electronics

CHARACTERISTICS OF NOISE

(First in a series)

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Color TV Tube Electron Trajectory Plotter

MARCH • 1956

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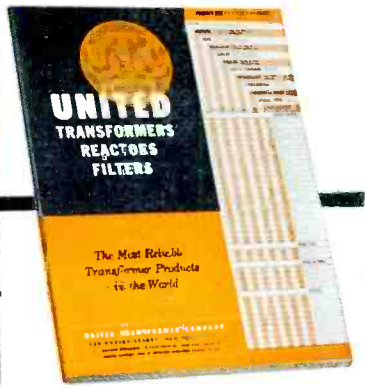

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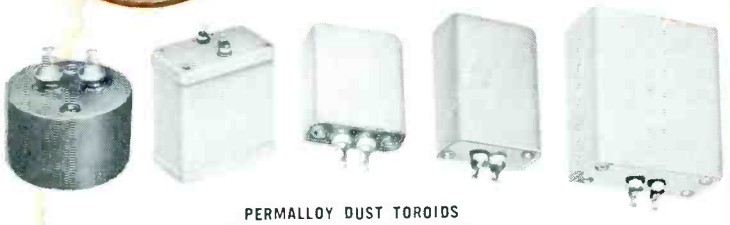

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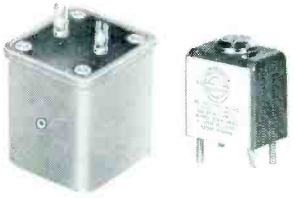

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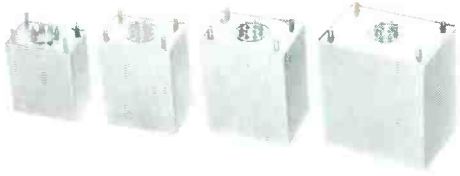

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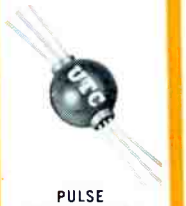

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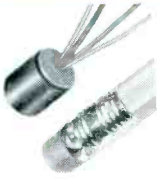

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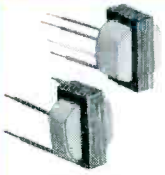

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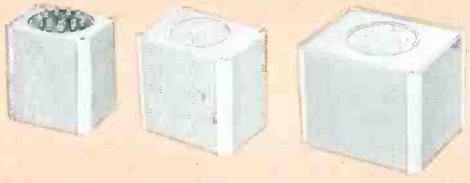

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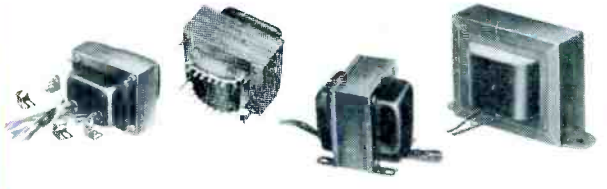

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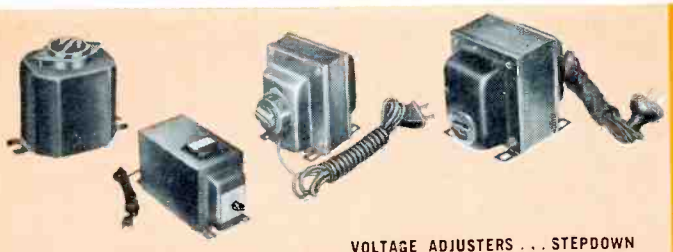

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MARCH • 1956

COLOR TV TUBE TRAJECTORY PLOTTER—Automatic tracer, developed by Philco and used in designing its new single-gun color tube code-named Apple. Combines analog computer with servo-controlled carriage to make pen trace on paper the path taken by an electron of varying velocity through focusing electrodes simulated by copper half-cylinders in electrolyte (see page 210) ..... COVER

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SHOP

▶ **NEXT MONTH . . .** Two editors teamed up, surveyed a field and turned out a job that needed doing for our next issue. Haig Manoogian worked with Alex McKenzie, and their joint effort will appear in the April issue as a special report on telemetering.

Still a little numb from the job of sorting mounds of material (every known company in the field was contacted) and talking with countless engineers, the authors haven't vouchsafed many opinions. However, we get the distinct impression that telemetering is a red-hot field, growing to beat the band, and that all the people in it are jammed full of ideas and enthusiasm.

▶ **TUBE SIMULATOR . . .** Whenever an editor has an opportunity to direct the taking of pictures of electronics equipment he always tries to show the electron tubes as prominently as possible. This often requires opening the cabinet to show the chassis or exposing the tubes to view in some background equipment.

A recent demonstration of the Lavoie Robotester was made in the wine cellar of a New York restaurant. Thousands of "glass envelopes" lined the walls and sparkled like tubes. Unfortunately, the photograph that was taken in this environment and used in the Production Techniques department of this issue had to be cropped to one-column width because of makeup requirements.

electronics

MARCH, 1956 Vol. 29, No. 3

Member ABC and ABP

TALK

We hope the accompanying photograph gives a better view of the simulated tube background.

▶**WE DEFLATED IT . . .** Occasionally an author supplies us with changes for his article just before we go to press. Then ensues a scramble to have the changes made at our printing plant, 150 miles away. The correction is relayed by eleven people between editor and type changer.

Just recently we received the following breathless note from a contributor:

"We feel like an embezzler. Somehow or other we made off with half a million dollars between the head and the text of a story we sent you (on construction of a new building by Superior Tube Company) . . .

"The head said it was a half-million dollar building—which it is. But the text, heedlessly inflation minded, termed it a million-dollar plant. The correct figure is a half-million dollars.

"The best we can say in our defense is that we were half right. But half right, of course, is wholly wrong. Our apologies for the error and would you please make the correction . . . thereby saving us $500,000 of embarrassment."

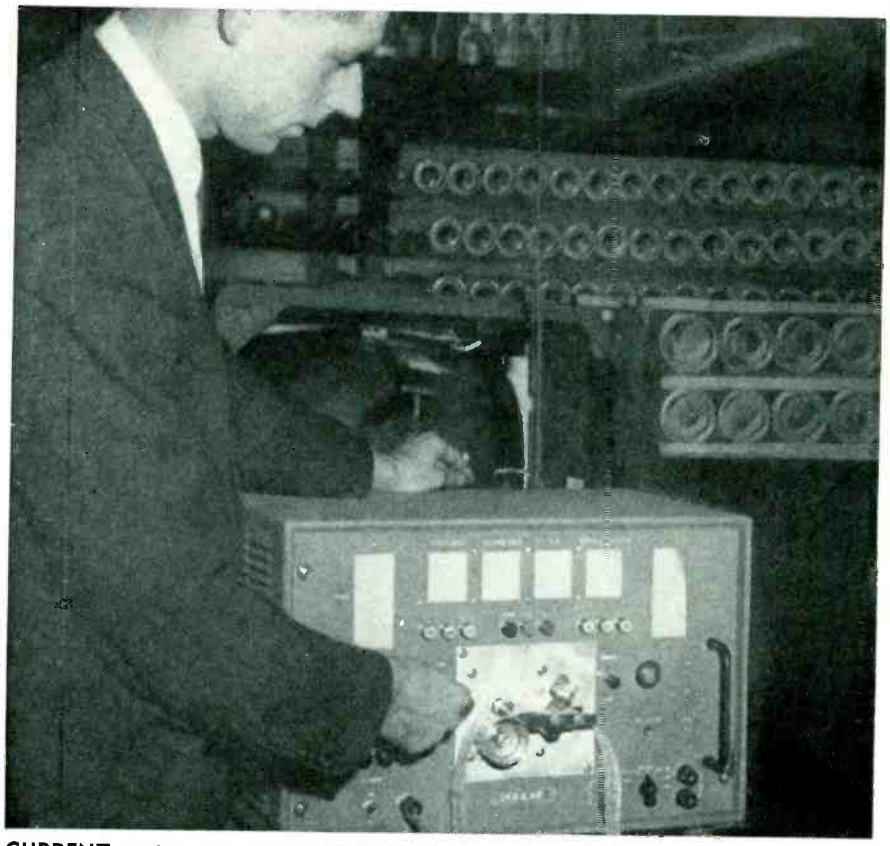
▶**DATA HANDLING . . .** The difficulties of locating someone in the Pentagon without knowing the telephone extension have become legend.

In calling Major John L. Lombardo (Radar Warning Net Uses Centralized Control, p 168) to check facts on SAGE, we gave the New York City operator all the information we had on rank, department and section.

The Pentagon operator did an excellent job—especially since the only information the New York operator gave her was "I have a call for Mr. Lombard of the Pentagon."

▶**STUDENT AID . . .** Many ELECTRONICS subscribers file the whole magazine for future reference when they are through reading. Others clip items that interest them and file these. Far be it from us to discourage such flattering procedures.

To those who do neither when they have digested its contents a suggestion: Give the magazine to someone who has a son in college and headed for an engineering degree.



CURRENT engineering designs of electronic simulators stimulated our thinking toward an electron tube equipment simulator—glass envelopes but filled with wine

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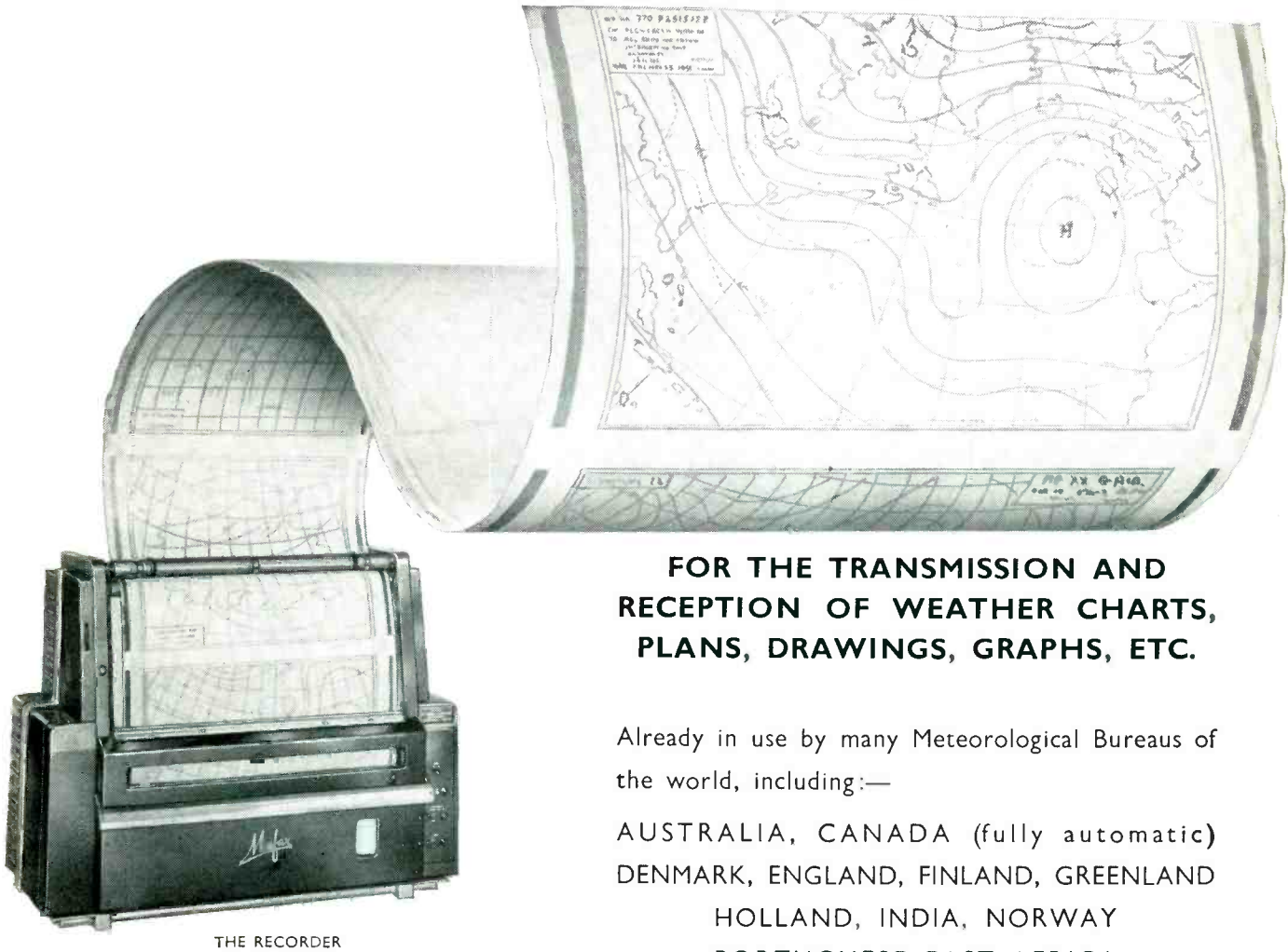

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FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Dec. '55	Nov. '55	Dec. '54
Television sets, total	604,626	631,654	833,423
With UHF	89,606	114,645	129,181
Color sets	nr	nr	nr
Radio sets, total	1,786,330	1,580,797	1,261,575
With F-M	40,305	44,357	22,055
Home sets	396,535	389,316	300,023
Clock radios	343,330	276,049	312,967
Portable sets	182,204	181,573	109,001
Auto sets	864,261	733,859	539,584

RECEIVER SALES

(Source: RETMA)	Dec. '55	Nov. '55	Dec. '54
Television sets, units	933,467	591,366	1,093,702
Radio sets (except auto)	1,388,801	865,602	1,158,588

RECEIVING TUBE SALES

(Source: RETMA)	Dec. '55	Nov. '55	Dec. '54
Receiv. tubes, total units	38,049,000	45,965,000	37,908,894
Receiv. tubes, value	$30,673,000	$34,788,000	$27,391,916
Picture tubes, total units	881,465	1,086,999	1,009,398
Picture tubes, value	$17,533,105	$20,894,647	$20,521,562

SEMICONDUCTOR SALES ESTIMATES

	Nov. '55	Oct. '55	Nov. '54
Germanium diodes, units Silicon diodes, units	2,850,000	2,700,000-r	1,900,000

INDUSTRIAL TUBE SALES

Quarterly Figures

(Source: NEMA)	Latest Quarter	Previous Quarter	Year Ago
	3rd '55	2nd '55	3rd '54
Vacuum (non-receiving)	$9,027,845	$8,933,453	$8,803,740
Gas or vapor	$3,438,835	$3,365,008	$3,570,586
Magnetrons and velocity modulation tubes	$10,998,967	$13,193,395	$13,112,244
Gaps and T/R boxes	$1,421,138	$1,677,574	$1,476,407

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	Jan. '56	Dec. '55	Jan. '55
TV stations on air	484	482	443
TV stations CPs—not on air	105	108	130
TV stations—new requests	26	29	19
A-M stations on air	2,834	2,824	2,686
A-M stations CPs—not on air	120	111	101
A-M stations—new requests	242	229	174
F-M stations on air	538	540	545
F-M stations CPs—not on air	16	17	10
F-M stations—new requests	3	3	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Dec. '55	Nov. '55	Dec. '54
Aeronautical	44,836	43,939	41,156
Marine	53,950	53,622	48,472
Police, fire, etc.	19,885	19,637	16,931
Industrial	27,269	27,427	22,874
Land transportation	8,481	8,381	7,206
Amateur	142,819	142,408	127,257
Citizens radio	14,426	14,147	9,336
Disaster	321	319	306
Experimental	674	666	643
Common carrier	2,093	2,056	1,782

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Nov. '55	Oct. '55	Nov. '54
Prod. workers, comm. equip.	408,200-p	405,900-r	373,500
Av. wkly. earnings, comm.	$75.12-p	$75.12	$71.23
Av. wkly. earnings, radio	$71.98-p	$71.40	$69.26
Av. wkly. hours, comm.	41.5 -p	41.5	40.7
Av. wkly. hours, radio	40.9 -p	40.8	40.5

STOCK PRICE AVERAGES

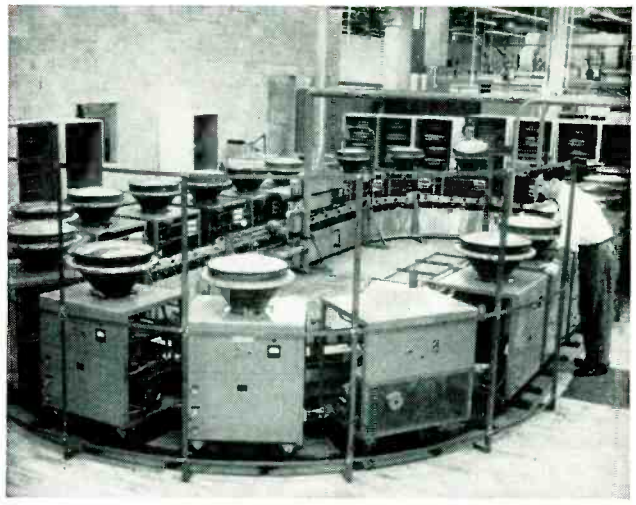
(Source: Standard and Poor's)	Jan. '56	Dec. '55	Jan. '55
Radio-tv & electronics	435.6	451.5	463.7
Radio broadcasters	500.5	519.1	413.4

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR THE YEAR 1955	1954	Percent Change
Television set production	7,756,521	7,346,715	+ 5.6
Radio set production	14,894,695	10,400,530	+43.2
Television set sales	7,421,084	7,317,034	+ 1.4
Radio set sales (except auto)	6,921,384	6,430,743	+ 7.6
Receiving tube sales	479,802,000	385,089,458	+24.6
Cathode-ray tube sales	10,874,234	9,913,504	+ 9.7

Completely aligned and tested 26-tube color sets come off one-per-minute line in RCA's Bloomington plant



Mechanization of aluminizing speeds production of color tubes in RCA's Lancaster plant

Color Television Receiver Boom Expected

RCA orders color-mask tubes from other tube-makers to counter possible bottleneck

WITH the single exception of color tubes, all components needed for RCA color television receivers are in sufficiently good supply to meet the requirements of two lines already running and four others that have been converted for color on a standby basis in this company's Bloomington, Indiana plant.

Expected 1956 holiday season demand for color sets, stimulated by broadening of the color line to include models selling below the present $695 low-end sets, means that year-end shipments could be held up for lack of color tubes.

►**Countermeasure** — Although 220,000 sq ft for development and manufacture of color tubes have been added in RCA's Lancaster plant and the entire production facilities for the type 21AXP22 three-gun color tubes are now being duplicated to double the output by midsummer, this can only boost production per shift to about 30,000 tubes per month.

Looking ahead, tube-making know-how has been passed on to other tube manufacturers to get additional sources of supply. Appreciable quantities of color tubes have been ordered from some of these firms.

Increasing mechanization of color tube production is another attack on the possible bottleneck. Examples here include placement of three layers of phosphors on the glass face and photographic application of the resist pattern to obtain more accurate positioning of the three sets of dots on the phosphor layers, as required for a high degree of white purity.

Aperture mask production by etching has likewise been improved through further mechanization. A battery of 125-ton presses shapes the masks to the required accurate contours. Cost of this mechanization program at Lancaster is nearly $10 million.

►**Receiver Figures** — With one production line now running on a 60-second time cycle and another rapidly approaching this at Indianapolis, production of RCA color sets now approximates 960 per day. The other four lines in the Bloomington plant have been retooled for color at a cost of over $5,000,000 and key employees have been trained for these lines. Changeover from black-and-white output can be made almost overnight when consumer de-

mand warrants. This would give a potential capacity of about 65,000 color sets per month on a one-shift basis.

▶**Sales and Service** — The company's color sets are selling at the rate of about 2,000 per week, with an estimated 35,000 sets in use. About 20 percent of current sales are the $695 table model, going chiefly into bars and other public places where a small set for shelf mounting about eyelevel is the big seller.

A recent reduction by RCA Service Company brings the price of a color tv service contract down to $99.95 for installation and unlimited one-year service, including parts. This compares to $50-$60 for black and white.

▶**Under $400**—The possibility of a color set to list around $400 still exists. Chromatic Laboratories has been demonstrating 26 and 22-tube receivers for several weeks.

The circuits are modified from the early circuits used with the Lawrence tube (ELECTRONICS, p 89, Dec. 1951). In quantity production the receiver chassis is estimated to cost about $60 without the picture tube. Twenty such receivers have been built for Chromatic by Telechrome Inc. and more are on order.

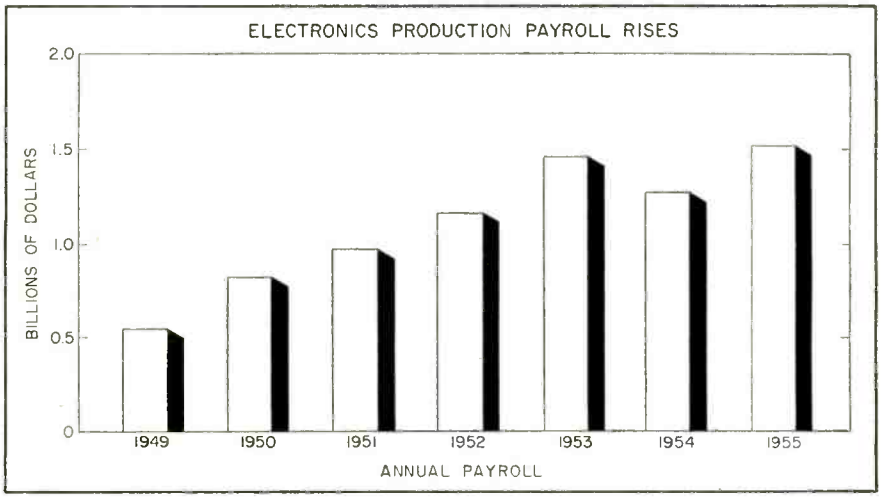
▶**22-inch Set** — Westinghouse is planning to produce color television receivers starting sometime in mid-year.

The firm has designed a small compact receiver employing a 22-inch rectangular all-glass color tube for production of table model color sets not much larger than 21-inch black-and-white receivers. Console color receivers will also be manufactured.

The color receiver will employ a high degree of mechanization using large printed circuit boards, according to the company.

The 22-inch sets will have essentially the same customer controls as the present receivers, will tune as easily as current black-and-white receivers and will be competitive in price with other color sets which have smaller tubes, according to the company.

Electronics Wage Payments Rise



Despite some declines in number of workers, pay totals keep climbing

TOTAL annual wages paid out by the electronics industry to production workers have increased substantially throughout the past five years despite fluctuations in the number of workers employed. In 1955 the industry paid out an estimated $3.7 billion, an increase of about $200 million over the 1954 total.

▶**Wages**—Rising weekly wages of production workers have more than offset declines since '54 in employment as far as total industry wage payments are concerned. Present weekly wages for communications equipment production workers average $75, according to the Bureau of Labor Statistics. This includes production workers in radio, tv, tubes, phonograph, telephone, telegraph and related equipment plants. In 1949 weekly wages averaged $53.

▶**Future**—Effect of automatic production on employment and wages in one company is indicated in a case study by the Department of Labor of a major manufacturer of radio and tv sets that adopted printed circuitry and automatic inserting machines in producing its 1955 tv sets.

The new methods reduced but did not eliminate hand asembly operations. Some new machine tending jobs were created requiring no greater skill or training. However certain new machine operations, utilizing higher paid labor and additional skilled occupations, were created. Some unskilled jobs were eliminated but no worker was laid off as a result of changes.

IRE Show Plans Top Attendance

Over 45,000 people are expected at the industry's largest technical meeting

PROGRAM of 55 technical sessions and 714 engineering exhibits awaits the electronics engineer and executive who attends the 1956 IRE National Convention to be held March 19-22 in New York City.

▶**Engineering**—Technical sessions are scheduled for all four days at the Waldorf-Astoria hotel, Kingsbridge Armory and the Belmont Plaza Hotel. Highlights of the program will be two symposia on Tuesday evening, March 20, on the U. S. earth satellite program and color television tape recording.

Other topics such as the impact of computers on science and society, nuclear effects on communication systems, the future of medical electronics and air traffic control will

(Continued on page 10)

NEW 60-VOLT power transistors

For circuits and systems where you need higher voltage ratings

—offers all the important advantages which made its 30-volt counterpart so popular

• high current gain • low thermal resistance
• 4 watts average dissipation with heat sink
• hermetic seal • low relative cost

Here is an exclusive Sylvania Transistor development designed to broaden power transistor applications in circuits operating from power supplies up to 60 volts.

Sylvania's new 60-volt power transistor can also introduce improvements in the design of inductance coupled circuits operating from power supplies up to 30 volts.

Like its 30-volt counterpart, the new 60-volt power transistor provides high current gain over a wide range of operating conditions and high current switching for computer applications.

Write for complete details on these new 60-volt power transistors as well as the popular 30-volt series

60-volt power transistors	30-volt power transistors
*Type 2N141 (PNP)	*Type 2N68 (PNP)
Type 2N143 (PNP)	*Type 2N95 (NPN)
	Type 2N101 (PNP)
*with cooling fins	Type 2N102 (NPN)

"another reason why it pays to specify Sylvania"

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LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

SEE SYLVANIA IN BOOTH NOS. 168-172 AT THE 1956 I.R.E. SHOW

also be featured. The complete schedule of all technical sessions and individual papers, including time and place for each, begins on page 468 of this issue.

▶ **Exhibits**—The Radio Engineering Show exhibits will fill the 4-acre floor of the Kingsbridge Armory in the Bronx and overflow into nearby Kingsbridge Palace. Equipment ranging from color tubes to giant computers will be on display and available for inspection. Exhibits of similar equipment will again be grouped and identified, as far as possible, along aisles carrying product names so that specific fields can be covered more easily.

▶ **Other**—The annual meeting of the IRE at the Waldorf on the opening Monday morning of the convention will feature a talk by John T. Henderson, director of the IRE Canadian Region and principal research officer of the National Research Council, Ottawa, Canada. On Monday evening the get-together cocktail party will be held at the Waldorf. On Wednesday evening the annual banquet will take place at the Waldorf and the IRE awards for 1956 will be presented.

▶ **Registration**—Visitors may register for the convention at either the Waldorf-Astoria or Kingsbridge Armory.

Special show buses will provide registrants with free transportation between the two locations at frequent intervals.

Miniature paging receiver . . .

Lightweight two-way radio and . . .

Musical telephone appear as . . .

Communications Gear Adopts Transistors

Radio, telephone, carrier-current and industrial control markets beckon

ADDITIONAL markets for the transistor are opening in communications and industrial control.

▶ **Two-Way Radio**—Use of transistors in four two-way radio models has been announced by Motorola. Nine to 11 Motorola type 2NJ2 low-power or 2NJ6 medium-power transistors and 4 to 8 high-power 2NJ4's are used.

The sets operate in the 25 to 54 or 144 to 174-mc bands. Output ranges from 1 to 8 w; weight from 7 lb 9 oz to 15½ lb.

▶ **Pocket Pager** — A 10-oz paging receiver uses seven 2NJ2's and sells for $165. An f-m unit features selective calling. Base station sells for $800 with $200 for installation, including inductive loop.

A frequency-shift-keyed power-line carrier system uses 16 2NJ2 transistors. It operates in the 40 to 200-kc band with 500-cps channel spacing.

Motorola has been in production of transistors for about 18 months. Output is for the company's own end equipment. A $1.5-million transistor plant near Phoenix will soon be in operation.

▶ **Telephone**—A musical tone generated by transistors is replacing the bell in 100 Crystal Lake, Ill. telephones during field trials by the Bell System. Unit operates off 1 v instead of the usual 85 v. Tone seems better for oldsters who can't hear the high-frequency components of telephone bells. The tones cannot be confused with doorbells, alarm clocks and kitchen timers.

An auxiliary amplifier for telephones that will make life easier for the hard-of-hearing is being marketed by Fisher Research of Palo Alto, Calif. Price is $32.50.

▶ **Industrial** — Another Fisher product is a three-transistor audio amplifier with 85-db gain. Unit picks up sound of termites, fluid leaks and worn-out bearings. Weight is 15 oz.

Transistorized alarm unit by GE protects generators in electric power stations. It sounds off if negative-phase-sequencing current exceeds full-load positive-phase-sequencing current by 7 to 15 percent.

A nine-transistor automatic thickness control regulates speed and pressure of a 3, 800-fpm five-stand steel rolling mill in U. S. Steel's Irvin Works in Pittsburgh. Controller is by GE. Also by GE is a double-based diode that does the work of two electron tubes when hooked up as a multivibrator.

(Continued on page 12)

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

Sprague LITTL-LYTICS* for transistor circuitry

HERE ARE THE SMALLEST *aluminum electrolytic capacitors ever made to Sprague's rigid quality standards.* Add to that their low leakage current, high reliability, and moderate price, and you have a new series of *miniature* electrolytic capacitors ideal for use in transistorized pocket radio receivers, wireless microphones, personal-style wire recorders, and similar equipment.

Their ultra-low leakage current is particularly important for it means minimum drain and long battery life when used in filtering applications across a battery, and excellent circuit performance when used in coupling applications.

Sprague Littl-Lytics are available in a full range of capacitance ratings from 1 to 110 mf, and in standard working d-c voltages of 1, 3, 6, 10, 12, and 15. Sizes range from 3/16"D x 1/2"L to 3/8"D x 3/4"L. Maximum operating temperature of the new Type 30D capacitors is 65°C.

Performance characteristics, sizes and ratings of metal encased, hermetically sealed Littl-Lytics are all in Engineering Bulletin 320, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

typical ratings

Cat. No.		30D6	30D16
WVDC		6	6
μF		3	60
Leakage Current (μA Max.)		2.0	3.0
Can Size	D"	3/16	3/8
	L"	1/2	3/4

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

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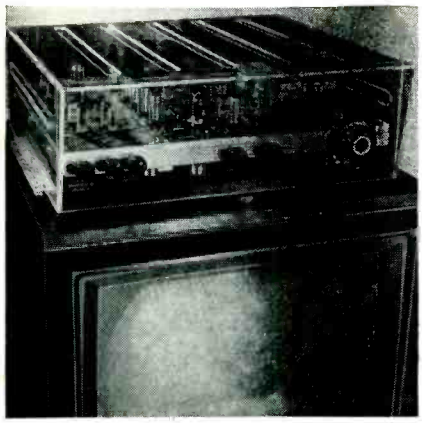
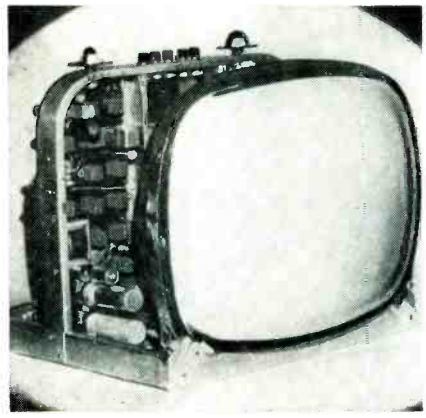
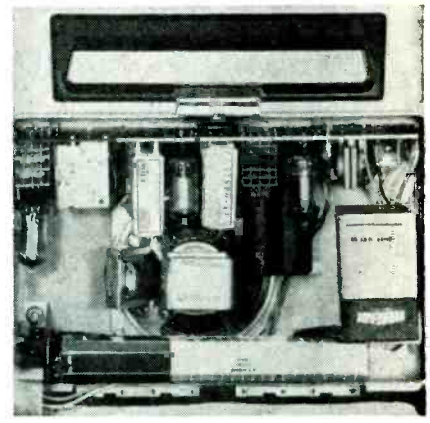






COLOR and monochrome tv sets built by ACF Electronics and a Motorola portable demonstrate new module applications as . . .

Manufacturers Push Modular Electronics

Module makers plan expanded production as set producers ready complete receivers

ECLIPSE in modular electronics activity after the announcement of the government sponsored Tinkertoy project was only temporary, according to recent indications from several manufacturers in the field.

▶**TV**—Emerson Radio has announced plans to introduce a modularized tv set. The company, in conjunction with ACF Industries, is currently designing receivers incorporating the components.

Du Mont is working on a modularized tv set for possible trial production on a limited basis. Another set maker, in conjunction with Aerovox, has converted a production model tv receiver to modular design.

Aerovox has worked with five tv manufacturers on production model conversion. ACF has worked with eight set makers on modular designs. Both companies foresee at least eight modularized tv sets on the market by July, 1957.

▶**On the Market**—One firm is reported to have incorporated modules in a portable industrial 2-way radio. Motorola uses them in a portable radio. Within the next three months another manufacturer plans to introduce a modularized transistorized counter for industrial use.

The Navy, which has officially endorsed use of modular electronics equipment for the fleet, is reported to have ordered additional modularized sonobuoys (Electronics, p 160, Dec., 1953). It is also evaluating a modularized frequency meter built under Navy contract by an electronic equipment manufacturer located on the west coast.

▶**Makers**—Aerovox, which took over the National Bureau of Standards module plant in Virginia last year, and ACF are pushing expansion plans for modular electronics. Aerovox has already budgeted for a substantial expansion of its module manufacturing facilities and plans to allocate a quarter of a million sq ft of space in its New England plant facilities for increased output. It expects to be in full production at the plant by the early part of 1957 with an output of 50,000 modules a day.

The firm started out last year with 7 different types of modules for use in industrial and military prototype applications. It expects to have 25 standard circuit modules available by June, including a voltage regulator, four audio stages, a delay circuit, three high speed flip-flops, three gate generators, a gate amplifier and a blocking oscillator.

ACF employs about 150 people in its plant in Alexandria, Va. The plant has a capacity of a quarter of a million modules a month based on the average 7 or 8-wafer module. Making smaller modules, capacity could reach a million a month. Since the firm entered the module field two years ago it has invested some $2.5 million.

Among the modular products ACF has produced are an wideband i-f amplifier, a video amplifier, a 300-volt d-c regulator and a decimal counter. In the tv receivers shown, approximately 80 percent of the components in the monochrome set and 65 percent in the color receiver are contained in 17 and 38 modules respectively.

