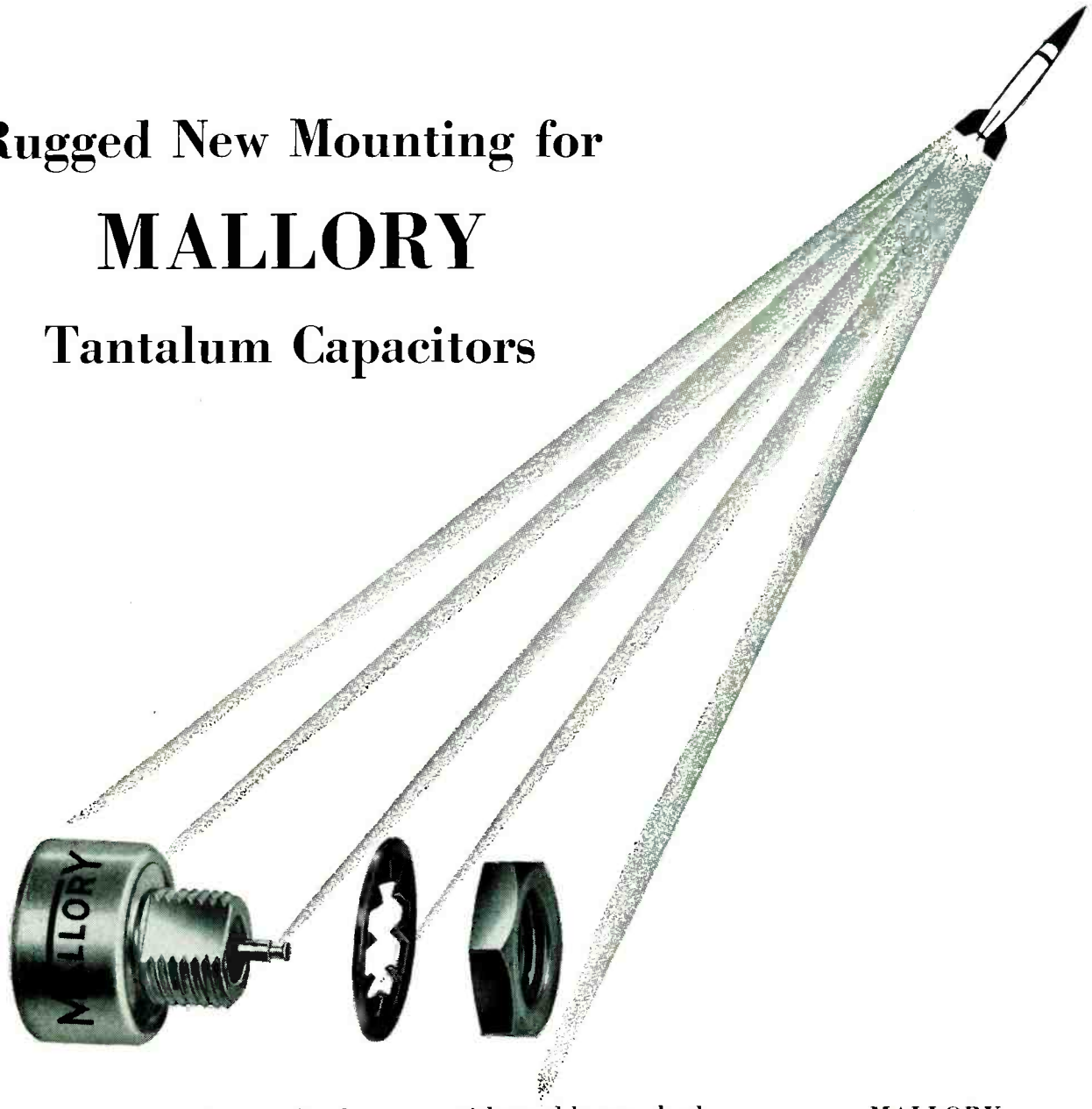
(continued on page 180)

ELECTRONICS REFERENCE SHEET

Rugged New Mounting for

MALLORY

Tantalum Capacitors



ESPECIALLY DESIGNED for circuits that must withstand heavy shock and vibration is this latest version of the famous Mallory XT Tantalum Capacitor.

The case has a sturdy threaded neck that fits through a keyed slot in the chassis. Lock washer and hex nut are supplied to give you an assembly that will withstand the most severe service. Mounting requires only seconds to complete . . . needs no strap or other hardware.

Next time you need capacitors for extreme-temperature, high-acceleration duty, plan to use these new Mallory units. They come in a complete range of ratings and sizes up to $2\frac{1}{4}$" height. Write to Mallory today for complete data.

MALLORY
Tantalum Capacitors meet the toughest specifications

- **Long life** at temperatures up to 175° C. . . . can be supplied for use at 200° C.
- **Low-temperature stability** down to −55° C.
- **Closer tolerances** . . . only +50 per cent, when desired.
- **Lower leakage currents** than ever before.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Type TAW

Subminiature Silverlytics*

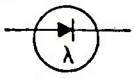
The smallest capacitor for its rating . . . 4 or 6 mfd. at 4 VDC. Only .145" in diameter, ⅜" long. Electrical characteristics comparable to larger capacitors. **Trade Mark*

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

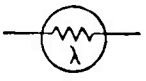
Standard Symbols for Electronics

(continued from page 178)

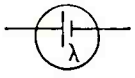
PHOTOCELL



Asymmetrical Photoconductive Transducer
(Resistive. Use solid arrowhead; λ means element varies with light)



Symmetrical Photoconductive Transducer; Selenium Cell



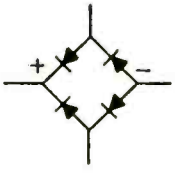
Photovoltaic Transducer; Barrier or Blocking-Layer Cell

PICKUP

RECTIFIER

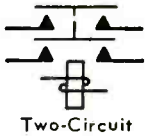
Metallic Rectifier; Crystal Diode; Electrolytic Rectifier; Asymmetrical Varistor
(Use solid arrowhead Arrow shows direction of forward or easy current, not electron flow)

Example: Full-wave bridge rectifier. Polarity of d-c output voltage is as shown when a-c is applied between top and bottom leads of bridge

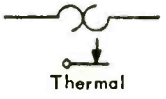


RELAY

SPDT Contacts

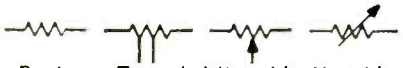


Two-Circuit



Thermal

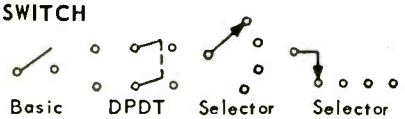
RESISTOR



Basic Tapped Adjustable Variable

SHIELDING

SWITCH



Basic DPDT Selector Selector

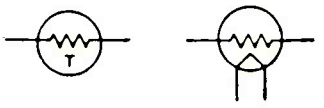
SYNCHRO

Basic

Synchro Control Receiver, Transmitter or Transformer

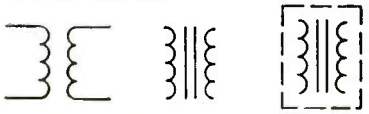
Differential Synchro Receiver or Transmitter

THERMISTOR



General With Heater

TRANSFORMER



General Magnetic Core Shielded

Shield between Windings, Connected to Frame

One Winding Adjustable

Both Windings Adjustable

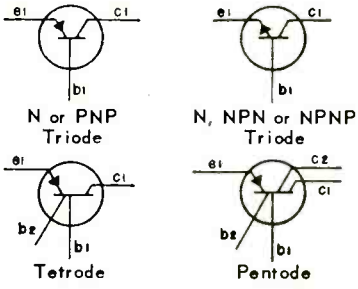
Adjustable Mutual Inductor

Auto-transformer

Tapped

(There is now no special core symbol for powdered iron cores; symbol for adjustable inductance serves instead to indicate a movable core)

TRANSISTOR



N or PNP Triode

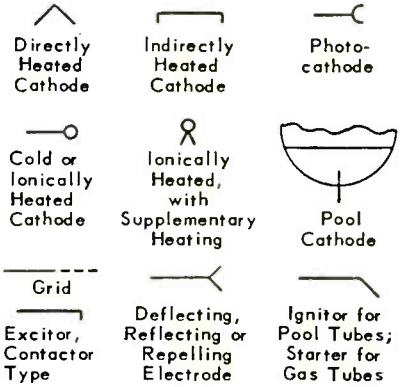
N, NPN or NPNP Triode

Tetrode

Pentode

(Arrowhead on emitter is solid and shows current flow, not electron flow. Arrowhead must not touch circle or base line. Letters are not part of symbol; e = emitter, c = collector and b = base. These are MIL-STD-15A symbols, not yet in ASA)

TUBES



Directly Heated Cathode

Indirectly Heated Cathode

Photocathode

Cold or Ionically Heated Cathode

Ionically Heated, with Supplementary Heating

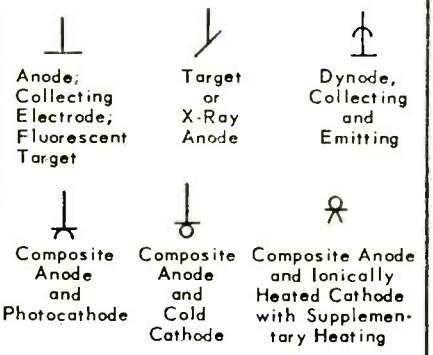
Pool Cathode

Grid

Excitor, Contactor Type

Deflecting, Reflecting or Repelling Electrode

Ignitor for Pool Tubes; Starter for Gas Tubes



Anode; Collecting Electrode; Fluorescent Target

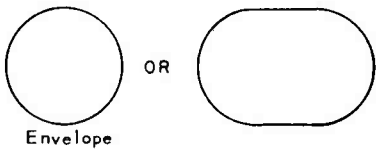
Target or X-Ray Anode

Dynode, Collecting and Emitting

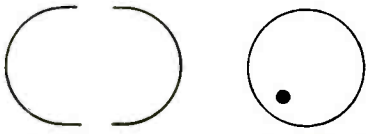
Composite Anode and Photocathode

Composite Anode and Cold Cathode

Composite Anode and Ionically Heated Cathode with Supplementary Heating

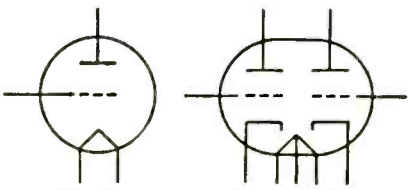


Envelope OR



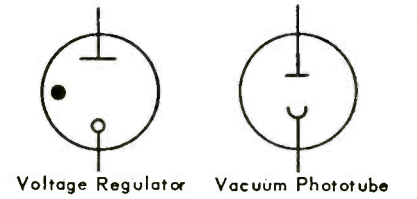
Split Envelope

Gas-Filled Envelope



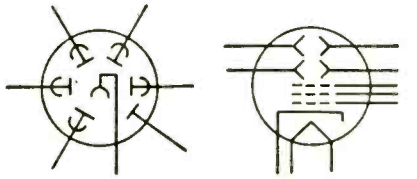
Triode

Twin-Triode



Voltage Regulator

Vacuum Phototube



Multiplier Phototube

Cathode-Ray Tube, Electrostatic

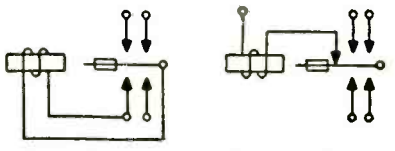
VARISTOR

Asymmetrical; Metallic Rectifier

Symmetrical

(Arrowhead is solid and shows direction of forward or easy current, not electron flow)

VIBRATOR



Shunt Drive

Separate Drive

(Showing of terminals is optional)

ELECTRONICS REFERENCE SHEET

WE MAKE AND FABRICATE . . .
STRONG, LOW-COST SPIRAL TUBING

Spiral Tubing, another outstanding C-D-F product, is an important new material for the progressive, cost conscious design engineer (and purchasing agent). It is a high strength plastic made from paper or fibre that is spirally wound, then impregnated with phenolic resin or insulating varnishes and carefully cured at high temperatures. The resulting tubes (round, square, rectangular or formed to special shapes) are stiff, sturdy, resistant to crush, with good tensile strength.

This unique product has good dielectric strength with low dielectric loss properties. Moisture resistance and dimensional stability is easily controlled in the manufacturing process. The wide variety of sizes, shapes, forms; the strength; low cost; ease of fabrication; speed of delivery; all combine to make C-D-F Spiral Tubing worthy of your investigation.

PRIMARY APPLICATIONS

COIL FORMS OF ANY SIZE OR SHAPE
- for tuned or untuned RF, IF, oscillator, and other coils used in radio, television, electronic circuits
- for solenoids, relays, circuit breakers
- for transformers
- for permeability tuners

INSULATORS
- for selenium rectifiers
- for electric motors
- relays

BUSHINGS OR SPACERS
- armature shaft spacers
- for mechanical support

SHIPPING PROTECTORS AND FOR SPECIALIZED PACKAGING

BOBBIN TUBES

BODIES FOR PAINT ROLL APPLICATORS

AS A COMBINATION MATERIAL
- with other C-D-F high strength plastics or electrical insulating materials

SIZES

The round tubing ranges from 3/32 to 8" ID, with wall thicknesses from .0075 to ¼". The minimum ID of square and rectangular tubing is ⅜", with 2⅛" the maximum ID. Wall thicknesses range from .010 to 3/32".

Standard lengths are from 2 to 4', with special sizes and grades, plain or impregnated, open for your discussion with our C-D-F sales and engineering staff.

FABRICATION

Spiral Tubing is readily sawed, punched, drilled, tapped, riveted, stamped, painted, depending on the grade; it is suitable for automatic machine operations, but not recommended for conventional machine threading. Waxing or varnish impregnation to improve moisture resistance is usually done on the finished coils by the user.

GRADE SELECTION

C-D-F has mass production facilities for both the manufacture and fabrication of eighteen distinct grades of Spiral Tubing. For example, there's a special punching grade, fine for punching rectangular or square holes near the end of the tube. A relatively soft tube is supplied for difficult stapling or riveting. C-D-F makes high strength automotive electrical bushings from a very hard tubing with high axial compressive strength. Combinations of kraft, chipboard, Diamond "fish paper" Insulation, and other materials are available.

FORMS: ROUND • FORMED • FORMED AND NOTCHED • SQUARE AND RECTANGULAR

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also, write for C-D-F Spiral Tubing folder ST-53, (a workbook showing grades, applications, properties), free test samples, or send us your print for quotation.

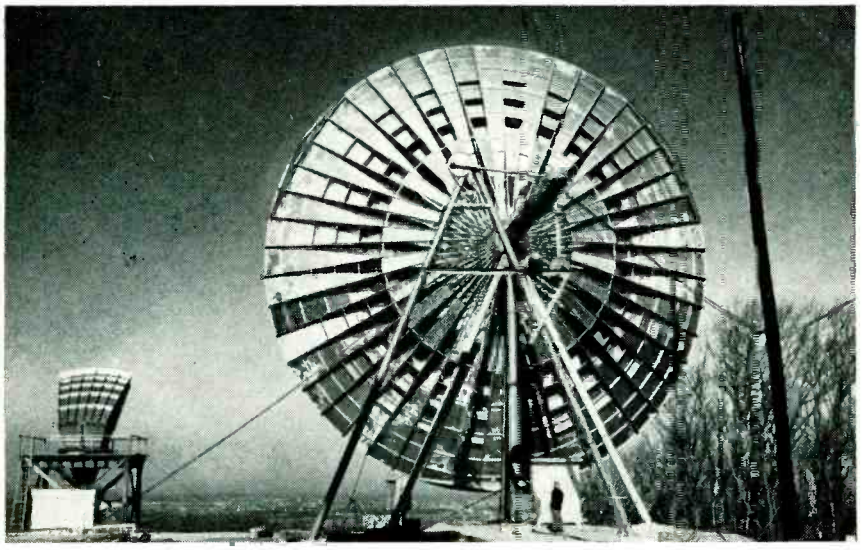
Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 16, DELAWARE

Electrons At Work

Edited by ALEXANDER A. McKENZIE

New Transmission Techniques Extend Range Sevenfold



Rear view of 60-foot experimental antenna used in 200-mile broadband propagation experiments at uhf. It is compared with modern scoop antenna now being used in conventional microwave circuits up to 30 miles

RELIABLE communication over long distances using frequencies in the ultrahigh region of the spectrum has been accomplished by engineers of Bell Telephone Laboratories and Massachusetts Institute of Technology. Television and multichannel telephone transmission has been proved possible over a 200-mile circuit without relays. This contrasts favorably with present microwave radio relays across the United States in which the relay stations are 30 miles apart.

Although early experimenters presumed that uhf signals traveled only in straight lines so that the receiver could be assured satisfactory operation only if the transmitter was within line of sight, it was discovered in the early 1930's that transmitted signals could often be picked up at much greater distances.

The practical contribution of the most recent work has been use of powerful transmitters in the order of 10 kw and high-gain, directive antennas having 30 times the antenna area used in the present transcontinental microwave system —60 feet in diameter.

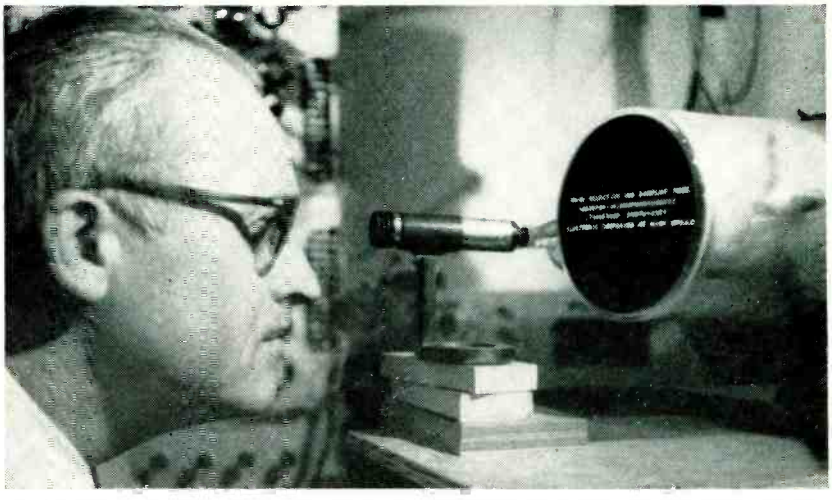
Television was first successfully transmitted over the horizon in 1954 between Holmdel, N. J. and New Bedford, Mass., a distance of 188 miles.

Over-the-horizon signals should not be confused with so-called ionospheric scatter useful for radiotelegraph communication at relatively low frequencies. Unlike signals propagated by means of the ionosphere, the new technique provides a suitable medium for broadband signals.

Transducer Tube Changes Signals To Letters

HIGH-SPEED PRINTING, required for the output of various devices, like computers, may be possible with a new electron-image tube. Developed by W. H. Bliss and J. E. Ruedy under the supervision of C. J. Young and G. A. Morton of RCA, the tube simulates typesetting. It selects letters and figures one by one from a font and places them in luminous form on a 5-inch circular tube face in lines or any desired pattern.

The font comprises a lantern slide bearing a chart of letters and figures that are projected from outside the tube onto a sensitive layer at the rear of the tube. This photoemissive layer emits a stream of



W. H. Bliss of RCA, Princeton, inspects resolution of letters on the face of an electron-image tube that translates coded information into printing

KEPCO

KR SERIES

7 NEW

VOLTAGE REGULATED POWER SUPPLIES

for powering electronic equipment

SAVE TIME AND MONEY

Build these compact Power Supplies into your equipment!

Kepco Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient. The regulation specified for each unit is available throughout its output voltage range for line voltage variations from 105-125 volts and load variations from 0 to full load.

FEATURES:

- Superior Regulation.
- Ultra-Stable 85A2/0G3 Reference Tube.
- Low Ripple.
- Low Output Impedance.
- Fast Recovery Time, Suitable for Square Wave Pulsed Loading.
- Voltage Range continuously variable without Switching.
- Either Positive or Negative may be Grounded.
- Oil Filled Condensers.
- Wire Harness and Resistor Board Construction.
- Power Requirements 105-125 volts, 50-60 cycles. Units operate up to 400 cycles.
- Terminations and locking type voltage control on rear of unit.
- AC, DC Switches, Fuses, and Pilot Lights on Front Panel.
- Color Grey Hammertone.
- Guarantee One Year.

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 1-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR1-C) and Add $10.00 to the Price.
To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-1MC) and Add $40.00 to the Price.
PRICES F.O.B. Flushing.

MANUFACTURING CORP. KEPCO Laboratories

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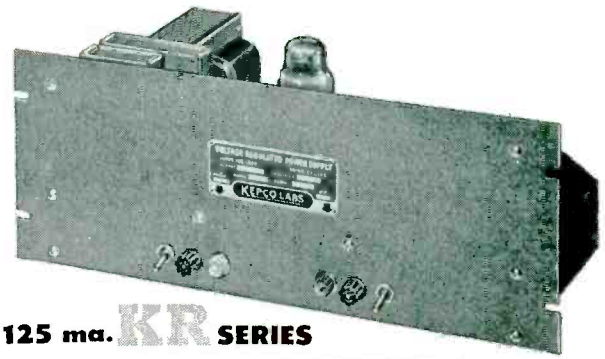
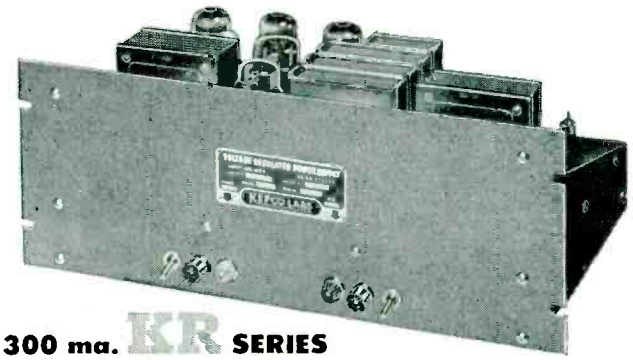


125 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V.	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR1 $90.	1	100-200	0-125 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				
KR2 $90.	1	200-325	0-125 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				

*AC Voltages unregulated



300 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V.	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR3 $180.	1	100-200	0-300 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				
KR4 $180.	1	200-325	0-300 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				

*AC Voltages unregulated.

600 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V.	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR5 $240.	1	100-200	0-600 ma.	0.3 volts	0.3 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR6 $240.	1	195-305	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR7 $250.	1	295-405	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				

*AC Voltages unregulated.

electrons in the pattern of the projected letters. The stream is accelerated by a voltage applied to the wall coating of the tube.

Selection of letters in the required order is accomplished with a tiny aperture at the neck of the tube, permitting only one character at a time to pass through. The stream is shifted by a magnetic deflection coil around the outside of the tube to choose the desired letter or character.

Another set of coils focuses and deflects the character to its proper place where it appears in visible form on a phosphor screen. Enlargement can also be accomplished by the second set of coils.

As many as 4,000 characters have been produced clearly in a single pattern on the 5-inch tube face. The typesetting process can take place at speeds up to 10,000 letters a second.

Source of information for tests has been perforated paper tape, but output of magnetic tape, wire or radio signals or electronic storage unit could also be used.

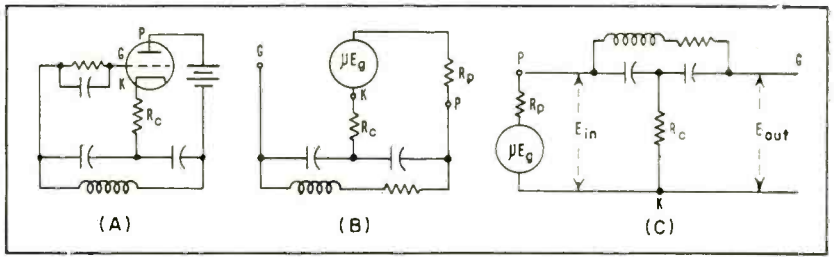
In the laboratory, 2,000 characters a second have been clearly recorded on standard 35-mm film.

Producing Oscillations With A Colpitts Circuit

By Richard White McCusker
Merced, Calif.

Failure to obtain oscillations from a class A Colpitts oscillator without changes in initial component values is sometimes encountered. Analysis may show that the circuit of (A) is equivalent to the circuit shown in (B) which can then be redrawn in the form shown (at right) in (C).

Components are now arranged in the configuration of a bridged-T network in which a null is produced at the output. With pure sine-wave input, it may actually give zero output.



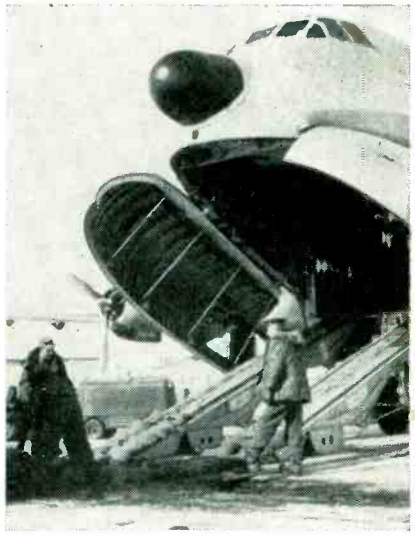
Colpitts oscillator circuit (A) redrawn in equivalent form (B) and rearranged to show bridged-T network configuration (C)

In those cases where an oscillator fails to function, it may be that the constructor has paradoxically built a bridged-T network that produces a null grid voltage at or near the very frequency the oscillator was designed to generate.

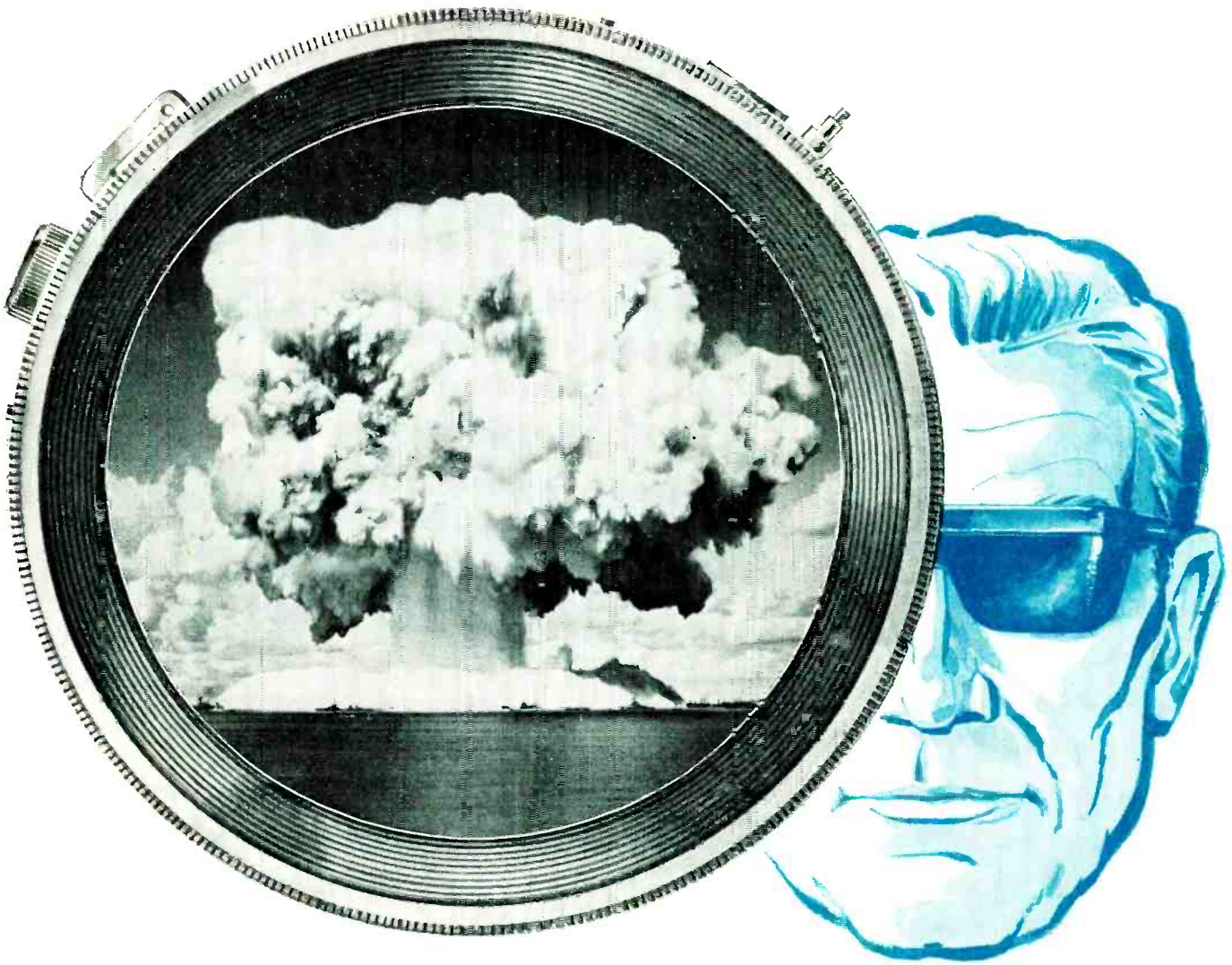
(continued on page 186)

DEW Line Radar Network In The North Spots Planes

Experimental radar unit in the Arctic is prototype of those for Distant Early Warning (DEW) Line to be constructed for detection of approaching unauthorized aircraft. Mushroom-shaped rubber dome houses a radar antenna and protects it from weather. Western Electric is prime contractor



Tractors and other heavy equipment are transported in Arctic by aircraft. Transport shown shuttles between Alaska and forward base



how to stop an h-blast

WANTED: a camera to stop the action of a nuclear explosion at a pre-selected microsecond, with high quality image-definition . . . that was the problem handed by the AEC and its Los Alamos Scientific Laboratory to the Boston firm of Edgerton, Germeshausen & Grier, Inc. EG&G solved it by inventing the non-mechanical Rapatronic shutter . . . employing the Faraday Effect of magnetically rotating the plane of polarized light as it traverses an optical element . . . and relying on HELIPOT* precision potentiometers and DUODIAL* turns-counting dials for sensitivity setting and calibration.

A light-pulse from the blast falls on a photocell . . . generates a signal that passes through a variable time-delay to trigger a condenser-discharge circuit . . . releasing energy which surges through a coil wound around a lead-glass lens. The resulting magnetic field rotates polarized light from the blast as it passes through the lens . . . effecting a one-microsecond exposure.

Sensitivity of the photocell circuit is controlled by a standard-linearity Model A 10-turn HELIPOT, calibrated with a Model RB DUODIAL. Time-delay from photocell pick-up to shutter operation . . . continuously variable from 0 to 100 microseconds . . . is controlled by a Model A 10-turn HELIPOT of 0.1% linearity, calibrated with a Model W10 DUODIAL.

The coil of the HELIPOT is wound with more than 10,000 turns of resistance wire . . . the DUODIAL is settable to a fraction of any of its thousand scale-divisions . . . and the Rapatronic shutter can be tripped at any preselected fraction of a microsecond.

For complete details of this and other HELIPOT applications, write for Data File 501

MODEL A HELIPOT

W10 DUODIAL

Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

BECKMAN

* 342 T.M.REG.

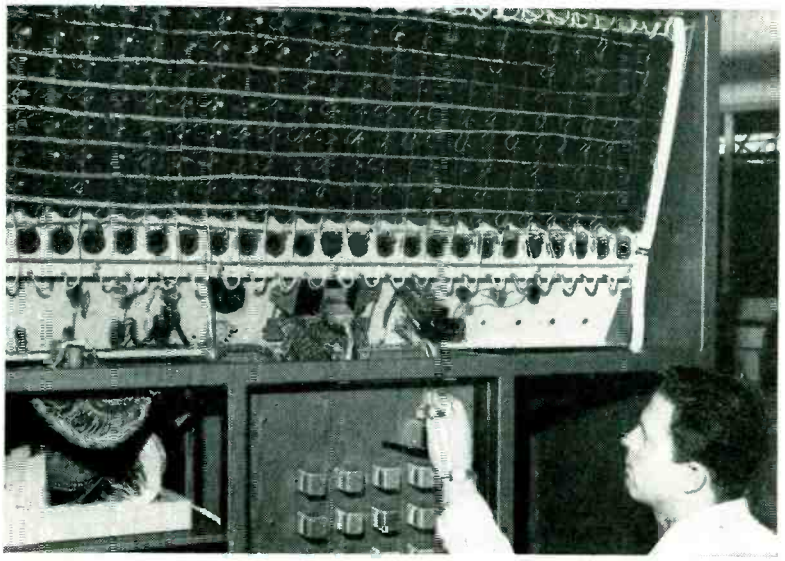
THE FRONT COVER

MULTICHANNEL recorder designed and built by Beckman Instruments, Inc. speeds static testing of aircraft structures at Convair in San Diego. The instrument automatically measures and records the output of as many as 200 resistance strain gages within 5 minutes.

As hydraulic rams apply calculated loads to the aircraft structure, the strain gages attached to the structure produce unbalance voltages. Fast-cycling stepping switches momentarily connect the recorder's measuring circuit to each gage circuit. During this brief contact period, strain voltage from the gage is compared with a slide-wire reference voltage and the analog result—in terms of strain vs known load—is printed on a tabulating card.

Before a test run begins, gage circuits are balanced at zero load by means of 200 10-turn Helipots and a portable servomotor. Any voltage differential in an unbalanced circuit drives the servo motor, which spins the corresponding Helipot shaft until the circuit balance point is reached.

Immediate availability of information permits structures engineers and stress analysts to maintain a constant check as a test progresses. The recorder can also be equipped with a digital conversion unit so that digital data can be printed, punched on tape or preserved in some other form.



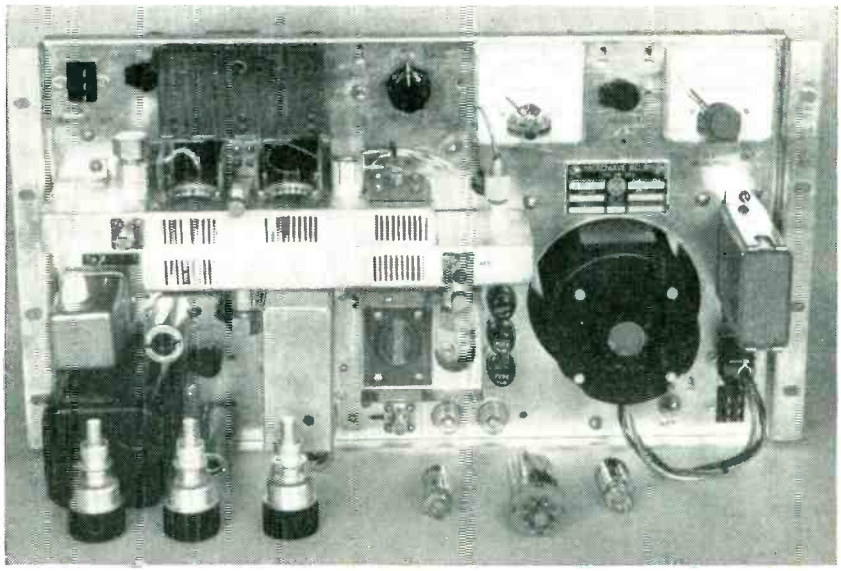
Technician testing multichannel recorder used to collect strain-gage data during aircraft structural tests. The equipment measures and records output of 200 strain gages within five minutes. Beckman Instruments, Inc. built the device for Convair

Designing 2,000-Mc Components For Communications

By N. C. COLBY
RCA Victor Division
Radio Corporation of America
Camden, N. J.

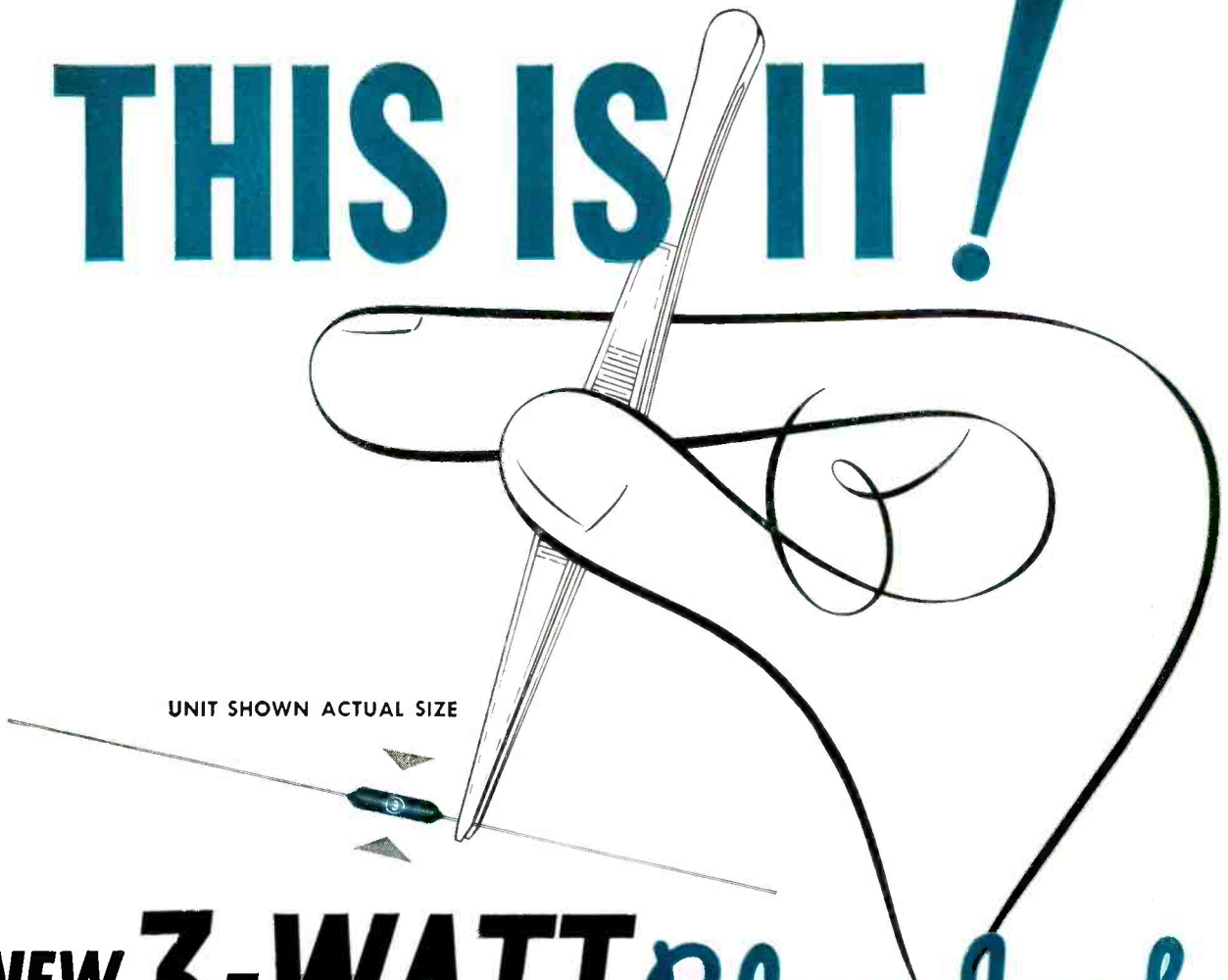
WHEN DESIGNING ultra-high frequency circuits for commercial applications some of the factors that must be considered are the parasitic capacitance of tubes, the desired tuning range, tube accessibility, means of ventilating the tubes, power output coupling methods and manufacturing costs.

The physical size of tuned circuits, usually of the transmission-line type, is determined by the characteristic impedance of the transmission line, the working frequency and the input or output capacitance



Tuned cavities at left center of chassis provide coupling between oscillator mixer and amplifier

THIS IS IT!



NEW 3-WATT Blue Jacket®

miniaturized axial-lead wire wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
151E	3	1 7/32	13/64	10,000 Ω
27E	5	1 1/8	3/8	30,000 Ω
28E	10	1 7/8	3/8	50,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

WRITE FOR ENGINEERING BULLETIN NO. 111B

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.

of the tube. Physical size of the circuits is inversely proportional to both the characteristic impedance and the capacitance. This fact usually rules out parallel-line circuits whose characteristic impedance is of the order of 240 ohms. Coaxial structures are widely used because they provide good shielding, high Q, and can be built to have a characteristic impedance as low as five or ten ohms, but their size also is governed by the capacitive loading at any given frequency.

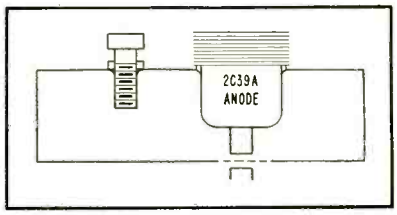


FIG. 1—Resonant cavity using single tube and tuning slug

Using a 2C39A tube in a coaxial circuit at 2,000 megacycles it is found that the output line or cavity is 0.97 inch long, assuming a quarter-wavelength section, and has an output capacitance of 2 $\mu\mu$f and a characteristic impedance of 30 ohms. The length of the tube from the grid ring to the end of the cooling fins is 1.6 inches—a difficult situation. In many applications a possible way out is to use multiples of a quarter wavelength but in applications where maximum bandwidth is desired the additional stored energy is a serious problem. What is needed is a resonant cavity whose dimensions are essentially independent of capacitive loading.

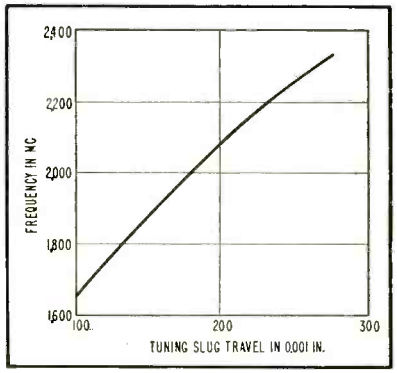
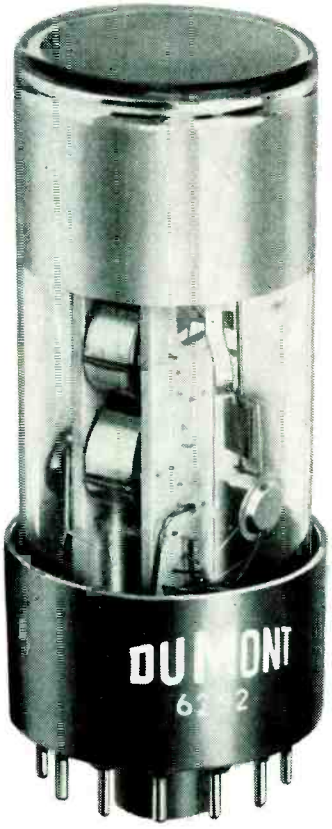


FIG. 2—Change in frequency with adjustment of tuning slug in single-tube cavity

A ridge waveguide cavity provides approximately this feature. If a cavity is constructed from a

STABILITY...

One of the Many Outstanding Characteristics of the DU MONT TYPE 6292 Multiplier Phototube

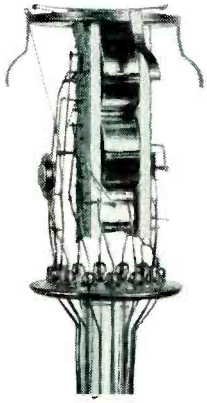


Stability — the ability of a multiplier phototube to operate over extended periods of time without appreciable change in output characteristics — is essential to *reliable* quantitative measurements and to high-quality flying-spot scanner applications, particularly those involving color signals. The stability of the Type 6292, achieved with silver-magnesium dynodes and a construction exclusive to Du Mont multiplier phototubes (see below) assures reproducible results without continual recalibration of equipment or, in the case of flying spot scanners, continual readjustment of video level.

Unparalleled stability, added to excellent sensitivity and cathode uniformity, very low dark current, and high signal to noise ratio makes the Type 6292 particularly well suited for those applications where quality of performance must not be compromised.

The unique Du Mont Dynode Structure

Note independent screen between photocathode and first dynode, which is brought out to a base pin. By varying the potential on the screen, optimum electron collection is achieved, greatly improving signal to noise ratio. Linear arrangement of box-type dynodes provides longest possible leakage paths between low- and high-voltage dynodes, greatly minimizing dark current and noise. This construction also provides effective shielding of electron stream, minimizing the effects of external fields.



SPECIFICATIONS

Spectral Response	S11
Cathode Luminous Sensitivity (at 210 V. 0 cps) between cathode and all other electrodes	60 μA/lumen
Anode Luminous Sensitivity	
105 v/stage; 0 cps	13 A/lumen
145 v/stage; 0 cps	120 A/lumen
Current Amplication at:	
105 v/stage	215,000
145 v/stage	2,000,000
Average Anode Current	5 ma
Peak Anode Current	25 ma
Tube Diameter	2 ± 1/16 in.
Seated Height to Center of Window	4-7/8 ± 3/16 in.

The performance features of the Type 6292 are representative of those of the entire line of Du Mont Multiplier phototubes, covering the entire range of sizes from ¾-inch to 16 inches. All are built to Du Mont's rigid specifications for quality, and are backed by the well known Du Mont guarantee. For full technical details on the Type 6292, or other Du Mont multiplier phototubes, write the *Technical Sales Department, Allen B. Du Mont Laboratories, Inc., 2 Main Avenue, Passaic, N. J.*

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Like so many other electrical manufacturers, Furnas Electric found that PLASKON Alkyd was the *one* plastic that could do *all* the things required of it. Having the right material can make the difference between success and failure of a product. And time after time, PLASKON Alkyd has proved itself to be exactly right for tough electrical jobs.

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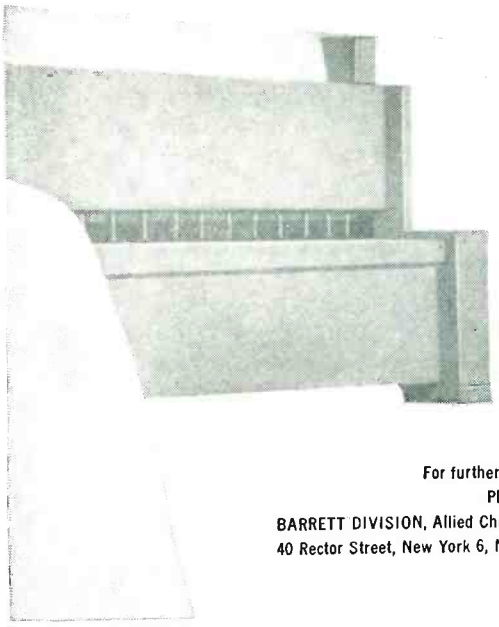
Dimensional stability, moisture resistance, heat-dissipating qualities and minimum after-shrinkage make PLASKON Alkyds popular with the many electrical and electronic manufacturers who have found them to be the only satisfactory plastic for their top quality needs.



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section of ridge waveguide by soldering a conducting sheet over each end there will be a resonant frequency associated with it having a field configuration corresponding to the TE_{10} mode in rectangular guide. If the ridge is extended across the cavity to increase the capacitance between the broad faces of the cavity, it will be necessary to reduce the length of the cavity to maintain resonance at a given frequency, but as the capacitance is increased indefinitely the resonant length of the box approaches, as a limit, one half wavelength in free space.

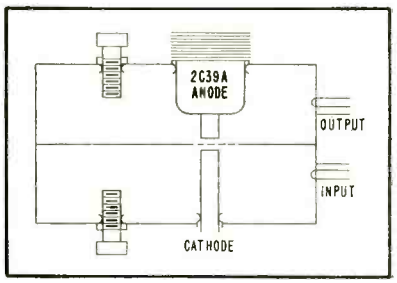

FIG. 3—Dual-cavity amplifier with separate cavities for anode-grid and cathode-grid circuits

On the assumption that the capacitance of the ridge could be simulated by the capacitance of a tube and tuning slugs distributed along the length of a cavity, a model was built using a single 2C39A tube and a tuning slug, as shown in Fig. 1. The model consisted of a rectangular copper box proportioned to accommodate the tube and to resonate in the desired frequency range. Connections to the anode and grid structures of the tube were made by means of spring fingers. Measurements of the tuning range showed the assembly to be tunable from 1,200 to 3,500 mc. No objectionable spurious resonances were observed. The wide tuning range and the quite linear relationship between resonant frequency and tuning slug insertion as shown in Fig. 2 are desirable characteristics.

Following these simple experiments an amplifier was built using two cavities, one in the anode-grid circuit and one in the cathode-grid circuit. Figure 3 shows the arrangement. The two cavities were identical in size and had a common wall. The tuning range of the two cavities was essentially the

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same despite the fact that the input capacitance of the tube is three times as large as the output capacitance.

Performance of the amplifier was good. Gain depended on signal level and bandwidth. The exact design used in a particular application is governed by the requirements of the application. Interesting variations in the designs can be achieved through the use of actual ridges in the cavities to vary the coupling between tube and cavity.

Coupling in and out of the cavities is done with loops placed in regions of strong magnetic fields. The optimum position of the coupling loops changes little over the tuning range, eliminating the necessity of coupling loops that move as the cavity is tuned.

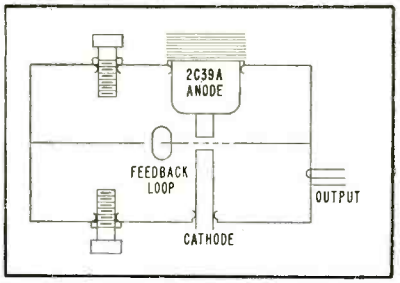
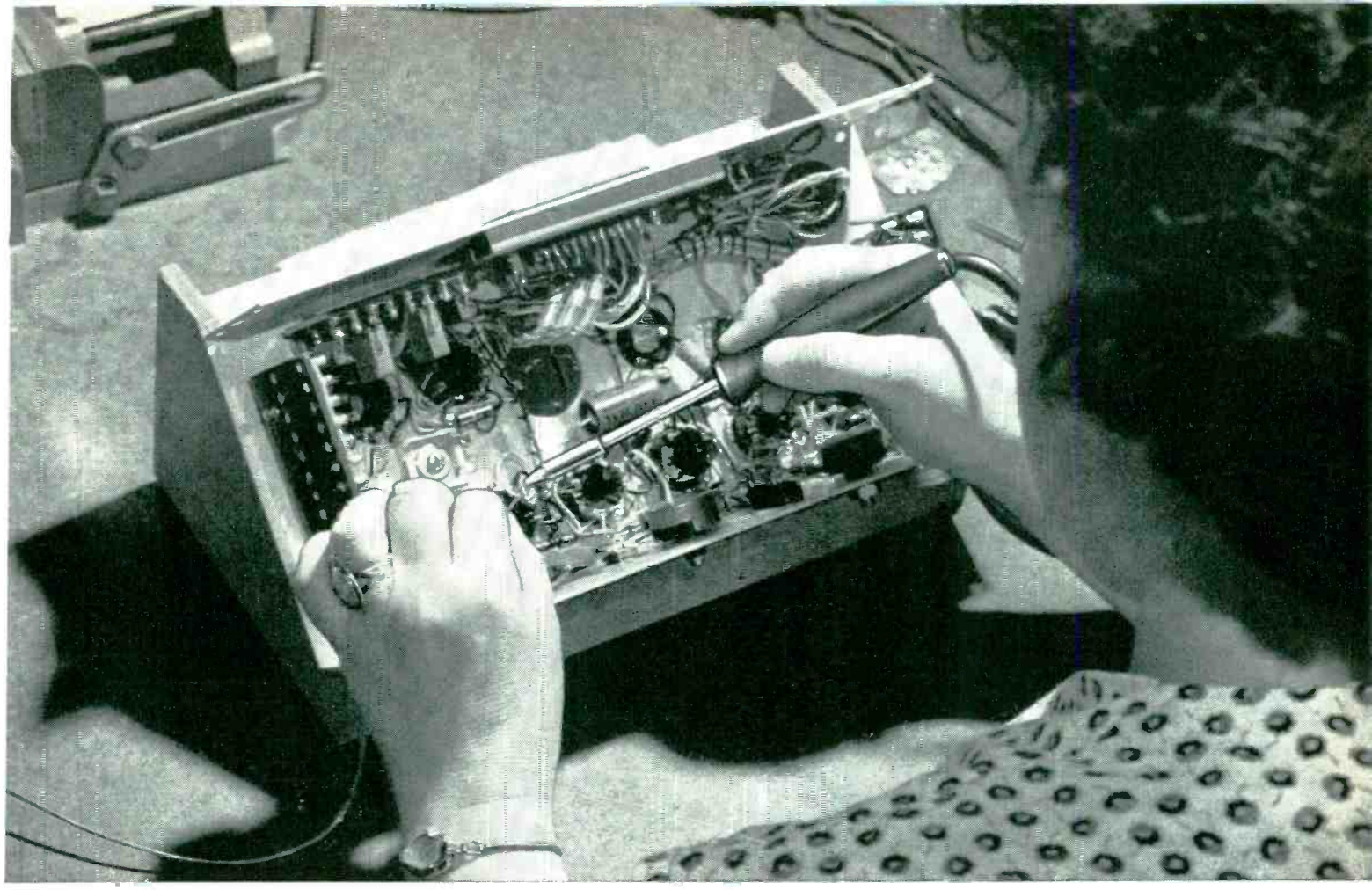


FIG. 4—Oscillator uses same configuration as amplifier with feedback loop added

To make an oscillator it was only necessary to provide feedback of the correct magnitude and phase. This was accomplished as shown in Fig. 4. The method shown employs the feedback structure at a point as close to the tube as possible to obtain operation over a wide band of frequencies.

With a given feedback-loop size, operation over a 300-mc band is achieved with power output variation of two decibels. An output of ten watts can be expected at 2,000 mc with 500 volts on the anode. Better performance could be obtained, possibly, with a symmetrical feedback system and with a cavity in which the current distribution is symmetrical but the cost of the symmetry was not justified for the use to which this cavity was put.

In practice, useful power is taken from the grid-cathode cavity. As a result of the external loading and the inherently low input imped-



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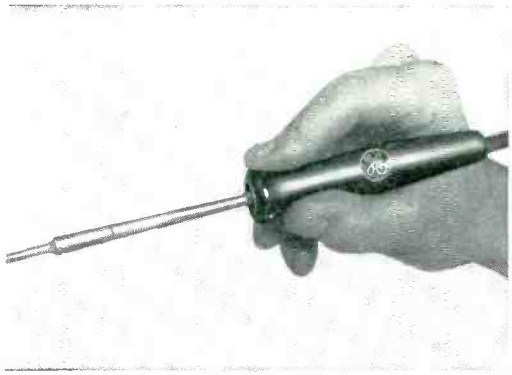
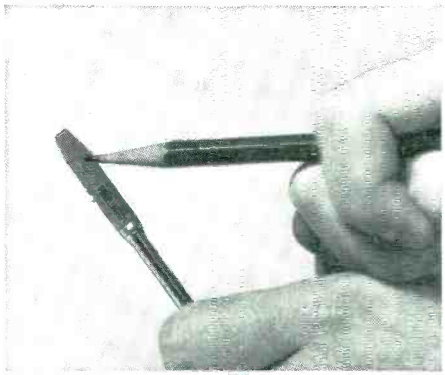


HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



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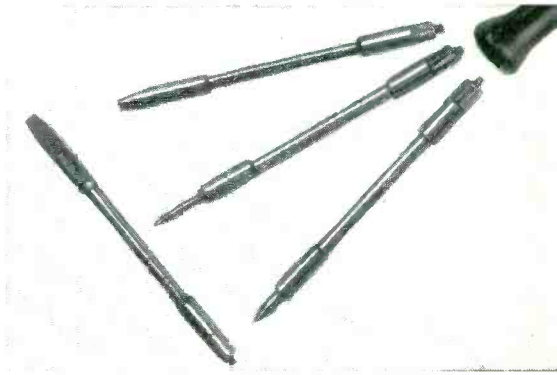
*Reg. trademark of the General Electric Company



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GENERAL ELECTRIC

ance of the tube the grid-cathode circuit is a relatively low-Q circuit compared to the grid-anode circuit. Since the grid-anode circuit has a high Q it is the main frequency-determining circuit. The oscillation frequency can be changed over a ten-percent range by tuning only the grid-anode cavity. This characteristic is exploited in the application of automatic frequency control.

The practical problem of applying d-c voltages for bias and anode voltages is solved by the use of fabricated mica-dielectric bypass capacitor structures. The grid is operated at d-c ground potential with self-bias obtained with a cathode resistor.

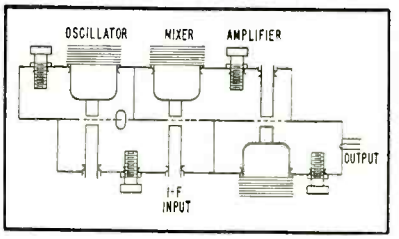

FIG. 5—Oscillator, high-level mixer and amplifier system. Oscillator grid-cathode cavity is shared with mixer

Tube ventilation is obtained by means of slots in the cavity walls. The slots are cut parallel to the lines of current flow to minimize losses due to leakage. A blower properly placed relative to the cavity will force air through the slots and also through the cooling fins attached to the tube anode. This arrangement makes it possible to cool the glass-to-metal seals of tube as well as the anode, thus prolonging the life of the tube.

The cooling arrangement and the construction of the r-f bypass capacitators do not interfere with ready accessibility of the tubes.

Cavities of the type just described were used to make an oscillator, a high-level mixer and an amplifier for use in a microwave transmitter. To achieve a compact economical easily tuned r-f head the cavity configuration shown in Fig. 5 is used. The tube on the left is the oscillator with the feedback loop located near it. The middle tube is the high-level mixer, and the right-hand tube is the r-f amplifier.

As can be seen in Fig. 5, the

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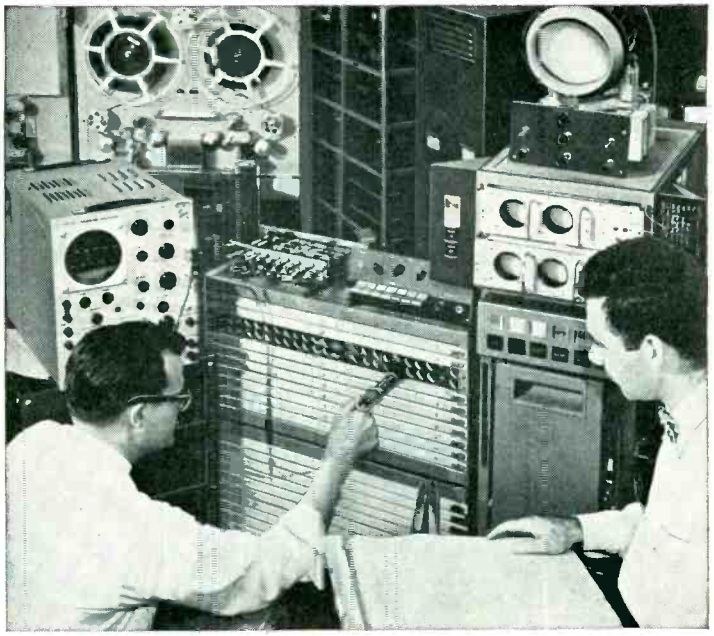

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oscillator grid-cathode cavity is shared with the mixer, thus supplying an r-f signal to the mixer between its grid and cathode. A low-frequency signal is applied between the cathode of the mixer and ground by circuits not shown. The grid-anode cavity of the mixer is tuned to the upper or lower sideband as desired.

The mixer anode shares a cavity with the cathode of the amplifier tube which gets its driving signal in this manner. The amplifier anode cavity contains a coupling loop by means of which power is taken out and fed to an antenna. The novel feature of this cavity configuration is the equivalent single-tuned coupling circuit between tubes. This particular arrangement eliminates frequency sensitive connecting cables and permits changing frequency and tuning the transmitter in the field by inexperienced persons. All transmitter adjustments are made to maximize output power. With the compact arrangement shown a single blower is used to cool all three tubes with a minimum of duct work.

A microwave transmitter that operates in the 1,700-2,000-mc band and employs the cavity configuration just described is shown in the photograph. Acknowledgement is made of the assistance of J. A. Liggett, who is responsible for the mechanical design, and of R. H. Fricke, who contributed many of the electrical refinements during the developments of the assembly.

Observing Whistlers

SWISHES, tweeks, the dawn chorus and whistlers are names that have been given to an old electrical phenomenon recently enlisted to study effects of lightning storms.

When the phenomenon is in effect, sounds for which the names are descriptive can be heard in the output of a high-gain audio amplifier to which a loop or antenna has been connected. A sensitive record-player amplifier or hearing aid amplifier may suffice.

The sounds are thought to be caused by lightning flashes that generate radio waves of low fre-

Stromberg-Carlson uses new Du Pont MYLAR* to increase switchboard wire production rate 46%

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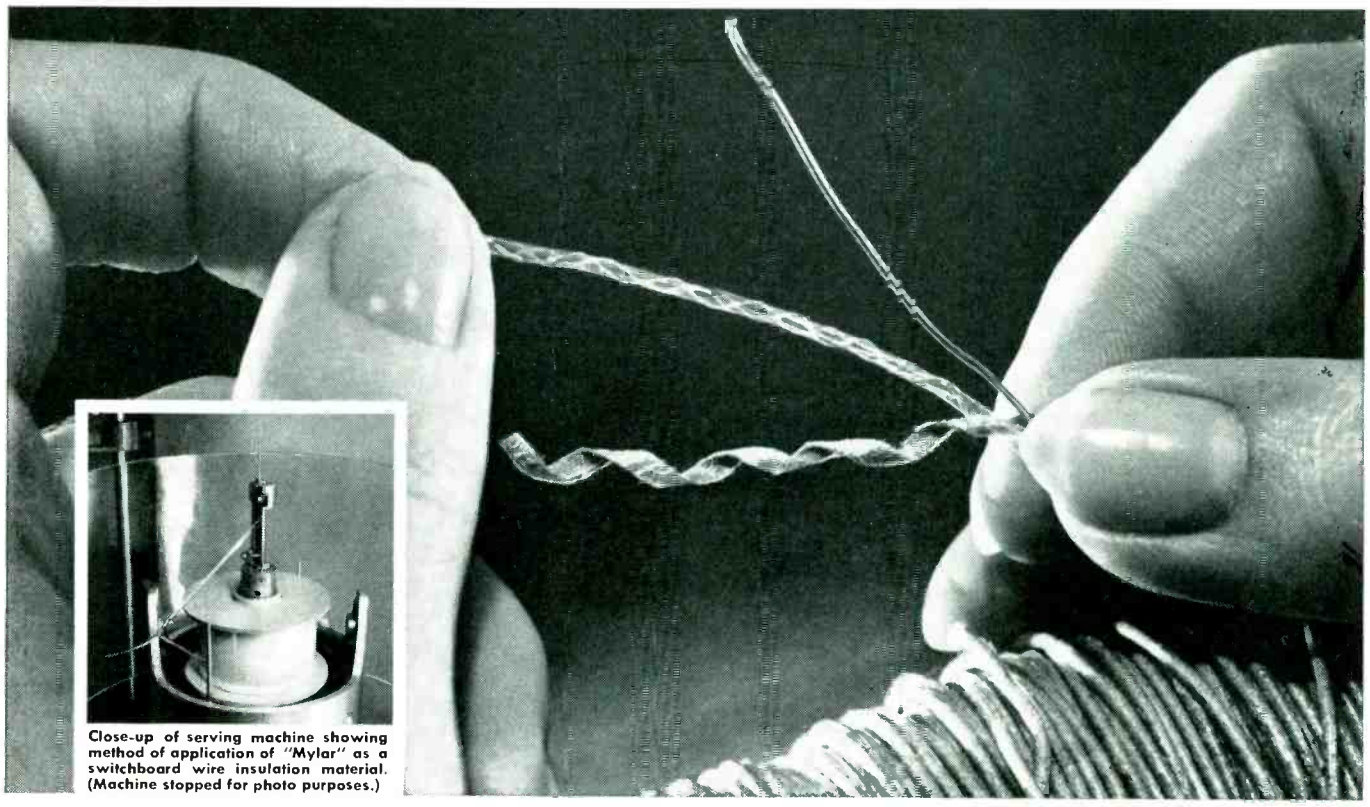

Close-up of serving machine showing method of application of "Mylar" as a switchboard wire insulation material. (Machine stopped for photo purposes.)

Unusual properties of "Mylar" make possible improved insulation

Here's another example of the outstanding improvements now possible with Du Pont "Mylar" polyester film—switchboard wire made by Stromberg-Carlson. The company reports that "Mylar," one-half the thickness but twice the tensile strength of the material formerly used, increases the production rate of the switchboard wire insulating machines up to 46%. And the superior insulating properties of "Mylar," along with its physical properties, give many other important advantages.

For example, Stromberg-Carlson tests show a three-to-one improvement, after humidity exposure, for the insulation made with Du Pont "Mylar." What's more, "Mylar" is tough, flexible, heat-stable, has good aging qualities . . . and it reduces the outside diameter of finished wire by approximately 5 mils.

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quency that follow the earth's lines of magnetic flux. The waves apparently travel from one hemisphere to another, crossing back and forth over the equator.

The fact that swish or whistler may sometimes be heard in multiples may indicate that it has traveled from one hemisphere to another, bounced back to its point of origin and then duplicated its path.

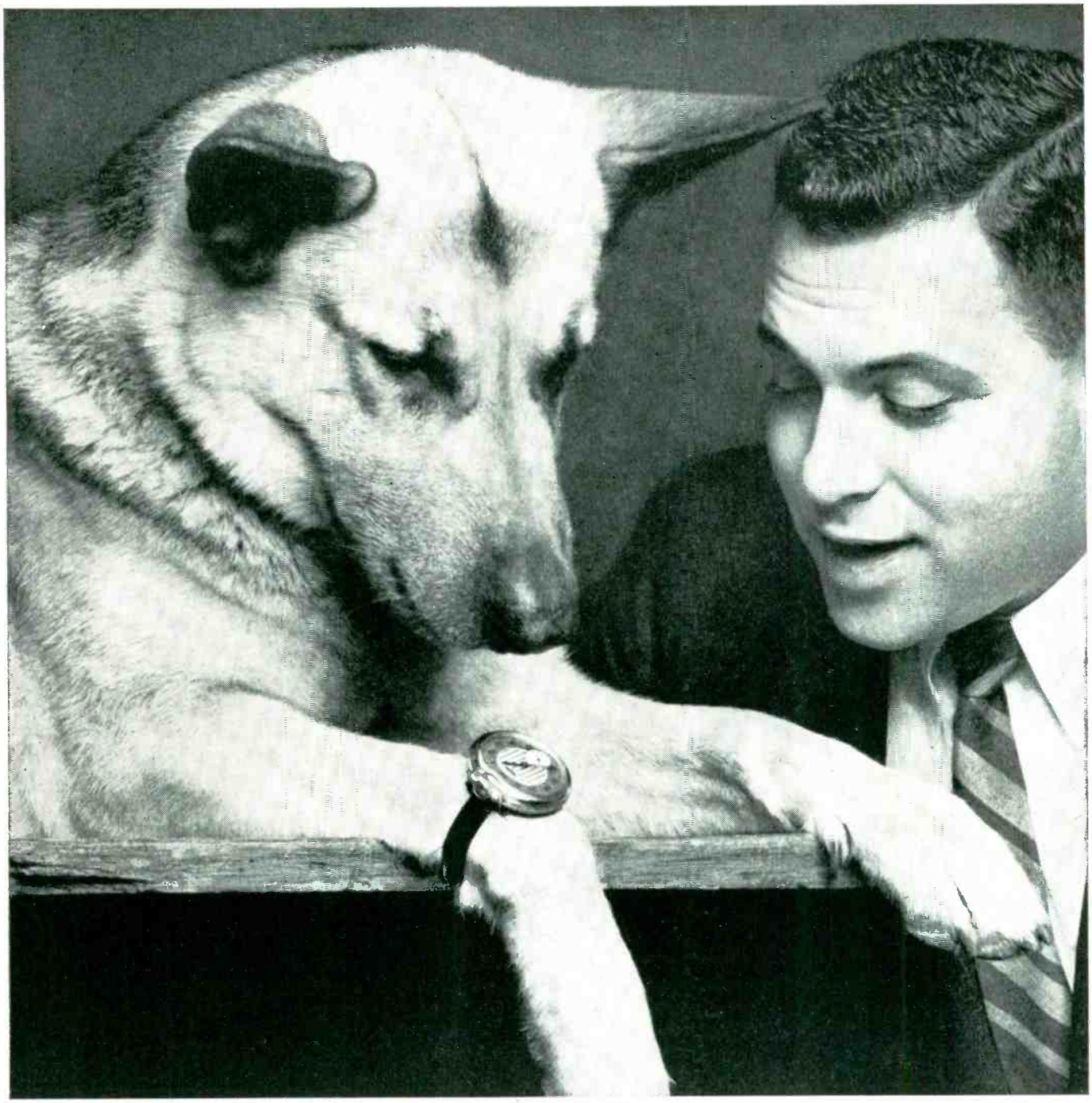
It is believed that the waves go to the outer reaches of the earth's ionosphere, to a distance in space twice the earth's radius or 7,127 miles.