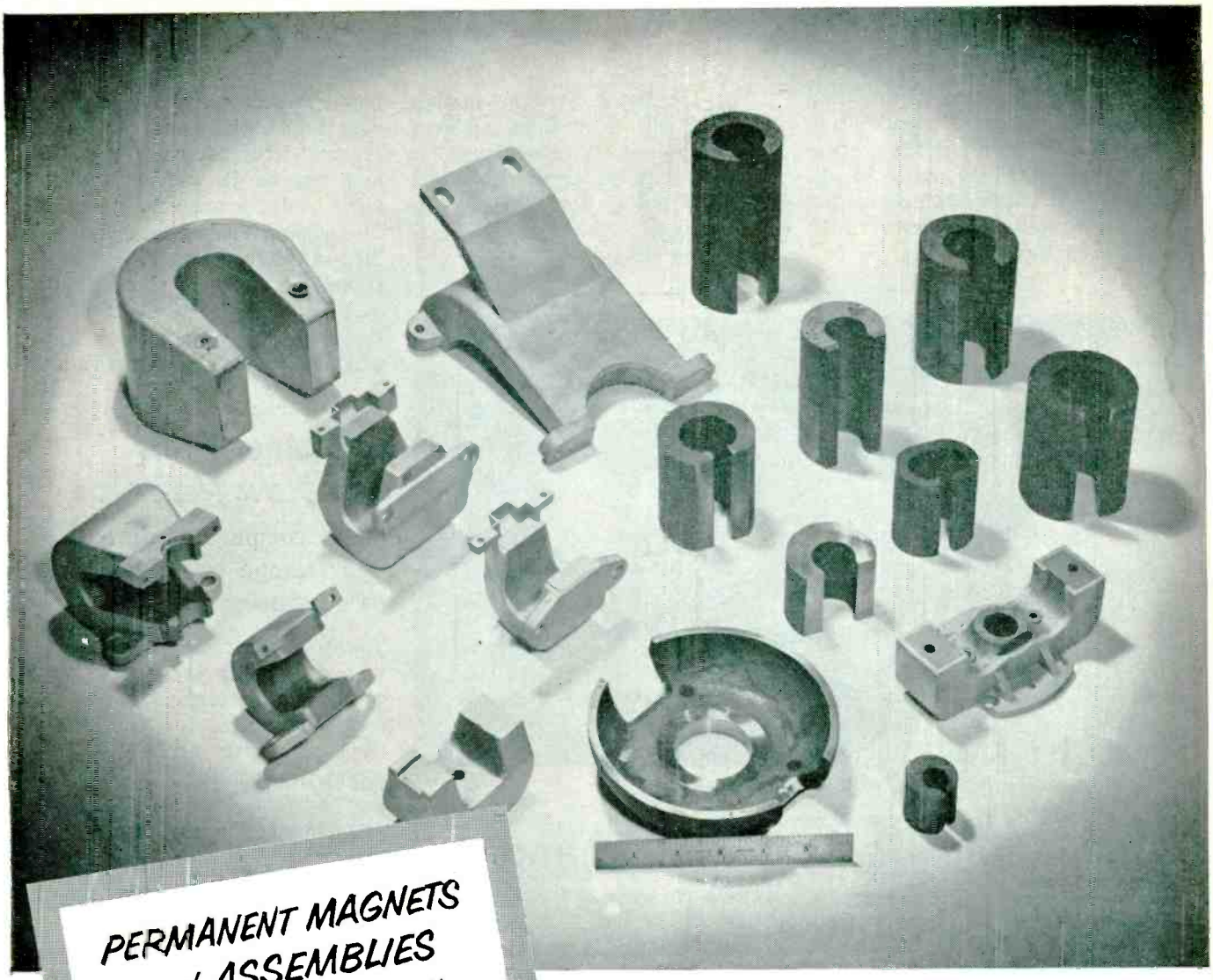
▶**Future**—The average black-and-white tv receiver would probably use between 8 and 17 modules and a color set, 25 or more, depending on the number of wafers and the extent of modularization. With this potential in tv alone, module makers are optimistic about future business, and look for module production this year above 4 million units.

New Heat Proposed To Spur UHF-TV

FCC scheme would allow rebroadcast on top channels at low cost

FORCED incubation of the egg laid by uhf-tv has been attempted several times. Latest proposal by the Commission is the establishment of a new kind of supplemental station.

(Continued on page 14)



PERMANENT MAGNETS and ASSEMBLIES for Wave Guides, Traveling Wave Tubes and Magnetrons

We can handle ANY requirements you have

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- ★ Any size, shape or coating required
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- ★ Write for Bulletin GC-106 A on all Arnold Products

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The group of magnets illustrated above are indicative of the great scope of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need; in weights ranging from a few ounces to 75 pounds or more; and with die-cast or sand-cast aluminum jackets, Celastic covers, etc., as required. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized as desired. • Let us handle your magnetron, traveling wave tube and wave guide permanent magnet requirements, *or any other magnetic material specification you may have.*

WSW 5996

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Called a translator, the station would pick up and rebroadcast in isolated areas the programs of other tv stations. Only the upper 14 uhf channels (70-83) would be allocated to this service. Top power of 10 watts is proposed.

The translator station, costing around $1,000, is not to be confused with proposed booster stations that would operate on the same channel as the parent station to fill in unserved areas within normal coverage of the uhf parent.

SETS, moving down Bendix line for new Fords, show that . . .

Auto Radio Designs Are Changing

Big three auto makers push transistors. Conventional tube set output keeps pace

THE automobile radio accounts for nearly 50 percent of total radio production. It is also becoming one of the most important users of transistors with Chrysler, General Motors and Ford now using transistorized auto sets. Current tube receiver output is about 80 percent of present estimated auto production.

Total auto receiver output set a record last year. It reached 7.2 million units compared to the previous high of 5.1 million in 1953.

▶ **Where**—Last year an estimated 67 percent of all autos produced had radios installed at the factory. Another 10 percent had radios installed by auto dealers and the remainder had sets obtained through mail order houses, chain stores and other types of dealers.

One manufacturer estimates that this "after market" business accounted for about 6 percent of the total car radio business last year. Since 1946, except for 1948, the percentage of autos with factory installed radios has increased, from 62 percent in 1946 to the present 67 percent. This is doubly significant when it is realized that passenger car production has climbed from 2.1 million in 1946 to an all time high of nearly 8 million in 1955.

▶ **Transistors**—The auto industry's big three, General Motors, Chrysler and Ford are all using transistorized car radios. GM has a Delco-made hybrid set available in the Chevrolet Corvette for this year (ELECTRONICS, Feb. p. 10). Chrysler announced that transistor radio-equipped Imperials are being shipped to dealers and that production line installation of the set began January 3, 1956. The sets are made by Philco.

Ford presently has 1,000 transistor radios installed through production and sold to the public. More are being installed in a test program to determine the firm's future car radio plans. The radios, made by Bendix and Motorola, are sealed hybrid units that contain one germanium junction-type audio power transistor. If breakdown occurs in a unit, Ford dealers will remove it for return to the maker and replace it with a tube-type radio under a one-year guarantee. Studebaker, Packard and American Motors have not yet announced transistor car radio plans but it is expected that by the end of this year, all U. S. auto manufacturers will have transistor sets available.

Computer Firms See New Markets

Small computers, printers and storage systems featured as companies map sales drive

TREND of electronics firms aligning themselves with established office-equipment concerns to market electronic computers for the business and industry is again evident in recent developments. Several technical advances are contributing to expansion of the market.

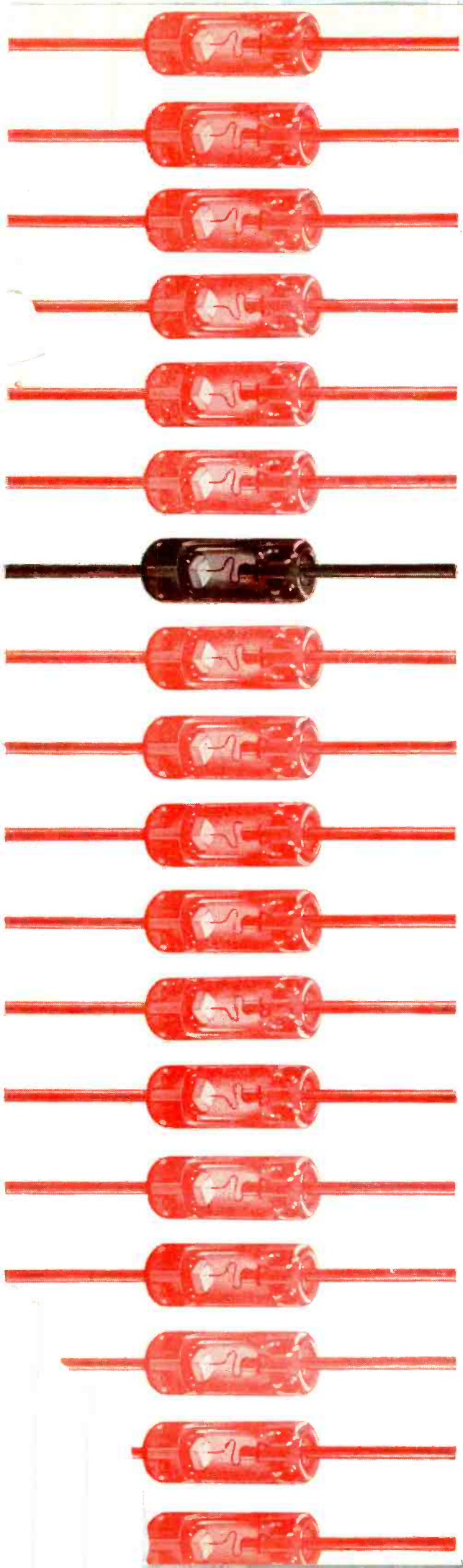
▶ **Printing**—Addressograph-Multigraph is augmenting its line of electronic gear for printing magazine mailing labels by handling the Eastman-Kodak multiple-stylus printer. The device prints 3,000 lines a minute. It rents for $4,000 a month.

In normal label printing, the unit prints four 24-character lines on each label. It differs from Eastman-Kodak's original machine (ELECTRONICS, p 98, Feb. 1953) in that data is first transcribed electronically from punched cards to magnetic tape. The card-to-tape converter also rents for $4,000 a month. The machines are in production and installations are expected this year.

Addressograph - Multigraph already has a line of eight models of facsimile label printers. Magnavox has taken out a nonexclusive license to manufacture and market the Eastman Kodak Minicard data storage system.

▶ **Alignment** — Royal-McBee and General Precision Equipment have formed a company known as Royal Precision to explore the field of

(Continued on page 16)



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faster,
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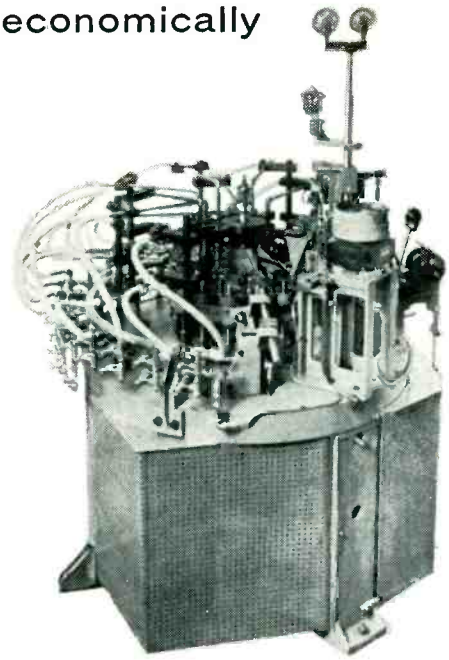

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Designers and builders of special automatic and semi-automatic equipment for all industrial operations.

CONTI

electronic computing for science and engineering. GPE is parent company of Librascope which recently announced the LGP-30 general purpose computer. Royal-McBee maintains a research and development lab in Hartford, Conn.

General Electric, maker of Ordvac, has formed a computer section to broaden its computer activities. A full line of computers, both analog and digital, simulators and components is planned.

IBM has announced a $50-million expansion of sales, manufacturing, service and research facilities on the west coast. Twenty-five IBM electronic data processing machines are installed in the area.

▶ **Small Computers**—Burroughs is in volume production of the E101 computer at its Detroit plant. The unit sells for $32,500. Several are on order for the aircraft, optical, banking, general business, oil, chemical and pharmaceutical, general research and engineering fields.

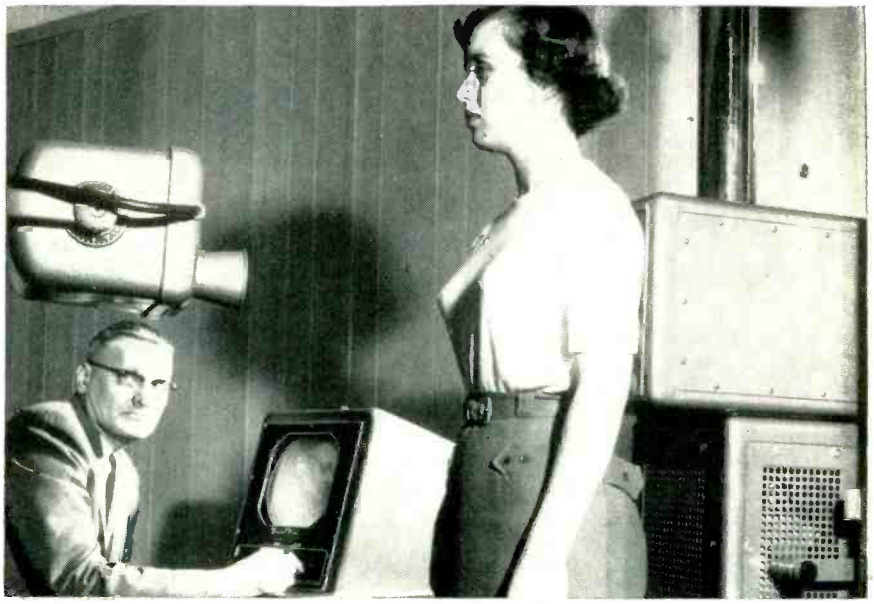
At United Aircraft's Computation lab in East Hartford, Conn. an E101 is used to debug problems for a $1-million computer. Another E101 will be installed at All American Engineering, a Wilmington manufacturer of aircraft devices.

Underwood is tooling up at Bridgeport to make 25 Elecom 50's a month. The machines rent for $650 a month or sell for $17,000 to $28,000 depending on auxiliaries.

▶ **Magnetics**—Sperry-Rand is taking orders on their $12,500 magnetic-amplifier computer. The Univac file computer, which costs about $200,000, will be available about the middle of the year. The company announced four sales of the $1-million Univac during January.

Potter Instrument of Great Neck, New York is in production on random-access memories that provide 100,000 locations of 200 characters each in 0.3 seconds. Data is stored on magnetic tape in a three-dimensional bin arranged like pages in a book.

The company is working on a $1 million computer using Magnistors, ferrite toroids with three coils. These units combine the functions of a flip flop and a gate.



LOW-INTENSITY x-rays permit extended fluoroscope diagnosis when . . .

TV Amplifies Light 40,000 Times

Low-noise amplifier circuits are key to ultrasensitive closed-circuit television

INDUSTRIAL and medical radiology, astronomy and possibly television broadcasting are potential markets for a recently introduced closed-circuit television system that amplifies light 40,000 to 50,000 times.

Developed by Bendix, the Lumicon can produce a bright, detailed image on its monitor even when the subject is barely visible by the naked eye owing to low light level.

▶ **How It Works**—The system uses an image orthicon camera tube fitted with the fastest possible lens. Scanning rate is 1,029 lines, 30 frames a second. Bandwidth is 15 mc.

The camera picks up visible light. Key to the high light amplification is a low-noise amplifier with a gain of 500,000. Although circuit details have not been released, it appears that several stages of distributed amplification are used.

The amplifier in the camera unit apparently uses seven 6CB6's. Other amplifiers, pulse and sweep circuits are located with the picture tube unit. In all, about 35 tubes are used.

▶ **Production**—The Lumicon puts Bendix squarely in the industrial television business. The unit will sell for about $20,000. The company plans to produce about 25 units this year.

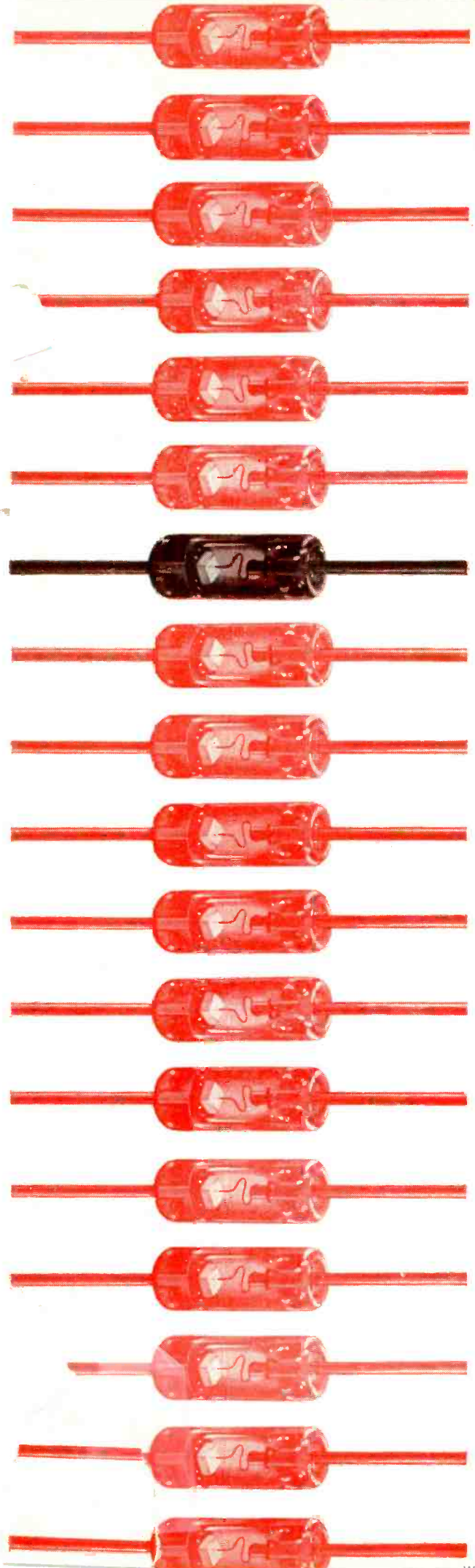
▶ **X-rays**—Since low light levels can produce an adequate image, extended observation at safe levels of x-radiation is possible. This opens up possibilities of x-ray movies of internal organs and more extensive use of the fluoroscope.

The system could permit a radiologist to watch the progress of x-rays in cancer treatment. Several monitors can be used for education of medical students.

▶ **Industrial**—Safety afforded the operator makes the system attractive for industrial inspection of castings and forgings. Used with a fluoroscope, the system may be useful for inspecting suspicious packages. Other applications include surveillance under conditions of low light level.

▶ **Astronomy**—Equipped with the Lumicon, a 200-inch telescope would have the light-gathering power of a 1,200-inch unit. Possibilities include study of nearby planets, extended observation of the sun for better understanding of ionosphere storms and study of meteor showers.

(Continued on page 2



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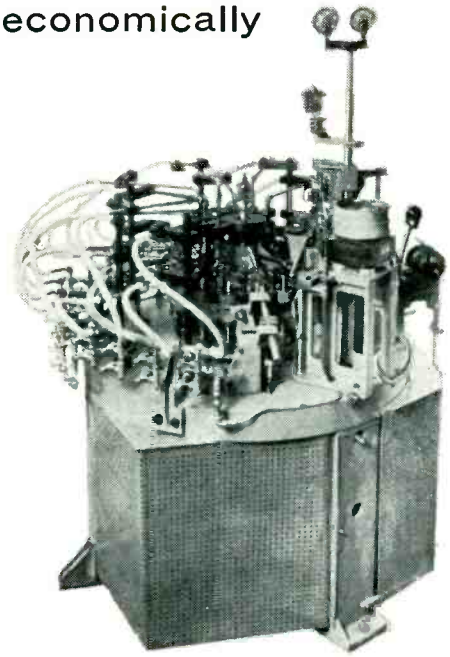

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(Continued on page 2?)

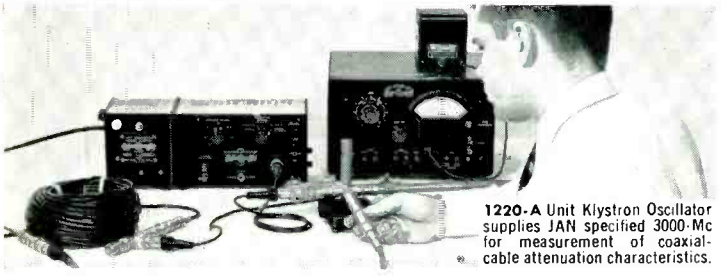
NEW Low Cost KLYSTRON OSCILLATOR

Type 1220-A Unit Klystron Oscillator shown here with plug-in Type 1201-A Unit Regulated Power Supply.

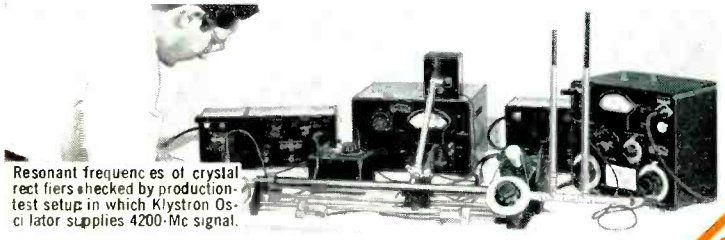
. . . for Use at Frequencies from 2700 to 7400 Mc

The Type 1220-A Klystron Oscillator is a low cost, small and compact microwave signal source designed for use where the complexity of a signal generator is not required. This new Oscillator is both convenient and flexible in operation . . . a UHF-SHF signal source that is capable of producing a stable high-frequency signal of adequate power for laboratory measurements, production-test work, or for use in college experimental class.

Standard reflex klystron tubes with self-contained cavities are used in the Oscillator. Eight different tubes are provided to cover the 2.7 to 7.5 kMc range. An important feature of this versatile self-contained unit is the provision for internal square-wave modulation, and the ease with which it can be pulse or frequency modulated from external sources.



1220-A Unit Klystron Oscillator supplies JAN specified 3000-Mc for measurement of coaxial-cable attenuation characteristics.



Resonant frequencies of crystal rectifiers checked by production-test setup in which Klystron Oscillator supplies 4200-Mc signal.

SPECIFICATIONS

Type 1220-AO Klystron Oscillator, $205, without tube

Frequency Range: Depends on klystron tube used (see table); all units are otherwise identical — frequency range of any unit can be changed to that of any other by inserting the appropriate klystron tube.

Range	Type No. & Price* Klystron Oscillator including tube	Klystron Tube Type	Price for Tube only	Nominal Power Out (mw) Average Over Frequency Range
2700–2960 Mc	1220-A1, $254.65	726C	$ 49.65	100
2950–3275 Mc	1220-A2, $272.90	6043	$ 67.90	90
3400–3960 Mc	1220-A3, $265.75	2K29	$ 60.75	90
3840–4460 Mc	1220-A4, $312.15	2K56	$107.15	75
4240–4910 Mc	1220-A5, $261.45	2K22	$ 56.45	100
5100–5900 Mc	1220-A6, $301.45	6115	$ 96.45	80
5925–6450 Mc	1220-A7, $272.90	QK404	$ 67.90	100
6200–7425 Mc	1220-A8, $272.90	5976	$ 67.90	90

The klystron tubes used in these oscillators are designed for relatively infrequent tuning. The flexible copper diaphragm used to vary the frequency is subject to failure due to fatigue.

*Note: Power Supply Required.

Internal Modulation: 1-kc square wave, adjustable ±15 cycles

External Modulation:

Square wave. 50 c to 200 kc; sine or square-wave modulating signal of at least 15v, rms required — G-R Type 1210-B R-C Oscillator recommended modulator.

Pulse. 1 to 10,000 μs duration, 0.25 μs rise and fall time, 50 c to 200 kc repetition rate; at least 20v peak pulse voltage required — Type 1217-A Unit Pulser recommended modulator.

Frequency Modulation at least ±10 Mc excursion obtained with less than 3 db change in output — at 60 c an rms input of the order of 10v is suitable.

Output Connector: 50Ω Type 874 Coaxial Connector.

Power Supply:

Type 1201-A Unit Regulated Power Supply, $80.00, recommended for high stability and minimum incidental fm.

Type 1203-A Unit Power Supply, $40, for less critical applications where cost is an important factor.

Type 1202-A Unit Vibrator Power Supply, $125.00, for use in the field from 6v or 12v, d-c power.

Accessories Recommended: Type 874-G10 10-db Pad and Type 874-G20 20-db Pad — Type 874-Q series of Adaptors for connection to circuits fitted with military-type connectors.

We Sell Direct. Prices shown are net, f.o.b. Cambridge or West Concord, Mass.

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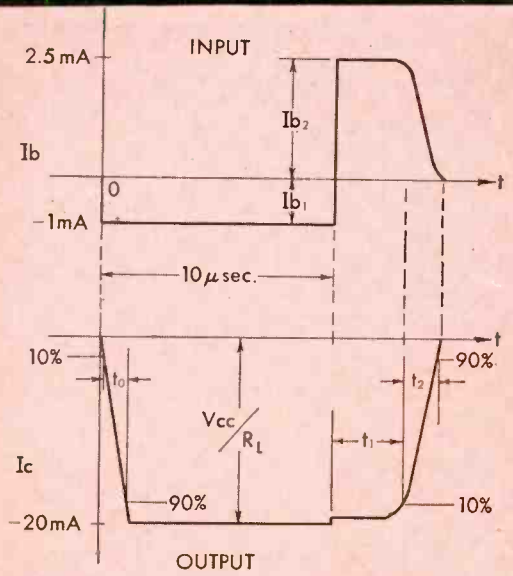
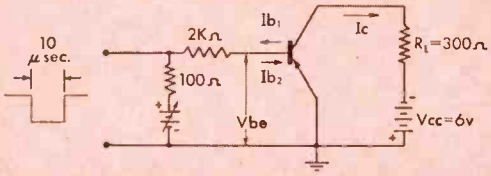


2N113 COMMON-EMITTER SWITCHING CIRCUIT



TEST CIRCUIT FOR FIGURES 1 and 2

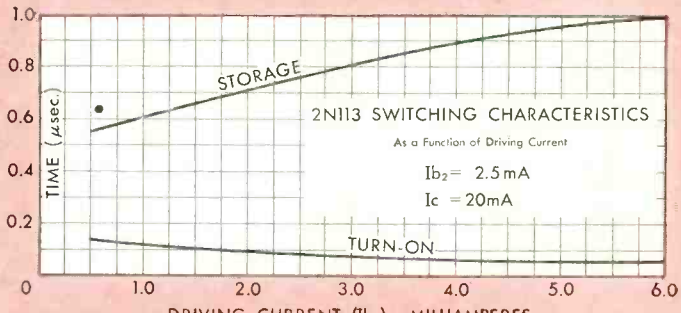


Fig. 1

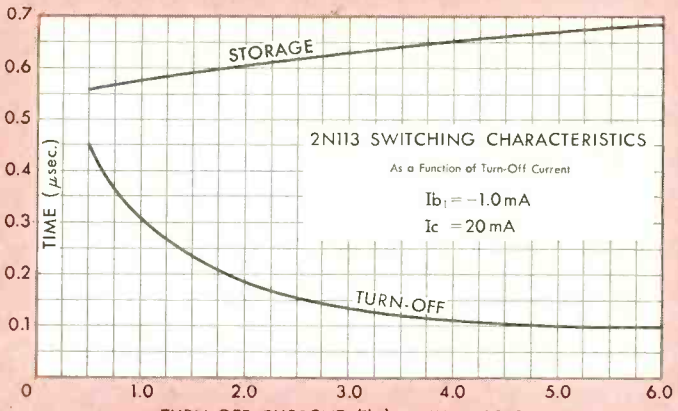


Fig. 2

Look at these typical switching characteristics

	Characteristic	Condition	Raytheon 2N113 Transistor	Raytheon 2N114 Transistor
Switch "On"	saturation impedance	Ic = −20mA	7 ohms	7 ohms
Switch "Off"	reverse impedance	Vcc = −6v, Vbe = +1.5v	15 megohms	15 megohms
Control Power	peak power gain	VccIc/VbeIb1	30db	32db
Load	switchable power (peak)		1 watt	1 watt
Switching speeds	t_0 — rise time, Gnd. Emitter t_1 — storage time, Gnd. Emitter t_2 — decay time, Gnd. Emitter	Ic = −20mA Ib1 = 1mA Ic = −20mA Ib1 = 1mA Ic = −20mA Ib1 = 1mA	0.1 μsec. 0.6 μsec. 0.15 μsec.	0.05 μsec. 0.7 μsec. 0.1 μsec.

Raytheon 2N113 and 2N114 Transistors give you an electronic switch with these outstanding advantages:

- **low impedance when "on"**
- **high impedance when "off"**
- **small control power input with high power gain**
- **rapid switching time**

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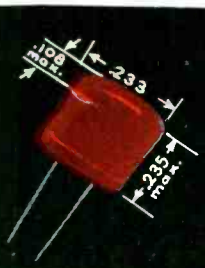


RAYTHEON BONDED SILICON DIODES

RAYTHEON Type	Peak Inv. Voltage 25°C	Forward Current at +1.0 V (min.) 25°C	Reverse Current at −10 V (max.) 25°C	Reverse Current at specified voltage (max.) 25°C	Rectified Current (max.) 100°C	Rectified Current (max.) 150°C
1N300	15 V	8 mA	.001 μA	.001 μA at 10 V	23 mA	12 mA
1N300A	15	30	.001	.001 10	50	25
1N432	40	10	.005	.005 10	30	15
1N432A	40	20	.005	.005 10	48	22
1N301	70	5	.01	.05 50	23	12
1N301A	70	18	.01	.05 50	40	20
1N450	90	5	.01	.1 75	23	12
1N460A	90	15	.01	.1 75	40	18
1N303	125	3	.01	.1 100	23	10
1N303A	125	12	.01	.1 100	35	16
1N433	145	3	.01	.1 125	23	10
1N433A	145	10	.01	.1 125	30	16
1N434	180	2	.01	.1 150	20	10
1N434A	180	7	.01	.1 150	25	13
1N302	225	1	.01	.2 200	15	8
1N302A	225	5	.01	.2 200	23	12

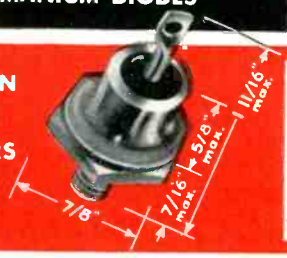
RAYTHEON BONDED SILICON REFERENCE DIODES

Type	Zener Voltage	Zener Impedance (max.) at 0.5 mA	Zener Impedance (max.) at 5.0 mA	Zener Temp. Coeff. %/°C
1N436	3 to 5 V	100 ohms	10 ohms	0.03 max.
1N437	5 to 7	100	10	0.05
1N438	7 to 9	100	10	0.08
1N439	9 to 11	100	10	0.08

RAYTHEON GOLD BONDED GERMANIUM DIODES

Type	Peak Inverse Volts (max.)	Average Rectified mA (max.)	Peak Rectified mA (max.)	Maximum Inverse Currents in μA at −10v	at −50v	at −100v	Forward mA at 0.8v	at 1.0v	Ambient Temperature Range °C
1N305	60	125	300	2.0	20		100		−55 to +100
1N306	15	150	300	2.0			100		−55 to +100
1N307	125	50	300	5.0		20		100	−55 to +100

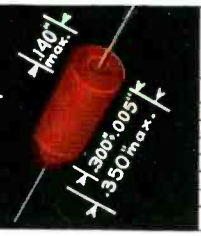
RAYTHEON POWER RECTIFIERS



Diode	25°C Max. Rating Vf @ 5a If volts	PIV volts	RMS volts at PIV volts	−Ir at PIV ma	Max. Ratings for all four types (CK774, CK775, CK775-1, CK776) Amb. Temp. °C	Therm. Res. °C/watt	Al. Fwd. Power Dis. watts	Case Temp. °C	I avg. amps	I pk amps
CK774	1.5	25	17.5	25	25	23 *	6.0	163	3.3	9.9
CK775	1.5	60	42.5	25	25	5.5 **	14.5	105	5.9	17.7
CK775-1	1.5	125	88.5	25	75	23	4.0	167	2.5	7.5
CK776	1.5	200	141.5	25	75	5.5	11.5	138	5.1	15.3

* Approx. equivalent to sea level convection cooling without a radiator. ** Approx. equivalent to sea level convection cooling with a 3 x 3 x 1/16 inch copper fin.

RAYTHEON POINT CONTACT GERMANIUM DIODES



Type General Purpose	Peak Inverse Volts	Average Rectified mA (max.)	Peak Rectified mA (max.)	Maximum Inverse Currents in μA at −5v	at −10v	at −50v	at −100v	Forward mA at +1v
1N66	60	50	150		50	800		5.
1N67	80	35	100	5		50		4.
1N68	100	35	100				625	3.
1N294	60	50	150		10	800		5.
1N297	80	35	100	10		100		3.5
1N298	70	50	150		250μA (max.) at −40v.		(50°C)	30mA (min.) at +2v.
VHF and UHF								
1N295	40	35	125		200	Video detector		

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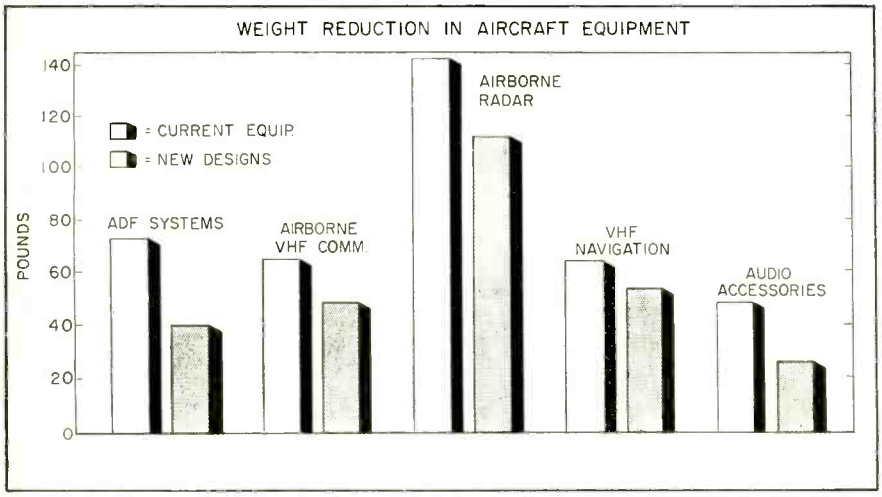


Aircraft Electronics In Squeeze

Manufacturers reducing size and weight of equipment as airborne use increases

PROGRESS made by aircraft electronic manufacturers in reducing size and weight of equipment is indicated by weight reductions accomplished by Bendix Radio in recent months.

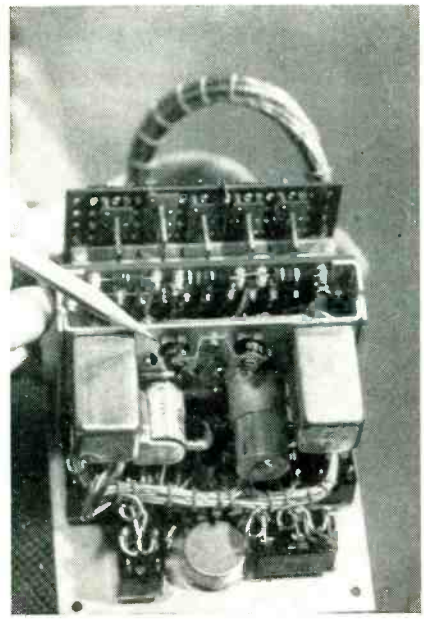
The total weight of a typical installation comprised of a dual adf system, a single airborne weather radar system, dual vhf communications, dual vhf navigation with single marker and an audio system with interphone system, cockpit speakers, p-a amplifier and selective calling, has been about 583 pounds. With new designs, its weight is cut to 420 pounds for a saving of 163 pounds.

► **Items** — Bendix made largest weight savings in the radar synchronizer-power supply. It was reduced 27 pounds, from 48 pounds to 21 pounds, by combining power supplies and using silicon rectifiers instead of selenium. The weight of the interphone amplifier was reduced from 20 pounds to 2 pounds.

It was done by using transistors instead of vacuum tubes. The vhf transmitter was reduced by 15.5 pounds through changes in layout and by using new components and lighter materials.

► **Space** — According to Bendix, along with the saving of 163 pounds in the typical aircraft installation, a total rack space saving of 4¼ ATR results from new designs. A saving of 1½ ATR is made in the dual adf system, ½ ATR in the radar system, 1 ATR in the dual vhf communications, ¾ ATR in the dual vhf navigation and ½ ATR in the audio system.

Space savings made in specific equipment include ½ ATR in the adf systems receiver, ½ ATR in the synchronizer power supply of the airborne radar and ½ ATR in the airborne vhf communication transmitter.



Bendix transistorized audio control panel for installation in aircraft

Manufacturers Add Over Ten Million Sq Ft

Military electronics plants and research laboratories lead in expansions

MAJOR manufacturers in the electronics industry announced plant and facility expansion plans exceeding 10 million sq ft during 1955. The building projects involved over 115 companies in the field and will cost over $140 million.

► **Area**—Plant plans for military electronics exceeded that of all other types. Over 1.7 million sq ft of space were added by major companies in the field. Western Electric's planned expansion of over 700,000 sq ft topped the list. Westinghouse followed with a 350,000 sq ft building plan.

Research, development and engineering laboratory expansions were second. Over 1.2 milion sq ft of lab space was built or planned. Raytheon, with over 375,000 sq ft of space, led the roster.

► **Parts** — Component manufacturers' expansion plans totaled over 1 million sq ft of space, much of it for capacitors and much of it located in the South. Biggest individual plant expansion was that of General Instrument for its 106,000 sq ft plant in Georgia.

Computer manufacturers were active in factory build-up with over 600,000 sq ft planned. Remington Rand led the list with an announced expansion plan of 200,000 sq ft.

► **Tubes**—While picture tube manufacturers were among the top plant expanders in 1954, expansion was only about 500,000 sq ft in 1955, much of it additional warehouse space. Microwave tube makers added over 150,000 sq ft of space. Three transistor plant expansions during the year added an estimated 200,000 sq ft.

Among the other major plant expansions during 1955 were electronics controls, instruments and aircraft electronics.

(Continued on page 22)

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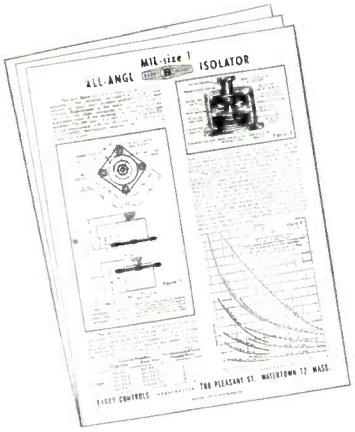

you load-deflection curves, transmissibility curves, and load-versus-natural-frequency curves that show how these isolators perform under various loads and vibration inputs and for different directions of applied acceleration. They explain how these curves can be used to evaluate isolator performance. And they contain detailed drawings that show all necessary dimensions and clearances.

Because of their proved efficacy in protecting delicate electronic apparatus through every flight attitude, ALL-ANGL Barry Mounts give the designer valuable aid in cramming the most instrumentation into the least space. They make it practicable to mount equipment on any available surface — upright on a deck or shelf, hung from above, attached to a bulkhead, or at any angle necessary to fit a unit into limited space. Regardless of mounting position, ALL-ANGL Barry Mounts give protection against high-frequency vibration through every operational maneuver of the most modern aircraft.

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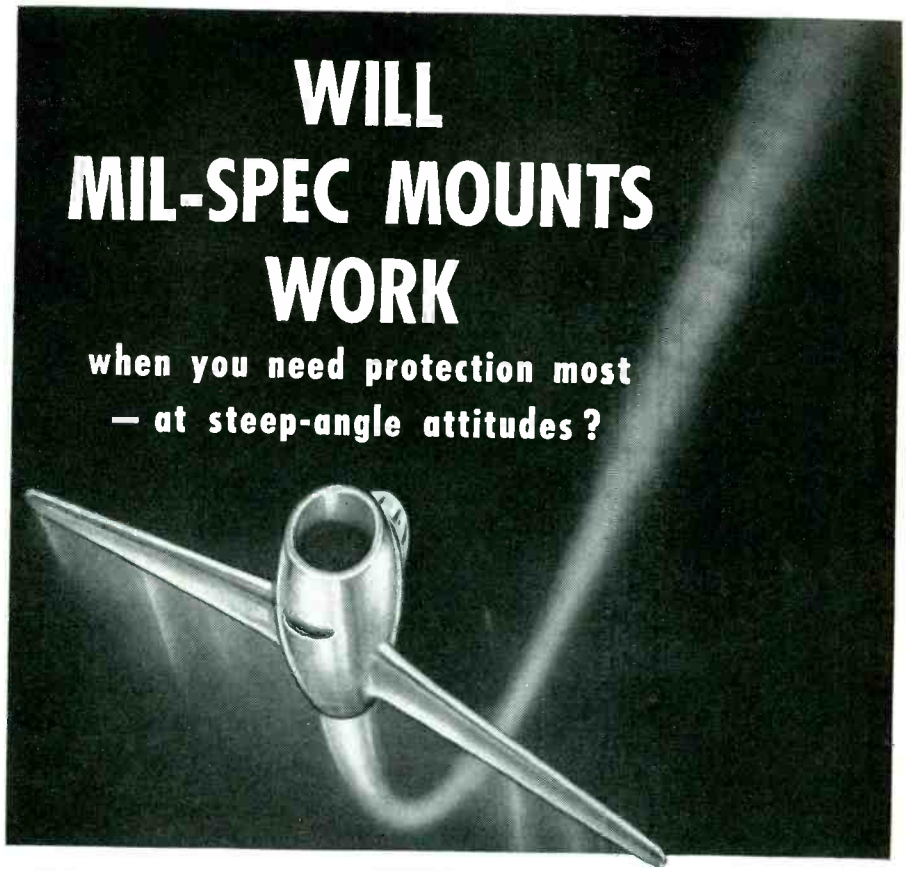

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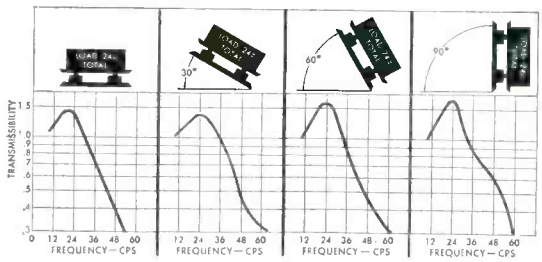

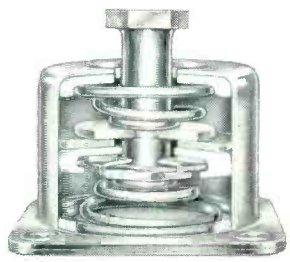

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▶ **Cost Analysis**—Plant expansion costs average about $14 per sq ft with a range of from $4 per sq ft to $25. At that rate, major electronics expansion plans in 1955 exceeded $140 million.

▶ **Where**—Nearly half of the announced plant expansion plans were made in California followed in order by New York, New Jersey, Massachusetts, Illinois and Canada. Ten expansions were in the South.

TRAYSFULL of tantalum capacitors come down the line at P. R. Mallory as . . .

Tantalum Capacitor Sales Increase

Volume goes up as applications increase. Imports of tantalum reach record high

SINCE 1949 when commercial mass production of tantalum capacitors began, the units have been produced in increasingly larger quantities. Today, they are used in almost all types of airborne electronic equipment and in communications gear. Because of small size, they are widely used in transistorized equipment.

There are relatively few manufacturers of tantalum capacitors in the U. S. and only one major processor of tantalum ore for the items. Still, the electronics industry is a major consumer of the metal, accounting for about 50 percent of total consumption. Besides its use in capacitors, the metal is used as anode and grid material in transmitting tubes.

▶ **Growth**—Indicative of increased use of tantalum capacitors the sales volume of Fansteel Metallurgical Corp. is now over 37 times greater than it was five years ago. The company also supplies primary tantalum to other capacitor manufacturers and has experienced a three-fold increase in the shipments since 1949. It considers its program for the gradual fourfold increase in capacitor production facilities conservative in the light of the potential market.

▶ **Product**—A new type of tantalum capacitor has recently been announced, the solid tantalum capacitor. There is no liquid or paste electrolyte used so that problems of mechanical leakage or corrosion are eliminated. A porous sintered tantalum anode with an electrochemically formed tantalum oxide dielectric is used.

▶ **Ore**—Prior to 1954 there were periodic shortages of tantalum ore in the U. S. and almost complete dependence upon imports. However, according to a recent report by the Bureau of Mines, the supply picture has changed from acute scarcity to one of abundant supply.

U. S. mine shipments have increased and indications are that Canadian deposits, if exploited, will further lessen U. S. dependence on overseas imports. At present, however, the U. S. imports 95 percent of its tantalum concentrates.

Principal tantalum producing countries, in order of output, have been Brazil, Australia, Portugal, Union of South Africa, West Germany and Nigeria. In 1954, nearly one million pounds of tantalum concentrates were shipped into the U. S., a new high in import volume. Previous high was 753,000 pounds imported in 1953.

Engineers Tour Russian Electronic Plants

U. S. engineers study mechanized production on two-week tour of plants and laboratories

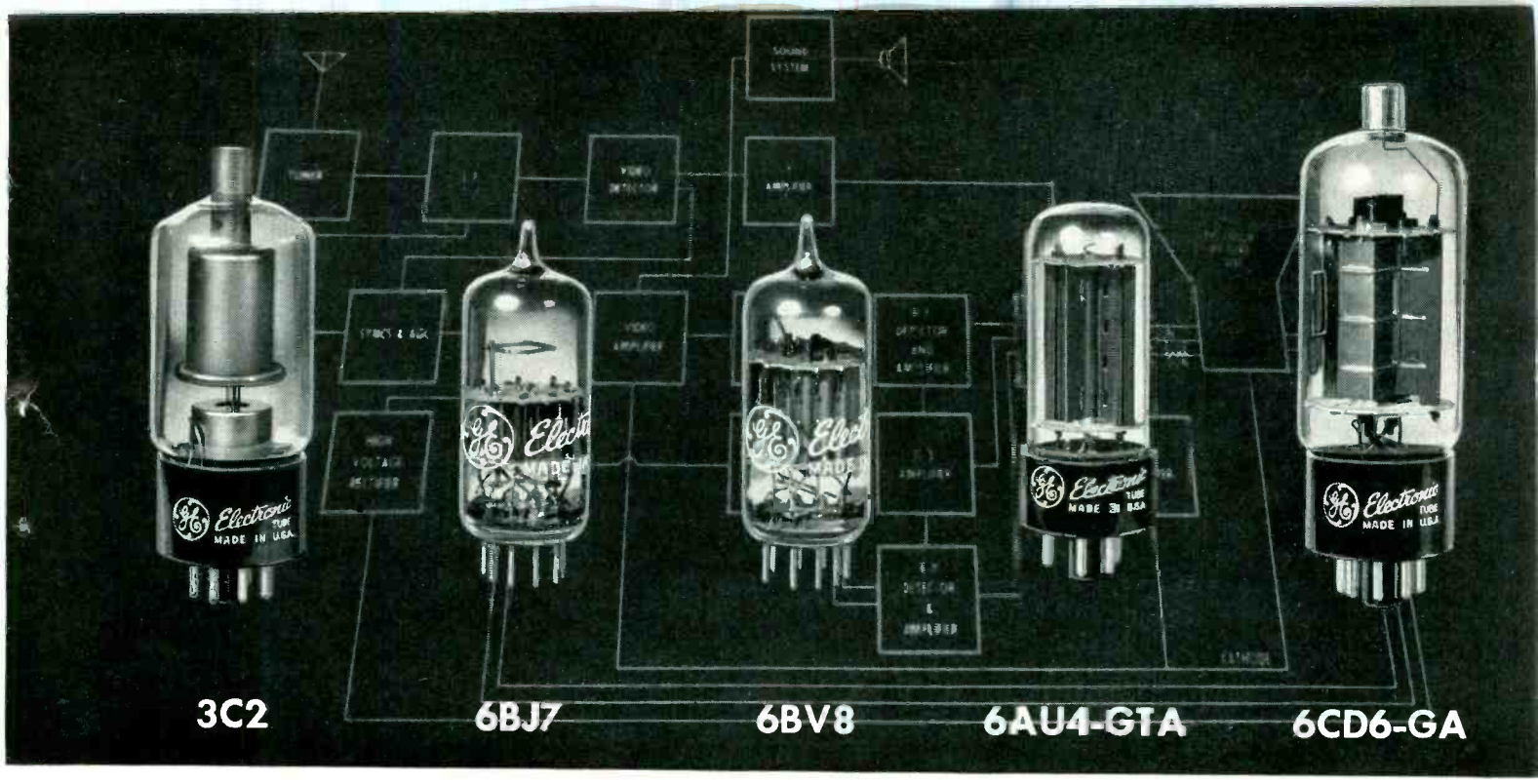
IN RETURN for allowing three Soviet engineers to visit a machine-tool show and a number of manufacturing plants in this country, three U. S. engineers were given the same opportunity in the Soviet Union. The group included W. H. Brandt, engineering manager of the Director Systems Dept. at Westinghouse, whose informal report is abstracted here.

▶ **Computer**—At the Institute of Precision Mechanics and Calculating Technology, a three-address computer for the solution of scientific problems was seen. This used a cathode-ray memory for actual computation, a diode memory for storing problem constants, two forms of magnetic memory, five drums and four tapes. The unit operates 24 hours a day. Test time takes 20 percent and error losses run 8 percent.

▶ **Balancer**—In a machine-tool research institute, the group was shown an automatic balancing machine for electric motor rotors. At the first machine position the rotor is spun, the unbalance is measured and the location and amount of unbalance is stored in a memory device.

The rotor is then moved automatically to the next position, where

(Continued on page 24)



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CONSISTENTLY, General Electric tube designers have worked with TV manufacturers to reduce costs of monochrome sets. Now similar G-E cooperation is extended on color . . . to help bring down receiver prices, so that more users can enjoy this new form of entertainment, with the increase this will bring in color-TV popularity and sales.

Five G-E receiving tubes for color . . . ready and available now . . . contribute to simpler, more economical chassis design. The sum of their cost saving, when translated into retail TV price reduction, is substantial.

All 5 tubes, in addition, are specially engineered for stamina and dependability . . . meaning low-reject TV factory production, and set-ownership with minimum service complaints.

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162-1A2

Saves filament power-supply circuitry!

3C2. High-voltage rectifier for color TV. Center-tapped filament can be used for either series or parallel operation, so permits design and use of most economical high-voltage power-supply circuit. Special mandrel-wound construction minimizes filament pull-out. High inverse voltage rating—33,000 v (d-c and peak). High d-c output current rating—1.1 ma.

Saves by eliminating one tube!

6BJ7. A miniature triple-diode d-c restorer for the three signal channels of TV color receivers. The triple-diode design enables this tube to do the d-c restoration work of two duo-diodes . . . saves the cost of a second tube. Individual cathodes for each diode permit cost-saving circuitry.

Saves over-all circuitry costs!

6BV8. A medium-mu duplex-diode triode for use as synchronous detector and chroma amplifier. Separate cathode and plate for each diode give choice of most economical circuit combinations to cut over-all chassis costs. 6BV8 also is a good high-perveance duplex-diode triode for many monochrome applications . . . saves stocking another tube.

Saves a special transformer winding!

6AU4-GTA. A damping diode for horizontal-deflection circuits. Heater is specially insulated to withstand a high peak voltage of 4,500 v. This saves cost of separate transformer winding. High d-c output current rating—190 ma; low tube drop—25 v at 350 ma. Use for both color and monochrome—keep down tube inventory!

Saves high tube cost; also cuts tube inventory expense!

6CD6-GA. A beam pentode for use as horizontal-deflection amplifier. High positive-pulse plate voltage—7,000 v. Economical in price, also useful for both color and monochrome, with 20 w plate dissipation . . . you stock one tube, not two! Features include high perveance, high pulse current at low plate and screen voltages, and high ratio of plate to screen current.

drills remove the required amount of metal from these locations.

► **Magamp** — At the Institute of Automechanics and Telemechanics, an experimental magnetic amplifier setup used toroidal cores as on-off devices, with relays connected to make audible the results of operations.

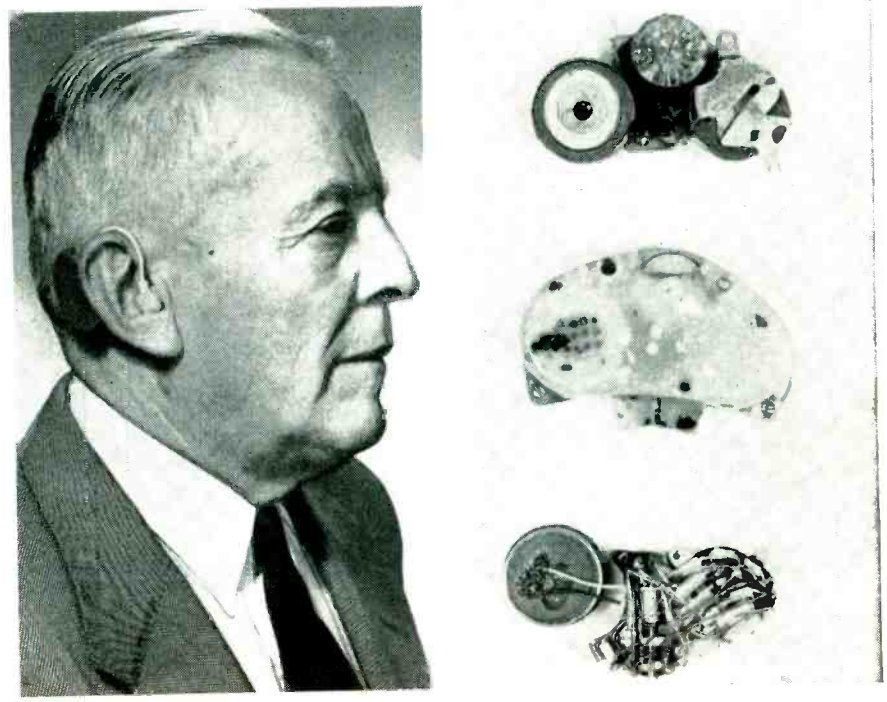
► **Frustration**—At the Kagonoich state ball bearing plant in Moscow, the chief engineer was asked if any difficulty was encountered with soft spots or nonuniformity of steel in the races. He answered that their steel was made to the most careful specifications on chemistry and heat-treating processes. Further questioning brought the same answer. He seemed flustered because a magnetic tape recording of his words was being made.

► **Radio Plant**—At the Krasny Zarya radio factory in Leningrad, production included 12-volt vibrators carrying up to 6 amperes and guaranteed for 750 hours operation, as well as telephone-type relays good for 10,000,000 operations. Salaries for engineers here range between 1,100 and 2,500 rubles per month, with average wages of workers running about 800 rubles per month. (Official exchange rate is 25¢ per ruble, but on comparable purchasing power basis a ruble is 5 to 8¢.)

An automatic checker was used for final inspection of some switchboards. The test set checks connections automatically, stopping and turning on an indicator light if a defect is found.

► **Education**—At Moscow University, about 96 percent of the students are paid stipends, in amounts determined by their grades. Straight A students graduate with a gold medal, and Bs get a silver medal. Stipends range from 290 to 450 rubles per month, with 780 rubles per month for all postgraduate students. A professor makes 5,500 rubles per month and an instructor 1,750 rubles.

► **Market** — The Russians stated that they would be interested in purchasing industrial control equipment if restrictions were lifted.



LATEST approach to problem of impaired hearing is shown as . . .

Hearing Aids Move Up To Head

SUBMINIATURIZATION has inspired the hearing-aid industry to design smaller and lighter units. These hearing aids may overcome mechanical and esthetic deterrents to the use of aids by people with impaired hearing.

► **Market**—It is estimated that 5 million people in the U. S. could benefit by wearing hearing aids. Of these about 1,500,000 wear them.

Prices of hearing aids range from $49.50 to $485 depending on whether the aid is an electron-tube type, transistorized and/or binaural.

► **Latest**—A self-contained hearing aid which is placed in and behind the wearer's ear has been marketed by Sonotone of Elmsford, N. Y. The aid uses four *pnp* transistors and subminiature parts. It is assembled on a laminated fiber chassis.

Frequency response is 400-3,500 cps with a maximum acoustic gain of 47 db.

Power is supplied by a 1.3-v mercury cell whose life expectancy is in excess of 100 hours. The cost of operating the hearing aid is approximately $1.20 a month.

► **Eyeglasses**—Hearing aids built into spectacle frames are available. One model by Otarion of Dobbs Ferry, N. Y., provides one microphone at each temple feeding a single amplifier. This unit sells for $284 to $296. The manufacturer expects to produce 20,000 to 25,000 units in 1956.

Beltone Hearing Aid Co., Chicago, Ill. is making binaural hearing glasses. Each temple is a complete hearing aid. The glasses sell for $285 as a monaural aid and $485 as a binaural aid.

R-F Lamp Brightens Filming Future

Light source has high output for motion picture, color tv and computer uses

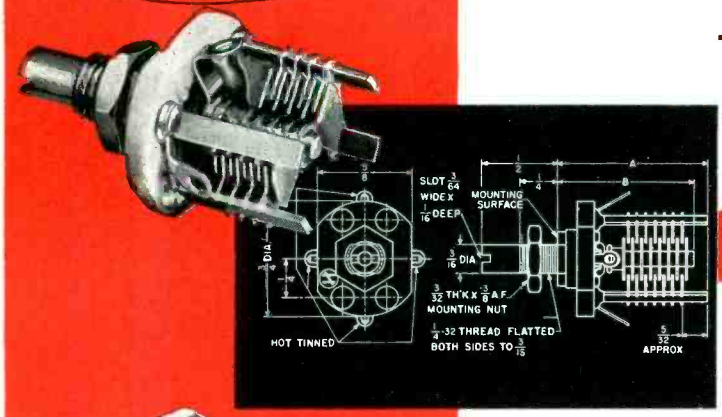
DESIGNED for high-speed contact printing of motion-picture films, a new lamp is powered by induction from an r-f source. Developed by Sylvania Electric Products, Inc., the light source has applications in radar display, computer read-out

(Continued on page 26)

for Miniaturized Variable Capacitors...

naturally its...

HAMMARLUND

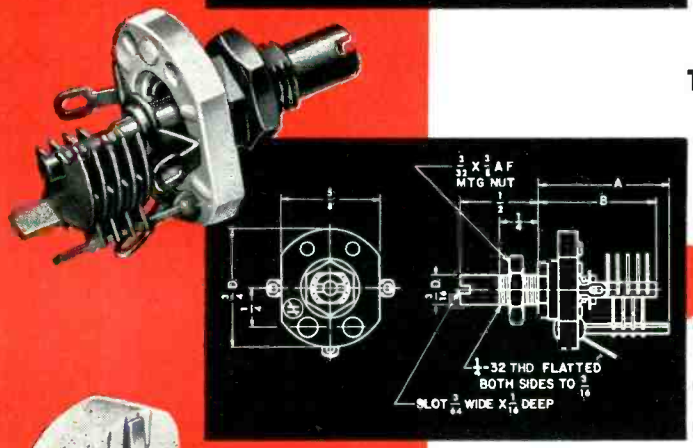


TYPE MACBF

Butterfly design provides extremely low capacity for VHF range. Silicone-treated steatite base. Rotor and stator soldered brass, nickel-plated. Screwdriver or knob adjustment. Air gap 0.017" nominal. Tested at 750 V RMS, 60 cps. Straight line capacity.

CODE	*CAPACITY (mmf.) Max.	Min.	PLATES Per Sect.	DIMENSIONS (in.) A	B
MACBF-3	3.1	1.3	7	45/64	39/64
MACBF-5	5.0	1.6	9	13/16	23/32
MACBF-8	7.9	2.0	15	1	29/32
MACBF-11	10.8	2.4	21	1 11/64	1 5/64

*Nominal value per section.

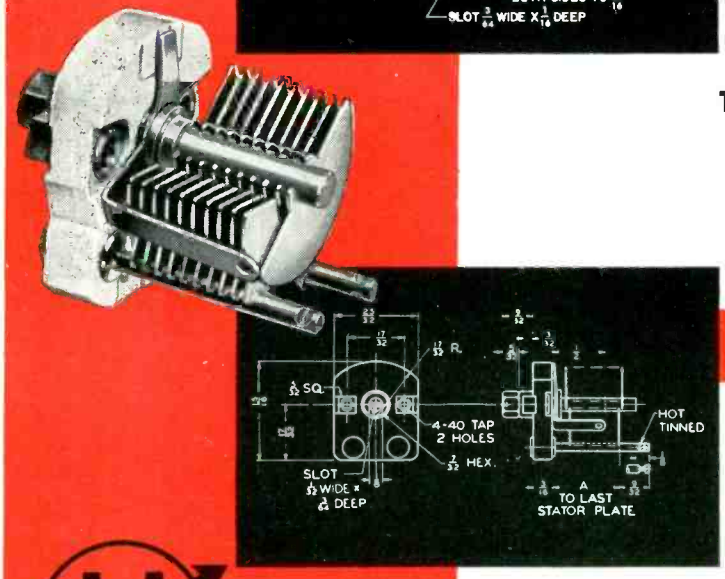


TYPE MAC

Smallest dimensions practical to meet requirements of trimmer in VHF range. Silicone-treated steatite base. Rotor and stator soldered brass, nickel-plated. Screwdriver or knob adjustment. Air gap 0.017" nominal. Tested at 750 V RMS, 60 cps. Straight line capacity.

CODE	*CAPACITY (mmf.) Max.	Min.	PLATES Per Sect.	DIMENSIONS (in.) A	B
MAC-5	5.4	1.3	5	45/64	39/64
MAC-10	9.6	1.5	9	13/16	23/32
MAC-15	15.8	1.9	15	1	29/32
MAC-20	21.5	2.2	21	1 11/64	1 5/64

*Nominal value.



TYPE MAPC

Low minimum capacities and low inductance. Ideal for VHF use. Rotor and stator soldered brass, nickel-plated. Nickel-plated beryllium copper wiper. Silicone-treated steatite base. Screwdriver or hex wrench adjustment. Tapped brass mounting studs permit mounting without grounding rotor. Air gap 0.0135" nominal. Tested at 600 V RMS, 60 cps. Straight line capacity.

CODE	*CAPACITY (mmf.) Max.	Min.	PLATES Per Sect.	DIMENSIONS (in.) A
MAPC-15	15.0	2.3	6	17/64
MAPC-25	25.0	2.6	10	3/8
MAPC-35	35.0	2.9	14	15/32
MAPC-50	50.0	3.2	19	37/64
MAPC-75	75.0	3.9	29	53/64
MAPC-100	100.0	4.5	38	1 5/64

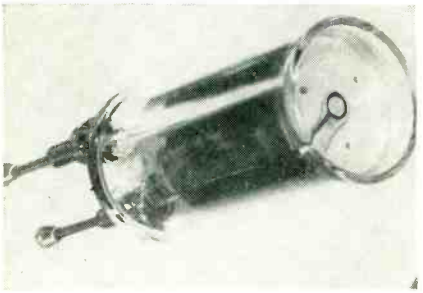
*Nominal value.

For more information on the Hammarlund line of standard and special variable capacitors, write for Bulletin E 356.

THE HAMMARLUND MANUFACTURING COMPANY, INC.
460 West 34th Street, New York 1, N. Y.
International Division: 13 East 40th Street, New York 16, N. Y.

Established 1910

Want more information? Use post card on last page.



R-F lamp with cooling coil removed to show construction. Light source is 5/16 in. disk at center

systems and in color-tube processing.

A coil carrying 800 watts of 3-mc r-f power is used to heat a tantalum-carbide disk to temperatures at which wire filaments would vaporize. Use of a disk light source provides a uniform area of light.

▶**Applications** — In addition to printing motion-picture films, the r-f lamp has been applied in printing dot patterns on color tv picture tubes where high output in the blue region of the spectrum is required. Exposure factor was improved by 2 over that of mercury vapor lamps.

In computer readouts where numerical data is filmed from the face of a special-type cathode-ray tube, the brightness of the display is dependent on the amount of light falling on the photocathode of the tube. Use of the r-f lamp as a light source has increased readout speed by 3.5.

FUTURE MEETINGS

MARCH 2-3: Third Cleveland Electronics Conference, Western Reserve University, Cleveland, Ohio.
MARCH 6-7: Conference on Radio Interference Reduction, Armour Research Foundation, Chicago, Ill.
MARCH 15-16: AIEE Fifth Annual Spring Conf., Cleveland, Ohio.
MARCH 19-22: IRE National Convention, Waldorf-Astoria Hotel, Kingsbridge Armory, New York, N. Y.
MARCH 23-24: 1956 Career and Job Show, 71st Regiment Armory, New York, N. Y.
APRIL 2-4: Harvard University, Air Force Cambridge Research Center, IRE Symposium on Microwave Properties and Applications of Ferrites, Harvard University, Cambridge, Mass.
APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.
APRIL 9-22: International Exhibition on Instrumentation-Automation, Oslo, Norway.
APRIL 10-12: Twelfth Annual Meeting and Metal Powder Show, Hotel Cleveland, Cleveland, Ohio.
APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.
APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.
APRIL 16-18-19: NARTB Tenth Annual Broadcast Engineering Conference, Conrad Hilton Hotel, Chicago, Ill.
APRIL 19-20: Second Annual Meeting, Environmental Equipment Institute, Sheraton Hotel, Chicago, Ill.
APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston, Mass.
APRIL 23-25: International Conference on Electron Physics, NBS, College Park, Md.
APRIL 25-27: Symposium On Nonlinear Circuit Analysis, II, Polytechnic Institute of Brooklyn, New York, N. Y.
APRIL 26-27: Conference On Recording and Controlling Instruments, AIEE, ASME, ISA, Bradford Hotel, Boston, Mass.
APRIL 29-MAY 3: Fourth Annual Semiconductor Symposium, Electrochemical Society, Mark Hopkins Hotel, San Francisco, Calif.
APRIL 29-MAY 8: Hannover Germany Industries Fair, Hannover, Ger.
APRIL 30-MAY 3: URSI Spring Meeting, NBS, Wash., D. C.
MAY 1-3: The 1956 Electronic Components Symposium, U. S. Department of Interior Auditorium, Washington, D. C.
MAY 14-16: National Aeronautical & Navigational Conference, PGANE, Biltmore Hotel, Dayton, Ohio.
MAY 14-17: The Design Engineering Show and Conference, Philadelphia, Pa.
MAY 21-24: Electronics Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.
MAY 22-23: RETMA Symposium on Reliable Applications of Electron Tubes, Irvine Auditorium, University of Penna., Philadelphia, Pa.

New Activity Seen in Citizens Radio

ANOTHER entry in the Citizens Radio Service is a transceiver that sells for $59.75. Demand for the units has led the manufacturer, Vocaline Co., to hope to double present production of 1,000 units a month within two or three months.

▶**Technical Details** — The transceivers measure 9 by 6 by 5 in. and weigh 4 lb. They operate at 465 mc and put out ½ watt of amplitude-modulated r-f. (See p. 310)

Three tubes serve both transmitting and receiving functions. The oscillator circuit uses a bimetal element for temperature compensation to keep the operating frequency within class B regulations.

Industry Shorts

▶**British** electronics exports reached nearly $92.4 million for 1955, about 12.8 percent or $7.7 million higher than volume in 1954.

▶**Laboratory** version of a system for recording and reproducing tv pictures on magnetic tape, has been constructed by Ampex Corp.

▶**Sales** of picture tubes to Mexico totaled about 60,000 in 1955. Volume is seen rising to 80,000 in 1956 and 100,000 in 1957, according to Sylvania.

▶**Work** on integrated Alaskan communications study at Middleton Island in the Gulf of Alaska, called White Alice, which provides circuits in support of the Alaska Air Defense System, is scheduled for completion in July. TACAN will also be installed on the island for the Air Force.

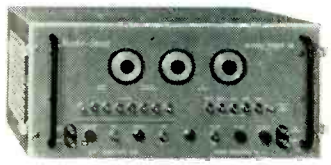
▶**Hotpoint Co.** will introduce a full line of monochrome tv sets in July, 1956, made initially by GE. Color sets will be produced when the product becomes more stabilized.

▶**Helicopter** equipped with Pye industrial tv demonstrated how system could aid police to study traffic or carry out searches.

▶**Anti-trust** settlement with IBM opens business data processing to small companies. Market will grow for auxiliary equipment for big IBM units.

New KAY Instruments

Precision Electronic Test Equipment for Laboratory or Production Line



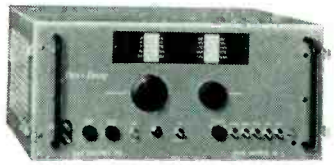
Marka-Sweep

Model Video 50 All-Electronic Sweeping Oscillator with Marks

A 50 mc wide video sweep which includes the low end of the video spectrum and provides a continuously variable IF frequency sweep.

SPECIFICATIONS

Range: 50 kc to 50 mc, continuously variable. **RF Output:** 1.0 v peak to peak into 75 ohms, flat within ±0.5 db over widest sweep. **Sweep width:** Linear sweep continuously variable 4 mc to 50 mc. **Sweep rate:** Variable around 60 cps, locks to line frequency. **Attenuators:** Individually switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db. **Markers:** Both internal and external crystal controlled pulse type markers, individually selected at 10, 20, 30, 40 and 50 mc. Substitutions above 10 mc on order. **Price:** $695. F.O.B. Plant.



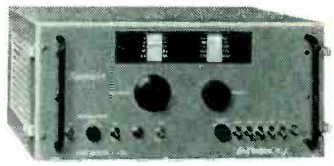
Vari-Sweep

All-Electronic Broad Band Sweeping Oscillator

Designed for continuous coverage from 2 to 220 mc with sweep width to 30 mc plus, and with high output automatically held constant over both frequency sweep and tuning range.

SPECIFICATIONS

Range: Fundamental frequency 2 to 220 mc, continuously variable in ten switched overlapping bands. Direct reading frequency dial calibrated to ±2%. **RF Output:** 1.0 v rms into 75 ohms, metered. Flat within ±0.5 db over widest sweep and over frequency band. **Sweep width:** Continuously variable ±2% to ±30% of center frequency to maximum of at least 30 mc. **Sweep rate:** Continuously variable 10 to 60 cps, locks at line frequency. **Attenuator:** Switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db. **Price:** $695. F.O.B. Plant.



Signalator

High Level Constant Output Signal Generator

Designed for continuous CW operation from 1 to 230 mc with high output—2.0 v—automatically held constant over the tuning range.

SPECIFICATIONS

Range: Fundamental frequency 1 to 230 mc in ten switched overlapping bands. Direct reading frequency dial calibrated to ±1%. **RF Output:** 2.0 v rms into 75 ohms, metered. Output over band constant within ±0.5 db. **Modulation:** 400 cps. **Attenuator:** Switched 20, 20, 10, 6 and 3 db plus. Continuously variable 6 db. **Price:** $595. F.O.B. Plant.

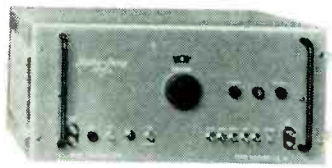
Trans-Pix

Model 2 and Model 25 Low Power RF Color TV Picture Transmitter for Use With Antenna or Cable

Covers low frequency TV channels; fulfills color requirements of differential phase shift and envelope delay. May be used for B & W and Color TV.