Tweeks, which sound like their name, may sometimes be heard on a rural telephone line. They result from lightning flashes that send a pulse of energy generated by the discharge bouncing back and forth between the earth and the lower inosphere.

The dawn chorus is sometimes heard early in the morning and sounds like spring frogs peeping in a swamp, according to Millett G. Morgan, director of research at the Thayer School of Engineering at Dartmouth College. Dr. Morgan has set up a co-operating network for simultaneous observation with stations at Hanover, N. H.; Knob Lake, Labrador; Washington, D. C.,

TV Previews New Tube

Closed-circuit television was used by General Electric to announce a new lighthouse tube on the occasion of the IRE national convention. Information on the type 6442 tube (similar in many ways to the 2C39) was transmitted from the company plant in Schenectady to New York City. The tube, of which a model is shown in cross-section, has a coaxial form and operates at frequencies as high as 4 kmc



Alan Press, Traffic Manager of Screen Gems, Inc., TV subsidiary of Columbia Pictures Corp., tells:

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and Gainesville, Fla. Observations were also made aboard the U. S. S. Atka off the Palmer Peninsula in the Antarctic.

It is thought that understanding the mechanism of propagation of whistlers may lead to new means of communication and aids to navigation.—A. A. McK.

Insect Control by Electron Irradiation

By Vernon H. Baker
Research Professor
Agricultural Eng. Dept.
Virginia Polytechnic Institute
Blacksburg, Va.

Oscar Taboada
Assistant in Entomology
Michigan State College
East Lansing, Mich.

and Dennis E. Wiant
Professor of Agricultural Eng.
Michigan State College
East Lansing, Mich.

Two of the worst pests that infest grain products, the granary weevil and the flour beetle, were selected for tests to determine the effectiveness of accelerated electrons as an insect control.

Tests made by the Agricultural Engineering, Entomology and Home Economics Departments at Michigan State College in cooperation with The Upjohn Company of Kalamazoo, Michigan, indicate that adult granary weevils and flour beetles can be killed[1,2] with accelerated electrons from a Van de Graaff generator. Relatively low doses of accelerated electrons sterilized eggs of these insects and also prevented adults from reproducing.

Testing procedure consisted of counting a known number of insects into a dish containing a weighed sample of wheat or flour. These samples were then placed in a constant-temperature constant-humidity incubator to allow sufficient time for the insects to lay their eggs. The samples were then irradiated with various doses of accelerated electrons. Some samples were left untreated as controls.

The Van de Graaff generator used for irradiation built up a charge of about 2-million volts. The electron beam is passed through a thin aluminum window into the product

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being irradiated on a conveyor belt.

Applied doses of electrons are measured in rep (roentgens equivalent physical). The rep is a very small quantity of energy and may be defined in terms of calories, or kilowatt-hours. A dose of 100,000 rep is equal to about 0.20 calorie per gram. A dose of 100,000 rep will raise the temperature of a one-gram sample of wheat or flour about 0.5 C. A dose of 500,000 rep will raise the temperature of this same sample about 2.5 C.

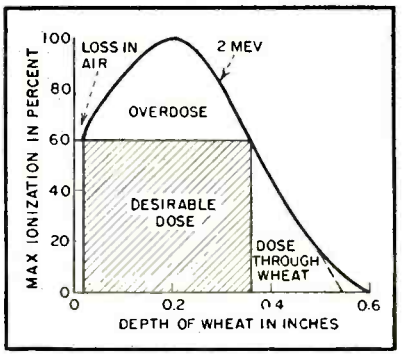

FIG. 1—Depth of penetration of 2-mev electron beam in wheat with 60-percent ionization at top and bottom of layer

Results of some of the first tests show that 80 percent of adult granary weevils died within one week after receiving a dose of 100,000 rep. About 90 percent of adult flour beetles died one week after receiving a dose of 250,000 rep. Complete kill, immediately after treatment, was obtained with 250,000 rep for the granary weevil and 500,000 rep for the flour beetle.

For practical purposes, doses much lower than mentioned above may be sufficient for insect control. It was found that a dose as low as 10,000 rep will sterilize granary weevil and flour beetle eggs already laid and this same dose prevents adults of these insects from reproducing.

Preliminary baking and taste tests conducted at Michigan State College showed that a satisfactory loaf of bread can be made from wheat flour irradiated with doses great enough to kill the adult insects immediately after treatment, which is a dose 50 times greater than is needed for egg sterilization. Some differences were noted in tenderness, flavor, moistness of bread baked with treated flour when

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100 per cent inspection and aging of every TI diode assures maximum reliability. Thoroughly tested at high temperatures, these uniformly high quality silicon diodes will increase electronic equipment dependability where heat, shock and vibration are problems. Every unit is hermetically sealed, providing maximum protection against ambient moisture.

					Maximum Ratings at 25°C			Maximum Ratings at Elevated Temperatures				Typical Capacity $\mu\mu fd$ f = 500 kc Temp. = 25°C Rev. Volts −12V†
TI Type	Max. Rev. Working Voltage	Min. Junct. Breakdown Voltage	Minimum Forward Current 25° Ma.	Volts	Reverse Current Amperes*	Dissipation mw	Average Rectified Forward Current ma	Ambient Temp. °C	Reverse Current Amperes*	Dissipation mw	Average Rectified Forward Current ma	
600C	—	30.0	3	1	$1\cdot10^{-6}$ @ −1V	100	25	100	$0.4\cdot10^{-4}$	40	15	2.5
601C	—	50.0	3	1	$1\cdot10^{-8}$ @ −1V	100	25	150	$0.5\cdot10^{-4}$	20	10	2.5
604C	4.7	5.5	60	1	$1\cdot10^{-7}$	150	100	150	$0.5\cdot10^{-4}$	40	40	20
606C	6.8	7.5	35	1	$1\cdot10^{-7}$	150	90	150	$0.5\cdot10^{-4}$	40	35	16
608C	10.0	11.0	25	1	$1\cdot10^{-7}$	125	75	150	$0.5\cdot10^{-4}$	20	25	12
610C	15.0	17.0	12	1	$1\cdot10^{-7}$	125	60	150	$0.5\cdot10^{-4}$	20	20	7
612C	22.0	25.0	7	1	$1\cdot10^{-7}$	125	50	150	$0.5\cdot10^{-4}$	20	20	5
614C	33.0	37.0	5	1	$1\cdot10^{-7}$	125	35	150	$0.5\cdot10^{-4}$	20	15	3.5
616C	47.0	52.0	3	1	$2\cdot10^{-7}$	100	30	125	$0.4\cdot10^{-4}$	20	15	2.5
618C	68.0	75.0	1.5	1	$2\cdot10^{-7}$	100	25	125	$0.4\cdot10^{-4}$	20	10	2.0
620C	100.0	110.0	0.9	1	$2\cdot10^{-7}$	100	20	125	$0.4\cdot10^{-4}$	20	8	1.4
622C	150.0	170.0	6.5	4	$2\cdot10^{-7}$	90	15	100	$0.3\cdot10^{-4}$	30	5	1.2
624C	220.0	250.0	3	4	$0.4\cdot10^{-6}$	80	10	71	$0.2\cdot10^{-4}$	40	5	1.0
626C	330.0	370.0	2	4	$1\cdot10^{-6}$	75	7	71	$0.2\cdot10^{-4}$	30	4	0.9
628C	470.0	520.0	1	4	$1\cdot10^{-6}$	70	5	71	$0.2\cdot10^{-4}$	20	3	0.7

* At maximum working voltage.

† On types 604C, 606C, and 608C reverse voltage was reduced below breakdown voltage.

For detailed information about TI's complete line of silicon junction diodes, write for Bulletin No. DL-S 431.

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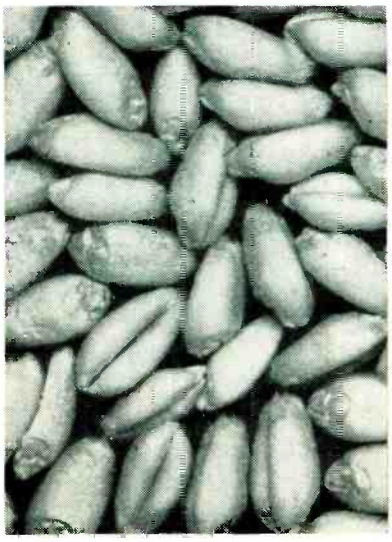
compared to bread baked with the same flour untreated. Some tasters preferred bread made from treated flour. Further tests are needed using flour treated with reduced doses before definite conclusions can be reached.



Irradiated sample of weevil-infested wheat after 43-day incubation period

Control sample of nonirradiated infested wheat after 43-day incubation

The doses of electrons used definitely damage wheat for use as seed. Seed receiving a dose as high as 500,000 rep will sometimes germinate, but will not emerge and grow when planted. Wheat plants from seed receiving doses of 10,000 rep, which is enough to sterilize insect eggs, are definitely retarded in growth.

The effect of accelerated electrons on vitamins has been studied by B. E. Proctor and his associates at

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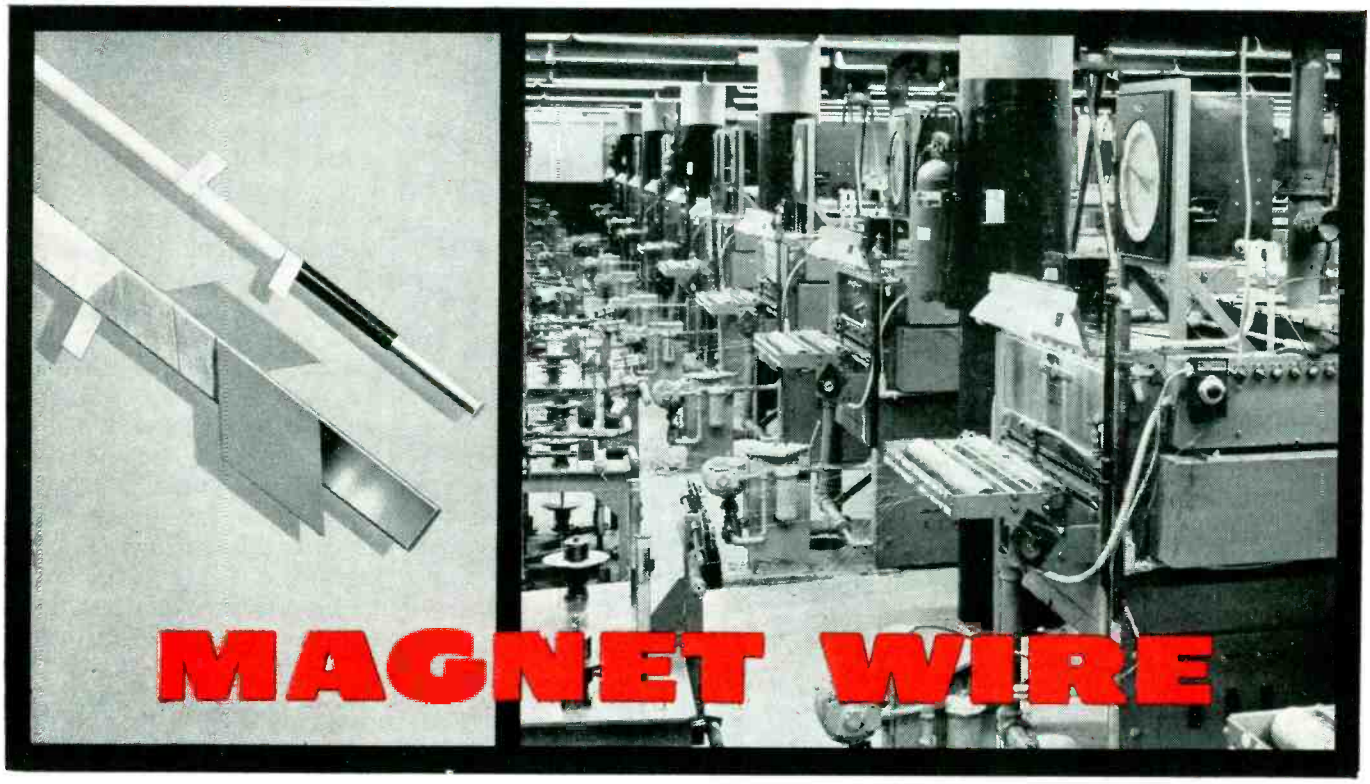

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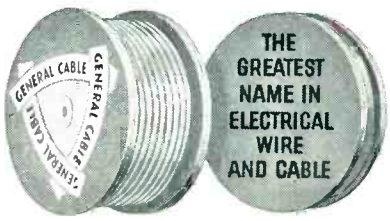

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Massachusetts Institute of Technology. Their data indicated no appreciable destruction of niacin and carotene in a concentration of 100 micrograms per ml when treated[3] with a dose of 10,000 rep. There was about 95-percent retention of ribloflavin with the same dilution as above, when treated with a dose of 100,000 rep.

For treatment on a continuous basis the wheat can be fed onto a conveyor belt and passed through the electron stream. A depth of about $\frac{3}{8}$-inch of wheat or flour can be treated with a 2-million volt machine, a depth of about $\frac{9}{16}$-inch of wheat or flour with a 3-million volt machine, and a depth of about $\frac{11}{16}$-inch of wheat with a 5-million volt machine. The width and speed of the conveyor belt can be adjusted to give various rates within the electrical capacity of the machine.

The calculated cost of electrical energy for treating wheat and flour with a dose of 100,000 rep using an overall efficiency of 10 percent, is about 15 cents per ton when electricity costs 2 cents per kwh. With a dose of 10,000 rep the cost of energy is about 1.5 cents per ton. Major cost to be considered is the installation or initial costs.

References

(1) V. H. Baker, O. Taboada and D. E. Wiant, Effects of Electrons on Insects which Infest Wheat and Flour, *Agric. Eng.*, Nov 1953.

(2) V. H. Baker, O. Taboada and D. E. Wiant, Effects of Electrons on Insects which Infest Wheat, Flour, and Beans, *Agric. Eng.*, June 1954.

(3) S. A. Goldblith and B. E. Proctor, Effect of High Voltage X-Rays and Cathode Rays on Vitamins (Ribloflavin and Carotene) *Nucleonics*, 5, No. 2, p. 50, 1949.

Autopilot Magnetic Servo Amplifier

By Marcel Zucchino

Signal Corps Engineering Laboratory
Fort Monmouth, N. J.

A MAGNETIC AMPLIFIER for use in laboratory experiments on a flight control system is shown in Fig. 1 and the photograph. The two-stage amplifier is designed for phase-sensitive d-c input signals and provides a phase-sensitive d-c output. As shown in block form in Fig. 2, the rate and displacement error signals are picked off gyro-operated potentiometers, while the displace-

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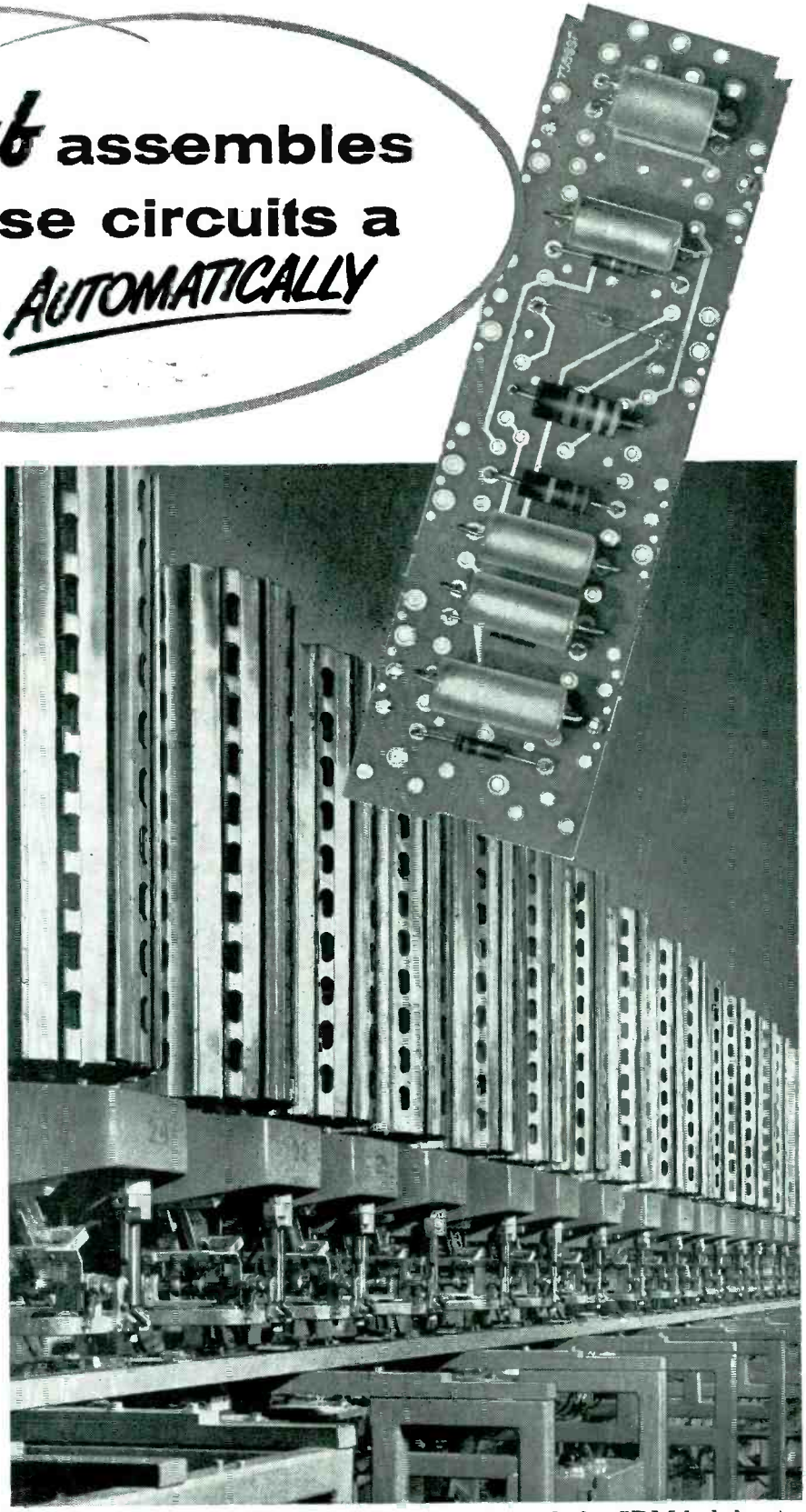

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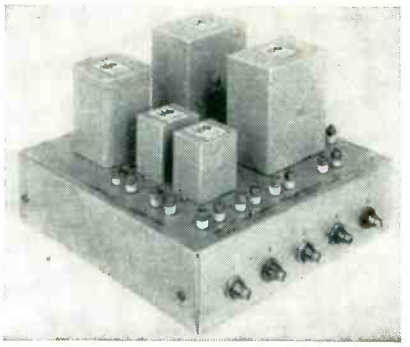
ment feedback is picked off a potentiometer mounted on the output shaft of the actuator.

The actuator consists of a constant-speed motor coupled to the load through two magnetic clutches. One clutch engages the motor and load for positive signals while the other engages for negative signals. The result is a phase-sensitive output torque proportional to the sum of the rate and displacement error signals.



Laboratory model of autopilot magnetic amplifier

The input windings are designed to the following specifications. The displacement-error winding has an input resistance adjustable from 1,000 to 6,000 ohms with an input signal of 0 to 350 μa.

The rate winding has the same input resistance range with an input signal of 0 to 175 μa. Input resistance of the displacement-feedback winding is adjustable from 2,000 to 7,000 ohms with an input signal of 0 to 175 μa.

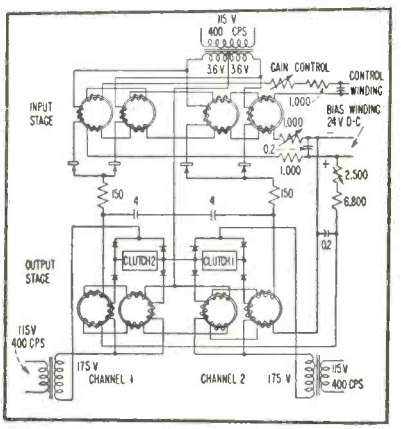
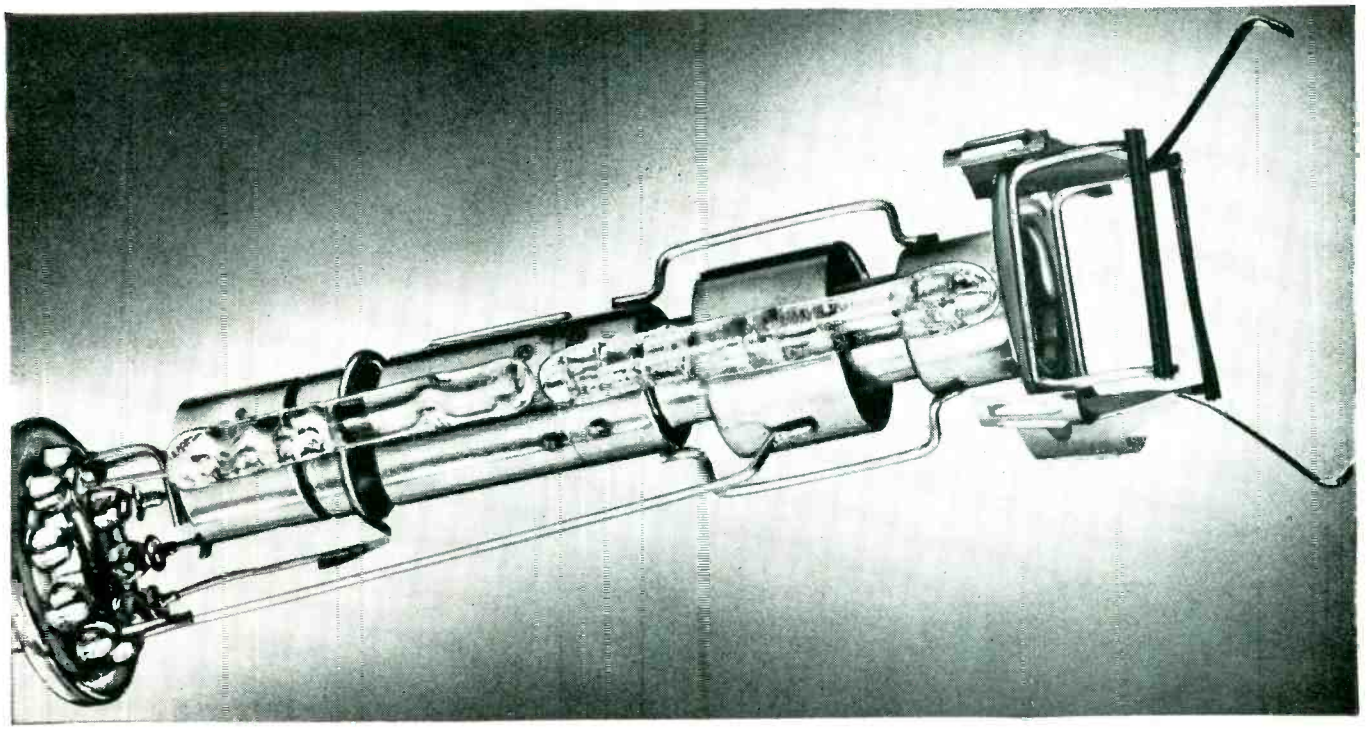


FIG. 1—Dual-channel magnetic amplifier controls magnetic clutches in autopilot system

The output stage of the magnetic amplifier operates into the field windings of the two clutches. Each winding has a resistance of 10,000



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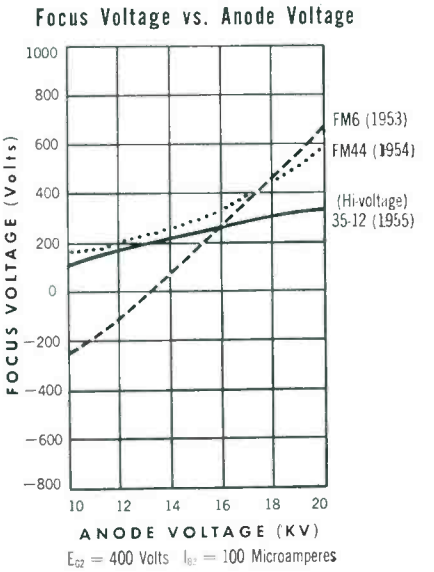

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ohms and a current rating of 0 to 10 ma.

The magnetic amplifier consists of two identical channels. One channel responds to positive signals and the other to negative signals. The first stage of each channel has a full-wave d-c output and is doubler connected. The output of this stage ranges from 0.5 to 9 ma through a 150-ohm load and is biased at 2 ma. It is then driven to 6 ma or 0.5 ma, depending on the polarity of the d-c signal.

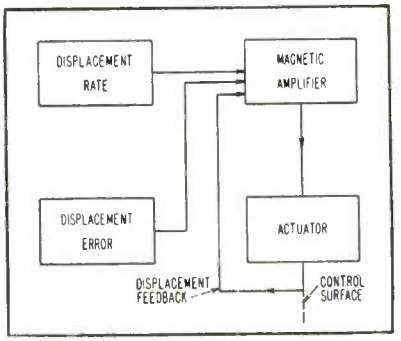

FIG. 2—Control-actuator motor is coupled to clutches controlled by magnetic amplifier

The input stage is coupled to the output stage through an R-C network that isolates it from power-supply voltages induced in the control winding of the output stage. It was found experimentally that 150 ohms in series with the control winding of the output stage and 4-μf shunting capacitance would provide suitable isolation, with negligible effect on the over-all time constant of the amplifier.

The second stage has a full-wave d-c output and is bridge connected. This connection is used for inductive loads because it provides a discharge path for the back voltages induced in the load by quickly changing load current.

The output of the second stage ranges from 0.5 to 10 ma through a 10,000-ohm load and is biased at 0.5 ma. The bias current in this stage not only sets the operating point, but cancels the 2-ma quiescent current present in the output of the first stage.

The over-all power gain is about 8,000 and the time constant, as determined from frequency response measurements, is 0.013 second.

Core material in each stage is Supermalloy. It is used in the first stage because it results in high

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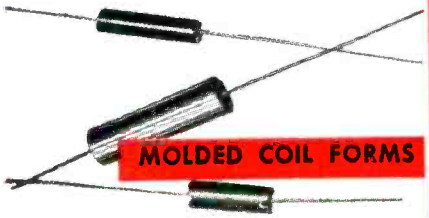

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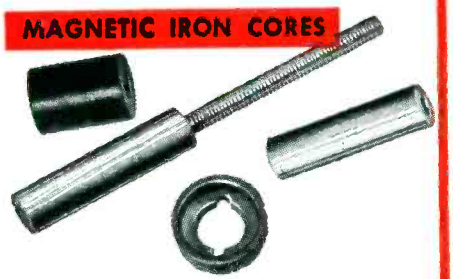

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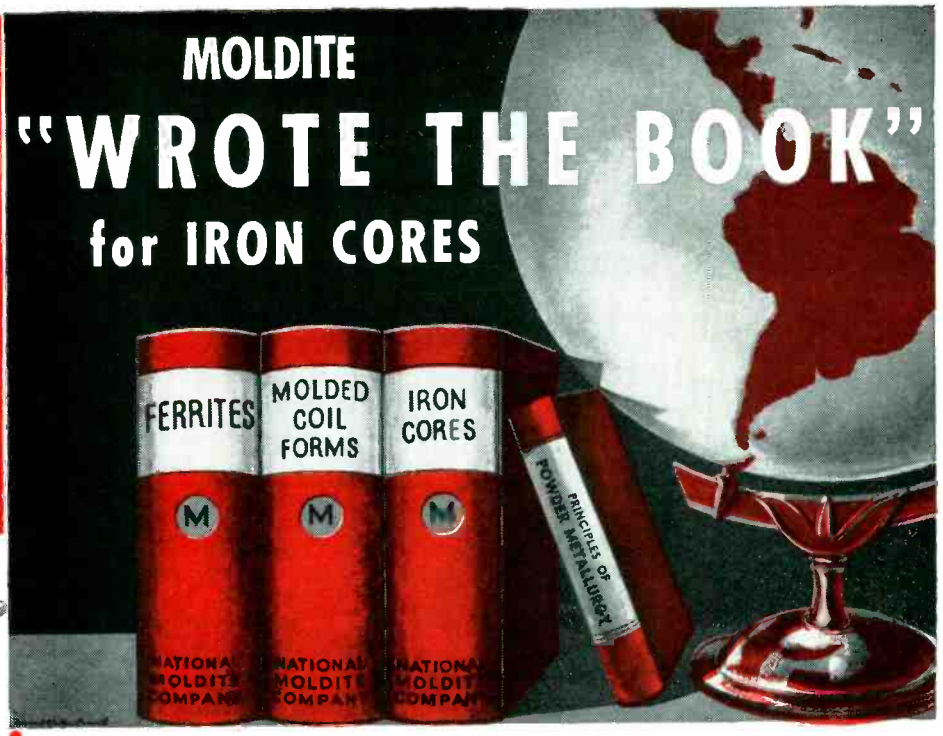

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sensitivity and in the second stage because of its low magnetizing current. While the second stage would be smaller with Deltamax cores, the minimum current could not be reduced below 2 ma, which is sufficient to engage the clutch.

Table I—Specifications for Magnetic Amplifier Components

First Stage Reactor
- Core—Arnold Eng. 5340 S2
- Power winding—500 turns, No. 40 wire
- Displacement-error winding — 90 turns, No. 40 wire
- Rate-error winding—180 turns, No. 40 wire
- Displacement-feedback winding—180 turns, No. 40 wire
- Bias winding—150 turns, No. 36 wire

Second Stage Reactor
- Core—Arnold Eng. 5387 S2
- Power winding—6,000 turns, No. 38 wire
- Control winding—350 turns, No. 38 wire
- Bias winding—150 turns, No. 38 wire

When designing magnetic amplifiers on Supermalloy cores, rectifier leakage current is more critical than usual because of the narrow hysterisis loop exhibited by this material. It follows that the rectifier leakage must be maintained at a

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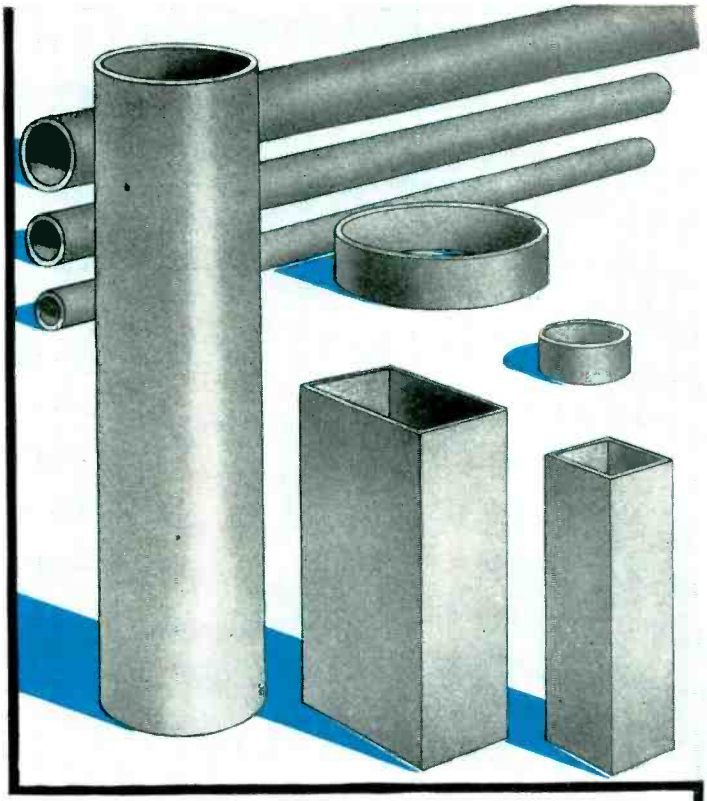
Eight analog computers simulate the four 3,500-hp aircraft engines of the C-124A Douglas Globemaster. Electronic equipment shown is a simulator used by the Electronics Division of Curtiss-Wright Corp.



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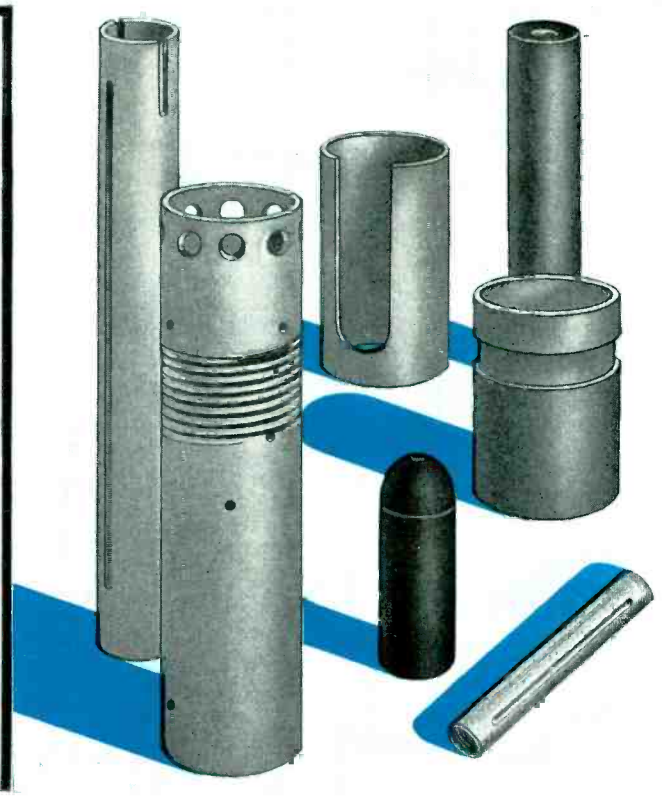

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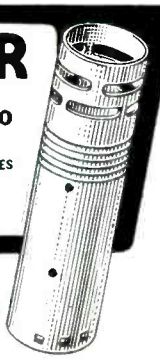

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low value over a wide range of temperature. With this in mind, fused-junction silicon diodes are used in the first stage and high-quality cartridge-type selenium rectifiers are used in the output stage.

This unit was developed with the aid of the Telesynd Research Section, Wire Communications Branch, Coles Signal Laboratory.

BIBLIOGRAPHY

Minneapolis-Honeywell Aero Document U-ED9006, "The Mechanization of Automatic Flight Stabilization Systems."

G. F. Schoreders, "What Magnetic Amplifiers Can Do To Increase Aircraft Reliability" Ford Instrument Co.

Mobile Power Supply for 6 and 12 Volts

BY KENNETH BACKMAN
Senior Development Engineer
Motorola, Inc.
Chicago, Ill.

ADVENT of 12-volt batteries for vehicles resulted in a challenging problem to the mobile communications equipment manufacturers.

Because of the long-life of two-way equipment, a unit capable of operation from 6 and 12 volts interchangeably was desirable. The 12-to-6 volt converter developed for the purpose may be described as a d-c version of an autotransformer.

The transformer used is a 6-volt center-tapped unit with a 1-to-1 turns ratio. Assume that the vibrator reed in Fig. 1 is in motion and is in the upper position engaging contacts *A* and *B*. The instantaneous current flow will be from the battery through the upper half of the primary winding through contacts *A* and *B*, which are connected by the reed, through the upper half of the secondary to ground. Since the two winding halves are of equal turns and are connected as an autotransformer, the reed will be at one-half the input potential or 6 volts, as long as the flux is changing in the core. When the reed moves to the opposite side, shorting *C* and *D*, a flux reversal will take place and currents will flow through the other halves of the transformer but the reed will still be at a positive 6-volt potential. The reed, therefore becomes a source of pulsating d-c voltage

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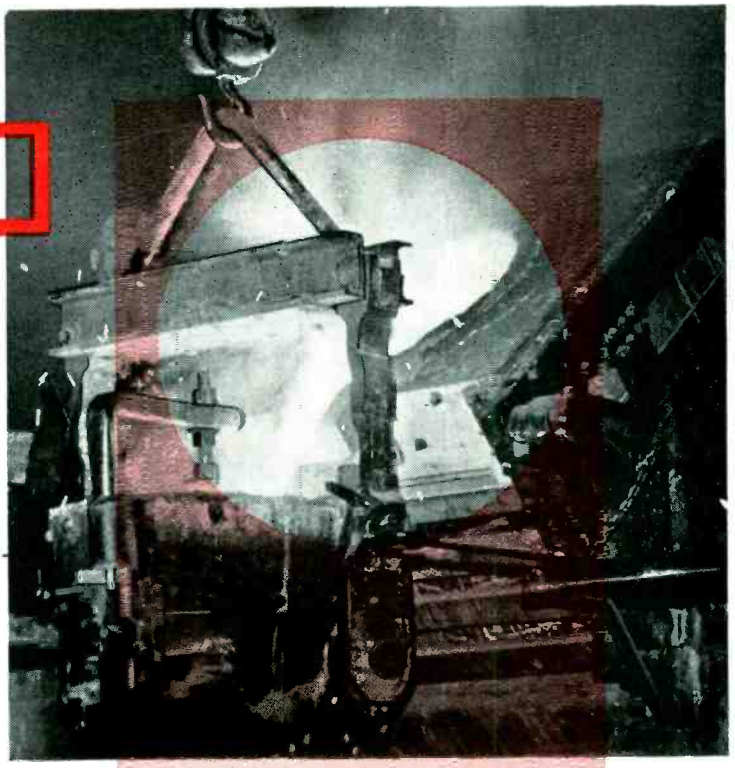

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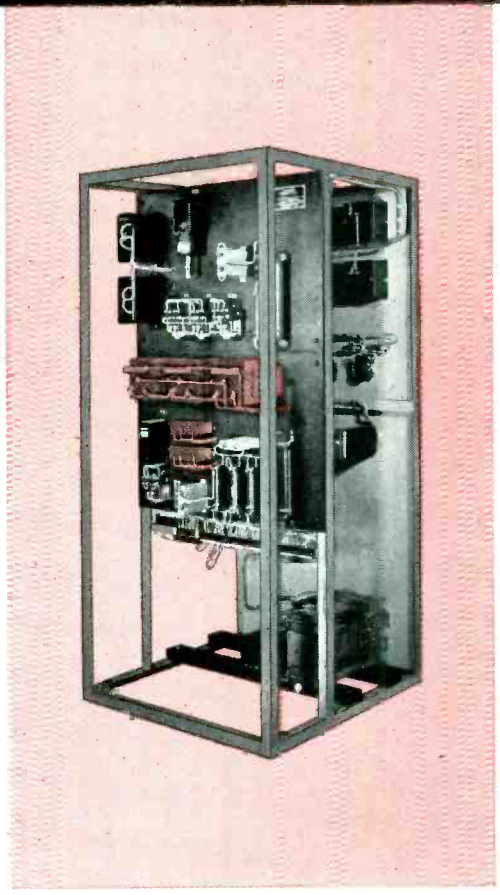

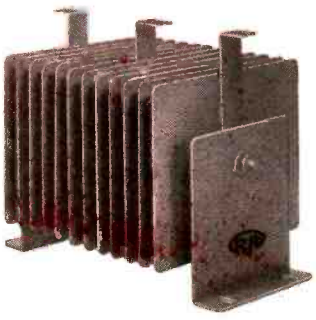

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that is then filtered in a conventional pi-section filter. Again, as in a 2-to-1 ratio autotransformer, the primary and secondary will each supply one-half the current to the load through the respective contacts, thereby permitting greater current-handling capabilities.

Once the vibrator is in motion, the driving coil is operating between a 6 and 12 volt potential or actually across 6 volts and therefore a standard 6-volt vibrator is used. When the unit is first turned on, the vibrator reed is essentially at ground potential and there will be 12 volts across the driving coil but this will only be of a 0.01 to 0.02 second duration until the reed engages the main power contacts and will not harm the vibrator. The vibrator used is a heavy-duty tandem type that has four opposing sets of contacts and the load current is therefore divided equally across all four sets.

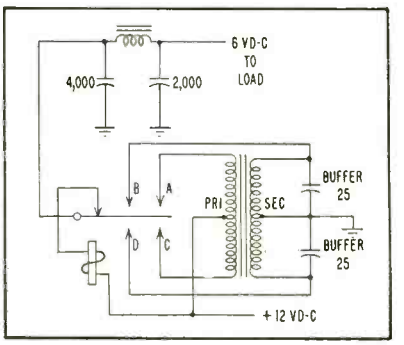

FIG. 1—Basic circuit of 12-to-6 volt converter

The next problem was that of developing a complete mobile system that would operate from either a 6 or 12 volt source. It did not appear too difficult to produce a unit to work off both voltages by changing taps on the transformers and rearranging jumpers, but there would always be the danger of plugging into an incorrect voltage, resulting in serious damage to the radio. For this and other reasons, it was desirable to have a unit which would work interchangeably from either voltage without making any such modifications.

With this goal in mind, a split-reed vibrator was developed that has two independent interrupters within a single envelope, driven by a common driving coil to give a

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completely interchangeable 6-12 volt set.

The basic circuit of the new 6-12 volt unit, shown in Fig. 2, consists of a power transformer with two separate 6-volt vibrator primary windings. Each winding has its own independent reed, but the two reeds are ganged together to operate in synchronism. This arrangement permits operating the windings either in series or in parallel as required. The proper connections are determined in the primary power plug.

Assume that the vibrator reed is in the upper position. With a 6-volt primary source as shown, the input currents will be in the directions indicated by the solid arrows. Separate currents will be fed from

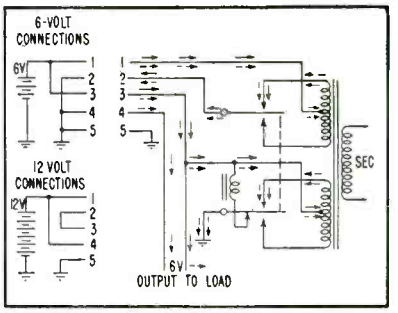

FIG. 2—In final model of converter connection to wrong voltage is avoided by wiring of power plugs

the battery to the two primary windings, but each will be in phase, aiding. The same action will take place when the reed is in the lower position, but the currents will be through the lower halves of the windings in the reverse direction.

The filaments, relays and other 6-volt elements are connected in a series-parallel, 6-12 volt arrangement with a common bus in the center. When operating from 6 volts, the two outer buses are grounded and the center bus is fed directly from the battery. The lower bus is permanently grounded but the top bus is grounded in the power plug.

When a 12-volt cable is connected to the systems, the upper and lower primary windings are placed in series by the jumper across pins 2 and 3 in the power plug. If the reed is again in the upper position, the primary current will now be in the direction indicated by the dashed arrows. The current is still,

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	F-125 DIA. ROD .250" ±.015"*	F-214 DIA. ROD .330" ±.020"*	F-429 WIDTH .725" ±.025" THICKNESS .125" +.030" −.000"
LENGTH	PART NO.	PART NO.	PART NO.
7.520 ± 7/32	1	6	11
6.250 ± 3/16	2	7	12
5.300 ± 5/32	3	8	13
4.625 ± 1/8	4	9	14
4.100 ± 1/8	5	10	15

*Camber .011 per inch

BASIC TOROIDAL MEASUREMENTS

Initial Permeability μ_0 (1Mc)	125
Figure of Merit Q (1Mc)	400
Loss Factor $\frac{1}{\mu_0 Q}$ (1Mc)	.000020
(5Mc)	.000050
(10Mc)	.000130
(20Mc)	.000500
μ_0 vs Frequency Characteristics	Good to over 30 Mc
Q vs Frequency Characteristics	Good to over 30 Mc
Curie Temperature (°C)	350
Temp. Coeff. of μ_0 (1Mc) %/°C (25°C to 70°C)	+0.10 max.
Temp. Coeff. of Q (Same units as above)	−0.75
Saturation Flux Density	
Bs (gauss) at Hdc = 25 oersteds	3300
Max. Permeability μ max	400
Coercive Force H (oersteds)	2.10
Residual Magnetism Br	1800

TYPICAL ANTENNA ROD MEASUREMENTS

FREQUENCY	Q	C = mmf.
0.6	310	360
0.8	331	200
1.0	325	126
1.2	325	85
1.4	310	63

TEMPERATURE COEFFICIENTS

Antenna Rod No. F-214 (.330 x 7.520"). Standard Test Coil—Space wound solenoid 85 turns #26 AWG, Formex copper, occupying approx. 90% of length of rod and centered on rod. (Resonates at 1 Mc. with 126 mmf.)

$$TC = \frac{\% \Delta \mu_0}{\mu_0} \quad (25° \text{ to } 75°C)$$

Temp. Coeff. of Rod. +1.0 to +2.0
Temp. Coeff. of Coil only = 0

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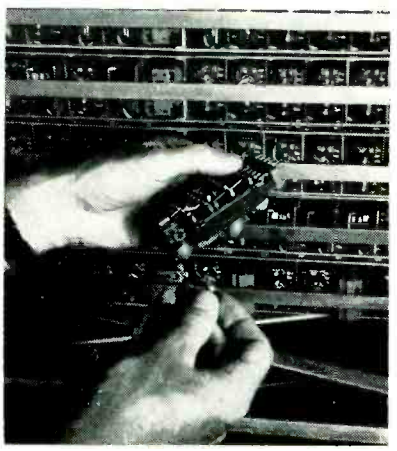
however, in the same direction through each winding, that is, in phase, aiding.

Also, since the 12-volt input is divided equally across halves of both the upper and lower windings, each half will still be operating from 6 volts and the same number of ampere-turns will exist, producing the same secondary voltage. The 12-volt input is also connected to the top bus of the filament and relay arrangement supplying power to all the 6-volt elements. The center bus is connected to the center junction of the two transformer primary windings.

This connection offers an advantage. With the windings connected in series, the unit acts as an autotransformer in much the same manner as the 12-to-6 volt converter, producing 6 volts at this junction. It is therefore not necessary to have a balance between the 6 and 12 volt sides of the filament arrangement. Any unbalance will be supplied by the autotransformer action of the primary windings. This means that power wasting voltage dropping resistors are no longer neded in series with the odd

Tradic Computer Uses Transistors



Miniature electronic brain in the form of a digital computer has been developed by Bell Labs particularly for aircraft flying at supersonic speeds. It uses transistors to cut electric current drain and generates practically no heat. Preproduction memory package shown above is plugged into computer that employs nearly 800 transistors. The name Tradic evolves from transistor digital computer

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tubes and relays. Note also that the vibrator driving coil is connected between this junction and ground. Since this bus is always at 6 volts, it is possible to use a 6-volt vibrator for either 6 or 12-volt operation.

The two vibrator halves share the heavier current load on 6 volts while on 12 volts, which is more difficult to commutate because of arcing, the contacts form a double-break circuit.

Magnetic Frequency Multiplier for Fluorescent Lighting

By E. G. Downie

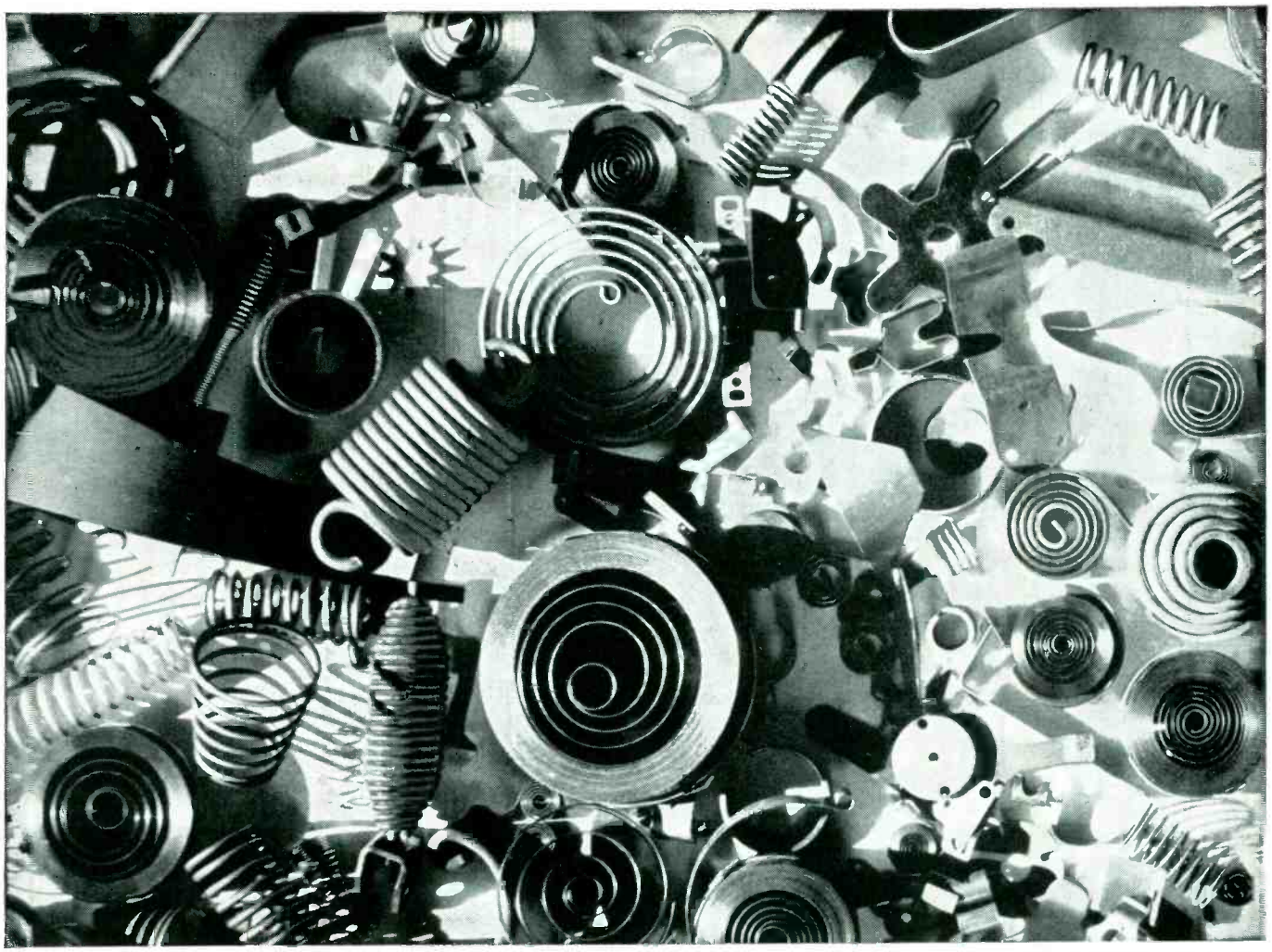
General Electric Co. Fort Wayne, Ind.

Practical operation of fluorescent lamps at frequencies higher than 60 cps requires a dependable source of power. Rotating frequency converters or motor-generator sets may be used, but they bring up maintenance problems not encountered in the usual building power distribution systems. Conversion of standard 60-cycle power to 360 cycles at a suitable voltage level and with preferred waveshape, by means of a static device presenting no more installation and maintenance problems than a distribution transformer is desirable.

The magnetic frequency multiplier is such a device. Using magnetic, metallic rectifier and capacitor components, the multiplier converts 480-volts, 60-cps 3-phase power to 700 volts, 360 cps, single phase, with automatic current limit and wide range of current control. The multiplier's square or flat-topped wave of current into a lamp load is equivalent in lamp performance to a 7,000 cycle sine wave.

The diagram shows the basic circuit used in the multiplier. There are three elements: the frequency tripler stage (60 to 180 cps), the frequency doubler stage (180 to 360 cps), and the current limiting and controlling stage.

The tripler stage is made up of six saturating transformers, a center-tapped choke and selenium rectifiers to supply saturating direct current. The transformers are



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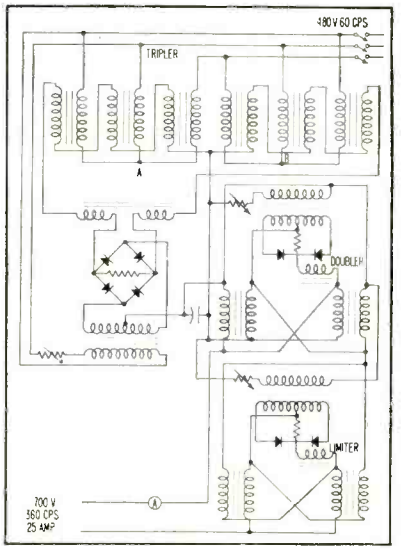
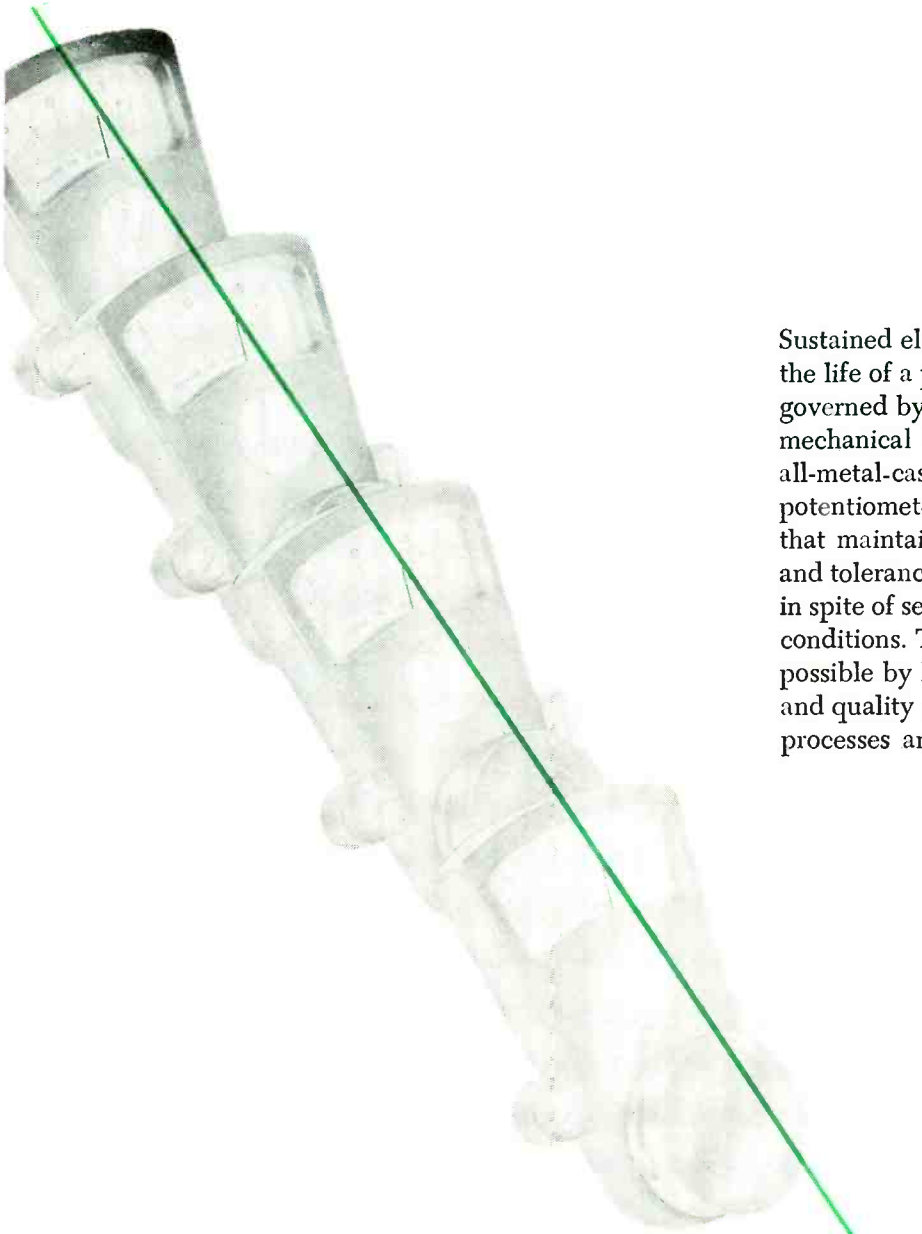
not saturated by the a-c applied voltage, but are saturated by the secondary d-c, which is many times the normal a-c magnetizing current. One core is always saturated, and the voltage at points *A* and *B* becomes successively that of the three lines. The output voltage, which is half the sum of the six secondary voltages, is a 180-cps voltage of reasonably good waveshape. A bank of capacitors at the output of the tripler stage corrects for the highly inductive loading of the following doubler stage.



Magnetic multiplier gives 700-v, 360-cps output from 480-v 60-cps input

The second, or doubler stage uses two saturating transformers, a choke reactor, and a selenium rectifier. Low voltage a-c excitation for the saturating current rectifiers is furnished to all stages by isolating step-down transformers. Operation of the second and third stage saturating circuits from the first stage 180-cps output, rather than from incoming 60-cps power, insures proper starting sequence.

As in the first stage, the transformers are not saturated by the a-c applied voltage, but are saturated by the secondary d-c which is many times greater than needed to bring the excitation over the saturation curve knee. The choke reactor keeps the d-c saturating current essentially free of alternating current components. The secondary or output voltage is equal in magnitude to the 180-cps input voltage, but by effect of the d-c saturation, switches in polarity each half



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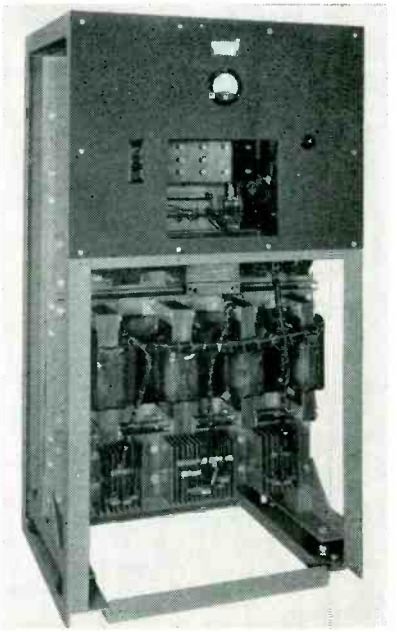


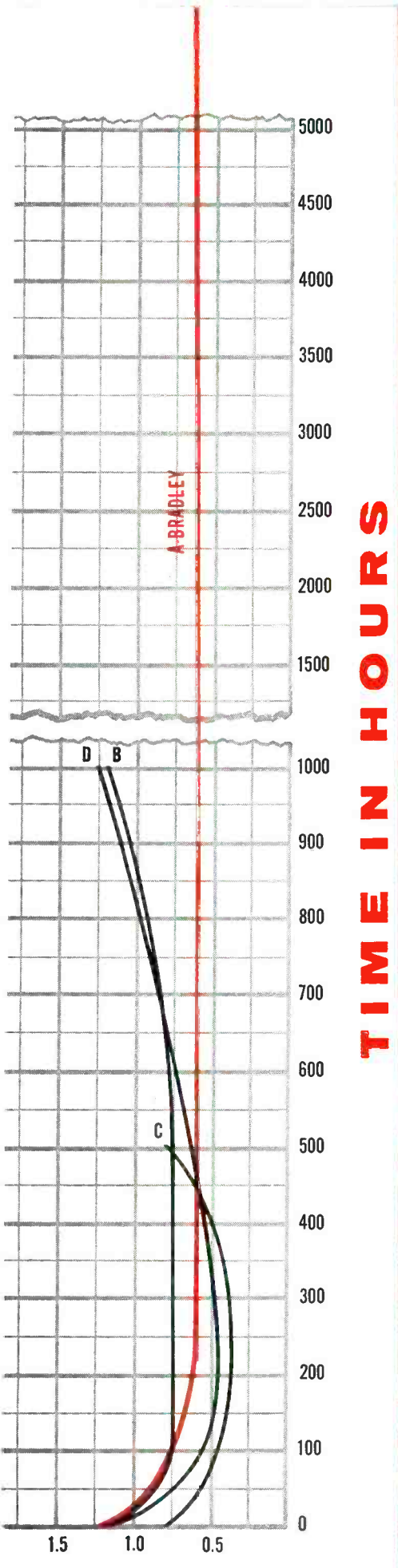
Twenty-five ampere, 700 volt output of frequency multiplier is sufficient to start 96-in. fluorescent tubes without auxiliary equipment

cycle, so that it becomes 360 cycles of peaked waveform.

A final stage is required to provide control and proper waveshape of output current for best operation of a fluorescent lamp load. This stage is a series saturable reactor designed and connected so that the windings carry a-c load current and d-c saturating current simultaneously. When the demagnetizing effect of the a-c load current overcomes the d-c saturation, the reactor windings begin to absorb voltage and prevent greater flow of load current.

Adjustment of the d-c saturating current, by varying the series resistance in the primary of the rectifier supply transformers, thus controls the output current, which has the characteristic flat-topped or square-wave shape of a series-connected saturable reactor with high control-circuit impedance. The components of this limiter stage are very similar to those of the doubler stage except that the saturating transformers have less core area.

Actual performance approximating the theoretical operation depends a great deal on the sharpness of saturation of the various saturating transformers. Manufacture of this device for sale has been made practical by the use of cold



Life test curves comparing reverse leakage of Bradley vacuum processed selenium rectifiers with units produced by different processes by other manufacturers.

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The rated continuous output of the multiplier is 25 amperes at approximately 700 volts, 360 cps in a capacitive ballasted lamp load. The current control permits adjustment of output current between approximately 13 and 30 amperes. The useful range may be limited by characteristics of the attached lamp load and multiplier continuous current rating. The output voltage is enough to start 96-in. cold cathode lamps without auxiliary means.

The efficiency of the multiplier in transforming incoming line watts to actual lamp watts at full load is 72 percent. Additional losses with power-factor correction reduce this to 70 percent. The overall efficiency of light production with the recommended lamps is approximately the same as realized from these lamps controlled by conventional ballasts on 60-cycle power.

Errata

DRAFTING and proof-reading errors appeared in two recent articles in this department. In "Transistor Amplifier Performance" by Cecil E. Williams, p 196, Feb. 1955, the capacitor across R_1 in Fig. 2 has a value of 0.5 μf; voltage gain is incorrectly designated "voltage gain in volts" in both Fig. 3 and Fig. 4 (top). Base current should be in microamperes rather than milliamperes in the center drawing of Fig. 4.

The caption for Fig. 2 of "Pulse-Series Generator", by N. T. Grisamore and G. U. Uyehara, p 224, Mar. 1955, should describe values in millimicroseconds rather than microseconds.—A. A. McK.

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DIMEN. B 1 3/16"
LENGTH 2 1/2"

HU-710
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DIMEN. B 3 3/4"
LENGTH 4 1/4"

HU-716:
DIMEN. A 2 5/8"
DIMEN. B 2 57/64"
LENGTH 2 5/8"

HU-701:
DIMEN. A 2 13/16"
DIMEN. B 3 5/16"
LENGTH 4 7/8"

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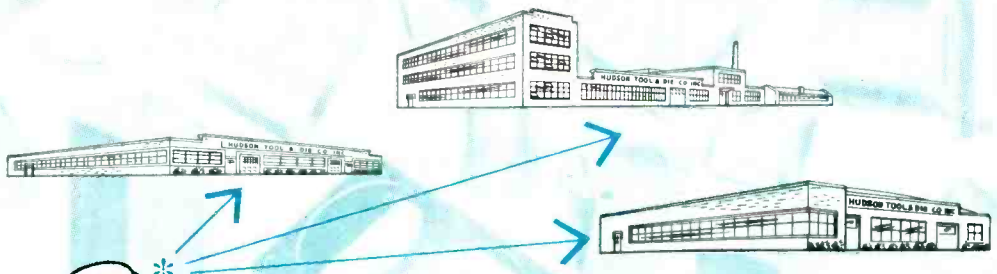

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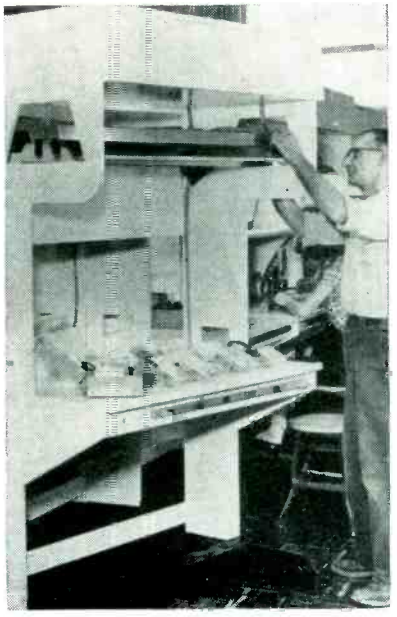
Production Techniques

Edited by JOHN MARKUS

Unitized Production Benches Facilitate Assembly-Line Changes

Seven-bench assembly line using unitized design. Each worker has own fluorescent fixture with two 4-foot lights, storage compartment above fixture and plywood box on floor alongside chair for tote boxes. Utility connections are on ceiling



Construction of bench. Two may be placed back-to-back if desired. Fluorescent fixture gives ample illumination

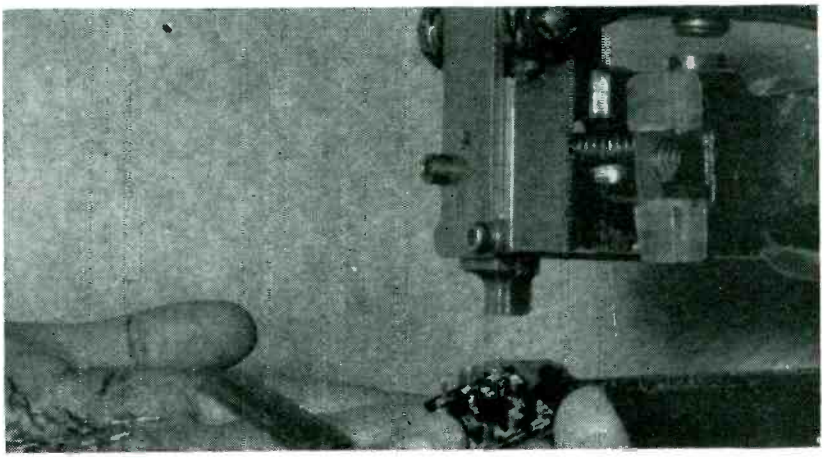
INDIVIDUAL production-line tables designed by engineers of Assembly Products Inc., Chesterland, Ohio are equipped with built-in lights, electrical plug-mold and air connections. The single-worker tables are easy to move and have simplified utility connections. They are currently used in assembling panel meters, indicating pyrometers and automatic controls. The universal design facilitates changes.

Wishbone-Shaped Soldering Staples Save Space on Panels

WHEN the Lenkurt Electric Co. of San Carlos, Calif. began producing a new type of miniaturized carrier equipment for the first time, the soldering staples for phenolic boards had to be miniaturized. Insertion of the staples in boards was being done with a machine manufactured by the Acme Staple Co. of Camden, N. J. The standard staples were improperly shaped and much too big for the new subassemblies because after insertion, the staples were shaped like inverted pyramids with wide loops at the top. The staples also took up too much space at the base where they were fastened to the board.

Since no staples were available in the shape or size needed, the problem was solved by a Lenkurt industrial engineer who redesigned the driving mechanism of the stapling machine and made a die to reform the staples into a different shape before use.

The staples now are reformed into a shape somewhat like a chicken wishbone. When fastened in the phenolic boards, the bases of



New staple-type terminals permit miniaturization of subassemblies

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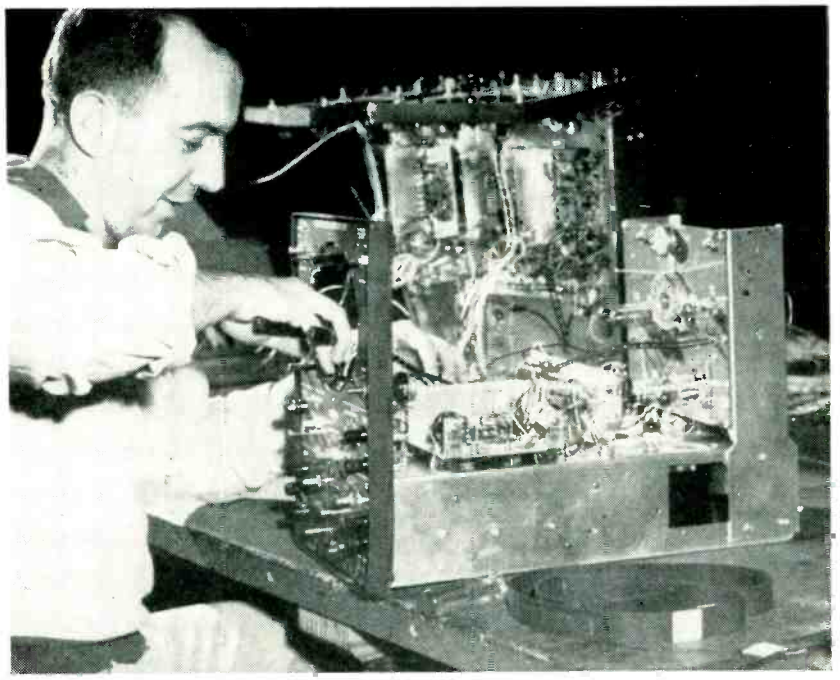
the staples are small enough that they can be placed close together in both directions. The portion of the staple protruding from the board is now straight and narrow, so that minimum space is needed at both the top and bottom. The new staple is also easier to wire or solder than the previous staples.

Rubber Band Protects Panel Finish During Assembly on Bench



A SIMPLE method of preventing instrument cabinet panels from having their edges scratched or chipped during production is in use at the Instrument Division plant of Allen B. Du Mont Laboratories, Inc., Clifton, New Jersey. Large strips of rubber are stretched around the panel edges in rubber-band fashion, held in place by the rubber's elasticity.

Bands are made up in correct sizes for various products by cutting strip rubber to the required lengths and cementing the ends together with auto inner-tube patches.

Large rubber band protects panel of cathode-ray oscilloscope during assembly

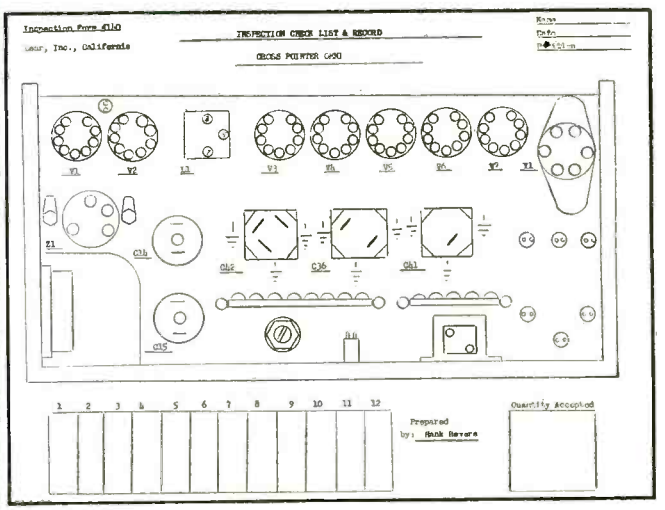
Pictorial Inspection Records Expedite Flow of Quality Data

By FRANK H. SQUIRES
Quality Manager
Lear, Inc., LearCal Division
Santa Monica, Calif.

A WORKSHEET for electronic assembly inspectors should accomplish the following objectives: (1) Serve as a simple check list for the inspector; (2) indicate at a glance the number of defects, the nature of the defects and their location; (3) become an easily maintained record or history sheet. These requirements are met by pictorial inspection records, which have outlines of electronic assemblies on which the soldered connections and components are clearly indicated.

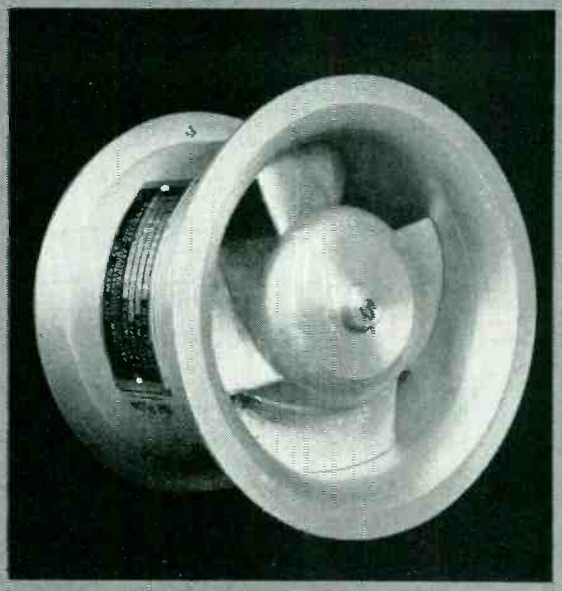
To simplify the inspector's job

Method of marking pictorial inspection record to show defects



Example of inspection record for cross-pointer omnichassis

From VERY SMALL ... to LARGE CAPACITY



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are available to meet any ELECTRONIC COOLING NEED

Joy AXIVANE Electronic Cooling Fans are expressly designed to meet the needs of this exacting field of service. They are built in a complete range to suit any requirements, such as: spot cooling of ventilated units where local high-temperature conditions arise; heat removal from pressurized or hermetically-sealed units; or heat removal where space is so restricted that natural ventilation through the unit or over its surface is insufficient. Important operating advantages of these fans are their strength, high resistance to shock and vibration, and efficiency in low or high-pressure service. Aluminum and magnesium construction keeps weight at a minimum.

Available in sizes from 2" I.D. up, these Joy Fans are built to meet all present Air Force and Naval electronic specifications. They can be furnished with totally enclosed or explosion-proof motors, if desired.

In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units.

If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY'S experience as the world's largest manufacturer of vaneaxial-type fans. ● Write ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada; *Joy Manufacturing Company, (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

W&D 1 5375

JOY

WORLD'S LARGEST MANUFACTURER OF VANE-AXIAL FANS

of describing defects, the twelve most common causes for rejection are coded 1 to 12, and 12 columns or boxes are provided on the pictorial record for recording them. An additional box is provided for recording the number of units inspected.

Method of Marking

In daily use the inspector makes a check mark in the number-inspected box as each unit is inspected, checks the appropriate box as discrepancies are found and also makes check marks in red at the points on the outline where they occur.

Each pictorial is good for one assembly for one day. Thus, at the end of the day, or at any moment during the day, it will indicate: (1) number of units inspected; (2) number of discrepancies found; (3) quality level in average defects per unit; (4) which discrepancy occurred the most frequently; (5) where the discrepancies occurred (indicated by the clustering of check marks at various points on the outline).

Most effective is the line of 12 boxes in which check marks for discrepancies accumulate. This easy-to-read frequency distribution is a constant stimulus to corrective action. It is a sensitive indication of the quality of workmanship, and production supervisors look to it for prompt indications of change.

Use of Reports

The information which is being generated at every inspection station on the line is collected and consolidated into a summary for management. In the journey from line to front office it reaches into every part of the organization where a knowledge of product quality is required.

The pictorials are seen by:

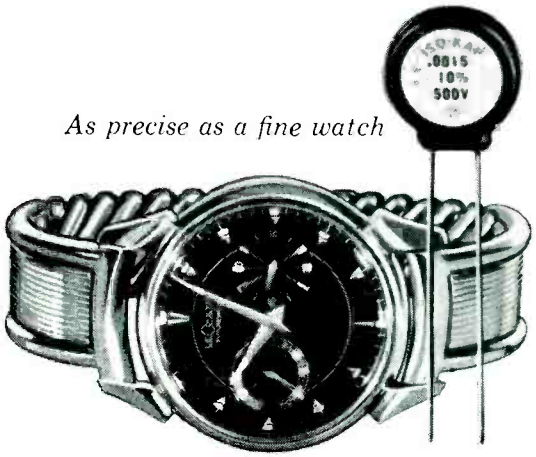
(a) Production group leaders, who learn at a glance what defects are occurring most frequently and where.

(b) The supervisor of assembly line inspectors, who keeps an eye on the pictorials throughout the day and combines all of them into one bundle at the end of the day. He

ANOTHER CENTRALAB FIRST!

NEW ISO-KAP*

Molded Disc Ceramic Capacitor



As precise as a fine watch

Nothing else like it! The only molded, *completely* insulated ceramic disc capacitor. Not merely a dipped covering—breakdown to ground in excess of 3000 V.D.C.

Highest mechanical strength. One-piece construction is unaffected by extremes of vibration; by ozone, salt water, or any known acid or solvent at room temperature.

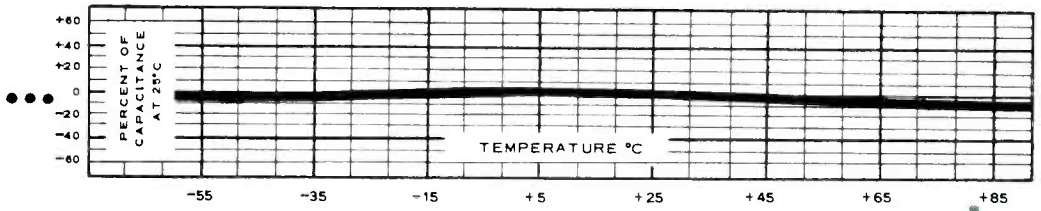
Mechanically accurate. Thickness, diameter, and lead spacing are always exact. And leads are always on perfect center line—never offset. The answer for automatic assembly.

Highest dependability. New basic ceramic body. Capacitance characteristics are virtually flat over a wide temperature range (see graph).

Highest lead strength. Above the tensile strength of No. 22 wire itself. Leads can't pull out.

Easiest identification. Clearly labeled to avoid confusion and mistakes. Stamped with capacity, voltage rating, and tolerance.

TYPICAL ISO-KAP CURVE



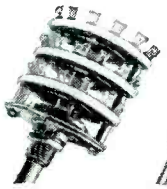
Get detailed facts that help you visualize Iso-Kap's exciting possibilities. Write for engineering bulletin EP-48.

More proof that if it's a job for electronic components, it's a job for Centralab

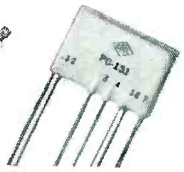
Centralab's advanced engineering continues to create the prototypes of the components industry

Volume Controls

Capacitors



Switches



Printed Electronic Circuits

Ceramics

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie.

D-556

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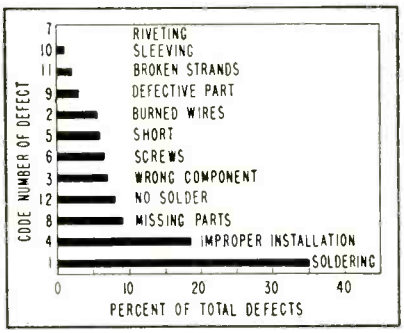
scans them for any unusual deviations and advises the production general supervisor that the situation is normal or that there is trouble on a particular product or in a particular area.

(c) The production general supervisor, who gets the combined bundle at the end of the day, together with the inspection supervisor's summary. If there is trouble, the pictorials pinpoint the exact location.

(d) The quality control engineering office, where the pictorials are analyzed daily. The tabulation shows average defects per unit for all products and average defects per unit on particular products which are being watched.



Relative frequency of defects, as obtained from inspection records over 1-month period

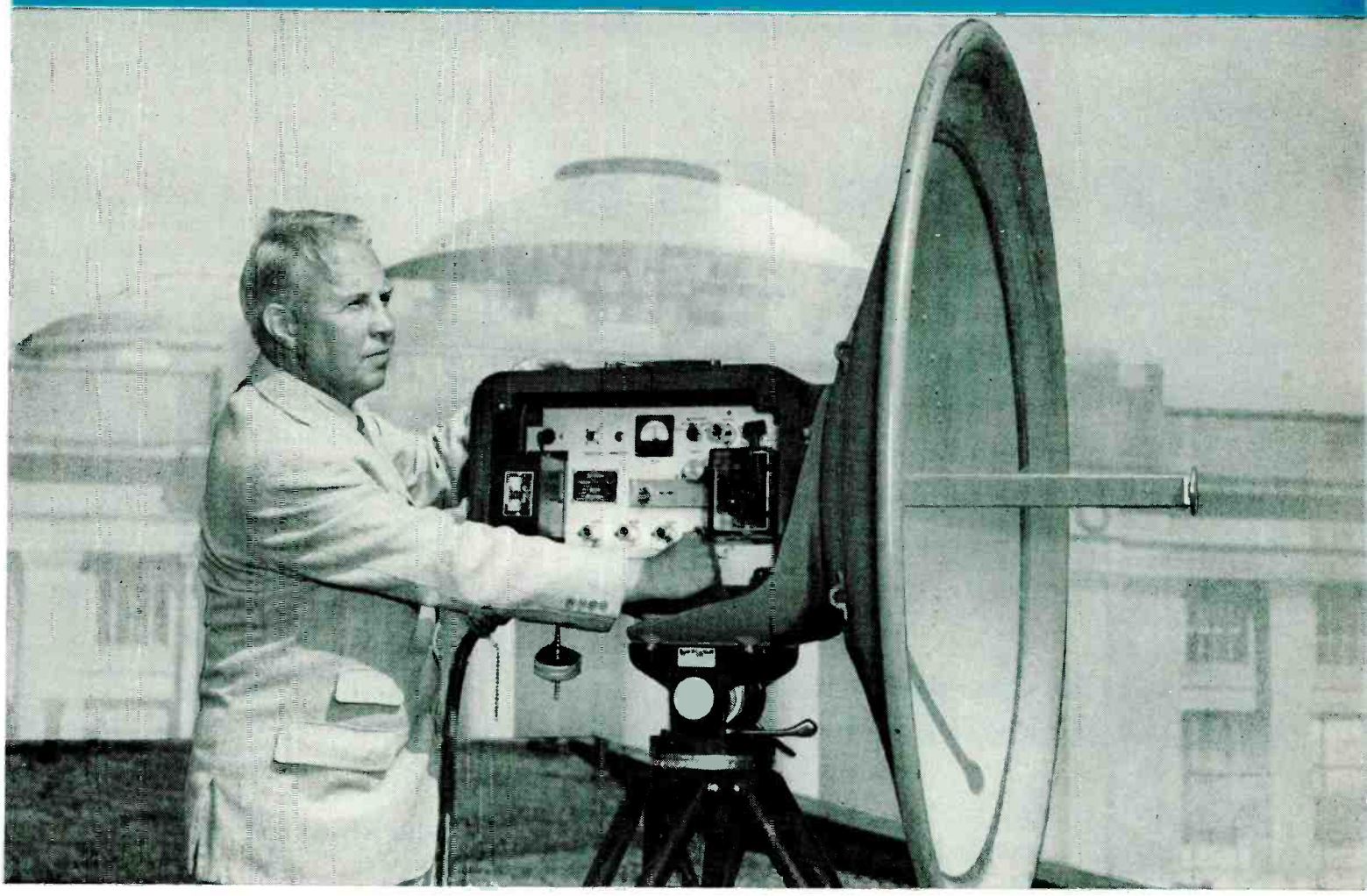
(e) The quality manager, who develops the weekly quality report from the analyzed pictorials and other inspection records.

(f) The general manager and all department heads, who receive the quality report routinely.

(g) The entire personnel of assembly, to whom their original data comes back condensed to a point plotted on the quality curve.

The pictorial was originally meant to be no more than a useful inspection technique; it has, however, become the nucleus of an effective communication system. Each check mark made by an inspector is, as it were, one drop in a stream of information which collects from every point along the assembly lines and flows to top management informing everyone in its course. The analyzed summary, which returns and is posted as a point on the quality curve, closes a circular path of com-

Raytheon – World's Largest Manufacturer of Magnetrons and Klystrons



Arthur W. Richardson, Chief Engineer, Station WGBH-TV, Boston, Mass., at station's Raytheon KTR-100 microwave relay which transmits picture and sound simultaneously.

More than 75 TV stations using this equipment for STL, remotes, and network intercommunication have proved the performance of the 5976 Klystron.

Color TV relay uses Raytheon 5976 Klystrons

The new, compact Raytheon KTR-100 microwave relay is a good example of the use of the long-life Raytheon 5976 in regular and color TV relay equipment. This reliable Klystron has also been selected for additional applications by other leading manufacturers–for these five reasons:

Over 22,000 hours of life–many users report more than 22,000 hours (over 2½ years) of continuous service.

Low temperature coefficient–temperature need not be held to close tolerance. No forced air cooling.

low power requirements–only 300 volts at 25 mA. Easy to install.

Low initial cost–lowest cost Klystron in its class. Immediate delivery in any quantity.

Low maintenance cost–long life means absolute maximum of trouble-free operation . . . ideal for isolated installations.

Condensed Operating Data—5976 Klystron

	3¾ Mode	2¾ Mode
Power output	110 mW av. (6750 Mc)	150 mW av. (6750 Mc)
Frequency range	6200-7425 Mc	6200-7425 Mc
Reflector voltage	–78 to –158 Vdc	–200 to –285 Vdc
Resonator voltage	300 Vdc	300 Vdc
Current	25 mA	25 mA
Modulation sensitivity	1.0 Mc/v	0.5 Mc/v
Temp. coefficient	–.10 to +.10 Mc/C°	–.10 to +.10 Mc/C°
Pulling figure	0.2% of operating freq.	0.1% of operating freq.

Write for valuable Data Booklets on Raytheon Magnetrons and Klystrons, including the stable, reliable 5976. Our Application Engineer Consultation Service is also available to you without cost or obligation. Call us when you have a microwave tube problem.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PL-21

WALTHAM 54, MASSACHUSETTS

munication back to the line.

The communication can be conceived of as flowing round the circle at an irregular or spasmodic pace according to the varying quality of the work and the relative urgency of management's reaction. It follows a uniform rate of flow only when the quality is maintained at a high level.

Much useful information has been obtained from the analysis of the pictorial inspection records. The predominance of soldering defects over other causes for rejection was demonstrated most emphatically by the bar chart shown in the illustration. The reaction was to set up a soldering school for new operators and for those whose work fell below the minimum quality levels.

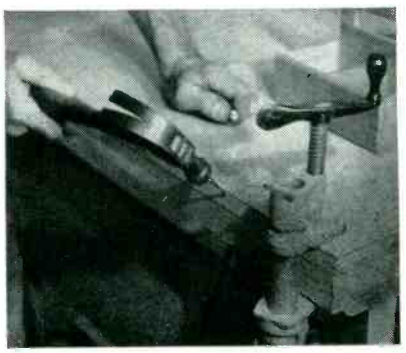
Inspectors and producers meet in conference periodically to discuss the progress of quality revealed by the pictorial summaries. Comparisons are made and competition between groups is stimulated.

The pictorial helps to build quality into the product by making quality information readily available to all levels of the organization.

Formica Bench-Tops Reduce Rejects

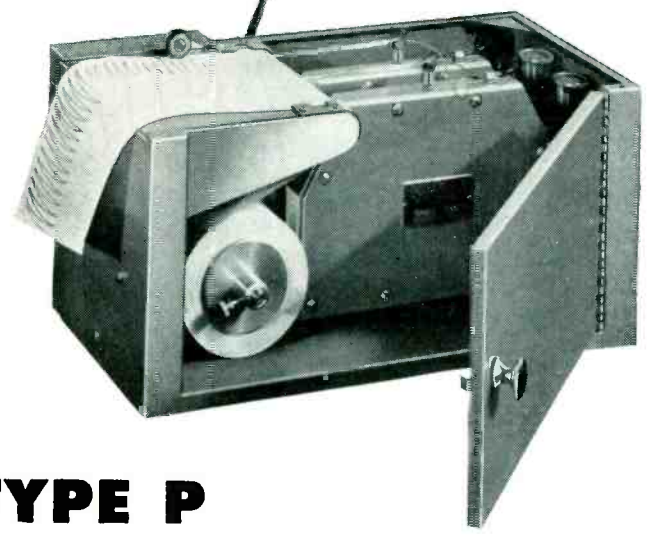
USE OF GLOSSY, easy-to-clean Formica panels as tops for assembly benches has paid for itself in improved quality of product and reduced rejection rate during assembly of precision potentiometers in the South Pasadena, Calif. plant of Helipot Corp.

The benches are made in the



Method of anchoring Formica-faced plywood bench top to wood frame

NEW

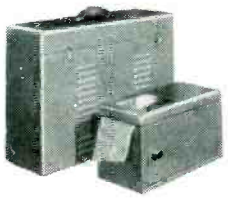


. . . 15 Microvolts D-C Sensitivity

. . . Absolutely Stable

. . . Complete Versatility

NEW...OFFNER TYPE P
PORTABLE DYNOGRAPH



This high speed, direct writing oscillograph recorder provides exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type gauges without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph are made possible by the exclusive, patented chopper amplifier. It is used for recording a wide variety of transient variables, such as strain, vibration, temperature, analog computer write-out, etc.

The performance specifications of the Type P Portable Dynograph are identical with those of the Type M Console model, but it is mounted in two convenient carrying cases as illustrated. The Type P is available with one or two channels.

Check these exclusive features:

Speed plus sensitivity. The Dynograph gives you the maximum in speed and sensitivity—15 microvolts d-c per millimeter deflection with a response speed of less than 1/120th second.

Large easy to read records. Over 8 cm excursion, permitting the recording of large dynamic variations. Chart speeds 1 to 100 mm per second.

Absolute non-drifting stability. The Dynograph is absolutely stable and non-drifting—it is stable when it starts working and has *absolutely zero* base line drift.

No Hysteresis. The high-torque movement always returns the stylus to the base line—even with the paper stationary. Linearity is within one percent for four cm.

Compare and you will select the Dynograph

Write for your copy of Bulletin L-742. It gives you complete details and application information on both portable and console models of the Offner Dynograph.

OFFNER ELECTRONICS INC.

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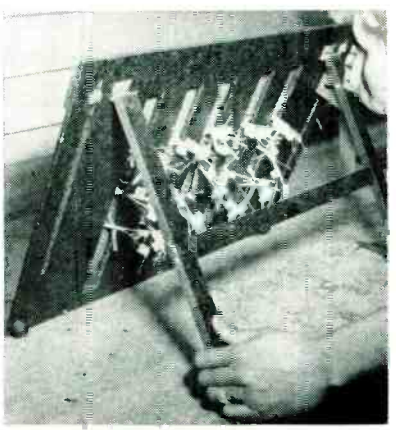
plant's own carpenter shop. The bench frame is constructed conventionally, the Formica-faced plywood is clamped to the frame and the plywood is then anchored in position by toeing finishing nails through the backing into the framework. Wood or metal trim is then applied to the edges, much as for kitchen counters, to complete the bench.

Universal Holding Jig for Terminal Boards

ASSEMBLY of components on standard turret terminal boards is expedited in the Baltimore plant of The Glenn L. Martin Co. by use of a jig that holds six boards at a time at the optimum working angle. The empty boards are inserted in

Method of using universal fixture for holding component boards. External leads for first board are in front at left, but corresponding leads for other boards project behind through slots



Rear view of fixture, showing method of attaching legs. Wing nut for adjusting angle of legs is near right hand of operator

COMMON CHARACTERISTICS OF ALL TYPE 2131 GEARED MOTOR GENERATOR UNITS

O.D. of Case.....1.000 inch
Case Length.....3.301
Weight.....7.5 ounces
Frequency.....400 cycles
No. of Poles (Motor).....6
*No Load Speed (Min.).....6500 rpm
Rotor Inertia.....1.1 gram-cm²

*Motor Speed at input to gear train

NEW
integral gear head in small servo motors

OUTSTANDING FEATURES OF TYPE 2131 GEARED MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt–115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2028	Motor Generator

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. An unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

INPUT PER PHASE ONLY 1.8 WATTS

ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2131 GEARED MOTOR GENERATORS

			MOTOR			GENERATOR		
TYPE NO.	EXCITATION FIXED	EXCITATION CONTROL	INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration At Stall	EXCITATION FIXED	INPUT	OUTPUT PER 1000 rpm
2131-0411110	26	26	2.3	0.4	25600	26	1.8	.51
2131D-0412120	26	26	4.0	0.6	38500	26	2.2	.68
2131D-0413120	26	26	1.8	0.3	19200	26	2.2	.68
2131-0460600	115	115	4.0	0.6	38500	115	2.6	1.00
2131-0463600	115	55	4.0	0.6	38500	115	2.6	1.00
2131-0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

Latest catalog and/or complete specification drawings will be sent upon request.

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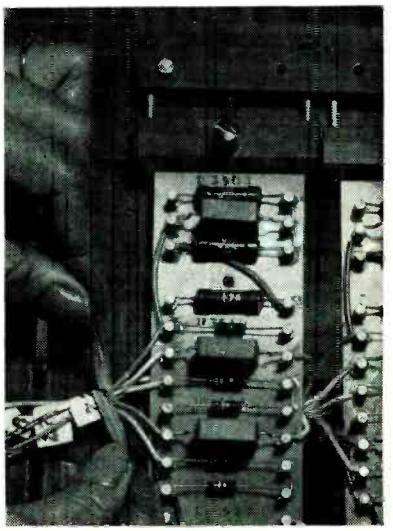
recesses at the bottom, then pushed down into spring-loaded holding pieces at the top. The six top clamps are mounted on a single strip of pressed wood that is held in position by bolts with wing nuts. This upper strip can be moved up or down to accommodate different lengths of terminal boards, by loosening the wing nuts so that the bolts can slide in the vertical slots of the fixture panel.

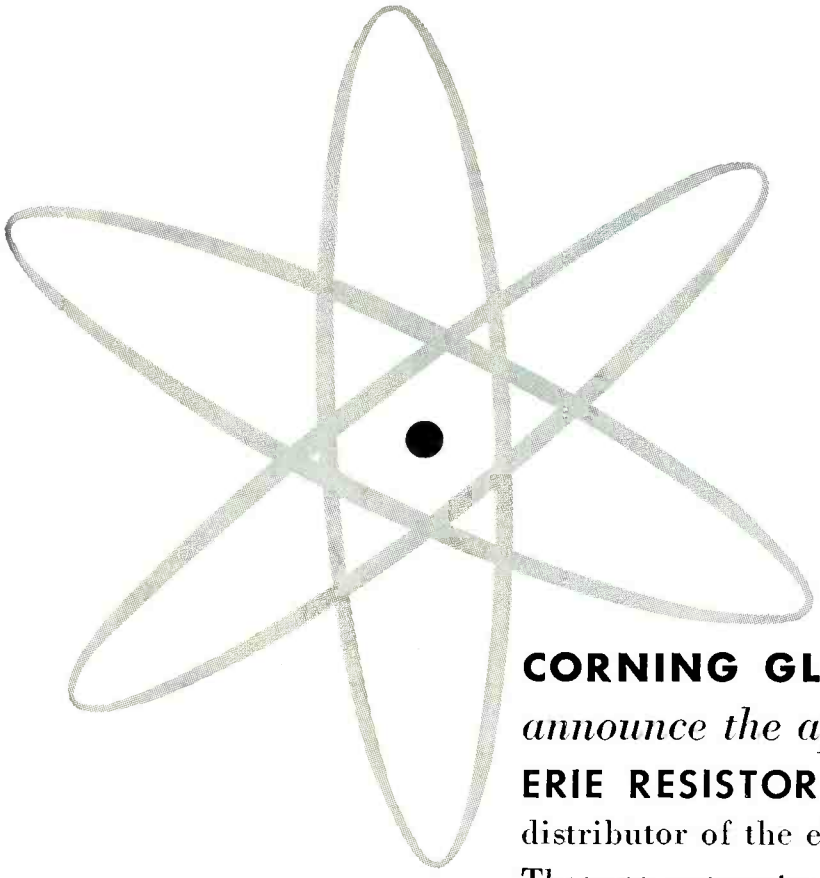
Five other slots, each about 1 inch wide, are also cut in the panel, directly behind the spaces between terminal boards. These allow the operator to push connecting leads behind the panel where they do not interfere with the wiring of adjacent terminal boards.



Method of tying leads together in groups with wire-reinforced paper tape

Hinged legs made from half-inch pressed wood hold the fixture up on the bench. The angle of support can be changed by loosening a wing nut on a bolt going through one leg.

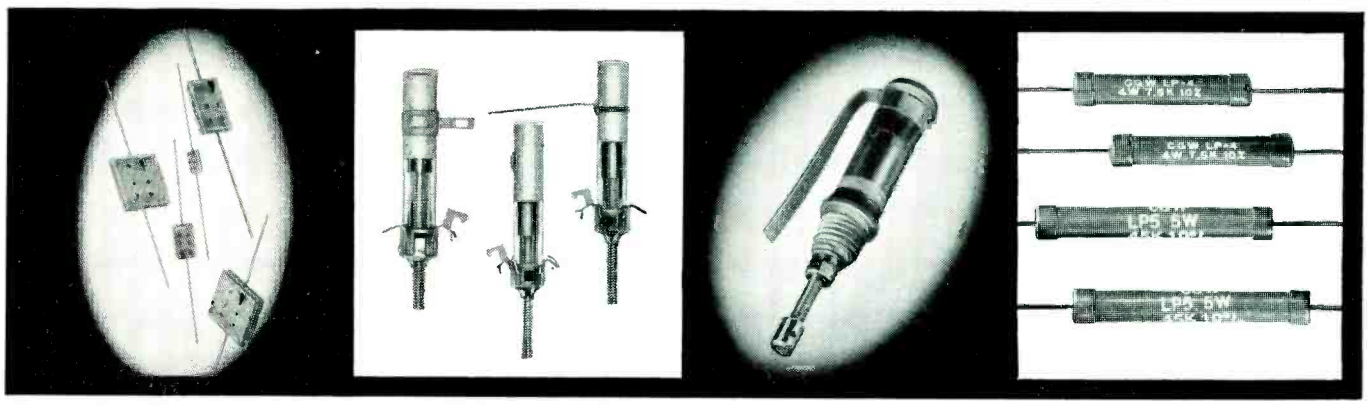
Wires projecting from the boards are held together temporarily in three logical groups per board with wire-reinforced paper pieces known as Wire Ties, made by H. F. Hanscom and Co. This tape is similar to that used by gardeners for tying plants to stakes. A single twist suffices to hold the tape around a group of leads, permitting easy removal later. The same tape is used throughout the plant in various precut lengths, for temporary grouping of leads in the many cables used in



CORNING GLASS WORKS *is pleased to announce the appointment of the* **ERIE RESISTOR CORPORATION** as a stocking distributor of the electronic components listed below. These components are available for immediate delivery through authorized ERIE distributors in the United States and Canada

ERIE electronics

For information and prices, write, wire, or phone Erie Resistor Corporation, 644 West 12th St., Erie, Pa., or your Erie Distributor.



Corning Fixed-Glass Capacitors
CY10, CY15, CY20 and CY30
300 and 500 VDCW
Corning Fixed-Glass Capacitors for extreme miniaturization, strength, stability.

Corning Midget-Rotary Trimmer Capacitors. Wide mounting variety in range from 1-12.0, 1-8.0, 0.3-3.0 mmfds. Accurate. Economical.

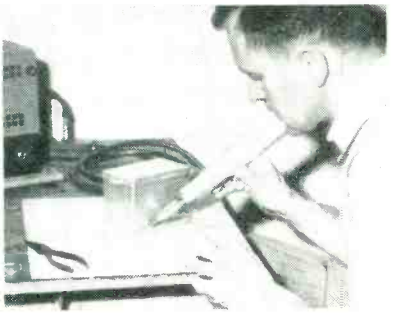
Corning Direct-Traverse Trimmer Capacitors. For critical applications where you need an absolutely smooth capacitance curve even under extremely variable ambient temperatures.

Corning Low-Power Resistors
LP4—4 Watt, 200-40,000 Ω
LP5—5 Watt, 200-45,000 Ω
Corning Low-Power Resistors give you the highest resistance range of any low-power resistors available.

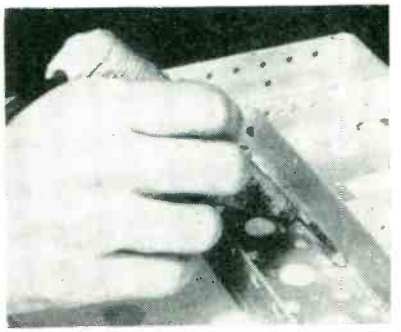
CORNING GLASS WORKS, Corning, New York
New Products Division
Corning means research in Glass

the Matador guided missile and in other electronic equipment for aircraft.

Ultrasonic Soldering Tools



Obtaining hermetic seal on aluminum housing with ultrasonic soldering tool

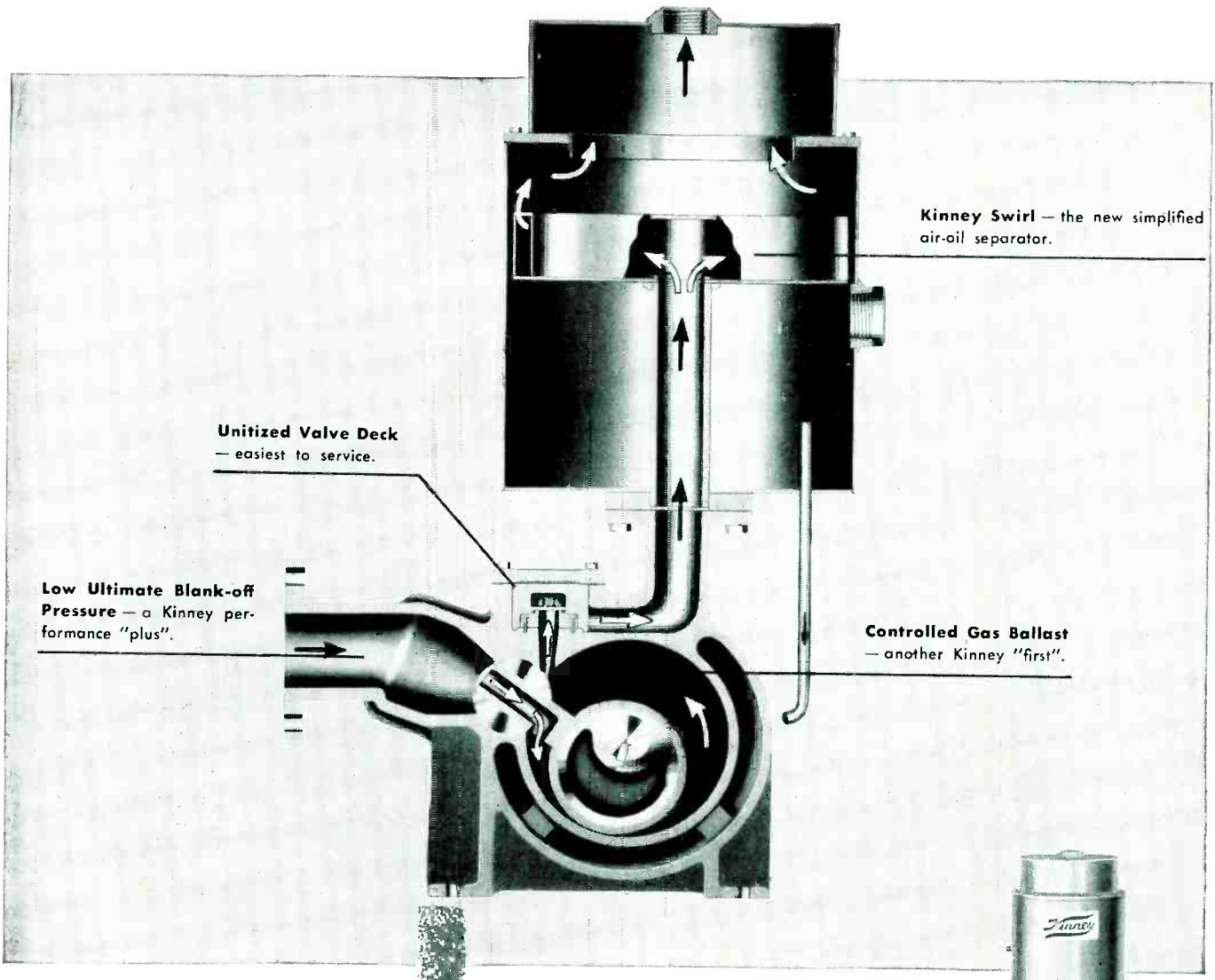


Using hand-held ultrasonic soldering tool to achieve continuous bonding of aluminum shield to chassis

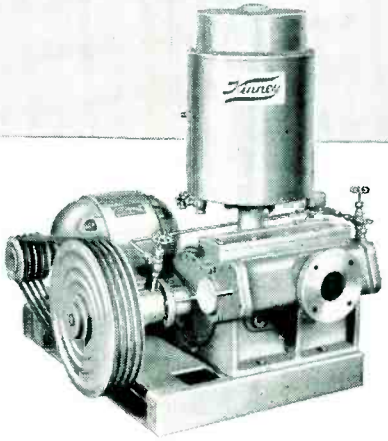
ULTRASONIC soldering provides a simple and inexpensive method of grounding an aluminum chassis, even after the parts have been anodized or alodized. The chassis sections are grounded by soldering a small fillet at the intersection of the pieces. This can be done readily with a hand-held Sonobond ultrasonic soldering unit.

In the assembly of electronic tubes, the copper wires on the base of the tube can be soldered to silver-plated pins without the use of flux. The possibility of subsequent corrosion is thus eliminated, and the operation can be completed in the short time of about 3 seconds. A shallow bath of solder is supported on the tip of an inverted Sonobond unit, and the tube is placed in the bath with the pins down. The ends of the pins and wires are soldered in this way and the solder travels about ¼ inch up inside each pin.

Selection of the correct size of



the NATURAL way to get UNNATURALLY low pressures



More and more companies are coming to Kinney with their vacuum problems every day — it's the natural thing to do. Originator of the cam and piston vacuum pump, Kinney offers more mechanical vacuum pump models, more answers to the water-vapor problem, and more highly specialized vacuum experience and knowledge to help you. SEND COUPON FOR DETAILS . . . or tell us about your own vacuum problems. Consult the competent vacuum engineers in our district offices — in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles. Kinney Manufacturing Division, Boston 30, Massachusetts.

Kinney

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
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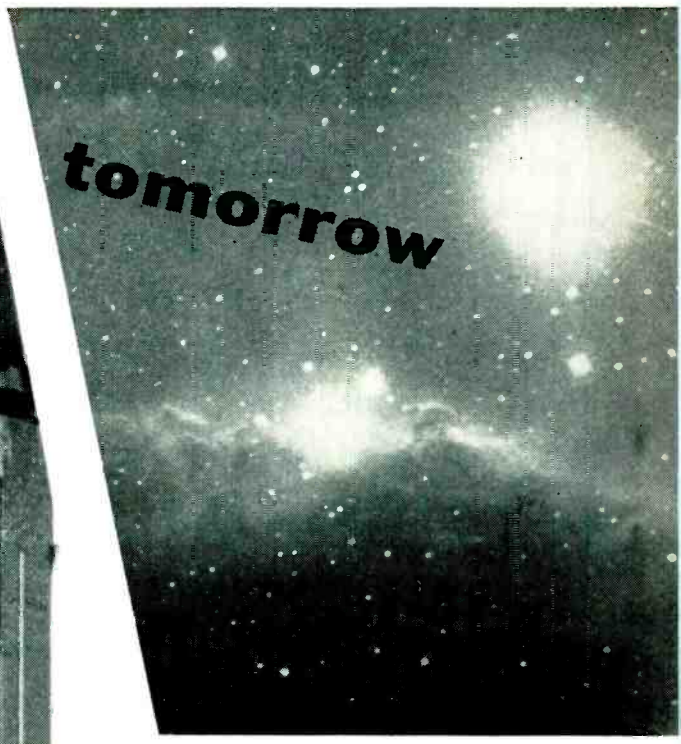
Solder pot set into inverted Sonobond unit serves for soldering tube lead wires to pins of base without flux

hand-operated ultrasonic soldering unit to suit the parts to be tinned is important for efficient production. Small hand units, ⅛ inch in diameter, are best for small wire connections and for hermetic sealing of small cans. Larger hand units are more efficient for applications where larger areas must be tinned.

In all sizes of units it is important that sufficient ultrasonic energy is delivered to the soldering tip to cause cavitation, the phenomenon which removes the oxide coatings and allows the solder to alloy with the base material.

Specially designed tips often improve the transfer of ultrasonic energy to the surface being soldered. Thus, tips shaped to fit contoured surfaces help to increase the cavitation level at the area to be soldered.

An ultrasonic soldering shop is maintained by Areoprojects Inc., West Chester, Pennsylvania, for experimental or production orders of 1 to 10,000 parts. In this way companies interested in the new process can prove its usefulness as a production method before pur-



Shown here is a giant step toward tomorrow.

Conceived and developed by a team of Martin people who have been working with Navy scientists since 1946, Viking 12 is the latest of a series of high-altitude research vehicles.

It was designed to explore the problems of controlled flight in the near-vacuum conditions of the outer atmosphere and at speeds in excess of 4,000 m.p.h.

In this long-range Viking program, technical problems are continuously being solved which support advancements that are now being made toward the next frontier of flight—rockets having intercontinental ranges.

And beyond that lies space itself!

MARTIN

BALTIMORE · MARYLAND

Use of 600-watt electric heating platen eliminates need for heating element in ultrasonic soldering head, thereby reducing its weight to 10 ounces. Aluminum, copper, brass, magnesium or silver parts placed on platen can be tinned rapidly without flux

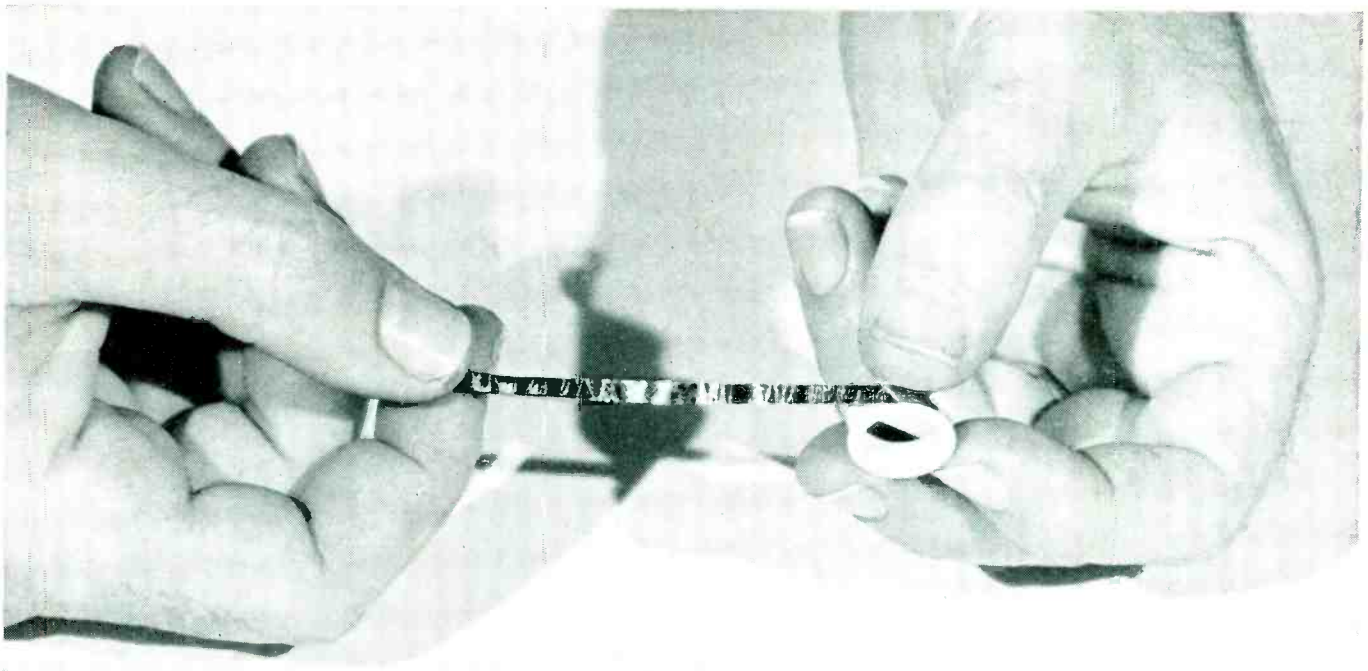
chasing ultrasonic equipment. When a company is satisfied with the process, and production methods have been worked out, it can then procure the equipment best suited to its needs and install the operation in its own plant.

Embedding Technique for Three-Tube Plug-in Unit

By Roy C. Fox
Westinghouse Electric Corp.
Baltimore, Maryland

One of the most serious problems encountered in casting circuits in plastic is removal of heat from the components, principally the tubes. Although circuits can be designed with very low plate and screen dissipations, filament power alone amounts to approximately 1 watt per tube. When three or four tubes are incorporated into a unit approximately the size of a cigarette package, the normal heat dissipation through the plastic is inadequate to maintain safe glass-bulb temperatures.

Commercially available spring tube shells were first considered for conducting heat away from the tubes. A rough calculation will quickly show, however, that the thin cross-section of these shells is insufficient to maintain an adequately low temperature gradient. The shells finally used were made



Here's the Magnetic Material that Remembers

Here is magnetic iron alloy that's high in nickel content. It is only one of the grades that Armco produces for memory cores of digital computers and reactors in servo-networks requiring a high rate of change of flux with respect to time. These are the grades available:

ARMCO 48 ORTHONIK

This grade, containing approximately 48 per cent nickel, is rolled in thicknesses of 6 mils down to ⅛-mil. It has a high degree of crystal orientation resulting in a hysteresis loop of maximum rectangularity.

Thicknesses 1 mil and less are especially useful in high-speed memory cores and reactors using high rates of magnetization. In thicknesses up to 6 mils the grade is ideal for magnetic amplifiers that must handle relatively large loads with high gain.

ARMCO 48 NI

This nickel grade offers high permeability at low and moderate inductions of 40 gaussses to 10,000 gausses. It is made in thicknesses of 14 through ⅛-mil. The heavier thicknesses are used for stamped laminations; thicknesses under 5 mils are for wound cores.

OTHER THIN MAGNETIC MATERIALS

In addition, Armco produces Thin Silicon Steels in thicknesses of 7, 5, 4, 2 and 1 mil. They are used for frequencies of 400 to 200,000 cycles per second for radio, television and other electrical devices. They offer exceptionally high permeabilities for silicon steels, low hysteresis losses for such thin material, and excellent stacking factors.

ARMCO STEEL CORPORATION
1145 Curtis Street, Middletown, Ohio

*Send me information on Armco 48 ORTHONIK and Armco 48 Ni. These are our requirements*_____

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SPECIAL STEELS

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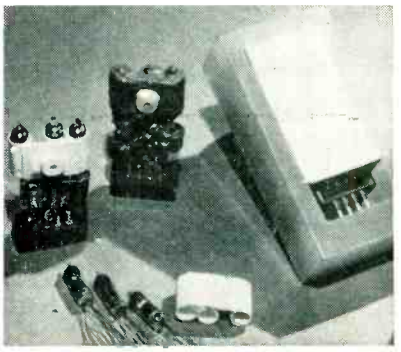
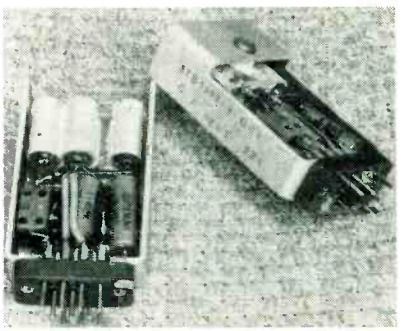
of 0.045-inch copper, silver-plated. The rigidity of these shells makes it necessary to keep the holes larger than the largest diameter permitted by tube tolerances. Conduction from tube to shell is aided by vacuum-filling the interstices with a flexible silicone elastomer material. This also minimizes large temperature gradients on the glass bulb, which would normally occur with a spring shell contacting the glass only in spots.



Special tube shell conducts heat away from three subminiature tubes in assembly, shown at upper left before and after dipping in silicone elastomer. Finished plastic-embedded plug-in unit is shown in its flexible mold at right



Metal guide-jigs serve to determine limits of space for components and act as handles during production testing

A solid brass boss welded to the tube shells serves to conduct heat out of the plastic plug-in unit to a metal bracket on the chassis. Experimental units utilizing thin tube shells yielded a temperature gradient of 73C from tube base to the end of the brass boss. The final design reduced this gradient to less than 14C.

Wiring within the cast units is direct. Most components are supported by their own leads. The tube shell assembly is held in position during wiring by a special aluminum form bracket that maintains

Now Puerto Rico Offers 100% Tax Exemption to New Industry

by BEARDSLEY RUML

"We don't want runaway industries" says Governor Muñoz. "But we do seek new and expanding industries." Federal taxes do not apply in Puerto Rico, and the Commonwealth also offers full exemption from local taxes. That is why 300 new plants have been located in Puerto Rico, protected by all the guarantees of the U. S. Constitution.

Beardsley Ruml

IN A dramatic bid to raise the standard of living in Puerto Rico, the Commonwealth Government is now offering U. S. manufacturers such overwhelming incentives that more than three hundred new factories have already been established in this sun-drenched island 961 miles off the Florida coast.

First and most compelling incentive is a completely tax-free period of ten years for most manufacturers who set up new plants in Puerto Rico.

For example, if your company is now making a net profit after taxes of $53,500, your net profit in Puerto Rico would be $100,000—a gain of 87 per cent as a result of non-applicability of U. S. Corporate Income Tax in Puerto Rico.

Your dividends in Puerto Rico from a corporation there could be $50,000 against $25,000 net in the U. S.—owing to the non-applicability of the U. S. Income Tax.

What About Labor?

Puerto Rico's labor reservoir of 650,000 men and women has developed remarkable levels of productivity and efficiency—thanks, in part, to the Commonwealth's vocational training schools. These schools also offer special courses for managers and supervisors.

The progress made in technical skills may be gauged from the fact that there are now twenty-eight factories producing delicate electronic equipment.

Among the U. S. companies that have already set up manufacturing operations in Puerto Rico are Sylvania Electric, Carborundum Company, St. Regis Paper, Remington Rand, Univis Lens, Shoe Corporation of America, and Weston Electric.

CORPORATE TAX EXEMPTION

If your net profit after U. S. Corporate Income Tax is:	Your net profit in Puerto Rico would be:
$ 17,500	$ 25,000
29,500	50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

DIVIDEND TAX EXEMPTION

If your income* after U. S. Individual Income Tax is:	Your net income in Puerto Rico would be:
$ 3,900	$ 5,000
7,360	10,000
10,270	15,000
14,850	25,000
23,180	50,000
32,680	100,000
43,180	200,000
70,180	500,000

*These examples are figured for dividends paid in Puerto Rico to a single resident. Based on Federal rates effective Jan. 1, 1954.

"Close to Paradise"

Listen to what L. H. Christensen, Vice President of St. Regis Paper, says:

"The climate is probably as close to paradise as man will ever see. I find Puerto Ricans in general extremely friendly, courteous and cooperative.

"This plant in Puerto Rico is one of our most efficient operations, in both quality and output. Our labor has responded well to all situations."

Mr. Christensen might have added that the temperature usually stays in the balmy 70's twelve months a year.

The swimming, sailing and fishing are out of this world. Your wife will rejoice to hear that domestic help is abundant.

The Commonwealth will leave no stone unturned to help you get started. It will build a factory for you. It will help you secure long-term financing. It will even screen job applicants for you—and then train them to operate your machines.

Transportation

Six steamship companies and four airlines operate regular services between Puerto Rico and the mainland. San Juan is just 5½ hours by air from New York.

Light-weight articles such as radar components come off the line in Puerto Rico one day and are delivered by air freight next day in Los Angeles, Chicago and other mainland cities. And, of course, there is no duty of any kind on trade with the mainland.

Are You Eligible?

Says Governor Muñoz: *Our drive is for new capital. Our slogan is not "move something old to Puerto Rico," but "start something new in Puerto Rico" or "expand in Puerto Rico."*

The Commonwealth is interested in attracting all suitable industries, and especially electronics, men's and women's apparel, knitwear, shoes and leather, plastics, optical products, costume jewelry, small electrical appliances, hard candy and pharmaceuticals.

To get all the facts, and to find out whether you and your company would be eligible for complete tax exemption, mail the coupon below.

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Commonwealth of Puerto Rico, Dept. V2
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Product_____

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a firm assembly and serves as a protector for the components while plugging units into sockets during testing. The bracket is so dimensioned that it also serves as a guide for the shape of the wired unit. If all components and wire leads are kept within the extremities of the bracket, the unit will be properly sized and positioned on the socket for casting.

The plastic connector plug should be well abraded on all surfaces that mate with plastic resin, to assure a good bond. Upon completion of testing, the form bracket is removed and the unit is coated.

A synthetic lastic is applied over the entire subassembly before casting in plastic. This provides a cushion between the plastic and materials having a different coefficient of expansion, such as glass and metal. When the completed unit is subjected to a rise in temperature, the plastic expands more than the glass or metal. High temperatures usually cause no difficulty. When units are cooled, however, the plastic shrinks more than glass or metal. If no buffer is used, either the plastic cracks open, or if heavy enough to remain intact, crushes the glass tubes.

The heat-conducting boss is

Dipping assembled unit in silicone elastomer to obtain cushioning coating before embedment

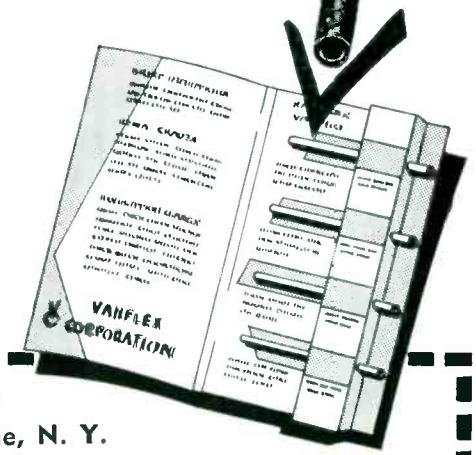
SHOPPING FOR LOW COST CLASS B *Insulation?*

Nothing on the market today excels the low priced Class B protection of Varflo Tubing and Sleeving

Flexible Varflo is solvent-, oil-, moisture-, flame-, and fungus-resistant. Passes the NEMA heat endurance test of 15 minutes at 225°C. Also passes 100 hours at 125°C. Will not lose dielectric strength when subjected to severe handling, bending and twisting. Has good shelf life.

Available in Grades A-1 and B-1 tubing and Grades C-1 and C-2 sleeving.

Let us help you with your problem. Describe it in a letter—no cost, no obligation.



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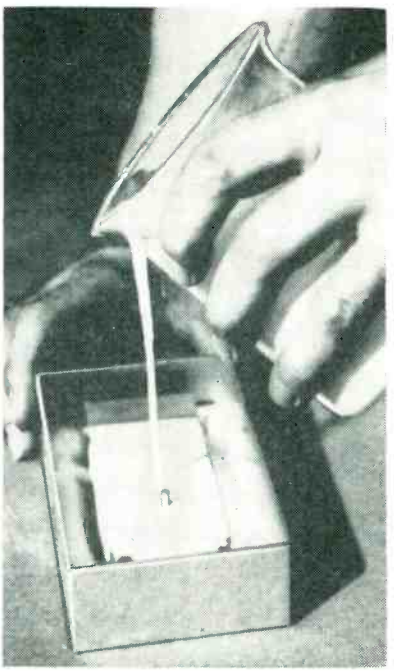


Making flexible mold by pouring vinyl plastisol mold material over polished aluminum pattern

brought out without lastic coating to avoid creating a moisture leakage path. Bosses up to 7/16 inch in diameter have not cracked the plastic even when cooled to minus 65C. Completed units have been subjected to temperature tests from −65 to +85C without failure.

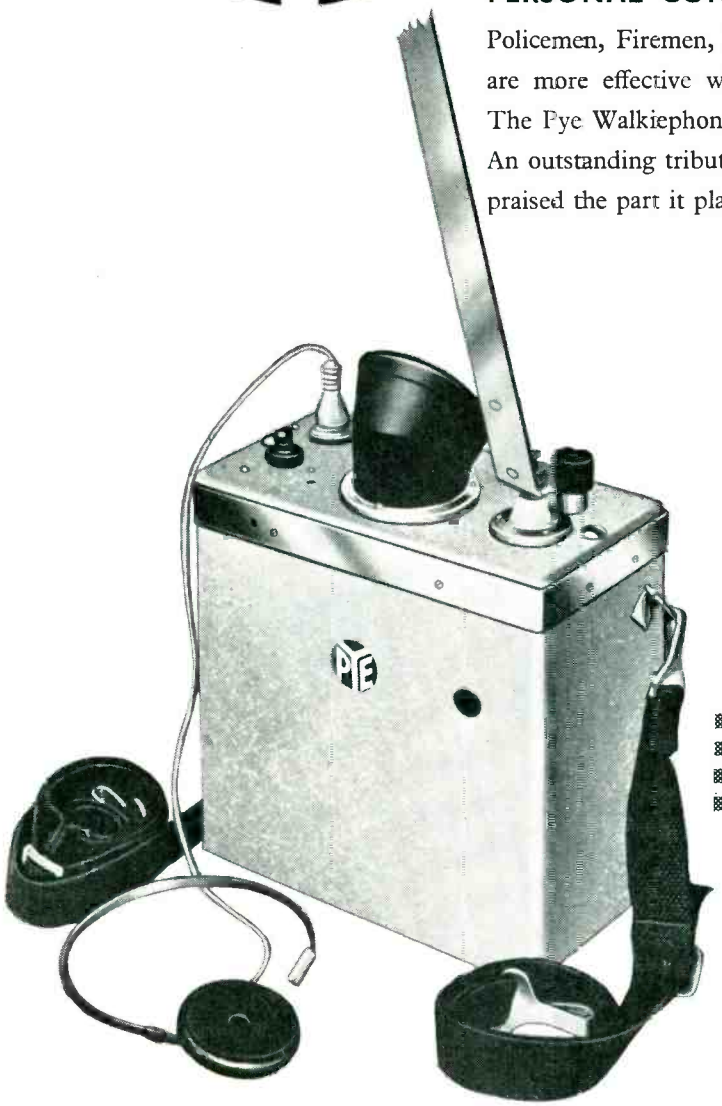
Some plastic resin mixes are now available that have a thermal coefficient of expansion very close to that of aluminum. It might be inferred, therefore, that unlimited masses of aluminum can be used in contact with this resin. However, there is another factor that must be considered. Although aluminum and the plastic have the same coefficient of expansion, they have different coefficients of heat conductivity. Rapid temperature changes will therefore cause faster heat absorption by the aluminum and thus the aluminum will expand faster than the plastic. This again creates stresses in the unit and possible destructive cracking. It is important, therefore, to keep metal and glass masses small unless they can be adequately protected by a cushioning coating.

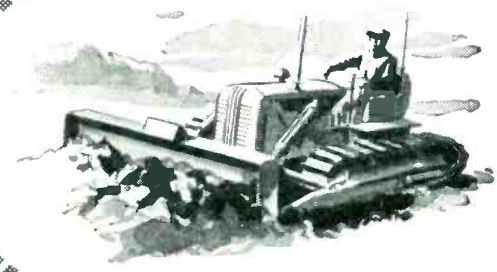
The synthetic lastic supplied by the manufacturer is reduced 50 percent in xylene. Before using, this is further reduced with xylene to 30-percent solids content. The material is applied by dipping, flow-

WALKIEPHONE

PORTABLE RADIO TELEPHONE FOR PERSONAL CONTACT WITH KEY MEN

Policemen, Firemen, Foremen, Airfield Supervisors and many other key men are more effective when in constant radio contact with their headquarters. The Pye Walkiephone, which weighs only 10½ lb., is ideal for this purpose. An outstanding tribute to the Walkiephone was paid by Sir John Hunt, who praised the part it played in the victorious assault on Everest.





Telecommunications

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Pye (New Zealand) Ltd. Auckland C.I., New Zealand	Pye Canada Ltd. Ajax, Canada	Pye-Electronic Pty., Ltd. Melbourne, Australia	Pye (Ireland), Ltd. Dublin, Eire
Pye Radio & Television (Pty.) Ltd. Johannesburg South Africa	Pye Limited Mexico City	Pye Limited Tucuman 829 Buenos Aires	Pye Corporation of America 5th Avenue Building 200, 5th Avenue, New York

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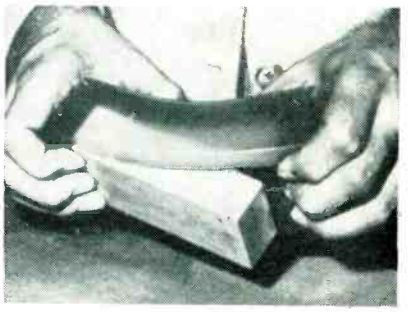
ing or brushing, depending on the assembly to be coated. The coating is allowed to air-dry for 20 to 30 minutes and is then heat-cured for one hour at 60C.

More than one coat of lastic may be required to build up a coating approximately 1/32 inch on all surfaces. Sharp corners and ends of long rigid parts of glass or metal should be given special consideration.

The synthetic lastic has good electrical insulator properties, yet contains sufficient extenders to render it heat-conductive. It remains pliable at very low temperatures.

Flexible molds are used for casting the final assembly. The mold material is poured over a polished



Removing aluminum pattern from flexible mold

aluminum pattern. This is then baked for ½ hour or longer depending upon the size and shape of the pattern.

Where close tolerances are not required or where the final cast unit is machined to size, the flexible molds offer the advantage of low tooling cost and simplified casting methods since the cast part will not adhere to the mold.

The unit to be embedded is placed in the mold with a vertical dam made of polyethylene (or similar material inert to casting resins). This keeps plastic away from the bottom side of the connector plug. The brass boss, which serves as a heat sink, is flush with the surface. A hole is tapped in the center. In the equipment, the completed unit is secured in place by a screw which clamps the unit to an aluminum angle-bracket mounted on the chassis. The boss therefore serves as heat conductor, electrical ground and mechanical retainer to

"The World's Most Promising Technological Revolution"

The Electronics industry is truly "the world's most promising technological revolution."

Even though it grew phenomenally during World War II, Electronics really came into its own following the war. By 1948, it had become a $3,000,000,000 business, and was rapidly becoming a major industry.

Today, Electronics is a $9,000,000,000 industry—counting television, radio, military electronics, commercial electronics, broadcasting, and related areas. There is every indication that by 1960 it will be a $15 billion dollar industry and $20 billion by 1964. And it will keep right on climbing.

No other major industry will grow that fast in the next decade.

The Armed Services, by far the largest customers of electronic products, spent an estimated $145,000,000 in 1948 for electronic equipment for communications, navigation, gunnery systems, etc. Today, government electronic purchases amount to $2,300,000,000 (or 6.3 per cent) of its total defense expenditures. Within the decade, this may increase to 10 per cent of total government buying as the Armed Services become increasingly electronified. It is estimated that government electronic purchases will amount to over $4,000,000,000 by 1964.

The potential volume in commercial and industrial electronics is unprecedented, especially in the field of computers, the heart of data processing, and "automation." Sales of electronic equipment to commerce and industry amounted to $1,000,000,000 in 1954, and the surface was barely scratched. This figure will more than double within the next ten years, for this area of electronics has a future limited only by one's imagination.

The future of Electronics has no horizon. Many of the nearly 2,000 scientists and engineers throughout Sylvania are working on Electronics, constantly finding new and better ways to put Electronics to work. *They are keeping an eye to the future—assuring constant progress in the years ahead* . . . "the world's most promising technological revolution."

(Engineers: *Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact David W. Currier, Supervisor of Professional Placement, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.*)

SYLVANIA

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prevent loosening by shock and vibration.

A polyester resin is used as the casting resin. A filler, 50 percent by weight, is added. This improves the mechanical characteristics by reducing brittleness. Presence of the filler reduces shrinkage during curing.

Just prior to casting there is added to the mix cobalt naphthanate and tertiary butyl hydroperoxide. The cobalt drier is stirred in well, then the peroxide catalyst is added, being careful not to cause unnecessary trapping of air bubbles during mixing.

After pouring, the assembly is placed under vacuum. The cast is next cured at room temperature, then removed from the mold and given an oven-bake cure.

Symbol number and other identification is engraved or hot stamped directly into the plastic material. As a further aid to identification, the entire unit is colored by addition of pigment to the plastic resin before casting. This color coding is used to identify the various blocks such as discriminator, multivibrator and other block components. Bright colors are used, of the same series as used for color-coding resistor and capacitor values. In any one chassis, the colored units are arranged in the

Pouring polyester casting resin over assembly in flexible mold. Metal channel prevents sides of mold from bulging, and polyethylene vertical dam keeps plastic away from terminal plug

NEW TEST KIT of GLOBAR®

Type BNR VARISTORS

for design and application work

Quantity	Cat. No.	R @ Calibration Voltage	Load Watts
6	432	100000 @ 10 volts	0.25
6	479	100000 @ 100 volts	0.3
6	328	10000 @ 40 volts	0.5
6	463	24000 @ 40 volts	1.0
6	524	24000 @ 100 volts	1.5
6	430	17500 @ 175 volts	2.7

KIT No. 3 Type BNR VARISTORS PRICE **$20.00**

to evaluate use of **GLOBAR®** Type BNR Varistors *for*

- **Reduction of surge voltage peaks from 50% to 90%.**
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- **Stabilizing amplifier gain.**
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- **Stabilizing of rectifier circuits by limiting peak voltages.**

OTHER TEST KITS

of GLOBAR® Ceramic Varistors and Thermistors now available to help you solve your circuitry problems include:

KIT No. 1 PRICE $29.25

Type F THERMISTORS

- To evaluate series filament circuit application in radio and television receivers.

Quantity	Cat. No.	R @ 25 C	R @ Rated Current	B Constant	Load Watts
6	763	15		1500	0.5
6	441	880	100 ohms @ 150 ma	1900	2.7
6	341	375	40 ohms @ 300 ma	1950	3.6
6	525	250	20 ohms @ 600 ma	1900	7.2
6	327	460	35 ohms @ 600 ma	1900	12.6
6	421	125	43 ohms @ 600 ma	1100	16.5

KIT No. 2 PRICE $24.50

Type H THERMISTORS

- To evaluate time delays in relay and solenoid circuits; temperature compensation in field coils and meters.

Quantity	Cat. No.	R @ 25°C	B Constant	Load Watts
6	416	1200	3200	0.7
6	479	1000	3800	1.85
6	373	10	2700	3.0
6	343	20	2700	3.0
6	549	5000	3200	1.5
6	588	11000	3200	2.0

KIT No. 4 PRICE $18.25

Type F, Type BNR VARISTORS and THERMISTORS

- To evaluate stabilizing rectifier circuits by limiting peak voltages.

Quantity	Type BNR Cat. No.	R @ Calibration Voltage		Load Watts
6	432	25000 @ 10 volts		0.25
6	432	100000 @ 10 volts		0.25
6	432	200000 @ 10 volts		0.25
	Type F Cat. No.	R @ 25°C	B Constant	Load Watts
6	763	15	1500	0.50
6	763	120	1750	0.50
6	763	330000	2150	0.50

EACH KIT CONTAINS 36 resistors — 6 of each specified type, packaged in attractive transparent plastic boxes. Pertinent engineering bulletins giving detailed engineering data are sent with each kit. Kits will be shipped postpaid to any point in the United States and Canada. All resistance values specified carry standard production tolerance.

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THE CARBORUNDUM COMPANY
Dpt. EL87-56, Niagara Falls, New York

Please ship kits as follows:

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☐ Check enclosed (to which we have added applicable local tax)

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Please send FREE engineering bulletin on Kit No.____

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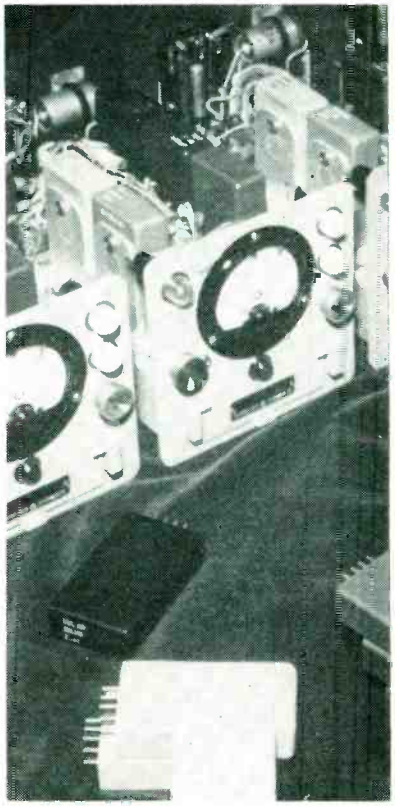


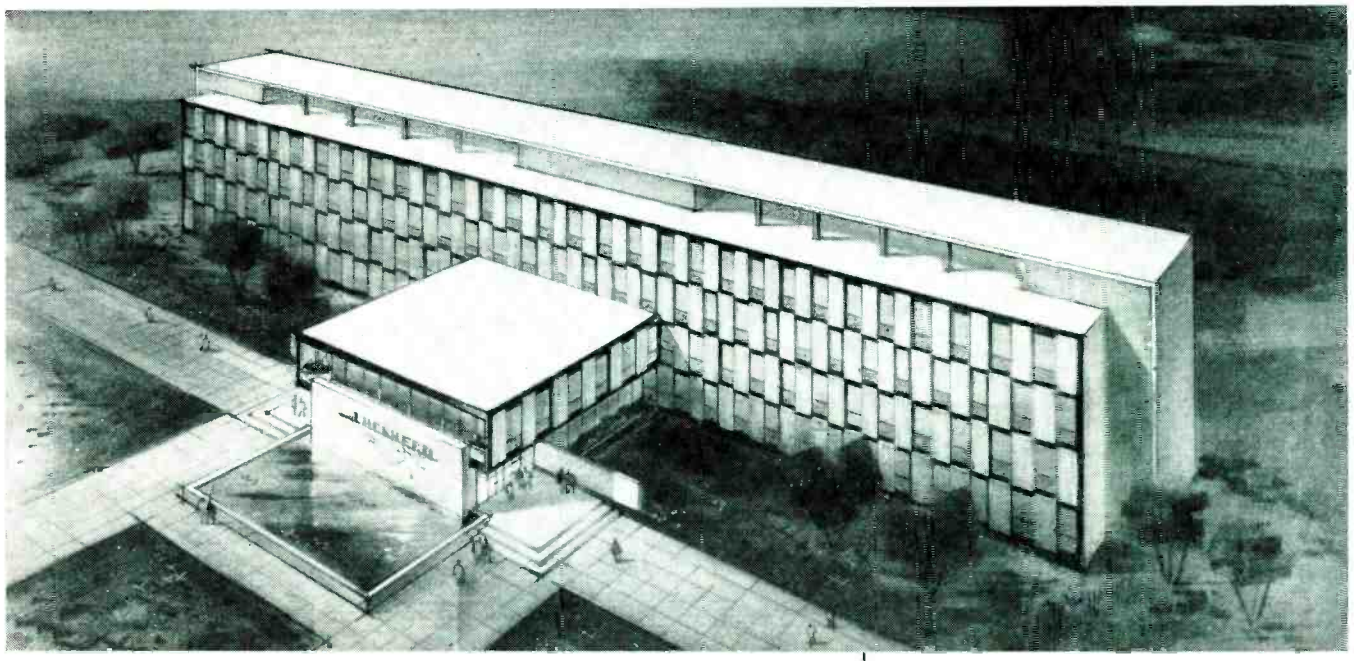
Finished plug-in units and method of mounting against heat sink made of heavy vertical plates fastened to chassis

proper numerical-color sequence, such as black, brown, red and yellow. In practice, this color coding has proved to be of great value in development work, testing and servicing by speeding identification and preventing errors.