SPECIFICATIONS

Picture Carrier: 25 watt peak power into 50 ohms. **Video Response:** 4.5 mc ±1 db. **Video Modulation:** Linear to 87.5% of zero carrier. **Differential Phase Shift:** Approximately ±3 degrees at the color carrier. **Phase Delay:** Compensated to within ±.01 microsecond. **Audio:** ±25 kc. for 100% modulation. ±40 kc. maximum. **Audio Frequency Response:** 50 cycles to 15 kc. **Carrier Separation:** 4.5 mc. ±1000 cycles. **Filter:** Single side band. **Output:** 2 outputs, each at ½ power into 50 ohm antennas. A single 50 ohm dummy load for ½ power single antenna operation is provided. **Price:** $6950. F.O.B. Plant. **Trans-Pix Model 2:** RF specifications as above. **Power Output:** 2 watts. **Price:** $2500. F.O.B. Plant.



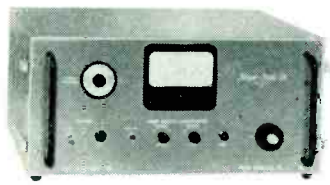
RF-P *Marka-Sweep*

All-Electronic Sweeping Oscillator With Marks

New design provides high level—1.0 v—output automatically held constant over both frequency sweep and frequency range.

SPECIFICATIONS

Frequency Range: All 12 VHF TV channels plus IF channel centered at 43.5 mc. **RF Output:** 1.0 v rms into 75 ohms. Flat within ±0.3 db over sweep width; constant within ±0.5 db between bands. **Sweep Width:** At least 15 mc wide on all bands. **Sweep Rate:** Variable around 60 cps, locks to line frequency. **Attenuators:** Switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db. **Markers:** Crystal controlled picture and sound carrier, markers on each channel. Both internal and external pulse type markers provided. **Price:** $695. F.O.B. Plant.



Mega-Node, Sr.

Random Noise Source Providing Output From 10 to 3,000 MC

New design includes: regulated DC filament to completely eliminate modulation; regulated power supply to extend noise diode tube life; and extension of low frequency to 10 mc.

SPECIFICATIONS

Range: 10 mc to 3,000 mc. **Output impedance:** 50 ohms unbalanced into type N connector. **Noise Figure Range:** 0 to 20 db. **Filament Voltage:** Regulated DC supply. **Meter Calibration:** Linear in db noise figure; logarithmic in direct current. **Power Supply:** Completely regulated **Price:** $790. F.O.B. Plant.

Write for new Kay Catalog

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KAY ELECTRIC CO.

Dept. E-3 **14 Maple Avenue. Pine Brook, N. J.**

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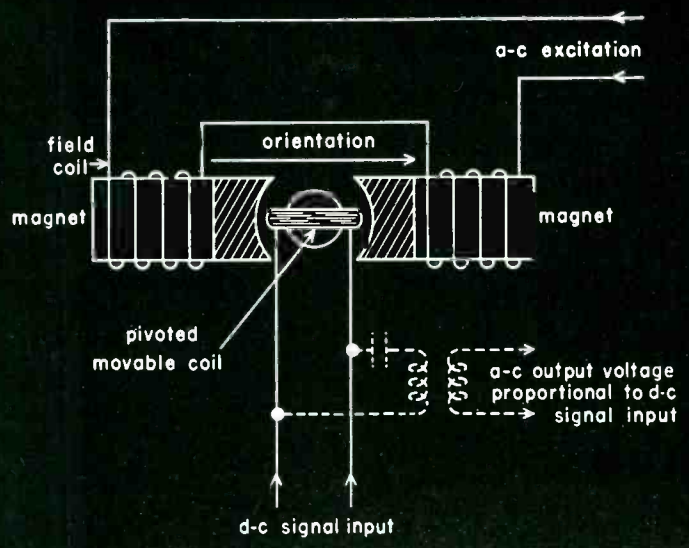
New Principle

OF D-C, A-C CONVERSION

(Actual size)



INSTRUMENTS *by* WESTON

NEW WESTON INDUCTION MODULATOR

- has no contacts
- provides conversion gain
- output wave form sinusoidal

In contrast to conventional transducers, the compact light-weight Induction Modulator is of hermetically sealed-in construction, making it impervious to moisture, dust and other exposures . . . is never subject to contact troubles . . . presents a constant resistance to the d-c signal input, and is unaffected by pick-up from stray fields. Further it is extremely rugged, sufficient to assure trouble-free service in airborne devices and other electronic equipment.
For complete information write,
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
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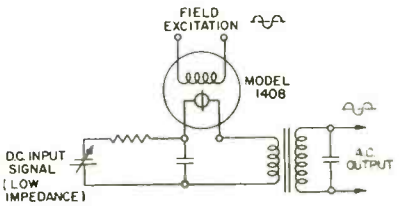
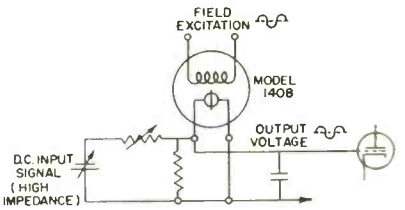
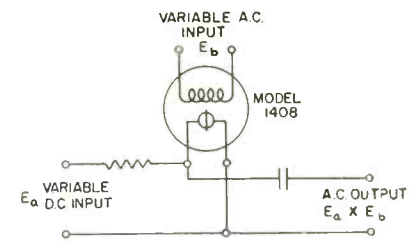
TYPICAL CIRCUITS







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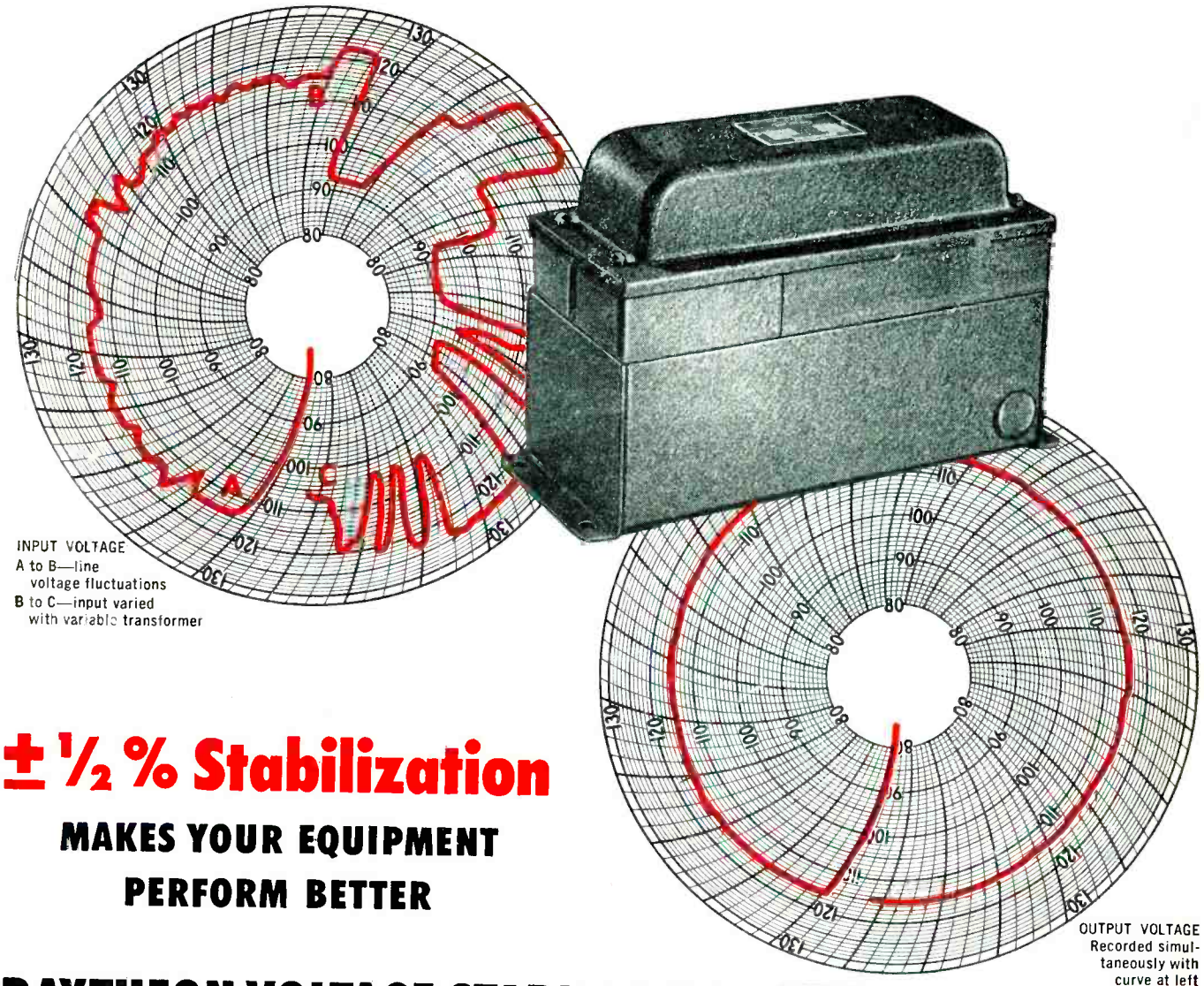

±½% Stabilization

MAKES YOUR EQUIPMENT PERFORM BETTER

RAYTHEON VOLTAGE STABILIZERS

These curves demonstrate one simple fact—that if the satisfactory operation of your equipment depends on a well regulated power supply, Raytheon voltage stabilizers are your assurance of top performance under virtually all conditions.

How these curves were made

These curves were traced simultaneously by identical recording voltmeters. The left hand chart indicates input voltage, and the other, output of a standard Model VR-6110 Raytheon voltage stabilizer. Region AB results from actual line variations caused by motor-driven machines. The wider fluctuations, BC, are produced by a variable transformer in the stabilizer input.

26 Models

Raytheon voltage stabilizers are available in a wide variety of input and output voltages from 15 to 2000 watts and, where needed, harmonic filtered models for 250, 500 and 1000 watts.

CHECK THESE IMPORTANT FEATURES

- Guaranteed stabilization to ±½%
- Stabilized voltage increases tube life as much as 50%
- Close regulation with temperature and frequency changes
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- Compact, rugged, dependable, low-cost

For full information see your electronic supply house or write Dept. 6120—please request bulletin 4-260.

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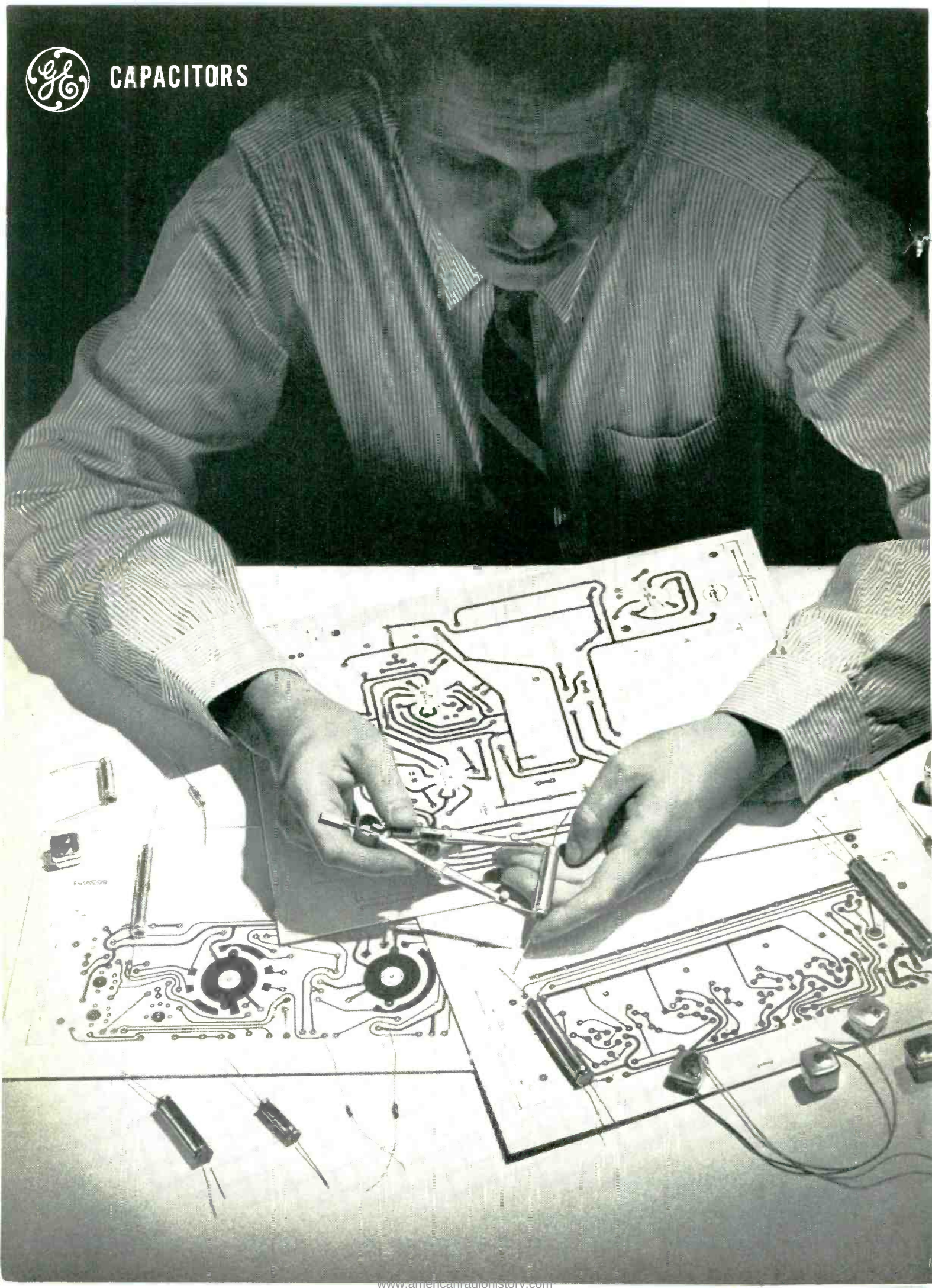


How G-E Tantalytic* Capacitors help solve your critical design problems

Three separate lines of G-E tantalum electrolytic capacitors to meet your size and temperature needs

No matter what capacitor problems you face in your most critical electronic applications, you're almost sure to find an answer in the three proven lines of Tantalytic capacitors now offered by General Electric.

Is size your problem? G-E Tantalytic capacitors carry extremely high uf ratings per cubic centimeter, especially in the 0–150 VDC range. In some ratings, Tantalytic capacitors are actually less than 1% the size of comparably rated paper capacitors.

Is high reliability your problem? Where small size and high reliability are "musts," as they are in communications equipment for example, G-E Tantalytic capacitors meet the challenge. Their high quality assures long, more reliable operation —at a real saving in circuit space.

Is high temperature your problem? For extremely high ambient temperatures, as found in high-speed aircraft and guided missile applications, you can count on G-E high-temperature Tantalytic capacitors. They operate at full rated voltage from −55C to +125C. Rectangular and tubular designs are available to meet the varying requirements of modern electronic design.

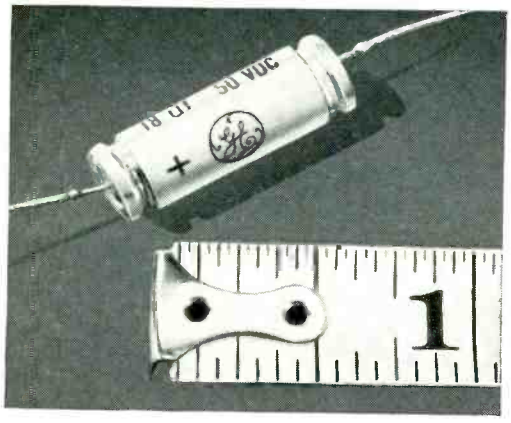
General Electric engineers have accumulated a wealth of life test and other data through a long period of testing tantalum capacitors under every conceivable condition of operation. As a result, G-E Tantalytic capacitors may be relied upon for mechanical and electrical stability and maximum efficiency in operation.

Let your G-E Apparatus Sales Representative show you how these capacitors can answer your particular problems. Or, if you would like further information (ratings and specifications) on G-E Tantalytic capacitors write directly to the General Electric Company, Section 442–30, Schenectady 5, N. Y.

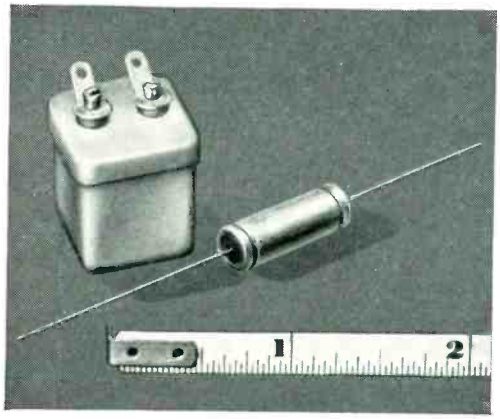
*Reg. trade-mark of General Electric Co.

Progress Is Our Most Important Product

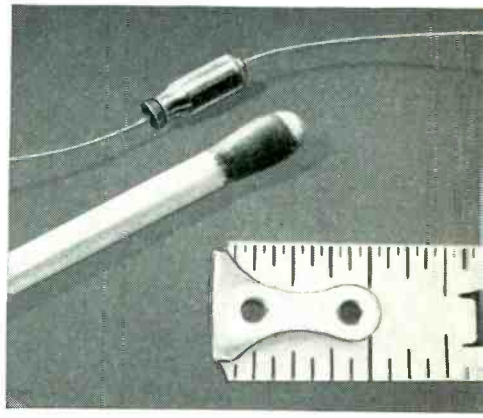
GENERAL ELECTRIC



85 C TANTALYTIC CAPACITORS for circuits requiring low leakage current, long shelf life. Available in polar or non-polar types for a-c and d-c. Ratings 0.25–580 uf, 3.75–150 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +85 C. Write for Bulletins GEC-808 and GET-2333.



125 C TANTALYTIC CAPACITORS for high-speed aircraft and guided missile electronic systems where quality, long life, small size are main requirements. Available in plain or etched foil, in rectangular or tubular designs. Ratings 0.25–180 uf, 10–100 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +125 C. Write for Bulletins GEA-6258, GET-2502, and GET-2513.



MICRO-MINIATURE TANTALYTIC capacitors for low-voltage d-c, transistorized electronic equipment such as hearing aids, pocket radios. Ratings 1–8 uf at 4 VDC, 1 uf at 8 VDC, 0.5 uf at 16 VDC. Tolerance −0 to +200%. Temperature range −20 to +50 C. Bulletins GEA-6065 and GET-2405.

COLORED SILICONE THAT LASTS— BH "1151" SLEEVING

BLUE • RED • GREEN
BROWN • YELLOW • NATURAL

When you want the indentification possibilities of color, and need the extra protection of a silicone insulation, your first choice should be BH "1151" Silicone-Fiberglas Sleeving.

For all their beneficial properties, silicone insulations do have an enemy . . . it's COLOR! Unless the coloring pigments used are compatible with the basic silicone sleeving, insulation effectiveness can be lost. But . . . you can use BH "1151" with complete confidence of product protection. A superior Class "H" insulation, it loses none of its strength, or resistive properties, through the incorporation of color.

Take your choice of red, yellow, blue, green, brown, or natural (off white). With these five colors, and with the addition of tracer stripes in any of these colors, the identification range becomes a wide one when you use BH "1151" Silicone-Fiberglas Sleeving. Or, you may have special colors made up, provided compatible pigments are available.

And here's another advantage! The minimum order for special colors, or those not in stock, is only 500 feet. Write today for samples and data sheets and make your own tests.

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*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.

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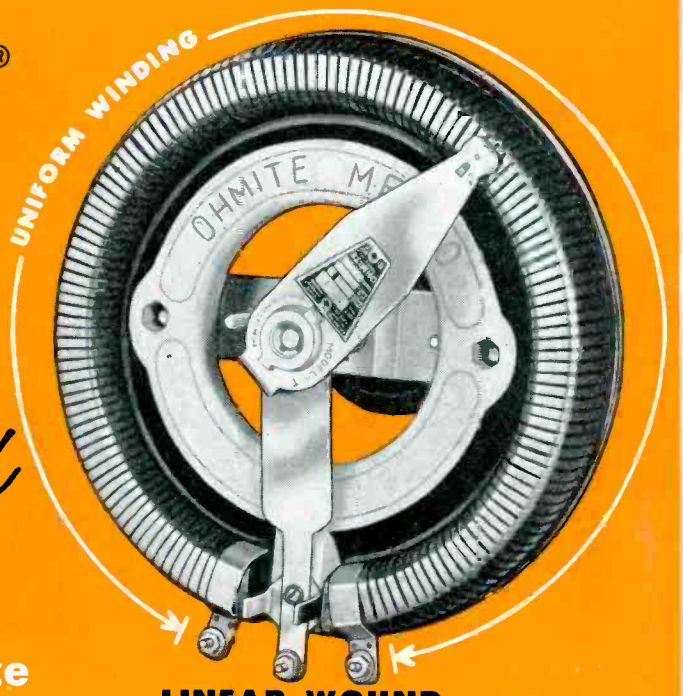
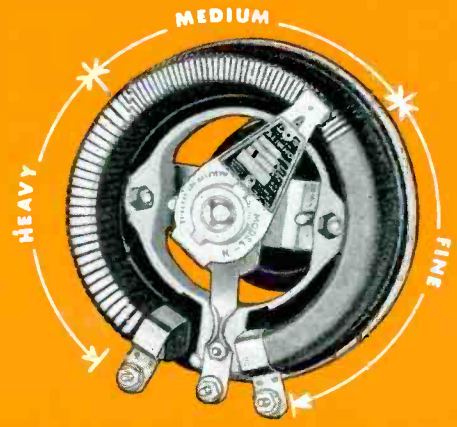
reduce rheostat size required

Tapering the wire size to match the current carried permits greater capacity in a smaller unit!



LINEAR-WOUND



EQUIVALENT TAPER-WOUND

A smaller rheostat may often be used for a given load by having the rheostat windings tapered or wound in two or more sections of diminishing wire sizes. This can be done because only the first turn of the winding carries the maximum current . . . succeeding turns carry reduced amounts. This makes possible great savings in control-panel space, making Ohmite taper-wound rheostats particularly useful in portable equipment. Ohmite taper-wound rheostats are also very durable because they use the largest wire sizes practical for the current to be carried.

MORE UNIFORM CONTROL—For a given application, the tapered winding also provides more uniform control. Because a linear-wound rheostat adds a constant number of ohms per degree of rotation to a constantly increasing number of ohms, the current changes more slowly as the resistance is increased. A tapered winding, by increasing the number of ohms per degree of rotation as the total ohms in circuit increases, makes the current curve more nearly linear.

Ohmite has an extensive line of standard tapered rheostats, or will design special tapered windings to suit individual needs.

Write on company letterhead for Catalog and Engineering Manual No. 40.

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

MORE OHMITE RHEOSTATS SOLD THAN ALL OTHER MAKES COMBINED

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

OHMITE®

has exactly the resistor you need

Ohmite offers the most complete line of wire-wound resistors on the market . . . fixed, adjustable, tapped, non-inductive, and precision resistors in many sizes, types of terminals . . . in a wide range of wattages and resistances.

Industry's most complete line of wire-wound resistors!

The extensive range of Ohmite types and sizes makes possible an almost endless variety of Ohmite resistors to meet each individual need. Ohmite offers resistors in more than 60 sizes—ranging from 2½″ diameter by 20″ long to ¼″ diameter by $\frac{9}{16}$″ long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK. These rugged resistors have proved their quality under the toughest operating conditions. Ohmite application engineers will be pleased to help you in selecting the right resistors for your job.

Write on company letterhead for Catalog and Engineering Manual No. 40.

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

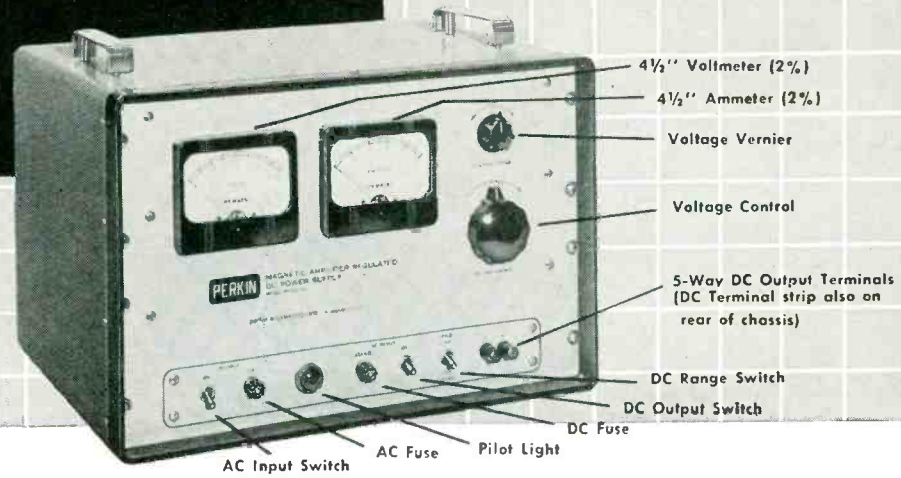
Be Right with **OHMITE®**

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

2 TO 36 VOLTS @ 15 AMPS DC POWER SUPPLY

The NEW PERKIN MODEL MR532-15A with ±½% REGULATION

IMMEDIATE DELIVERY !



Now...for Your Laboratory...the most versatile TUBELESS, Regulated and Filtered Power Supply

For PROMPT REPLY, wire the factory collect or phone our nearest sales office.

New York City:	HUnter 2-7784
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Syracuse:	2-1167
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Minneapolis:	MIdway 2-7884
Seattle:	MOhawk 4895
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Ontario, Canada	AXminister 3-5771

- REMOTE SENSING • VERNIER VOLTAGE CONTROL
- NO TUBES, MOVING PARTS OR VIBRATING CONTACTS

Specifications . . . .

REGULATION: 5-32V Range: ± ½% for combined line changes of 105-125VAC and load of 0-15A. DC.
2-5V Range: ± 2% for combined line changes of 105-125VAC and load changes of 0-15A. DC.
32-36V Range: ± 2% for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19½" wide x 15½" deep x 13¼" high with cabinet. (19" wide x 14¾" deep x 12¼" high rack panel construction)

FINISH: Gray Hammertone **WEIGHT:** *Approx. 135 lbs.*

Write for Bulletin MR 532-15A

See it at the IRE Show
BOOTH 324

PERKIN D C power supplies

PERKIN ENGINEERING CORP.
345 KANSAS ST. • EL SEGUNDO, CALIF. • ORegon 8-7215 or EAstgate 2-1375

A major step forward has been achieved by uniting Fairchild precision potentiometers with dynamically balanced and sensitive pressure-sensing elements. The result is a line of superior pressure transducers with potentiometer outputs and featuring all the characteristics of precision, reliability and quality that are identified with Fairchild potentiometers. A specially trained staff of engineers is at your service to consider problems of transducer design and manufacture to meet your specific requirements.

BOOTH 648
IRE SHOW
NEW YORK

PRESSURE TRANSDUCERS

Featuring Fairchild accuracy and reliability

The TPD-300 Transducer illustrated introduces a new line of Fairchild controls. Now, pressure transducers will be available to you in a wider range of resistances in either linear or functional, single or dual potentiometer output elements. The unit shown features two pressure-sensitive diaphragm elements which actuate two precision potentiometers through a dynamically-balanced, stable mechanical linkage. Variations of size, conformation and pressure ranges for measurement of differential, absolute or gauge pressures are also available. For complete information, write Fairchild Controls Corp., Components Division, Dept. 140-69A.

EAST COAST
225 Park Avenue
Hicksville, L. I., N. Y.

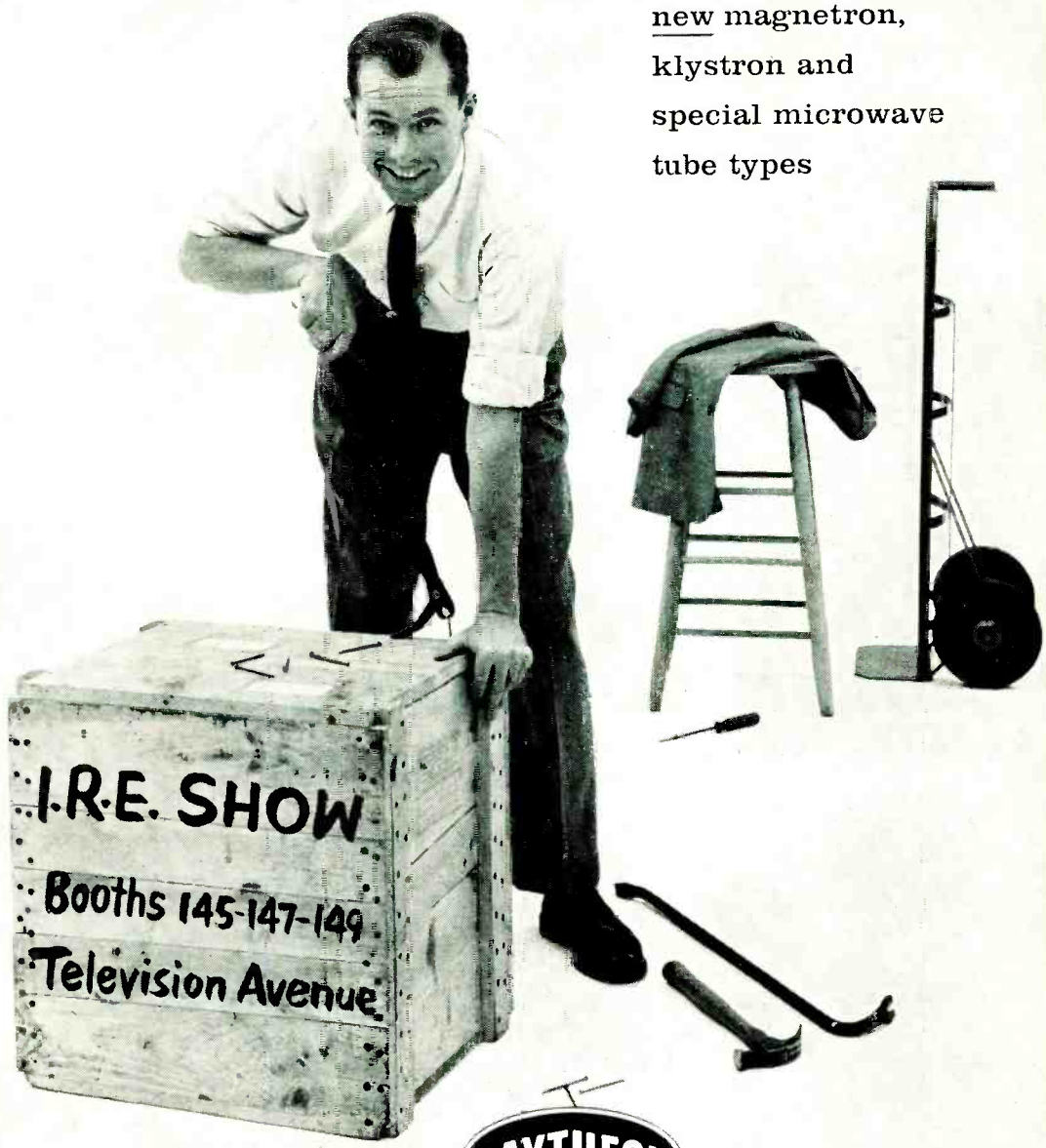
WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.

FAIRCHILD
PRECISION POTENTIOMETERS
PRESSURE TRANSDUCERS

See Us At Booth 648 — Circuits Ave. — IRE Show

Wraps coming off!

a presentation of
new magnetron,
klystron and
special microwave
tube types

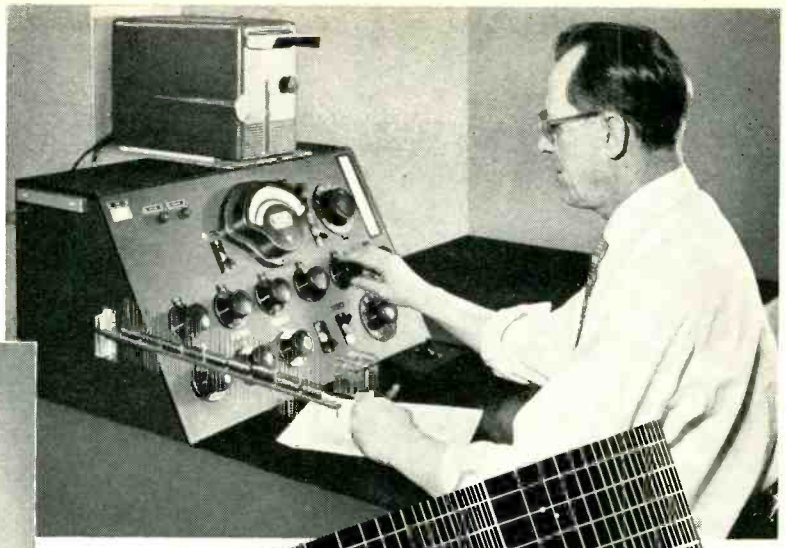


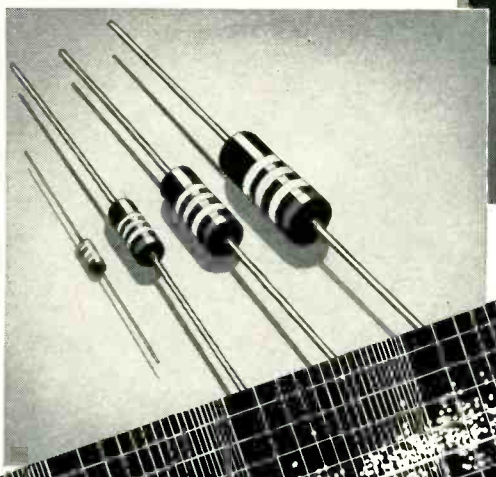
RAYTHEON

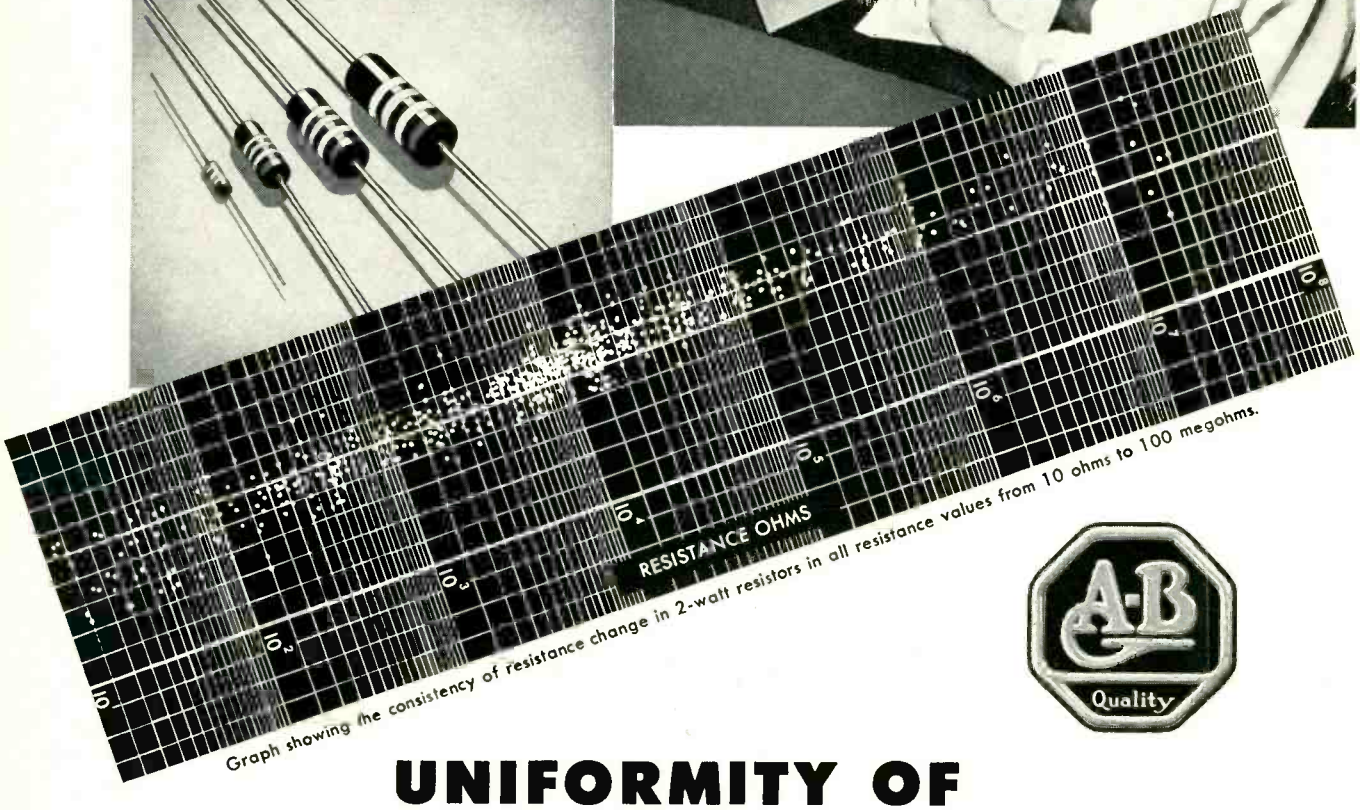
MICROWAVE AND POWER TUBE OPERATIONS, WALTHAM 54, MASS.

Right—Testing the resistance change of Allen-Bradley fixed resistors after 113 hour, 95% humidity test. The results are then platted on the graph shown below.

Below—Allen-Bradley fixed molded resistors are available in 4 sizes—1/10-watt, 1/2-watt, 1-watt, and 2-watt. In all standard RETMA resistance values.







Graph showing the consistency of resistance change in 2-watt resistors in all resistance values from 10 ohms to 100 megohms.

A-B Quality

UNIFORMITY OF ALLEN-BRADLEY RESISTORS IS THE KEYNOTE OF THEIR QUALITY

Allen-Bradley resistors have the greatest *uniformity* in mechanical size, shape, and electrical characteristics of any electronic component manufactured.

As a function of Quality Control, Allen-Bradley continuously samples its resistor production, running tests on each characteristic to verify *uniformity* and *consistency* of the production.

Graph shows production sampling of over 100 million resistors showing the small deviation in the resistance change characteristic in a humidity test conducted at 95%, 55°C for 113 hours. Such a *phenominally low deviation* over such a *large quantity of production* is the reason that Allen-Bradley fixed resistors are the *standard* of the electronic industry—where quality counts!

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

In Canada—
Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

now in production... and available for immediate delivery!

the MODEL B 611 DATRAC

DATRAC

by EPSCO

Reversible voltage-to-digital converter makes a complete, independent voltage-to-digital conversion every 22 microseconds or a complete digital-to-voltage conversion every 2 microseconds!

Now EPSCO, Incorporated, the leader in precision high-speed data reduction has available, as a shelf item, the Model B 611 Datrac Converter featuring ultra-high-speed and accuracy without manual calibration or adjustment of any type! Conservative design and total absence of mechanical switching assures reliable field operation.

ALSO AVAILABLE: THE BINARY CODED DECIMAL MODEL B 613 DATRAC CONVERTER having voltage-to-digital conversion time of 26 microseconds; all other specifications remain the same.

FEATURES:

1. Voltage-to-digital conversion time:	22 microseconds
2. Digital-to-voltage conversion time:	2 microseconds
3. Maximum full scale input voltage:	± 1,000 volts
4. Minimum full scale input voltage:	± 10mv
5. Data code:	Binary
6. Accuracy:	± .05% full scale ± ½ least significant digit
7. Calibration:	Automatic to an internal standard cell reference
8. Data Code Output Forms:	a. Serial pulse train b. Parallel semi-static binary valued voltage lines c. Positive parallel-line trigger pulses
9. Size:	19 inches wide by 26¼" high relay rack mounting (also available with cabinet as shown)

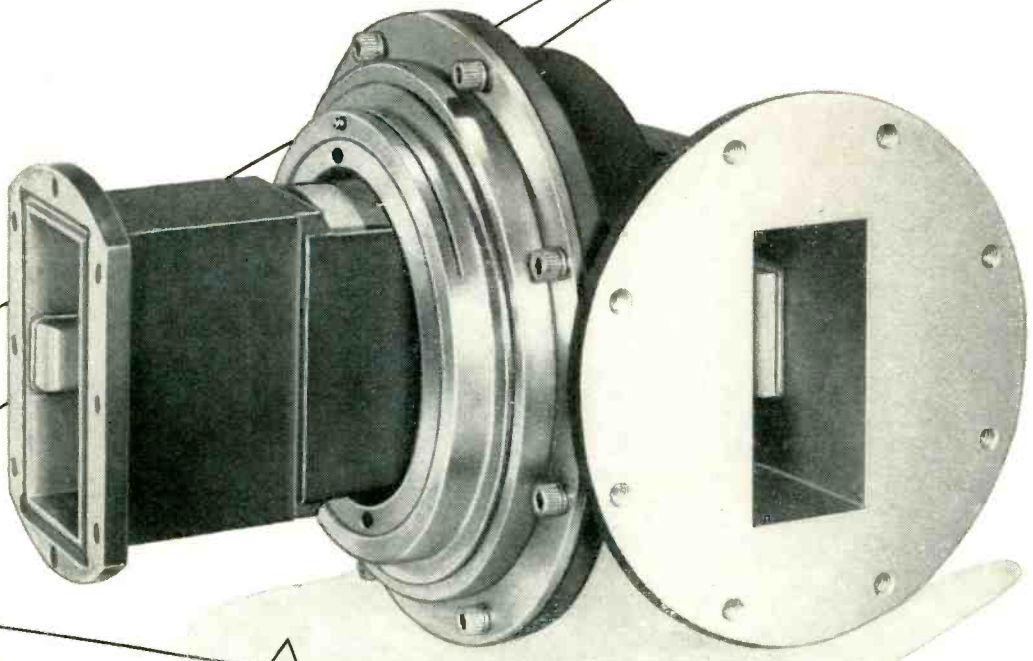
GET THE FACTS: Send for your copy of the detailed specifications and applications notes on the EPSCO high-speed DATRAC Series B Converters.

EPSCO INCORPORATED

588 Commonwealth Ave., Boston 15, Mass.

SEE US AT THE WALDORF DURING THE NEW YORK I.R.E. SHOW MARCH 19-22

low VSWR
compact
high speed...



rotary waveguide joints by Reeves INSTRUMENT CORPORATION

specifications

VSWR: Less than 1.10 for entire range of $f_o \pm 0.06f_o$.

PEAK POWER: (unpressurized, ¼ μsec pulse) 80 kw for K_u band; 175 kw for X band; 1500 kw for S band.

PEAK POWER: (pressurized, ¼ μsec pulse) approximately proportional to square of the absolute pressure.

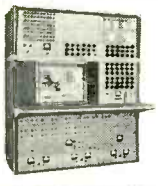
HIGH ROTATIONAL SPEEDS: Center conductor supported in oilite bearing; main housing supported on ball bearing.

LOW LEAKAGE: RF chokes incorporated to prevent leakage.

MEETS MIL SPECS: Including weatherproofing for outdoor use.

NO WOW: Coaxial design eliminates amplitude changes with rotation.

REAC Analog Computers



Precision Floated Gyros

Precision Resolvers and Phase Shifters

Servo Mechanical Parts

Compact rotary joints for either 90° or 180° orientation of input waveguide sections provide 360° continuous rotation at high speeds with broadband operation and high power handling capability. May be operated fully pressurized if desired. Standard models for K_u, X and S bands—other bands available on special order.

Write for complete details and operational data and curves.

Reeves INSTRUMENT CORPORATION

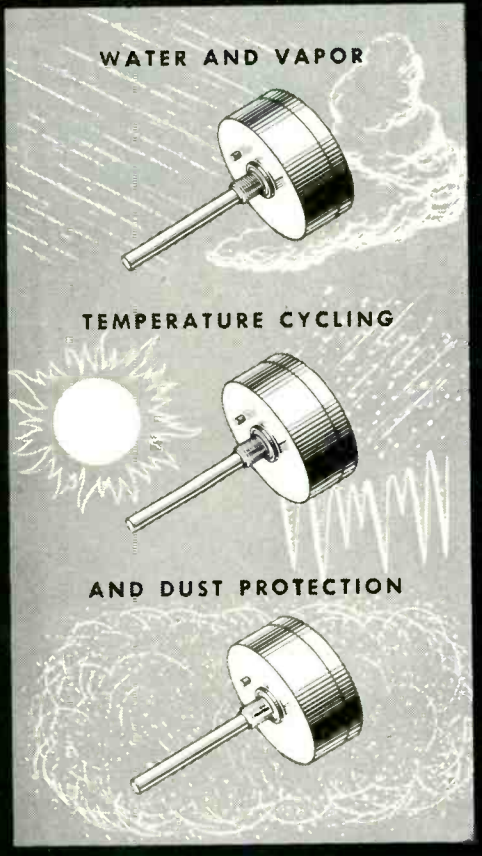
REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

201 East 91st Street, New York 28, New York

4RV56

BUILT-IN
PROTECTION



POTPOT
Potentiometers

Another **Clarostat** "first," meeting the latest requirements for ultra-dependable components.

"POTPOT" means potted or encapsulated potentiometers. Either in wire-wound or carbon types, including **Clarostat** Series 48M, 49M, 43, 37, 51, 58, and 10 controls. New encapsulating material means water- and vapor-tight molded enclosures imbedding entire unit with exception of external shaft assembly and terminal tips. Special water-tight assembly for shaft bushing.

Designed specifically to meet MIL-STD-202 Test Specification. Incorporating necessary salt-spray, humidity and temperature cycling requirements of MIL-E-5272 climatic standards. Excellent shelf life. Electrical specifications are those of given **Clarostat** control type.

CLAROSTAT®

WRITE FOR COMPLETE DETAILS . . .

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

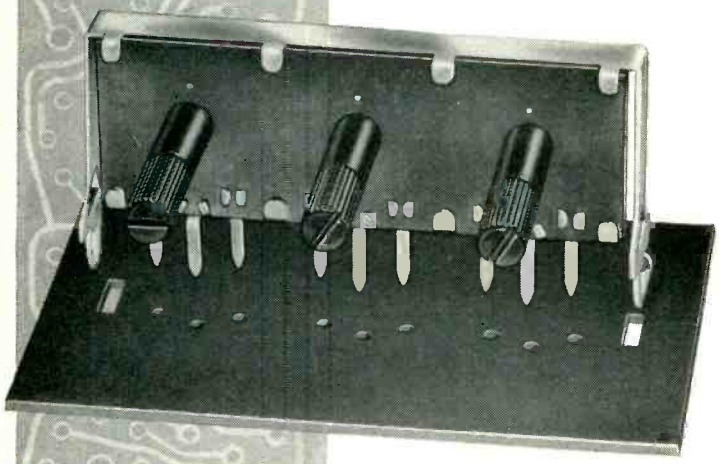
In Canada: **CANADIAN MARCONI CO., LTD.**, Toronto 17, Ont.
Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W. 1, Concessionaires for British Commonwealth except Canada.

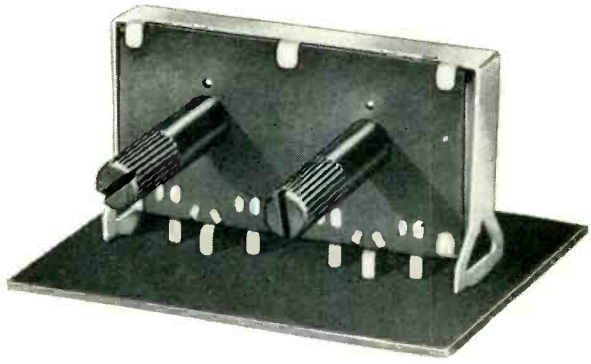
Want more information? Use post card on last page.

NOW!

designed specifically for PRINTED CIRCUITS

SNAPS INSTANTLY INTO PLACE—REMAINS FIRMLY LOCKED





Illustrations are actual size—note compact multiple units

CONSERVES PANEL SPACE—REDUCES HANDLING COSTS

A NEW TOTALLY FUNCTIONAL DESIGN CONCEPT

1. Snaps instantly into place with full length sturdy spring supports that lock control rigidly to printed panel.
   Wide shoulders provide rugged support.
   No mounting hardware, no separate support needed.
2. Compact multiple units conserve panel space, reduce handling costs and number of automatic assembly stations.
3. The only variable resistor with external contour designed specifically for mechanized handling and feeding into a printed panel.
4. Exclusive clip-off mounting supports and terminals for easy removal by service man without a solder pot.
5. Mounts upright with shafts parallel to printed panel, eliminating need for shaft protection during panel solder immersion.
6. Available in 2-control units (Series X52) or 3-control units (Series X53) as illustrated.

Many other types of controls available for your printed circuit and automation needs.

A CTS control can be tailored to your specific requirement. Let CTS SPECIALISTS help solve your current control problems. Write or phone today.

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Camden 2, New Jersey
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Los Angeles 35, Calif.
Phone: Crestview 4-5931
TWX No. BEV H 7666

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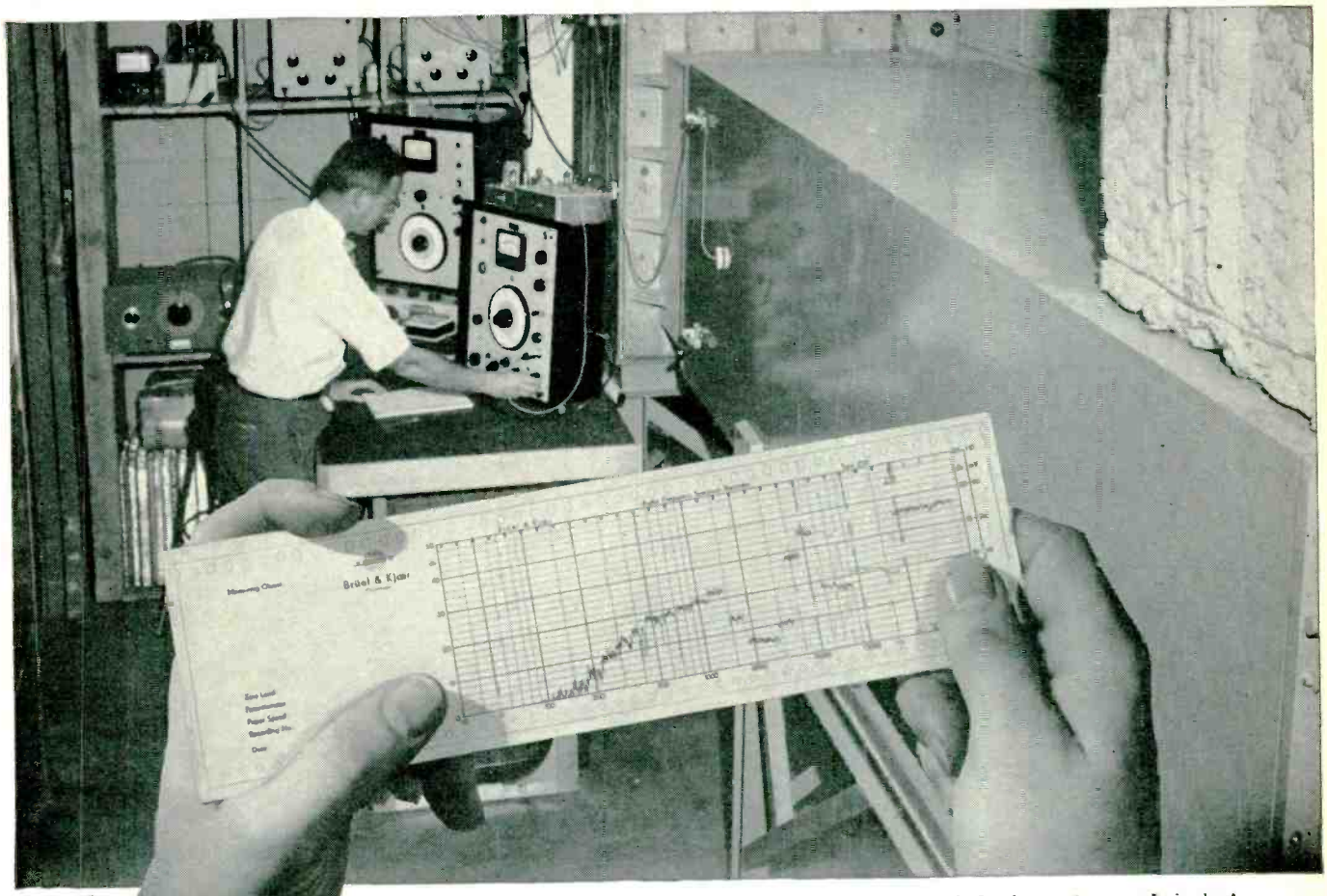
ELKHART • INDIANA

The Exclusive Specialists in Precision Mass Production of Variable Resistors

BURTON BROWNE ADVERTISING

BRUSH . . . *complete systems for noise or vibration measurement*



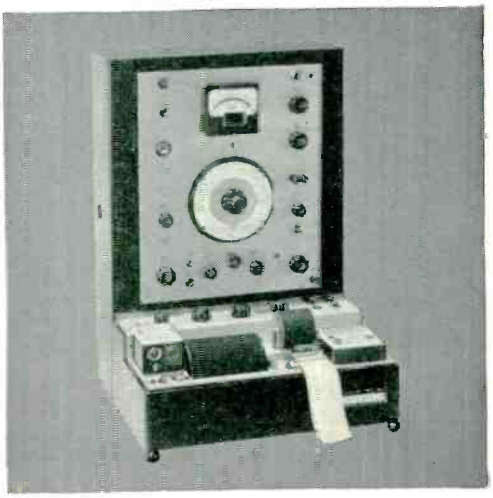
Shown above: typical noise spectrum analysis chart.

Complete frequency-amplitude noise record helps Lockheed design quieter aircraft

This test at Lockheed Aircraft measures the loss in acoustic transmission through fuselage wall panels. To design for noise reduction, engineers needed *complete* data, selected the Brush Spectrum Recorder for these advantages:

- **Recorder automatically scans and records sounds from 35 cycles to 18,000 cycles per second *automatically* eliminating laborious recording.**
- **Measurements made in one-third octave steps, to positively identify frequencies.**
- **Complete recording through the audible frequency range takes only 18 seconds, to save valuable engineering time.**

For noise or vibration analysis, Brush offers the outstanding line of instrumentation available. It's a *complete* line, thus units are matched, and we can offer application assistance on the complete project. For bulletin on this instrumentation write Brush Electronics Company, Dept. K-33, 3405 Perkins Avenue, Cleveland 14, Ohio.



Third-octave Spectrum Recorder, key instrument in a complete line for noise and vibration measurements.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
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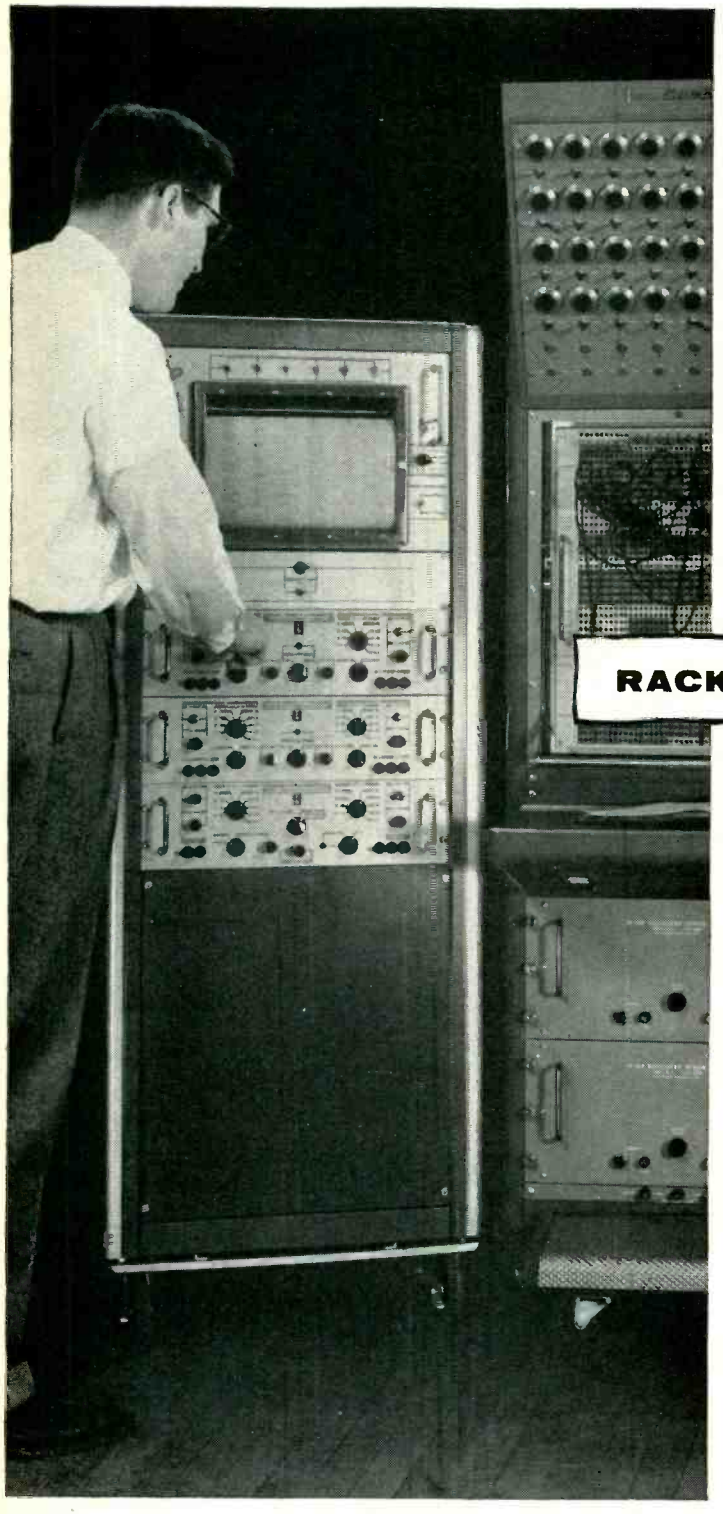
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

HOW TO SPEED YOUR TESTING



Complete line of

BRUSH RECORDING SYSTEMS

offers exact instrumentation you need to record data faster... more easily

RACK-MOUNTED SYSTEMS

Oscillographs and amplifiers fit standard 19-inch racks. For 1, 2, 4 or 6-channel systems.

MOBILE INSTRUMENT CART

Single or dual-channel oscillograph with accompanying amplifiers may be mounted in this mobile instrument cart. "Instrumentation on wheels" saves engineers' time.

I.R.E. SHOW

See the Brush Exhibit:
Booths 869, 871, 873, 875, Theatre 4

AND DEVELOPMENT

These direct-writing oscillographic systems record variables from d.c. to 100 cycles per second immediately, eliminate the manual labor in data recording.

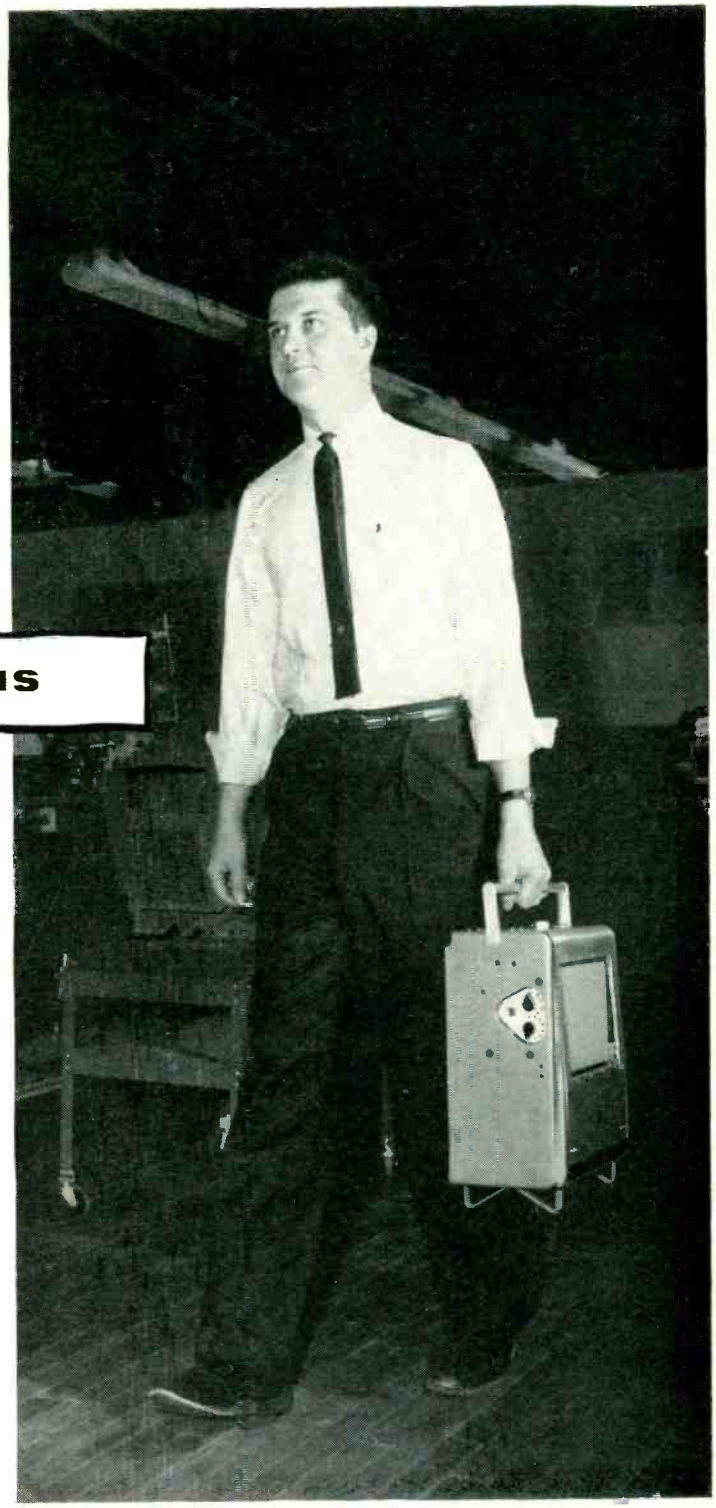
Only Brush offers all these features:

WIDE SPEED SELECTION . . . choice of 8 or 16 chart speeds allows you to select the speed best suited for the variable being measured, assuring optimum readability, accuracy and economy in chart paper.

EASILY OPERATED . . . set-up time is at a minimum. Instantaneous switching and remote control streamline operation.

COMPLETE LINE . . . Brush Systems are complete. You have a choice of D.C. Amplifiers, amplifiers for use with either resistive or inductive transducers, or high gain amplifiers. Choice of ink or combination ink and electric writing oscillographs.

GET THE FACTS. . . Ask your Brush Representative for complete specifications, or write Brush Electronics Company, Department K-3, 3405 Perkins Avenue, Cleveland 14, Ohio.



PORTABLE SYSTEMS

Portable oscillographs and amplifiers are light in weight, easy to set up on the job. Four channel oscillograph weighs 38 pounds, 6-channel unit 51 pounds.

IDEAL FOR FIELD USE

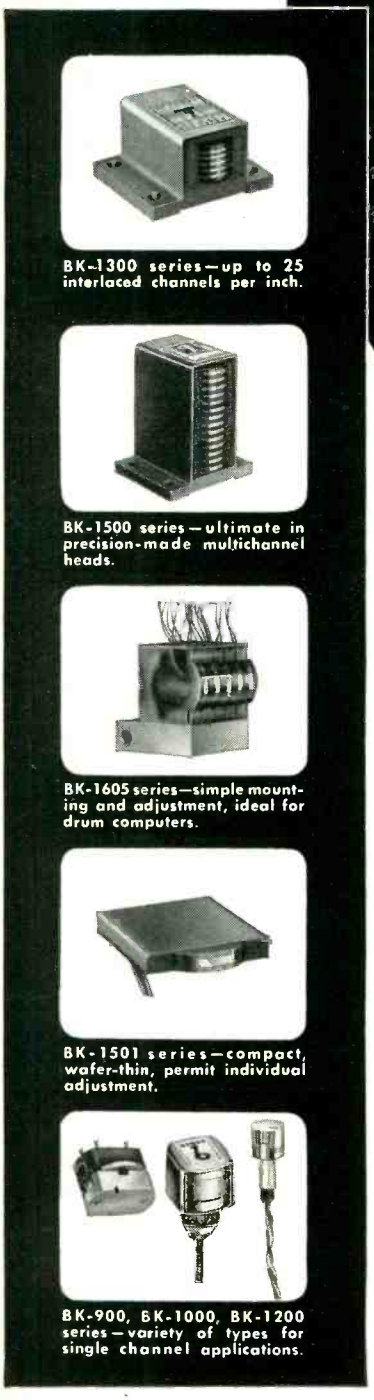
Portable units are rugged, designed to stand up under tough field testing conditions, yet perform with laboratory accuracy. Brush equipment is ideal for instrumentation set-up in station wagon, trailer, etc.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

Brush Magnetic Heads



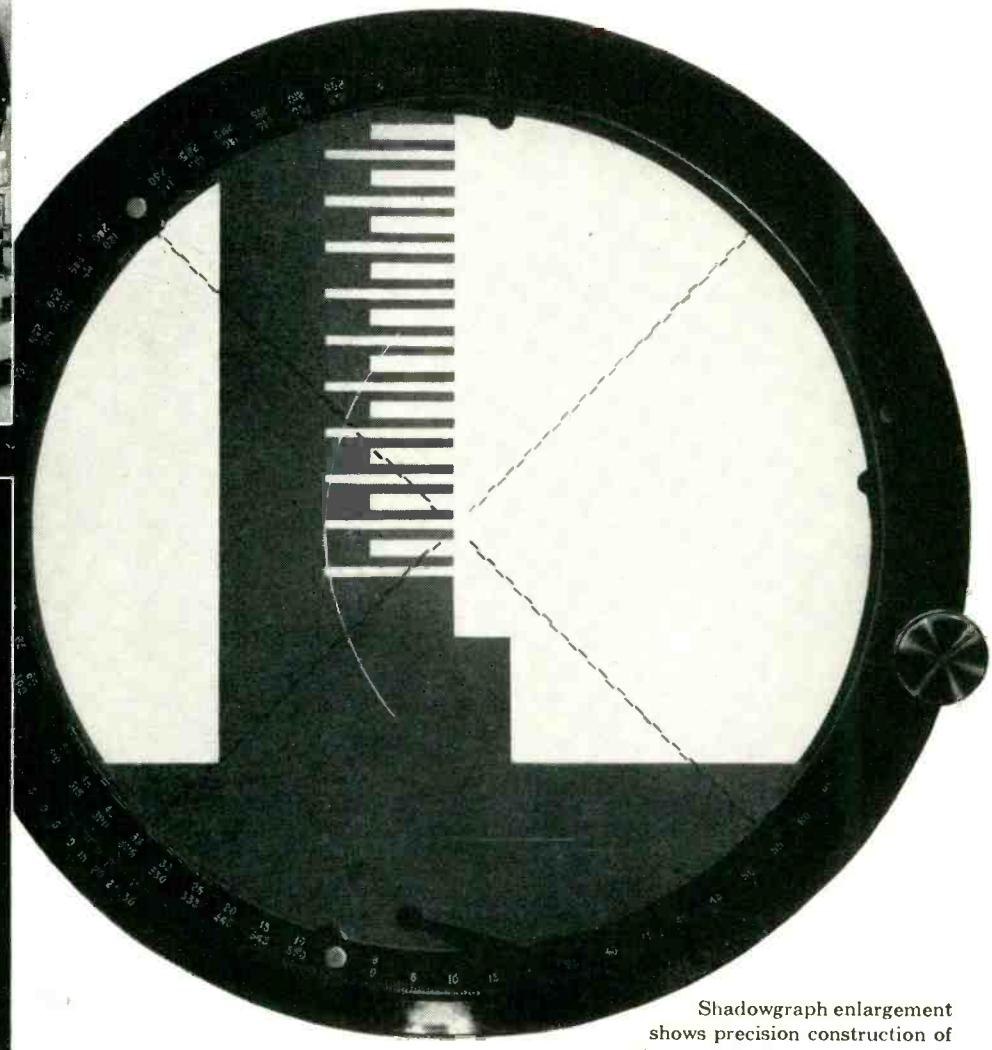
BK-1300 series—up to 25 interlaced channels per inch.

BK-1500 series—ultimate in precision-made multichannel heads.

BK-1605 series—simple mounting and adjustment, ideal for drum computers.

BK-1501 series—compact, wafer-thin, permit individual adjustment.

BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.



Shadowgraph enlargement shows precision construction of magnetic head with 13 channels per inch.

MORE TRACKS PER INCH

with perfect channel spacing

THIS magnification check is one of many that verifies accurate channel spacing and alignment of Brush multichannel heads. In some cases, tolerances of less than .0002 in. must be observed.

This precision pays off in performance—permitting interlacing of heads for greater density of information. Thus you can design computing or data handling equipment with increased storage capacity. In addition, dimensional accuracy permits interchangeability and standardization.

For complete information on standard magnetic heads, or special designs to your requirements, write Brush Electronics Company, Dept. K-33, 3405 Perkins Avenue, Cleveland 14, Ohio.