The colored mixes are obtained by adding color pastes in amounts varying from 2¼ percent for violet to 7½ percent for white, based on the total mixture.

Casting of circuit subassemblies in the manner described provides excellent stability of the completed unit in the presence of shock, vibration and moisture. However, crowding of components and flexibility of selfsupporting components has meant that considerable care must be exercised in design and wiring of units to avoid failures during the casting process. Special attention is given to such things as alternate placement of composition resistors and metal-case capacitors to preclude the possibility of short-circuits should the components touch.

High-impedance circuits are usually protected by ground barriers from high-voltage components



NEW MISSILE SYSTEMS RESEARCH LABORATORY RISES AT LOCKHEED

Scheduled for occupation this fall, Lockheed's new Missile Systems Research Laboratory is now well along in construction. First step in a $10,000,000 research laboratory program, it is especially designed to provide the most modern facilities for meeting the complex problems of missile systems research and development.

Scientists and engineers able to contribute importantly to the technology of guided missiles are invited to write.

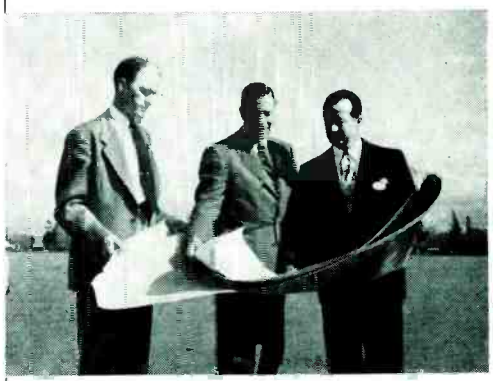
Lockheed MISSILE SYSTEMS DIVISION

research and engineering staff

National Conference on Aeronautical Electronics
May 9-11
Dayton, Ohio
Dayton-Biltmore Hotel
Telephone: Adams 2161

National Telemetering Conference
May 18-20
Chicago, Ill.
Morrison Hotel
Telephone: FRanklin 2-9600

C.T. Petrie and senior members of the technical staff will be available for consultation at both convention hotels.



Dr. E. H. Krause, Research Laboratory head (left), examines blueprints of the new laboratory with E. R. Quesada, Missile Systems Division vice president and general manager (center), and W. M. Hawkins, chief engineer, during ground-breaking ceremonies.

LOCKHEED AIRCRAFT CORPORATION • VAN NUYS • CALIFORNIA

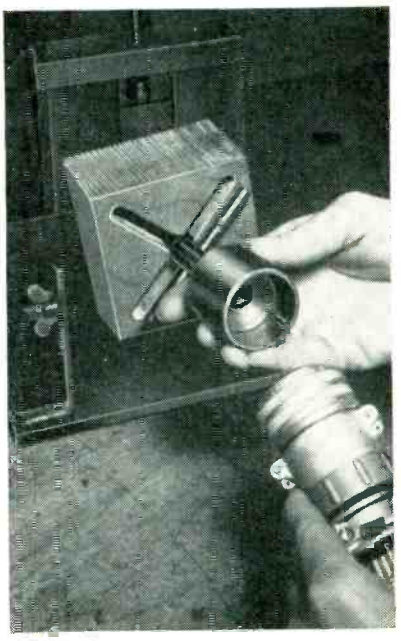
where high-impedance leakage may interfere with circuit function. For example, a low-resistance cathode-bias resistor serves as an effective barrier between a high-value grid resistor and a high-voltage component.

In some cases, additional grounded leads may be added to divert leakage currents away from high-impedance grid circuits. A typical unit assembled and wired in a straightforward manner may present five or six potential failure points due to slight repositioning before and during casting procedures. Careful rearrangement of the same components will yield a unit virtually free of such accidental failures. This type of preventive design pays big dividends in reduction of failures during manufacture and in the field.

Cable Plug Wrench

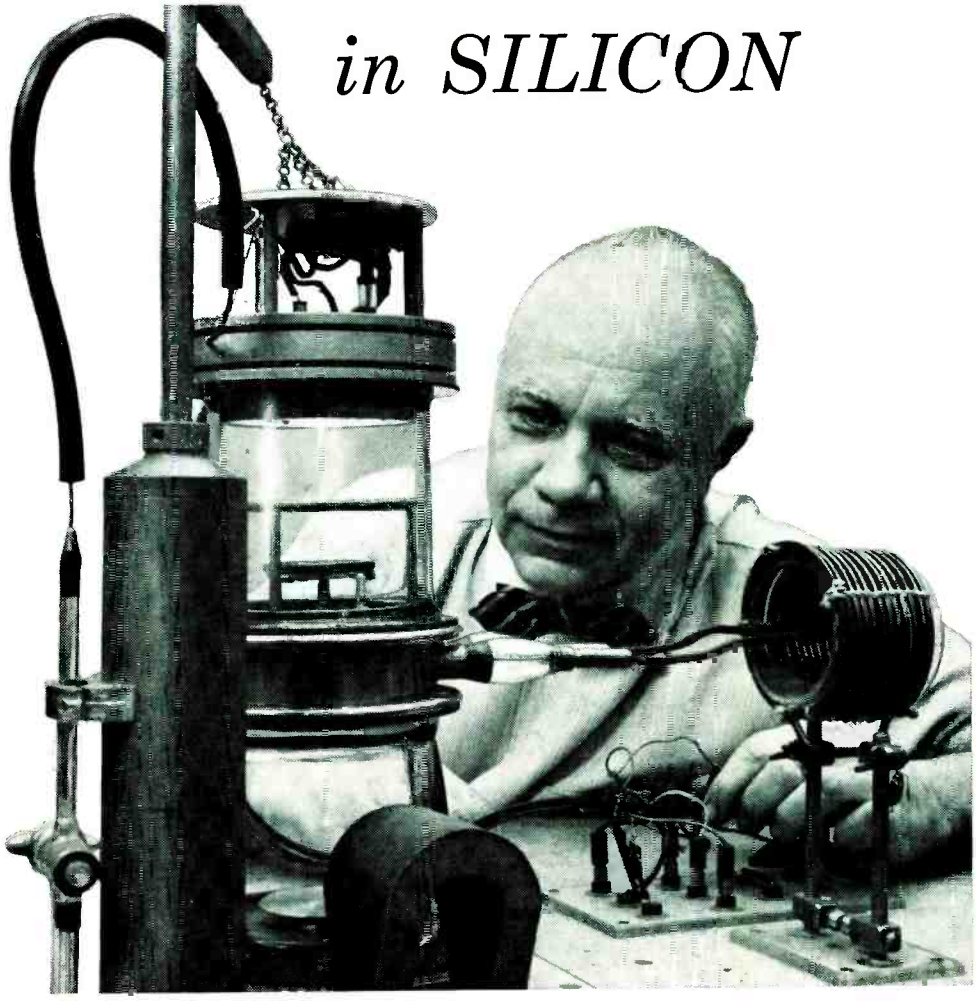
SPECIAL CABLE plug wrenches in various sizes are used in the Baltimore plant of The Glenn L. Martin Co. for setting the keyways of plugs and for closing the plugs. A projection on the inner surface of the tool mates with the keyway of the plug to hold this part securely during the tightening operation.

Although the wrench can be hand-held, it is generally supported by a multiple-position X block,



Inserting wrench in holding block

AN ADVENTURE *in SILICON*



One example of junction technology at Bell Laboratories. Here a junction is produced on the surface of silicon by bombardment with alpha particles. Bombardment enhances silicon's performance at very high frequencies.

One day in the 'thirties a revolutionary adventure began for Bell scientists. They were testing an experimental silicon crystal they had grown to make microwave detectors.

Intriguingly, they found that one end of the crystal conducted by means of positive charges, the other end with negative. Positive and negative regions met in a mysterious barrier, or junction, that rectified, and was sensitive to light. It was something entirely new . . . with challenging possibilities.

The scientists went on to develop a theory of junction phenomena. They showed that two junctions placed back-to-back make an amplifier. They devised ways to make reproducible junctions. Thus, junction technology came into being, and the 20th Century had a new horizon in electronics.

This technology has already produced at Bell Telephone Laboratories the versatile junction transistor (useful in amplifiers and switches); the silicon alloy diode (surpassingly efficient in electronic switching for computers); and the Bell Solar Battery which turns sunshine directly into useful amounts of electric current.

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Tightening connector while wrench in block holds plug. Rack at rear holds other sizes of wrenches

leaving both hands of the operator free for work. The hardwood block is clamped in a holding fixture that can be adjusted to the optimum working angle.

Specifications for Printed-Wiring Production

To standardize production techniques for printed-wiring boards that are to be set into magnesium picture-frame mountings, engineers of the Electronic Division in the Baltimore plant of Westinghouse Electric Corp. established the following specifications:

(1) Layouts are to be done on a scale of 2:1.

(2) Layouts are to be on glass cloth, component outlines on one side, circuitry on the other. Give one outside (longest) dimension on both sides of board to be used as a scale target for the photographer.

(3) Component cutouts, on a 2:1 scale, are available in drafting department for use in making the layouts.

(4) The minimum spacing between any conductors after soldering must be at least $\frac{1}{16}$".

(5) All leads shall be $\frac{1}{32}$" wide actual size except $\frac{1}{16}$" for filament leads and other leads carrying 500 ma and over. Wider leads shall be used for r-f grounds. Engineer to specify all leads wider than $\frac{1}{32}$".

(6) Tube socket holes are to be punched 0.807" diameter actual for

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9-pin sockets, 0.687″ diameter for 7-pin sockets and 1$\frac{3}{32}$″ for octal sockets.

(7) Holes in bullseyes for components are to be punched 0.070″ diameter +0.000 and −0.001.

(8) Eyelets are to be installed in the 0.070″ component holes. On layouts use $\frac{1}{4}$″ o.d. bullseye.

(9) All leads on the layout going to the connector or ground shall be identified on component side, such as +150, TRIG, GATE OUT and GND.

Ground Lead

(10) Because of the magnesium picture-frame mounting planned for the boards, a $\frac{1}{4}$″ actual-width ground lead shall be put along both edges and along one end of the board on one side only. The outer edges of this ground strip on the sides shall indictate the maximum overall width of the board. Because of the magnesium frame, all bullseyes shall be kept out of the $\frac{1}{4}$″ ground strip.

(11) Reverse printing shall not be used unless approved by the Section Manager.

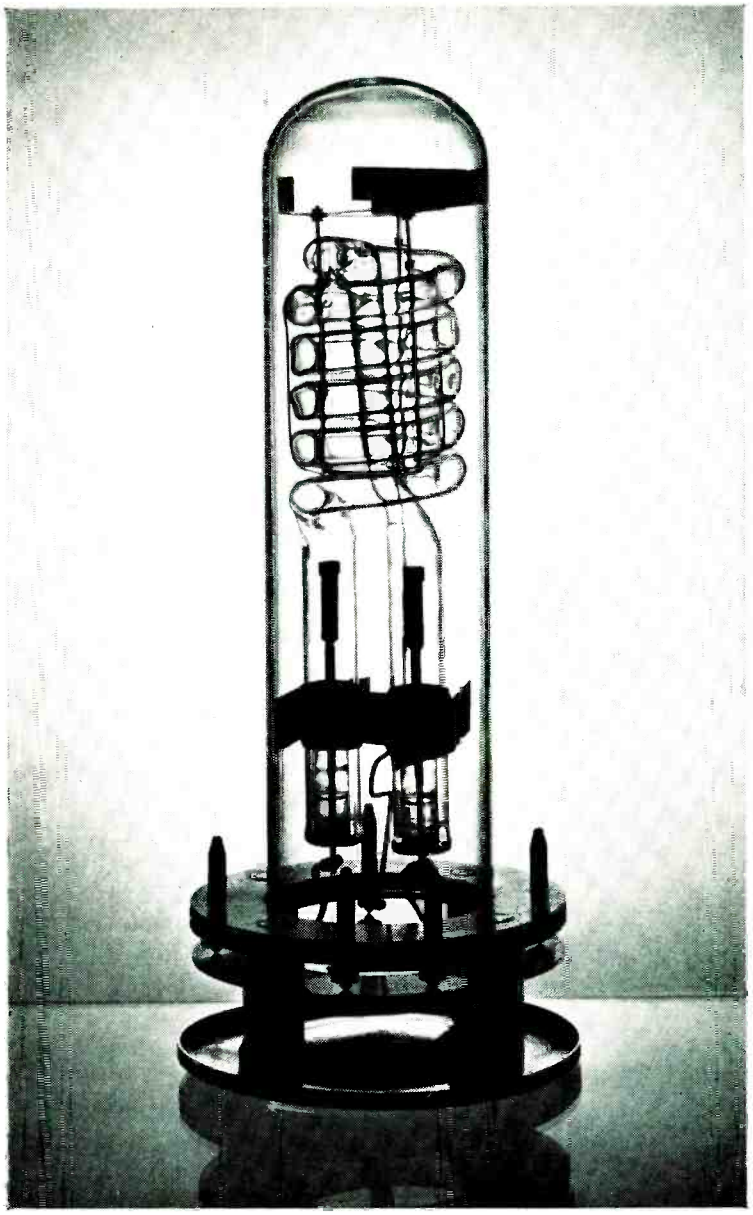
(12) The proper positions of the components and tube JAN No. shall be suitably designed on the top or tube side of the board, and shall be identified by symbol number. All designation markings and lettering must be kept $\frac{1}{16}$″ minimum away from the spun-over eyelets or other conducting leads such as jumpers.

NOTE: No lettering or eyelets shall be placed either wholly or partially within the circle formed by the outer edge of the tube pin contact wedges, on either side of the board. This is to prevent contact being made with any shield bases.

(13) Tube sockets shall be indexed as to contact positions on the wiring side of the board. The center connection must have a contact point for grounding. Tube shield must be identified by a ground symbol. Socket holes must be keyed to match socket.

(14) All jumpers shall be printed and riveted on component side of board.

(15) Two holes, whose only purpose is for registration, shall be shown on the layout. They shall be dimensioned on the drilling plan



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drawing as they will be used as a basis for all tooling.

(16) If any cases arise in making the layouts where Scotch tape must be used, use only the nonreflective Scotch Tape No. 810.

(17) All lettering on the layouts shall be Leroy 120 minimum in size.

(18) The printed boards shall be tin-plated before eyeletting, mounting components and dip soldering.

Producing Formed and Inside-Out Grids for UHF Pencil Tubes

By H. J. ACKERMAN
Tube Division
Radio Corporation of America
Harrison, N. J.

GRIDS used in typical commercial pencil-tubes triodes consist of lateral wire wound at a relatively coarse pitch around many supporting siderods as shown in Fig. 1. The siderod array, rather than the grid lateral wire, serves as the effective electron-control element.

The extent to which this type of structure can be used in high-frequency tubes is limited, however, because the minimum size of the siderods and the closest practical spacing between them depend on mechanical considerations and the need for thermal conduction of heat from the grid.

Two modifications of grid configuration which overcome these limitations, currently being employed in developmental uhf pencil tubes, are the formed grid and the inside-out grid.

In the formed grid structure, shown in Fig. 2, the lateral wire is formed against an internal mandrel so that the inside diameter of the grid is substantially the same as

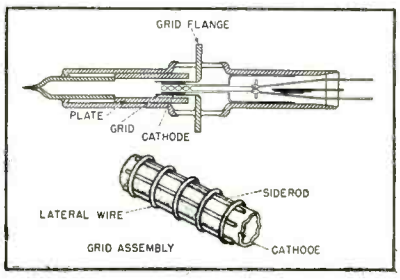

FIG. 1—Cross-section of typical pencil-tube triode and enlarged view of conventional coaxial grid and cathode

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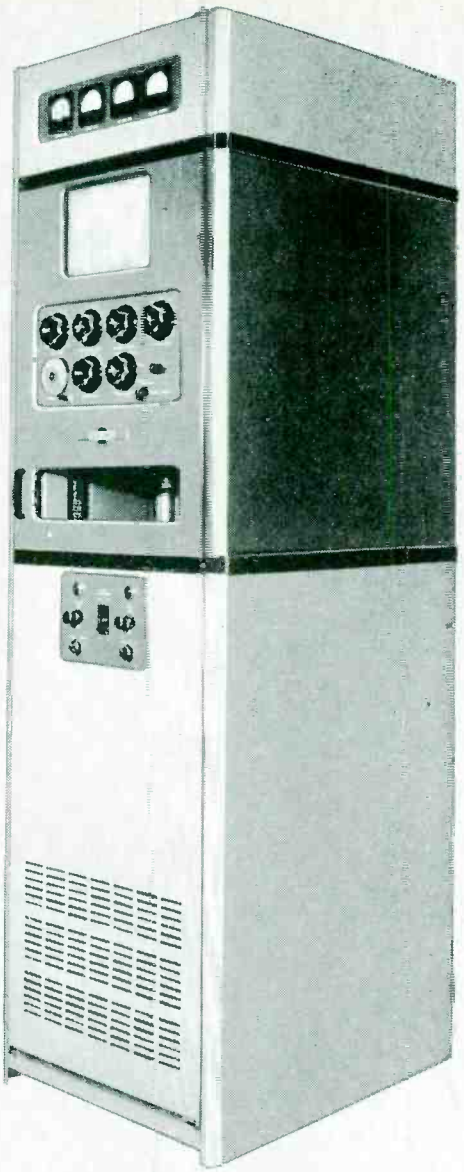
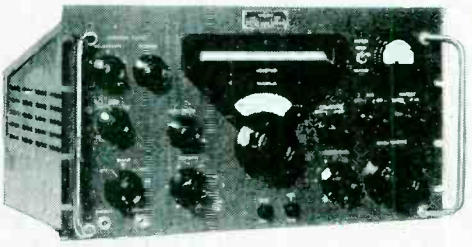


COLLINS 430 Series offers a choice of 12 transmitters to meet your individual communications requirement. Frequency range is 2.0 to 30.0 mc. Automatic channel switching on ten pre-set frequencies from a local or remote position is available when Collins Autotune is employed. Provision is made for use of master oscillator. Power output: 431 series — 1,000 watts CW, FSK or AM voice; 432 series — 2,500 watts CW or FSK, 2,000 watts voice. Frequency stability is .003% for CW or voice and .0005% for FSK.

COLLINS 512B-2 RF Impedance-conversion unit may be used in the range of 2 to 30 mc to couple unbalanced 52-ohm transmitter output to a 600-ohm balanced transmission line. No tuning is required.



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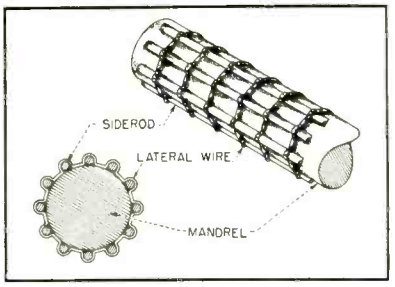

FIG. 2—Formed grid, showing lateral wire formed against internal mandrel

the diameter of the mandrel. The lateral wire is then the dominant control element.

In the fabrication of a formed pencil-tube grid, a conventional grid is first made on the equipment shown in Fig. 3. Eighteen 0.002-inch nickel-clad copper siderods are positioned around a continuously moving mandrel of oxidized nickel-chrome alloy. The diameter of the mandrel is substantially equal to the desired internal diameter of the grid. A silver-plated nickel-cobalt alloy lateral wire having a diameter of 0.0005 inch is then wound under tension around the siderods at 400 turns per inch, which is suitable for effective control. The lateral wire is r-f brazed to the siderods in a hydrogen atmosphere at a mandrel temperature of about 1,000 C in the coil region. The silver plating of the lateral wire serves as the brazing material so that a joint is obtained between the lateral wire and the siderods at each crossover point.

To form the grid, a mandrel-and-grid assembly is positioned on a rubber pad in the die as shown in Fig. 4, just under the punch, which also contains an attached

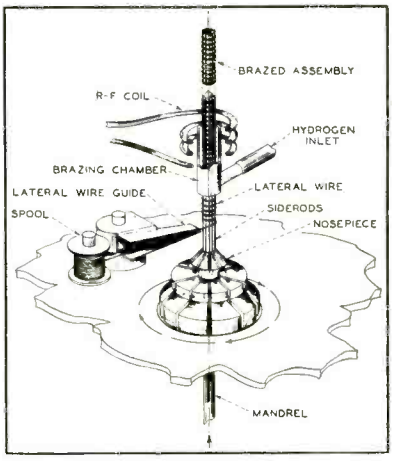

FIG. 3—Apparatus used for fabrication of conventional pencil-tube grids

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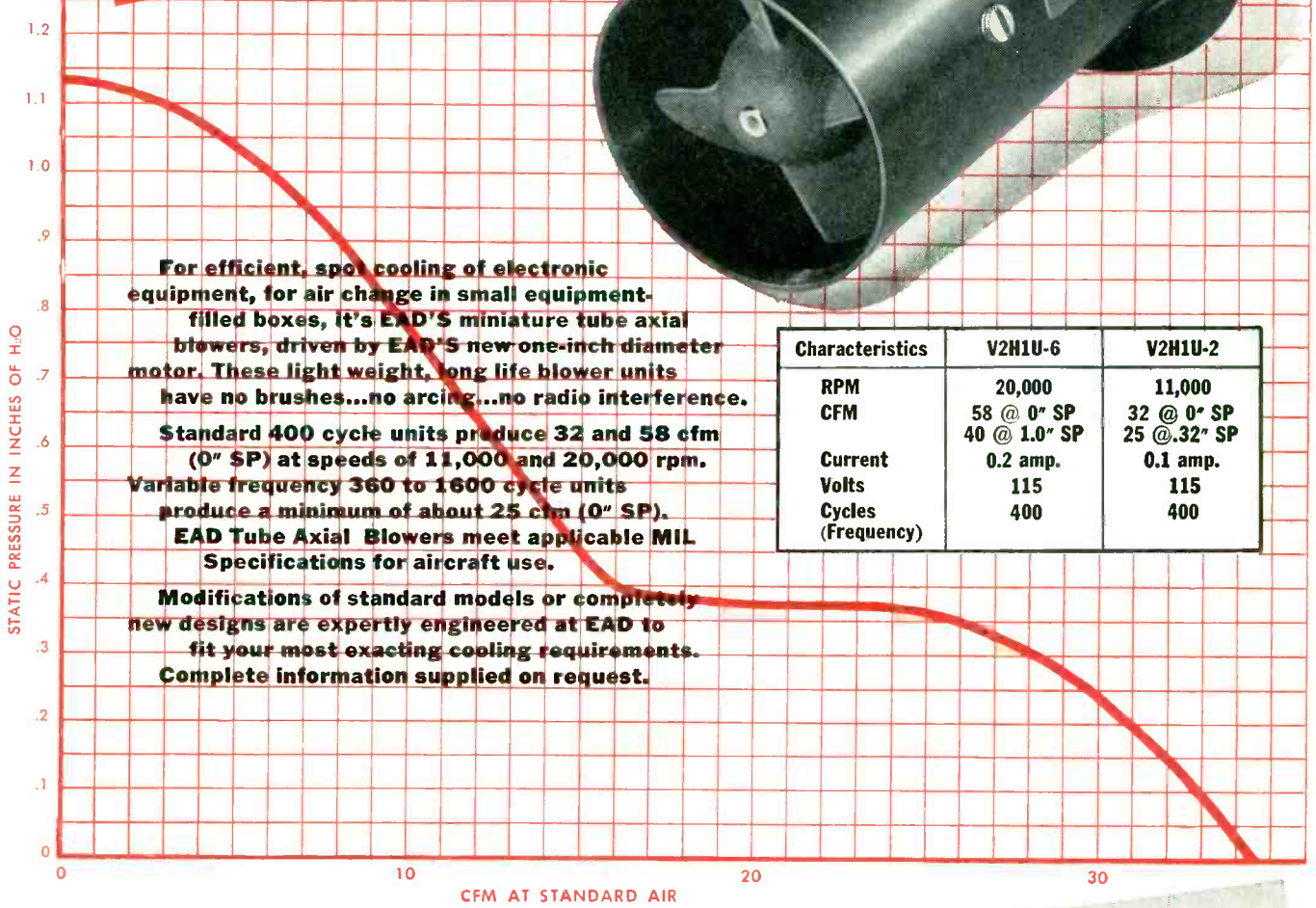

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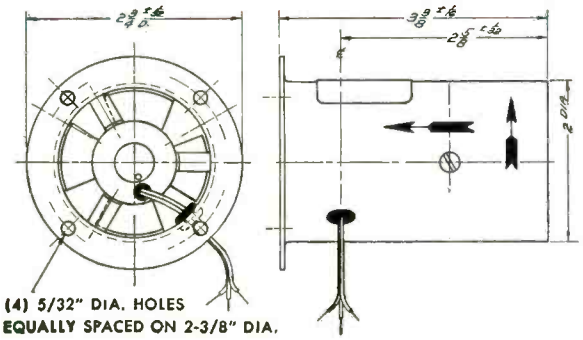
Characteristics	V2H1U-6	V2H1U-2
RPM	20,000	11,000
CFM	58 @ 0" SP 40 @ 1.0" SP	32 @ 0" SP 25 @.32" SP
Current	0.2 amp.	0.1 amp.
Volts	115	115
Cycles (Frequency)	400	400



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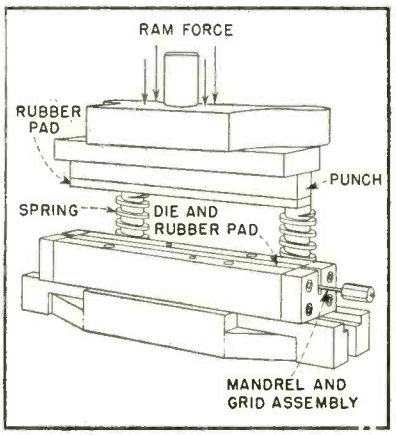

FIG. 4—Grid-forming apparatus

rubber pad. A ram force of 3,000 pounds per square inch is applied to the rubber pads and transmitted to the lateral grid wire. The portions of the lateral wire between adjacent siderods are formed against the mandrel. Thus, this technique serves both a grid-sizing and grid-forming function. After the grid is formed, the grid assembly on the mandrel appears as shown in Fig. 2.

After the grid strip is formed, it is cut into grids of required length and these grids, still on the mandrel, are washed in a degreasing agent, rewashed in water, rinsed in methanol and dried. The grids are then fired in a hydrogen atmosphere at a temperature of 600 C for 5 minutes and removed from the mandrel for use in tubes. When these formed grids are used, the grid-cathode spacing in a pencil tube is not limited by the thickness of the supporting rods, but only by tube-assembly techniques.

The inside-out grid has the lateral wire fastened to the portion of the siderods nearest the cathode, as shown in Fig. 5. To make this, the lateral wire is wound around the mandrel prior to insertion in the nosepiece. A securing wire is used to hold the siderods in position

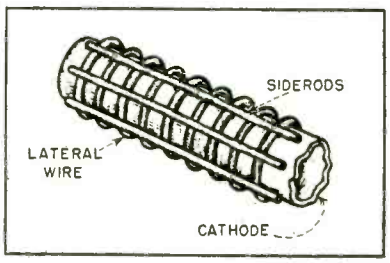

FIG. 5—Inside-out grid with side rods outside the lateral wire

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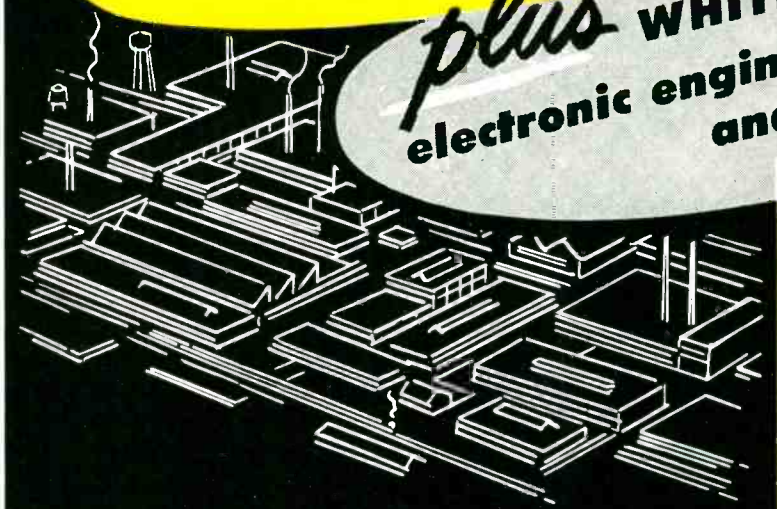

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against the lateral wire as they are positioned by the winding machine, as shown in Fig. 6.

A typical inside-out grid is made as follows: Silver-plated nickel-cobalt alloy or gold-plated tungsten lateral wire having a diameter of 0.0005 inch is wound under tension at the desired pitch around a nickel-chrome alloy mandrel having an oxidized surface. The mandrel then passes through a pencil-tube grid-winding machine, and 18 nickel-clad copper or silver-plated

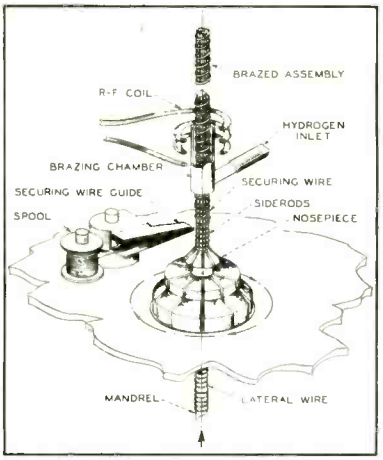


FIG. 6—Apparatus used for fabrication of inside-out grid

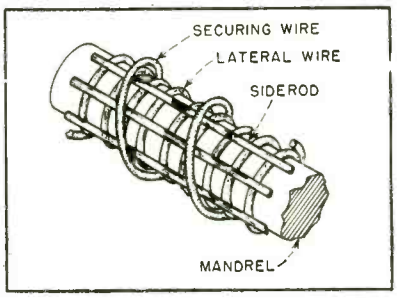


FIG. 7—Inside-out grid strip assembly, showing mandrel, lateral wire, siderods and external securing wire

nickel-clad copper siderods are positioned around the helix parallel to the axis of the mandrel. The siderods are held in place around the outer surface of the helix by an external wrapping of oxidized stainless steel wire having a diameter of 0.0015 inch; the securing wire is wound at a coarser pitch than that used for the grid lateral wire. The grid strip is r-f brazed in a hydrogen atmosphere so that the grid lateral wire and the siderods are joined to each other at the points of contact. Because both the mandrel and the external securing wire have oxidized surfaces, they do not

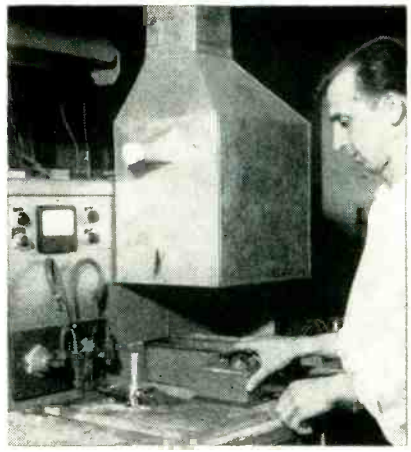
join with the materials of the lateral wire and the siderods during the brazing process. Figure 7 shows a portion of the grid strip assembly consisting of the mandrel, the lateral wire, the siderods and the external securing wire.

After the grid strip assembly is brazed, the external securing wire is removed and the strip is cut into grids of required length. The grids are then washed, fired and removed from the mandrel for use in tubes. A finished grid positioned about a cathode is shown in Fig. 5. Because the grid-cathode spacing in a pencil tube employing this inside-out grid is not limited by the thickness of the supporting siderods, the minimum spacing is limited only by tube-assembly techniques.

Induction Soldering of Coaxial Tuned Stubs

AFTER ASSEMBLY of quarter-wave coaxial tuned stubs for tuned circuits of 400 to 470-mc two-way radio equipment, a soldered hermetic seal is achieved by induction soldering in Motorola's Chicago plant. A Reeves 5-kw induction heating generator is used as the power source. The water-cooled work coil is constructed from $\frac{3}{16}$-inch square copper tubing.

An alignment jig is used inside the coaxial unit to establish correct alignment of the adjustable center plunger and the quarter-wave stub. The solder used is Kester 60-40 No. 44 rosin-core solder, applied during heating as well as by means of preforms.



Induction soldering setup. Hood carries away soldering fumes

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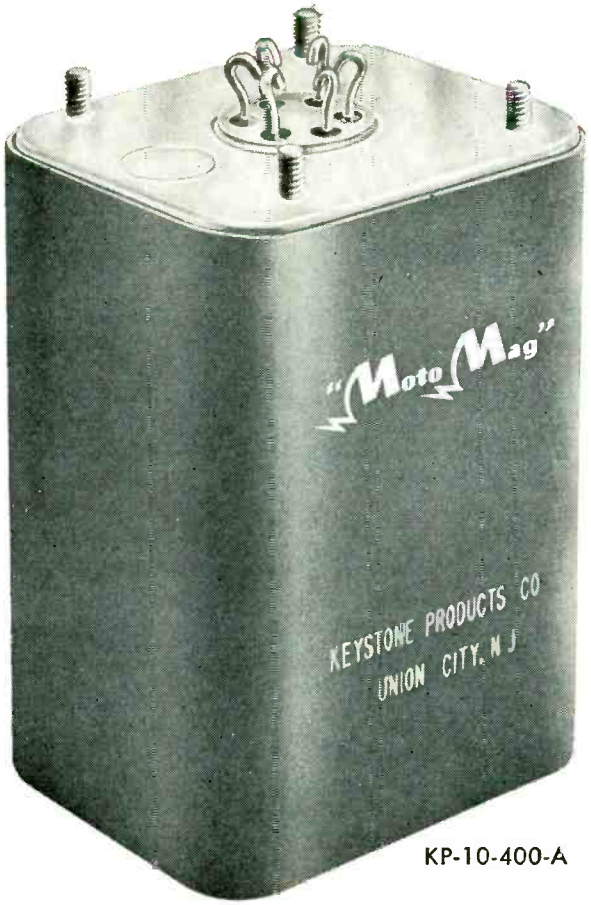

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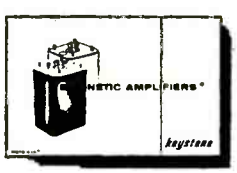

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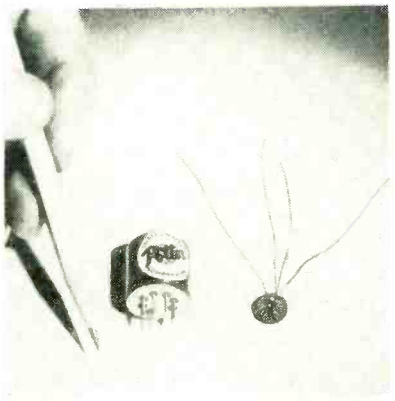

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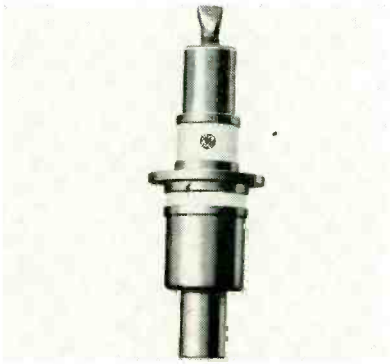
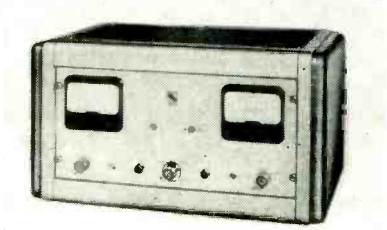


GENERAL ELECTRIC CO., Schenectady, N. Y. The GL-6442 miniaturized lighthouse triode is capable of delivering power up to 4,000 mc. It is designed for use in low-power radar, beacons, navigation, microwave relays, special test equipment and telemetering. It features an exceptionally strong grid flange for rigid mounting. Together with coplanar construction and the use of metal and ceramic, this provides greater resistance to shock and vibration than conventionally-constructed tubes of this class. Extra-large silver-plated terminals assure low-loss contacts. Peak power output at 3,500 mc is 2.0 kw with a peak positive-pulse plate supply of 3,000 v. As a Class C r-f power amplifier operating at approximately 2,500 mc, the triode is rated at 8 w plate dissipation with 350 v and 35 ma on the plate. In plate-modulated service the maximum ratings are 6 w input and 275 v and 35 ma on the plate.

COUNT RATE METER

with very wide range

NRD INSTRUMENT CO., 6429 Etzel Ave., St. Louis 14, Mo. Model CRM-560 precision count rate meter has an unusually wide range, form 5 to 10,000 counts per sec full scale. It incorporates a sensitive linear amplifier and discriminator, with 2 mv sensitivity. Statistical error may be chosen as 1, 2, 5, 10 or 20 percent. There is no needle kick when switching ranges or error settings. The well regulated high voltage is variable over a range of 750 to 2,000 v, and is indicated on a 4-in. meter. Count rate is shown on a separate 4-in. meter, so that both values are visible at all times. An external recorder may be used, and is controlled by a panel switch.



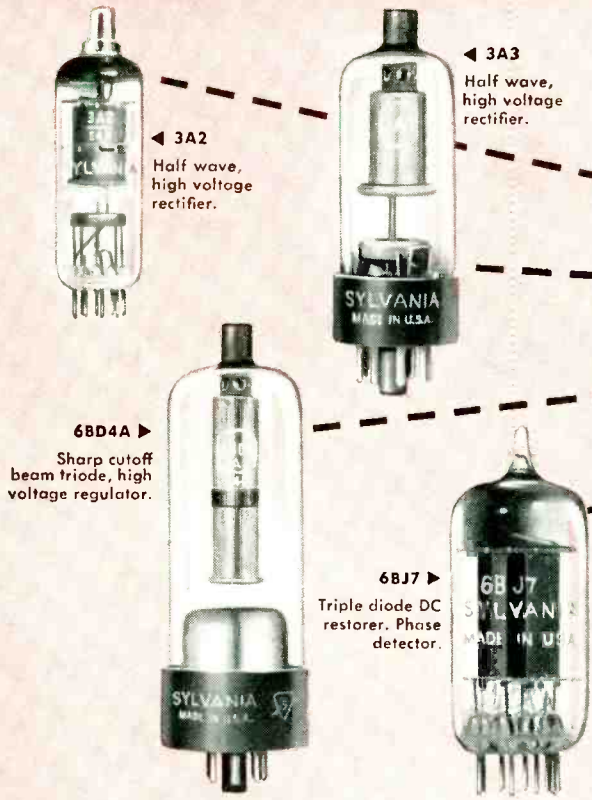
MINIATURE RELAY

for operation up to 125 C

RADIO CORP. OF AMERICA, Harrison, N. J. A hermetically sealed,

Important developments in

COLOR TV Receiving Tubes



Expect them to keep coming from Sylvania

To make the color TV picture better as it gets bigger, Sylvania tube research, in close liaison with leading set designers, is busy developing and testing new tube types . . . designed especially for big-screen color TV.

Development of the 6BD4A to fill the need for a higher-rated voltage regulator is a typical example of Sylvania pioneering in color TV receiving tubes.

These tubes, together with important Sylvania prototypes being offered to the industry today, will be color TV's "bread and butter" types tomorrow, and will be available from Sylvania in production quantities.

Expect Sylvania to supply your color TV picture tube requirements, too.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., Montreal

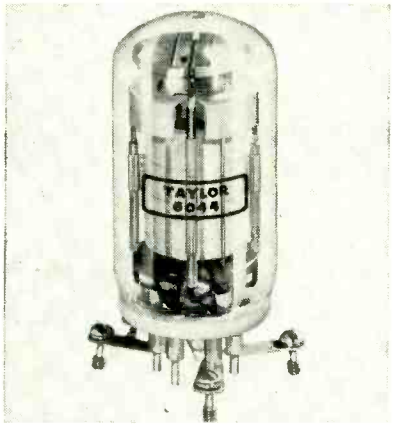
LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

rotary-type miniature electric relay designed for efficient operation in electronic equipment with ambient temperatures ranging from −65 to +125 C has been announced. The relay (RCA-204W1) is a 26.5-v 6-pole, double-throw type engineered for use in a wide range of critical applications, including airborne intercommunications systems, signaling and control equipment, guided missiles, rockets and radar systems. It will withstand an impact acceleration of 50 g maximum, and a vibrational acceleration of 10 g maximum up to 500 cps. The palladium contacts are rated at 2 amperes for a resistive load and 1 ampere for an inductive load. The relay has an average life expectancy of more than 1 million operating cycles at no load, or 100,000 cycles with full-rated load at 125 C.

XENON THYRATRON

for motor control circuits

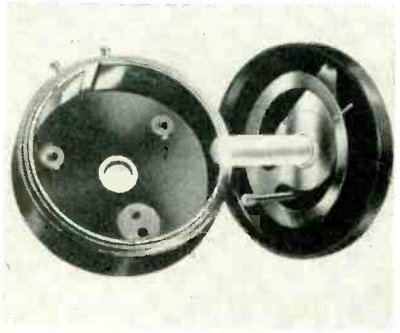
TAYLOR TUBES, INC., 2312 W. Wabansia Ave., Chicago 47, Ill. A new inert gas grid controlled rectifier featuring use of high shock multiform glass wafer stem, the 6044 is designed especially for motor control circuits where short deionization time is required. The tube will also serve on applications requiring high peak current carrying capacity such as timing control. Using a design where the electrical contacts and mechanical supports are provided by the same set of



connections, the 6044 can be fastened to the mounting panel by captive screws on the tube terminals. This gives extreme rigidity and eliminates tube sockets for simplified mounting. The tube features a 6.4-ampere average anode current and a low average arc drop of 12 v. Ambient temperature limits are −65 to +85 C. Filament voltage is 2.5 a-c or d-c, and filament current is 17 amperes. Peak current is 77 amperes and peaked forward or inverse voltage is 500 v. Maximum physical dimensions of the tube are 5.5 in. high and 2.2 in diameter.

POTENTIOMETERS

in 8 different models

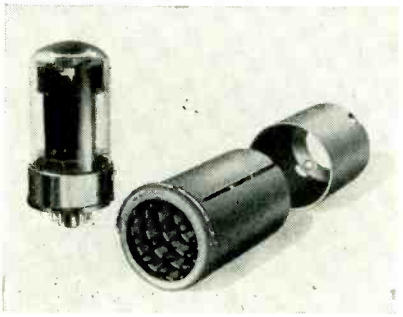


GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass., has announced 8 different models in the 970 series of wire-wound potentiometers. Power ratings range from 2 to 20 w at 40 C ambient, and 17 stock resistance values cover the range from 2 to 500,000 ohms. Linearity runs from ±0.2 percent on largest models to ±2 percent on the smallest. Resolution similarly runs from less than 0.05 percent to 1 percent. All models are totally enclosed, yet capacitance is kept low by the use of phenolic body and cover plus a glass-reinforced-polyester shaft. Simple and rigid mounting is provided, and a positive stop is used with no force on the brush. The bearing and brush designs have been chosen for long wear with very low electrical noise. Ganged assemblies as well as units for other special requirements are available on order.

TUBE SHIELD

for T-12 envelope size

INTERNATIONAL ELECTRONIC RESEARCH CORP., 177 W. Magnolia Blvd., Burbank, Calif., has available a new tube shield for use with tubes of the T-12 envelope size similar to the 6080, 6146 and 6293. The base fits the following JAN-approved submounted sockets: TS 101P 01, TS 101P 02, TS 101C 01 and TS 101C 02. A handle has been made an integral part of the shield

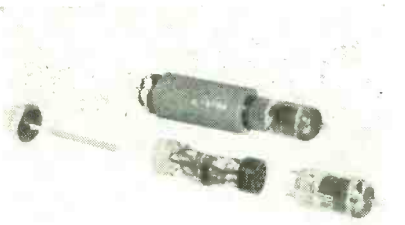


to aid in its removal from tight places. For greater stability under vibration and shock two additional counter-sunk holes have been added to the base, the use of which is optional. Ask for technical bulletin 1014–255.

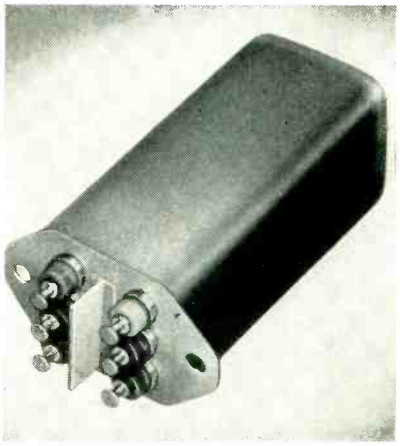
EMBEDDED CIRCUITS

known as Encapsors

ALCOR ELECTRONICS CORP., 180 Lafayette St., New York 13, N. Y.,



introduces the new lock-in and plug-in Encapsor, a durable plastic embedded electronic circuit arranged in the form of a small cylindrical cartridge having means to accept a vacuum tube and which plugs into and is securely locked to a tube socket. They are used in place of conventional methods of assembly and wiring components associated with vacuum tubes. Maintenance time is vastly reduced for by simple substitution with a new Encapsor, a faulty unit can be replaced. Made of Alcorite plastic, gold-plated receptacle contacts, plug pins of phosphor bronze, A-B type resistor, Mylar capacitors, silicon diodes and other high quality components, it is available for both standard and printed circuits application. Literature and schematics are available upon request.



ELECTRONIC CHOPPER
with no moving parts

AVION INSTRUMENT CORP., 299 State Highway No. 17, Paramus, N. J., has developed the model 307 electronic chopper with no moving parts. It is able to modulate d-c to frequencies up to 400 cps, for a minimum life period of 3,000 hours. Modulation is accomplished by illumination of a photoconductive

New products developed by GUARDIAN®

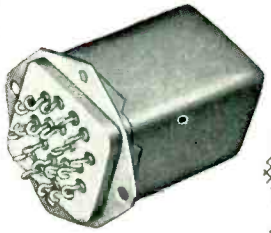
in step with today's electronic designs

SERIES 805 D.C. RELAY

Guardian 32-pole Series 805 can simultaneously connect together 32 circuits. Individual contact blades molded in thermo-setting phenolic; all contacting members enclosed in aluminum cover. Wt.—5 oz.

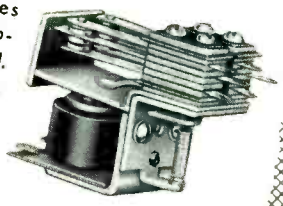
SERIES 2005 RELAY

This 6 P.D.T. hermetically sealed 5 Amp. sub-miniature relay meets specs. MIL-R-6106-A and MIL-R-5757-B. Rugged unit withstands 100 G shock, 10 G vibration at 75—2000 cyc. Wt.—4.25 oz.



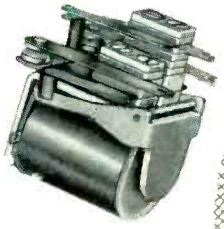
SERIES 210 UM RELAY

New magnetic motor controller unit carries full Underwriters' Laboratories approval. Contacts rated at 115 v. A.C. 60 cyc., single phase, ¼ H.P. Combinations SPST up to DPDT.



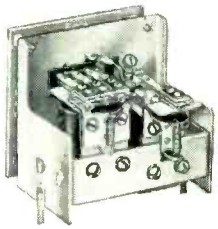
SERIES 595 D.C. RELAY

Midget telephone type, Series 595 with contacts capable of withstanding an inrush current of 50 amperes and rated for continuous operation at 15 amperes. Also available hermetically sealed.



STEPPERS

The new electrical reset P.E.R. stepper operates up to 20 steps per second. Also available from Guardian are various add and subtract, continuous rotation, electrical reset, pulsing, ratchet and other types.



P E R STEPPER

These new Guardian developments have already earned an enviable reputation for dependable performance. Each unit is a "best seller" to important military and industrial users. Such preference should justify *your* selection of these and other associated Guardian controls.

Write for NEW GUARDIAN CATALOG NO. 11

GUARDIAN ELECTRIC

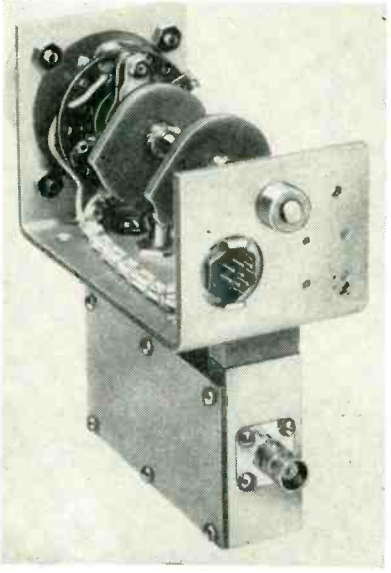
1625-F W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

element in a typical voltage divider. The new features which have been provided include: (1) temperature insensitive operation over a range of −50 to +100 C; (2) d-c to a-c conversion ratio over 0.5; (3) noise pickup of less than 200 μv rms; (4) 115-v, 3-ma, a-c excitation. The chopper measures only $\frac{7}{8}$ in. high × $\frac{7}{8}$ in. wide × 2 in. long and weighs 1.6 oz.

UHF-TV TUNER
reduces interference

RADIO CONDENSER CO., Davis & Copewood Sts., Camden 3, N. J., has developed a new uhf-tv tuner to meet the r-f interference objectives of both RETMA and the FCC. Model T-90 tuner features a rearrangement of the usual tv tuner components and better shielding which combine to act as oscillator radiation fixes, thereby preventing the oscillator from radiating interference outside the recommended limits. Ask for bulletin T-90.



R-F ATTENUATOR
with remote control

THE DAVEN CO., 191 Central Ave., Newark, N. J., has made available a new remote control adaptation of its standard r-f attenuator. The new unit, series 544, is cam operated and solenoid driven. Its salient feature is a special arm which permits remote selection of any of the following cam operated positions: (1) First position and

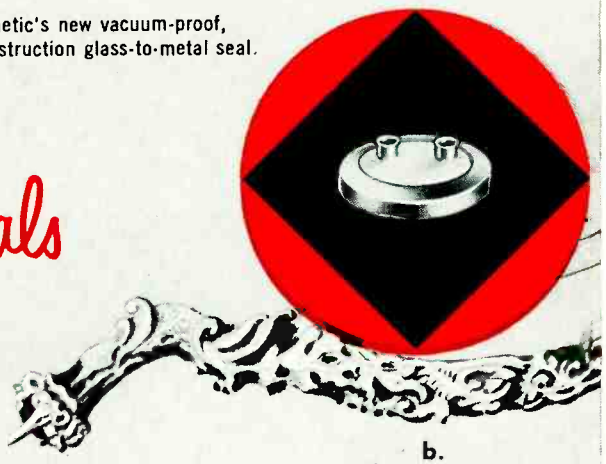
Variety that spurs imagination

a.

Designed with either matched glass or Vac-Tite* compression construction . . . with O. D.'s that range from .152 to .962 . . . these Hermetic Condenser Seals are produced to fit standard condenser cans. They provide the design engineer and manufacturer with an unprecedented variety of economical, low-cost packages for use in the design and production of impregnated paper capacitors, rectifiers and filter networks.

*Vac-Tite is Hermetic's new vacuum-proof, compression construction glass-to-metal seal.

Hermetic Condenser Seals

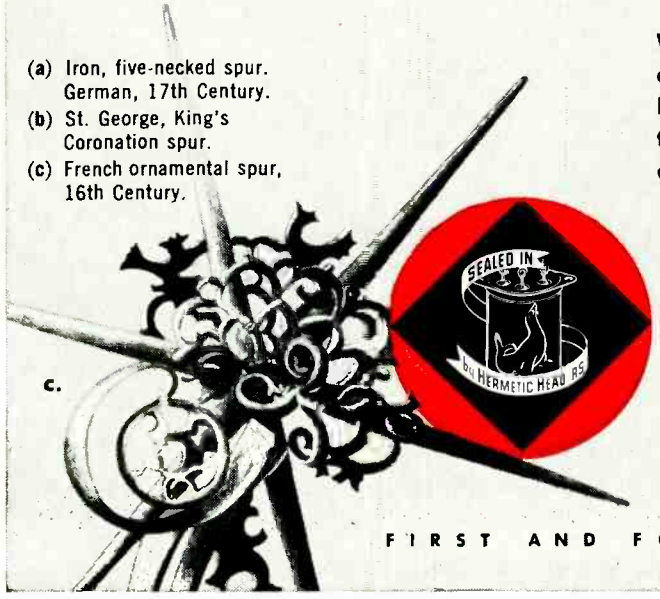


b.

Design Variations . . . Hermetic Condenser Seals are offered in 2-tube configurations from .377 O. D. and 3-tube configurations from .477 O. D.

Mounting Variations . . . These Condenser Seals can be supplied with mounting lugs attached to the tubular terminals or with flattened and pierced tubing. They can be mounted on flat sheet metal covers that have a recess in which the part can be positioned and the solder confined.

(a) Iron, five-necked spur. German, 17th Century.
(b) St. George, King's Coronation spur.
(c) French ornamental spur, 16th Century.



c.

Write for engineering data, drawings, prices and samples on these and the many other Hermetic standard parts available that satisfy the most extreme requirements of industry and the Services.

Hermetic Seal Products Company

31 South 6th Street, Newark 7, New Jersey

FIRST AND FOREMOST IN MINIATURIZATION

second position, entirely out of circuit; (2) first attenuation position in the circuit, and second attenuation position out of the circuit; (3) both attenuation positions in the circuit. This cycle can be repeated indefinitely. The unit shown has 3 steps, but variations can be provided with up to 5 steps plus zero attenuation. A maximum of 20 db per step can be supplied.

TRANSFORMER CONTROL
measures displacement

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J. Type 332 differential transformer control is a complete, self-contained unit designed for use with medium-frequency differential transformers and c-r oscillographs. When used with the type 324 oscillograph, the type 332 can measure static or dynamic displacements in the region of ±0.000025 to 0.1 in. per major scale division of deflection. It is very useful as a static or dynamic micrometer for measurements of displacement, velocity, acceleration or vibration. It has a frequency response extending from d-c to 1 db down at 1,000 cps.

MAGNETRON
for weather radar service

RADIO CORP. OF AMERICA, Harrison, N. J., has announced a magnetron designed specifically for service as a pulsed oscillator at a fixed frequency of 5,400 ±20 mc in weather radio equipment. The 6521 magnetron has a maximum peak anode voltage rating of 16 kv and a peak anode current rating of 10 to 16 amperes. It operates with high

for telephones, too

CRUCIBLE PERMANENT MAGNETS

mean maximum energy . . . minimum size

You get *consistently higher* energy product from Crucible *prescription-made* alnico permanent magnets.

That means more energy from a smaller magnet . . . greater design freedom for manufacturers of telephone sets, high-fidelity sound equipment, controls, instruments, and magnet-equipped devices of all kinds.

Crucible, the nation's leading producer of *special purpose steels*, has been making these quality magnets ever since the development of alnico alloys. They're available sand cast, shell molded, or investment cast to meet every size, tolerance, shape and finish need.

For prompt delivery – or helpful advice on magnet problems – call Crucible. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

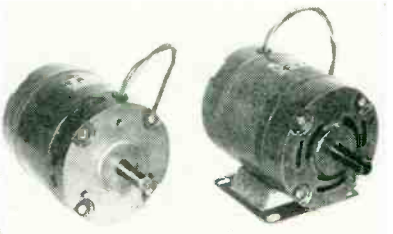
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

efficiency at pulse durations up to 2.2 μsec. Peak power outputs ranging from 60 kw to approximately 100 kw are attainable. Full ratings may be used at altitudes up to 16,000 ft without pressurization. Design of the magnetron incorporates a large, sturdy cathode and an integral Alnico magnet which is covered by a protective die-cast aluminum jacket. Large-area cooling fins provide efficient cooling with little air flow. A waveguide output flange, conforming to proposed RETMA standards, is designed for coupling to a 1-in. × 2-in. rectangular waveguide.

IMPREGNANT
for transformers and coils

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass., has announced a new class H impregnant for transformers, coils and electronic components. The solvent-free, epoxide base material is designated ECCO W 28 G. It is suitable for continuous use at 200 C. It is simple to use and no catalyst is required. A filler designated A-21 is also supplied so that it can be used simultaneously as an impregnant and embedment compound. Properties are available on request.



SMALL MOTORS
hysteresis or a-c induction

INSTRUMENT MOTORS, Box 5, Acosta St., Stamford, Conn., has announced a new line of miniature, high-power motors in its recently developed Frame 43 models for continuous-duty, class A service. They are available as either hysteresis or a-c induction units. Improved design

. . . the efficient socket . . . for your printed-circuit

Sylvania Printed-Circuit Sockets

7-pin and 9-pin sockets now available

. . . for more efficient *printed-circuit* design

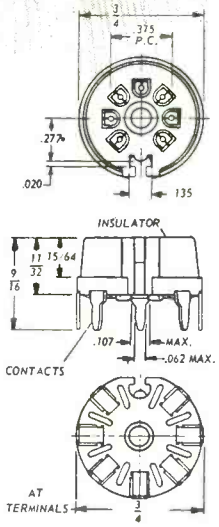
Contacts fit through smaller holes in the circuit board, providing more space and greater freedom in design of circuitry. Circuits can be arranged for shorter conductor paths and greater compactness, including cross circuits between contacts.

. . . for more efficient *printed-circuit* production

Sockets lend themselves to automatic socket-to-board assembly techniques. Tube shield ground strap location keys the socket for positive orientation. Strap retains and grounds the tube shield. Sockets are supplied with ground strap loose, eliminating the need to stock two production assemblies.

. . . for more efficient *printed-circuit* performance

Sylvania's printed circuit socket, provided with an all-molded insulator, eliminates moisture traps, offers higher insulation qualities and superior contact characteristics. Top surface installation allows greater heat dissipation.



INSULATOR:
General Purpose or Low Loss Phenolic

CONTACTS:
Brass, Cadmium plated

TUBE SHIELD GROUND STRAP:
Brass, Cadmium plated

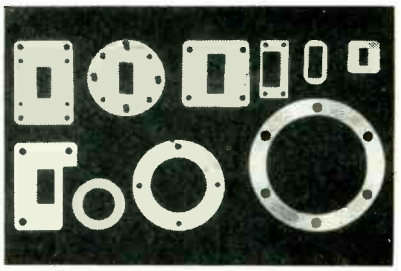
Sylvania manufactures a complete line of high quality sockets, terminal strips, and other electronic components. Write for the complete catalog. Address literature or quotation requests to Department E20S.

SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.,
University Tower Bldg.,
St. Catherine Street, Montreal, P.Q.

and built-in air conditioning give a very low temperature rise with ratings up to ⅛ hp in a frame only 4⅜ in. o-d × 5½ in. long. The induction-type motors incorporate rotors that are insulated silicon-steel, pressure die-cast with 99.5 percent aluminum. The hysteresis type have rotors of cobalt steel machined and heat-treated, then fitted to aluminum spiders, pressed and pined to the shaft. Both types are specially designed for easy modification to meet a wide range of requirements.



WAFER FLANGES
for all waveguide sizes

AMERICAN RADAR COMPONENTS INC., Box 418, Whippany, N. J., has available a new series of wafer flanges WF-100. These flanges are now stocked for all sizes and types of waveguides, a few of which are shown. Particular emphasis has been placed on the transition size Xs-X1. They should prove equally valuable for test setups as well as for production. Complete engineering specifications are available on request.

FREQUENCY STANDARD
is compact signal generator

D & R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif., has announced production of a new compact signal generator which acts as

HERE IT IS! . . .

the greatest improvement

in

Vinyl Glass Sleevings

in 5 years

BH Vinyl-Sil 8000 Sleeving has no capillarity. Shown above, are two sleeving samples in a beaker of water. They have been split to show braided construction. On the left, is new BH Vinyl-Sil 8000. Note how light in color it is. The sample on the right is ordinary vinyl-glass sleeving, noticeably darker in color from water which rose by capillary action . . . the bottom edge is completely water soaked.

BH Vinyl-Sil 8000 Sleeving . . . for unequalled heat resistance and non-corrosiveness . . . plus 8000 volt *minimum* short-time dielectric breakdown.

The new BH Vinyl-Sil 8000 Sleeving combines stabilized organic resins with those of the silicone group to provide these outstanding features of each . . . high dielectric strength and unusual heat resistance. Flexibility permanence has been increased far beyond previous records. Even after 2000 hours at 130°C. — with tests continuing — BH Vinyl-Sil 8000 continues to provide a short-time dielectric breakdown of 8000 volts *minimum* and shows no appreciable change in physical characteristics. It meets and surpasses *all* NEMA and ASTM Specifications for Class B-A-1.

BH Vinyl-Sil 8000 Sleeving is non-wicking (note illustration at the right). There can be no entrapped moisture to impair the effectiveness of varnish impregnation. Data Sheets and samples of BH Vinyl-Sil 8000 are yours for the asking. Write today and use the advantages of this *new* superior vinyl-glass sleeving.

BENTLEY, HARRIS MANUFACTURING CO.
1305 Barclay Street
CONSHOHOCKEN, PENNSYLVANIA
Telephone: Conshohocken 6-0634

BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

For more information, use coupon on last page.

a secondary frequency standard with a short-time accuracy of 1 part per million. Generating 12 selected standard frequencies between 100 kc and 20 cps, the model FS-1 has a long-time accuracy of the stabilized characteristic 100 kc standard crystal of 20 parts per million over normal room temperature ambient range. Eleven sine-wave frequencies, available at approximately 1-v level, selected by front-panel controls are: 20, 15, 10, 5, 3 and 1 kc; 400, 300, 100, 60 and 20 cycles. In addition, a constant 100-kc signal may be used for reference to a primary standard or to WWV for precise correlation. All frequencies delivered have the same accuracy as the 100-kc crystal.

ATTENUATOR
covers 4,000 to 12,400 mc

POLARAD ELECTRONICS CORP., 43–20 34th St., Long Island City 1, N. Y., has announced a continuously variable, stub-tuned, mutual inductance attenuator designed for external use in making microwave measurements with spectrum analyzers, signal sources, receivers and for power measurements. Model SIJ attenuator (waveguide beyond cut-off type) will insure r-f circuit isolation and may be used to convert a signal source or laboratory oscillator to perform many of the functions of a signal generator. Frequency range is from 4,000 to 12,400 mc.

MANUAL KEYCARD
for X-Y plotting

LIBRASCOPE, INC., 1607 Flower St., Glendale, Calif., has developed a

YEARS AHEAD of the industry...

Type 105 Model 6

New! Northern Radio

FREQUENCY SHIFT KEYER

Sets a new standard for the Industry. It supersedes and directly replaces its LEADER PREDECESSOR, the Type 105 Model 4.

New! *Highest Stability achieved by any Frequency Shift Keyer*

New! *Increased Frequency Range 1.0 to 7.0 mc*

New! *Pre-selection of Proper Frequency Shift for any particular transmitter frequency multiplication*

New! *Permits use with external oscillator without need of adapters*

New! *Improved Accessibility — for even easier maintenance*

The new Northern Radio Frequency Shift Keyer Type 105 Model 6, is a very high stability RF oscillator which provides a means for shifting an RF carrier in accordance with the intelligence. This exciter replaces the crystal oscillator in a transmitter and produces "Mark" and "Space" carrier shift for transmission of teleprinter or telegraph signals, or a linear carrier shift for transmission of FM telephone, facsimile or telephoto. In addition to the technical advancements mentioned above, this new Keyer continues to embody the following performance-proven features:

- Direct-reading frequency calibration of shift from 0 to 1000 cps.
- Frequency shift dial adjusts "Mark" and "Space" frequencies equally above and below the carrier position, which remains fixed.
- Simplfied frequency setting makes only the upper sideband tuning indication visible on the meter over substantially all of the tuning range.
- Direct-reading frequency calibration of mixer and output tuning dials from 1.0 to 7.0 mc.
- Direct-reading calibration of output frequency vernier ± 600 cps.
- Pulse-shaping circuit to permit operation within assigned bandwidth with no adjacent channel radiation.
- Highly stable temperature-controlled oven with control of ± 0.1°C. at 60°
- Linear carrier shift up to 1400 cps for Fax operations.
- Component ratings according to JAN specs for greater assurance of trouble-free operation.

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.

147 WEST 22nd ST., NEW YORK 11, NEW YORK

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

Write for Free Catalog E-5.

new manually operated decimal keyboard that activates a plotter by supplying excitation for the X and Y input transducers. A major innovation is the elimination of the problem of sticking switch contacts and high contact resistance. Self-wiping, slide-type contacts, linked directly to the keys, completely eliminate the necessity for any adjustments of the switches and contacts. The keyboard simulates resistance potentiometers by means of two voltage dividers, each consisting of 3 banks of series-connected precision resistors which are switched into the input circuit by pressing the front panel keys. It is energized by voltage from the recorder. No external power sources are required. The unit measures 6 in. × 11 in. × 8½ in. and weighs only 12 lb. A variety of contact configurations are available which make possible the manual feeding of decimal or binary coded decimal inputs to computer and other systems.

VACUUM CAPACITORS
available in many ranges

DOLINKO & WILKENS, INC., 1901 Summit Ave., Union City, N. J., announce a new line of heavy-duty vacuum capacitors featuring extra-rugged end terminal connectors ($1\frac{33}{64}$ in. o-d × $1\frac{3}{8}$ in. i-d × $\frac{3}{4}$ in. long). Units are available in many capacitance ranges including 250 μμf (VC250-A), 100 μμf (VC100-A), and 50 μμf (VC50-A), with voltage ratings of 32 kv. The new larger terminal surfaces plus increased heat dissipation from both interior and exterior of the terminal connectors allow for cooler operation under heavy load than

INSTANTANEOUS MEASUREMENT OF INSULATION RESISTANCE...

500 MILLION MEGOHMS

Tera-Ohmmeters are outstanding for accuracy, stability, and the unprecedented sensitivity of 500 tera-ohms (500 x 10^{12} ohms).

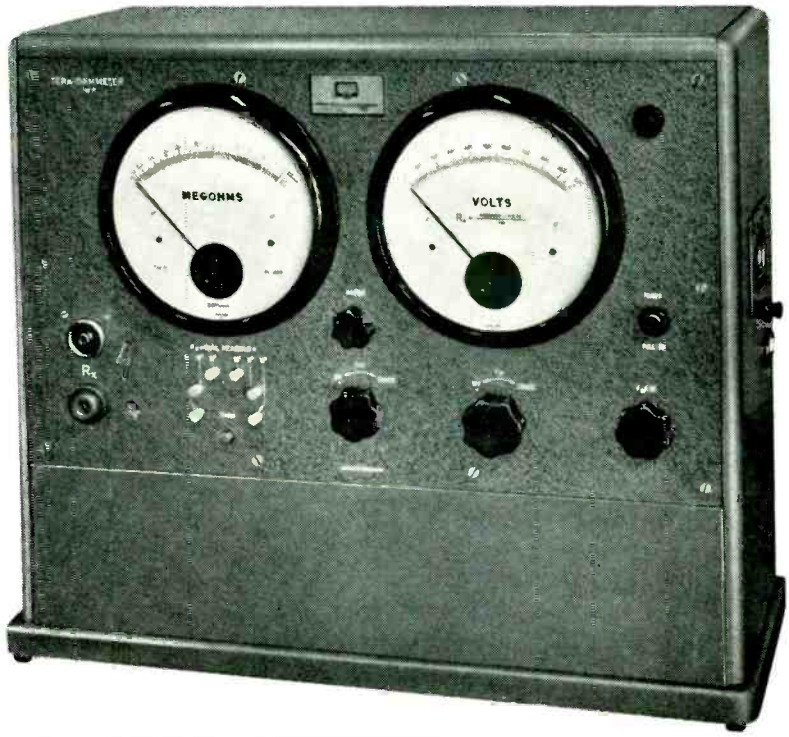
Instantaneous response of electrometer circuit makes it possible to measure rapid variations of insulation resistance as a function of time, temperature, voltage, moisture and other parameters. This is of extreme value since insulation resistance is rarely of a fixed magnitude.