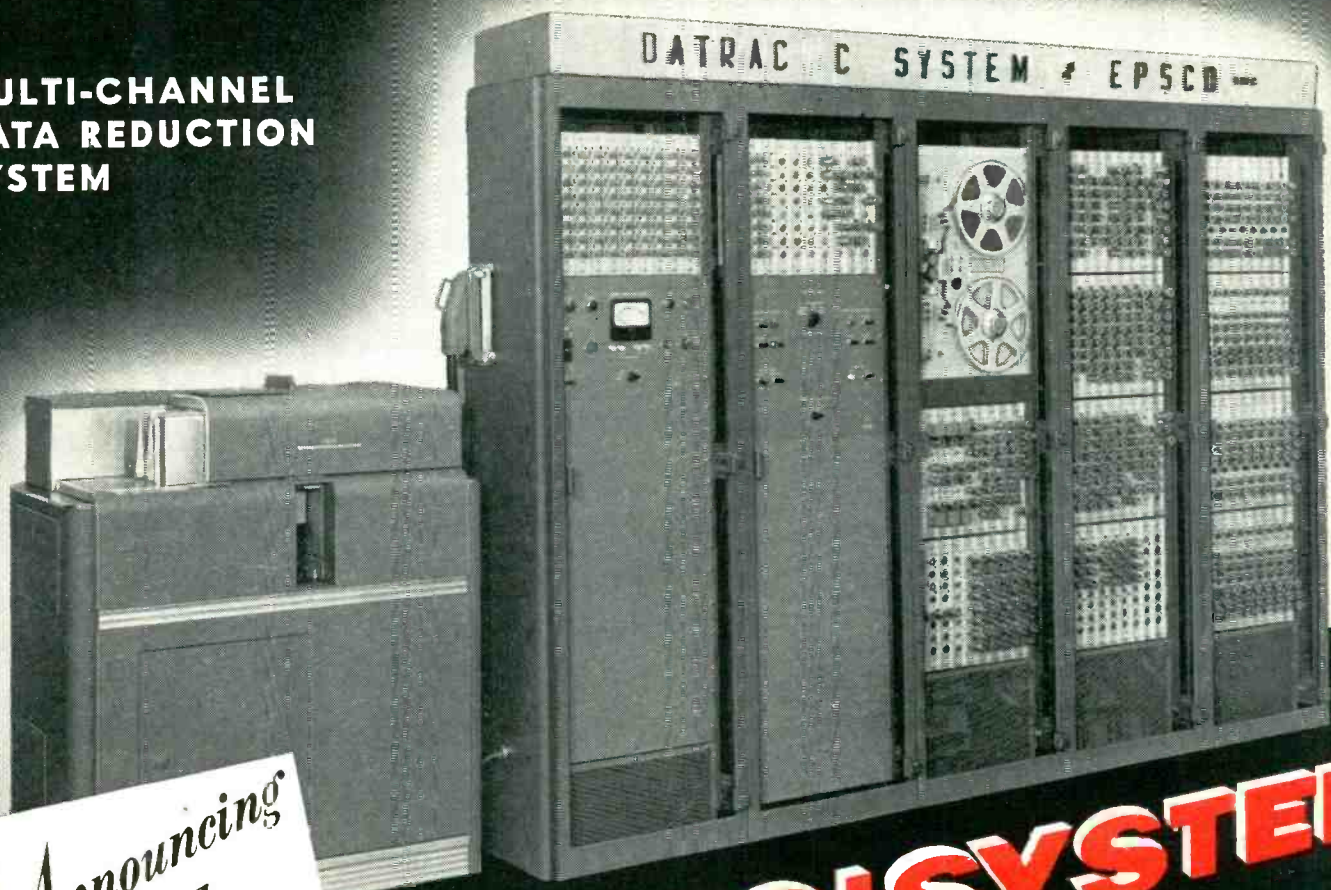
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

MULTI-CHANNEL DATA REDUCTION SYSTEM



Announcing the

DATRAC 'C' SYSTEM BY EPSCO

Punch Card Unit:
IBM #523 Gang Summary Punch
is shown at left

18-Channel Simultaneous Sampling System reduces voltage data into magnetic tape and IBM punched-cards

The EPSCO DATRAC 'C' System simultaneously samples and converts 18 bipolar input voltages into their numerical representation and stores the resultant digital codes on a magnetic tape. Up to 750,000 individual data points may be stored on a single 10½" reel of magnetic tape. The incoming data may be visually monitored during the data run. Following the data run, the DATRAC 'C' System transfers the information from the magnetic tape or to IBM punched cards. In operation, the system is entirely automatic; although provision is made for both manual control and synchronization to an external timing source. Further, the DATRAC 'C' System automatically checks the accuracy of the data as it is being transferred from the magnetic tape to the punched cards.

MAJOR DESIGN FEATURES:

- Extensive use of magnetic circuit elements
- Chopper stabilized input amplifiers
- Standard cell automatic internal reference
- Conservative computer type circuit design

Suitable for a wide variety of applications, this system has the following outstanding features:

1. *Input full scale voltages*	*Multiple ranges from ±10 mv full scale to ± 1000v full scale*
2. *Overall system:*	
Relative accuracy	*0.025%*
Absolute accuracy	*0.05%*
3. *Effective sampling time for 18 input channels*	*0.25 microseconds*
4. *Number of data points per second*	*Up to 180*
5. *Tape Coding*	*Sign and 4 decimal digits in 8-4-2-1 binary decimal code with parity check and sprocket pulse.*
6. *Information content for each magnetic tape block or IBM punched card*	*One complete set of 18 readings plus frame number*
7. *Magnetic tape output*	*Either single block or continuous*

Write for literature on Model "C" DATRAC System

EPSCO INCORPORATED
588 Commonwealth Ave., Boston 15, Mass.

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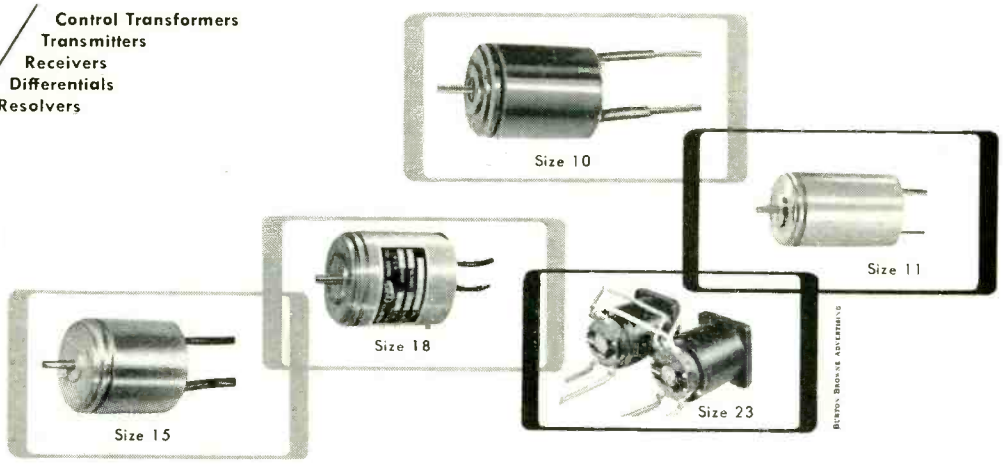
SYNCHROS

TO YOUR EXACT SPECIFICATIONS

AVAILABLE AS
- Control Transformers
- Transmitters
- Receivers
- Differentials
- Resolvers

Oster®



TYPE SYNCHRO	SIZE	OSTER TYPE	Frequency C.P.S.	Input Rotor Volts	Input Rotor Amps	Input Rotor Watts	Output Stator Volts	Input Stator Volts	Input Stator Amps	Input Stator Watts	Output Rotor Volts	Rotor Resistance Ohms	Stator Resistance Line to Line Ohms	Null Voltage	Angular Accuracy Maximum Spread
Control Transformer	10	3G-4055	400	26	0.030	0.30	11.8	11.8	0.060	0.20	21.3	160	45	0.050	30′
Control Transformer	10	3G-4079	400	26	0.008	0.10	11.8	11.8	0.018	0.10	20.3	510	200	0.050	30′
Transmitter	10	3G-4075	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	30′
Receiver	10	3G-4059	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	1½°
Differential	10	3G-4071	400	—	—	—	—	11.8	0.070	0.30	11.8	90	45	0.050	30′
Resolver	10	3G-4063	400	26	0.033	0.40	11.8	11.8	0.050	0.20	18.0	235	42	0.050	30′
Resolver	10	3G-4067	400	26	0.011	0.10	11.8	11.8	0.018	0.10	20.3	450	165	0.050	30′
Control Transformer	11	2C-4105	400	26	0.040	0.030	11.8	11.8	0.085	0.19	22.5	91.5	14.2	0.050	20′
Transmitter	11	2C-4125	400	26	0.150	0.80	11.8	—	—	—	—	20	4.3	0.050	20′
Transmitter	11	2C-4123	400	26	0.230	1.0	11.8	—	—	—	—	10.3	4.0	0.070	20′
Control Transformer	15	2G-4005	400	26	0.065	0.40	11.8	11.8	0.150	0.40	21.4	40	10.2	0.050	15′
Transmitter	15	2G-4025	400	26	0.225	1.25	11.8	—	—	—	—	9.5	3.8	0.070	20′
Receiver	15	2G-4009	400	26	0.10	0.45	11.8	—	—	—	—	16	6.7	0.070	45′
Differential	15	2G-4021	400	—	—	—	—	11.8	0.325	0.9	11.8	—	—	0.040	20′
Differential	15	2G-4041	400	—	—	—	—	11.8	0.120	1.3	11.8	14	10.2	0.050	15′
Resolver	15	2G-4017	400	26	0.014	—	18.0	18.0	0.015	—	21	239	180	0.050	40′
Transmitter 12 Power	18	3H-3309	400	26	0.77	2.3	11.8	—	—	—	—	1.032	0.675	0.050	20′
Differential	18	3H-3301	60	—	—	—	—	90	0.070	2.0	90	730	385	0.125	24′
Transmitter	23	3J-4222	60	115	0.120	3.2	17.0	—	—	—	—	140	8.3	0.050	30′

MANY OTHER VARIATIONS AVAILABLE. YOUR DETAILED SPEC GOVERNS:

- Angular accuracy
- Impedance
- Transformation ratio
- Input and output
- Phase shift
- Humidity treatment
- Fungus treatment
- Mil specs to be met
- Operating temperature range

Consult Oster specialists on your synchro problems today.
Come to Booth 747 at the IRE Show

Other products include Actuators, Servos, AC Drive Motors, Servo Mechanism Assemblies, DC Motors, Motor-Gear-Trains, Fast Response Resolvers, Servo Torque Units, Reference Generators, Tachometer Generators, Motor Driven Blower and Fan Assemblies and Synchro Indicators.

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Your Rotating Equipment Specialist

Avionic Division
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"There's always time to improve."

Courtesy of Bristol Clock Museum, Inc. Bristol, Conn.

Made and Sold by ELI TERRY Plymouth

To early Americans, the words "time" and "Terry" were synonymous . . . for Eli Terry's hand-crafted clocks represented a distinct improvement in the art of American clock making. Today they are still known everywhere as time-pieces of enduring accuracy.

NOW... FXR Universal KLYSTRON POWER SUPPLY

...with Pulse Modulation

FXR TYPE NO. Z815B*

SPECIFICATIONS

BEAM (two ranges):
200 to 2000 volts @ 0 to 125 ma
1800 to 2500 volts @ 0 to 100 ma
2500 to 3600 volts @ 0 to 250 watts

REFLECTOR:
Negative: 0 to 1000 volts

CONTROL GRID:
Positive: 0 to 150 volts @ 0 to 5 ma
Negative: 0 to 300 volts @ no load

MODULATIONS: (0 to 200 volts)
Sine Wave: Line frequency
Sawtooth: 40 to 120 cps
Square Wave: 250 to 2500 cps
Pulse: 1 to 10 μsec (width); 250 to 2500 cps

FILAMENT:
6.3 volts (a.c.) to 3 amperes, unregulated.

REGULATION:
0.03% for input variations from 105 to 125 volts (50-60 cps)

RIPPLE:
3 mv (RMS) max. from any point to ground

STABILITY:
A 5651 Reference Tube insures optimum stability

The true craftsman seeks constant improvement. This credo of craftsmanship is clearly demonstrated by FXR's new Universal Klystron Power Supply. In improving this fine precision instrument, which has already won acclaim as a basic microwave tool, FXR has added internal *Pulse Modulation*, and has also increased its range to a maximum delivered power of 250 watts at 3600 volts. This new power rating extends even further the impressive list of Klystrons that can be operated with this instrument. (A handy, informative reference list of Klystrons is available on request.)

Here is a truly versatile instrument, designed for years of dependable use. Produced with master-crafted attention, in production quantities, the new Universal Klystron Power Supply is typical of the complete line of reliable FXR Precision Microwave Test Equipment.

WRITE TODAY FOR COMPLETE CATALOG OF FXR PRECISION MICROWAVE TEST EQUIPMENT

*See it at the I.R.E. SHOW
March 19 – 22
BOOTH NO. 375
MICROWAVE AVENUE

FXR ELECTRONICS & X-RAY DIVISION · F-R MACHINE WORKS, INC.

FIRST BY FAR

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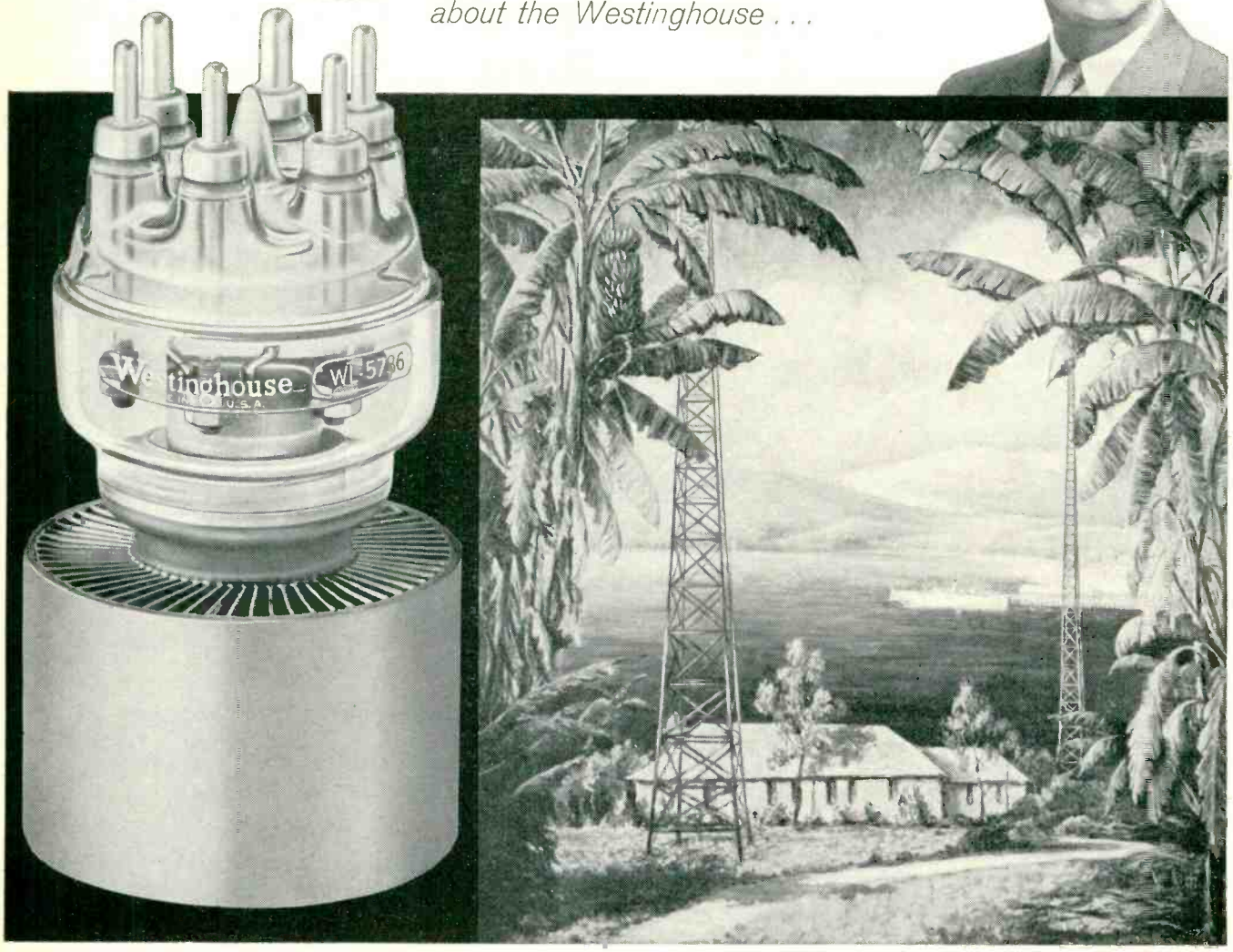
"Reliability where it counts,"

says C. C. Harris,
Vice President and Chief Engineer,
Tropical Radio Telegraph Company,
about the Westinghouse . . .



WL-5736 POWER TUBE

"We have been using the WL-5736 for seven years," says Mr. Harris. "We have found it to be highly reliable and to give long life. Tropical Radio Telegraph Company requirements are strenuous, especially in hot, humid, tropical climates. Our radio network is vital to Middle-American tele-communications service, and the WL-5736 has given us reliability where it counts."

Reports from dozens of other users echo the experience of Tropical Radio Telegraph. For the WL-5736 has long set the standard of excellence in communications and RF heating equipment of all types.

Wherever you need 2.5 kilowatts RF in a small, dependable package, you too will find its performance unbeatable.* Write today for full design data. Commercial Engineering Dept., Westinghouse Electric Corporation, Elmira, N. Y.

ENGINEERS! For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director today.

6ET-4106

** Where cooling by low-pressure blower is desirable, specify the new WL-6623 with extra-large radiator and "flying leads."*

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

RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

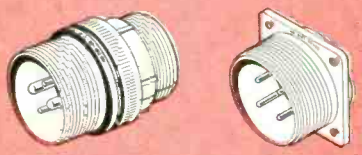
FOR RAPID DISCONNECT

Multi-Contact Electric Connectors

IN RADIO • SOUND • TV AND RELATED FIELDS USE TOP QUALITY CANNON PLUGS

MIL-SPEC

AN is the prefix for Military Specification electric connector assemblies. Reasonably priced because of extensive tooling and world-wide demand. Light weight shells. Interchangeable inserts.



AN Series

260 different insert layouts. 15 diameters. 6 shell styles. 22 to 245 amp. contacts. Thermocouple and coaxial contacts available. Cable clamps, conduit fittings, telescoping bushings, junction shells, dust caps, dummy receptacles, potting kits. Majority of assemblies available from shelf stock.

HIGH TEMPERATURE . . . FOR AIRCRAFT AND INDUSTRIAL USE. Firewall connectors in standard steel shell varieties and insert combinations. Maintain circuitry for 5 minutes at 2000°F.

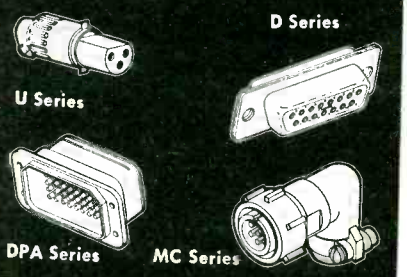
VIBRATIONPROOF-MOISTUREPROOF APPLICATIONS. With resilient inserts, interfacial sealing.

HERMETICALLY SEALED APPLICATIONS. Steel shells, glass-fused inserts. Standard, miniature, and subminiature sizes. For control, relay, power, instrument applications.

PRESSURIZED APPLICATIONS. AN-C pressurized for 30 psi. Cannon K's, pressurized. Wide variety for different conditions.

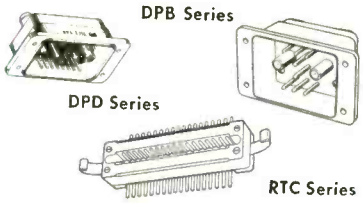
Also, heavy-duty watertight units; external power plugs and receptacles; high-voltage types; special breakaway designs.

MINIATURES



Cannon miniatures and subminiatures are designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, small pre-amps, and general instrumentation where space is limited and current requirements are generally not over 5 amperes. Variety of shell styles, junction shell, and insert arrangements. 3 to 50 contacts, plus coaxials.

UNIT PLUG-IN'S



for RACK/PANEL/CHASSIS

Permit quick disconnect, interchange, replacement, testing and inspection of assemblies and sub-assemblies. For transmitters, TV cameras, control equipment, radar, etc. Rack-and-panel, integral clamp, shell-less types, bail-and-gear disconnects, center-screw extraction, 10 to 156 contacts including high voltage.

Printed circuit connectors in 5 sizes, 10 to 44 gold-plated contacts, Zytel shells.

AUDIO

Cannon audio connectors give you the highest quality . . . in the greatest variety to meet your every need. Standard on leading microphones. Straight, angle 90°, oval; wall-mounting, panel, locknut mounting, adapter receptacles, single and two-gang receptacles; latch-lock. 5-to-30-amp. contacts, coaxials.

INFORMATION AVAILABLE

Ask for Literature by Application

Cannon also makes plugs for switching and patching, test point jacks, external power connectors, missile launching connectors, buffet connectors, cable terminals, dc solenoids.

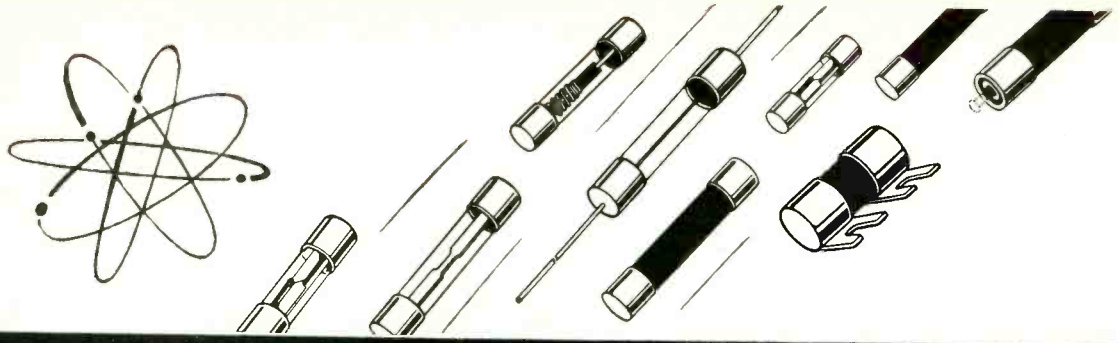
PLEASE REFER TO DEPT. 120

CANNON PLUGS

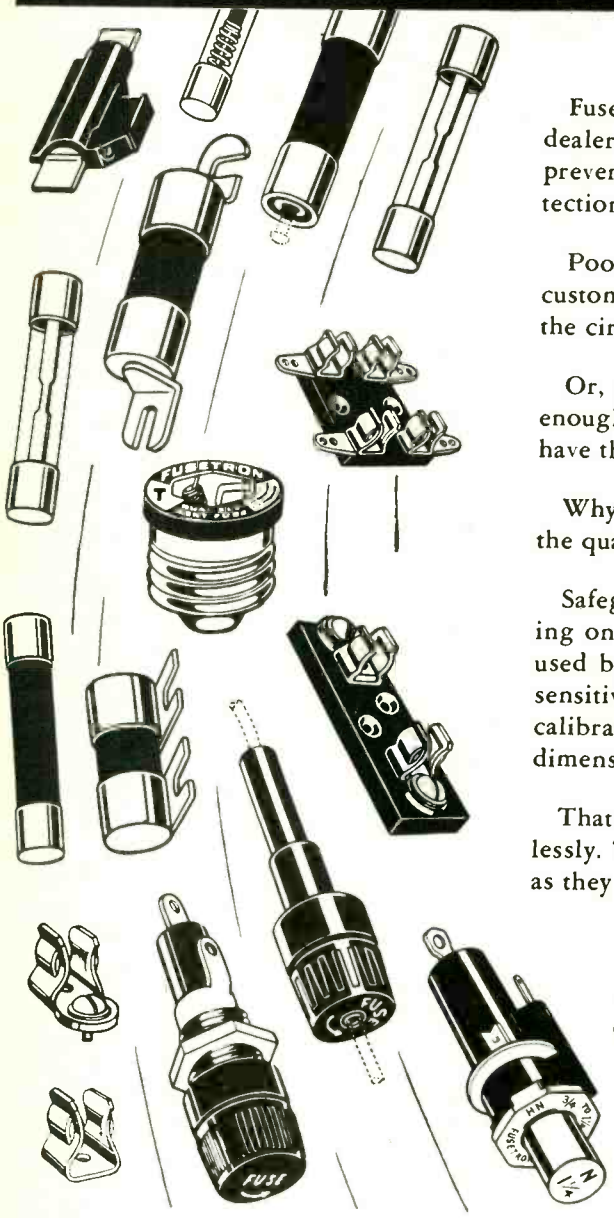
CANNON ELECTRIC

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31 Calif. Factories in Los Angeles; East Haven; Toronto, Can.; London, Eng.; Melbourne, Australia. Licensees in Paris, France; Tokyo, Japan.

Cannon Connectors are available from more than 1000 audio-industrial-electrical distributors from coast to coast



dependable BUSS FUSES can help safeguard the good name of your Product or Service



Fuses may be considered a small item by many service dealers and manufacturers—however, BUSS quality fuses can prevent endless trouble by giving dependable electrical protection under all service conditions.

Poor quality fuses can blow needlessly and shut down your customers' equipment — even though no trouble exists on the circuit.

Or, poorly made fuses might *not* shut down the circuit quick enough when there is an electrical fault — and your customers have the expense of replacing needlessly burned out parts.

Why chance having these troubles mistakenly blamed on the quality of your product or service?

Safeguard against loss of customer good will by standardizing on "trouble-free" BUSS fuses. Each BUSS fuse, normally used by the Electronic Industries, is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

That's why BUSS fuses blow only to protect — never needlessly. Thus they help safeguard your good name — as surely as they protect users.

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

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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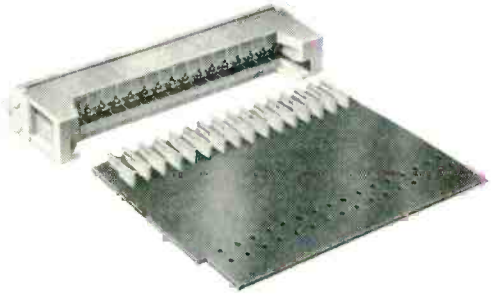
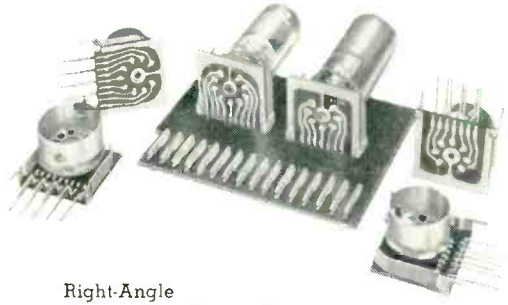
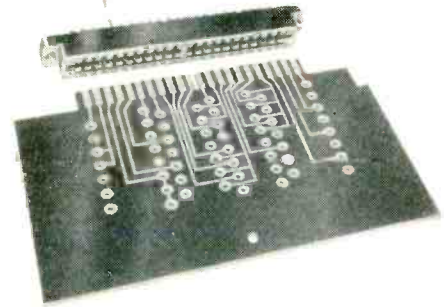


Printed Circuit Varicon Connectors



Right-Angle
Printed Circuit Sockets



Printed Circuit Connectors

BOOTH 792, IRE SHOW, MARCH 19-22, 1956

ELCO presents with pride, the newest of its ever-new quality-line . . . and invites you to come and see components you have been wishing for, looking for, hoping-against-hope that someone would produce soon. Well, sir, "soon" has arrived . . . and we modestly believe from every standpoint . . . design, engineering, construction and tested-in-use-operation . . . you will find these new products all you have been seeking for printed circuitry and automation. Complete literature is available, too, upon receipt of your request on your company letterhead.

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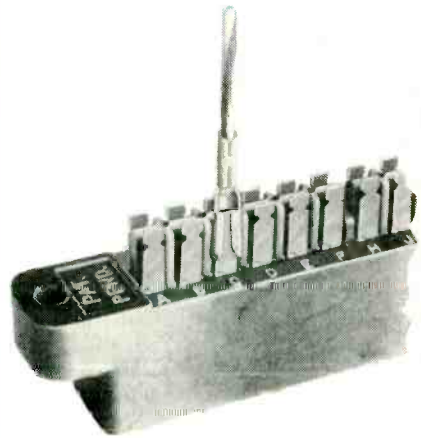

Enlarged View
Printed Circuit Connectors

Printed Circuit
Subminiature Varicon Connectors

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indispensable for measurement and reception

MICROWAVE

MODEL R

with these special features:

EXCELLENT GAIN STABILITY—Equipped with automatic gain control, as well as "signal-lock" Automatic Frequency Control. Performance stable over entire frequency band.

HIGH SENSITIVITY—Achieved with unique double-tuned cavity pre-selector which tracks automatically with local oscillator. Efficient wideband microwave input coupler and crystal mixer maintains sensitivity.

SELF-CONTAINED—Complete with electronically regulated low and high voltage power supplies; signal metering circuits; IF, local oscillator, audio-video, and FM plug-in sub-units. Four interchangeable, plug-in microwave tuning units cover frequency range 950-11,260 mc.

ALL-PURPOSE—Receives AM, FM, CW, MCW and pulse-modulated signals. Equipped with recorder output, trigger output (constant amplitude), video and audio outputs. Meter reads directly in db.

UNI-DIAL CONTROL — Automatically tracks klystron voltages, double tuned pre-selector, oscillator, and linear direct reading frequency dial — all simultaneously.

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

BROADBAND
950–11,260 MC

FIELD INTENSITY RECEIVER

UNI-DIAL CONTROL

One of the most complete and versatile measurement instruments ever designed for reception and quantitative analysis of microwave signals in the range 950-11,260 mc.

The Polarad Model R Microwave Receiver is ideal for the reception and monitoring of all types of radio and radar communications within its range. It permits comparative power and frequency measurements, by means of its panel mounted meter, of virtually every type of signal encountered in microwave work.

It is compact and functional, featuring four integrally designed plug-in, interchangeable RF microwave tuning units to cover 950-11,260 mc; non-contacting chokes in pre-selector and microwave oscillator to assure long life and reliability; and large scale indicating meter for fine tuning control.

Call any Polarad representative or direct to the factory for detailed specifications.

SPECIFICATIONS:

Basic Receiver: Model R-B
Tuning Unit Frequency Ranges:
Model RL-T: 950 — 2,040 mc
Model RS-T: 1,890 — 4,320 mc
Model RM-T: 4,190 — 7,720 mc
Model RX-T: 7,260 — 11,260 mc
Signal Capabilities: AM, FM, CW, MCW, pulse
Sensitivity: —80 dbm or better throughout range on all models
Frequency Accuracy: ±1%
IF Bandwidth: 3 mc
Video Bandwidth: 1.5 mc
Image Rejection: Greater than 60 db
Gain Stability with AFC: ±2 db
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 v./mc
Skirt Selectivity: 60 db — 6 db bandwidth ratio less than 5:1
IF Rejection: 50 db
Input AC Power: 105-125 v., 60 cps, 440 watts
Input Impedance: (ANT) 50 ohms
VSWR: Less than 4:1 over band
Range of Linearity: 60 db
Receiver Type: Superheterodyne
Maximum Acceptable Input Signal Amplitude: 0.1 v. rms without external attenuation
Video Response: 20 cps to 1.5 mc
Size: 17" w x 23" d x 19" h
Weight: 180 lbs.

Price:

Model R-B (Basic Unit):	$1,500
Model RL-T:	2,500
Model RS-T:	2,500
Model RM-T:	2,500
Model RX-T:	2,500

Note: To the basic cost of $1,500 add cost of tuning units required.
Prices subject to change without notice

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CONSULT US ON YOUR MICROWAVE RECEIVER PROBLEMS.

for these applications:

- **Broadband receiver for AM, FM, CW, MCW, and Pulse Modulated signals**
- **Field intensity meter**
- **Frequency measurements**
- **Leakage, interference and radiation measurements**
- **Bandwidth measurements**
- **Measurement of relative power of fundamental and harmonic signal frequencies**
- **Trigger pulse amplifier**
- **Noise figure measurements of r-f amplifiers**
- **Antenna field patterns**
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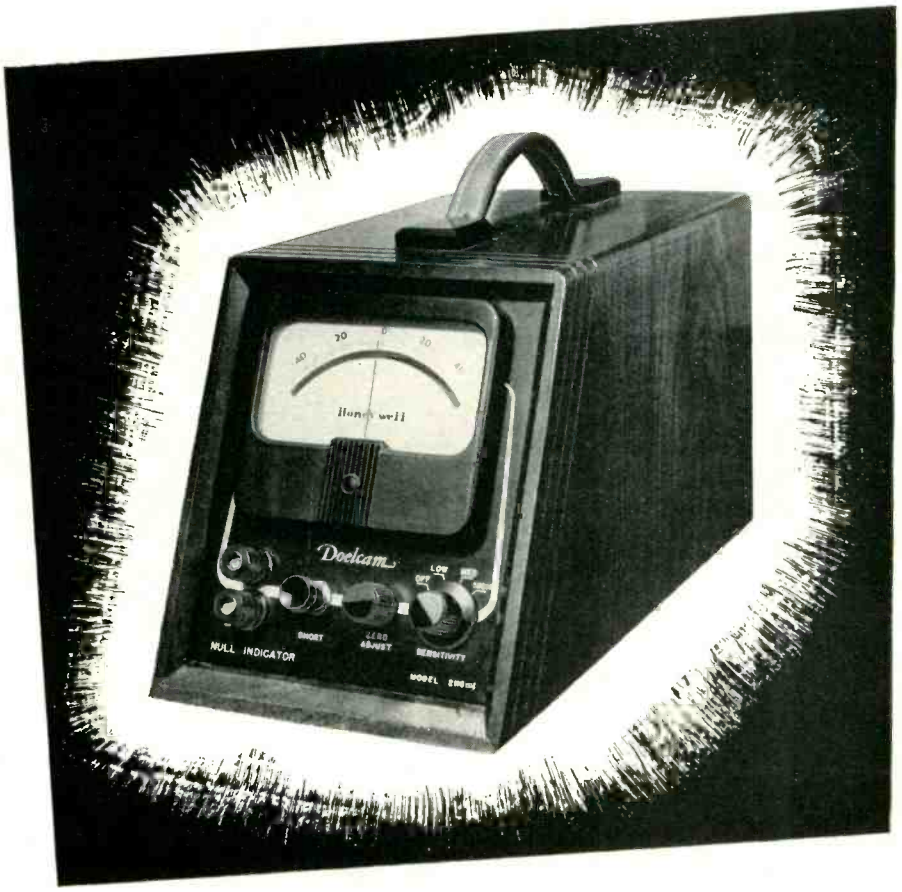

EXCLUSIVE FEATURES

- **High Sensitivity**
- **Linear Deflection**
- **Magnetic Converter**
- **Isolated Input**
- **Low Noise Level**

Write for Bulletin NI-7

THE DOELCAM Magnetik Null Indicator, Model 2HG-1, is *both* a null balance detector and a linear deflection indicator. It may be used as either a low level laboratory instrument where *accurate null* measurement is important, or as a fast measuring production test instrument where *linear* off-balance readings and ability to withstand rough usage are essential. All around improved performance is achieved by use of the unique DOELCAM Second-Harmonic Magnetic Converter as the input modulator.

CHARACTERISTICS

HIGH SENSITIVITY: 2 Microvolts per division. 0.003 Microamperes per division.

PROPORTIONAL DEFLECTION: Linearity over full scale range is within 5% accuracy.

ISOLATED INPUT: Input terminals are isolated from chassis and circuit ground.

LOW NOISE LEVEL: Less than 2 microvolts equivalent input. Insensitive to 60 or 120 cycle pickup.

EXCELLENT STABILITY: Zero drift less than 1 division per hour.

INDEPENDENT OF LINE VOLTAGE: No observable drift or change in sensitivity for line variations from 105 to 125 volts.

QUICK READING: Time constant of less than 1 second.

RUGGED: Not damaged by overrange of 1.5 volts d-c.

POLARITY SENSITIVE: Zero-center mirror-scale meter for polarity sensing measurements.

LOW MAINTENANCE: Only one vacuum tube. No moving parts except meter.

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A DIVISION OF MINNEAPOLIS-HONEYWELL
H HONEYWELL
SOLDIERS FIELD ROAD
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Instruments for Measurement and Control
Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

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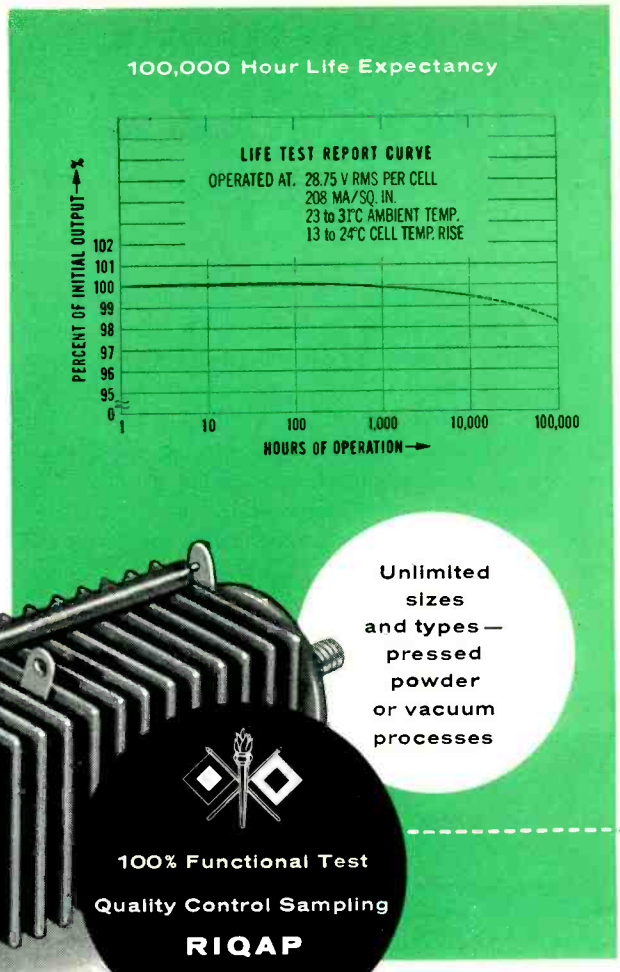
HIGHEST STANDARDS OF RELIABILITY IN THE INDUSTRY !



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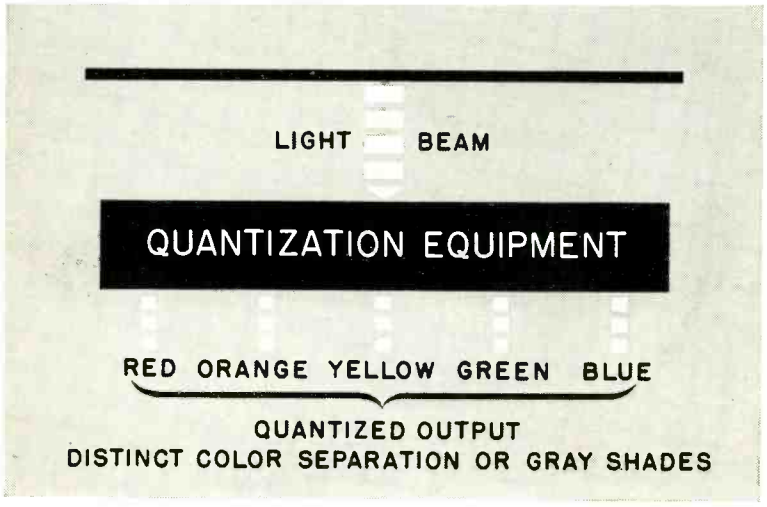
FORD INSTRUMENT QUANTIZES LIGHT

Colored lines or spots on a piece of paper can become a means of conveying information — Rorschach charts, impressionist paintings and survey maps are all visual message carriers. Ford Instrument engineers found it necessary to translate such color information into electrical or mechanical quantities, (quantization) with less distortion than is inherent in the usual photographic techniques. Such quantities can in turn be used as signals that actuate computers, make offset plates, and generally put to use the information implied by the difference between the colors or the distribution of the colors.



The quantization performed by Ford is not restricted to color alone. For example, a black and white photograph represents an aggregate of light and dark areas of varying shades, and this display must frequently be converted into continuous or discrete electrical quantities for various purposes and uses. Ford engineers recently developed equipment which can quantize and record the various degrees of color, or gray areas in photographic negatives, and to correlate this information into usable data. This equipment was developed for a classified project — the equipment is unavailable for general use — however the technical know-how gained by Ford — combined with Ford's superior production and engineering facilities — is available in the creation of light quantizing equipment for you.

Light quantizing is but one of the many facets of Ford Instrument design and development. For more information about Ford's products, services and facilities, write for an illustrated folder. Ford engineers will be happy to discuss your problems of control with you.

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FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
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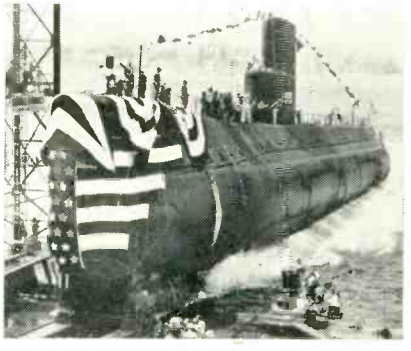
Beverly Hills, Cal. • Dayton, Ohio

Ford's capabilities are among the finest in the country

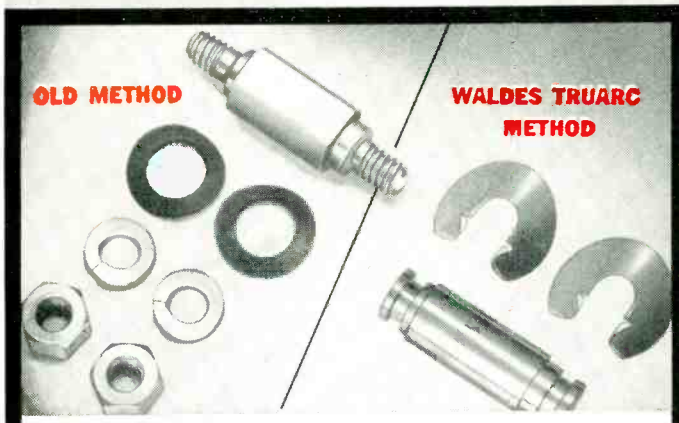
Three dimensional cams are used in elaborate computing devices to characterize shell ballistics, magnetic variation, or to solve some basic mathematical function. Precision in 3-D cams is of vital importance. Ford Instrument designed and built a unique machine that can produce extremely accurate cams from a skillfully made master. As many as two thousand data points are end-milled to set precisely the contours of the handcut masters.

Equipment used for defense must undergo rigorous tests for accuracy and dependability in combat. At Ford, environmental testing laboratories reproduce extremes of desert or arctic battle, shock of warship broadside, salt fogs and heavy seas. When flaws have been detected and corrected, equipment is okayed for volume production and use throughout the armed services.

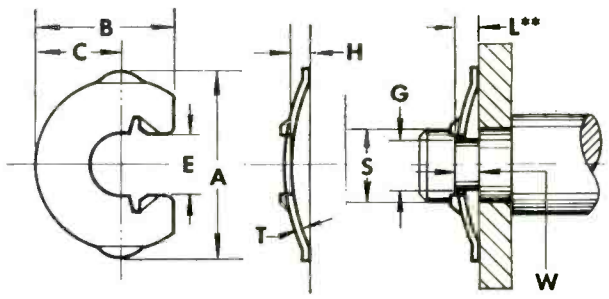


Typical of Ford Instrument's 40 years of experience in precision control is its work in the field of nuclear power. The Company, for example, is building the control rod drive mechanism for the Seawolf, second atomic submarine. Reactor designs, sensing mechanisms, control equipment and systems, nuclear calculations, and other specialized equipment and abilities are offered by the Company to this expanding industry.

New Waldes Truarc locking-prong ring functions as spring, shoulder, fastener... and STAYS PUT!



Above assembly shows how 2 Waldes Truarc Locking-Prong Rings (Series 5139) replaced 6 parts... eliminated threading operation... and need for skilled labor.



WALDES TRUARC LOCKING-PRONG RING (Series 5139)
U. S. Pat. Pending

Ring No. 5139-	SHAFT Dia. S	tol.	RING DIMENSIONS A	tol.	B	tol.	C	tol.	E	tol.	H	tol.	T†	tol.†	average ultimate shear strength lbs.*	GROOVE DIMENSIONS Dia. G	tol.	Width W	tol. −.000	L min.	L max.	resilient end play take up L max−L min
12	.125	±.002	.340	±.010	.307	±.010	.166	±.005	.086	±.004	.050	±.010	.010	±.0013	400	.082	±.0015	.045	+.005	.035	.045	.010
★15	.156	±.003	.380	±.010	.330	±.010	.184	±.005	.108	±.004	.055	±.010	.010	±.0013	600	.104	±.002	.050	+.005	.035	.045	.010
18	.188	±.003	.445	±.010	.390	±.010	.213	±.005	.130	±.005	.060	±.010	.015	±.0015	900	.124	±.002	.065	+.005	.045	.055	.010
25	.250	±.003	.581	±.010	.500	±.010	.280	±.005	.172	±.005	.070	±.010	.015	±.0015	1000	.165	±.002	.070	+.005	.050	.065	.015
31	.312	±.003	.744	±.010	.620	±.010	.360	±.005	.234	±.005	.095	±.010	.018	+.001 −.002	1300	.228	±.003	.080	+.005	.080	.095	.015
★37	.375	±.003	.853	±.015	.740	±.010	.427	±.005	.280	±.005	.130	±.010	.020	±.002	1900	.270	±.003	.105	+.005	.090	.115	.025
★43	.438	±.003	.960	±.020	.820	±.020	.475	±.010	.337	±.010	.130	±.010	.020	±.002	2200	.327	±.003	.105	+.005	.095	.120	.025

Additional Sizes Under Development ★Production dies not available as of date of printing †Applies to unplated rings only *Recommended safety factor =3 to 4.

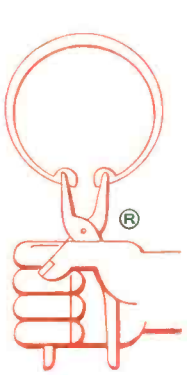
The Waldes Truarc Locking-Prang Retaining Ring is a new, low cost, radially applied fastener which can be locked positively in its groove and used as a shoulder against rotating parts. It is primarily intended for use in the automotive, electronic and aeronautical industries.

This radially applied ring locks positively in its grooves by means of two prongs at the open end. Because of its high thrust-load capacity the Waldes Truarc Locking-Prong Ring may be used as a shoulder against rotating parts. Its bowed construction provides for end-play take-up in the assembly and makes less critical the tolerances required for the parts being fastened. Since it serves as a spring as well as a shoulder, this ring eliminates the need for springs, washers, and other accessory fastening devices.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.



SEND FOR FREE SAMPLES

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Locking-Prong Rings. (please specify shaft size_____)

☐ Please send me supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

Name.....

Title.....

Company.....

Business Address.....

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

E 038

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.

The Standard of Accuracy for

FREQUENCY MEASUREMENT and CONTROL

FREQUENCY STANDARDS

Offers a Comprehensive Line of—

MICROWAVE FILTERS AND PRESELECTORS

- SINGLE SHAFT TUNING AVAILABLE
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- USABLE OVER WIDE TEMPERATURE RANGES
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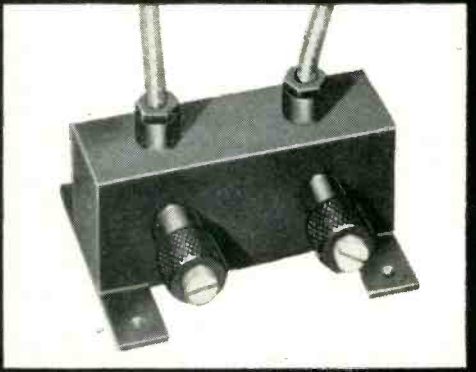
See us at the Show!
BOOTH 332
COMPUTER AVENUE



In order to utilize the crowded microwave spectrum to the greatest possible advantage, Frequency Standards now offers a comprehensive line of filters and preselectors. These units are engineered and constructed with the same exacting care and precision which has made Frequency Standards' wavemeters a standard in the industry.

Frequency Standards is proud of its reputation to undertake development and production work in the fields of preselection, frequency measurement and control which approaches the "state of the art." Our engineering services are available at all times to assist you with your problems.

RESONANT FREQUENCIES AVAILABLE

	L	S	C	X
Bandwidth (Maximum available)	5%	3%	2%	1%
Number of Sections*	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4
Insertion Loss (For 1% bandwidth)	≤1.5 db	≤1. db	≤1. db	≤1. db
Rejection ($F_0 \pm 2xBW$) (db)	24 36 48	24 36 48	24 36 48	24 36 48
Input VSWR (Matched Load)	≤1.5	≤1.5	≤1.5	≤1.5

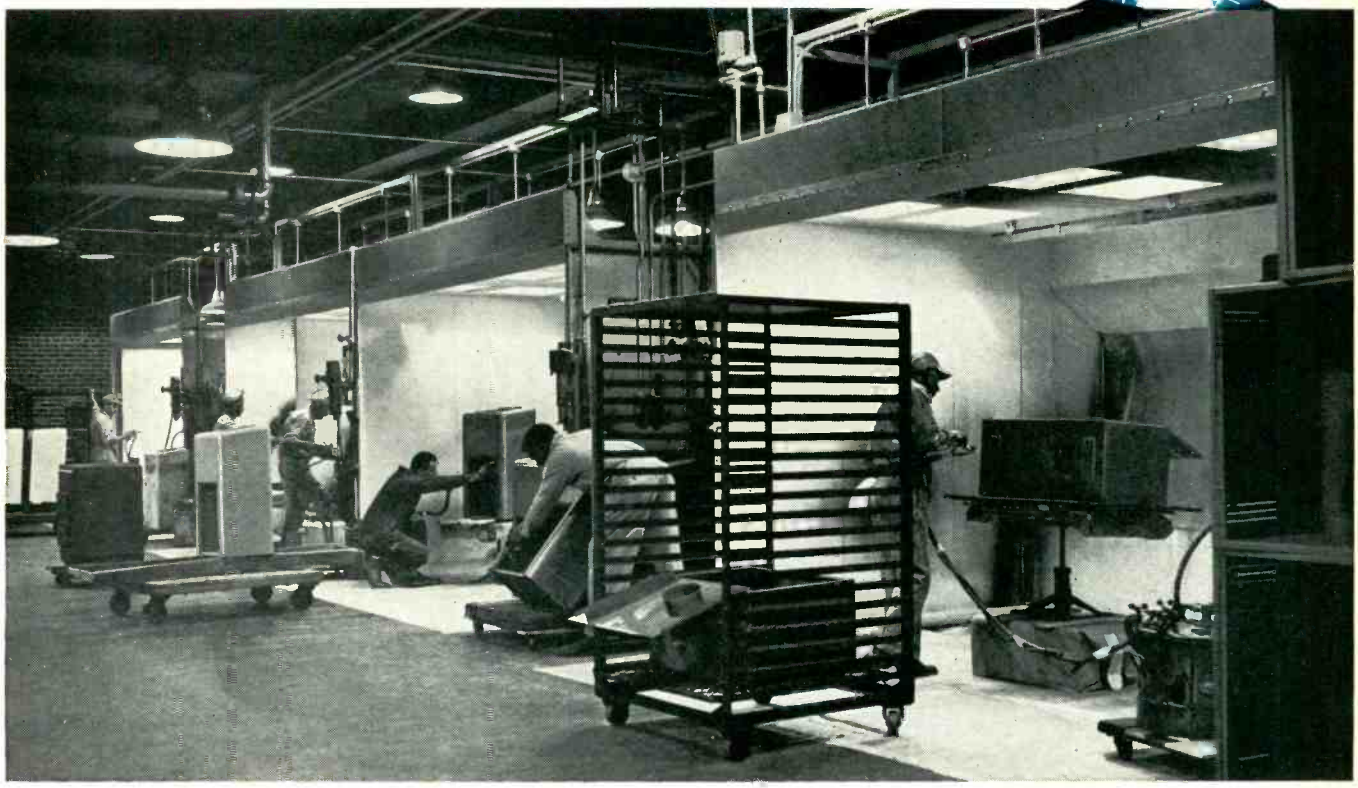
*More Sections Available without Gang Tuning.

NEW CATALOG ON REQUEST—Call or write for new Brochure with complete data on precision-built Microwave Filters, Preselectors, Frequency Meters and Field Test Instruments.

Frequency Standards
ASBURY PARK, NEW JERSEY

Please address inquiries to BOX 504A

HOW KARP FINISHES OFF YOUR CABINET PROBLEMS!



Dependable one-stop service ...complete sheet metal fabrication plus final painting all under one roof!

Just unpack your Karp made cabinets and place them on your own final assembly line. No inspection is needed. Every dimension is dependably accurate ...and the finish is ready for your most exacting customer. No need to shuttle cabinets from fabricator to you to finisher and back to you. You save valuable production time—you eliminate double handling, and that brings down your final cost considerably.

More than that, you get the top-quality job that keeps so many blue chip customers happy with Karp service. For Karp brings you a perfectionist's idea about custom craftsmanship. Backed by one of the most modern sheet metal fabricating and finishing plants in the world. Plus creative experience in tooling complex jobs...and developing cost-cutting ideas for our customers, whether orders are small or large.

Why not find out how Karp craftsmanship can finish off your own cabinet problems to perfection. Let us quote on your next requirement. No expense or obligation to you, of course.

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Custom fabricators of enclosures, chassis, panels in any metal • All welding facilities U. S. Air Force Certified • Air-conditioned spray room • Complete baking facilities • Over 3,000 dies available • Complete sub-assembly facilities

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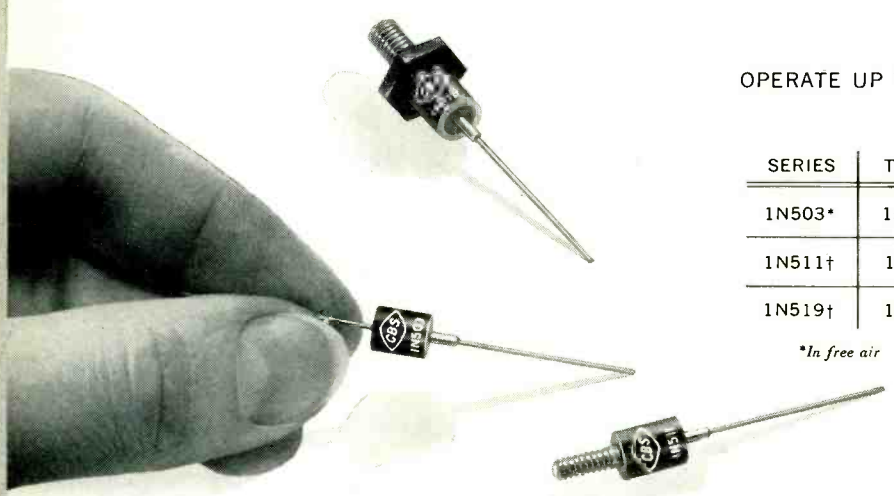
THREE NEW FAMILIES OF CBS SILICON POWER RECTIFIERS



OPERATE UP TO THESE MAXIMUM LIMITS

SERIES	TEMP.	AMPS.	VOLTS
1N503*	150°C	⅓	50 to 600
1N511†	150°C	1	50 to 600
1N519†	150°C	1¼	50 to 600

**In free air* †*With suitable heat sink*

CBS-HYTRON offers you, in three basic designs, a wide selection of high-power silicon junction rectifiers with uniformly controlled characteristics. All three series feature compactness and high rectification efficiency (up to 99%) at high currents. Low forward and high back resistances give high power handling capabilities. And low thermal resistance permits operation up to 150°C.

Possible applications are innumerable . . . wherever you need highly efficient, high-current miniaturized rectifiers. As illustrated, the 1N503 series is supplied with convenient flexible leads. And the 1N511 and 1N519 series are designed with screw studs for easy attachment to heat sinks. For complete data ask for Bulletin E-263. Or request a quotation on CBS silicon power rectifiers suited to your applications.

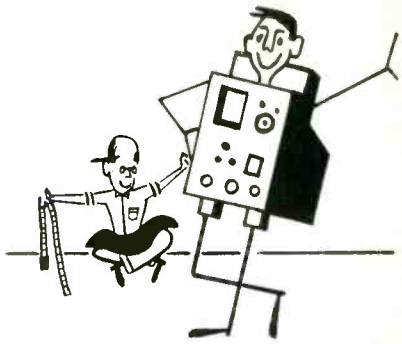
CBS semiconductors

CBS-HYTRON, Danvers, Mass.

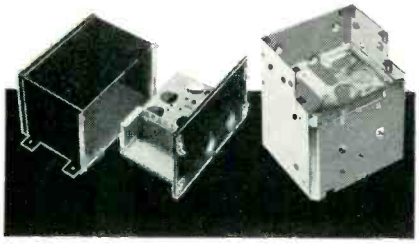
A Division of Columbia Broadcasting System, Inc.

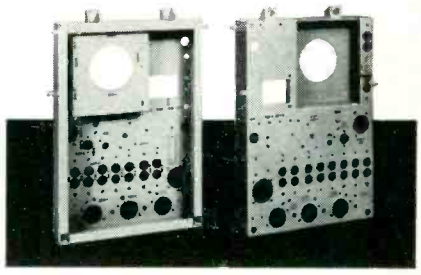
Reliable products
through Advanced-Engineering.

why you should use BALTIC custom built enclosures...

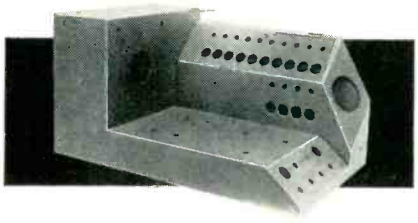


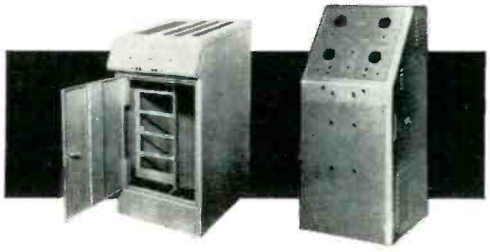
Your product in a BALTIC custom built housing has a luxury look . Individually designed to meet your specifications . . . and you can be assured of perfect fit and skilled craftsmanship. Our large stock of standard and Whistler die combinations eliminates unnecessary tool charges and send your unit cost way down.

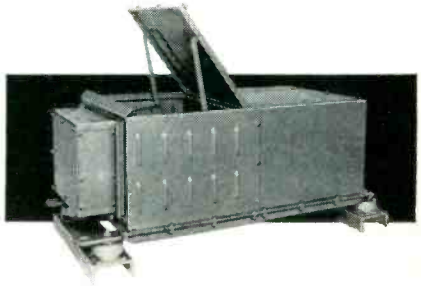




All our products are interchangeable to assure speedy assembly on your production line. Each unit we turn out is accurately engineered to close tolerances and finished to perfection, reflecting our long years as specialists in solving sheet metal fabrication problems.







Whether you need simple chassis or enclosures for the most complicated equipment, BALTIC will custom build it . . . in any metal, any size, any gauge, any finish, in large or small quantities. Complete facilities for finishing and shipping all under one roof.

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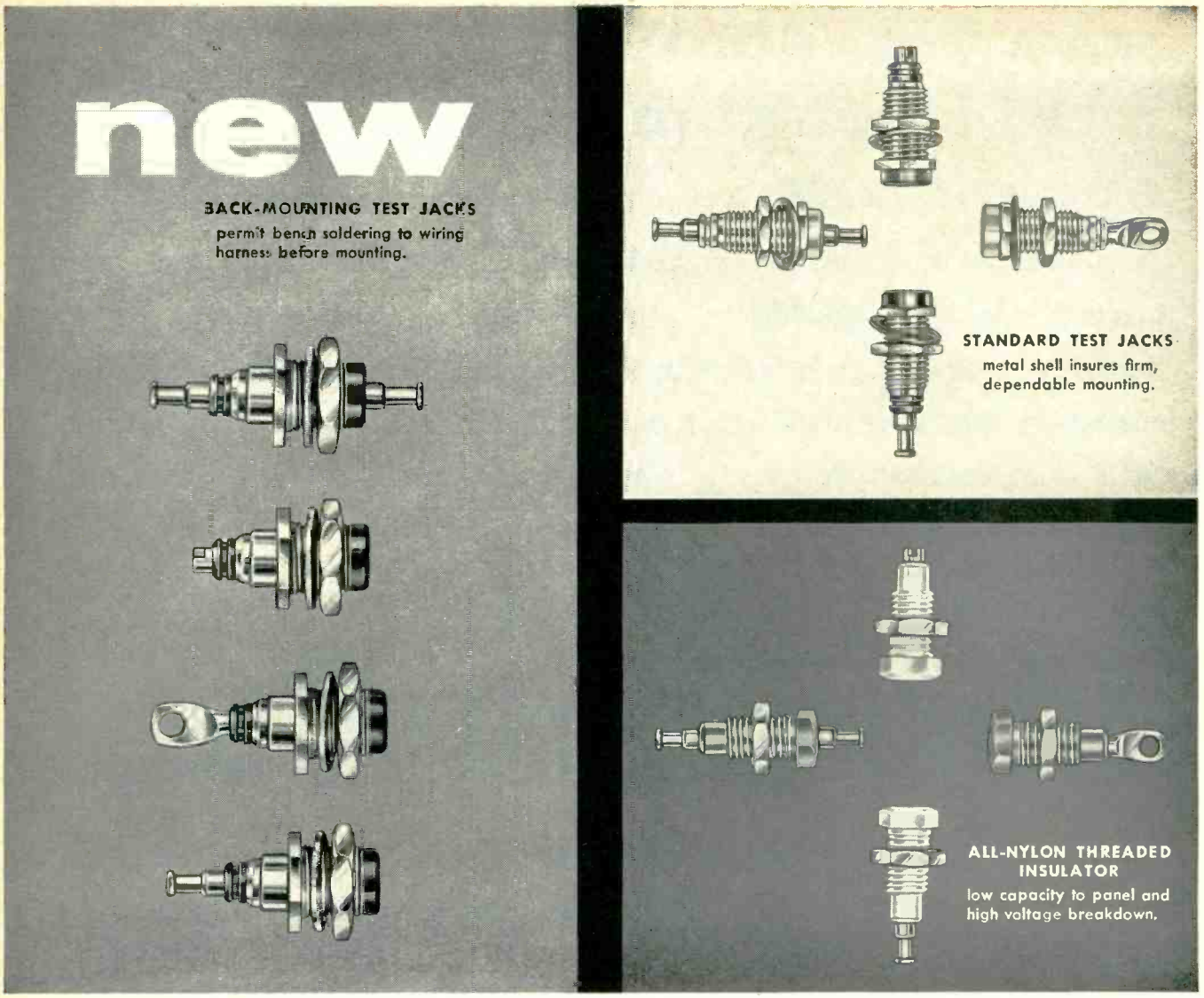

Test Jacks by Ucinite

The introduction of Ucinite's back-mounting jacks makes available for the first time a *complete* line of *high quality* test jacks suitable for use in equipment where long life and dependability are essential.

Ucinite Test Jacks, designed for standard .080 phone tips, are available in a variety of colors ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements.

For full information, call your nearest Ucinite or United-Carr representative or write directly to us.

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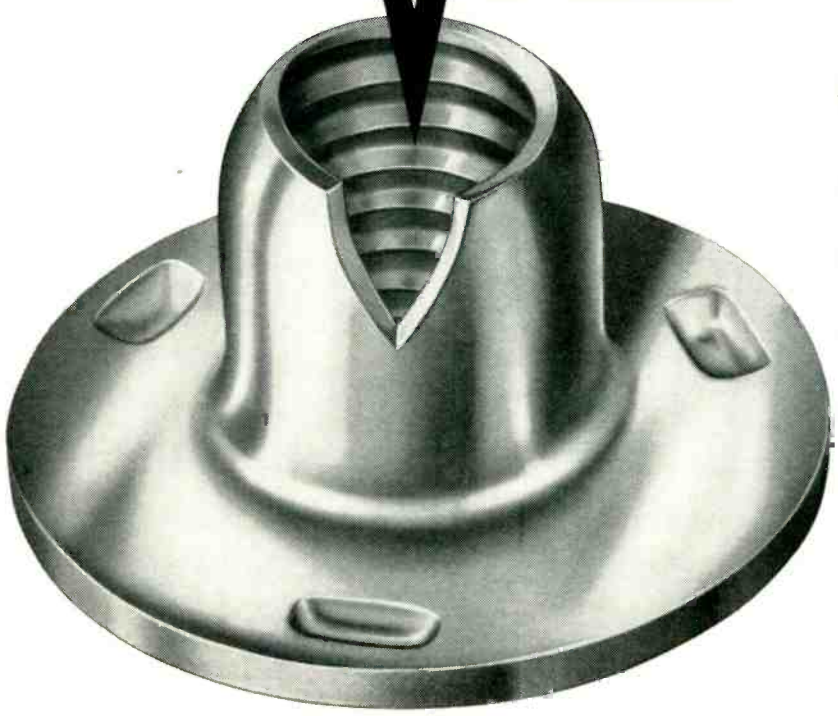
Want more information? Use post card on last page.

NEW V-LOCK TEENUTS®

PATENT APPLIED FOR

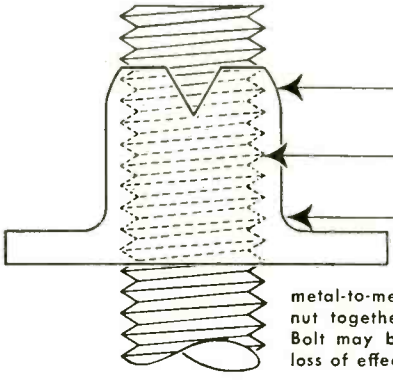


- self-locking
- vibration-proof
- one-piece construction
- proven effectiveness
- highly adaptable
- re-usable

The upper portion of this precision-made Teenut incorporates a V-type notch with the circumference of the barrel compressed inwardly toward the axis to form a permanent set. This makes it a re-usable, prevailing-torque-type, self-locking nut.

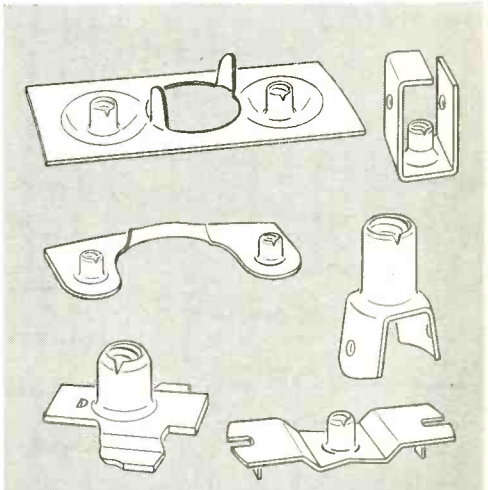
It is a one-piece, self-contained unit in which the self-locking device is an integral part of the design. No non-metallic materials or stamped parts are used so that the V-lock Teenut is not affected by heat or oils and has high tensile strength.

As the V-lock Teenut does not rely on base load to obtain its friction grip, it may also be used as a stop nut. (Indentations in base flange are welding bosses).



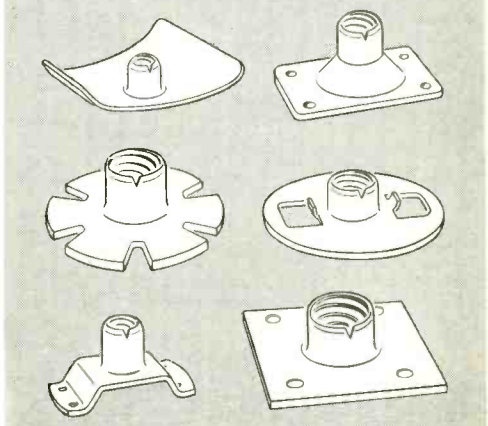
Bolt spins freely into nut until it reaches gripping area. Then, spring action creates strong, metal-to-metal wedging force, locking threads of bolt and nut together to make assembly virtually vibration-proof. Bolt may be removed and replaced many times without loss of effectiveness in nut.

The V-lock Teenut is but one of thousands of special purpose fasteners designed and manufactured by United-Carr to help speed assembly, cut costs and improve product performance. For further information on the V-lock Teenut or for help with any other fastening problem, consult your nearest United-Carr field representative or write us for his name and address.



UNLIMITED VARIETY

V-lock Teenuts can be engineered in various shapes and sizes to suit customer's specifications. Can be manufactured *in volume*... in brass, bronze, stainless steel, aluminum, etc.... with unified screw threads, class 2B, in both coarse and fine thread series. Finishes: zinc, cadmium, chrome, parkerized, etc. to customer's specifications.



UNITED-CARR FASTENER CORPORATION

31 Ames Street Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

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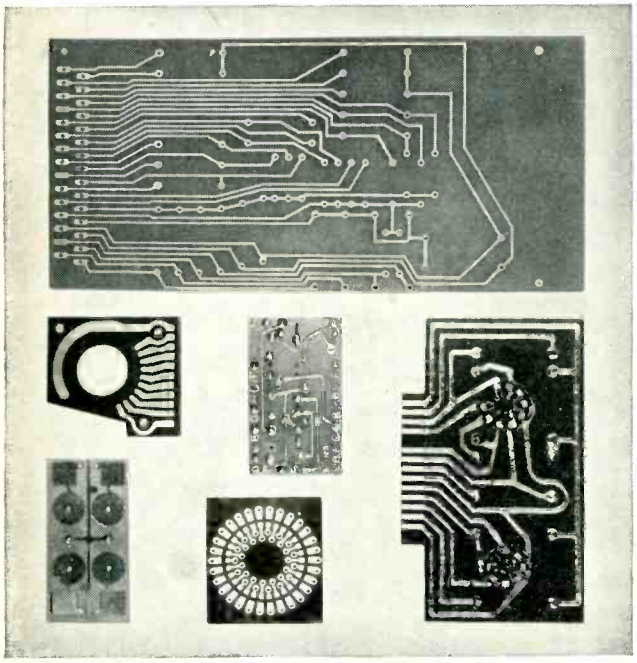
For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-24)	Copper-Clad EPOXY (Grade GB-116E)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-116T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35° C. & 90¾ RH	50,000	50,000	30,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

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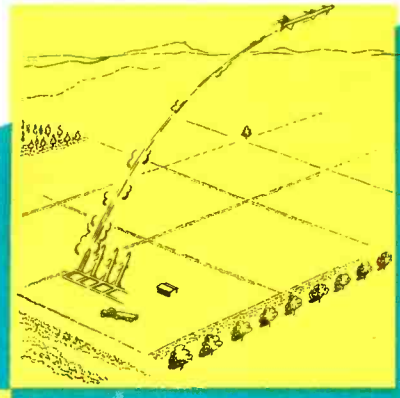
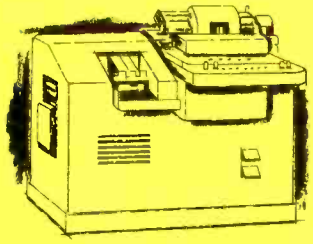
CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

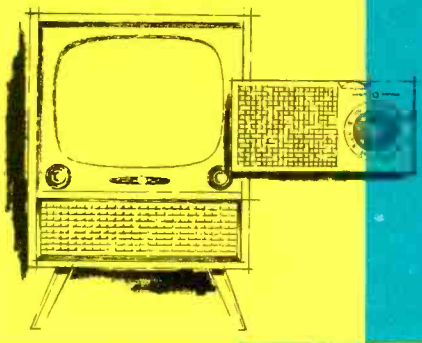
NEWARK 16, DELAWARE

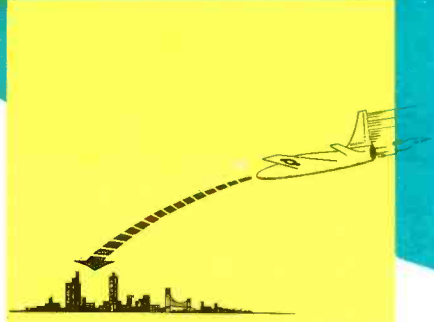
The Widest Coverage of Semiconductor Circuit Requirements Available . . . Anywhere

General Electric's Expanded Line of Transistors and Rectifiers Now Offers Greater Power Performance at Extended Frequency and Temperature Limits.