Partial and complete breakdown of insulating materials can be observed without chance of damage to the equipment. Major applications include insulation measurement of resistors, capacitors, tube sockets, switches, transformers, wires, cables, electrical machines and other equipment.

Greatest accuracy and stability of test conditions are assured by battery-supplied test voltages . . . equipped with charger circuit. Fixed test voltages of 3, 10, 100, and 500 volts are available in several models. One model, the type H, provides a continuously adjustable test voltage from 100 to 1000 volts. Accuracy of measurement is ±3% in center of scale for all ranges.

Widely used by government and industrial laboratories . . . today's most versatile insulation measuring equipment . . . assures efficient and thorough evaluation of all insulation problems.

Calibrated Comparison Resistors mounted in shielded holders are available for reference purposes. These resistors, in values from 10^9 to 10^{13} ohms, are calibrated to an accuracy of 1%.



Type FT-H Tera-Ohmmeter

Measurements in accordance with ASTM standards

FEATURES

- Measures *instantaneous* changes in resistance
- Direct reading on 7" precision meters with knife-edge pointer
- Wide range from .2 megohms to 5 x 10^{14} ohms
- High accuracy of measurement: ±3% in scale center
- Simplicity of operation—readily used by unskilled personnel
- Test samples can be measured grounded, ungrounded, or with guard-ring electrode
- Charge button for rapid charge of capacitors

INSTRUMENT DIVISION

Federal

A DIVISION OF I T & T

Federal Telephone and Radio Company, *A Division of* INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
Instrument Division, 100 Kingsland Road, Clifton, N. J.

☐ Please send further information on Tera-Ohmmeters.

☐ Please send latest Instrument Catalog.

☐ Please arrange for demonstration.

*Name*_____ *Position*_____

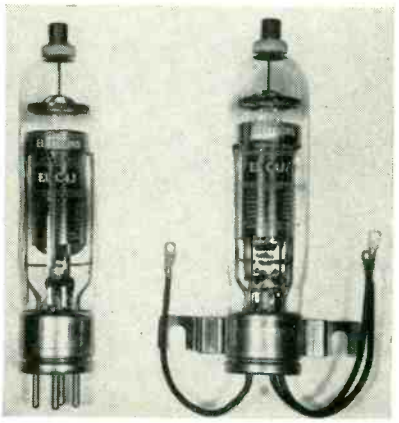
*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

Dept. S-513

previously possible. Conservative current ratings of 100 amperes rms without external cooling, and 150 amperes rms with an air blast of 7 cfm are given. The capacitors are of all oxygen-free, high-conductivity copper and Pyrex glass construction with overall dimensions of $6\frac{5}{8}$ in. o-l and $2\frac{7}{8}$ in. o-d.



THYRATRONS
for socket, panel mounting

ELECTRONS, INC., 127 Sussex Ave., Newark 3, N. J., is manufacturing two new xenon-filled thyratrons having identical electrical characteristics. They are ideal for application in motor control and ignitor firing circuits. The ELC4J is desinged for socket mounting; the ELC4J/F for panel mounting wherever conventional sockets might not be desirable. Ratings of both are 4 amperes d-c continuous average anode current; 30 amperes oscillograph peak current with maximum peak forward and peak inverse of 900 v. The average arc drop is 12 v and heating time is 60 sec. Stable grid characteristics are maintained throughout life and the critical grid current is less than 10 μa.

JUNCTION TRANSISTOR
for high-temperature use

CBS-HYTRON, a Division of Columbia Broadcasting System, Inc., Danvers, Mass., has announced a *pnp* junction transistor for high temperature amplifier applications. The type 2N82 germanium transistor is capable of 35 mw collector dissipation at 71 C. Its metal case,

E-I *presents*

NEW EXPANDED LINE OF HERMETICALLY SEALED

COMPRESSION TYPE END SEALS

*PATENTS PENDING—ALL RIGHTS RESERVED

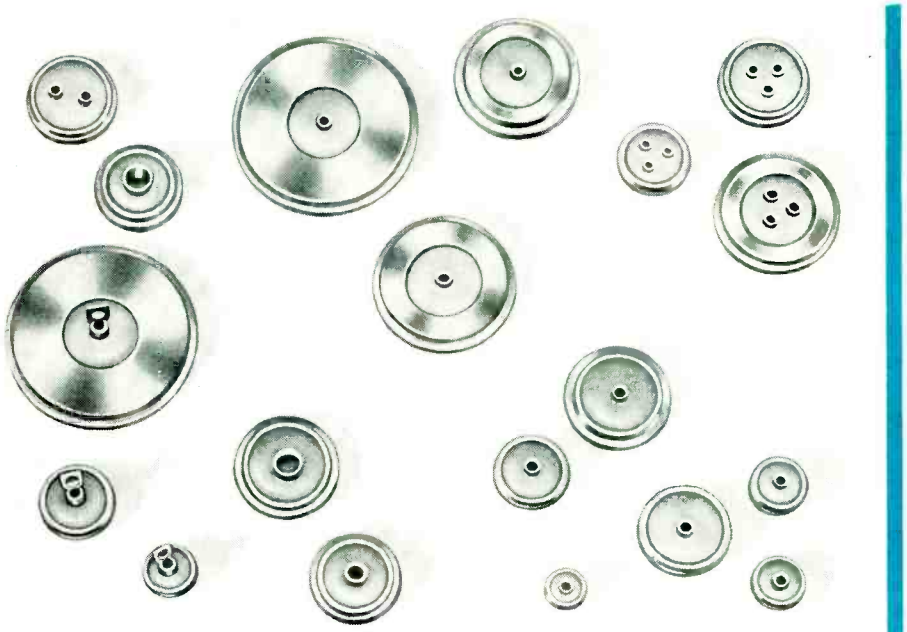
FOR HERMETICALLY SEALING CONDENSERS, RESISTORS AND OTHER TUBULAR COMPONENTS

E-I standardization now makes it possible to offer designers and engineers the economy of standard components in a wide selection of types and sizes. These rugged compression type end seals are available in a broad range of dimensions, in either flared tube or pierced terminals, with single or multiple lead terminations. Inquiries invited.

—here's how

COMPRESSION CONSTRUCTION PROVIDES THE TIME-PROVEN LASTING SEALS

In this exclusive E-I compression construction, the glass remains under constant compression and is therefore extremely strong. These seals possess extraordinary immunity to shock, vibration and pressure changes. For all practical purposes E-I Compression Seals are indestructible. No special skill is required to apply and assembly is rapid as all metal parts are tin dipped for easy soldering.

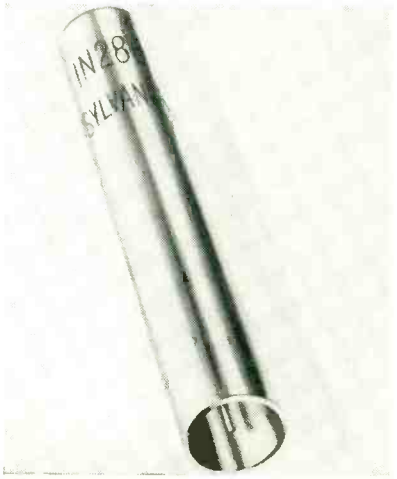


E-I Leadership—in the field of hermetic sealing assures dependability, economy and fast delivery . . . specify E-I for multiple headers, octal plug-ins, transistor bases and closures, sealed terminals, end seals and color coded terminals.

ELECTRICAL INDUSTRIES

Division of Amperex Electronics Corporation • 44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

only 0.33 in. long by 0.225 in. in diameter, is hermetically sealed against surface contamination, light excitation and humidity.



CRYSTAL DIODE
is point-contact type

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. The 1N286 silicon crystal diode is a broadband, coaxial, point-contact type. It is designed for use as a crystal mixer and its internal geometry makes it possible to cover the band of frequencies from 10,000 to 20,000 mc. With the crystal holder made in WR-75 waveguide the band of frequencies from 10,000 to 15,000 mc can be covered and with the crystal holder made in WR-51 waveguide the band of frequencies from 15,000 to 22,000 mc can be covered. Because of its broadband characteristics, it is particularly useful in such applications as tunable frequency radar systems and countermeasures devices.

CATHODE ALLOY
has high hot strength

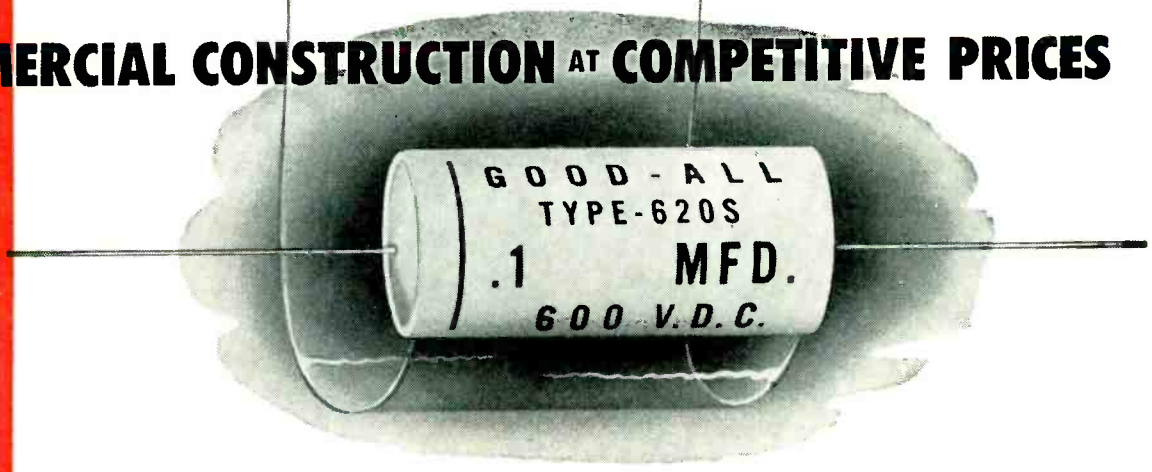
SUPERIOR TUBE CO., 1523 Germantown Ave., Norristown, Pa. Cathaloy A-32 can be used for cathodes in virtually any electron tube—entertainment, computer, instrument—requiring an active cathode alloy. It contains 2.25 percent tungsten and 0.10 percent aluminum. The 2.25 percent tungsten in Cathaloy A-32 gives it high strength at both room temperature

Good-ALL capacitors

MYLAR* DIELECTRIC

*Du Ponts Trade Mark for its Polyester Film

COMMERCIAL CONSTRUCTION AT COMPETITIVE PRICES



Good-ALL SERAMELITE Capacitors

MODELS 620S and 621S

. . . combine the excellent electric characteristics of "MYLAR" with the superior humidity resistance properties of "Seramelites" to produce a completely new capacitor for exacting applications at reasonable prices.

These competitively priced new miniature capacitors closely approximate the performance of expensive hermetically sealed units. They are designed to cover the entire capacitance and voltage range.

CHARACTERISTICS:

- Insulation resistance 20,000 megohm-microfarads
- Power Factor is Less than 1%
- Operating Temperature −55° C to + 125° C
- Generally smaller than RETMA Standards
- Tolerances as close as ½ of 1%

CONSTRUCTION FEATURES:

- Tubular Ceramic Enclosure
- New Plastic End Seal
- Inserted Tab or Extended Foil
- Miracle X Impregnated

OTHER GOOD-ALL "MYLAR" CAPACITORS

FILM-X (Hermetically Sealed) • MARBELITE (Plastic Impregnated Paper Tube)

Available for printed circuit or other applications in all mounting styles. Built to your specifications.

So *Superior* . . . They are being used extensively by leading Electronic, TV, and Radio Manufacturers throughout America.

GOOD-ALL ELECTRIC MFG. CO. 120 FIRST ST • OGALLALA, NEBRASKA

Good-ALL capacitors

Want more information? Use post card on last page.

and operating temperatures. The alloy's hot deflection strength—the stress necessary to withstand elastic deformation of one mil—is 3,750 lb per sq in. at 900 C. It is particularly recommended where resistance to shock and vibration is required.

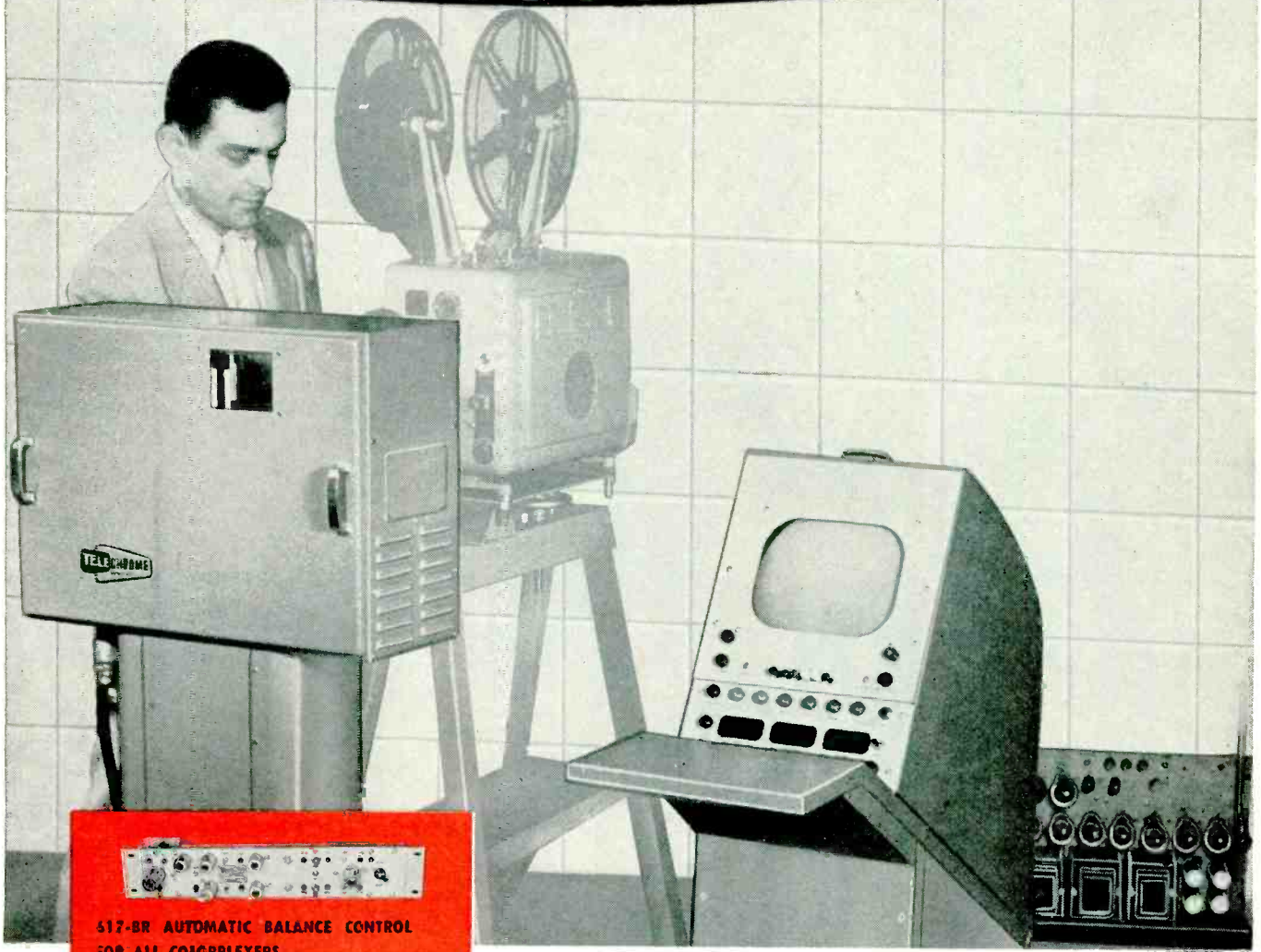
SEALING BOOT
for wide range of cables

WHITNEY BLAKE CO., Electronics Div., New Haven 14, Conn., has available a new type sealing boot to replace cable clamp adaptors AN3057, AN3057A and AN3057B. This boot is used on jacketed cables and on wires covered by sleeving to furnish support at the plug or connector and to relieve strain on the connections. Made of oil-resistant neoprene with a threaded ring of light weight aluminum, this boot is self-centering. An aircraft-type hose clamp supplies positive sealing action. The boot seals on cables over a range of sizes three times as great as for any other Army-Navy type cable clamp adapter. Gripping power is sufficiently great so that when the cable is pulled there is never a strain on the soldered terminals.

SWITCHING DEVICE
for computing and control

COMPUTER INSTRUMENTS CORP., 1964 Utica Ave., Brooklyn 34, N. Y., has introduced the precision commutator and impulse generator, as a standard component in their integrated line of miniature precision potentiometers. The unit is intended for use as a high-speed switching device for counting, digital indication of shaft rotation, pulse shaping, pulse gating, se-

YOUR STATION HAS COLOR TV FILM EQUIPMENT



BUT YOU MAY NOT REALIZE IT

Your present 16 mm., 35 mm. or slide projectors used with the TELECHROME 3-Vidicon Color Film Chain are full color film facilities.

The vidicon principle for black and white film, widely proven for best signal to noise ratio and highest resolution detail is now applied to COLOR . . . one vidicon each for Red, Green, Blue.

TELECHROME 3-V provides highest quality color pictures. It is most compact, easy to operate and least expensive since you need not purchase additional film projectors. A built-in folded optical system multiplexes three light sources. Films of light and heavy density are equally accommodated. The 3-V may also be used as a single channel monochrome film chain.

IMMEDIATE DELIVERY

Literature on these and more than 150 additional instruments for color TV by TELECHROME are available on request.

517-BR AUTOMATIC BALANCE CONTROL FOR ALL COLORPLEXERS (Regardless of Manufacture)

An ingenious circuit locks the entire encoding equipment in balance within 20 seconds after being turned on. Thereafter balance is held under even the most difficult operating conditions.

1601-AR CHROMASCOPE

Signal Certification Equipment. Accurately measures the performance alignment, and phase errors of color TV equipment. New secondary phase standard for accurate reading to .01°. Presents on a cathode ray screen a continuous polar plot of the phase and amplitudes of all colors in a composite color video signal. Capable of .02° accuracy with 1604-AR phase magnifier.

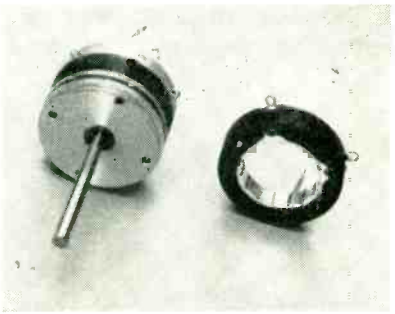
636-B CHROMALYZER

Portable Precision Color Bar Generator for checking color broadcast studio and transmission facilities, receivers and monitors. Can be tied into a system. Provides complete composite colors & quals at 100 or 75% chroma.

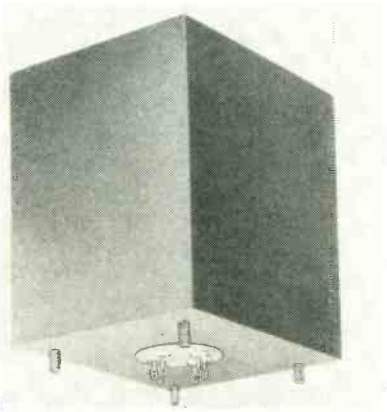
TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

See us at location **32-NARTB Convention**

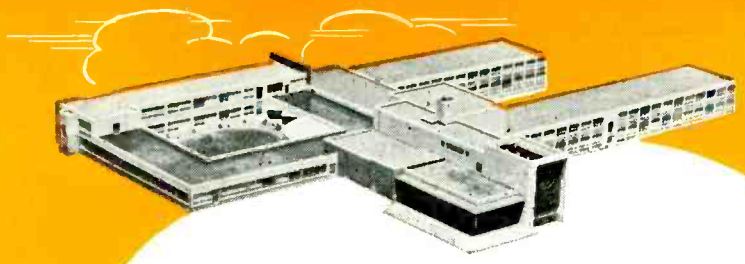


quence circuit control and the like. The commutator-generator consists of a series of conducting segments, bonded to a high-temperature plastic base, insulated from one another, and interconnected to form a wide variety of coded commutation or pulse sequences. The use of multiple isolated wipers permits commutation in several circuits simultaneously, and increases total pulse count per revolution. The element is approximately 1 in. in diameter and weighs 2/10 oz. Precious metal contacts are used throughout. Operational speeds up to 1,000 rpm are permissible, with a life in excess of one million revolutions.



SERVO AMPLIFIER
performs without rectifiers

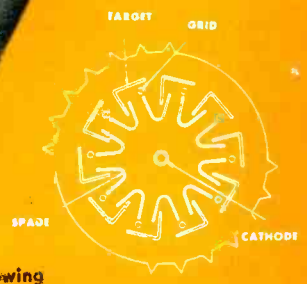
POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The T6C16W1 saturable transformer will drive 115-v, 60-cps servo motors requiring up to 16 w to the control phase. Performing without the use of rectifiers, this inexpensive unit provides low drift and exceptionally long, trouble-free life over a wide range of temperature from −55 to +85 C. Containing only static, magnetic components, it is highly resistant to shock and vibration. Bandwidth is 0 to 3 cps, and a power



Newest ELECTRONIC CONCEPT BY
BURROUGHS CORPORATION RESEARCH CENTER

BEAM SWITCHING TUBE...

AVAILABLE NOW IN PRODUCTION QUANTITIES



Cross Section showing
Cathode, Grids,
Spades and Targets for
10 position switching.

The beam switching tube offers a new basic device to the engineer of electronic equipment. Versatility of the basic ten-position tube is such that any desired type of sequential, simultaneous or random switching of any number of positions may be obtained. The simplicity of the tube design and associated required circuitry results in a new standard of reliability. It reduces the total number of tubes required in a circuit, space, weight, and heat in control and switching systems.

Perfected by the Burroughs Research Center... rigidly tested and accepted by key electronic plants and communications labs throughout the world... this revolutionary new tube is now precision-manufactured in production quantities with complete accuracy and dependability by the Haydu tube division, specialists in the electronic industry.

The simplicity and reliability of this new basic building block have been demonstrated in applications performing the following functions:

- DISTRIBUTING
- SAMPLING
- FREQUENCY DIVIDING
- COUNTING
- CODING
- MODULATING
- GATING
- TIMING
- CASCADING
- MULTIPLEXING
- MATRIXING
- OSCILLATING

HAYDU

BROTHERS OF NEW JERSEY

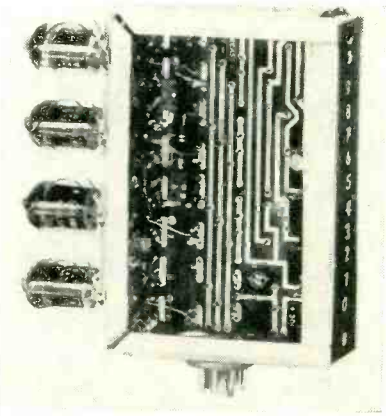
PLAINFIELD, NEW JERSEY

Subsidiary of Burroughs Corporation

An Applications Engineering Department, offering engineering service and consultation, has been set up to assist you in taking full advantage of this device. For further information, contact:

APPLICATIONS ENGINEERING DEPARTMENT
HAYDU BROTHERS OF NEW JERSEY
c/o BURROUGHS RESEARCH CENTER
PAOLI, PENNSYLVANIA

gain of 20 is realized. Hermetically sealed in a MIL type can, the unit is $3\frac{7}{8}$ in. long × $3\frac{5}{16}$ in. wide × $5\frac{1}{4}$ in. high. It weighs $6\frac{1}{2}$ lb. It is designed to operate with a simple v-t voltage preamplifier, such as a 12AU7. Neither the T6C16W1 nor its preamplifier requires a d-c power supply.



DECADE COUNTER
operates recorders

HEWLETT-PACKARD Co., 395 Page Mill Rd., Palo Alto, Calif. Model AC-4A decade counters provide a 120-kc counting rate and have an output voltage suitable for recorder operation. They feature etched circuits wherein every circuit segment is fully visible, clearly labeled and arranged diagrammatically, for simple servicing. These decade counters are engineered to fit all standard electronic counters, regardless of make, and also may be used separately in experimental or special setups. The new etched circuits give good balance and uniform incidental capacities for the high 120-kc counting rate. Resistors are premium quality 5-percent tolerance units; coupling capacitors are silver mica; and the 4 electronic tubes employed in each counter are of the computer type. Price is $45.

BACKWARD-WAVE OSCILLATOR
for microwave use

STEWART ENGINEERING Co., Box 277, Soquel, Calif., has developed a helix-type backward wave oscillator type OX-7-11-50 for service in microwave equipment. The tube operates as a continuously voltage-

Midwestern Instruments' NEW CURRENT SOURCE

A PRECISION INSTRUMENT TO SUPPLY A few Microamperes to 100 Milliamperes

This unusually accurate instrument was originally designed to be used in Midwestern's Galvanometer Shop for precision calibration. It was so extremely valuable there we are now making it available for commercial sale. It is a finely-regulated dc power supply, with unusually small ripple content, operated in conjunction with a network of precision, temperature-stable resistors. Output is controlled by a 10-turn precision potentiometer in the bias circuit of the electronically-regulated power-supply section. A highly accurate voltmeter measures voltage across the precision resistor and output load network, and is calibrated in terms of current.

WRITE FOR COMPLETE DETAILS.

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
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MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS

41st and Sheridan Road — Tulsa, Oklahoma

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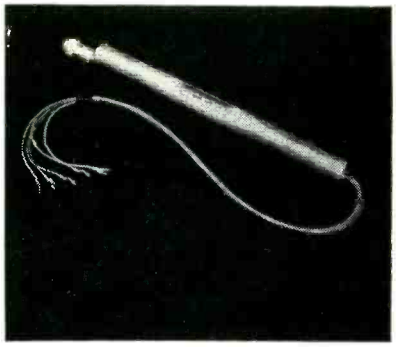
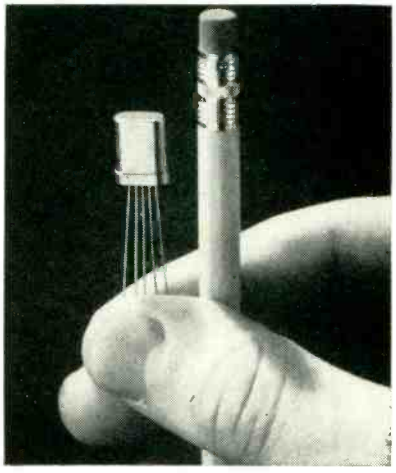


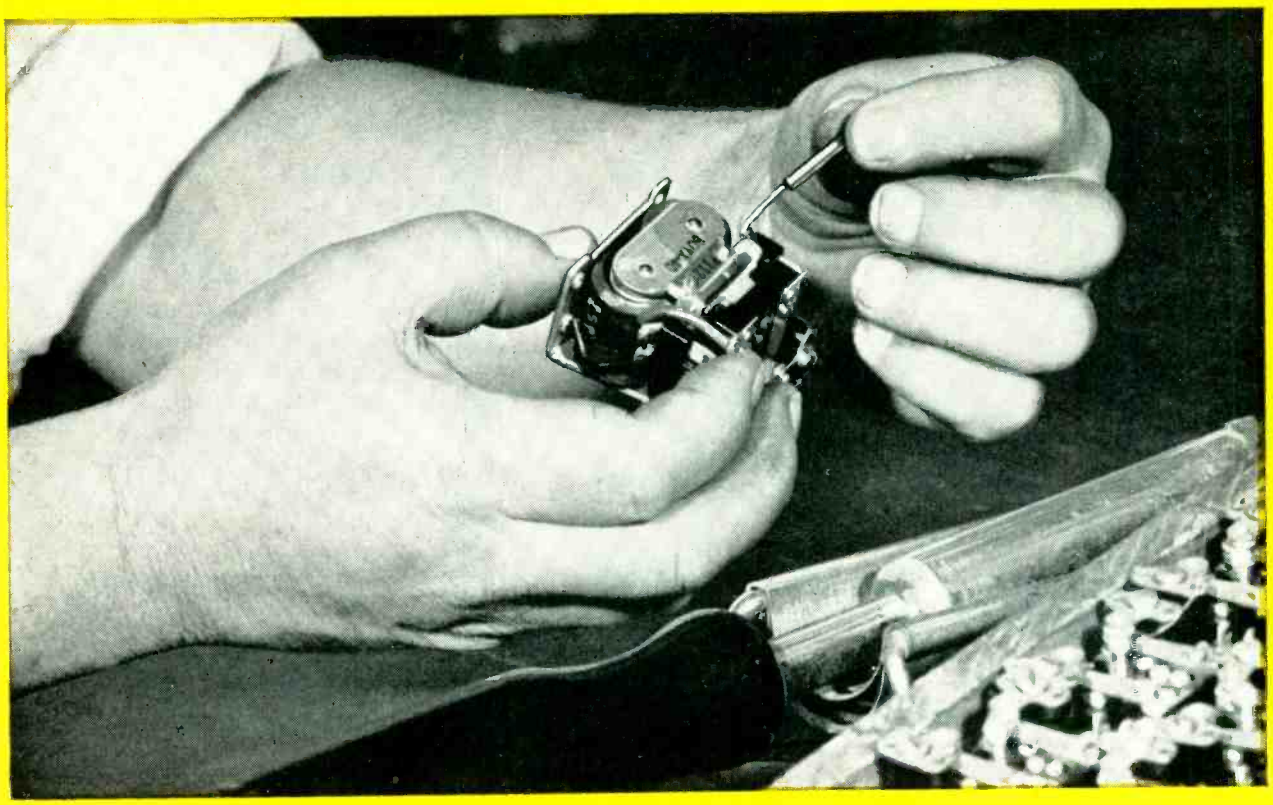
tuned oscillator over the frequency range 5.8 to 11.6 kmc, by varying the helix voltage from 250 to 1,500 v. It provides a stable microwave signal source having a minimum power output of 50 mw over the band 7 to 11.6 kmc and at least 5 mw over its entire frequency range. Frequency of oscillation of the oscillator is relatively independent of changes in its load. A less than 1-percent frequency change results when the load is varied, from a perfect match to a short circuit of any phase, in the absence of pads between the tube and its load.



TINY RELAY
is shock resistant

ELGIN NATIONAL WATCH Co., Elgin, Ill., has introduced the Neomite shock-resistant relay housed in a standard transistor case half an inch high. It is expected to have particular application in guided missiles. The spdt relay is designed for applications in which capacity, weight, size and reliability are of extreme importance. It can withstand severe shock and vibration, together with violent extremes in temperature. The Neo-

Slips Easily Over Stranded Lines



"Flexible at Low Temperatures"...Reports Allied Control Co. on IRV-O-LITE XTE-30

Ability to retain its initial flexibility over long periods of operation at low temperatures is one of the major reasons why Allied Control Company, Inc., New York, has selected Irvington's IRV-O-LITE XTE-30 extruded plastic tubing. Tubing is used for insulating the flexible pigtail connections to the moving contact arms on Allied's Type BOY relays.

Because of its smooth interior surface, XTE-30 tubing slips easily over the finely stranded wire leads without breakage of strands. In addition to its high dielectric strength, the tubing affords mechanical protection from abrasion and tearing.

Other features of XTE-30 include high tensile strength and resistance to acids, alkalies and most solvents.

Send for data sheet which gives technical specifications, dimensions and color range.

1905 GOLDEN ANNIVERSARY 1955 IRVINGTON

PLASTICS PRODUCTS

IRVINGTON DIVISION

MINNESOTA MINING & MANUFACTURING COMPANY

11 ARGYLE TERRACE IRVINGTON 11, N. J.

mite weighs 0.035 oz. It has a ¼ ampere contact rating (noninductive) and a 26.5-v d-c rating. Sensitivity is 100 mw and it can be adjusted down to approximately 40 mw.

MINIATURE TUBE
for television receivers

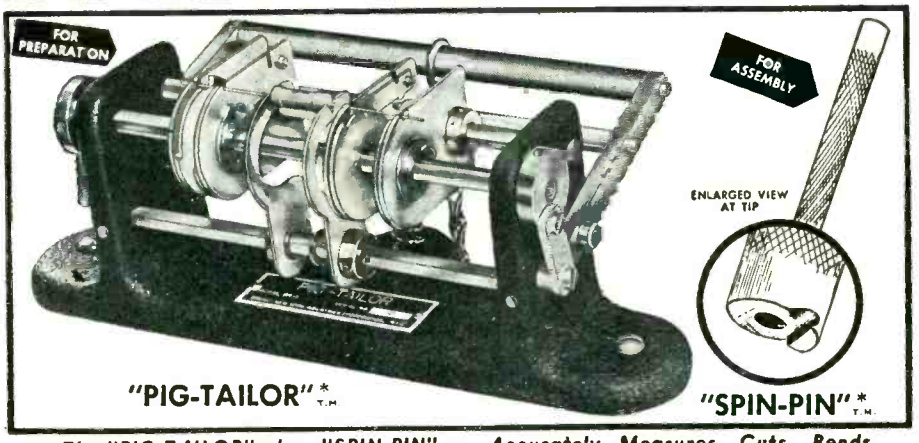
RADIO CORP. OF AMERICA, Harrison N. J. The 6AZ8 general-purpose multiunit miniature tube contains a medium-mu triode and a semi-remote-cutoff pentode in one envelope and utilizes a 9-pin base. The triode unit with its relatively high zero-bias plate current is useful in l-f oscillator, sync separator, sync-clipper and phase-splitter circuits. The pentode unit, which has high transconductance and features a semiremote-cutoff characteristic to minimize cross-modulation effects and overload distortion in picture i-f stages, may be used as an i-f amplifier, video amplifier, age amplifier and as a reactance tube. Coupling between the triode and pentode units is virtually eliminated by the basing arrangement and internal construction of the tube. The 6AZ8 has a maximum overall length of 2⅞ in. and a maximum diameter of ¾ in.

TIME DELAY RELAY
is silicone-controlled

HEINEMANN ELECTRIC CO., 455 Plum St., Trenton 2, N. J. Type A Silic-O-Netic relay is available with standard timings from ¼ to 120 sec. Variable flux operation, caused by the changing relationship of a solenoid coil and its core, produces

"PIG-TAILORING"

. . . . . *a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.*



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. E5-P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

Broadband RF Power Meters

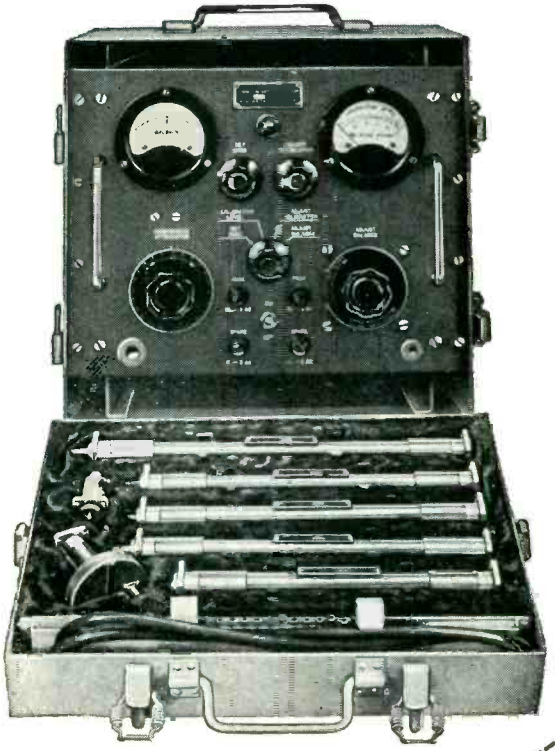
THE CHOICE OF ALL ARMED SERVICES FOR MICROWAVE POWER MEASUREMENTS

POWER: PULSE and CW—5μW to 5W average
FREQUENCY: 20MC — 10,000MC
ACCURACY: 5% Absolute at all ranges, frequencies, temperatures

- . . . . . **INDICATIONS:** Direct Reading
- . . . . . **CALIBRATION:** Compensates for All Variables
- . . . . . **R-F COMPONENTS:** 3, 6, 10 and 20db Attenuators, Bolometer Mount and Elements, R-F Cable
- . . . . . **BOLOMETER:** Broadband, High Overload Capacity
- . . . . . **PLUMBING:** 3/8" and 7/8" 50-ohm Coaxial
- . . . . . **POWER SOURCE:** 115VAC ±15%, 50-1000 cps
- . . . . . **CONSTRUCTION:** Rugged, meets all JAN, MIL requirements

TYPICAL APPLICATIONS

Microwave Links . . . Television . . . Communications . . . Radar . . . Telemetering . . . Signal Generators . . . Laboratory Standards.



Write for descriptive literature to Department E5-M

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DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

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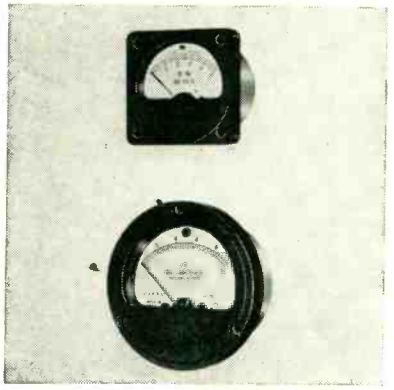
highly definitive contact action. A movable iron core, hermetically sealed in a nonmagnetic metal tube extending through a solenoid coil, is drawn into the magnetic field resulting when the coil is energized. The silicone fluid slows the rate of core travel, thus controlling the response time. Contacts are actuated as the core touches the pole piece and check valve construction within the core allows faster resetting of the relay. The relays are furnished with coil ratings from 24 to 240 v, a-c; 6 to 125 v, d-c.



PANEL METERS
either ruggedized or sealed

DEJUR-AMSCO CORP., 45–01 Northern Blvd., Long Island City 1, N. Y., has available a new group of 2½ in. and 3½ in. panel instruments in a choice of ruggedized or sealed models. The ruggedized versions withstand heavy duty military and ASA standard shock and vibration extremes under a wide range of temperature conditions as defined by Signal Corps specifications MIL-M-10304. Both ruggedized and sealed meters are calibrated for magnetic and nonmagnetic panel mounting, and are available in a vareity of special ranges, scale divisions, markings and color combinations. Complete specifications and a table of standard ranges are available.

FILTER
helps sound reproduction

CINEMA ENGINEERING CO., Division of Aerovox Corp., Burbank, Calif. Type 7052 is a variable high and low frequency filter for use in

a "midget"* in size

A GIANT

IN PERFORMANCE

New Astron "Midget"
Type ET Electrolytic Capacitors . . .
Designed Specifically for Printed Circuitry

Good designs do come in small packages . . . for instance, the new "Midget"* type ET Subminiature Electrolytic Capacitors . . . newest miniaturized capacitor design from Astron, industry leader in size reduction.

The extreme compactness of "Midget" type ET Electrolytics offers *the* absolute minimum in space and weight . . . *industry's widest selection of values* for savings in a variety of applications with miniature tubes and/or transistors.

Tiny . . . but tough "Midget" type ET Electrolytics incorporate the famous Astron "SM"* Safety Margin electrolytic construction for the *extra* stamina needed to withstand surge voltages, ripple currents and high temperature applications.

Dependable "Midget" type ET Electrolytics are hermetically sealed in aluminum cans for absolute environmental protection. . . stable 85°C operation due to Astron's exclusive treatment of extremely pure foil and special manufacturing processes . . . exceptionally low leakage current . . . low-resistance terminal tab construction . . . individually tested and guaranteed.

Save valuable space, increase your designing flexibility and reduce ultimate costs . . . write for **Bulletin AB — 22 today!**

ASTRON
CORPORATION
255 GRANT AVENUE — EAST NEWARK, N. J.

Export Division: Rocke International Corp. 13 E. 40 St., N. Y., N. Y. In Canada: Charles W. Pointon 6 Alcina Ave., Toronto 10, Ontario

*Trademark

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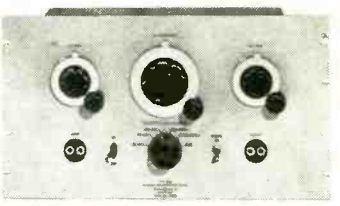
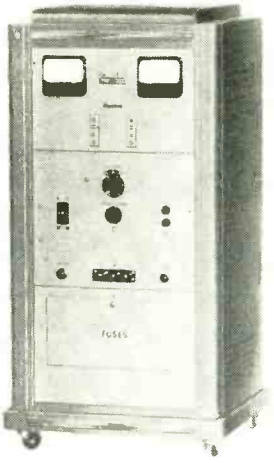


sound reproduction to eliminate unwanted noises, arc rumble, whistles and the like. The dip filter is also designed as a laboratory tool to measure harmonic distortion. It incorporates a 4-stage amplifier having an R-C interstage coupling network. Features include "in-and-out" switch, triple mu-metal shielding of transformers, shock mounting of tubes and general electrostatic and electromagnetic shielding to permit operation in low-level circuits. Frequency range is 20 to 15,000 cps; response, ±1 db. Output level is −2 dbm with output impedances to work into 200–250, 500–600 ohm balanced lines. Power requirements are 250 v d-c at 5 ma, and 6.3 v at 1.2 amperes.

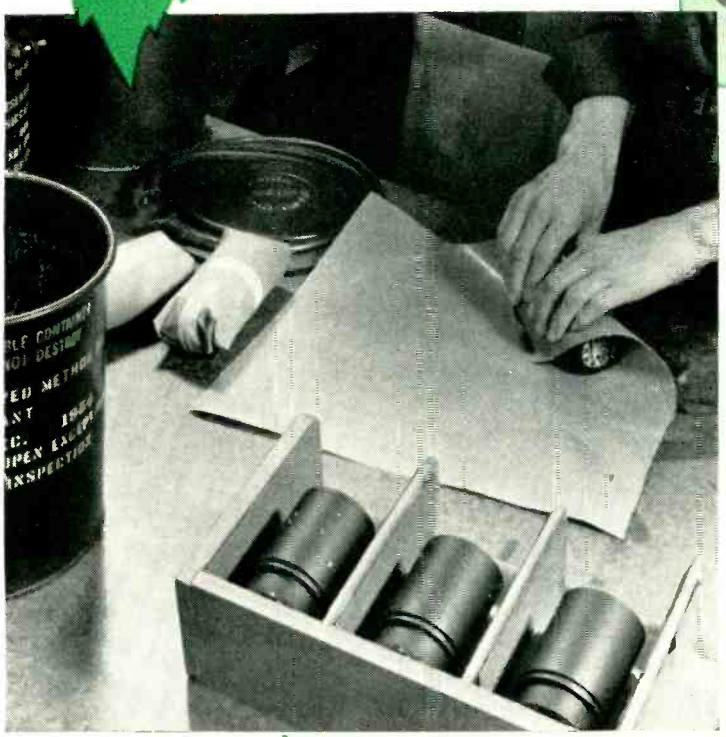


COMPUTER
uses new control system

ELECTRONIC MEASUREMENTS Co., Lewis St., Eatontown, N. J. Model 210-A employs the Regatron control system which affords super-regulation and long-time stability for both low and high voltages. This model provides 0 to 3 amperes at 0 to ±360 v directly calibrated on a multiturn panel dial, plus a 3-v electrical vernier which permits extremely fine control. Regulation error is measured in mv, ripple voltage in μv, and output imped-

They're on the Way...!

HIG-4 GYROS BEING SHIPPED BY Greenleaf



More and more guided missile and fire control system manufacturers are now utilizing the Greenleaf HIG-4 Gyro. This Hermetically-sealed Integrating Gyro has been thoroughly proven and production quantities are ready to go to work for you.

DATA

Spin Motor: 12 Volts, 400 cps, 2 phase
Synchronous Speed: 8,000 R.P.M.
Angular Momentum:
10^4 Gram-Centimeter^2/second
Gimbal Travel: $\pm 5°$ Maximum
Signal Generator Sensitivity:
10 mv/mr, with 55 ma, 400 cps
Torque Generator Linearity Deviation:
less than 1%
Heater Power: warm-up 100 watts,
running 25 watts, 115V, 400 cps
Weight: 1.5 pounds

ENGINEERING • DEVELOPMENT • PRODUCTION

THE Greenleaf MANUFACTURING COMPANY

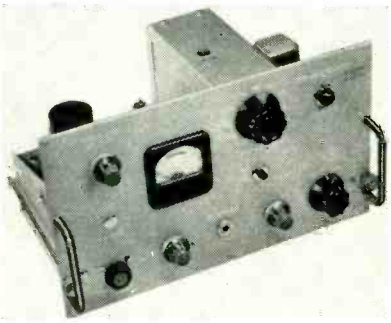
7814E Maplewood Industrial Court • Saint Louis 17, Missouri

Where quality control *works on* the production line... producing the new HIG-3 and the HIG-4 Gyros, Rate Gyros, Differential Pressure Switches, Synchros, Air Speed Indicators, Actuators, Transducers and many other precision-built components.

ance in milliohms. Individual monitoring of series tubes, forced air, and multiple overload protection (available at the front) are provided to reduce down time. Auxiliary potentials and other features are available on order.

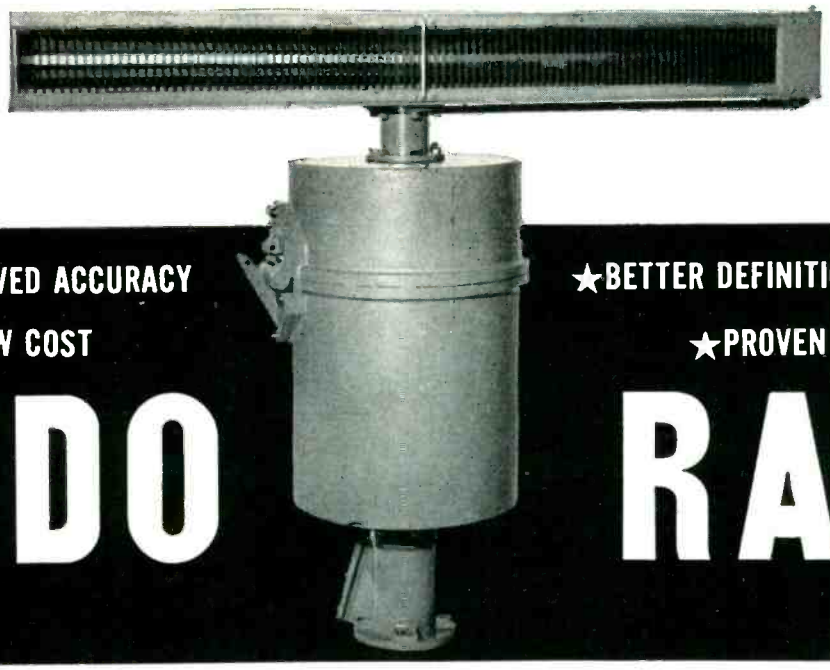
WIDE-BAND SCOPE
for tv and industrial uses

SUPPLY DIVISION, NATIONAL RADIO INSTITUTE, 16th & You Sts., N. W., Washington 9, D. C., announces an inexpensive oscilloscope having many laboratory-quality features. The instrument can be used for industrial applications where square-wave and pulse type signals must be observed. Vertical amplifier response is flat from 10 cycles to 4.5 mc (±3 db). The 4-step frequency-compensated vertical attenuator is calibrated for direct peak-to-peak voltage measurement. Sensitivity is 0.014 v (rms) per in. of deflection. Linear sweep range is 10 cycles to 100 kc.



PREAMPLIFIER
is servo monitor

SANBORN CO., 195 Massachusetts Ave., Cambridge, Mass. Model



★IMPROVED ACCURACY ★BETTER DEFINITION

★LOW COST ★PROVEN DEPENDABILITY

EDO RADAR

with PATENTED SLOTTED WAVEGUIDE ANTENNA

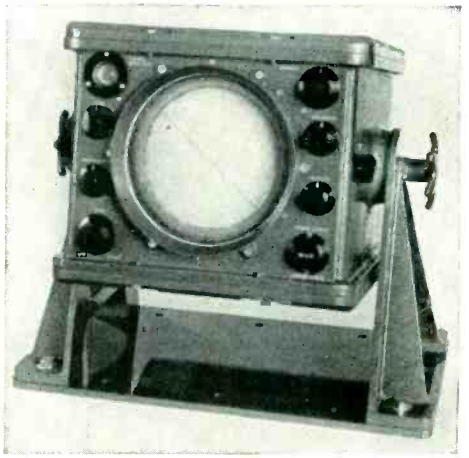
Now, EDO, famed builder of high performance sonar for the United States Navy and other fine marine electronic equipment for commercial craft, announces the Edo Model 320 Radar.

This fine, thoroughly-tested piece of electronic equipment has been created especially for use in small craft where space and generator capacity are limited. Operating on a wave length of 3.2 centimeters (X-band), it provides clear, precise definition of shore line, buoys, boats or other hazards on five scales—1, 2, 5, 10 or 20 miles—and showing objects as close as 25 yards—making it useful for operation in both open and restricted waters.

The exceptional performance of the Edo Model 320 Radar stems from the use of the compact, patented, slotted waveguide antenna which reduces side lobe reflections. This exclusive antenna cuts down windage and is impervious to weather. The Edo Radar has been designed for ease of operation, long life and simple maintenance. Despite its superior performance it is in the lowest-priced bracket bringing the time and money-saving advantages of radar to many owners of smaller boats who could not previously afford this latest aid to navigation.

You can install Edo Radar in your craft with utmost confidence, for it bears the famed Edo Flying Fish emblem, known and respected as the mark of superior, dependable performance on depth sounders, survey depth recorders, the famed Edo Fishscope, the Edo Loran and other marine electronic equipments. Write for further information.

Another example of EDO's ever-increasing role in the field of MARINE ELECTRONICS



PPI Display Unit can be conveniently mounted on bulkhead, desk or overhead and is designed for greatest possible ease of operation. It can be fitted with hood for viewing under bright-light conditions.

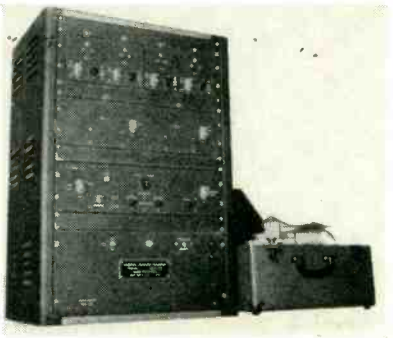
Edo

Edo CORPORATION College Point, L.I., N.Y. SINCE 1925

150–1200 servo monitor preamplifier, one of several interchangeable front ends for use with a power supply-driver amplifier unit in Sanborn 150 systems, is a phase discriminating a-c amplifier designed for use in recording the error signal of a servo system. The preamplifier measures the components of an a-c voltage that are in phase or 180 deg out of phase with a fixed or reference voltage of the same frequency. Basic sensitivity is 10 mv per cm, which can be reduced by attenuator ratios from 2 to 1,000. Input voltage range is 50 mv to 50 v; reference voltage, 10 to 125 v; frequency range, 60 cps to 10 kc. Further specifications are available on request from the company.

AUDIO SHIFT NETWORK
designed for ssb use

BARKER & WILLIAMSON, INC., 237 Fairfield Ave., Upper Darby, Pa., has available an audio phase shift network especially designed for single-sideband receiving and transmitting applications. Designated model 350, type 2Q4, the unit provides a constant 90-deg phase shift ±1.5 deg, over the audio range of 300 to 3,000 cycles, yet requires no more space than a 6J5 tube.



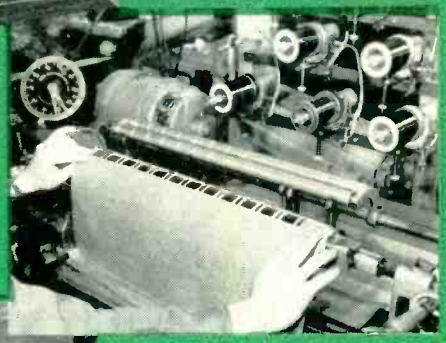
TRANSIENT RECORDER
is a 4-channel unit

MAGNE-PULSE CORP., 140 Nassau St., New York 38, N. Y. Type 104 transient recorder magnetically records up to 4 signals simultaneously. Providing a frequency response of d-c to 2 kc, a 1-second period, and simultaneous playback of

Bogen
HIGH FIDELITY
BECAUSE IT SOUNDS BETTER

TRANSFORMERS ARE INSULATED *with* NATVAR Straight Cut V.C.

With the new Bogen R-765 Auto-Lock Tuner, you simply tune until you hear the FM station you want. Then the R-765 automatically "zeros in" to optimum adjustment and locks into position.



Operator of this multi coil winder finds it easy to insert Natvar V.C. as interwinding insulation, because it is always pliable and never sticky.

Leads are dead soft, but are easily inserted in Natvar Varnished Fiberglas Sleeving because it is so smooth inside. Operator slips sleeving back while stripping the enamel before hot tin dipping.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

THE DAVID BOGEN CO., INC., manufactures high fidelity home music systems of highest quality. Their matched tuners, amplifiers, record players and accessory units are noted for their flat frequency response over the entire audio range, minimal distortion, and other features such as the Bogen Auto-Lock tuning circuit to simplify tuning and eliminate drift.

Engineering and design are up to the minute, and components are carefully built of the best of suitable materials. Natvar straight cut varnished cambric is used as transformer interwinding insulation because "it is soft, pliable, and easy to handle, of uniform thickness throughout the sheet, with no thin spots. It is consistently good. Each shipment is exactly like the last."

Natvar flexible insulations are uniformly dependable no matter where or when purchased. They are available either from your wholesaler's stock or direct from our own.

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800

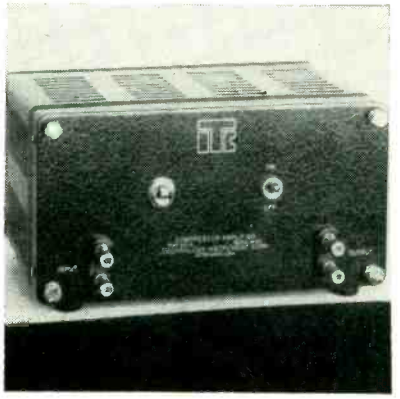
CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

any 2 channels, this equipment also features the use of magnetic disks which can readily be removed and stored permanently, or erased and used again. The equipment should find wide application for the recording of transients in aircraft, power lines, petroleum exploration, medical research, electronic analysis and other related fields.

TUBING & SLEEVING
conforms to MIL specifications

ALPHA WIRE CORP., 430 Broadway, New York 13, N. Y., have announced the new Alphlex line of tubing and sleeving for industrial electronic applications. It includes extruded plastic tubing, impregnated tubing and sleeving, high temperature glass fiber sleeving, plastic coated glass fiber tubing and sleeving, silicone impregnated glass fiber sleeving and silicone-rubber-coated glass fiber tubing. The line conforms to MIL specifications and UL standards.



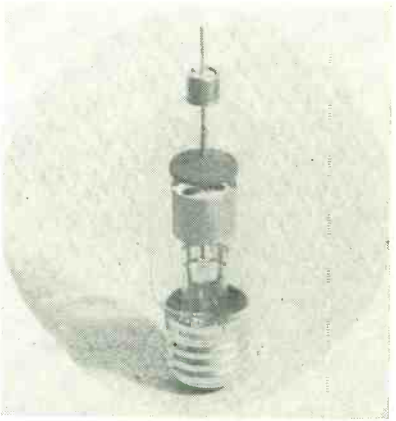
COMPRESSOR AMPLIFIER
provides constant output

TECHNOLOGY INSTRUMENT CORP., Acton, Mass., announces the type 501-A compressor amplifier. It accepts input signals of variable amplitude between 1.25 and 50 v and delivers an output signal of the waveform but held at a substantially constant amplitude of 0.25 v by a servo-controlled distortionless variable attenuator. Compression ratio is 40 to 1 (32 db) from 500 cps to 1 mc; slightly less below 500 cps. Frequency range for complex signals at any compression condition is 50 cps to 50 kc,

within ±3 percent. Total harmonic distortion is less than 1.5 percent under all normal operating conditions and less than 0.5 percent up to 40 v input. The unit is ideal for stabilizing varying signals to eliminate necessity for adjusting levels when measurement or observation of signals are to be made with oscilloscopes, bridges, phase comparators or wave analyzers.

LACING TAPE
of rubber-covered Nylon

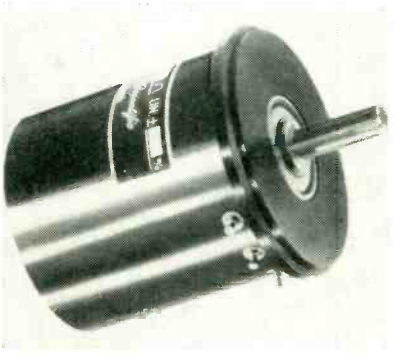
GUDEBROD BROTHERS SILK CO., 225 W. 34th St., New York 1, N. Y. Gudelace-H is a braided, rubber-covered Nylon lacing tape which offers knot security with either continuous or interrupted ties in all electrical harnesses. It is coated with special fungistatic synthetic rubber containing no corrosive compounding ingredients and is unaffected by heat within the temperature range of Nylon yarn. The flat tape with its special finish provides nonslip holding power. It does not cut through insulation and complies with the fungus-resistant requirements of Government Specification JAN-T-713.



MERCURY RECTIFIER
for l-v industrial uses

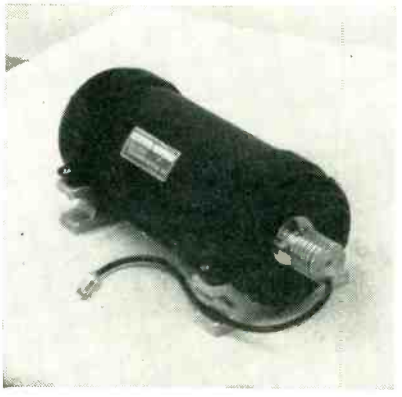
NATIONAL ELECTRONICS, INC., Geneva, Ill., has developed a new 6-ampere rectifier designated as the NL-619. It is a mercury-vapor tube designed for long life, low arc drop and high efficiency. It is especially designed for low-voltage industrial rectifier applications. Ratings are: filament volts, 2; filament current, 12 amperes; peak inverse, 300 v;

anode average current, 6 amperes; and peak anode current, 20 amperes.



POTENTIOMETER
is extremely precise

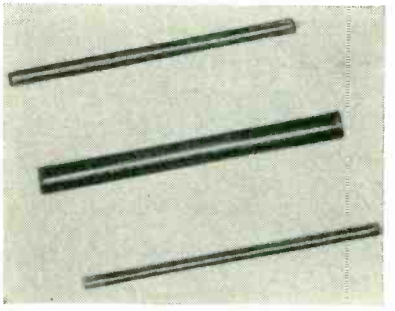
GENERAL SCIENTIFIC CORP., North Hollywood, Calif., has available a new, extremely precise potentiometer, known as the M10-3000 HT. This 10-turn, high-resolution potentiometer is recommended for applications where extreme accuracy is required, such as fire control equipment and analog computers. It is provided with servo mountings and will function in ambient temperatures up to 200 C. The unit is very compact and rugged.



OSCILLATORS
are backward-wave type

ROGER WHITE ELECTRON DEVICES, INC., Route 17 and Erie R. R., Ramsey, N. J. Backward-wave oscillators are voltage tunable microwave oscillator tubes. These tubes are constructed with an r-f structure which has an internal feedback mechanism, the frequency of which is controlled by the voltage applied to the electron beam. There is no associated inertia or wear and the tube can be operated

continuously at high sweep rates with no effect on tube life. The tubes are ideally suited for sweep freqeuncy sources, local oscillators in high speed afc circuits and laboratory signal sources. Specifications and a characteristics chart are included in bulletin BWO 12-54.



TUNGSTEN ROD
is microscopically inspected

ELECTRONICS PARTS MFG. CO., INC., Union City, N. J., has available ground seal tungsten rod, 100 percent microscopically inspected for defects. The inspection insures that when the rod is used in production, there will be no splits, cracks or other flaws to cause costly rejects. The ground seal tungsten rod is used for precision leads in electronic tubes and many other applications.

COMPARISON BRIDGE
and go-no-go gage

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston, Texas. The E-2 comparison bridge can now be operated by means of an optional foot switch, as well as by the conventional push button. Improved stability, accur-

acy and sensitivity enable resistors, capacitors and inductors to be compared over a range of 1 ohm to 5 megohms at 60 cps. Differences as small as 0.1 percent may be easily measured on the 1-percent full scale meter range; other scale ranges of 2.5, 5, 10 and 25 percent are also provided. In addition to its use as a comparator and go-no-go gage, the E-2 may be combined with a decade box to make quick and accurate measurements of absolute values.

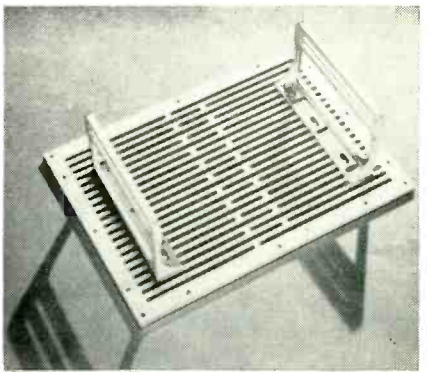
PICTURE TUBES
are of the aluminized type

SEL-SON ELECTRONIC & TUBE CORP., 9th and Summit Sts., Darby, Pa., has added to its line aluminized picture tubes in all sizes from 10 in. to 27 in. They are being marketed under the trade name Alumilite.

HIGH-POT TESTER
operates automatically

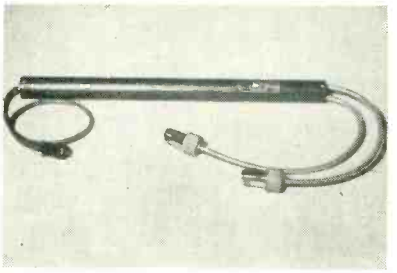
INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York 3, N. Y. Model A Hi-Pot tester automatically tests, in sequence, the dielectric strength between any 10 conductors and indicates the location of breakdown when it occurs. The test interval can be accurately controlled up to 120 sec, and the applied voltage is continuously variable up to 2,000 v rms. A dual scale, hand-calibrated meter insures accurate setting of the test voltage. High sensitivity to breakdown is made possible by employing a specially designed relay in series with the h-v circuit. The instrument can be used for production

testing of slip rings, commutators, cable connectors, synchros, transformers and similar devices.



SERVO PLATE
with precision alignment

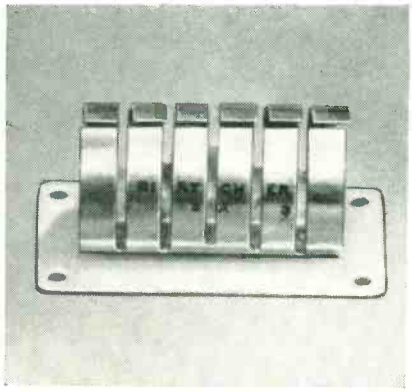
STERLING PRECISION INSTRUMENT CORP., 34–17 Lawrence St., Flushing 54, N. Y., is offering a new type of breadboard equipment featuring top-side fastening and precision alignment. The servo plates are reinforced with stainless steel sheets for extra rigidity and the hangars and accessories are fastened to the plate from the top side with special T-nut cap screws. The need for supporting legs or suspensions is eliminated. Slots in the hangars permit additional fine adjustments ensuring optimum alignment and mesh.



T-W TUBE AMPLIFIER
operates over 7-14 kmc band

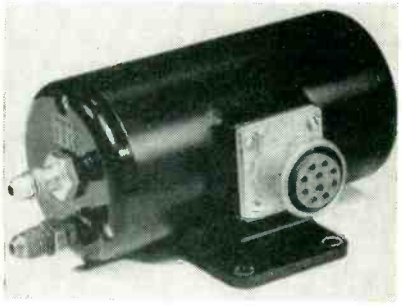
HUGGINS LABORATORIES, INC., 711 Hamilton Ave., Menlo Park, Calif., has announced a new broadband low-power traveling-wave tube amplifier designed to operate over the 7 to 14-kmc band. The tube finds its greatest use in applications where wide bandwidth and high gain are required at a low level such as r-f preamplifiers, untuned r-f receivers and in laboratory

microwave measurement work. Grid control is provided for modulation and age applications. Approximate operating characteristics over this band are 30 db gain and 5 mw output. The unit requires a 400 gauss field and a 1,200-v regulated power supply.



TUBE CLAMPS
are sleeve-type devices

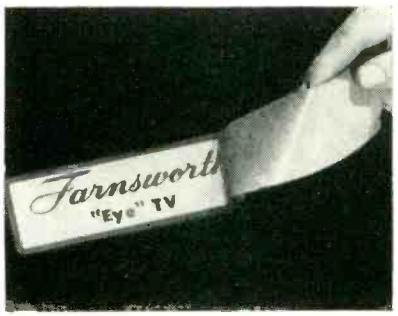
THE BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif. Number 6A-3 Kool Klamp is designed for miniature tubes with T-6½ and T-7 envelopes. The same design is readily available for tubes with sizes T-5 and T-5½ envelopes. The sleeve-type clamp features the company's multiple finger construction. These fingers act independently of each other and provide excellent contact between tube and clamp. This construction improves heat conduction, simplifies tube insertion, and reduces tube breakage, particularly when slightly irregular tube envelopes are encountered.



PRESSURE TRANSDUCER
is dual element unit

TECHNOLOGY INSTRUMENT CORP., Acton, Mass., announces a dual element air flow differential pressure

transducer. It is designed for high output to speed-altitude-time computers, telemeter systems, electric recorders, servo systems, meter display or alarms. The pressure response movements of each of two metal bellows is translated into motion of sliders of paired precision potentiometers. Through an external electrical combining network, dynamic data may be automatically normalized or corrected with respect to static data as required by the application. Typical application to speed-altitude measurement provides a range from 0 to 580 knots over an altitude range of −1,000 to 20,000 ft. Potentiometer resistance ratio vs pressures is linear within 0.5 percent; hysteresis within 0.5 percent; change with temperature (−55 C to +71 C), not over 0.5 percent; resolution increment, less than 0.2 percent of pressure range. Construction withstands 40-g shock. Size is $2\frac{7}{8}$ in. × $4\frac{3}{8}$ in. × $5\frac{7}{8}$ in.; weight, 1.3 lb.



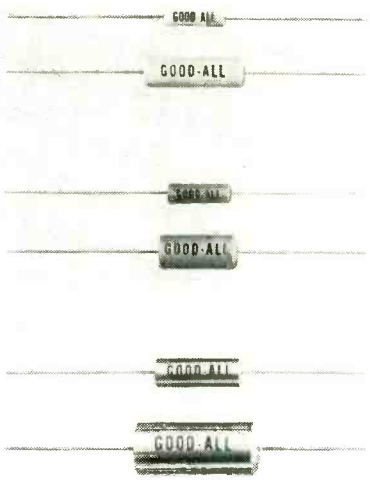
METAL NAMEPLATES
of etched aluminum

C & H SUPPLY CO., Inglewood, Calif., has developed premasked Metal-Cals, suitable for application to unpainted surfaces. The thin anodized, etched aluminum nameplates are completely masked to allow painting of an article after the trademark or label is applied, thus building up the paint around the edge of the trademark and making it an integral part of the item to which it is affixed. The masking is easily stripped of the Metal-Cal after painting. The Metal-Cals are backed by the same pressure-sensitive adhesive which has been used on the unmasked plates and which makes them permanent, as well as easy to apply without screws or rivets. Available in a wide range

of colors, they may be applied to any smooth, curved or flat surface. Samples and literature are available on request.

COUPLER
for vswr measurement

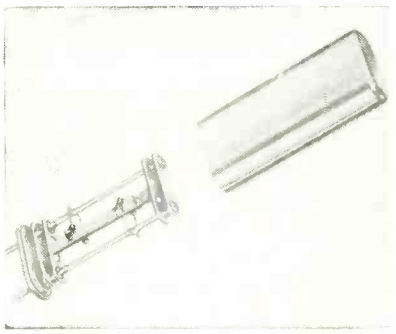
COLOR TELEVISION INC., San Carlos, Calif. Model 110B X-band vswr measuring system combines high accuracy with simplicity of operation, and simultaneously fills the need for a continuously-tunable, direct-reading laboratory instrument and a production line go-no-go test device. For checking waveguide components, the instrument takes a fraction of the time required for slotted-line tests, covers every point in its spectrum, needs no readjustments for frequency changes, avoids probe and slot error, and is not affected by r-f power changes. An illustrated description, showing chief features and specifications, is given in bulletin Form 110-255.



MYLAR CAPACITORS
are miniature in size

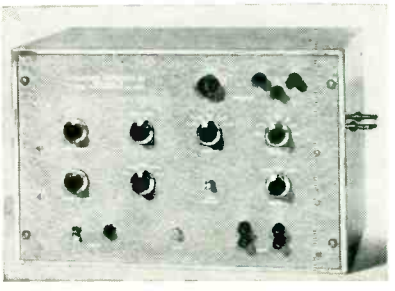
GOOD-ALL ELECTRIC MFG. CO., Ogallala, Neb., has announced a new line of Mylar capacitors that incorporate the humidity resistance features of its Seramelite capacitors and the electrical characteristics of DuPont's Mylar. Models 620S and 621S are miniature in size and are available in extended foil or inserted tab construction. Miracle X liquid impregnate is used in the capacitors and they are housed in ceramic tubular enclosures using a new thermosetting plastic end seal. They easily exceed RETMA speci-

fication REC 118A. Both models are available for standard printed circuit or specialty applications.



QUARTZ CRYSTALS
in two new types

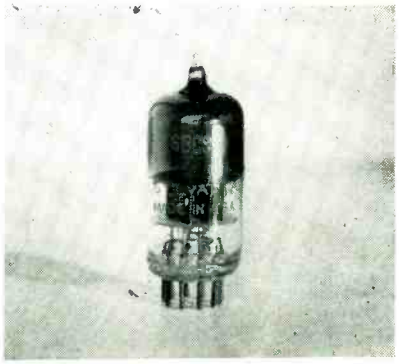
CRYCO, INC., 1138 Mission St., South Pasadena, Calif. Both CR-38/U and CR-50/U quartz crystals conform to MIL-C-3098A specifications. The CR-38/U frequency range is from 16 to 100 kc; load capacitance, 20 $\mu\mu f$; frequency tolerance, ±0.012 percent; temperature range, −40 C to +70 C. Holder is HC-13/U. The CR-50/U is the same with the exception of load capacitance, which is in series. All units are ultrasonically cleaned and hermetically sealed. Recommended drive level is 0.1 mw.



TRANSISTOR TESTER
is family curve tracer

POLYPHASE INSTRUMENT CO., Bryn Mawr, Pa., announces the model TA-3A transistor analyzer, a transistor family curve tracer. It displays on an oscilloscope the R_{12}, R_{22} and H_{12} families in the grounded-base connection and the R_{22} family in the grounded-emitter connection. Either *n, p, npn,* or *pnp* transistors can be tested. Collector current power supply has a peak rating of 100 ma at 100 v enabling the instrument to be used

for testing power transistors as well as conventional transistors.



DUAL TRIODE
for use in vhf tv tuners

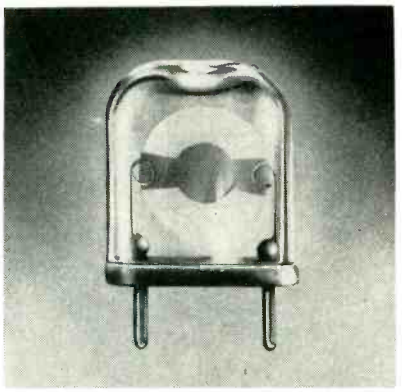
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. A new tube type, the 6BC8, a miniature 9-pin, medium-mu dual triode with semiremote cutoff characteristics, has been announced. It lends itself very readily to applications as a cascode amplifier in vhf tv tuners, and also gives more satisfactory performance in agc systems under both strong and weak signal conditions. The tube also provides relief from objectionable cross modulation effects when reception of a weak signal is degraded because of strong adjacent channel station interferences. This effect is minimized because the transfer curve of the tube approaches the desirable square low characteristic, which is the optimum shape for minimizing cross modulation.

STRAIN GAGE BRIDGE
used with indicating devices

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton,

For additional information on all items on this page, use post card on last page.

N. J. Type 335 strain gage bridge is designed to permit the use of any commercially available strain gages with virtually any c-r oscillograph using suitable preamplifiers, or directly with the DuMont type 324 c-r oscillograph. It may also be used with indicating devices such as recording galvanometers and meters. By proper selection of gages, strains in the range of 15 μin. per in. to 1,000 μin. per in. can be measured and recorded. Catalog No. 1725-K gives complete information and specifications.

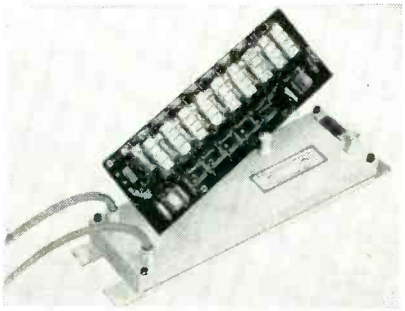


QUARTZ CRYSTAL UNIT
is hermetically sealed

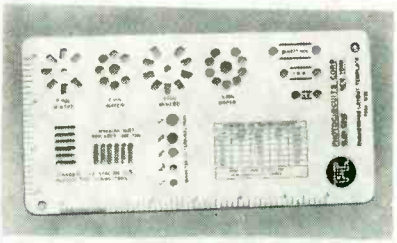
McCOY ELECTRONICS CO., Mt. Holly Springs, Pa., is producing a Cryst-O-glas quartz crystal unit. Featuring an all-glass case and holder, this new development places the crystal in a perfectly hermetically sealed container. Because heat alone is used in the bonding operation, the crystal itself is never subjected to the chemical fumes given off by conventional sealing compounds. This absence of contamination results in greatly increased crystal stability and virtually eliminates the possibility of even slight frequency changes.

I-F AMPLIFIERS
with low-noise front ends

RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif., announces standard production of miniature lightweight i-f radar amplifiers incorporating low-noise front ends. New techniques, materials and methods are used to provide, for example, a 9-tube com-



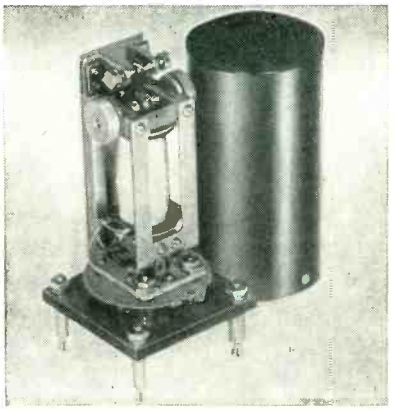
pletely enclosed amplifier that measures only 8½ in. × 3 in. × ¾ in. and weighs only 1 lb. Center frequency is 20 to 100 mc; bandwidth, 2 to 12 mc; gain, up to 120 db; automatic and/or manual gain control, 100 db or greater; noise figures, better than 2 db; ambient temperature operating range, —65 C to +100 C. These amplifiers will operate under 30 G shock and 10 G vibration for extended periods. Standard circuits are available to provide for low-impedance output, video detection, fast time constant, tuning detection, video amplification and video limiting. Variations of standard circuits are available on special order.



LAYOUT TEMPLATE
for printed circuit design

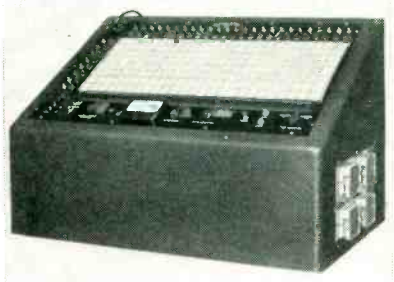
PHOTOCIRCUITS CORP., Glen Cove, N. Y. A newly designed plastic template facilitates drafting of components for printed circuitry. The engineering layout template is pocket size, 4 in. × 8 in. in dimension, and is satin finished for clearly indicated markings, scales and stencils. A variety of stencil die cuts provides for accurate resistor spacings, standard component spacings and plug-in tab spacings as well as 7 and 9-pin molded and wafer socket layouts and terminal pads from ⅛ in. to ¼ in. A current carrying capacity chart is

included, and on two edges are scale divisions.



POLARIZED RELAY
for teletypewriter uses

KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y., is now manufacturing a polarized relay utilizing a reed type, Permaloy armature with antichatter contacts. The armature is equipped with extra heavy ($\frac{3}{32}$ in. diameter) palladium copper contacts. The contact screws have $\frac{1}{8}$-in. diameter tungsten contacts rated at 2 amperes, 110 v d-c. The P255A relay, ideal for use in teletypewriter applications, consists of a coil with two parallel windings of 136 ohms each.



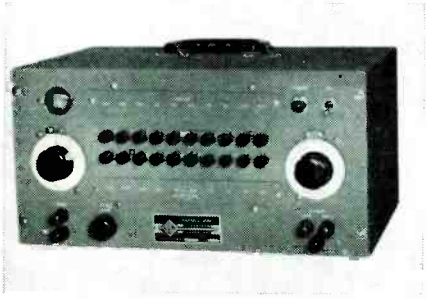
CIRCUIT ANALYZER
for complex testing

DIT-MCO, INC., Electronics Div., 505 W. 9th St., Kansas City, Mo. Model 200 universal automatic electrical circuit analyzer is a new development in the field of aircraft electrical systems testing. It is designed to test automatically for line and insulation resistance simultaneously up to 200 megohms featuring 28 and 500-v d-c test ranges. Multiplier sections can be

a 600 or 1,200 circuit capacity. It's simple in operation.

TINY TRANSISTOR
for use in hearing aids

CBS-HYTRON, Danvers, Mass. No bigger than a match-head, this tiny transistor is designed for hearing aids. It is produced in three types: HA-8 and HA-9, which are low-level, high-gain units for the first and second stages of hearing-aid circuits; and HA-10, for the power output stage. These space-saving transistors are hermetically sealed. Besides hearing aids the transistors have many other applications.



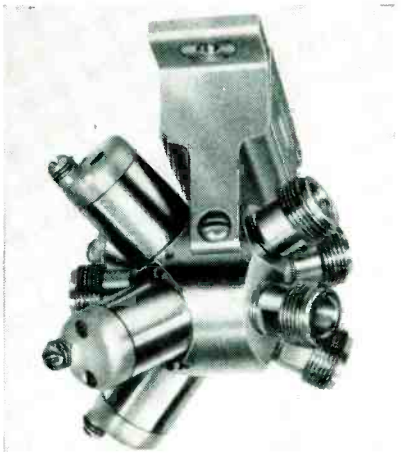
TEST OSCILLATOR
with pushbutton controls

TELETRONICS LABORATORY, INC., 54 Kinkel St., Westbury, L. I., N. Y. Any of 19 different preselected frequencies in the range from 20 cps to 20 kc may be selected by pushbutton controls on the model TO-100A pushbutton test oscillator. A deviation dial permits calibrated deviation from the center frequencies up to ±10 percent. The output frequencies include those recommended by the FCC for distortion measurements on broadcast transmitters. The output amplitude is calibrated from 1 to 25 v open circuit from a 600-ohm source. A low impedance (approximately

18 ohms) is also included. Waveform distortion at 18 mw output is less than 0.25 percent above 100 cps and less than 0.5 percent below 100 cps. Facilities for calibrating an unknown external signal by means of a zero beat indicator are provided. Factory modifications can be made to extend the frequency range to 100 kc.

RING ASSEMBLY
meets varied applications

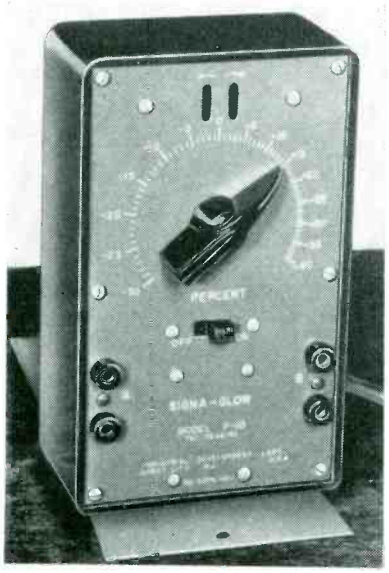
D. E. MAKEPEACE CO., Attleboro, Mass., has available a slip ring and brush assembly designed to meet a wide variety of applications for rotating electromechanical devices. From 2 to 10 circuits can be obtained in 1 assembly, and 2 or more assemblies of 10 each can be stacked together to achieve a greater number of circuits. Currents up to 20 amperes and extremely low noise levels make these assemblies useful for a great variety of applications, including strain gages, telemetering, radar test equipment and controls.



R-F COAX SWITCH
weighs only 12 oz

TRANSCO PRODUCTS, INC., 12210 Nebraska Ave., Los Angeles 25, Calif. A new addition to the com-

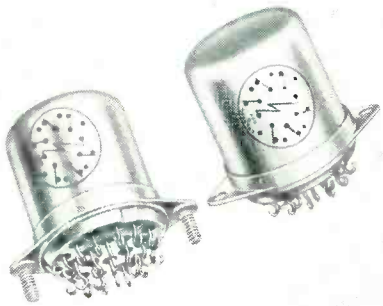
pany's line of miniature broadband r-f coaxial switches permits switching of 4 circuits by remote control. The unit weighs 12 oz and occupies only 3 in. × 3½ in. × 2½ in. space. Performance is excellent for frequencies up through X band. Switch models are available with two r-f circuit combinations. The SP4T unit has an actuator power rating of 18 to 30 v d-c at 0.18 ampere maximum per coil. Ambient operating temperature range is −65 F to + 225 F; actuating time, 10 milliseconds. Life duration is 500,000 operations minimum. The unit is designed to meet MIL-E-5272 specifications.



COMPARISON TESTER
has dual-null indicator

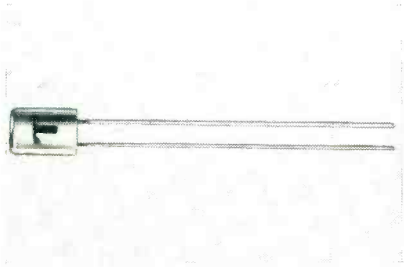
INDUSTRIAL DEVELOPMENT LABORATORIES, INC., 17 Pollock Ave., Jersey City, N. J., has announced the Signa-Glow, model P-10, a new instrument for rapid comparison tests. It features a dual-null indicator incorporated into a Wheatstone bridge circuit. The unit tests over the wide resistance or impedance range of 100 ohms to 5 megohms by comparing a component or circuit with a reference standard. To sets of jacks are used, one for the standard and one for the unknown. In operation, the dual-null visual indicator shows the direction of unbalance; and a pointer-knob, which is turned to reach the null, indicates the percentage of deviation from the standard. Range of the scale is

from −30 percent to +40 percent deviation.



SEALED RELAY
features simplified design

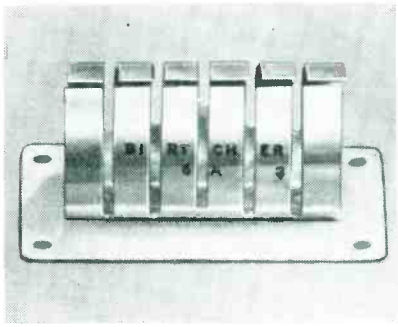
STRUTHERS-DUNN, INC., Pittman, N. J. Type FC-6 six-pole, double-throw relay is low-priced due to its simplified construction. It withstands 0 to 2,000-cycle vibration to 30 g and withstands 60 g shock without contact opening. It is designed to exceed MIL-R-5757B and to meet MIL-R-25018 and MS-24115 specifications. It is available for both 85 C and 125 C ambients. Nominal coil voltage is 26.5 v d-c. The relay incorporates safety factors that make it ideally suited for difficult applications, even in low-energy circuits.



JUNCTION DIODES
with high forward conductance

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available silicon junction diodes for operation up to 150 C and featuring high forward conductance and high inverse resistance. They are ideally suited to nearly all low and medium-frequency diode applications. Designed primarily for signal magnetic amplifier and power supply use, these diodes are also finding

application in voltage regulator and limiter service. Their extremely sharp Zener break provides a stable voltage reference.



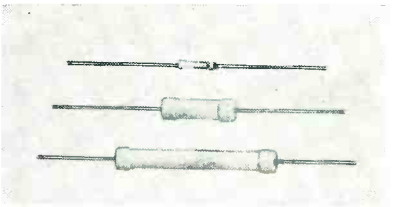
TUBE CLAMPS
are slotted type

THE BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif., has announced the 6A-3 Kool Klamp, designed for miniature tubes with T-6½ and T-7 envelopes. The sleeve-type clamp features the multiple-finger construction. These fingers act independently of each other and provide excellent contact between tube and clamp. This construction improves heat conduction, simplifies tube insertion and reduces tube breakage.

COAXIAL RELAY
is moving-coil type

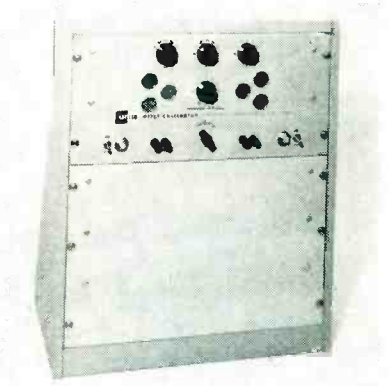
MARION ELECTRICAL INSTRUMENT CO., Manchester, N. H., has developed a new moving coil relay design incorporating the advantages of the company's coaxial mechanism. Very sensitive, rugged and reliable, the coaxial relay is a hermetically sealed, minature unit mounted on a standard 7-pin tube base. It weighs 1½ oz, and is ⅝ in. in diameter, 1⅞ in. high, 1⅛ in. overall. Engi-

neering data are available on request.



METAL FILM RESISTORS
with axial leads

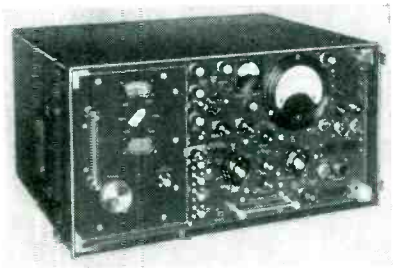
CONTINENTAL CARBON, INC., 13900 Lorain Ave., Cleveland 11, Ohio, has available metal film resistors (Noblette) with axial leads in $\frac{1}{2}$, 1 and 2-w ratings. Resistance range is: 1 ohm to 1 megohm in $\frac{1}{2}$ w; 1 ohm to 5 megohms in 1 w; and 2 ohms to 10 megohms in 2 w. Tolerances available are ± 1 percent, ± 2 percent and ± 5 percent. Write for the new 1955 catalog.



METER CALIBRATOR
a standard d-c reference

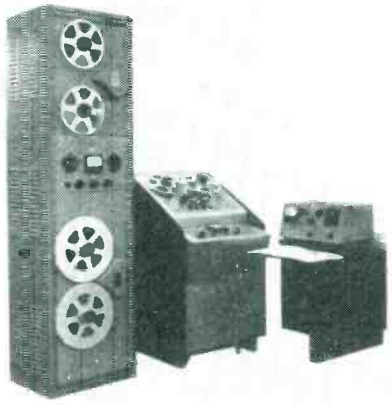
KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif. Model M100A-20 meter calibrator is a standard d-c reference providing both voltage and current calibration ranges from 0 to 1,000 v at 200 ma maximum and from 0 to 100 ma at 1,000 v maximum. The unit maintains long time stability of 0.01 percent, accuracy of 0.05 percent, and regulation for ± 10-percent line voltage change of 0.01 percent. Voltage output is variable in 0.1-v steps and current output is adjusted in 4 ranges. On the lowest range of 0 to 0.1 ma the output varies in 0.01-μa steps. Other full scale current ranges are

1 ma, 10 ma and 100 ma. The unit is useful in analog computer facilities, telemetering, instrumentation groups, afc calibration and as a secondary standard voltage source.



L-F TUNER
covers from 150 kc to 20 mc

EMPIRE DEVICES PRODUCTS CORP., 38-15 Bell Blvd., Bayside, L. I., N. Y. A new tuning unit covering the 150-kc to 20-mc range has been developed for noise and field intensity meter model NF-105. Addition of this tuning unit, catalog No. TA/NF-105, makes it possible to conduct measurements of r-f interference and field intensity over the 150-kc to 1,000-mc range by means of only one instrument. The wide frequency range is obtained by use of 4 separate tuning units. The new 150-kc to 20-mc tuner employs one stage of tuned r-f amplification. It utilizes a 6-band turret arrangement for frequency range switching. As in the other ranges, an impulse generator furnishes the calibrating voltage.

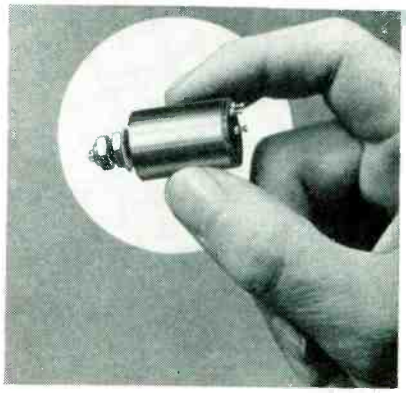


BROADCAST SYSTEM
operates automatically

AMPEX CORP., 934 Charter St., Redwood City, Calif. A new automatic

For additional information on all items on this page, use post card on last page.

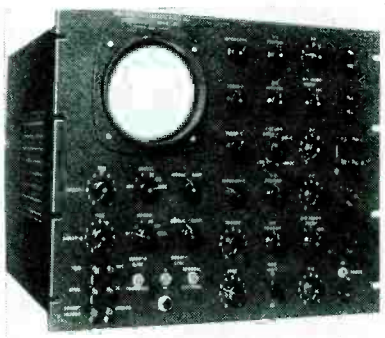
broadcast system consists of two electronically interlocked tape playback units, one capable of playing eight hours of recorded material from a single tape, and the other, up to four hours. On the first unit is placed program material, either from a library built up by the station over a period of time or from a network or commercial transcription service. Spot announcements, local programs and station breaks are recorded daily in the station's own studio and placed on the second machine. After each segment of program material and after each local announcement, a subaudible tone is recorded. At the end of a program segment the electronic brain hears this tone and starts the announcement machine. After the announcement, another tone starts the program. This see-saw action continues until, at each half-hour, a timing device corrects for any slight time deviation in the system and inserts a station break.



POTENTIOMETER in 7 standard values

MAUREY INSTRUMENT CO., 2450 E. 72nd St., Chicago 49, Ill. A ¾-in. diameter wire-wound potentiometer is now available in values of 25, 500, 1,000K, 5,000K, 10,000K, 50,000K 100,000K ohms. A 5-percent resistance tolerance is standard with a temperature coefficient of 0.00002 and a resolution of 0.1 percent available in the higher resistance values. The trimmer was especially designed for use in military aircraft instruments. A standard locking device firmly holds the resistance setting under rugged vibration and shock conditions. The unit is moisture re-

sistant with a Teflon gasket sealing the shaft. The pot is designed to operate at a temperature range of −55 to +125 C with a dielectric breakdown exceeding 1,000 v rms at 25 C.



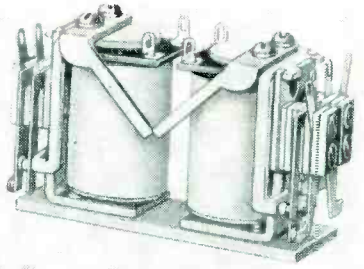
OSCILLOSCOPE
for the research worker

AMERICAN ELECTRONIC LABORATORIES, INC., 641 Arch St., Philadelphia 6, Pa., has available a specialized dual-beam oscilloscope for the research worker. It is particularly useful in the investigation of long-time phenomena using sweeps up to 10 sec (200 sec on special order). Signals on the two beams may be related using the variable delay trigger, so that a slowly moving signal displayed on sweep 1 can have small detail occurring at midsweep displayed on sweep 2 on a much faster time scale. Amplifier frequency response is flat from d-c to 100 kc, at 1 v per in. Power supply is remote; critical voltages are regulated. Photographic recording, either by single frame or with moving film or paper, is aided by the high accelerating voltage (4,000 v), sharp focus and the axis shift, which, either locally or remotely, changes the mode of operation from viewing to recording by stopping the sweeps and transferring the signals from Y to X axis.

DEMONSTRATORS
for educational use

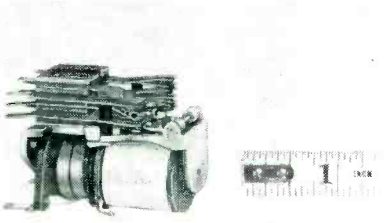
THE AQUATRON CO., 90 Jordan St., Brockton 14, Mass., has available a radio transmission demonstrator and an equivalent plate circuit demonstrator, and other types of educational display boards and

class-room demonstration equipment. Each unit comes with suitable lecture text and detailed demonstration instructions.



LATCH-IN RELAY
is mechanically interlocked

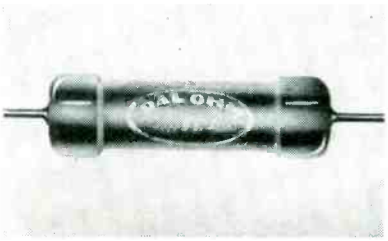
MAGNECRAFT ELECTRIC CO., 3350 W. Grand Ave., Chicago 51, Ill., has announced a new miniature latch-in relay in which the armature mechanically latches in the energized position. It comprises an operating relay and a reset relay with mechanically interlocking arms. When the operating coil pulls the armature into the energized position the levers mechanically lock the armature in place. The armature may be reset electrically or manually. The latching levers are alloy steel, heat treated and hard chrome plated for long wear. Available for 6, 12, 24, 48 and 115-v d-c operation, they can be furnished with a wide variation of contact ratings and contact combinations. Approximate overall length is $2\frac{5}{8}$ in.; width, 1 in.; height, $1\frac{5}{8}$ in.



MIDGET RELAY
has self-contained rectifier

PHILLIPS CONTROL CORP., Joliet, Ill. Type 8AC relay has its own self-contained rectifier thereby eliminating exterior wiring and requiring less space. The rectifier occupies only a fraction of an inch of space

adjacent to the coil. One section of the rectifier is for half-wave control while the other section shunts the coil to prevent a-c vibration. This relay can operate 4 Form C up to 55 C, whereas the usual 400-cycle relay operates only 1 Form C. In military applications where operation is necessary at 85 C the relay can be used continuously for approximately 10,000 hr while limited to 2 Form C. Likewise for any frequency greater than 400 cycles the power is reduced, limiting the relay to smaller pile-ups. The relay can be supplied in hermetically-sealed enclosures for commercial, military and aircraft use.



RESISTORS
are deposited carbon type

DALE PRODUCTS, INC., Columbus, Nebraska, announce availability of the type DCM deposited carbon resistors to specification MIL-R-10509A, type RN20. They are manufactured in resistance values from 10 ohms to 2 megohms with tolerances of 1 percent. Higher or lower values are available on request.

Literature

Current Ratio Indicator. Thomas A. Edison, Inc., West Orange, N. J. A catalog-sheet technical bulletin illustrates and describes model 222-1J meter which indicates the ratio of two direct currents. Included are a wiring diagram, dimensional drawings, and data on accuracy and coil current strength.

Pilot Light. Industrial Devices, Inc., Edgewater, N. J., announces its latest catalog covering the series 1000 Omni-Glow neon pilot lights. The catalog is intended as

a guide to basic data on pilot lights for application and design in industrial devices. The book is replete with detail drawings and photographic illustrations showing the standard model and practicable combinations of all elements to meet specific requirements. A copy of the 8-page presentation is available on request.

Shock and Vibration. Barry Controls Inc., 1000 Pleasant St., Watertown, Mass. Bulletin 804A is designed to provide a quick reference sheet for electronics and aviation design engineers. Each of the military specifications is listed with the specific vibration and shock requirements summarized. Such requirements as resonance, durability, cycling, crash safety and performance are listed.

Digital Multitester. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass. A single-page catalog sheet covers the model 503 digital multitester, a versatile instrument of high precision for the measurement of positive or negative d-c voltages up to 1,000 v, a-c voltages from 50 cps to 100 kc up to 1,000 v rms, and resistances up to 10 megohms. Complete specifications are given.

Flexible Shafts. The S. S. White Dental Mfg. Co., 10 E. 40th St., New York 16, N. Y. Bulletin 5306 contains basic information and data on the company's line of flexible shafts for remote control and for power drives. Functions, advantages, construction and characteristics are given. Also included is information on flexible casings for use with the shafts.

Precision Phase Detector. Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J. A single-page bulletin illustrates and describes the type 205 precision phase detector which measures envelope delay, time delay or phase angle with an accuracy of 1 percent or 0.1 deg. The instrument described consists essentially of two cathode followers, a continuously variable delay line, a differential tuned amplifier, bal-

anced phase detector and a sensitive output indicator.

Pressure Potentiometer. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif. Model 304 miniature gage pressure potentiometer is covered in a 4-page brochure. Chief features are illustrated and describes; and dimensions and full specifications are given.

Resistors. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Specifications of the firm's complete line of d-c electrical standards as well as secondary standard a-c resistors are given, and significant design and manufacturing techniques are described. Electrical characteristics are tabulated and construction features are included as well as ordering instructions.

Ceramics Buyers Guide. Centralab, a division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Bulletin 42-221 is a 16-page, 2-color engineered ceramics buyers guide designed for the use of purchasers and designers of ceramic parts. Advantages of engineered ceramics over other materials and the types of ceramic for specific uses are given. A tour through the CRL plant showing how ceramics are manufactured is a special feature of the guide.

Voltage Reference and Stabilizer Tubes. Mullard Ltd., Century House, Shaftesbury Ave., W. C. 2, London, England. A new booklet is entitled "A Guide to the Application of Voltage Reference and Stabilizer Tubes." It contains sections on fundamentals of voltage reference and stabilizer tubes; the interpretation of published characteristics; and applications. There are also tabulated data on the company's current tubes.

Picture Tube Guide. General Electric Co., 1 River Road, Schenectady 5, N. Y., has announced a new edition of its quick selection guide for tv picture tubes (ETD-1001A). Purpose of the booklet is to help designers select a particular tube from the large number of types now on the market. It

lists 205 types and for each of these the following information is listed: whether it is aluminized or not, external conductive coating capacitance, type of ion-trap magnet, face, dimensions and style of anode terminal.

Powder Cores. Magnetics Inc., Butler, Pa. Bulletin PC-103 deals with the company's line of molybdenum Permalloy powder cores. A full page of tabular data gives information on standard sizes, electrical specifications and tolerances and types of core finish.

Test Measurement. Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif., has published a 4-page folder illustrating and describing electronic instruments for precision test measurement. Included are such instruments as recording oscillographs, amplifiers, bridge balancers and the Milac analog computer.

Instruments Folder. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass., has published a 4-page folder introducing five new electronic instruments. Illustrated and described are an ultra-low distortion power amplifier, ultra-high regulation power supplies, wide-range audio oscillators and variable electronic filters.

Industrial Relays. Sterling Engineering Co., Inc., Laconia, N. H. Description, coil and pile-up information, and sizes of ten industrial relays are given on a single-page bulletin, form 13C033.

Relays. Potter & Brumfield, Princeton, Ind., has available a 1-sheet bulletin that illustrates and points out advantages of 15 of the more than 110 of the company's standard relay structures. It also discusses the general purpose series KA, appliance series AB and multiple leaf series GA relays.

Industrial Oscilloscope. Precise Development Corp., Oceanside, N. Y. A recent bulletin covers the model 305R industrial oscilloscope —a basic laboratory instrument with an extended low frequency,

highly linear, horizontal circuit. The unit described also incorporates an internal sweep delay up to 100 milliseconds. Electrical characteristics are given.

Power Supplies for Transistors. Burgess Battery Co., Freeport, Ill., has available literature dealing with a line of small batteries that meet the exacting specifications required in transistor operation so far as those requirements have been ascertained. Complete descriptions, and curves showing battery requirements for transistor circuits are given.

Capacitor Microphones. Frank L. Capps and Co., 20 Addison Place, Valley Stream, N. Y., has announced an 8-page brochure entitled "Technical Information on Condenser Microphones." The publication is aimed at helping engineers and others doing professional sound work to utilize capacitor microphones to their best advantage. It details the basic construction of capacitor microphones, their operational theory and gives in chart form typical characteristics of Capps capacitor microphones, with comparisons to other types. Nine formulas and four charts are included.

Servo Literature. Norden-Ketay Corp., 99 Park Ave., New York 16, N. Y., has published a bulletin describing its products and services, and another listing characteristics and specifications of over 130 servomechanism components now in production. Both are available on request.

Crystal Calibrators. Measurements Corp., Boonton, N. J. A 4-page folder illustrates and describes models 111 and 111-B crystal calibrators. Specifications and circuit diagram are shown. One page is devoted to the company's "famous firsts" in laboratory standards.

Audio Amplifier. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Bulletin 85–950 describes the type FG 5-or-10-kw variable frequency audio ampli-

fier. Applications of the amplifier are suggested. The type FG can take a signal from any conventional 30 to 10,000-cps source and amplify it tremendously without distortion. Design and construction features of the equipment are discussed, and operation is described. Complete electrical characteristics are included.

Molded Terminal Boards. General Products Corp., Union Springs, N. Y. A new 15 page, illustrated catalog, T-55, describes and shows details on a complete line of Navy type and new miniature molded terminal boards. Molded-in stud advantages, molding compound characteristics and electrical operating values are fully explained.

Sync Switching Unit. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-844 deals with the type 5240-C sync switching unit that provides means for selecting signals from either of two sync generators for routing to studio terminal equipment. Illustrations, chief features and specifications are shown.

Eyelets. United Shoe Machinery Corp., 140 Federal St. Boston, Mass. A new folder, SE-15, illustrates more than 60 different standardized eyelets. Included are pictures of eyelets used in such electronic products as tv tuners, switch and chassis components and terminal strips. In addition, the folder also lists the maximum thickness of noncompressible material in which the eyelet can be set to give normal roll.

Microwave System. Radio Corp. of America, Camden, N. J., has announced a comprehensive guidebook to the nature and applications of the first microwave radio system designed for use in the unused frequency band of the microwave spectrum, 2450 to 2700 mc. The booklet describes the MM-26 microwave system which makes available 250 mc of uncrowded channel space, provides up to 30 voice channels, and permits establishment of new microwave stations in geographic areas already closed or crowded. In addition to

technical and application data the booklet illustrates how up to 9 parallel duplex systems can be used in this frequency range in a given locality to meet requirements of utilities, pipeline operations, railroads, turnpikes and commercial carriers.

Power Supplies. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y., has published a 24 page booklet on power supplies for laboratory and industry. Special features and specifications are given for over 15 regulated (portable) and unregulated (rack and bench) power supplies. Ordering information is included.

Test Equipment. Lavoie Laboratories, Inc., Morganville, N. J. Electronic test equipment is described and illustrated in a 4-page folder. This literature covers communications sets, radar, air navigation systems and precision components.

Aircraft Instruments and Controls. Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, N. Y. A 6-page foldout bulletin gives a brief history of the company and lists its products. Products are listed under the following headings: (1) aircraft instruments; (2) precision controls; (3) precision computers and components; (4) optics; (5 radio communications and navigation equipment; (6) motors and synchros; and (7) instruments for simulated flight trainers.

Transformers. Kenyon Transformer Co., Inc., 840 Barry St., New York 59, N. Y. Hermetically sealed units and portable broadcast transformers are described and illustrated in a 4-page bulletin. Export data and technical specifications are included.

Precision Electronic Measuring Equipment. New London Instrument Co., P. O. Box 189, New London, Conn. A recent 8-page folder illustrates and describes a line of precision electronic measuring equipment. Included are descriptions of the model 100C f-m signal generator; model 130A uhf tv

sweep frequency generator; model 131 uhf sweep test rack; model 200 uhf grid dip oscillator; model 175 vhf-uhf noise source; model 155 signal generator; model 160 broadband amplifier; model 167 uhf balun; model 701 frequency standard; model 252 modulation monitor; model 183 square wave generator; and model 901 transconductance analyzer and circuit simulator. Specifications for each are given.

Germanium Diode Bulletin. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. Bulletin GD-2 lists ratings and specification on germanium diodes. Describing the company's complete germanium point contact diode line, it offers specifications on the high temperature diodes, computer diodes, uhf mixer diodes, meter protection diodes and general-purpose diodes. A complete interchangeability and replacement chart is also included in this literature.

Military Transformers. Microtran Co., 84-11 Rockaway Beach Blvd., Rockaway Beach 93, N. Y., has published a 12-page catalog listing detailed information on typical transformers designed and available for specific military ruggedized application. Complete photographs, electrical data and mechanical dimensions are given to aid the design engineer in properly specifying his requirements. The catalog is available upon letterhead request.

Precision Potentiometer. Helipot Corp., 916 Meridian Ave., So. Pasadena, Calif. The 1½-in. long × ⅜-in. diameter, 1-oz series AJ precision potentiometer is the subject of data sheet 54-06. A 10-turn precision potentiometer for servo or bushing mounting, the series AJ combines high resolution and close linearity characteristics with minimal weight and size. The illustrated data sheet lists specifications, construction, coil characteristics and available modifications.

Oscillographic Recorder. Technology Instrument Corp., 531 Main

St., Acton, Mass., has available literature on its new oscillographic recorder which has a response up to 900 cycles. The 4-page brochure tells how oscillograms are traced on blackened 35-mm acetate film by styli directly actuated by small excursions of galvanometer type movements. The magnified image of the film is directly projected on a built-in screen for studying or monitoring the progress of the recording. In the unit described eight recording channels are provided plus a ninth for use as timing or reference marking.

Induction-Heating Equipment. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. An 8-page bulletin describes a complete line of induction-heating equipment. The h-f motor-generator sets and associated apparatus discussed are specifically designed for induction heating operations such as hardening, annealing, brazing, forging and heat-treating of metals. The motor-generator sets described have standard output frequencies of 960, 3,000, and 9,600 cps, with power ratings of 30 to 1,500 kw and higher.

Silicon Diode Catalog. Microwave Associates, Inc., 22 Cummington St., Boston, Mass., has published a new 4-page 2-color catalog 55S which describes over 54 types of silicon diodes. Sections include Low Noise Mixer Diodes, Video Detectors, Diodes for Balanced Mixer Use, Modulator Diodes and complete tabular specifications.

Electronic Timers. G. C. Wilson & Co., 1950 Eighth Ave., Huntington, W. Va., has available a 5-page brochure with current information describing its standard line of electronic timers. Included in the line described are delay, repeat cycle and interval timers, all of which are available from stock.

Panel Meters. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page bulletin illustrates and describes the series 100 1-in. round and square watertight panel meters. It gives

general specifications, a table of standard ranges and approximate resistances, outline drawings and ordering information. The meters described meet MIL M-3823 specifications.

Precision Potentiometer. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. The single-turn, high precision series G potentiometer is the subject of data sheet 54-36. Compact, rugged and long-lived, yet low-priced, the series G units construction, specifications and linear coil characteristics are described in detail in the sheet.

Metallized Ceramic Coating. Frenchtown Porcelain Co., Trenton 9, N. J. Bulletin 155 is a 4-page folder discussing Nicote, a metallized ceramic coating for use with both hard and soft solder. Chief features, applications and handling information are included. The bulletin also contains a page of tabular data showing properties of the company's various ceramics.

Electromechanical Products. Transitron, Inc., 154 Spring St., New York 12, N. Y. A 20-page illustrated booklet describes modern facilities for the design and production of precise electromechanical and electronic products. Production facilities illustrated include precision machining, electronic and mechanical production, silver soldering, model making, and electromechanical and electronic testing and tropicallizing. The text outlines available services for government agencies and industrial organizations, engineers and contractors.

Facilities Brochure. Varian Associates, 611 Hansen Way, Palo Alto, Calif. The company's principal products—klystron tubes, nmr spectrometers and laboratory electromagnets, are fully illustrated and described, and related products, such as radar subsystems, microwave components, uhf water loads and stalos are discussed in the new brochure. Facilities of the company's two plants are set forth, together with an account of advanced manufacturing tech-

niques and processes. Unusual and interesting aspects of the firm's operations are presented with explanatory photographs. Current product applications, for both military and commercial uses, are discussed.

Radar Antennas, Mounts, Components. General Electric Co., Schenectady 5, N. Y., announces a new bulletin showing the company's radar antennas, mounts, components and accessories for use with land and ship based radar systems. Designated GEA-6279, the 8-page bulletin includes photographs of complete antennas and mounts, and various accessories and components. Also included is a description of production facilities, testing and inspection techniques and a short history of the company's antenna design and manufacturing experience.

Resistor Brochure. The Daven Co., 191 Central Ave., Newark 4, N. J. The series 850 Davohm metal-film type resistor is the subject of a 6-page brochure now available. Hermetically sealed, with temperature coefficient independent of resistance value, the resistor described is ideal for aircraft and radar use. The covering brochure gives full details of performance in the ½, 1, and 2-w sizes. Write to the company on your letterhead.

Tiny Jack and Plug Combinations. Telex, Inc., Telex Park, St. Paul 1, Minn. Advantages and applications of the company's miniature jack and plug combination are given in a new catalog sheet. One-third the size of previous models, the combination can be installed in computers, dictating machines, tape recorders and miniature radios. The illustrated literature reports that the unit is available with L-shaped plug molded to cord or detachable straight plug. Complete specifications are given.

Metal Detector Bulletin. Allis-Chalmers Mfg. Co., 935 S. 70th St., Milwaukee, Wisc. A description of what the a-c electronic metal detector is and what it does is told in bulletin 15B7217B. Used to in-

spect plastics, food, confectionery, tobacco, paper, rubber, textiles, medicines, explosives, glass, ceramics, leather, and wood, the metal detector helps to maintain product purity and prevent damage to equipment. The bulletin also tells how the detector is built and how it works to provide positive electronic inspection. The detector is easy to install and adapts readily to production line use, the bulletin points out.

Reflex Klystron. Varian Associates, Palo Alto 2, Calif. A 1-page bulletin announces the rugged VA-203 reflex klystron for airborne radar and beacon local oscillator service. Chief features are outlined and guaranteed specifications are listed.

Coil Winding Machines. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill. Catalog No. 55 is a 54-page booklet illustrating and completely describing machines for rapidly winding practically every type of coil including armature, transformer, bobbin, repeater, solenoid, resistor, lattice-wound universal, space-would, variable pitch, toroidal, deflection yoke and field coils. Among the accessories pictured and described are 12 tensions, 3 counters, model 105 wire scraper, a variety of gears and cams, a pi attachment, wax pot, wire takeoff guide and 6 wire guides. A full page of winding formulas is also given.

Analog Instruments. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass., has available a single sheet showing a representative selection of analog instruments. The bulletin offers a quick survey of products and computing techniques. New items include a plug-in d-c stabilizing amplifier, the electronic graph-paper display, and modernized versions of the earlier building-block components.

Sound Equipment. Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif., has issued a 36-page catalog containing complete technical data on all its engi-

neering sound products. It covers a-m/f-m tuners, transcription reproduction arms, 12 different broadcast, p-a and scientific microphones, more than 20 amplifiers and preamplifiers, power supplies, control consoles, 19 different speakers, horns, cabinets, and matching transformers. The catalog items are of sufficient scope to provide sound systems of any size.

Electronic Assembly Machine. Mechanical Division of General Mills, Inc., 1620 Central Ave., Minneapolis, Minn., has published a 4-page folder on the Autofab, a complete automatic assembly machine for electronic circuits. The machine described is readily adaptable to the assembly of any unit that uses standard electronic components on a printed circuit card. The bulletin is fully illustrated and gives chief features of the unit that completes an operation at the rate of 20 circuits every minute.

Ceramics Buyers Guide. Centralab, a division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. A 2-color, 16-page guide is designed for the use of purchasers and designers of ceramic parts. Advantages of engineered ceramics, other materials and the types of ceramic for specific uses are given. A tour through the CRL plant showing how ceramics are manufactured is a special feature of the Guide.

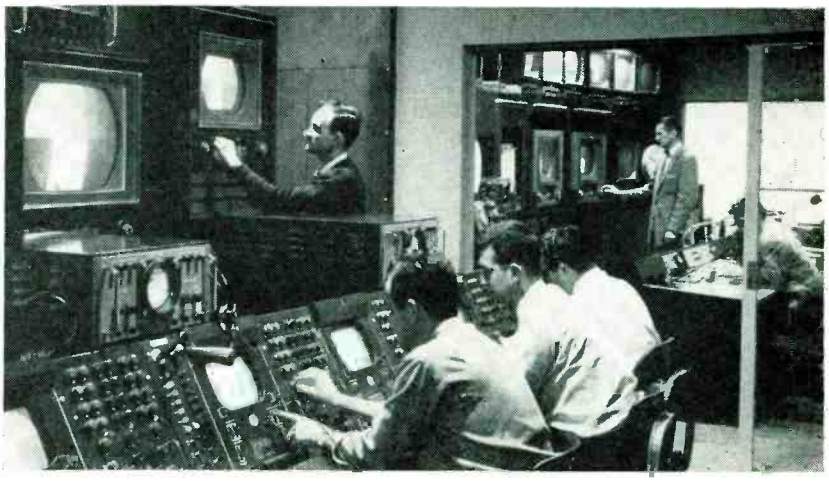
Tubing Guide. Superior Tube Co., Germantown Pike, Norristown, Pa. An 8-page catalog contains pertinent information needed for the selection and application of 46 principal analyses of tubing. Bulletin 40 groups the analyses into five classifications: (1) stainless steel, (2) nickel and nickel alloys, (3) carbon and alloy steels, (4) beryllium copper and (5) titanium. A short summary of the principal properties of each analysis and its normal production limits is given. The properties of six glass sealing alloys, used primarily for glass-to-metal seals in the electronic and electrical manufacturing industries, also are given.

Plants and People

Edited by WILLIAM G. ARNOLD

Electronic manufacturers expand plant facilities for civilian and military equipment. Companies plan merger actions and acquire assets of electronic and non-electronic firms. Engineers advance to new positions in the industry.

NBC-TV's Color City In Burbank Starts Operations



REPRESENTING an overall investment of more than $7,000,000, NBC's new color city in Burbank, Calif. features a studio built specifically for colorcasting. Built and equipped at a cost of $3,600,000, it is one of the world's largest television studios, with floor space of 140 feet by 90 feet and 42 feet of clearance from floor to ceiling.

The studio takes its place with two existing studios and a service building, all of which were constructed on NBC's 50-acre tract in Burbank in 1952. Other new construction includes a control building, a technical building and a rehearsal studio which can also be used for commercials and orchestral scoring. In addition, the service building, housing set-decoration shops and other facilities, has been extended to double its former size.

The new facilities total 12,600 sq ft, bringing the total color city space to 55,900 sq ft.

The new technical building serves as the nerve center for all NBC facilities at Burbank. On its first floor are the audio and video controls necessary to tie the studios into one manageable operation. On the second floor, is a film center with two RCA three-vidicon camera chains, each of which can be patched out to any of the live studios. The film control room is equipped with a console similar to those used in live studios. Also on the second floor is an announcer's booth designed for newscasts and commercials, and large enough to accommodate two camera chains.

Westinghouse To Build Electronics Plant

WESTINGHOUSE plans the construction of a combined manufacturing plant, engineering and office building for production of military electronic equipment in Baltimore.

Site of the proposed electronics division structure is adjacent to the air arm division plant. It will comprise a total of 350,000 sq ft of floor space with 210,000 sq ft being devoted to manufacturing space and the remaining 140,000 sq ft to engineering and office facilities.

The new installation will provide an expanded and up-to-date development for the continued manufacture of electronic equipment for the Defense Department. Plans now call for full occupancy and full operation by January 1956. It is hoped that expanded engineering facilities can be occupied prior to that time.

The new building will provide space in the division for approximately 150 additional engineers.

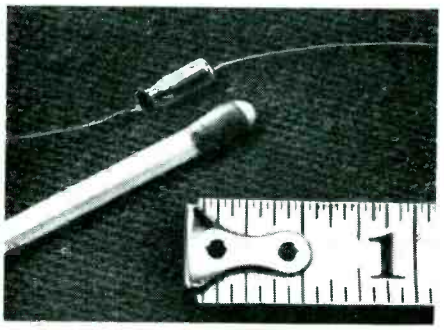
Westinghouse also announced that Trevor Clark has been appointed assistant to the engineering manager of the firm's air arm division.

Clark, prior to his present appointment, was associate director of Southwest Research Institute.

In 1938, he was sent to the Paris, France, laboratories of IT&T.

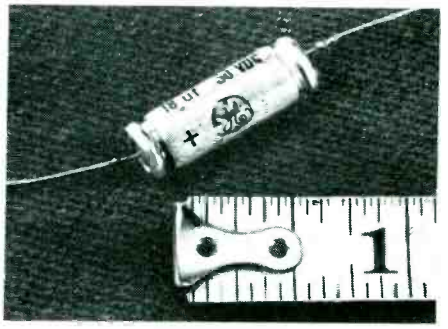
He returned to the U. S. in 1941

CAPACITORS by General Electric



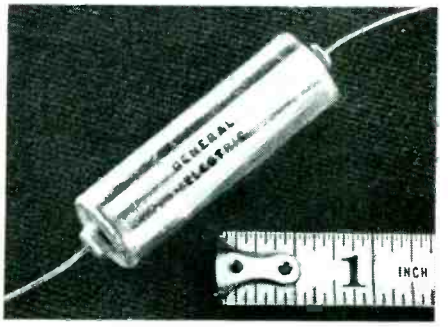
MICRO-MINIATURE

For low voltage d-c miniaturized electronic equipment (hearing aids, walkie-talkies, paging systems). Ideal for transistorized assemblies. **Ratings** 1-8 uf at 4 v. d-c, 1 uf at 8 v. d-c, 0.5 uf at 16 v. d-c. **Tolerance** −0 to +200%. **Temp. range** −20 to +50° C. BULLETIN GEA-6065.



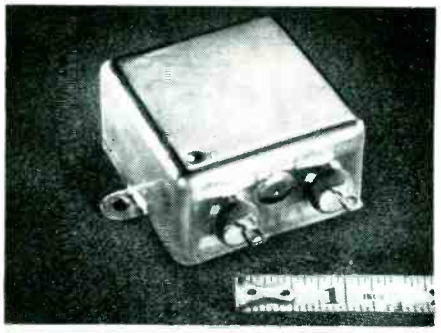
TANTALYTIC*

For electronic equipment requiring small size, low leakage current, long shelf life, wide temperature range. Plain or etched foil, and polar or non-polar types, suitable for a-c or d-c. **Ratings** 0.25−580 uf, 3.75−150 v. **Tolerance** ±20% (plain foil), −15 to +75% (etched). **Temp. range** −55 to +85° C. BULLETIN GEC-808.



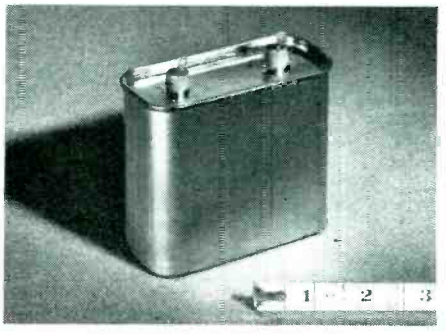
METAL-CLAD TUBULAR

For d-c uses where reliability under severe operating conditions is required (military electronic equipment). **Ratings** 0.001−1 uf at 100, 200, 300, 400 and 600 working v. d-c. (Can be applied to a-c circuits with adequate derating.) **Tolerances** ±5, ±10, or ±20%. **Temp. range** −55 to +125° C. BULLETIN GEC-987.



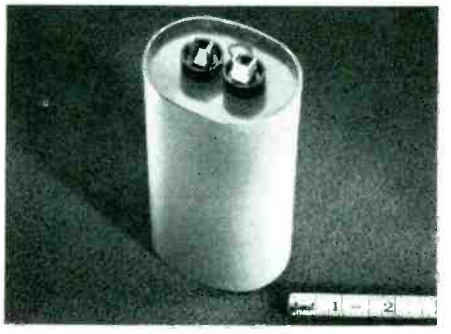
PERMAFIL-IMPREGNATED

Designed to meet requirements of MIL-C-25A, characteristic K specifications, and are suitable for high-temperature operation. **Ratings** 0.05−1 uf at 400 v. d-c. **Tolerance** ±10%. **Temp. range** −55 to +125° C. BULLETIN GEC-811.



STANDARD COMMERCIAL

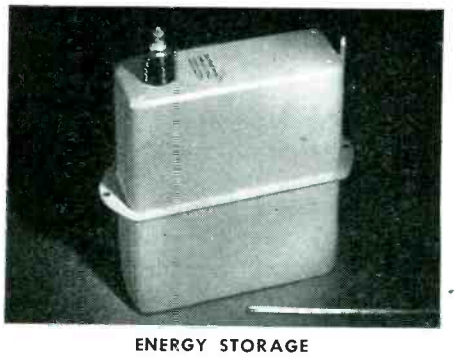
For motors, filters, communication equipment, luminous-tube transformers, industrial control. **Ratings** dual rated units (a-c or d-c) rated at 0.01−50 uf, at 236-660 v. a-c, 400-1500 v. d-c. Single rated units also available. **Tolerance** ±10%. **Temp. range** −55 to +85° C. BULLETIN GEC-809.



DRAWN-OVAL

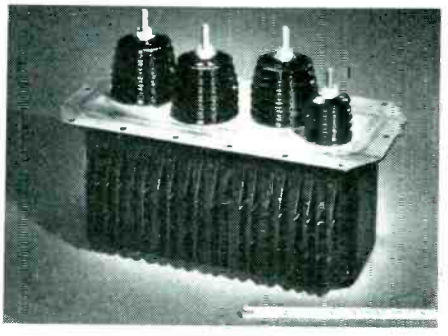
For air conditioning and refrigeration equipment, fluorescent lamp ballasts, business machines, voltage stabilizers. Single, dual or triple-section types. **Ratings** 1−20 uf at 236-660 v. a-c, and 1-15 uf at 600-1500 v. d-c. **Tolerance** ±10%. **Temp. range** −30 to +70° C. BULLETIN GEA-5777.

*Reg. trademark of General Electric Company.



ENERGY STORAGE

For use in high magnetic fields and high intensity arc discharge. **Ratings:** may be built as high as 2000 joules (watt-seconds). **Tolerance** ±10%. BULLETIN GEA-4646.



NETWORK

For guided missiles, aircraft, radar equipment. **Ratings:** built to user specifications. **Temp. range** −55 to +125° C, or to user specifications. BULLETIN GEA-4996.

NOTE: All capacitance tolerances are given at +25° C.

SEND COUPON BELOW for complete information about G-E capacitors.

General Electric Co.
Section G442-25
Schenectady 5, N. Y.

Please send me capacitor bulletins checked below.

☐ GEA-4646	☐ GEC-808
☐ GEA-4996	☐ GEC-809
☐ GEA-5777	☐ GEC-811
☐ GEA-6065	☐ GEC-987

Name.....

Position.....

Company.....

Address.....

City..... Zone..... State.....

Progress Is Our Most Important Product

GENERAL ELECTRIC

chanization program in the various plants.

Philco Advances Joseph Gillies

JOSEPH H. GILLIES in addition to his duties as vice-president and general manager of the government and industrial division, has been appointed vice-president in charge of manufacturing for Philco Corp.

In his enlarged responsibility, he will have charge of the coordination and direction of all Philco manufacturing activities, including government production, transistors, microwave equipment, industrial products and consumer goods.

Gillies joined Philco in 1929. He was named works manager in 1939 and became vice-president in charge of radio production in 1942.

He was in charge of all government production during World War II, and directed the manufacture of over 500,000 advanced airborne radar equipments for the Armed Forces. He assumed the responsibilities of vice-president in charge of operations for Philco's newly established government and industrial division in April, 1951, and became vice-president and general manager of the division in September of the same year. Since 1947 he has been a member of the board of directors of Philco.

Magnavox Expands Research Laboratories

THE MAGNAVOX CO. of Fort Wayne, Indiana plans expansion of their new research laboratories in West Los Angeles, Calif.

Ragnar Thorensen has been ap-

pointed director of research for the new laboratories. He directed work on the SWAC digital computer at U.C.L.A. and has many years experience in the electronic field. John Salzer, formerly with M.I.T. and Hughes Aircraft, has been appointed assistant director of research. The labs specialize in digital computers, fire control, missile guidance systems and other electronic projects. Data conversion equipment is being designed and manufactured for industrial and military organizations.

William H. Graham has been appointed general manager of the Magnavox plant in Greenville, Tenn.

Graham comes to Magnavox from Avco where he has been general manager in charge of manufacturing, engineering and purchasing of the Crosley division since 1947.

From 1937 to 1947 he was with National Cash Register as industrial engineer and production superintendant.

IBM To Enlarge Kingston Plant

IBM PLANS the expansion of its Kingston, N. Y. plant, which will allow an increase in personnel from 1,600 to 2,000.

The plant will be increased in size from 320,000 sq ft to 459,000 sq ft. The 139,000 square feet of additional space will be required for the manufacture of a defense project.

The expansion will consist of a two-wing extension of the central structure, now being built, and a warehouse, to be constructed near the east boundary of the property.

Clevite Buys Houston Firm

CLEVITE CORP. has purchased the business of Technical Instrument Co. of Houston, Texas, manufacturers and distributors of precision instruments for geophysical exploration for oil.

The acquisition is designed to complement Clevite's recently developed magnetic recording techniques in the field of seismography.

Technical Instrument will be

operated as part of Clevite's Brush Electronics unit. The company will continue to be under the direction of C. W. Bocock III, founder and president.

Edward R. Wagenhals has joined Clevite-Brush Development Co. as vice-president and director of components development.

Wagenhals has been with Booz, Allen & Hamilton, management consultants, in New York since 1950. His previous experience covers technical and management work in the electronics field, beginning with GE in Cleveland in 1927, and including 16 years with RCA. For three years before joining Booz, Allen & Hamilton he was works manager in charge of the operations of Sonotone Corp.

Motorola Communications Promotes Olson

ROY H. OLSON has been appointed director of engineering in the communications & electronics division of Motorola. In this capacity he will direct the technical activity of the division's industrial products department. He is in charge of engineering co-ordination for industrial products on non-military research and development efforts.

Olson has been associated with Motorola since 1951, when he joined the company's Phoenix Research Laboratory as an engineering section leader.

In 1934 he began a 13-year association with Collins Radio Co. Later he operated his own manufacturing and consulting firm before coming

to Motorola.

Since joining Motorola, Olson has been co-ordinator of National Bureau of Standards missile fuse projects and project leader for special military development tasks.

More recently his work has been with subminiature missile electronic fuses.

National Vulcanized Fibre Elevates Two Executives

NATIONAL VULCANIZED FIBRE announced that Gerard A. Albert, formerly staff manager, has been named manager of manufacturing. He has been with the company since 1929.

Henry C. Guhl, formerly manager of process engineering, has been named manager of engineering. Guhl, who joined National in 1954, was associated with Westinghouse as manager of engineering for the Micarta division.

Fairchild Builds In California

FAIRCHILD Camera and Instrument Corp. broke ground for a new 24,000 sq ft plant in Los Angeles, Calif. to house expanded manufacturing of the potentiometer division and offices for other divisions concerned with aerial cameras, graphic arts products and portable power tools.

A second 24,000 square foot unit is planned. Eventual employment will be approximately 300 persons. Completion of the first unit is expected by June this year.

Steel Companies Enter Electronics

ALLIED Structural Steel Companies have acquired a substantial interest in Electronics Protection of Chicago, formerly a division of Continental Communications, and have named V. Lee Cook president of the new company. Cook, who has been president of Continental, manufacturers of precision testing equipment, frequency measuring devices, and communications equipment, will continue to serve as head of that company.

The newly formed company spe-

cializes in the manufacture of electronic equipment designed to regulate traffic for the safe conduct of emergency vehicles, fire, police, ambulances, on city streets. A number of other items will be turned out during the coming year.

IRC Buys Hycor Companies

THE HYCOR COMPANIES of California and Puerto Rico have been acquired by the International Resistance Company. Management of the Hycor Companies will continue operations independently.

Annual sales of Hycor, manufacturers of magnetic and audio devices and precision resistors, exceed one million dollars.

In addition to Hycor IRC has two other wholly-owned subsidiaries—Ircal Industries of Los Angeles, California and Circuit Instruments of St. Petersburg, Florida.

Admiral Moss Heads Hoffman Laboratories

VICE ADMIRAL JOHN B. MOSS, U. S. Navy (Ret.) has been elected president of Hoffman Laboratories, wholly owned subsidiary of Hoffman Electronics.

Admiral Moss has been corporate-wide consultant for Bell Aircraft Corp. since his retirement from the Navy in 1953. He operated between Bell's Niagara frontier division in Buffalo, the Texas Helicopter division in Fort Worth and Bell's Washington office covering the company's activities in the guided missile, electronic, helicop-

ter and convertiplane fields.

Admiral Moss' most recent military assignment was assistant chief of the Navy's Bureau of Aeronautics, a position he held from March, 1951 until his retirement August 31, 1953. James T. McAllister has been appointed to the post of quality control manager of Hoffman Radio division. For the past three years, he has been national service manager for the firm.

In his new assignment, McAllister will report directly to the president and will have complete responsibility and authority for quality control on the Hoffman line of television, radio and high fidelity record players.

Helipot Appoints Development Chief

JAMES F. GORDON has been appointed chief development engineer of Helipot corp. in South Pasadena, Calif.

He was formerly chief engineer of the Berkeley division of Beckman Instruments and prior to that, principal research engineer of Bendix Radio.

Du Mont Forms Systems Group

DU MONT Labs has established a systems engineering group to assist industry by the application of electronic techniques to automatic production and quality control methods.

The new Du Mont activity makes available to industry and other interested users information and experience in the solution of problems of measurement and control in many diverse fields.

The systems engineering group is equipped to investigate specific problems in manufacturing processes and to make recommendations for their solution either by designing new automatic electronically controlled equipment or by integrating electronic control systems into existing installations.

The field of applications being covered includes all phases of manufacture and research from raw materials to finished products,

with special emphasis on non-destructive control testing.

Among the projects encompassed are the design of automatic test and control systems for oil and gasoline refineries, for production of metal alloys, metal cables, plastics, paint, electrical and electronic products and for a wide variety of other mechanical and electrical manufacturing equipment.

The firm also announced the appointed of Alfred Y. Bentley as assistant manager of the cathode-ray tube division. In his new position he will provide administrative assistance to the divisional management in the fields of engineering, manufacturing, sales, budgets and planning.

Bentley has a ten year background with Du Mont in technical and administrative positions. He has progressively served as assistant engineering manager of the cathode-ray tube division and manager of the division's engineering department. He was then named as manager of the engineering department of the television receiver division, after which he served as technical assistant to the president of the company.

Baldwin-Lima Buys Ruge-de Forest

BALDWIN-Lima-Hamilton Corp. has acquired complete ownership of Ruge-de Forest, of Cambridge, Mass. industrial testing-equipment and electronics manufacturer.

Operation of Ruge-de Forest will complement activities of the O. S. Peters Co. of Washington, D. C., makers of testing instruments and electronic devices. The Peters Company, also a wholly-owned B-L-H subsidiary, was purchased in June, 1954.

Ruge-de Forest's present officers, Dr. Arthur Ruge, Frank Hines and Edgar J. Jones, will continue to direct its operations.

Philamon Labs Acquires New Plant

PHILAMON LABORATORIES, formerly of Brooklyn, N. Y., has acquired a new 15,000 sq ft plant in Westbury,

Long Island, N. Y.

The increased space will be employed for stepped-up production, design and development of its line of frequency standards.

Ampex Elects Long New President

ALEXANDER M. PONIATOFF was elected founder and chairman of the board of directors of Ampex Corp. and G. I. Long will replace him as president.

Named vice-chairman of the board was T. Kevin Mallen who, for the past year, has been in Europe consolidating Ampex export activities.

Minnesota Mining Realigns Executives

LOUIS F. WEYAND, executive vice-president and director of Minnesota Mining & Manufacturing Co., has been named sales director for 3M, succeeding George H. Halpin, also an executive vice-president and board member, who will remain active as a consultant in specific sales and operating problems.

Halpin, who reached retirement age last year, had asked to be relieved of the responsibilities of director of sales.

Weyand is just completing 40 years of service at 3M. He joined the firm as a salesman in Chicago in 1915.

Halpin joined 3M as sales manager in 1930. He was elected a vice president of 3M and was made general sales manager of the company in 1938. He was elected to the board of directors in 1939. He has

been executive vice-president in charge of sales since 1949.

It was also announced that Wilfred W. Wetzel has been appointed general manager of the magnetic products division of the company.

He joined 3M in 1944 and became chief physicist of the central research department in 1946. Since 1948 he has been technical director of the magnetic products division.

Admiral Promotes Top Executives

JOHN F. GILBARTE, manager of Admiral's government sales division, has been elected to the newly created position of vice-president-government laboratories division.

Edmond I. Eger, vice president-advertising was elected to the board of directors.

Other appointments include the election of John B. Huarisa, executive vice president and one of the original founders of Admiral, to the additional post of treasurer, and George E. Driscoll, secretary, to assistant treasurer as well.

Lynn C. Park, treasurer of Admiral and a member of the board, has retired due to ill health after serving the company since 1937.

RCA Opens Waltham Lab.

THE RCA Aviation Systems Engineering Laboratory has been officially opened in Waltham, Mass. It will develop specialized electronic fire-control systems for military aircraft. Now in an initial operating stage, it is expected to employ by year's end approximately 100 scientists, engineers, and laboratory personnel. Manager of the new installation is Robert C. Seamans, Jr., for many years a member of the teaching staff at MIT.

Silicone Seals Formed In Chicago

SILICONE SEALS, has been formed in Chicago for the design and production of silicone rubber hermetic terminals.

The company has been organized

by Leonard E. Brown and Robert Shattow, both of whom have had considerable experience in engineering, design, production, and sales of hermetic terminals.

Hamilton Named Chief Engineer

G. EDWARD HAMILTON has been appointed chief engineer of WABC-TV in New York. In this capacity he has full responsibility for the technical operation of the station. Prior to this assignment he served as eastern division television engineer of ABC where he supervised the technical facilities.

General Mills Appoints Kober

CARL L. KOBER has been appointed to be in charge of airborne systems evaluation work for the mechanical division of General Mills.

Dr. Kober, who was chief of the German naval fire-control and shipborne radar board and worked on the Wasserfall and V-2 rocket teleguiding systems, has been working for the U. S. Air Force's Wright Air Development Center since the USAF brought him to this country in 1949. His last work for the USAF was on strategic bombing systems. He expects his U. S. citizenship this year.

At General Mills he will devote his time to creative work in airborne systems—radar, bombing, navigation and guidance. His background in these fields includes the

guidance work mentioned; infrared work in Germany for airborne target detection and fire-control; supervision of fire-control systems for the Bismarck and Tirpitz; snorkel radar for submarines; and heading of the projects for a large portion of German radars like the early warning FREYA and the Wasserman.

Panellit Acquires Jordan Electronic

JORDAN ELECTRONIC Mfg. Co. of Pasadena, Calif., manufacturers in the radiation monitoring field, has been acquired by Panellit, of Chicago. Panellit manufactures automatic control and data reduction information systems.

Panellit plans to accelerate research and development activities of Jordan in the field of industrial measurements in addition to its activities in the nuclear field. Jordan also plans to adapt Panellit's alarm and scanning devices to its present monitoring system.

Jordan is to be operated as a wholly owned subsidiary of Panellit with M. Jordan Nathason, the former owner, serving as president. Albert Sperry, president of Panellit, will serve as chairman of the board of Jordan. Other key personnel also will be retained.

Panellit will construct a new manufacturing plant in Alhambra, California. The first unit of 10,000 sq ft is expected to be ready for occupancy some time in May. This plant will be occupied jointly by Panellit's western division, now located in Los Angeles, and by Jordan.

Pye Establishes U. S. Subsidiary

PYE LIMITED, of Cambridge, England, has formed a wholly-owned subsidiary, Pye Corporation of America, in New York for promotion and distribution of its communication equipment. These products are designed and manufactured by the Pye Telecommunications Division in Cambridge, England.

The president of the new U. S. organization is C. O. Stanley and

management will be under the direction of W. M. Cagney.

ECA Appoints Chief Engineer

Harvey L. Hansberry

HARVEY L. HANSBERRY has been appointed chief engineer of the Fireye division of Electronics Corporation of America.

He was previously chief of the power plant branch of the CAA's technical development and evaluation center at Indianapolis. He was primarily responsible for development of aircraft power plant fire protection equipment and fire prevention design criteria.

He joins the ECA organization after a 15-year association with the CAA.

Carstedt Industries Plans Production Center

CARSTEDT RESEARCH of Downey, Calif. will move into the first unit of the new Carstedt Electronics Center, now being developed on a 10-acre tract in Long Beach, Calif.

The 36,000 sq ft facility will be the first of eight units owned and leased by Carstedt Industries, now being formed. The center will provide an integrated production area for companies working in related electronics fields on devices applicable to guided missiles, high-fidelity sound equipment and computers. Full employment at the center

is expected to be 800 when the project is complete, about two years from now.

Carstedt Research expects to quadruple production of its core-loop transformer components with the installation of equipment recently purchased from Westinghouse's transformer core-loop plant in Lima, Ohio. In addition to the expanded production equipment at the new site, approximately 150 more employees will be hired.

Winder Aircraft Plans New Plant

THE WINDER AIRCRAFT Corp. of Winder, Georgia, will build a new plant in the Southeast to manufacture electronic equipment. Present plans are for a structure of approximately 25,000 sq ft of floor space.

Eventual employment at the plant will be over one hundred employees.

Much of the new capacity will be used in manufacturing a new type of navigational equipment.

Link Promotes Seven Engineers

A TOTAL of seven appointments have been made in the engineering and manufacturing divisions of Link Aviation of Binghamton, N. Y.

Laurence E. Fogarty was named Link's chief engineer.

John M. Hunt was appointed director of research and development.

Robert F. Hall was appointed manager of manufacturing engineering.

Vincent S. Kraeger assumed the duties of manager of administrative engineering.

Milton S. Wade was named manager of standardization.

Melvain Oliphant was appointed project manager for the Link T-37A simulator and E-600 trainer projects.

James F. Newlon was named production manager for the company's main plant in Binghamton.

Dr. Fogarty moved up from his position as project engineer on the T-37A and E-600 projects. He joined Link four years ago as head

of the aerodynamic section.

Hunt formerly had been Link's chief development engineer.

Hall, who had been production manager, has been with Link for four years.

Kraeger was formerly a Link staff engineer.

Wade, a 15-year Link employee, was manager of project engineering before his new appointment.

Oliphant was manager of administrative engineering at Link. He has been with the company for six years.

Newlon, who has been with Link for 10 years, had served as manager of manufacturing engineering prior to his new appointment.

Sylvania Selects Computer Site

THE TOWN of Camillus, N. Y., near Syracuse, has been selected by Sylvania as the site of its new data processing center.

Construction work is expected to start soon on a building of approximately 50,000 sq ft.

The center, which will be company-wide in scope, will provide centralization of data processing functions in one large facility.

Under the new system, Sylvania's various installations—including division headquarters, plants, sales offices and warehouses—will feed financial and production information via a communications network to the center where the data will be instantly summarized for corporate and decentralized management.

The center will be linked with four Sylvania area reporting offices, which have not yet been designated, by a leased communications network. In turn, four to six facilities will report to each area office. When in full operation the center will employ approximately 300 persons.

The company also announced that Matthew D. Burns, recently appointed general manager in charge of electronic tube operations of Sylvania, has been elected a vice-president.

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Matthew D. Burns

panies since 1921, Burns has executive direction of the overall operations of the company's radio tube division, television picture tube division and the electronic product sales department.

He joined the company as an industrial engineer in charge of lamp quality. He later was placed in charge of radio tube quality and worked in the engineering department on production engineering problems. In 1932 he was appointed factory superintendent at Emporium, and successively held the positions of manager of the Emporium receiving tube plant, general manufacturing manager of the radio tube division, and general manager of the radio tube division until his most recent appointment.

Glass-Solder Names President

GLASS-SOLDER ENGINEERING of Pasadena, Calif., manufacturer of hermetic seals for the electronics industry, has named Hugh P. Moore, president and general manager. He was president of Acme Electronics division of the Aerovex Co. in Monrovia.

Felix Elected Vice-President Of Avco

CLARENCE FELIX, vice-president and general manager of Crosley government products division, has been elected a vice-president of the parent company, Avco Manufacturing Corp.

He will continue to act as general

manager of government products.

Felix, who was named a vice-president in 1954, joined Crosley 28 years ago in the engineering department. He was appointed chief engineer of automobile radios in 1934 and of all radio production in 1939.

In 1941, when Crosley entered full time war production, W. A. Felix became product manager of government electronics and later manager of all government products. After the war in 1945, he was appointed product manager of radio and television and in 1947 he was promoted to works manager of Crosley's Cincinnati plant. He became assistant to the general manager in 1949.

In 1953, with the establishment of an autonomous defense manufacturing division, he became general manager of government products.

Dunn Receives Army Award

LOUIS G. DUNN, right, associate director of the guided missile division of Ramo-Wooldridge has received the Certificate of Appreciation from the Army, for his work in missile ordnance including development and completion of the Corporal, the Army's surface-to-surface guided missile.

Presentation of the Certificate, the Army's highest civilian award, one of three awarded within the past ten years, was made by Major General Leslie E. Simon, chief of ordnance research and development division in behalf of the Army's chief of ordnance, Major General E. L. Cummings.

The citation honored Dr. Dunn for his work from 1947 to 1954 as director of the Jet Propulsion

Laboratory operated for the Army by California Institute of Technology.

Veeder-Root Selects Research Director

Allan L. Burton

ALLAN L. BURTON has been appointed research director of Veeder-Root, manufacturers of counters and computing instruments.

Market and product research will be combined under his direction.

He joined the firm a year ago, following specialized work in new product administration at RCA. Prior to that, he was manager of industrial sales of Tracerlab. During World War II, he carried out research work with the underwater sound laboratories at Harvard University.

Topp And Bonner Complete Merger

TOPP INDUSTRIES, of Los Angeles, Calif., electronics engineering and development company has merged with Bonner Machine Works, manufacturer of aircraft electronics systems, through a stock exchange. The merged companies are retaining the name Topp Industries with B. F. Gira, co-founder and president of Bonner as president; H. J. Peterson, founder and former president of Topp as executive vice-president and a director and Glendon L. Tremaine as secretary and a director.

Topp has filed with the Securities

and Exchange Commission for authorization to issue 139,000 shares of common stock, underwritten by Dempsey-Tegeler & Co. Proceeds from the sale are planned for use in the acquisition of Standard Electronics Manufacturing Co., plus leasehold improvements, equipment and increased working capital.

The merged companies' combined sales for the eight months ending December 31, 1954, totalled $1,299,870.

American Electronics Buys Pierson

AMERICAN ELECTRONICS of Los Angeles, Calif., has acquired Pierson Electrical & Engineering Corp. of Los Angeles.

Pierson manufactures miniature d-c motors and generators and develops miniature power supplies for guided missiles and electronic systems for atomic energy application.

By the acquisition, American Electronics augments its miniature components which were limited to a-c products.

R. T. Pierson continues as president of Pierson Electrical.

Norden-Ketay Acquires Acragage

ACRAGAGE Corp. of Milford, Conn. has been acquired by the Norden-Ketay Corp.

The Acragage Corp., formerly Clapp Instrument, was formed in 1942 to design and manufacture quality pressure and vacuum gages and is currently filling orders for some of the nation's largest users of these gages. In 1954, Acragage produced over 130,000 gages.

GE To Build Military Plant

GE's heavy military electronic equipment department plans the erection of the third building in the HMEE "Systems Center" in Syracuse, N. Y.

The new 69,000 sq ft structure will house the department's marketing section and engineering laboratories.

The HMEE "Systems Center" is

headquarters for the development and manufacture of complex electronic defense systems for the armed forces.

Ground will be broken for the new structure in the spring, and it is expected to be ready for occupancy by about 700 employees by the year's end.

The employees now work at other locations in the Syracuse area, where HMEE employs over 3,300 people in facilities with a total area of over 500,000 sq ft.

Radio Condenser Forms Automation Division

A NEW automation division for design and engineering connected with the manufacture of electromechanical assemblies has been formed by the Radio Condenser Co. of Camden, N. J.

Consisting of design and production specialists representing the various fields of engineering, the new group will design its own electro-mechanical assemblies to fit into customers' automation programs.

The new division will be headed by Joseph S. Robb, director of engineering, and Edward J. Penberthy, sales manager.

Servomechanisms Names General Manager

Harold R. Larsen

HAROLD R. LARSEN, vice-president of Servomechanisms of Garden City, N. Y., has been appointed general manager of the company's eastern and western divisions.

He joined Servomechanisms in

1950, and from 1952 until his recent appointment, he was manager of the company's western division. In his new capacity of general manager, Larsen will have the responsibility of directing the sales, engineering and production activities of the eastern and western divisions of the company and will report directly to the president, William W. Shannon.

Blonder-Tongue Opens New Plant

BLONDER-TONGUE LABS of Westfield, N. J. has put into full operation its second plant located in Newark, N. J. The new building provides over 30,000 sq ft of additional manufacturing space

Hermetic Seal Appoints Neidorf

HERMETIC SEAL PRODUCTS of Newark, N. J., appointed Samuel W. Neidorf as vice-president and general manger in charge of operations. He will supervise and take charge of the complete operation of Hermetic's three plants.

Neidorf joined the firm in 1948 as chief engineer and factory manager. Before his present appointment, he was in charge of all engineering departments.

He was formerly associated with IT&T and Tung-sol Electric. With the latter company he helped pioneer the engineering and devel-

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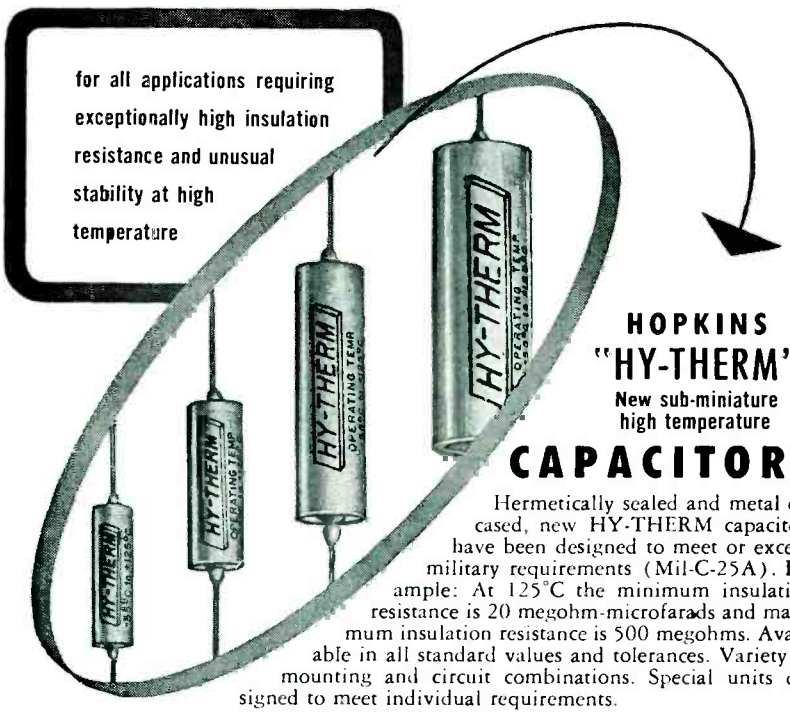

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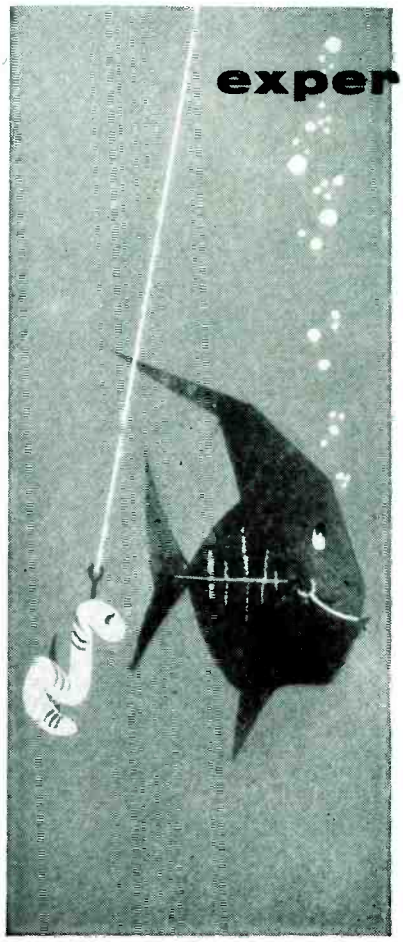

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opment of the all-metal vacuum tube and supervised the engineering and production of the miniature tube.

Packard-Bell Enlarges Staff

Robert S. Bell, left, and Neil H. Jacoby

NEIL H. JACOBY, dean of the School of Business Administration at the University of California at Los Angeles, has been elected to the board of directors of Packard-Bell.

A former member of President Eisenhower's three-man Council of Economics Advisers in Washington D. C., September 1953 to December 1954, Dr. Jacoby has been assisting in the writing of the administration's economic reports to Congress. He resigned in January.

The company also has appointed Major Gen. Edmund C. Langmead (ret.) former Commanding General of the San Bernadino Area of the Air Material Command, to assist in the direction of its technical products division.

Brush Electronics Elects New President

W. RUSSELL BURWELL, vice-chairman of the board, advances from the presidency of Brush Electronics, a Clevite unit, to full-time responsibilities as vice-chairman and as chairman of Clevite's research and development committee.

Douglas C. Lynch, executive vice-president, has been elected president of Brush Electronics.

He joined the company in 1952, having previously been head of the international operations of Crosley division of Avco Manufac-

turing Corp. and later a senior staff executive of Willys-Overland Motors. From 1937 to 1947 he was with Westinghouse in a number of engineering, sales and management positions and as assistant general manager of Westinghouse International.

Cooper Union Honors Dubilier

WILLIAM DUBILIER (left) received the first Gano Dunn medal of Cooper Union at the school's Founder's Day ceremony in New York, N. Y. The medal, for outstanding professional achievement, was presented by Irving Rossi, a member of the board of governors of Cooper Union Alumni Association. Dubilier was honored for his many important contributions and inventions.

Cornell-Dubilier also announced completion and formal opening of its new Los Angeles division plant.

Paul M. Keufler of Los Angeles has been appointed general manager and the plant will be under his direct supervision.

U. S. Testing Names Perenic

LAWRENCE J. PERENIC has been named manager of the electronics department of the United States Testing Co. of Hoboken, N. J.

He will supervise the electronic services of the firm which include electrical testing, precision measurements over wide frequency spectrums, environmental testing under extreme conditions, manufacturing, design and development for assem-

blies, systems and components of various types.

Prior to joining the company, Perenic was superintendent of engineering for Bogart Manufacturing in Brooklyn. Before that, for Western Electric in New York City, he was product engineer and staff engineer.

Stahl Forms Production Engineering

ALFRED R. STAHL has formed Production Engineering in Garnet Lake, Johnsburg, N. Y. for consulting work and building equipment. He was with GE for 6 years in advanced development of automatic equipment for such fields as component placement, tube production and automatic tube mounting. The new company will specialize in these fields.

Radio Frequency Elects Engineers

CHARLES A. HIGGINS and William A. Yonkers were elected to the board of directors of Radio Frequency Laboratories. Higgins joined Aircraft Radio Corp. of Boonton, N. J. in 1935, transferring to Radio Frequency Laboratories in 1945 as senior engineer.

Yonkers, executive engineer of Radio Frequency, joined the company in 1944.

Radioplane Expands Plant Facilities

RADIOPLANE CO. of Van Nuys, Cal., a subsidiary of Northrop Aircraft, has added a 28,000 sq ft office and laboratory building to its facilities. The new building brings to 200,000 sq ft the total space occupied by Radioplane.

Radioplane is a supplier of radio-controlled drones for the armed services and has built more than 40,000 pilotless aircraft, according to Northrop.

Kramer Promoted By Radio Receptor

STANLEY KRAMER has been appointed assistant manager of sales

engineers of the Radio Receptor semi-conductor division. Kramer joined the company several years ago as project engineer later becoming an applications engineer and sales engineer for the division. Prior to that he spent ten years doing project engineering in design and development work for several major radio and electronics companies.

Haydu Brothers Name Chief Engineer

Victor Le Gendre

VICTOR LE GENDRE has been appointed as chief engineer of the Haydu Brothers Division of Burroughs Corp, Plainfield, N. J.

Le Gendre comes to the firm from Chatham Electronics Corp. where he was design and development engineer for the past two and a half years. He holds a patent on fine pitch grid winding and has another patent pending on grid winding structures.

Between World War II and his experience with Chatham, Le Gendre was with Tung-Sol for five years and was quality control supervisor for a year and a half with National Union Electric.

Ohio State Antenna Lab Expands

THOMAS E. TICE has been made supervisor of the antenna laboratory of Ohio State University. Since last spring he has been acting supervisor of the laboratory, replacing V. H. Rumsey.

C. T. Tai has joined the Laboratory and has also been appointed associate professor in the depart-

ment of electrical engineering. He comes to Ohio State from the Stanford Research Institute.

Robert G. Kouyoumjian of the lab's staff has been appointed assistant professor in the department of electrical engineering.

Plans for a new field station for antenna testing have been completed by the University. This new station costing about $250,000 is expected to be completed by 1956.

General Transistor Elects President

HERMAN FIALKOV has been elected president of General Transistor Corp. of Jamaica, N. Y., manufacturer of transistors and germanium diodes.

Fialkov, formerly chief engineer of the germanium division of Radio Receptor Co. brings to General thirteen years of experience in electronics. He has served in engineering capacities with Emerson Radio, the Mutual Broadcasting System and Tele-tone Radio Corp.

Rattray Appoints General Manager

S. GANGI has been appointed as general manager of George Rattray & Co., manufacturers of precision potentiometers.

Gangi has had 25 years experience in the engineering and production of precision instruments and components.

Navy Promotes Trolese And Bernard

LOUIS G. TROLESE, who joined Navy's Electronics Lab as a radio engineer in 1942, was selected as head, Radar Branch succeeding Royal V. Keeran, who left the San Diego Laboratory for private employment. Trolese was formerly head of the Atmospheric Studies Branch at the Laboratory. He spent 8 years with RCA and General Air Conditioning companies before coming to what was then the Navy Radio and Sound Laboratory on Point Loma.

Commander William B. Bernard has been appointed to regular as-

signment as executive officer for the Laboratory. From 1937 to 1941 he worked for the FCC then went into active naval service in 1942. He served on the staff of Commander-in-Chief Atlantic Fleet, in the Electronics Branch, Office of Naval Research, Washington D. C., and as electronics officer, staff of the Commander Operational Developments Force before coming to NEL in 1953.

Teleregister Elects Schmidt V-P

THE TELEREGISTER CORP., manufacturer of special purpose electronic data handling and display systems, elected Edwin L. Schmidt as vice-president in charge of industrial sales.

Schmidt has been with the company since 1929 and holds numerous patents on data handling systems including the company's Magnetronic Reservisor for automatic processing of airline and railroad passenger reservations.

He has served as project engineer, associate director of engineering and manager of the company's Cleveland, Ohio office.

Marion Instrument Selects Gaffney

F. J. GAFFNEY has been named vice-president for engineering of Marion Electrical Instrument Co. of Manchester, N. H. Gaffney was most recently director of engineering for the guided missiles division of the Fairchild Engine and Airplane Co. During World War II he served as head of the test and measurements group of the MIT radiation laboratory. From 1945 until early 1953 he was general manager of the Polytechnic Research and Development Co.

Machlett Names X-Ray Manager

D. T. O'CONNOR has been appointed director of industrial x-ray of Machlett Labs. He was previously with the Naval Ordnance Laboratory as chief of radiology section.

NEW BOOKS

Handbook of Microwave Measurements

EDITED BY M. WIND AND H. RAPAPORT, *Polytechnic Institute of Brooklyn, N. Y.*, 1954, *Vol I & II*, 1,000 *pp.*, $12.00.

HERE IS AN ATTEMPT to bring together the various techniques and procedures used in making measurements in the frequency range where circuits must be considered distributed in nature. Measurement techniques in almost all the microwave fields are included. There are sections on the measurement of basic quantities such as frequency, power, impedance, attenuation, noise generation and spectrum analysis. In addition, there are sections dealing with measurements on microwave tubes, crystals, receivers, some microwave components and cables.

Several sections of the book are very good. The best of these is probably the section on the Precision Measurement of Impedance and Equivalent Representations. To this reviewer's knowledge, this is the first time that the material contained herein has been brought together and adequately coordinated. This section should prove useful to those people engaged in precision impedance measurements. Other sections which are particularly good are those dealing with attenuation measurements and power measurements. In the power measurements section, it is unfortunate that the efficiency of various bolometers as a function of frequency was not discussed as this is bound to be an important subject in the region of 1 cm and higher.

The Handbook has been written by several authors and it is unfortunate that there was not considerably more editing of the overall book. This lack of editing becomes apparent in the use of symbols which are not always consistent from chapter to chapter. There are also a rather large number of typographical errors, particularly in the equations. Many of the procedures are repetitious and some of them

contain extremely elementary steps. It is felt that coordinating the various procedures and elimination of some of the elementary steps would have made the Handbook considerably easier to read and much more useful.

In several places, there has been a very loose use of terms. For example, the terms primary and secondary frequency standard have been used on the basis of accuracy rather than on the basis of whether their accuracy is determined by a time or a frequency check. Another term which has come into rather wide usage is the power standing wave ratio. This term is really a misnomer and is not based upon physical facts. The only justification for using this term is that it avoids extracting the square root when a standing-wave ratio is read with a square-law detector and a linear meter.

In various sections, certain rather fundamental points have been glossed over a little too freely. For example, in the measurement of standing-wave ratios one is always faced with the problem of decoupling the probe as much as possible from the slotted section. The largest amount of decoupling is generally determined by the noise level in the meter following the detector. Thus it becomes important to know the error caused by noise when the signal-to-noise ratio is small.

Another point which would bear more consideration is the relation between sweep speeds and resolving power in swept systems and spectrum analyzers. This is a consideration that can lead to serious errors if certain fundamental limitations are not observed.

Standing-Wave Measurements

The section on the measurement of standing-wave ratio includes some good material on the measurement of connectors and general procedures used in slotted line work. There are, nevertheless, several powerful techniques for use when measuring standing-wave ratios which should have been included. One of these techniques is the use of a sliding load in conjunction with a slotted line to measure the re-

flection of four-terminal devices.

Another technique which is extremely useful, especially for low standing-wave ratios, is the use of directional couplers. Actually, directional couplers overcome many of the inherent disadvantages of slotted lines when used for low reflection coefficients and they are capable of a very high order of accuracy. These are extremely powerful methods and certainly deserve consideration.

Because of the scope of this handbook, it should prove useful to people concerned with microwaves. While it is quite complete, some of its real utility has been lost because of repetition of various procedures, the inclusion of many elementary steps and the inclusion of many steps peculiar to a certain type of equipment which could have been obtained from appropriate instruction books.—W. B. WHOLEY, *Hewlett-Packard Co., Palo Alto, Calif.*

The Present State of Physics

ARRANGED BY FREDERICK S. BRACKETT. *American Association for the Advancement of Science, Washington, D. C.*, 1954, 261 *p*, $6.75.

THIS BOOK constitutes a collection of papers based on a symposium held by the American Association for the Advancement of Science in New York on December 30, 1949. From the length of some of the papers and the fact that several contain references to 1952 literature, it is evident that the three years delay in publication is in part due to efforts of the several authors to present a more complete picture of the field than was possible at the symposium.

Content

The ten papers or monographs cover special topics in the fields of elementary particles, the physics of the solid state, chemical physics and biophysics. While most of them are of no more than passing interest to those of us whose activities are concerned primarily with electronics, a few of them are of considerable importance. These are

the three papers on solid-state physics:

The New Electronics, by K. Lark-Horovitz (70 pages)

Flow of Electrons and Holes in Semiconductors, by J. Bardeen (32 pages)

Barium Titanate Ferroelectrics, by A. von Hippel (19 pages)

Solid-State Physics

Professor Lark-Horovitz's paper, while assuming a fair knowledge of basic physics and mathematics on the part of the reader, presents an excellent description of the principal concepts of solid-state physics for the nonspecialist. Beginning with the experiments and speculations of more than a century ago, the development of modern views concerning the nature of the conductivity, Hall and thermoelectric effects, rectification and other properties are described. The band picture and the effects of lattice defects are developed in a simple, straightforward manner although a fuller discussion of electron pair bonding would have been worthwhile. The nature and usefulness of the *p-n* junction was not described, presumably because these topics are covered in the second paper of this group.

Transistor Theory

Dr. Bardeen's paper is understandable to the nonspecialist if the one by Lark-Horovitz is read first. The processes of carrier injection, the flow of electrons and holes, the characteristics of rectifying contacts and the descriptive theory of transistors are clearly and concisely covered.

Titanate Ferroelectrics

While ferromagnetic materials have been known for a long time, their use in electronic devices is still in a very early stage of development, largely because they are not as widely understood as they must be if full use is to be made of them. Interest in barium titanate ferroelectrics has been increasing during the past ten to fifteen years because of such factors as the high dielectric constant that can be achieved when these ceramics are made under certain conditions. Dr. von Hippel's paper, while rather

short, presents a nice summary of the principal facts and theory.—GEORGE D. O'NEILL, *Research Laboratories, Sylvania Electric Products Inc., Bayside, N. Y.*

THUMBNAIL REVIEWS

Transistor Circuit Components. Wright Air Development Center, 22 p, 1954, available from Library of Congress, Publication Board Project, Washington, D. C., microfilm $2.25, photocopy, $4.00. Survey discussing miniature components now available as well as those under development.

Table of Sine and Cosine Integrals for Arguments from 10 to 100. NBS Applied Mathematics Series 32, 186 p, 1954, $2.25, Government Printing Office, Washington 25, D. C. Useful in the theory of numbers, calculus of probabilities, antenna theory, nuclear physics and electromagnetic theory.

Materials for Product Development—1954. Clapp & Poliak, New York 17, N. Y. 1954, 160 p, $7.50. Proceedings of the Basic Materials Conference, Chicago, May 1954. Thirteen papers covering new materials, new methods, management policies, questions and answers.

Distribution of Radio Brightness on the Solar Disk. Special Report No. 4, 72 p, 1954, U.R.S.I., 42 rue des Minimes, Brussels, Belgium, 72 p, 100 francs. Review of the history and methods for measuring radio noise. Includes Report No. 5 on interstellar hydrogen.

Understanding High Fidelity. By Louis Biancolli and Lester H. Bogen. David Bogen Co., New York 14, N. Y., 56 p, 1954, 25¢. A second edition of a handy and useful explanation for laymen and engineers of the ins and outs of hi-fi.

Electrical and Electronics Patents. Office of Technical Services, Department of Commerce, Washington 25, D. C., 1954, $4.00. Abstracts of 1915 government-owned patented inventions available to the public on a royalty-free license basis.

Television and Radar Encyclopedia. Edited by W. MacLanachan. Pitman Publishing Corp., New York, Second Edition, 1954, 216 p, $6.00. New terms added to 1953 edition. Definitions are nonmathematical yet authoritative and clear, representing both British and American terminology. Appendix includes detailed comparison of BBC, RETMA and CCIR television standards.

Advanced Television Servicing Techniques. By RETMA Pilot Training Course Teaching Staff (P. B. Zbar and S. Schildkraut). John F. Rider Publisher, Inc., New York, 1954, 163 p, $3.60. Laboratory Workbook, 48 p, $.95. Sponsored by Radio-Electronics-Television Manufacturers Association to provide technicians with a systematic industry-approved troubleshooting procedure utilizing the most efficient techniques and the latest test instruments.

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BACKTALK

Pot Design Problem

DEAR SIRS:

MR. COLEMAN'S article "Potentiometer Design for Minimal Loading" on pages 184–190, Feb. 1955, contains an omission which causes the data presented to lead to false conclusions.

The curves showing loading error indicate maximum error at 50 percent of rotation. The author states his equations are relative to a 2-percent error. Fine and well, this information may be accurate and correct, but due to the omission, 2 percent of what, the curves and data mean little.

With voltmeters and other equipment percentage of error is based on full-scale readings. The author of this article based his percentage of error as ±2 percent, of expected voltage at any specified degree of rotation. On that basis, his information is correct. Utilizing standard technique however, maximum error occurs at approximately two-third rotation from the zero-voltage end. Curves on this may be found in Helipot catalog 540, an article by the writer, and in other published literature. Also his ratio of the load being four times higher than the potentiometer to limit the error to 2 percent is in error. The referenced curves indicate at least a 10:1 ratio must be maintained.

ALVIN B. KAUFMAN
Los Angeles, Calif.

Fast Tube Rate

DEAR SIRS:

WE WERE PLEASED to read the article, "Counting Circuit Batches Components," on p 157 of the February ELECTRONICS. We were, however, surprised to see "These (GS10C Dekatron selector tubes) have a counting rate of 550 a second—", and think this misleading phrase may be an inadvertant contraction of "The combination of a GTE 175M trigger tube and a GS10C Dekatron has a counting rate of 550 per second."

The GS10C Dekatron alone is

rated at 4,000 digits per second when driven by rectangular or sine waveforms.

L. C. BURNETT
Cold Cathode Tube Applications Lab
Etelco Limited
Nottingham, England

Noise Calculations

DEAR SIRS:

I WISH TO call your attention to an error in the article, "Low Noise Input Stage for Audio Preamplifier," which appeared in your February issue, p 147. The authors purport to give a curve showing the rms noise voltage appearing across an R-C circuit as a function of the value of R. Their treatment is somewhat misleading as they do not specify the frequency limits used in the calculation, and furthermore, the curve shown is numerically in error.

It is well known that the rms noise voltage appearing across an R-C circuit is given simply by $(kT/C)^{1/2}$, where k is Boltzman's constant in joules/°K, T the absolute temperature in degrees Kelvin, and C the capacitance in farads. This expression gives the noise in the entire spectrum from zero to infinity, and is seen to be independent of the value of R.

Using the numerical values of $T = 23°$ C and $C = 6\ \mu\mu f$, one finds that the total noise is 26 μv. When a finite bandwidth is assumed, the noise will obviously be less than 26 μv. This does not check with the maximum value given in Fig. 1C, which rises above 80μv.

A little pencil pushing reveals that the authors assumed a bandwidth of 20 cps to 20 kc. Using these values, the asymptotes of their curve are correct. However, in calculating the points in the region of 10^7 and 10^8 ohms, they have obviously slipped a decimal point, making the curves high by a factor of $\sqrt{10}$ in this region.

CLIFFORD E. BERRY
Assistant Director of Research
Consolidated Engineering Corporation
Pasadena, California

DEAR MR. BERRY:

THE EDITOR OF ELECTRONICS has forwarded to me a copy of your

letter regarding the article, "Low Noise Input Stage for Audio Preamplifier." I must apologize for the error in calculating the curve for thermal noise produced by the parallel R-C network.

As you point out, the greatest value is about 26 microvolts and computes to be maximum when $R = 4.6 \times 10^7$ (the capacitor value is actually 5.5 rather than 6 $\mu\mu$f and was used for the computations). The qualifying frequency band was omitted in editing, as were several other pertinent details.

We thank you for calling this to our attention.

JAMES J. NOBLE
Altec Lansing Corporation
Beverly Hills, California

Another Staple Technique

DEAR SIRS:

ON THE PROBLEM of removing staples: I find it easy to just push them through.

Clip off the top with a sharp diagonal cutter and grab the bent-over end and pull. Very easy this way since one goes with the grain rather than against it.

R. A. GRUNER
Dept. of Physics
University of Wisconsin
Madison, Wisconsin

Acknowledgment

DEAR SIRS:

DUE TO AN undetected editing on the part of one of our people, the acknowledgement originally at the end of my article, "Tape Controlled Servos Speed Chemical Analysis," was omitted. This article appeared in your February issue, p 136.

The electronic development for this project was performed primarily by R. G. Madsen. Important contributions were made by M. S. Stickney and R. C. Hawes. Portions of this paper were adapted from previous notes compiled by these persons.

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DIGITAL DATA HANDLING DEVICES			C			C			C			
MISSILE GUIDANCE			M			M			M			
INERTIAL NAVIGATION			M			M			M			
COMMUNICATIONS		F	C O F					F	C O F			
DESIGN • DEVELOPMENT												
COLOR TV TUBES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photo Sensitive Materials and Glass to Metal Sealing)	L	L	L	L	L	L	L	L		L	L	L
RECEIVING TUBES—Circuitry—Life Test and Rating—Tube Testing—Thermionic Emission	H	H	H		H	H		H			H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)		H	H	H			H	H			H	H
GAS, POWER AND PHOTO TUBES—Photo Sensitive Devices—Glass to Metal Sealing	L	L	L	L	L		L	L		L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization		F	M C F		F	M C F		F	M C F			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control		F	M C F		F	M C F		F	M C F			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming	C	C F	M C F	C	C F	M C F	C	C F	M C F			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems		F	M C F		F	M C F		F	M C F			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		O	O F		O	O F		O	O F			
MISSILE GUIDANCE—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		F	M F		F	M F		F	M F			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors		C	C		C	C		C	C			
MACHINE DESIGN Mech. and Elec.—Automatic or Semi-Automatic Machines		H	H		H	H		H	H			

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(Continued on page 416)

Lockheed antenna program offers wide range of assignments

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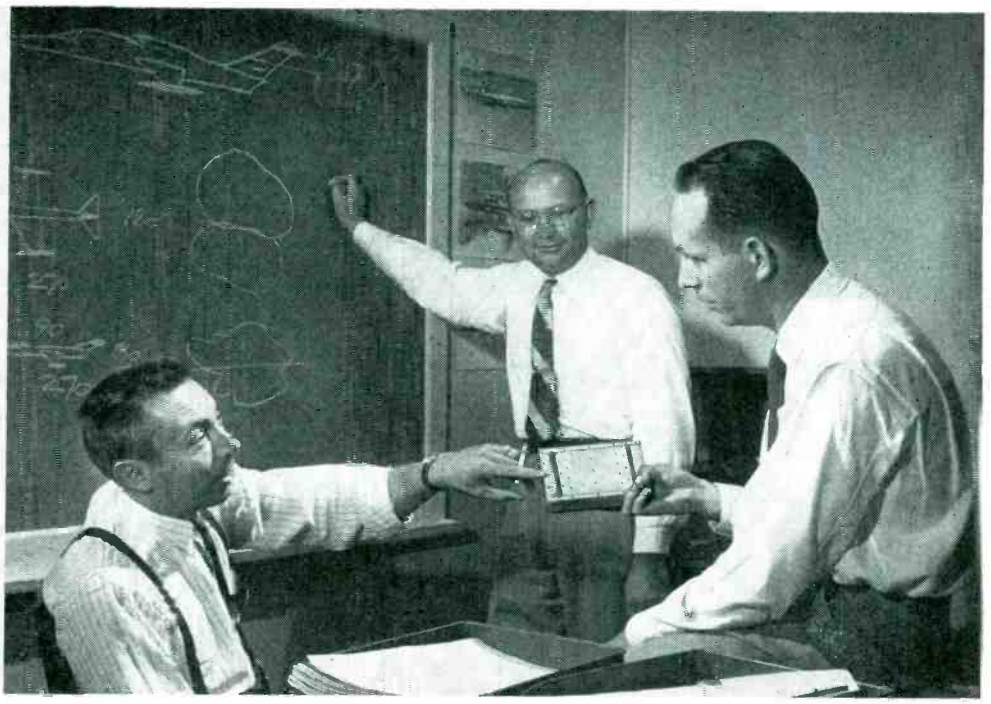

Research Specialist Edward Lovick (right) discusses application of experimental slot antenna in the vertical stabilizer of a high-speed aircraft with Electronics Research Engineer Fred R. Zboril and Electronics Research Engineer Irving Alne.

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An address by Edward Lovick on "An Electronic Square-Rooter and Pattern Integrator for use with Antenna Range Systems" is available to interested engineers. Address inquiries to Mr. Lovick.

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(Continued from page 414)

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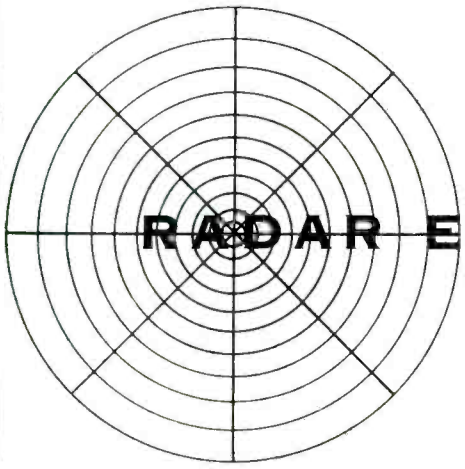
Fully equipped electronics production line for sub assembly, laboratory, and machine shop. Automatic power presses, die making facilities, and metal working machinery. Staff of engineers, technicians, and tool and die makers. Available for prime and sub contract work. Located in New York area. CWW-6050, Electronics.

Small electronic units or assemblies to wire. CWW-6102, Electronics.



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Immediate Openings on the Highest Technical Level for

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Also Immediate Openings for

SERVO AND COMPUTER ENGINEERS

WHERE YOU'LL WORK

- We're a national leader in armament and commercial projects, particularly in research, design and development of airborne fire control systems and guided missiles.
- We're a medium-sized company (5000 employees—300 armament engineers) where you're never "lost in the shuffle" but *rewarded* and *advanced* according to your abilities.
- We're located in one of St. Louis' nicer suburbs, within 5 to 15 minutes of new residential areas with attractive, moderately-priced homes.

THE BENEFITS YOU'LL ENJOY

- Graduate study program.
- Profit-sharing bonus and pension plan.
- Accident, life and health insurance.

Send complete resume, including salary requirements and phone number for local interview. St. Louis interview arranged at our expense. Write Engineering Personnel Manager.

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EMERSON ELECTRIC
OF ST. LOUIS

8100 W. Florissant, St. Louis 21, Mo.

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Unusual opportunities for outstanding and experienced men are available at the University of Michigan's Willow Run Research Center. Research Engineers and Physicists with advanced degrees and/or experience in the fields of:

DIGITAL COMPUTER LOGICAL DESIGN • INFRARED • ACOUSTICS • DIGITAL COMPUTER PROGRAMMING ELECTROMAGNETIC THEORY • COMMUNICATIONS CIRCUIT DESIGN • COMPONENT DEVELOPMENT • RADAR • OPTICS ENGINEERING • SYSTEMS DESIGN

Salary commensurate with training and experience. Excellent working conditions. Liberal vacation policy along with other fringe benefits. Unusual opportunity to carry on University graduate studies while working full time. Moving expenses paid. U. S. Citizenship required.

Write, giving details of education and experience, to

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University of Michigan
Willow Run Research Center,
Ypsilanti, Michigan

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Positions are available in all levels of experience for the following fields of electronics:

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Excellent positions with future are offered to men capable of working with a minimum of supervision.

Salaries are commensurate with background and ability.

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PRODUCT DEVELOPMENT

E.E. Degree plus demonstrated ability in design of electronic equipment. Experienced in development of AC and DC Amplifiers, Transducers and Carrier Amplifiers, Switching and Control Circuits and Electronic Counters. Practical production background also desirable.

Positions offer secure futures with aggressive and expanding organization. Excellent working conditions and associations. Starting salaries commensurate with training and experience.

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Prominent Eastern Instrument Manufacturer requires graduate E.E. with extensive industrial experience to assume responsibility for all electronic development activities, supervising engineering and laboratory technical personnel, and reporting to Vice President. Instrument background helpful. Please submit complete resume and state approximate salary requirements in first letter to

P-6121, Electronics
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ENGINEERS • *Electronic • Electromechanical*
PHYSICISTS
SALES ENGINEERS

Burroughs
Research Center, Paoli, Pa.
Invites You

To Inspect Its Openings on Both Commercial & Sponsored Projects

If you possess an educational and/or work background in Communications, Data Handling, Electronic, or Electro-Mechanical Business Machines... including such specifics as High Speed Mechanisms, Paper Handling Devices, Magnetic-Tape Transport Mechanisms, Magnetic-Drum or Tape Applications, Radar, Telemetering, Guided Missiles, Process Control Instrumentation, Digital and Analog Computers, Transistor and Magnetic Circuit Design and Analysis, Magnetic Amplifiers, Servo Mechanisms, and Electronic Packaging Design . . .

CONSIDER THESE OPENINGS AS

- **ELECTRICAL ENGINEERS; Junior & Senior**
- **MECHANICAL ENGINEERS; Junior & Senior**
- **LOGICAL DESIGNERS • PHYSICISTS**
- **PROJECT ENGINEERS**

- **SALES ENGINEERS** to sell E-101 electronic desk computers in all sections of the country. Sales & Technical experience in allied lines desirable.

Enjoy These Advantages!

In addition to paid vacations, liberal pension plans and numerous other valuable health and hospitalization benefits for you and your family, we provide cooperative educational aid at one of the many technical schools in the Philadelphia area for qualified applicants who find our center an ideal work-shop in which to secure the desired recognition in their chosen fields.

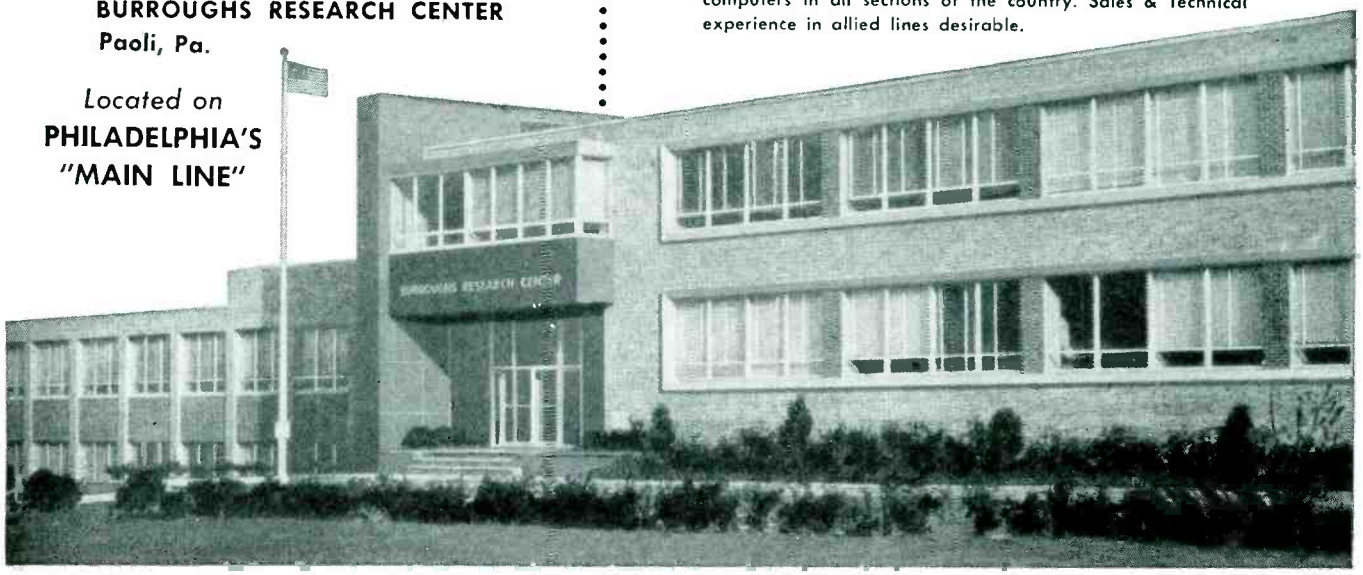
Your family, too, is important! And, here at Paoli, a delightful suburban community, thirty minutes from Philadelphia, you will find the cultural atmosphere as well as the educational facilities required for your children.

We will pay travel expenses for all applicants invited to visit our NEW Research Center to consider the application of their educational and/or work background to the many challenging problems we are engaged in for industry and the nation's welfare.

If you want the BEST for yourself and your family, consider NOW your qualifications for the openings listed on the right and —

Write **L. E. DICK,** *Personnel Manager*
BURROUGHS RESEARCH CENTER
Paoli, Pa.

Located on
PHILADELPHIA'S "MAIN LINE"



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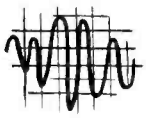
creating **engineering opportunities**

for

ELECTRONICS SECTION CHIEF



Responsible to the Chief Design Engineer for the design of all aircraft radio, radar and electronic installations and systems for a broad field of military aircraft. Candidates should have an engineering degree in Engineering Physics or Electrical Engineering and 12 years experience including 4 years in a senior supervisory capacity. Experience in the field of A.S.W. installations is desirable.

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To direct missile electronics design and development. Requires an Engineering Physics or Electrical Engineering degree, some graduate work in electronics preferred, with 8 to 10 years electronic design experience related to radar or fire control systems (including at least 3 years on guided missiles) and a strong background in systems analysis.

The future potential for those engineers who join Canadair is as apparent as the rapid industrial expansion now in progress in Canada itself.

Along with Convair and Electric Boat Company, Canadair is a division of General Dynamics Corporation, with the vast and varied facilities of each at its disposal toward the manufacture of military and commercial aircraft of all types.

On Canadair's engineering staff are men from all parts of the globe, contributing a wealth of new ideas and stimulating new thoughts on engineering practice.

The location is adjacent to a residential community where housing at moderate cost is readily available. The heart of historic Montreal is less than 6 miles away, and hunting, fishing and other outdoor recreations are near at hand. Generous relocation assistance will be given those who join the staff.

If you qualify for one of the positions listed above, please send a complete resume to E. H. Higgins, Chief Project Engineer, Dept. E-3. All replies will be held in strict confidence.

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C-L LIMITED

P.O. Box 6087, Montreal, P.Q., Canada

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for immediate placement

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ELECTRICAL ENGINEERS
MECHANICAL ENGINEERS
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ACT AT ONCE—Send resume of your education and experience to: EMPLOYMENT DEPARTMENT, TECHNICAL PROCUREMENT SECTION

THE NATIONAL CASH REGISTER COMPANY

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Electronics

Component Application

Analogue Computer

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Senior Microwave Research

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Growth and advancement. Because the group at GPL is small and closely integrated, recognition for outstanding work—and advancement—come quickly.

Men with interests in the above and related fields should submit resumes to Mr. Hollis F. Ware. Expenses will be paid for qualified applicants who are invited for interviews. We regret we can consider only U. S. citizens.

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A subsidiary of General Precision Equipment Corporation

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Excellent opportunity in Raytheon's expanding Cathode Sub-miniature Production Program for an engineer with experience in the manufacture of cathode sub-miniature type vacuum tubes. Minimum qualifications B.S. degree and three years experience in this field.

For appointment write to

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Personnel Mgr.
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EXCELLENT SALARIES
MINIMUM PREREQUISITES

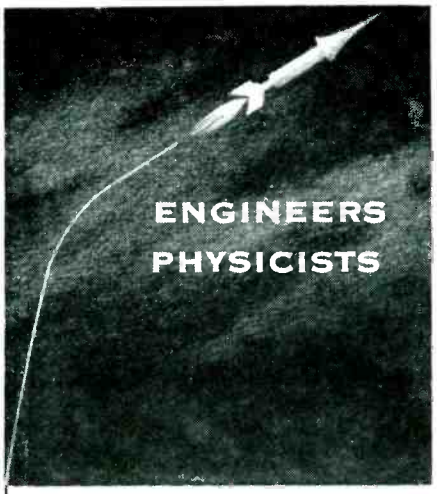
ENGINEER — EE Graduate with 3 years experience

TECHNICIAN — 2 years technical school in communications and 3 years experience.

Require installation adjustment and maintenance experience with communication receivers and associated terminal equipment. Also, men with similar experience with high-powered transmitters, antennas, transmission lines.

Must be willing to travel in United States and Overseas.

Page Communications Engineers, Inc.
710 Fourteenth St.,N.W., Washington 5, D.C.



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Sylvania has established a Missile Systems Laboratory. New laboratory facilities are nearing completion. This 54 year old company, renowned for its consumer products, and supplying vital "heart" parts to other manufacturers, now brings its research, know-how, stability and diversity to the guided missiles field. Behind this important new Sylvania laboratory stands the versatility, drive and dedication that has seen Sylvania expand to 45 plants and 16 laboratories, while *doubling* its engineering staff and almost tripling sales in the past 6 years.

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are now open in these fields:

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ANTENNA THEORY & DESIGN
ANALYSIS OF MISSILE GUIDANCE SYSTEMS
MATHEMATICAL ANALYSIS & SYSTEM DESIGN OF FIRE CONTROL & COMPUTER EQUIPMENT
INERTIAL GUIDANCE OR INFRA-RED FOR DETECTION & TRACKING
SERVO SYSTEM DESIGN & ANALYSIS
AERODYNAMICS
PROPULSION
AIRCRAFT OR MISSILE STRUCTURES

Relocation and interview expenses will be paid.

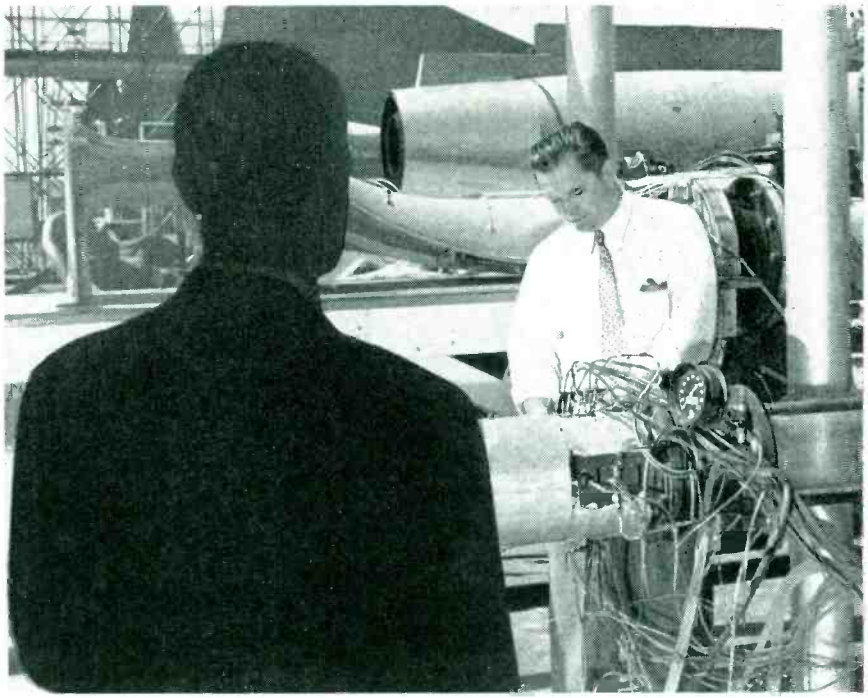
Please forward resume to:
Mr. Robert Koller
Supervisor of Professional Placement

missile systems laboratory

SYLVANIA
ELECTRIC PRODUCTS INC.

151 Needham Street, Newton, Massachusetts
(A suburban location just 8 miles from downtown Boston)

TO THE FINE ENGINEERING MIND
SEEKING THE CHALLENGING PROJECTS IN



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INSTRUMENTATION ENGINEERS experienced in the development and design of static and flight test instrumentation systems are offered unusual career opportunities now at Convair in beautiful San Diego, California. These responsible engineering positions call for experience in one or more of the following areas: instrumentation systems planning and study; transducer design, selection, and application; airborne and ground-based telemetering equipment development and design; instrumentation systems installation design.

CONVAIR offers you an imaginative, explorative, energetic engineering department... truly the "engineer's" engineering department to challenge your mind, your skills, your abilities in solving the complex problems of vital, new, long-range programs. You will find salaries, facilities, engineering policies, educational opportunities and personal advantages excellent.

SMOG-FREE SAN DIEGO, lovely, cool city on the coast of Southern California, offers you and your family a wonderful, new way of life... a way of life judged by most as the Nation's finest for climate, natural beauty and easy (indoor-outdoor) living. Housing is plentiful and reasonable.

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H. T. Brooks, Engineering Personnel, Dept. 905

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A Division of General Dynamics Corporation

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M. I. T.

LINCOLN LABORATORY

Staff research positions available for exceptional **electrical engineers** with advanced training or experience in **electronics** as applied to . . . Radar, Communications and High Speed Digital Computers.

Please reply to:
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For field representative work on electronic communications equipment. Must be free to travel or relocate. E. E. grads or equivalent experience. Top salary plus liberal expense allowance.

Write Personnel Director
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ELECTRONIC ENGINEERS

Required: Degree in Electrical Engineering or Physics and two or more years instrumentation and development of electronic circuits.

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Experimental dynamic performance testing, equipment evaluation for electrical and mechanical performance, developmental work on new test equipment. State qualifications.

PROJECT ENGINEER

Capable of responsible direction of project to develop complex equipment. Background in Aeroelasticity, Structural dynamics, Machine Design, Electronics helpful.

THE CALIDYNE COMPANY

Manufacturers of Vibration Test Equipment
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Effective with the July issue, a new section will start in ELECTRONICS. We will head this section: EMPLOYMENT OPPORTUNITIES. All Displayed Employment Opportunity advertising will be placed in this new section, with the exception of those advertisers who contract for run-of-book position. Advertisements in the EMPLOYMENT OPPORTUNITIES section will be billed at the new open rate of $21.50 per inch. Contract rates furnished on request. Advertisements are subject to Agency Commission.

For full information write:

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330 West 42nd St.,
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Well established manufacturer and developer of electro-mechanical and mechanical instruments is expanding its facilities and offers a challenging opportunity to a graduate electrical-electronic engineer, who will spear-head the design and development of electrical and electronic products. Must have background of experience which has demonstrated ability to fulfill the requirements of this position.

All replies held in strict confidence. Please send a complete resume including salary requirements to:

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RECEIVER ENGINEERS With Experience in VHF and UHF Frequencies

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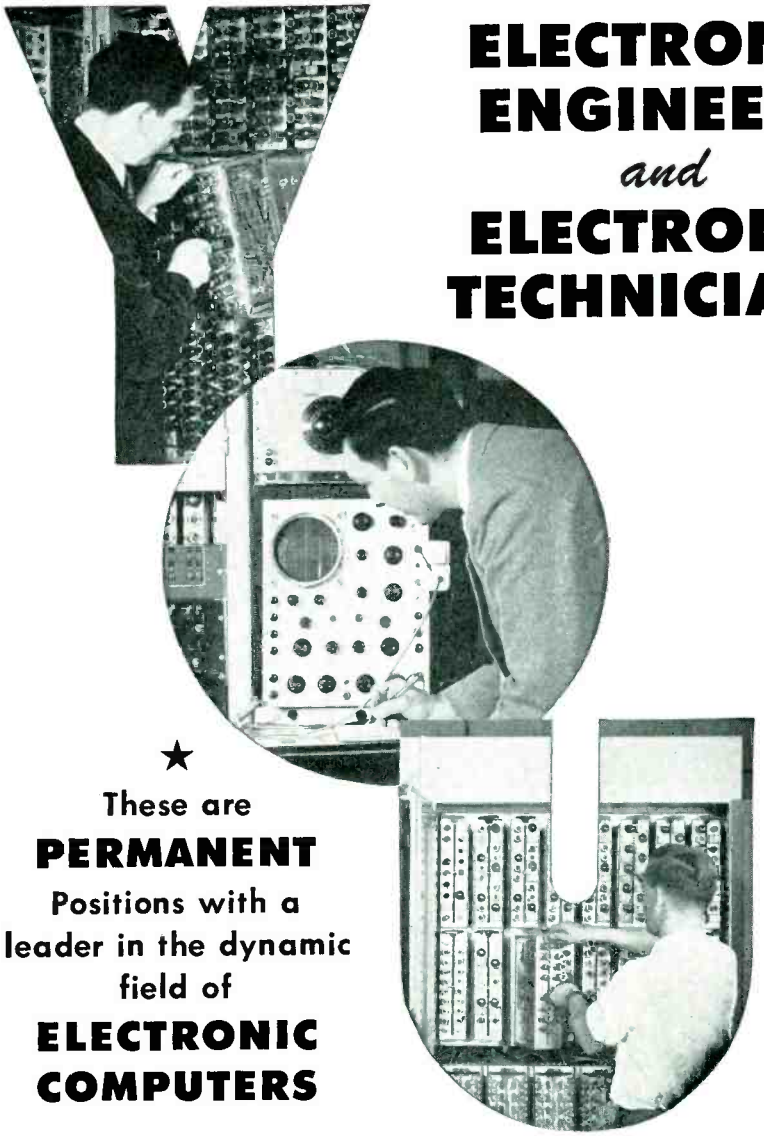
Chief Electronics Engineer
STROMBERG-CARLSON COMPANY
ROCHESTER 3, NEW YORK

OPPORTUNITY FOR ELECTRONIC ENGINEERS *and* ELECTRONIC TECHNICIANS



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Your best chance for increasing responsibility and rapid advancement in the electronic field is in the challenging field service work associated with digital computers. *Computer experience is not necessary.* You will receive extensive training in computer logic and circuitry and specialized training on specific computers. Good salaries start with the training period. After training you will be assigned to one of our large computer installations in continental United States. You will enjoy liberal travel allowances and other employee benefits.

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Minimum qualifications for ELECTRONIC ENGINEERS
Bachelor Degree—2 years electronic experience

Minimum qualifications for ELECTRONIC TECHNICIANS
High school plus electronic school (armed forces acceptable) and four years electronic experience

For further information regarding our computers and training programs, send a brief resumé of your education and experience to **Mr. R. A. Nelson, Employment Manager.** Interviews at our expense by arrangement. All contacts are held in strict confidence.

Remington Rand INC

ENGINEERING RESEARCH ASSOCIATES DIVISION
1890 W. MINNEHAHA AVENUE • ST. PAUL W4, MINNESOTA

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• ELECTRONICS • MECHANICAL

For progressive Chicago firm expanding in all types of research projects in military work. Positions also available for Lay-out detail and Design Draftsman.

Salary will commensurate with ability and qualifications. All details will be treated strictly confidential.

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Chicago 24, Illinois

Personnel
Division

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The engineers and technicians you want to reach are gathered in convenient, compact groups—as this 12-page booklet points out.

It keys the job titles these men hold to the McGraw-Hill publications they read for on-the-job information. It explains how you can make contact . . . channel, concentrate your employment advertising to just the men with the job qualifications you want . . . without wasting advertising money for higher-priced space in publications with general circulation, in which you pay for perhaps 999 unqualified readers for every 1 who may meet your job requirements.

Write for your free copy to: Classified Advertising Division

McGRAW-HILL PUBLISHING COMPANY, INC., 330 W. 42nd St., New York 36, N. Y.

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- *EQUIPMENT*
  (Used, or Surplus New)
- *PRODUCTS*
  to manufacture
- *CAPITAL*
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Searchlight Section closes
May 3rd for the June issue.

"SEARCHLIGHT" is LOW-COST NATIONAL

CLASSIFIED ADVERTISING

Send NEW ADVERTISEMENTS to N. Y. Office, 330 West 42 St., N. Y. 36, N. Y. The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

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Thoroughly experienced in Government and Industrial Sales with extensive knowledge of Advertising, Sales Promotion, Marketing and Market Analysis. Able to organize and direct complete sales force. Electrical Engineering degree or equivalent. Should have a proven record of 10 years of sales management with first rate company. Need man 38-50 years of age willing to locate in New York City. Products: Control and Communication equipment, Variable Capacitors and Radio Receivers.

Send complete Resumé and salary requirements to

HAMMARLUND MFG. CO., INC.
460 W. 34th St., N. Y. 1, N. Y.

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OFFERS OUTSTANDING OPPORTUNITIES IN FIELD ENGINEERING

E E graduates or equivalent with field experience in radar will find unequaled opportunities for professional advancement with Raytheon — a world leader in electronics. Foreign and domestic assignments. Excellent salaries. Liberal allowances.

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RAYTHEON
GOVERNMENT FIELD ENGINEERING
WALTHAM 54, MASS.

ENGINEER—TAPE RECORDER
PROJECT LEVEL
EXPERIENCED IN ALL PHASES OF MAGNETIC TAPE RECORDER MFG.
TOP SALARY—PERMANENT POSITION
SEND COMPLETE RESUME TO
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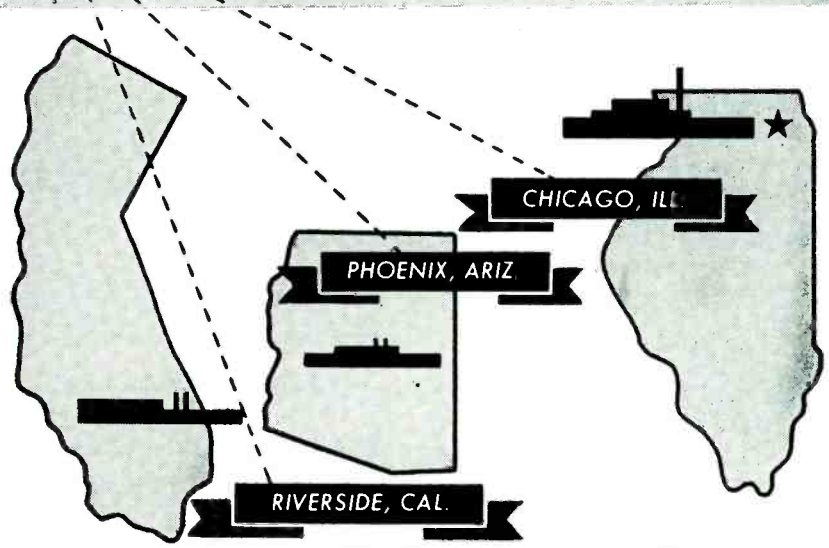
Manufacturer of electronic test equipment for military and commercial applications needs technically qualified representatives. Write giving qualifications, lines handled, territory covered.
RW-2178, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

ELECTRONIC ENGINEERS



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PHOENIX, ARIZONA—research laboratories—staffed with 800 scientists and engineers—special opportunities for experienced men in transistor research (chemists, physicists, metallurgists).

RIVERSIDE, CALIFORNIA—research laboratories—new, modern laboratory buildings—dynamic systems analysis—all electronic military weapon systems.

State your geographical choice and your preferred interest—Give important facts of education, training and experience—We require a minimum of 4 years' experience.

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WRITE—Attention: Daniel E. Noble, Vice President in Charge
COMMUNICATIONS AND ELECTRONICS DIVISION
4501 AUGUSTA BLVD., DEPT. E—CHICAGO 51, ILLINOIS

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SERVO MOTORS • RESOLVERS • OSCILLATORS • INVERTERS • GENERATORS
AUTOSYNS • SELSYNS • TORQUE UNITS • SYNCHRONOUS AND FRACTIONAL MOTORS

PIONEER TORQUE UNITS

Type 12606-1-A Torque Unit—manuf. by Eclipse-Pioneer. Has Type CK-5 motor connected to the output shaft through a 125:1 gear reduction and with a Type AY-43 Autosyn used as a control transformer. Output shaft revolves 30 revolutions for each revolution of follow-up Autosyn. Particularly suitable for use with Type 12077 Amplifier **34.95**

Type 12602-1-A Torque Unit—Identical to Type 12606-1-A except has a base mounted housing with terminal leads, rather than Amphenol connection. **34.95**

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DMF2506M
CONTINENTAL ELECTRIC
24-30 volts input; 5.5-4.5 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; PF 1.0 50 watts..$39.50

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PIONEER 12117
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. $19.95

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Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 20 amp. $65.00

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PIONEER 12130-3B
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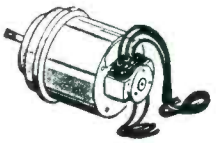
Output: 115 VAC: 400 cyc; single phase; 45 amp. Input: 24 VDC. 5 amp. $39.95

10285 LELAND ELECTRIC
Output: 115 volts AC, 750 VA, 3 phase. 400 cycle, .90 PF and 26 volts, 50 VA, single phase, 400 cycle, .40 PF. Input: 27.5 VDC, 60 amps, cont. duty, 6000 rpm. Voltage and frequency regulated $59.50

10486 LELAND ELECTRIC
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amps; cont. duty $90.00

PIONEER 10042-1-A
DC input 14 volts; output: 115 volts; 400 cycle, 1-phase; 50 watt....$39.50

10339 LELAND ELECTRIC
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 PF and 26 volts; 60 VA; 400 cycle, .40 PF. Input: 27.5 volts DC 18 amps cont. duty, voltage and freq. regulated $49.50



SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approximately 4" dia. x 6" long. Mfd. by Diehl and Bendix
QUANTITIES AVAILABLE
REPEATERS ..... $20.00 ea.
TRANSMITTERS ..... $20.00 ea.

SYNCHROS

GENERAL ELECTRIC MOD. 2J15M1; 115-57.5 volts, 400 cycle $22.50
KOLLSMAN AUTOSYN MTR. TYPE-403: 32 VAC: 60 cycle; single phase $9.95
BENDIX AUTOSYN MTR. TYPE-851; 32 VAC; 60 cycle, single phase. $9.95
MICROSYN UNIT TYPE IC-006A. $15.00
IF SPECIAL REPEATER; 115 volt-400 cycle $15.00
2J1F3 GENERATOR; 115 volt-400 cycle $10.00
5CT CONTROL TRANSFORMER; 90-50 volt; 60 cycle $45.00
5F MOTOR; 115-90 volt; 60 cycle $45.00
5SDG DIFFERENTIAL GENERATOR; 90-90 volts; 400 cycle..$30.00
BENDIX TRANSMITTER TYPE C-78248; 115 volt; 60 cycle $22.50
DIFFERENTIAL TYPE C-78249; 115 volt; 60 cycle $5.00
BENDIX REPEATER TYPE C-78410; 115 volt; 60 cycle $37.50
REPEATER, Type C-78663, AC Synchronous 115 volt, 60 cycle..... $9.95
DIEHL REPEATER TYPE FJE 22-2; 115 volt; 400 cycle; secondary 90 volt. $27.50
5G GENERATOR; 115/90 volt; 60 cycle $45.00
7G SYNCHRO GENERATOR; 115/90 volt; 60 cycle $75.00
6G SYNCHRO GENERATOR; 115/90 volt; 60 cycle $60.00
6DG SYNCHRO DIFFERENTIAL GENERATOR; 90/90 volt; 60 cycle. $50.00
2J5F1 SELSYN CONTROL TRANSFORMER; 105/55 volts; 60 cycle $22.50
2JD5HA1 SELSYN GENERATOR; 115/105 volts; 60 cycle..... $50.00
2J1F1 GENERATOR; 115/57.5 volts; 400 cycle $12.50
2J1H1 DIFFERENTIAL GENERATOR; 57.5/57.5 volt; 400 cycle.$12.50
2J1G1 CONTROL TRANSFORMER 57.5/57.5 volts; 400 cycle..... $7.50
2J5H1 SELSYN GENERATOR; Mfr. G.E.; 115/105 volts, 60 cycle...$27.50

RESOLVERS

Kearfott type R235-1-A.. **22.50**

Rotor: **2 phase 26 volts**

Stator: **2 phase 11.8 volts 400 cycle**

Reeves type R600..... **47.50**
Arma No. 213018 Limited Rotation 8:1 ..... **27.50**
Arma No 213044..... **49.50**

RESOLVERS
(sine-cosine generators)

Type FJE-43-9 Resolver: manufactured by Diehl; Designed for 400 cycle excitation of 115 volts, but will operate satisfactorily at reduced 60 cycle voltage. The two outputs (90 electrical degrees apart) give sine-cosine signals of a maximum value of 55 volts at designed input. Shaft 0.125" dia. extends ⅜". Case is 2½" long and 2½" dia.
$25.00 each

Type FPE-43-1 Resolver: manufactured by Diehl. Identical to type FJE-43-9 (S-7) except has primary - secondary step - up ratio such that 115 volt excitation induces a stator signal of 220 volts maximum..**$25.00 each**

• •

TACHOMETER or RATE GENERATOR

Elinco Type B-68 A-C Rate Generator; input volts: 120-60 cycles; input amps: 96 m.a.; DC OHM input phase: 770; DC OHM output phase: 770..22.50
AC Generator 67V 20 cycles 2 phase .015 amps; type PM-1 1200 r.p.m. **15.00**

400 CYCLE SERVO MOTORS

Kollsman "Teletorque" type 1377-0410	$ 9.95
Kollsman type 999-0411	15.00
Kollsman type 1515B-0410	22.50
Kollsman type 9446-0110202	15.00
Kollsman type 776-01 Drag Cup	12.50
Kollsman type 775-01 Drag Cup	12.50
Pioneer type 10047-2A Drag Cup	10.50
Pioneer type CK-2 Induction	35.00
Pioneer type CK-5 Drag Cup	22.50
Pioneer type CK 13	25.00
Kearfott type R110-2A-B	20.00
American type 172B	17.50
Western Electric KS 9154	12.50
Transcoil type 2900	15.00

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Eclipse Pioneer AY 201-s-2B **$17.50**
Eclipse Pioneer AY 202-s-1B **$17.50**
Eclipse Pioneer AY 201-3B **17.50**
Eclipse Pioneer AY 200-4-B **15.00**
Kearfott R-212-1A-A Transmitter **15.00**
Kearfott R-200-1-A Control Transformer **15.00**
Kearfott R-210-1-A Transmitter **15.00**

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OA5	4.00	3B28	6.00	7CP1	15.00	250TH	20.00	707B	3.00	913	12.50
OB2	.75	3C23	3.75	9GP7	5.00	250TL	15.00	708A	1.00	917	2.00
OB3/VR90	.75	3C24/24G	1.00	9LP7	3.50	WE-251A	30.00	709A	1.00	918	2.00
OC3/VR105	.75	3C45	7.00	9MP7	7.50	WE-252A	7.50	713A	.25	920	2.50
OD3/VR150	.75	3D21A	6.00	10Y	.25	WE-253A	3.50	714AY	17.50	922	1.00
ELC1B	3.00	3D22	9.75	12A6	.50	WE-254A	5.00	715A	1.25	923	1.00
1B22	1.50	3DP1	3.75	12GP7	12.50	WE-257A	2.00	715B	5.00	925	1.75
1B24	4.50	3DP1A	7.50	12J5WGT	2.50	WE-264C	3.00	715C	15.00	927	1.00
1B27	8.75	3E29	10.00	12K8Y	.50	WE-267B	6.00	717A	.50	931A	2.75
1B32	1.00	3EP1	1.50	12L8GT	1.00	WE-271A	7.50	719A	10.00	954	.25
1B35	4.75	3FP7	1.50	LM-15	200.00	WE-272A	5.00	721A	1.00	955	.25
1B42	4.50	3FP7A	5.00	FG-154	25.00	WE-274A	4.75	721B	8.75	956	.25
1B59	10.00	3GP1	2.50	FG-17/5557	3.00	WE-274B	3.00	722A	1.00	957	.25
1C21	2.00	3HP7	3.00	RK-19	1.25	274B	.50	723A/B	10.00	958A	.25
1P23	2.00	3J21	75.00	RK-20A	9.75	WE-275A	5.00	724B	.75	959	1.00
1P24	1.50	4AP10	3.75	RK-49	3.00	276A	3.00	725A	3.50	991/NE-16	.25
1P30	2.00	4B22/EL5B	6.50	TZ-20	2.00	WE-282A	2.50	726A	7.50	CK-1006	1.50
1P34	1.75	4B26	3.50	RK-21	1.00	WE-283A	3.50	726B	25.00	R-1100	5.00
1P36	2.50	4B27	2.50	RK-23	3.00	WE-286A	6.00	726C	25.00	1500T	100.00
2AP1	5.00	4B31	25.00	HK-24	2.00	304TH	10.00	730A	7.50	1608	3.50
2C21/1642	.50	4C22	7.50	HK-24G	1.00	304TL	10.00	801A	.25	1611	2.00
2C26A	.50	4C27	3.50	CE-25A/B	2.00	WE-305A	3.50	802	2.50	1613	1.00
2C33	.75	4C35	15.00	RK-25	2.50	307A/		803	2.50	1614	1.50
2C34/RK-34	.25	4E27	10.00	28D7	.75	RK-75	1.00	804	9.75	1616	.50
2C39A	7.00	4J30	45.00	28D7W	1.25	WE-300B	7.50	805	2.75	1619	.25
2C40	7.50	4J34	20.00	FG-166	35.00	WE-310A	3.50	806	9.50	1622	1.50
2C43	12.00	4J35	75.00	FG-32/5558	7.25	WE-311A	5.00	807	1.25	1624	1.00
2C44	.50	4J42	20.00	FG-33/5720	11.50	WE-313C	2.50	807W	4.50	1625	.25
2D21	.75	4J52	50.00	RK-39	2.50	316A	.50	808	1.50	1630	.50
2D21W	1.25	5AP1	2.00	FP-54/		WE-323A	10.00	809	2.75	2050	1.00
2E22	2.25	5B21	2.00	5740	60.00	323B	5.00	810	10.00	2051	.50
2E24	2.25	5BP1	2.00	HK-54	3.00	327A	2.75	811	3.00	ZB-3200	75.00
2E26	3.25	5BP1A	12.50	RK-60/1641	1.50	WE-328A	2.75	811A	4.00	R-4330	10.00
2J21A	3.50	5BP2A	2.50	RK-62	1.75	WE-336A	5.00	812	2.25	5551/652	40.00
2J26	5.00	5BP4	2.00	FG-67/		WE-339A	15.00	813	12.00	5556/PJ-8	6.75
2J27	5.00	5C22	28.00	5728	10.00	WE-349A	7.50	814	1.75	5610	1.25
2J29	25.00	5C30/C5B	1.00	RK-61	2.00	WE-350A	3.00	815	1.25	5645	6.50
2J30	50.00	5CP1	2.50	RK-65	7.50	WE-350B	3.00	822	10.00	5656	8.00
2J31	15.00	5CP7	7.50	RK-69	2.00	WE-352A	10.00	826	1.00	5696	1.00
2J32	15.00	5D21	6.50	RK-72	.75	WE-353A	3.50	828	7.50	5703	1.00
2J33	15.00	5FP7	1.50	RK-73	.75	WE-354A	15.00	829	5.75	5725	2.00
2J34	15.00	5FP14	5.00	T-55	5.00	WE-355A	15.00	829B	10.00	5801	2.50
2J36	35.00	5GP1	5.00	75T	5.00	368A	3.00	830B	1.00	5820 (See 2P21)	
2J37	10.00	5J23	25.00	75TL	5.00	371A	.75	832	4.00	5827	2.50
2J38	15.00	5J29	7.50	VR-78	.50	WE-393A	7.00	832A	5.50	CK-5829	1.50
2J39	10.00	5J30	7.50	FG-81A	5.00	394A	2.00	833A	35.00	5933	4.50
2J40	25.00	5J32	25.00	FG-95/		410R	100.00	834	7.50	5963	1.00
2J50	35.00	5JP1	12.50	5560	14.00	WL-417A	4.50	835	10.00	5948/	
2J55	50.00	5JP2	7.50	100R	7.50	GL-434A	3.00	836	2.25	1754	250.00
2J56	50.00	5JP4	7.50	100TH	5.75	446A	.50	837	1.00	5981/5650	50.00
2J61	15.00	5JP5A	7.50	WE-121A	3.50	446B	2.00	838	1.25	R-7301	10.00
2J62	5.00	5JP11	25.00	WE-123A	3.50	450TL	40.00	842	2.50	8002R	10.00
2K25	12.50	5LP1	8.00	WE-124A	3.50	WL-460	5.00	843	.25	8005	4.00
2K30	100.00	5LP1A	25.00	VT-127A	1.75	464A	2.25	845	5.00	8011	.25
2K33A	75.00	5NP1	5.00	F-128A	25.00	WL-468	10.00	845W	10.00	8012	1.00
2K41	90.00	5R4GY	.85	HK-154	5.00	SS-501	7.25	846	50.00	8012A	2.50
2K54	15.00	C6A	6.00	VT-158	10.00	CK-510AX	.75	849	20.00	8013	2.75
2K55	10.00	C6F	8.00	FG-190	3.50	527	15.00	850	10.00	8013A	3.75
2P21 (Image Orthicon)	250.00	C6J	6.00	HF-200	9.50	WL-530	15.00	851	12.50	8014A	50.00
		C6L/5528	3.75	203Z	5.00	WL-531	5.00	860	2.50	8020	1.25
2V3G	2.25	6AC7W	1.25	WE-122A	2.50	559	.50	861	7.50	8025	1.75
2X2/879	.25	6AJ5	1.25	WE-205B	.50	575A	12.50	864	.25	8025A	2.75
2X2A	1.00	6A16	2.50	207	35.00	WL-579B	10.00	65	.50	8026	3.50
EL3CJ	7.30	6AL5W	.85	211	.50	HY-615	.50	866A	1.00	PD8365	50.00
3A4	.50	6AN5	3.00	WE-212E	25.00	WL-632A	15.00	868/PJ-23	2.00	9001	.75
3A5	.50	6AS6W	2.00	217A	1.50	WL-670A	8.75	869B	20.00	9002	.75
3AP1	5.00	6BM6	35.00	WL-218	15.00	WL-681		872A	1.00	9003	1.00
3B22/EL1C	1.50	6C21	15.00	220C	182.50	5550	35.00	GL-872A	2.00	9004	.25
3BP1	2.00	6J4	3.75	221A	.75	701A	3.00	874	.50	9005	1.00
3B21	5.00	6SB7Y	1.00	CE-235	5.00	702A-B	.50	876	.75	9006	.25
3B24	2.00	6SC7GTY	2.00	WE-242C	5.00	703A	2.00	878	.50	9906R	1000.00
3B24W	5.00	6SK7Y	.50	WE-249B	3.00	704A	.75	884	1.00		
		6SN7WGT	2.00			705A	.75	885	1.25		

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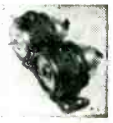
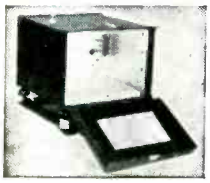


115 VOLT 60 CYCLE. Synchronous Transmitter C-78414. 5" x 3-½", Long Leads w/Bracket. Removed from New Equipment..... PAIR **$15.00**

BC-221 FREQUENCY CASE



BC-221, FREQ. CASE—Aluminum Case for BC-221 or TS-164, FREQ. METER — W/Voltage Regulator Supply using 1/VR-105 — 2/Ballast Tubes. Relay, Cable, etc. Front Compartment 9-¾" x 7-½" x 7-⅜", Rear Comp. 2" deep. Shock-mounted.

NEW: **$5.95**

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BC-212G Amplifier 2/6C5 Tubes..N: $3.95—U: $1.95
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BC-347 Amplifier—1/6F8G Tube.N: $3.95—U: 1.95
BC-357 Marker Beacon Receiver.....U: 4.95
BC-367 Amplifier—2/6V6GT Tubes.N: $4.95—U: 3.95
BC-375 TRANSMITTER .....U: 29.95
BC-453 RECEIVER—190 to 550 KC.....U: 14.95
BC-455 RECEIVER—6 to 9 MC.....U: 4.95
BC-459 TRANSMITTER—7 to 9 MC.....U: 8.95
BC-463 TRANS. & MODULATOR—67 to 74 MC U: 16.95
BC-605 Amplifier—2/1619 Tubes.....U: 3.95
BC-645 Transceiver—Converts 420 to 500 MC. N: 24.95
BC-709 Amplifier. Batt. Op., 1 Tube, N: $3.95—U: 1.95
BC-745 TRANSCEIVER—3 to 6 MC.....U: 14.95
BC-745 Transceiver—CHASSIS ONLY.....N: 5.95
BC-966 IFF SET—160 to 211 MC. 13 Tubes.U: 5.95
BC-1206 RECEIVER—200 to 400 KC.....N: 9.95
R-25/ARC-5 Receiver—1.5—3 MC.—Less Tubes U: 9.95
R-27/ARC-5 Receiver—6—9 MC.—Less Tubes U: 3.00
R-1/ARR-1 RECEIVER — Converts 2 or 6 Meters .....N: 3.95
RT-7/APN-1 ALTIMETER .....U: 9.95
RT-34/APS-13 Transceiver, Complete, Less Tubes .....U: 3.95
BD-72 Switchboard—Portable—12 Line.....U: 39.95
FL-8A Range Filter..$1.49—FL-5 Filter U: 1.00
TS-9 Carbon Handset, U: $3.95—TS-13 Handset .....U: 6.95
TS-10 Soundpowered Handset or Head & Chest Set 3.95

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0-500 Milliamp DC—2-½" Rd.; IS-22.....$4.95
0-5 MA DC WESTINGHOUSE, 2½" Sq.....$3.95

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Four Preselected Channels—Frequency Ranges 27 to 29.5—29 to 32—31.5 to 34.4—and 34.4 to 38.9 MC. Complete with 16 Tubes: 1/12SA7; 3/12SC7; 2/12SG7; 2/12SJ7; 1/VR-150; 1/6H6; 1/6SJ7; 2/6SL7; 1/6V6; 2/6AC7; 1/NE-20; and DC-14 Crystal 1000 KC.; Crystal, Calibrator, and Speaker. Power required: 12 or 24 V. DC and 275 V. DC 150 MA. Size: 6-¾" x 11-5/16" x 11-½"...

BC-923 RECEIVER. . . NEW: $34.95

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BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 3" intake; 2" outlet. Shunt Motor 4"x2"; 3000 RPM @ 24 VDC..$5.95

6 VDC SINGLE—100 CFM—No. 6100 .....$4.95

6 VDC FLANGE—150 CFM—No. 6150 .....$6.95

24 VDC DUAL—20 CFM—Min.—No. 2420.....$7.95

10 CFM BLOWER (Pictured—right)—27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-¼" x 4-½". Price $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM, 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110....$5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A.; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

115 V. 60 CYCLE BLOWERS:

115 VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake; 2" outlet. Complete size: 5" x 6" —No. 1C939 ..... **$8.95**
115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake; 2" Dis. Each Side. Complete size: 8" x 6"—No. 1C880..... **$13.95**
115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-½" intake; 3-⅜" x 3" Dis. Complete size: 4-¼" W x 8-⅜" H x 8-⅛" D—No. 2C067..... **$14.95**
115 VAC 60 cycle FLANGE TYPE—140 CFM: 3-½" intake; 2-½" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807.... **$13.95**
115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-½" intake; 3-¼" x 3" Dis. Complete size: 11-¾" W x 3-⅜" H x 8-1/16" D— No. 2C069 ..... **$21.95**

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W.E. 1-183A FREQUENCY METER: Freq. approx. 200 MC. Contains plumbing and 6 tubes, dual micrometer tuning, 110 V. 60 cyc. self contained power supply. Wt. 75 lbs..... **$24.95**

W.E. 1-185A OSCILLATOR. Freq. approx 200 MC. Uses cavity with 6 tubes. Self-contained 110 V. 60 cyc. power supply Heavy duty unit. Wt. 75 lbs. Only..... **$22.50**

RCA TYPE 308-A FIELD INTENSITY SET TS-481/U

Overall frequency range in 6 bands. 540-18,000 Kc. Field intensity range 20 microvolts to 20 V. per meter. Excellent condition. COMPLETE WITH ONE LOOP! Less power supply. Shipping wt. 48 lbs. Limited quantity..... **$29.50**

I-83 DYNAMOTOR TEST SET: Complete with 5 meters. Excellent condition..... **$19.95**

TS-24/ARR-2 GOLD PLATED CAVITY TEST SET. Tunes 234-258 MC.

Also includes 6-channel BDCST tuner, alignment tool, whip ant., test jacks and test point tips, also 2-955 acorn tubes.
Special. Limited quantity..... **$3.00**

BC-733-D LOCALIZER RECEIVER: With all tubes and crystals. Excellent cond..... **$14.95**

R156/ARR-16B RADIOSONDE RECEIVER

Excellent cond. WITH ALL TUBES AND DYNAMOTOR. **$19.95**

INTERPHONE AMPLIFIER: With tubes. Less dynamotor.
RL-7 ..... **$4.95** **RL-9** **$6.95**
DYNAMOTOR ..... $1.00 extra

METERS COMBINATION SPECIAL!!!

3 in. Rd. Black dial face. 0-750 MA. Excell. cond. .....Ea. **$3.50**
500-0-500 Microamps. 3 in. Rd. Excel. .....Ea. **$3.50**
0-2.5 amps. DC 3" Sq. Excel. ....Ea. **$3.50**

ANY THREE $10.00 POSTPAID!

TS45/APM X-Band Signal Gen.

For small labs, schools and service shops. Hurry—while they last! New Low Price..... **$69.50**

NEW 24 V TRANSFORMER & RECTIFIER COMB. a basic 24V. DC power supply of 110V AC primary, 24V secondary and Rectox Rectifier. Operates intermittently up to 1 or 2 amps. Ship. wt. 3 lbs..... **$2.95**

I-222 SIGNAL GENERATOR-MICROVOLTER

Freq. range: 8-15 Mc. & 150-230 MC. Complete with all tubes and 5 MC Calibrating Crystal. Self-contained 110 V. 60 cycle power supply. With Schematic. Excellent cond. Cost the Govt. approx. $700.00. ONLY..... **$39.95**

ADF AUTOMATIC DIRECTION FINDER RECEIVER

Model CAATC-980. Mark I mfg. by Sperry Gyroscope. Self-contained, 12 V. vibrator supply. This unit is used by major airlines. Freq. range: 200-500 Kc. AND 550-1500 Kc. Complete with all tubes. Used, good cond. Ship. wt. 65 lbs..... **$24.95**

RT48A/TPX-1 17-TUBE TRANSMITTER-RECEIVER

Receiver easily converted to 2 meter band.

Covers 157-185 MC. Receiver has acorn tube front end and 30 MC I.F. strip. Tube line-up: 3—956, 1—955, 6—6AC7, 1—6SL7, 1—6H6GT, 1—6SN7, 1—2C26, 1—5U4G, 1—2X2A. Brand new. Ship. wt. 60 lbs..... **$12.95**

W.E. TELEPHONE HAND SET

Complete with units and cord. Perfect for mobile and phone use. Postpaid. Only..... **$2.95**
MINIATURE LINE MATCHING XFMR: 1,000's of radio, TV & electronics uses. Postpaid.. **$1.25**

PULSE GENERATOR

Hazeltine Model 1017. Less tubes. Ship. wt. 100 lbs. ONLY..... **$29.50**

GN-39 DUAL OUTPUT D.C. GENERATOR

Puts out 1,000 V. @ 350 ma. 12 V. @ 25 amps. Generator may be driven from fan belt of car, an auxiliary pulley on rear wheel, or by a direct coupled gasoline engine. Great unit for Field Day! BRAND NEW! Ship. wt. 100 lbs..... **$12.95**

RG34U 71 OHM COAX. .625 dia. 5 KW rating. 85' roll with pl-173 plug at one end. New..... **$4.95**

Look! 701A XMTR. TUBES
$2.95 2 for $5
While they last at this reduced price! New, orig. boxes.
FILAMENT TRANSFORMERS for these, only..... **$2.95**
Socket..... **$1.50**
Free dope sheet.

DuMont 3GP1 Cathode Ray Tubes
$1.79 3 for $5
Same as used in Dumont 224A oscilloscope. New!
Free dope sheet available on request.

All items F.O.B. Whse., subject to prior sale and change of price without notice. Note New Address!

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COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices $17.50
POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors $12.50
LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $15.00
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $31.50
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 MC $4.00
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
HOLMDELL-TO-TYPE "N" Male Adapters, W. E. #D167284 ..... $2.75
I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—with video detector, A.F.C. less tubes $17.50
BEACON ANTENNA, AS31/APN-7 in Lucite Ball, Type "N" feed $22.50
ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50
"E" **PLANE BENDS,** 90 deg. less flanges $7.50

3 CM.—RG 52/U Waveguide

3 CM Motor-Driven Echo Box

Cavity Q to 30,000. Tuning range 80 mc Motor operates from 24 VDC Type "N" INPUT $32.50

3CM. DIPOLE FEED, 15" L. for APS-15 ..... $14.50
MITRED ELBOW, Cast aluminum, 1¼"x⅝" W.G. W.E. Flanges, "E" Plane $3.50
FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc. and VSWR is less than 1.02 ..... $7.50
3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 100 deg. at 35 scans per minute Elevation Scan: over 2 deg. Tilt: Over 24 deg. $35.00
Cross-Guide Directional Coupler. UG-40 output flange. Main Guide is 6" long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/ UG40 flanges. Coupling figure 20 db Nominal $22.50
RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ..... per length $5.00
Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ..... each. $17.50
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section with 15 lb. gauge $10.00
Directional Coupler, UG-40/U Take off 20db $17.50
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
Rotary joint choke to choke with deck mounting. $17.50
ADAPTER, waveguide to type "N". UG 81-U, p/o TS 12, TS-13, Etc. $7.50

ADAPTER. UG-163/U round cover to special BTL Flange for TS-45, etc. $2.50 ea.

1¼" x ⅝" WAVEGUIDE

CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD. . $10.00
X Band Wave GD, 1¼" x ⅝" O.D. 1/16" wall aluminum ..... per ft. 75c
Slug Tuner Attenuator W.E. guide, Gold plated. . $6.50
BI-Directional Coupler, Type "N" Takeoff 25 db coupling $27.95
BI-Directional Coupler, UG-52, Takeoff 25 db Coupling $24.95
Waveguide-to-Type "N" Adaptor, Broadband. . . $22.50

K BAND—½" x ¼" W.G.

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
Mitred Elbow, cover to cover $4.00
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

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc Center frequency. Bandwidth 2.5 Mc. gain figure; 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes $17.50
60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. New. Complete with tubes $15.00

BARGAIN SPECIALS

500 MC, RECEIVER, Type ASB, Uses lighthouse cavity-tuned RF Amp. and Mixer, plus GL-446 oscillator. I.F. is 60mc. New, less tubes $7.50

CAPACITOR, Split Stator, 30-200 MMF, per section, 6 KV, working, air space—0.168", Mfg. Cardwell $14.50
NFI-1 Noise Filters. Rated 100A./35 volts DC. AAF # 3300-399857095, Mallory ..... .79¢
POWER SUPPLY and modulator, MP-28. For TA-12 transmitter. Dynamotor rated: Input: 28 VDC/14.8A. Output 540V/450 MA. New, ... $21.50
TU-6 Tuning Units for BC 375 transmitter. Brand New, complete with case $3.95
RANGE CALIBRATOR, Sickles, Mod III, For Accurate checking of Sweeps, Markers, and Range Stopes ..... $185.
RA-58 Power Supply. Input: 115 VAC, 60 cy, 1 phase. Output: 10KV35 MA. Ideal as Hi-Pot Supply ..... $85.
CONVERTER: Navy Type CAJO-211444. Input: 115 VDC, Output 28V DC/20 A or 12 V DC/40 A. New, complete with Filter. Starting Box, etc. $67.50
WIRE: TYPE WD3/TT. Similar to W-130, except cotton-braid covered. On 1-mile reels ..... $5 per reel
PANORAMIC ADAPTER AN/APA-10. A combined Panoramic Adapter and Scope. Has 3 inputs for feeding in receiver I.F.'s of 455KC, 5.2Mc or 30 Mc. Designed also to be used as regular scope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR tube and instruction manual. **$115.00**
For operation on 115V 400~.
Harmonic coverage 40-500 Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial accuracy ± 0.7 per cent) H.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries. Part of APR countermeasures equipment. **$165.00**
New
NAVY ADF Receiver DZ-1, made by RCA. Continuous 15 to 1750 kc in 6 bands, gear-train tuning with vernier and coarse scales, broad or sharp band-pass. CW or MCW. All controls on front panel. No headaches of mechanical or electrical control interconnections. Beautifully built with 5-gang tuning capacitor, shielded tubes and coils. 8 tubes: 3—6D6, 2—76, 2—6C6, 1—41. Complete with tubes, less power supply **$22.95**
Hydrophone. MODEL MI-2. A lattice of 3 crystals in a disk-like structure; 17-37 Kc. High imp. $27.50
AN/CRW-3A Remote control receiver, for operating target planes, etc. New, with soundproof mtg. box. $34.50
TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50
TEL. REPEATER. EE 99, with 12 vdc. vibrator power supply (PE 204) $49.50
F.T.&R. 101-A, Two-wire applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems. $47.50
RADAR TRAINER. Model 15-C. Brand new, complete with pulse generator, power supply, main unit, all cables and instruction book $125
ID-60/APA-10 PANADAPTER, may be used with IF of 455, 5.25, or 30 mc. operates from 115V, 400 Cy. $150
UNDERWATER MICROPHONES, Model JR—Consists of a mosaic of 7 crystals. May be used at 17-37 Kc. omnidirectional. 50 ohm output $27.50
SA4A/APA-1 Motor Driven Coaxial Ant. Switch DPDT. Continuous Operation from 24VDC. Completely Enclosed $24.50
MP-22 MAST BASE Mobile Antenna Mount 4.59
SA1A/APN-1 Altitude Limit Switch for APN-1 Altimeter 7.95
ALTITUDE INDICATOR for APN-1 ..... 12.50
C-387-D Final P.A. Coil for BC610 2-3.5 MC. Variable Link 4.89
RA-74 Power Supply for Super Pro 69.50
C48/ARC-5 Control Box for ARC5 ..... 4.49
J-22/ARC-5 Junction Box 3.49
T-21 Artillery Microphone complete with preamp. tube. Condenser type $24.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR 83	14		375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM 33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	17.50
BD 60‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM 25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡Less filter. † Used, Excellent. * Replacement for PE 94.

PE 94-, Brand New 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A. 1 phase. Used, excellent $18.75
PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/500 cy 1500 Volt-ampere. NEW $32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New $22.50
EICOR—ML 3011-5. Input: 13.75V; 18.4A. Output: 115 V/400~, 3ϕ. 0.95 PF, 100 VA. New $59
PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400~, 1ϕ. 500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. $75

POWER TRANSFORMERS

COMBINATION—115V/60 ~ INPUT

CT-133	150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	$1.79
CT-127	900V/25MA PK. 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/.018V, 2.5V/5A/17,800 V. Test	22.50
CT-013	450-0450V @ 200MA, 10V/1.5A, 2.5, 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25
CT-929	4200V/.001A, 2.5V/2A, 6.3VCT/.6A	5.35

PLATE—115V/60 ~ INPUT

PT- 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	1.15
PT 157	660-0-660VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300 MADC	22.50
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC	33.00
PT 371	210-0-210V at 2.12 Amp	9.45
PT 133	3140/1570V. 2.36KVA	85.00
PT 801	22,000V/234 MA., 5.35 KVA	115.00
PT 521	7500V/.06A. Half Wave	59.50
PT 913	2500V/12 MA H'SLD	4.95
PT 12A	280VCT/1.2A	3.95
PT-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60 ~ INPUT

FT-140	5VCT @ 10A 25KV Test	17.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3V/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

FILTER CHOKES

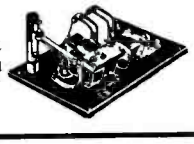
Stock	Description	Price
CH-914	12HY/250 MA 2500 V. Test	$3.25
CH-CEC 117	9-60H/.05-400 MA, 10 KV Test	$14.95
CH-113	2.5H/700 MA, 2.5 KV Test	5.75
CG-044	8.5H/350 MA, 3.5 KV Test	6.35
CH-291	0.1H/12 A, DCR: 0.3 Ohms	12.50
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA	4.69
CH-69-1	Dual 120H/17 MA	2.35
CH-8-35	2x.5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA 75 ohms	2.25
CH-344	1.5H/145MA/1206V Test	2.35
CH-43A	10HY 15 MA—850 ohms DCR	1.75
CH-366	20H/300 MA	6.95
CH-999	15HY/15 MA—400 ohms DCR	1.95
CH-445	0.5H/200 MA, 32.2 ohms, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 ohms	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5 KVINS	29.95

MICROWAVE ANTENNAS

3 cm. Horn, 1" x ½", with twist and 180 deg. bend. With dielectric window $22.50
AT49/APR—Broadband Conical, 300-3300 MC, Type N Feed $8.95
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 3'. New $72.50
Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50
AS14A/AP. 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors $4.50
AS46A/APG-4 Yagi Antenna, 5 element array $22.50
30' Parabolic Reflector Spun Aluminum dish $4.85
AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit $37.50
TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable $125.00
AN-154 3 vertical dipoles working against a rectangular mesh approx. 3'x4'. Freq. 140-200 mc. with lobing switch (115v, 60 cy) and portable slatted crate. Extremely rugged $27.95
LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc $12.50

H. V. SWITCH

15 KV Switch (For RA-38). Operates from 115V AC, 60 cy. Contacts will handle 100 Amp. Provision for Fuses. Etc. New **$24.95**



THERMISTORS

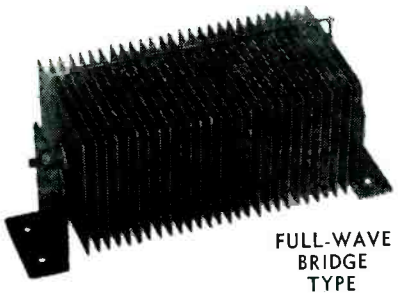
D-164699 Bead Type DCR, 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC $1.00
D-167332 Bead Type DCR is 2525-2550 Ohms. Rated 25 MA at 825-1,175 VDC $1.00
D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F. P. M. 2.5%, 1 Watt $1.00
D-166228 Disk Type 7120 Ohms @ 60° F. 4220 Ohms @ 80°F, 2590 Ohms @ 100°F., 1640 @ 120°F. $1.00

MAIL ORDERS PROMPTLY FILLED ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P.O.

131 Liberty St., New York 7, N. Y. Dept E-5 Chas. Rosen Phone: Digby 9-4124

MANY NEW TUBE TYPES IN STOCK!

We specialize in GM counter tubes and regulator tubes and Scintillation multiplier tubes as well as Western Electric subminiature, ruggized, JAN, 5000 and 6000 series electronic tubes.



FULL-WAVE BRIDGE TYPE

DIRECTRON SELENIUM RECTIFIERS

Max. Amps	18/14 Volts	36/28 Volts	54/42 Volts	72/56 Volts	130/100 Volts
1	1.35	2.35	3.80	4.60	7.50
2	2.00	2.75	5.40	6.00	9.25
3	2.95	4.15	6.00	7.90	12.90
4	3.50	6.50	11.50	14.50	22.00
6	4.10	8.00	13.00	17.50	29.95
10	5.95	11.50	20.00	25.00	41.50
12	7.50	14.50	22.50	30.00	44.50
20	12.00	23.00	38.00	49.00	72.00
24	14.50	29.00	45.00	58.00	81.50
30	18.00	34.50	57.50	72.00	110.00
36	22.50	42.50	66.00	88.00	135.00
50	29.75	54.50	.....	.....	175.00
100	60.00	120.00	.....	.....	.....

We build other Selenium Rectifiers. Transformers and Chokes to your specifications. Buy from the Direct Source for Quick Delivery.

NEW RECTIFIER TRANSFORMERS

Pri: 115V., 60 cycles in.
SEC: 9, 12, 18, 24 and 36 Volts
Continuous Ratings.

1 Amp.	$5.60
2 Amps.	6.60
4 Amps.	8.60
12 Amps.	16.60
24 Amps.	35.60
30 Amps.	46.60
50 Amps.	58.60

NEW RECTIFIER CHOKES

1 Amp	.1 Hy	1.5 ohm	53.95
2 Amps	.04 Hy	.9 ohm	4.15
4 Amps	.07 Hy	.6 ohm	7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohms	29.95
30 Amps	.005 Hy	.02 ohms	37.95
50 Amps	.005Hy	.02 ohm	53.95

FILTER CAPACITORS

Capacity	W. Voltage	Each
500 MFD	200 V.	$1.95
500 MFD	50 V.	.85
1000 MFD	15 V	.35
2000 MFD	50 V.	2.25
6000 MFD	15 V.	1.50

SELENIUM POWER SUPPLY KIT

115 VAC to 24-30 VDC, at 6 amps (conservative rating) consists of one hermetically sealed transformer with tapped primary and secondary and full wave bridge selenium rectifier.....$11.95

Victoreen Voltage Regulator VXR-130, subminiature. Brand New. Users net cost $6.50. Quantity in stock..... only **75¢**

NOW AVAILABLE!

WHITE COATED TUBE CARTONS

SIZE	EACH	SIZE	EACH
Miniature 1"x1"x3" 6AU6, 6AL5, etc.	$ .01	LARGE GT. 1⅛"x1⅛"x4½" 1B3,6BQ6GT,etc.	.015
GT 1¼"x1¼"x3⅝" 6SN7, 6W4, etc.	.0125	LARGE G 2"x2"x6" 5U4G, 6BG6G, etc.	.02

Also in Super-Gloss Red and Black.

Both types with new safety partitions—they meet U. S. Government specifications! Attractive discounts for quantity users. Minimum order 100 of a size. Be sure to specify white or color when ordering.

SNOOPERSCOPES

Army Snooperscope, in like new condition, complete with 1P25 Tube (but less 6 v. battery pack.) **16000**

Kit, same as above, with 1P25 Tube. Requires only power pack and rear eye piece **11000**

Kit, as above, less tube..... **6000**

BH	$3.00	5D21	7.75	800	2.00
BR	2.00	5JP5	10.00	803	1.75
OA4G	1.00	7BP7	4.50	829B	8.75
OB3/VR90	.85	7EP4	12.50	838	1.50
OC3/VR105	.85	7GP4	12.50	891	125.00
OD3/VR150	.85	8D21	455.00	958A	.50
1B26	1.50	9GP7	5.00	1619	.30
1B32	2.00	10BP4	9.00	1620	4.75
1B35	6.50	12DP7	10.00	1851	1.75
1B85	9.95	15E	1.00	1960	.60
1B86	7.75	15R	.10	5514	4.50
1P30	2.00	FG27A	11.95	5516	6.50
2B22	1.75	FG41	12.50	5634	7.00
2C33	1.00	FG67	12.00	5641	6.00
2C39A Surplus	13.75	CRP72	.60	5642	.95
2C40	12.75	FG98A	20.00	5651	1.40
2C43	12.75	100R Surplus	5.00	5656	7.95
2C44	.50	100TH Surplus	6.75	5670	2.15
2C46	6.60	100TL Surplus	8.50	5676	1.00
2C51	3.00	FG105	15.00	5678	1.15
2D21	.78	VT127A	2.50	5686	2.00
2E26	3.70	VXR130	.75	5687	3.00
2E30	1.75	FG172	45.00	5691	5.50
2E31	1.90	QK181	25.00	5692	5.25
2E35	1.95	211	.50	5693	4.75
2J33	10.00	249A	3.50	5696	1.15
2J36	35.00	249B	3.50	5702	2.00
2J21A	4.00	253	5.50	5703	.95
2J22	4.00	274B	1.00	5704	1.90
2J27	8.00	275A	3.50	5718	4.25
2J32	15.00	276G	8.50	5726/6AL5W	1.10
2J37	10.00	300B	6.00	5732	3.00
2J49	35.00	304TH Surplus	8.75	5744	1.00
2J50	35.00	304TL Surplus	8.75	5751	2.50
2J54	35.00	311A	5.50	5762	100.00
2K25	22.50	311C	2.50	5763	1.10
2K45	65.00	316A	.40	5780	250.00
2K59	25.00	337A	6.50	5795	250.00
2K60	25.00	350A	3.00	5812	2.75
2K61	25.00	WE355A	19.75	5814	1.60
2K62	25.00	359A	2.00	5820	Write
3B24	1.80	394A	3.50	5829	2.00
3B24/W	5.00	401A/5590	3.10	5840	5.00
3B27	3.50	403B/5591	3.15	5844	4.00
3B28	6.00	404A/5847	12.00	5879	1.40
3B29	6.00	416A	46.50	5881	2.65
3C22	52.50	416B	Write	5886	2.50
3C23	7.50	417A	4.00	5899	5.50
3C24/24G Surplus	1.75	417A/5842	12.50	5963	1.20
3C31/C1B	2.25	422A	9.95	6021	5.00
3C45	7.95	429A	8.75	6080	3.25
3D21A	6.00	446A	.75	6080WA	4.25
3J30	45.00	464A	2.55	6095	1.25
3J31	45.00	CK503AX	1.00	6096	Write
3BP1	4.50	GL673	13.00	6097	1.50
3BP11	7.00	WL678	33.00	6098	1.90
3DP1	3.30	703A	1.25	6099	1.50
3FP7	2.50	705A	.85	6101	1.50
4B24	5.00	707A	4.00	6113	1.25
4B28	3.00	707B	5.00	6187	4.00
4E27	9.50	708A	2.00	6189	3.75
4J36	75.00	709A	1.75	8020 Surplus	1.25
4J37	75.00	715B	3.00	6A7	.85
4PR60A Surplus	75.00	715C	8.00	6AG5	.60
4X150A Surplus	35.00	717A	.50	6B4G	.75
4X500F Surplus	65.00	721A	.75	D171584	8.75
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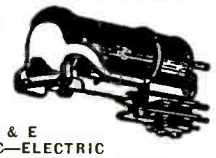
TELEPHONE RELAYS



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	Coil	Contacts	Operates at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	2600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.
8)	3000 ohms	1C	5 MA	1.75 ea.
9)	3000 ohms	1B	5 MA	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea.
2)	400 ohms	1A	24V	1.65 ea.
3)	500 ohms	1D	24V	1.65 ea.
4)	200 ohms	1A	24V	1.50 ea.

CLARE TYPE C STANDARD SIZE D.C. TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price
1)	1300 ohm	1B	24 to 85V	$2.25 ea.
2)	1300 ohm	2A-1B	24 to 85V.	2.75 ea.
3)	1300 ohm	2C-1A	24 to 85V	3.00 ea.
4)	1300 ohm	4C-2A	30 to 85V.	4.00 ea.
5)	1300 ohm	2A-1B-1C-1D	30 to 85V	3.00 ea.
6)	1300 ohm	6C	30 to 85V	4.50 ea.
7)	2500 ohm	1A	24 to 110V.	2.25 ea.
8)	2000 ohm	2C-1A	24 to 110V.	3.00 ea.
9)	2000 ohm	4C-2A	30 to 110V.	4.00 ea.
10)	2000 ohm	6C	30 to 110V.	4.50 ea.
11)	2000 ohm	8A	36 to 110V.	3.50 ea.
12)	3000 ohm	3A	24 to 150V.	2.75 ea.
13)	3300 ohm	1A	24 to 150V.	2.50 ea.
14)	3600 ohm	2C-1A	24 to 150V.	3.00 ea.
15)	110V. A.C.	2C-1A	110V. A.C. 60cy	3.50 ea.

CONTACT SYMBOLS
A=Norm. Open B=Norm. Closed C=S.P.D.T.
D=Make Before Break

Allied Type LKX-58 Tel. Relay. Coil-5,000 ohm contacts—3A Operates at 6 MA. Price—$2.50 ea.

Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma. Price—$2.75 ea.

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1) C-103C25 2200 ohms SPDT 4.5 MA....$4.00 ea.
2) C-104B28 700 ohms SPDT 6 MA.....$3.00 ea.

Bulletin #700 Allen Bradley Contactors 110V AC 60 cy. D.P.S.T. N.O. 25 Amps.....$7.50 ea.

ALLIED BJ6D36 MINIATURE RELAYS

1)	24V.	260 ohms	DPDT	$1.25 ea.
2)	24V.	100 ohms	DPST NO	1.00 ea.

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SIGMA TYPE 5F SENSITIVE RELAYS. Has two 70 ohm coils. Contacts—SPDT....Price—$3.00 ea.

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1) GM #13017 Relays, 24 volts 150 ohm. Contacts—3PDT 10 Amp.....Price—$2.00 ea.
2) Leach Relays Type 1025-SN-BF, Coil—24V. 425 ohms. Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps.....Price—$1.25 ea.

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VR-90	.89
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1B29	2.59
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1N22	.39
1N23	2.10
1N27	.89
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2AP1	7.49
2B22	1.49
2BP11	7.99
2C22	.36
2C26	**.22**
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2C40	9.99
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2C44	.85
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3C45	7.95
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3E29	8.99
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4D32	19.89
4E27	12.55
4E27A	29.95
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4J23	79.60
4J26	**79.50**
4J28	**79.50**
4J31	99.50
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5BP1	1.96
5BP4	**2.99**
5CP1	2.29
5CP1A	10.50
5CP7	8.99
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5C21/C6J	8.49
5C22	**28.99**
5D21	**7.99**
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5FP7	1.99
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5NP1	11.95
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715A	2.49
715B	7.75
715C	15.75
717A	.89
718AY/BY/CY/EY	21.99
719A	16.95
720AY/CY/EY/DY	29.75
721A	.96
721B	8.95
722	1.99
723A/B	10.44
724A/B	1.99
725A	7.50
726A	21.99
726B	29.99
726C	**39.50**
730A	12.99
800	.98
801A	.44
802	3.59
803	1.85
805	2.99
807	1.21
808	2.45
809	3.49
810	10.69
812	3.69
813	9.95
814	2.66
815	2.99
816	1.39
827R	79.50
828	9.75
829B	9.50
830B	1.99
832A	**8.49**
833A	37.49
836	3.20
837	1.22
838	1.69
841	**.26**
843	**.26**
845	11.99
849	49.69
851	24.99
860	3.99
861	9.99
864	**.29**
865	1.89
866A	.99
869B	**29.99**
872A	1.26
874	.86
876	.96
878	1.29
884	1.19
885	1.49
9-3	**.19**
902A	6.49
918	2.10
927	1.95
931A	3.99
954	**.16**
955	**.29**
956	.26
957	.26
958	.59
959	1.99
991	.44
1500T	84.50
CK1005	.49
CK1006	3.19
1608	.99
1613	1.70
1614	1.99
1616	.99
1622	1.55
1624	1.64
1625	**.19**
1626	**.11**
1629	**.16**
1630	.69
1632	.49
1633	.59
1639	.89
1641	**2.49**
1642	**.29**
1644	.69
1806P1	3.99
1851	1.39
1960	.99
2050	1.19
2050W	3.49
2051	.81
1A3	.69
1B3	.89
1G6GT	.69
1LC5	.94
1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
1V2	.69
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.79
6AN4	1.35
6AQ6	.59
6AR6	2.70
6AS5	.76
6AS7G	3.69
6AX4	.79
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BM6	35.99
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6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.99
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.69
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q7	.99
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
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14A7	.79
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14WL	.99
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25Z6	.61
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35Z3	.69
35Z5	.51
35Y4	.69
50A5	.69
50B5	.69
50C5	.69
50L6	.69
77	.49
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9002	.69
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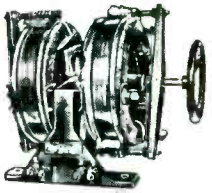

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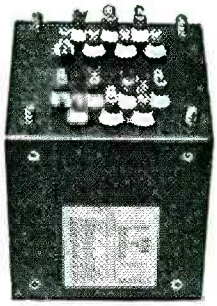

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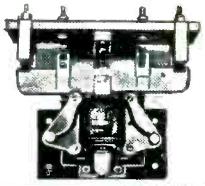

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1B23	6.95	2J55	150.00	4J27	150.00	KH24G	1.50	446A	1.95	807	1.25	1613	1.25
1B24	12.00	2J56	110.00	4J28	150.00	25T	2.95	446B	3.95	808	1.95	1616	1.25
1B26	1.75	2J61	35.00	4J29	150.00	RK39	2.75	450TL	45.00	809	2.95	1619	.45
1B27	12.50	2J62	35.00	4J30	150.00	HF50	1.75	450TH	52.50	810	10.50	1622	1.50
1B38	35.00	2K22	29.00	4J31	150.00	HK54	4.50	464A	7.50	811A	3.75	1624	1.75
1B50	23.00	2K23	15.00	4J32	150.00	RK72	1.00	471A	1.25	812A	3.95	1625	.35
1B51	7.50	2K25	19.50	4J33	150.00	RK73	1.00	527	18.00	813	13.75	1626	.25
1B56	35.00	2K26	68.00	4J34	100.00	FG95	18.95	WL530	23.00	814	3.75	1851	1.80
1B60	35.00	2K28	35.00	4J35	150.00	100TH	7.95	WL531	22.50	815	3.25	2000T	150.00
1N21	1.25	2K29	35.00	4J36	150.00	FG105	20.00	WL533	15.00	816	1.45	2050	1.80
1N21A	1.75	2K33A	75.00	4J37	150.00	122A	1.75	HK654	35.00	829	11.00	2051	1.00
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1N26	6.75	2K56	72.00	5BP1	3.95	252A	3.00	707A	9.75	838	5.95	8012A	2.50
1N27	3.50	3AP1A	10.00	5BP2A	12.00	274B	2.75	707B	15.00	849	35.00	8013	3.00
1N34A	.79	3BP1	7.20	5BP4	3.95	304TH	10.00	714AY	18.00	860	3.50	8013A	3.50
1N43	2.25	3B24	5.50	5CP1	7.50	304TL	10.00	715A	4.50	861	25.00	8019	1.75
1P25	75.00	3B25	5.50	5CP7	9.95	307A	3.50	715B	9.00	866A	1.50	8020	1.80
2C39A	13.50	3B26	5.00	5CP7A	18.00	310A	4.50	715C	22.50	869B	67.50	8025	3.75
2C40	9.00	3B28	8.00	5D21	10.00	310B	4.95	717A	1.50	869BX	50.00	PD8365	96.00
2C43	14.50	EL3C	5.50	5J1	27.50	311A	6.50	719A	22.50	872A	3.50	9001	1.52
2C44	.60	3C22	75.00	5JP2	19.50	312A	3.50	720AY/GY		878	1.50	9002	.90
2C46	7.50	3C24	1.75	5JP4	27.50	323A	15.00		50.00	879	.50	9003	1.25
2J1A	12.00	3C31	2.95	5JP23	25.00	327A	3.75	721A	1.50	884	1.50	9004	.35
2J22	9.00	3DP1	7.50	C6A	11.00	323A	6.75	721A	1.50	885	1.50	9005	2.75
2J26	15.00	3DP1A	10.00	C6J	7.50	350A	4.50	723A/B	18.00	931A	5.00	9006	.25
2J27	15.00	3DP1A-52	10.00	7BP7	5.00	350B	5.95	724A	1.95	954	.35		
2J31	24.00	3EP1	5.00	7DP4	9.00	HK354C	15.00	724B	2.25	955	.50	Thousands of other tubes	
2J32	29.00	3E29	15.50	12AP4	50.00	357A	15.00	725A	18.00	956	.75		
2J33	32.00			12DP7A	59.00	368AS	4.95	726A	18.00	957	.25		

NEW TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

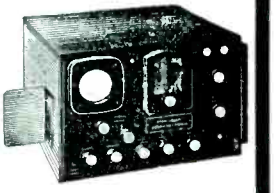
Hard-to-get X-Band Now Available

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER



Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width. c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube..... $990

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TSKI/SE	T35/AP	TS108	TS182	APA38
TS3A/AP	TS36/AP	TS110/AP	TS226	APS 3 APS 4
RF4/AP	1-96A	TS125/AP	TS239A-TS239C	APR4
TS12/AP	TS45	TS126/AP	TS251	APR5A
TS13/AP	TS47/APR	TS147	TF890/1	APT2-APT5
TS14/AP	TS69/AP	TS270	834	
TS33/AP	TS100	TS174/AP	SURPLUS EQUIP.	
TS34/AP	TS102A/AP	TS175/AP	APA10	

You Can Reach Us on TWXNY1-3235

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80
Large quantity of Polystyrene beaded coaxial cable.

Minimum Order 25 Dollars

***Phone:* WOrth 4-8262**

LIBERTY ELECTRONICS, INC.

135 LIBERTY STREET, NEW YORK 6, N. Y.

Cables: TELSERUP

CLOSE-OUTS

#36 Fahnstock clips: 90-A soldering lugs: Ammeters for 6 ampere battery chargers: 0-15 precision DC (Triplett) #321 ammeters: 6 ampere, 115 volt G-E rectifiers (220 V. input) Nos. 29, 30 & 31 SCE, #31 DCC & #44 HE magnet wire at closeout prices.
Special rectifiers, battery chargers & transformers made to order in any quantities.

STRICKLAND ELECTRIC COMPANY
COLUMBUS 11, OHIO

INDUSTRIAL X-RAY INSPECTION EQUIPMENT

General Electric OX-200, XRD Diffraction, Picker, Standard, Westinghouse and Keleket units from 100 KV up. Special inspection booths made to order.

MEDICAL SALVAGE CO., INC.
217 E. 23rd St. N. Y. 10, N. Y.

"TAB" THAT'S A BUY

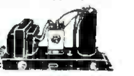
New Rectifier X fmrs

PRIMARY 115V 60cy
5 Amp †...$8.65; 2 for $15.75
12 Amp†...$16.65; 2 for $29.95
*24 Amp....$35.65; 2 for $69.95
*50 Amp......$59.00; 2 for $112
*100 Amp........$108; 2 for $210
18 Volt 2 Amp........$1.98; 3 for $5; 12 for $18
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased 2¾W/3⅛H/2¾D..........$3.59; 3/$10; 12/$36
* DUAL PRIMARY 115 & 220V 60cy
† SEC 2X ea 18-15-9-0, Can be in Series Parallel

110-115 V DC Power Supplies

for Fans, Shavers, Motors, Bells, Drills, Solenoids, Business Machines, Battery Chgrs, Machine Tools & Signal Systems.
up to 50W......$4.95; up to 100W.....$7.95
up to 250W....$12.95; up to 350W....$14.95
up to 800W....$28.95; up to 1100W....$32.95

DC Power Supply



Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 50cy Output 6.3V or 12.6V 2 Amp.
Model 2DCF (2 amp)..........$12.98
Model 5DCF (5 amp)..........$29.95
5DCF ACC/5 amp/1% Ripple..........$38.95

NEW 106W/SEC FOTOFLASH KIT AC & Dry Battery

Includes condensers two/525MFD/450V total 106W secds. Resistors, Capacitors, Rectifiers, Flash Tube in indicating flash gun, guide #40 Daylight Kodachrome, 120 on Ektachrome. Does not Incl. Batteries. AC Only.......$35 98
FIVE-90V Batteries .. @ $12 50
Flash Lamp Gun, Holder & 10" wide range. Reflector $4.98 w/Lo or Hi volt Flash Trigger Coil lamp..........$12.98
525MFD/450V/53W'Secds conds new low leakage famous mfgr DATED..........$9 @ 2/$16
16MFD/2500VDC/60WS Conds Oil..$6 @ 2/$10
16MFD/1.8 to 2.8KV/60WS Cond..$5 @ 2/ $8
Electronic Flash Handbook ckt data..........50c

PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Max	Each
TLH	FA 104/FT118	150	$5.98
THI	Amglo 5304X	100	10.98
238T	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA10Q	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98

TRIGGER COIL LO & HI VOLT FLASH $1.47
Write for "TAB" Flash Tube Data 50c

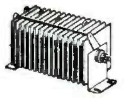
VARIABLE VOLTAGE XFMRS

SUPERIOR-GR-STACO-UTC
0-132V/1.25A*..........$7.99
0-135V/3A*..........11.99
Cased/0-135V/7.5A*..........21.95
Uncased/0-135V-7.5A*..........17.25
Cased/0-270V/3A*..........24.95
Uncased/0-270V/3A*..........18.95
Cased/0-135V/15A*..........41.98
Cased/0-270V/9A*..........41.98
Uncased 0/270V/7.5A†..........54.67
Cased 0-270V/9A†..........86.50
Cased 0-270V/12A†..........103.00
Cased 0-270V/15A†..........132.00
Cased 0-270V/30A†..........163.00
GR50A/0-135V/45A/LN..........100.00
GR50B/0-270V/31A/LN..........115.00
(LN) Like New. (*) New. (†) 3 Phase New
Industrials 6 or more 10% disc.

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED for INDUSTRY

"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps. convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.



***FULL WAVE BRIDGE • DATED & ONE YEAR GTD**

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase 120VAC 150VDC	Bridge 240VAC 300VDC
1	$1.35	$2.35	$3.75	$4.50	$7.45	$22.25	$2.10	$14.90	$28.95
2	2.00	2.75	5.35	5.90	9.15	28.85	Q	15.90	30.90
3	2.95	4.15	5.85	7.85	12.75	36.85	Q	Q	Q
4	3.50	6.45	11.35	14.35	21.75	38.85	2.95	18.90	36.95
6	4.00	7.75	12.85	17.30	29.75	54.85	3.25	20.90	39.95
10	5.90	11.45	19.50	24.80	41.35	84.85	4.75	36.90	71.95
12	7.25	14.35	22.10	29.75	44.25	99.85	5.95	41.90	81.95
20	13.05	25.05	37.25	48.75	78.50	160.85	7.95	50.90	97.95
24	14.25	28.75	44.50	57.65	81.00	190.85	9.95	89.90	159.95
30	17.95	34.35	56.50	71.00	109.00	235.85	Q	117.90	225.95
36	22.45	42.35	65.00	86.95	134.00	295.85	14.95	134.90	269.95
50	29.50	54.35	105.45	105.75	174.00	405.85	23.95	179.90	359.95

RECTIFIER BOOKS: "BRADLEY" 1.96, "SARKES TARZIAN" .96

New Rectifier Chokes

CR1A10/1 Amp/0.1 HY/1.4 Ohm/3 Lbs.....$3 95
CR1E11/2 Amp/0.1 HY/.67 Ohm/3 Lbs.....$5 95
CR7H12/5 Amp/.07 HY/.6 Ohm/10 Lbs.....$7 95
CR1L13/12 Amp/.01 HY/.1 Ohm/12 Lbs...$14 95
CR4N14/24 Amp/.004HY/.025 Ohm.......$29 95

Convert Your 6V "Fast" Charger to 12V/50A as well as 6V/100A Use

Details & Rectifier..........$22 ea; 3/$60
BCT 2/1A 2V Battery "TR" Chgr.......$3.98
BCT 6-12/2A 6 & 12V Battery TR Chgr. $7.98

Now Power Your Gov't Surplus Recr's & Xmitters from the Set Power Pack or Dynamotor from 115 or 230 VAC

B28V/5A for ARC5, BC312, BC342, BC348 $35.00
B28V/24A for BC654 or BC375..........110.00
B12V/50A for BC191..........110.00
B28V/100A for ART13..........395.00

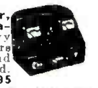
New! Basic Supplies, 115 VAC In

Stock No.	Cont. Rating	Basic
B115P5A	115 WVDC at 5 Amp	89.55
B115P10A	115 WVDC at 10 Amp	189.75
B230P5A	230 WVDC at 5 Amp	187.55
B230P10A†	230 WVDC at 10 Amp	282.75

PULSE TRANSFORMERS

W.E. TF1A31YY/0.25 u sec pulse 4300: 500 ohms/1:3 & 4:5..........$2
Pulse Blocking Osc, 3 wndgs, 1:1:1 ratio 1mh H'Sd. H V.......$2; 6/$10
VM/TR Raytheon UX7361B/4 wndgs U. S. N..........$2; 6 for $10
Pulse Blocking Osc. Video Interstage, 3 wndgs, 1:1:1 ratio, 4.3 mh, G. E. H'Sld, H V, 1 Micro Sec rise time..........$2

NEW VARIABLE 6 & 12 VOLT/12A DC POWER SUPPLY



Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V & A. Dsgnd for Cont. Service and up to 20 Amp intermittent overload.
Model T612V12AC..........$29.95

New "Cook" Diaphlex Ram Air Pressure Switch D.P.S.T. #555 Set for 9 to 11" W.G. adjustable, handles 5 amps. ....Special $2.49 @; 6/$12
4MFD/1200VDC or 10MFD/600VDC (or asst'd) Lots of 12 @ $1.50; Ea. $1.79.
Metal Parts Cabinet, 50 Draw Hvy Gauge Steel; 34½ H, 13 W, 9 L. Draw 3W, 2½ H, 8"L. 65 Lbs.......Special $35; 100 Draw, same as 50 Draw, 135 Lbs.......$59
New "Fenwal" #17300-24 Precision adjustable Knob Air Temp Control Thermoswitch—100 to + 400°F/10A/115VAC, Special..........$6.98 @ 2/$12
Linear Sawtooth DC Precision Line Potentiometer KS15138........$1.98 @; 6/$9

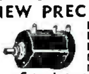
BARGAINS! BARGAINS!

Planetary Drive, 5:1 & 1 to 1 Special.....$2.49; 3 for $7.00
Klystron Socket, Cinch 5/$1
LM Freq. Meter 125-20KC "TAB" Special.......$69 95
Tuning Meter, 5MADC 3/$4
Condenser BT14/.012/25000 WVDC "TAB" Buy @ $4 98
Isol. Xfmr. V/S 110 to 220 or 440/150W....$4.00
Blower Turbine Type, 50CFM 28VACDC Dia. 3" Self Lub. Bearings, Rugged $4.98, W/115VAC Xfmr..........$5.98; Lots of 3/$15

HI-MEG HI-VOLT RESISTORS

2 MEG 5W 10KV..........99c; 10 for $3.50
7 MEG "MVP" 10W 10KV....1.35; 10 for $12.00
20 MEG "MVO" 15W 50KV.2.25; 10 for $20.00
50 MEG "MVE" 25W 40KV.2.75; 10 for $25.00

NEW PRECISION POTENTIOMETERS



Helipot 1000 Ohm/0.5%/10 Turn
Helipot 2000 Ohm/0.5%/10 Turn
Helipot 5000 Ohm/0.5%/10 Turn
Micropot 5000 Ohm/0.1%/10 Turn
Micropot 20000 Ohm/0.1%/10
Special @..........$6.49 ea; 6 for $24
WE BUY MICRO & HELIPOTS

VARISTORS-THERMISTORS

Thermistor W.E. D168391....$2.95 @ 3 for $8
Thermistor W.E. 1C..........$2.00 @ 3 for $5
Varistor W.E. 38C/CUO.......$2.49 @ 3/$6.50
Varistor W.E. D163906..........95c @ 3/$2

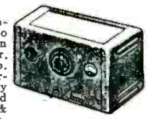
Miniature Hi Q Inductor, 0.5 Henry, Mu Metal Core..........$1.49 ea; 4/$5.00
GLOBAR T2FD Ohms/500W—RF Ant. Resistor & Clips..........$2.00
New "Ames" Jeweled, Shockless #111 Precision .0001 Micrometer Dial Gauge Range .025", Cal 0-5-0, GTD. Reg $36.50; special..........$18 @ 2/$32.00
Relay, Clare SK5010 VAC SLD/DPDT/18-28VDC/3A CTS Octal Base......$2.98

FLEXIBLE WAVE GUIDES

CG166U/42"/UG52U (E165003)..........$6. 3/$12
CG166U/12"/UG52U (E137858)..........$2, 3/$5
X-band to UG30 (2") plan F..........$1.50, 4/$5
HORN ANTENA & WG UG135U1/flange 90° twist to XWG to 180° Elbow & enclosure WGR-H1..........$6 @ 3 for $12
MAGNETRON TRAN 6.3V/40A/60KV.....$36

High Current Power Supplies

ONE YEAR GTD



Variable 0-28VDC. Completely Build. Ready to Go Full Wave Selenium Rectifier. Transformer, Variac, Volt & Amp. Meters, Switch Terminals & Fuse. In Hvy Duty Steel Cabinet Std 115V/60cy Input 110 & 220V† (3 Phase) to order.

Stock Number	Continuous Raitng	With Meters
T28V5A	0-28WVDC at 5 Amp	$45.00
T28V5ACC	5 Amp (1% Ripple)	69.00
T28V5A2CC*	5 Amp 0.01% Ripple	129.00
T28V12A	0-28 VDC at 12 Amp	108.00
T28V12ACC	12 Amp (1% Ripple)	145.00
T28V12A2CC*	12 Amp 0.01% Ripple	199.00
T28V24A†	0-28 VDC at 24 Amp	135.00
T28V24A2CC*†	24 Amp 0.01% Ripple	279.00
T28V/24ACC†	24 Amp (1% Ripple)	195.00
T28V50A†	0-28 VDC at 50 Amp	260.00
T28V50ACC†	50 Amp (1% Ripple)	370.00
T28V100A†	0-28 VDC at 100 Amp	469.00
T28V100ACC†	100 Amp (1% Ripple)	650.00

Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier, 4" Rectangular Volt & Ammeter, Overload cutout Dsgnd for cont. service.
Specify for 115 or 230VAC/1 phase, 60cy Input-

T120V5AC	75 to 135WVDC at 5 Amp	$169.50
T120V5ACC	75 to 135WVDC at 5 Amp (1 % Ripple)	217.60
T120V10AC	75 to 135WVDC at 10 Amp	215.50
T120V10ACC	75 to 135WVDC at 10 Amp (1 % Ripple)	265.60

230 TO 115V AUTOFORMERS

For 220V/50 60cy Input. To 110-120V or Step up with Cord, Plug & Receptacle.
TPA050/50W..........$2.55
TPA100/100W..........4.00
TPA250/250W..........6.75
TPA500/500W..........8.25
TPA075/75W..........3.65
TPA200/200W..........5.75
TPA750/750W..........11.75
Model TPA1000/1000 Watts/1KW..........$16.95
TPA1500/1500W ..$22.50; TPA2000/2KW...$34

SPECIALS ★ TEST EQUIPMENT

EMC #206 Mutual Cond. Tube Tester....$67.50
Hickock #600A Tube Tester.....$164 Reg..$150
Triplett #630 VOM..........$38.71 Reg..$36.00
Simpson #260 VOM..........$38.17 Reg..$36.00

NEW SONIC SOUND GENERATOR

115VAC Input
Cleans! Agitates! Washes & Mixes
"TAB" SPECIAL $29.95
Write For Complete Details

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube Hi-Sensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin/in. Tube & Data "TAB" Special...$10; 2 for $18
Snooperscope Pwr Supply 1800VDC/35MA. Using Doubler Crkt, Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper...$6.98

• 1st Quality • Hickock Mu Tested •

TUBES!! FULL RETMA WARRANTY

— NO ELECTRICAL OR MECHANICAL REJECTS —

OA2 $.74; OA2WA 4.15; OA3 .98; OA4 1.05; OB2 .74; OB2WA 4.15; OC3 .88; OY4 1.99; C1A 5.95; O1A .69; VS-1 12.49; 1A4 .79; 1A5 .64; 1AJ5 1.15; 1AX2 1.25; ELC1B 3.45; 1B3 .79; 1B22 1.68; 1B23 4.11; 1B24 4.98; 1B26 1.79; 1B32 2.94; 1B35A 6.90; 1B37A 8.75; 1B40 3.99; 1B41 48.00; 1B46 1.88; 1B51 7.60; 1B58 120.00; 1B63A 42.50; 1B67 74.99; 1B68 16.99; 1B86 7.99; 1B87 7.99; ELC1 2.70; 1C21 3.69; 1D8 .89; 1D21 3.49; 1L4 .48; 1LD5 .98; 1LN5 .78; 1P21 33.00; 1P28 9.50; 1P29 2.99; 1P30 3.19; 1P39 1.69; 1P42 10.97; 1Q23 150.00; 1Q26 69.00; 1S21 6.55; 1V2 .68; 1X2A .88; VS-2 5.07; 2AC15 7.47; 2AS15 7.47; 2C21 .75; 2C22 .32; 2C26 .36; 2C33 1.35; 2C34 .40; 2C36 25.09; 2C39A 16.90; 2C40 7.22

2C42 10.05; 2C43 9.09; 2C44 .59; 2C46 10.07; 2C50 11.25; 2C51 3.01; 2C52 3.01; 2C53 11.50; 2D21 .80; 2D21W 2.99; 2E22 1.89; 2E24 2.48; 2E25 5.15; 2E26 3.78; 2E30 2.58; 2E31 2.07; 2E32 2.07; 2E42 1.49; 2E43 1.49; 2J21 8.75; 2J22 8.95; 2J26 14.75; 2J27 15.79; 2J30 50.50; 2J31 15.11; 2J33 15.19; 2J34 15.11; 2J36 55.05; 2J38 17.55; 2J39 15.05; 2J42 99.50; 2J48 37.55; 2J50 49.50; 2J55 45.09; 2J56 50.01; 2J61 19.55; 2J62 6.05; 2K22 15.07; 2K23 17.50; 2K25 15.09; 2K26 45.15; 2K28 29.50; 2K29 27.59; 2K30 130.00; 2K33A 165.00; 2K34 139.55; 2K39 160.00; 2K41 125.00; 2K43 130.00; 2K44 130.00; 2K45 75.05; 2K50 315.00; 2P23 298.00; 3B22 1.51; 3B24 2.55; 3B26 3.55; 3B29 7.00; 3C22 65.09; 3C24 3.98; 3C31 2.95; 3C33 9.99

3C34 4.90; 3D21A 7.99; 3D23 5.90; C3J 12.05; 3K23 149.59; 3K27 175.05; 4-65A 19.49; 4-125A 19.09; 4-250A 35.50; 4B23 16.98; 4B27 4.98; 4B32 10.50; 4C25 5.98; 4C27 5.15; 4C35 16.95; 4C36 15.98; 4D21 18.99; 4E27 12.55; 4J22 49.59; 4J25 79.55; 4J29 79.55; 4J30 99.55; 4J34 79.55; 4J42 29.55; 4J52 649.95; 4T4/2 5.89; 4X150A 45.00; 4X500A 75.15; 4X500F 93.45; 5AN8 1.05; 5AX4 1.22; C5B 3.95; 5C21 9.89; 5C22 29.57; 5C30 1.79; 5D21 9.48; 5J30 19.97; 5J33 7.55; 5R4GY .96; 5U4 .54; 5V4 .89; C6A 6.59; 6A5G 2.98; 6AB4 .62; 6AC7 .68; 6AF4 1.35; 6AG5 .71; 6AH4 .87; 6AH6 .88

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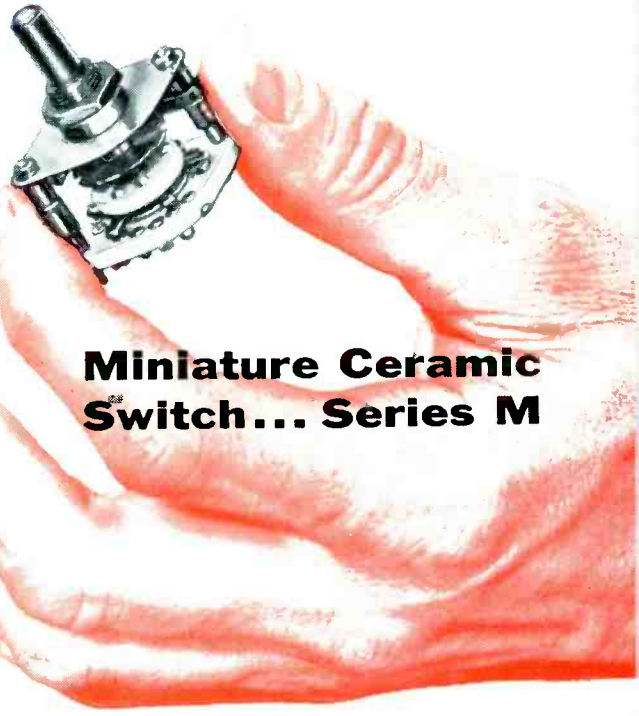

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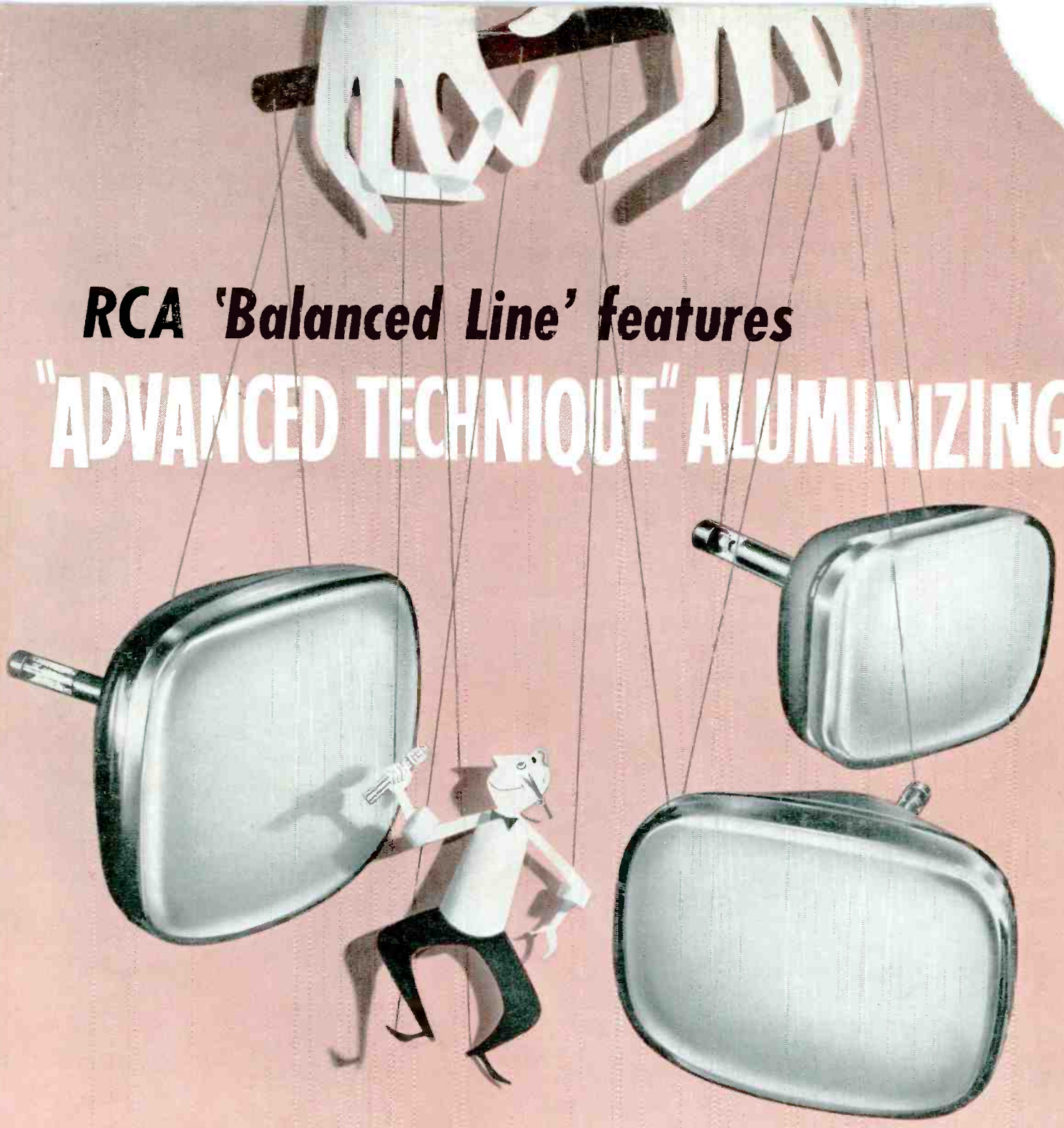

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21AWP4	72	M
21YP4-A	70	E
21ZP4-B	70	M
24CP4-A	90	M
24DP4-A	90	E
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