Within the past year, General Electric has introduced a number of new transistor and rectifier components with greatly expanded limits of operation, performance and reliability.

These recent developments have created broader areas of semiconductor application in both the electronics industry and the military.

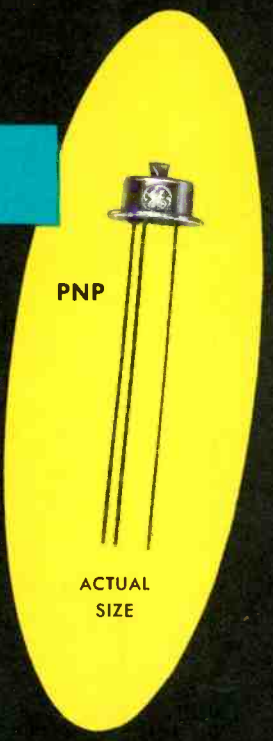
- HIGH SPEED COMPUTERS
- HIGH FREQUENCY AMPLIFIERS AND OSCILLATORS
- RADIO AND TELEVISION RECEIVERS
- AIRBORNE COMMUNICATION
- NAVIGATION
- FIRE CONTROL
- RADAR
- GUIDED MISSILES

The following five pages contain descriptions, illustrations, and condensed specification data covering General Electric's full line of transistors and rectifiers.

RECENT G.E. TRANSISTOR DEVELOPMENTS MAKE POSSIBLE COMPLETE TRANSISTORIZATION

. . . FROM MINIATURE RADIO RECEIVERS TO
HIGH SPEED COMPUTER SWITCHING APPLICATIONS

TRANSISTORS FOR RADIO RECEIVERS



For the IF amplifiers and mixers of radio receivers, G.E. offers both PNP and NPN transistors. The G-E 2N135, 2N136 and 2N137 transistors are alloy junction PNP types which provide uniformly high power gain in both mixers and IF amplifiers. The 2N78 NPN transistor, manufactured by General Electric's exclusive rate-grown process, may be easily neutralized with unselected components through controlled C_c and r_b'. The high f_{co} inherent in the rate-grown process provides power gains up to 39 db.

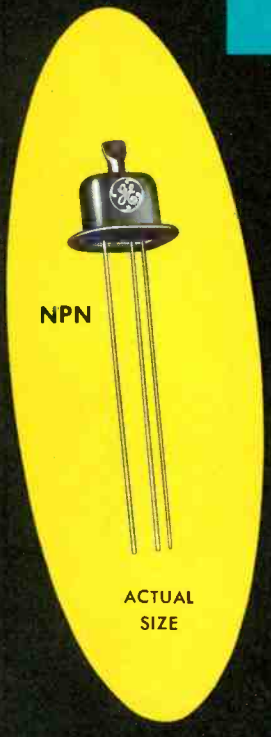
As the result of recent General Electric research, audio transistors have been developed which are capable of delivering 750 mw power output at less than 10% distortion, with audio stage gains up to 70 db. These transistors, G-E development types ZJ17, are now in production.

TYPICAL POWER GAIN(db) FOR A TRANSISTORIZED RADIO RECEIVER

TYPE	Mixer Osc.	1st IF	2nd IF	TYPE	Driver	Class A Output	Class B Output	Power Output
2N78	30	36	36	ZJ17	40		26	750 MW
2N135	30	36	36	ZJ17	40	30		100 MW

Power gain does not include transformer losses. Circuit information and transformer impedances can be obtained from your Semiconductor Products district representative (see back page).

TRANSISTORS FOR MILITARY, INDUSTRIAL AND DATA PROCESSING APPLICATIONS



General Electric pioneered the production of germanium transistors of high reliability at extended ranges of temperature. Exclusive G-E processing techniques provide stable gain over wide temperature areas and reliability in the most critical applications.

General Electric's 4JD1A17 is the commercial version of the Air Force transistor, type USAF-2N43A per revised spec, MIL-T-25380/1. The G-E type 2N123, a 5-megacycle 20-volt germanium alloy junction transistor, is specially designed and manufacture-controlled for switching applications in data processing equipment and industrial control circuits.

Like the 2N123, the G-E 2N167 transistor is designed, processed and specified for switching applications. The high collector voltage rating of 30 volts at a minimum frequency cutoff of 5 mc allows greatly expanded applications of transistors in electronic circuits.

ABSOLUTE MAXIMUM RATINGS				
TYPE	V_c	I_c	P_c	T_a
4JD1A17	—45	—50	150	85
2N123	—20	—125	100	85
2N167	30	75	65	85
	volts	ma	mw	°C.

ELECTRICAL CHARACTERISTICS: DESIGN CENTER (V_c=5V, I_E=1ma)							
h_{11}	h_{12}	h_{21}	h_{22}	B_{DC}	f_{co}	r_b'	I_{co}
28	$4X10^{-4}$	.977	0.5	—	1.0	—	5
28	$8X10^{-4}$	.98	0.9	50	8.0	80	2
40	$1.5X10^{-4}$	.975	0.2	25	8.0	500	1
ohms	—	—	μmho	—	mc	ohms	μa

GENERAL ELECTRIC TRANSISTORS	PNP TYPES			NPN TYPES
	2N43	2N44	2N135	2N78
	2N43A	2N45	2N136	2N167
	4JD1A17	2N76	2N137	2N169
	2N107	2N123		2N170

G-E RECTIFIER INFORMATION FOLDOUT ON OPPOSITE PAGE

NEW PRODUCTS

LATEST GENERAL ELECTRIC SEMICONDUCTOR DEVELOPMENTS WHICH GREATLY EXTEND THE POWER, FREQUENCY AND TEMPERATURE RANGES OF RELIABLE OPERATION

SILICON

New G-E Silicon Devices Offer Greater Power at Higher Temperature in Smaller Package.

TRANSISTORS

Increased Power with Operating Temperatures Up to 200°C.

SILICON POWER TRANSISTOR

8-watt dissipation at 85°C.

SILICON HIGH FREQUENCY TRANSISTOR

10-megacycle operation

Constructed with tiny metal shield on cap for automatic assembly indexing and/or grounding.
Leads are specially arranged for direct plug into printed circuit board.

SILICON DOUBLE BASE DIODE

Operation up to 200°C.
Replaces 2 junction transistors in computer circuits.

RECTIFIERS

High Temperature Operation *plus* G-E Reliability and Advanced Miniaturization.

SILICON HIGH CURRENT RECTIFIER

50 amps per cell at 300 PIV.
200°C. storage temperature
150°C. rated stud temperature

SILICON LOW CURRENT RECTIFIER

¼ amp per cell.
175°C. storage temperature
150°C. rated free ambient
(Full ratings *without* heat sink)
Solders directly into circuit for machine assembly.

*All products shown approximately full-scale size

GERMANIUM

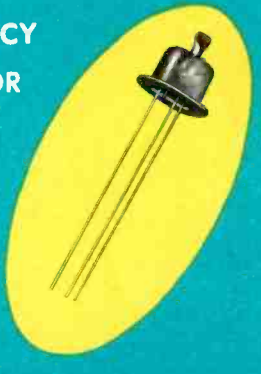
New NPN Transistors Extend Frequency Limits.

NPN TETRODE TRANSISTOR

50-megacycle operation at temperatures up to 85°C.

NPN HIGH FREQUENCY TRIODE TRANSISTOR

15-megacycle operation at temperatures up to 85°C.



The above semiconductor devices were developed, refined and submitted under government contracts AF33(600)-28956 and AF33(600)-17793, Wright-Patterson Air Force Base, Ohio.

For The Full Story On General Electric Semiconductors Contact Your Nearest G-E Semiconductor Products Representative

District #4 A. C. Oeinck
District #5 H. F. Hodsdon
District #6 V. J. Huntoon

Semiconductor Products
General Electric Company
4927 Oakton Street
Skokie, Illinois
Phone: ORchard 5-7505
Chicago—IRving 8-8668

District #1
F. J. Van Poppelen, Jr.
Building 7-Room 103
Electronics Park
Syracuse, New York
Phone: Syracuse 76-4411
Extension 2692 or 2374

District #2 C. J. Goodman
A. B. Dall
District #3 H. S. Berck

Semiconductor Products
General Electric Company
200 Main Avenue
Clifton, New Jersey
Phone: Gregory 3-6387
Wisconsin 7-4065

District #7
H. W. Gebhardt, Jr.
11840 West Olympic Blvd.
Los Angeles, California
Phone: Granite 9-7765
Bradshaw 2-8566

The specification and rating data presented on the five preceding pages have been condensed to cover but a few basic design requirements. Detailed information concerning General Electric's full line of transistors and rectifiers may be obtained by contacting your nearest G-E Semiconductor Products district representative or by writing to:

GENERAL ELECTRIC COMPANY
Semiconductor Products Section
Electronics Park, Syracuse, New York

When writing for information, please specify by publication numbers the material desired.

CURRENT G-E TECHNICAL PUBLICATIONS

TRANSISTORS

TYPE	PUBLICATION NUMBERS
2N43 (PNP)	ECG-20B
2N43A (PNP)	ECG-76
4JD1A17 (PNP)	ECG-117
2N44 (PNP)	ECG-21B
2N45 (PNP)	ECG-22B
2N76 (PNP)	ECG-58
2N81 (PNP)	ECG-67A
2N123 (PNP High Frequency)	ECG-100
2N135, 2N136, 2N137 (PNP High Frequency)	ECG-109
2N78 (NPN High Frequency)	ECG-78A
2N167 (NPN High Frequency)	ECG-119
2N169 (NPN High Frequency)	ECG-121
2N170 (NPN High Frequency)	ECG-120

RECTIFIERS

Diffused Junction Rectifiers	ECG-59
Germanium Rectifier Stacks	ECG-53A
1N315 High Temperature and 1N368 Magnetic Amplifier Rectifiers	ECG-131
4JA3011 Power Rectifier and Stacks	ECG-124

GENERAL ELECTRIC

ECG-129

PRINTED IN U.S.A.

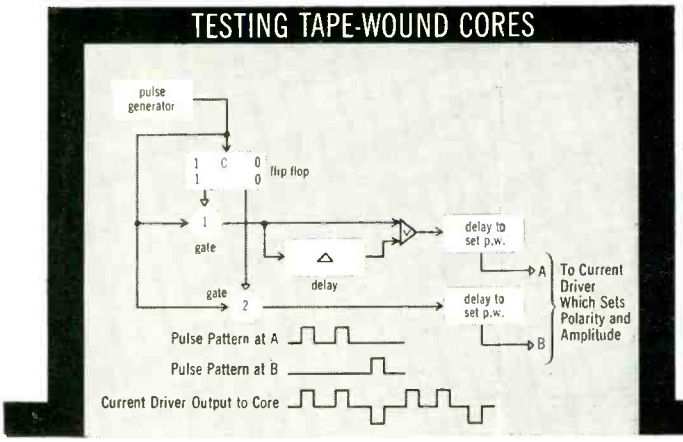
testing components with Burroughs pulse control systems

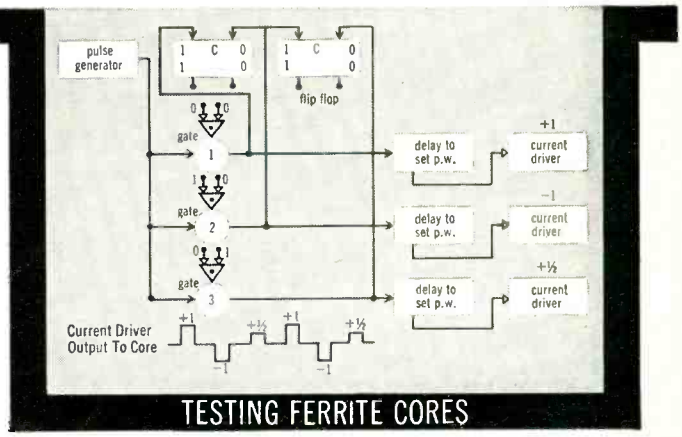
modern methods for testing cores

The future of magnetic cores in information handling systems is already well assured. Their high reliability, fast action, small size, and low power consumption stimulate the imagination of more and more engineers working in data processing, weapons systems, and control. And every day finds these new components included in more new designs.

One problem still facing those who want to exploit these exciting properties is the lack of precise uniformity in cores made on a production basis. For as Burroughs has found through 5 years of working with the pioneers in core applications, uncertainties still exist. And before cores become standardized, many changes will probably be made. Those who want to take advantage of the great potential in this new component now must use reliable test procedures which precisely check the tolerances of each core, and are versatile enough to check for the new core specifications of tomorrow.

Burroughs Pulse Control Systems answer this need for leading manufacturers and users of cores by simulating the actual conditions under which each core produced will eventually operate. When conditions require a change in core operating characteristics, the testing system is changed at will, in a matter of minutes, to meet the new requirements.





BURROUGHS

Electronic Instruments Division • 1209 Vine Street • Philadelphia 7, Pa.

Shown here are typical examples of how these core manufacturers, including Burroughs own core production department, use Burroughs Pulse Control Systems to check tape wound and ferrite cores. An interesting booklet describing core testing in greater detail is yours for the asking. But if you want to test another component by digital techniques, just send us your problem. We'll be glad to work it out, at no cost, and show you how Burroughs Pulse Control Systems can save you hours of engineering time and production headaches.

CLEANER, BRIGHTER CHASE® SHEETS

speed production, cut costs!

"Ready for production" is the way you receive Chase brass and copper sheet and strip. That means surfaces are smooth and bright — free from grease, dirt and oxide coating.

You'll get *trouble-free* production, whether you stamp, spin, punch or draw Chase sheet and strip. In fact, you can often *combine* forming processes, without intermediate annealing.

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Want more information? Use post card on last page.

PERFORMANCE IS BUILT INTO THIS CHOPPER

Painted case resists corrosion and is hermetically sealed to the base so that this chopper operates reliably in any atmosphere from sea level to 50,000 feet.

Permanent magnet polarizes switching to provide phase sensitive mechanical modulation of low-level signals.

Drive coil is conservatively rated for 6.3 volts RMS ± 10% at 400 CPS ± 5%.

Vibrating reed is resonant well above operating frequency to assure that switching phase of 65 degrees remains within ± 15 degrees for all operating conditions.

Buffer plate counteracts any tendency to chatter at make and break.

Ceramic insulators provide at least 100 megohms between contacts and case for use in high-impedance circuits.

Wiping action on fixed contacts, as in all Airpax choppers, help assure rated life of 2,000 hours.

Miniature 7-pin tube-type base rigidly supports internal assembly of this Airpax Type 300 chopper so that it withstands shock and vibration.

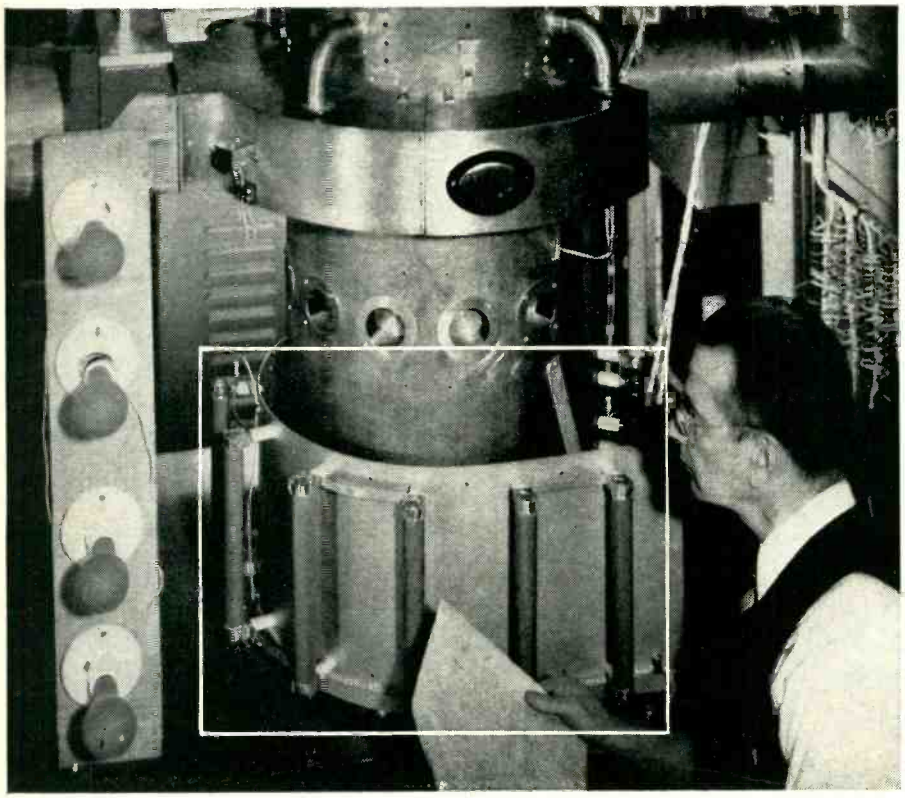
For complete specifications write to

AIRPAX PRODUCTS COMPANY
DESIGNERS ENGINEERS
MIDDLE RIVER BALTIMORE 20, MD.

Want more information? Use post card on last page.

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



BIG MOON RADAR undergoing tests. Ward Leonard resistors—like those in foreground—help this gear stay on the air—or, rather, on space.

New moon radar to explore outer space

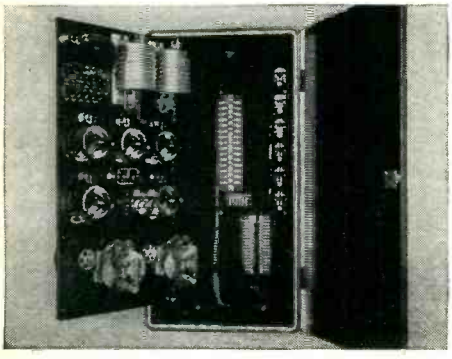
The U.S. Army Signal Corps hasn't got a transmitter in outer space—yet.

So, for their continuing studies of radio wave propagation in space and the upper atmosphere, they bounce radio waves from their new high-powered radar, Diana, off the moon and planets and study the return pulse.

Designed and built by Radio Engineering Laboratories of Long Island City, N. Y., the new radar transmitter puts out 50 kilowatts, continuous wave, and may be pulse modulated at various pulse widths and repetition rates. Receiver gain is 170-db at better than 3-db noise figure.

Throughout the equipment, high-stability Ward Leonard resistors, like the big Vitrohm resistors shown above, do duty as high-voltage bleeders, surge and current limiting resistors, and protective meter shunts in high-voltage circuits.

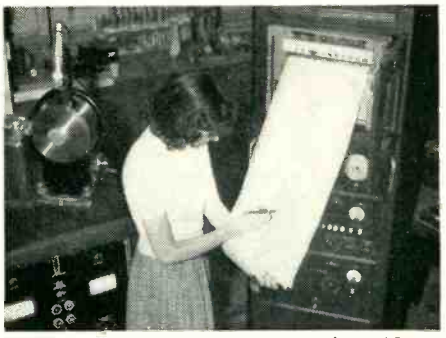
You'll find Ward Leonard Vitrohm resistors completely described in our 64-page Catalog No. 15, together with nomographs and charts to help select them. Write for your copy today.



Relays mastermind traffic lights

Sun, rain, sleet, snow, and continuous 24-hour-a-day duty is the lot of this master traffic light controller. Four dependable Ward Leonard relays select automatic timing cycles. Two more relays allow remote control of off-duty flashing amber signals and signal shut-down. Learn more about these rugged relays in Ward Leonard Bulletin No. 110.

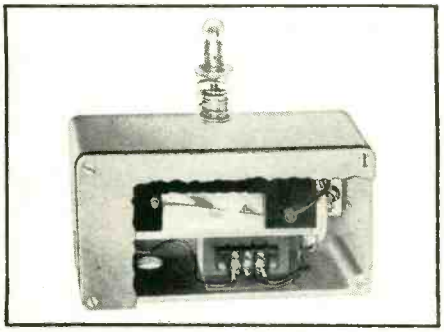
Photo courtesy Crouse-Hinds Co.



SHE'S CHECKING CHART RECORD from X-ray spectrometer in Ward Leonard's test lab.

Plant X-ray speeds quality control and helps catch crooks

X-ray diffractometer and spectrometer tests insure high quality and uniformity of both raw materials and fabricated components at Ward Leonard. These instruments check crystal structure in ceramics, magnetic amplifier cores, contact metal, and resistance wire. In off hours, they help the Mount Vernon Police and Fire Department put the finger on crooks and arsonists.



AUTOMATION FOR MACHINE TOOLS is simplified by this precision control potentiometer.

Control for machine tools

Accurate electronic control component for cutting tools, winders and processing machine drives is provided by this compact, precision potentiometer.

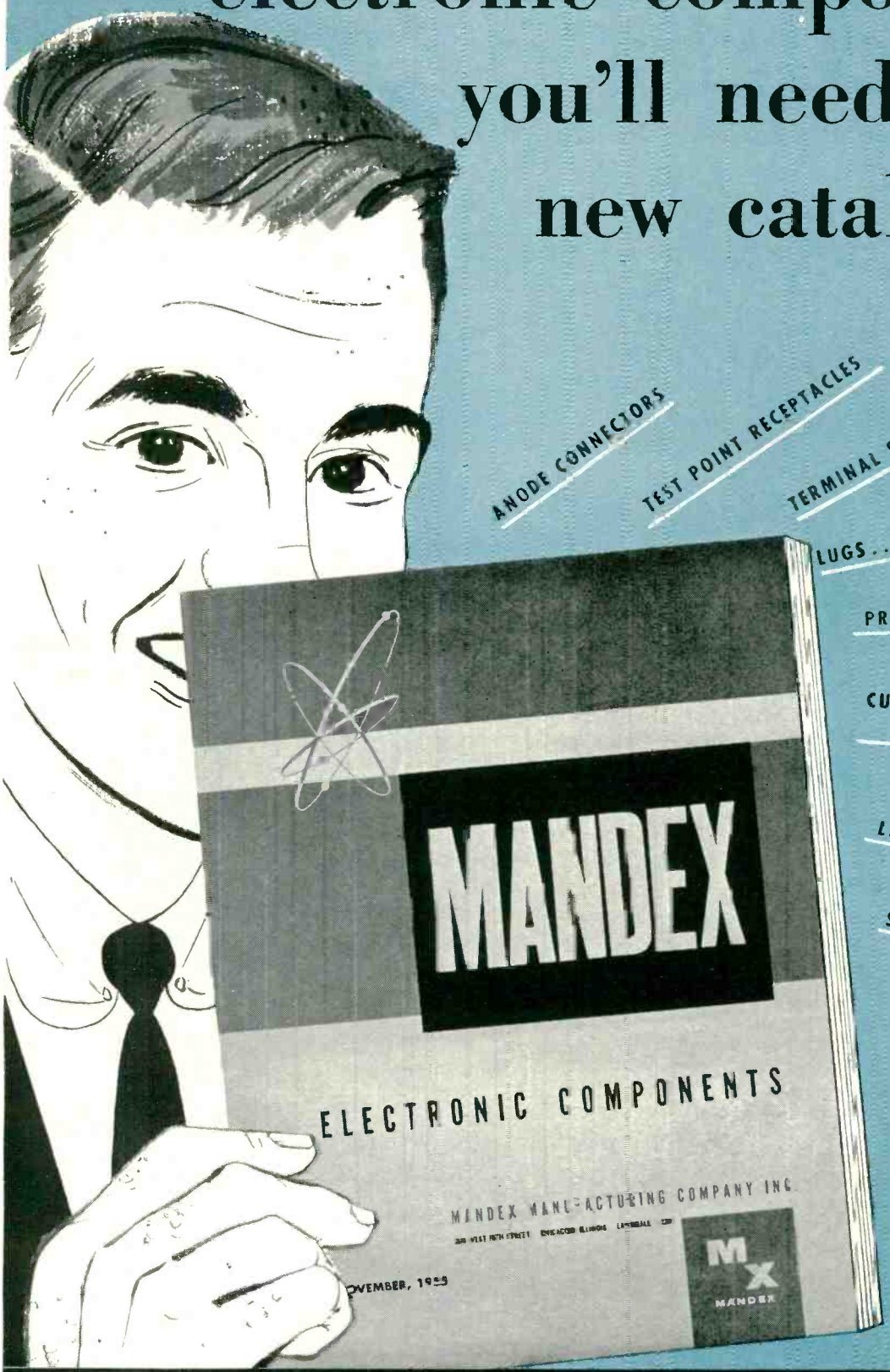
A half-inch plunger movement drives the metal alloy contact across the special resistance element. Enclosure is compact; calibration is permanent. Standard resistance—10,000 ohms; up to 25,000 ohms on special order. Write for Bulletin 68. 6-3

WARD LEONARD ELECTRIC COMPANY
31 SOUTH ST., MOUNT VERNON, N. Y.

Result-Engineered Controls Since 1892

RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

if you buy or use electronic components, you'll need this new catalog!



ANODE CONNECTORS

TEST POINT RECEPTACLES

TERMINAL STRIPS AND TUBE SOCKETS

LUGS . . . BRACKETS . . . CONTACTS

PRINTED CIRCUIT WIRING

CUSTOM MOLDINGS AND LAMINATING

METAL AND LAMINATE STAMPINGS

SPECIAL APPLICATIONS

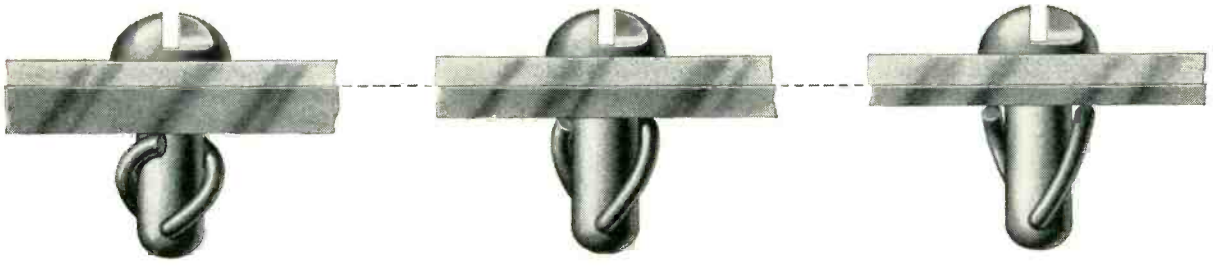
The new MANDEX Catalog contains 60 pages of electronic components now available to you. It's a real designer's or purchasing agent's "tool," chock full of real data, illustrations, drawings, and other useful information. **Better send for your copy today . . . no obligation!**

MANDEX MANUFACTURING COMPANY, INC.

2612 West 16th Street, Chicago 8, Illinois

Affiliate, P. R. Mallory & Co., Inc. Indianapolis

This fastener works through thick and thin!



Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION

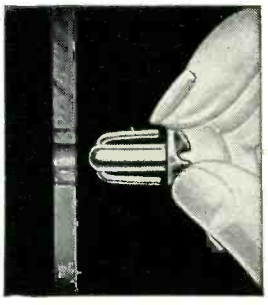
1750 North Broadway, Albany 1, New York

Simmons

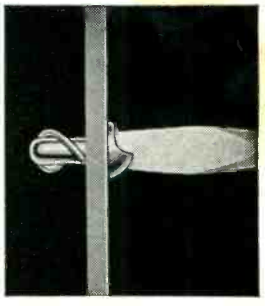
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS



1. *Insert fastener.*



2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

Transitron®

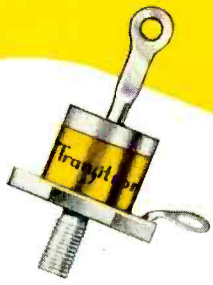
SILICON RECTIFIERS

actual size

35 amperes

Type	Maximum Average Current (amps)	Maximum RMS Voltage (volts)	Peak Inverse Voltage (volts)
1N411A	35	35	50
1N412A	35	70	100
1N413A	35	140	200

RATINGS AT 125°C CASE TEMPERATURE



actual size

20 amperes

Type	Maximum Average Current (amps)	Maximum RMS Voltage (volts)	Peak Inverse Voltage (volts)
1N248A	20	35	50
1N249A	20	70	100
1N250A	20	140	200

RATINGS AT 125°C CASE TEMPERATURE

Transitron silicon power rectifiers are designed for high temperature applications requiring maximum efficiency and small size. Their high forward conductance improves output regulation, and allows reductions in transformer size. Hermetic sealing assures long term stability and permanent environmental protection.

Types 1N411A and 1N412A are particularly useful as transformer rectifiers in 28-volt power supplies of 100 amperes, 200 amperes or higher. Types 1N413A and 1N250A are designed for line voltage bridge rectification and other high voltage applications.

Write for Bulletin TE-1337 . . .

immediately available

IRE Show Booth 580

Transitron
electronic corporation
melrose 76, massachusetts

Glass Diodes | Transistors | Power Transistors | Silicon Diodes | Silicon Rectifiers

T®

NOW AVAILABLE!

actual size

MILITARY type silicon rectifiers

IN254

IN255

IN256

Transitron's military type Silicon Power rectifiers meet the long felt need for reliable operation at temperatures up to 150°C. Available in production quantities with inverse voltage ratings up to 600 V, these rectifiers offer greatly improved performance because of their superior electrical and mechanical characteristics.

Hermetic Sealing is combined with miniature size to provide complete environmental protection along with size and weight reduction. These rectifiers are designed to meet the requirements of MIL-E-1B.

Write for Bulletin TE1336

Type	Continuous Inverse Working Voltage (volts)	Maximum RMS Voltage (volts)	Maximum Average Forward Current (ma)	Peak Forward Current (amps)	Maximum Surge Current (amps)
1N253	100	70	1000	4	4
*1N254	190	135	400	1.2	1.5
*1N255	380	270	400	1.2	1.5
*1N256	570	400	200	.6	.6

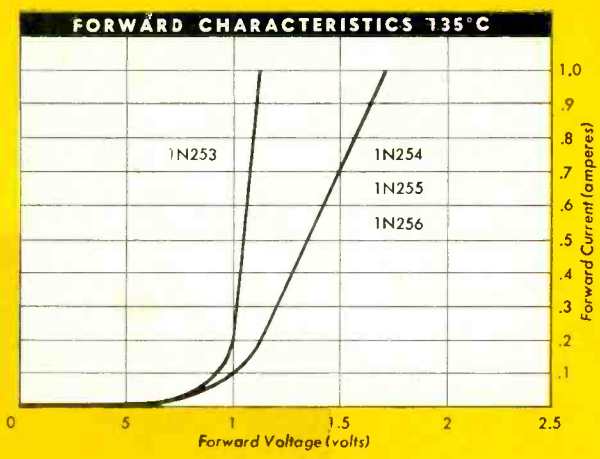
RATINGS AT 135°C CASE TEMPERATURE

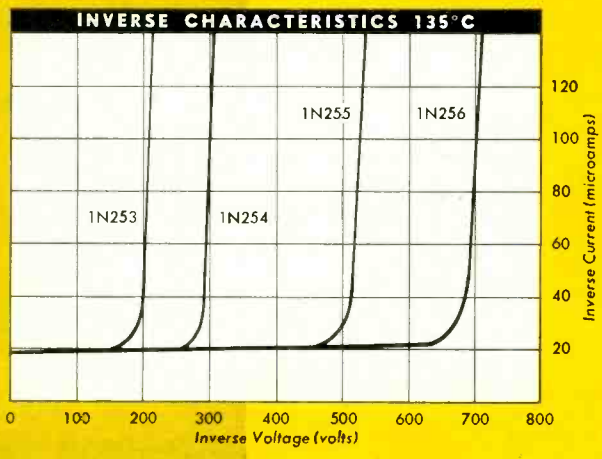
ENVIRONMENTAL TESTS

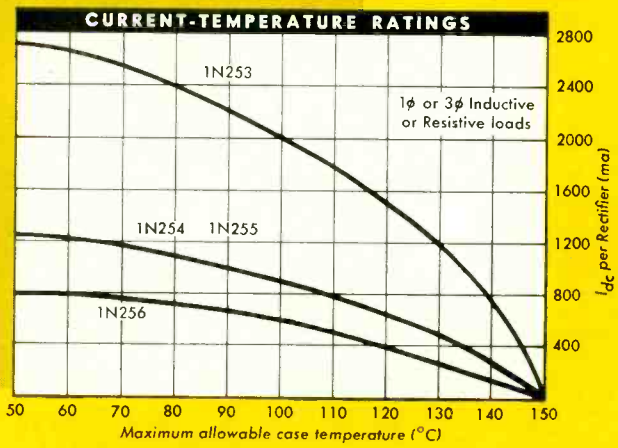
Life test per Para 4.11.4 MIL-E-1B	1000hr	min.
Vibration fatigue, 45 to 100 cycles, 10g	64hr.	min.
Vibration, 100 to 1000 cycles, 10g	16min	min
Centrifuge, two directions	5000g	min.
Shock tests per MIL-STD-202, 1 millisecond	500g	min.

*JAN Types

Transitron®
electronic corporation
melrose 76, massachusetts







FEATURES:

- **RELIABILITY AT HIGH TEMPERATURES**
  Rated for continuous service at 135°C
- **HIGH VOLTAGE RATINGS**
  Up to 600 volts
- **HIGH POWER HANDLING ABILITY**
  Up to 1 ampere at 135°C
- **MINIATURE SIZE**
  Less than .2 cubic inches volume

TYPICAL USES

Power Supplies for:

- Aircraft
- Missiles
- Radar
- Mobile Communications
- Computers
- Autopilots
- Telephone Systems

Magnetic Amplifiers

High Temperature AC Relays

DC Isolation

Arc Suppressers

Voltage Regulators

Motor Speed Controls

Battery Chargers

Magnetic Clutches

Circuit Breakers

Dynamic Brakes

Alternator Field Controls

Battery Equalizers

Switchboards

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IRE Show Booth 580


Glass Diodes


Transistors


Power Transistors


Silicon Diodes


Silicon Rectifiers

SMALL SIZE **LIGHT WEIGHT** **HIGH TORQUE** **HIGH QUALITY**

...all linked together in

GLOBE MINIATURE MOTORS

and motorized devices

SS sub-miniature permanent magnet d.c. motor. Speeds to 22000 rpm. 4 to 70 volts. Nominal rating 1/300 h.p. Dia. 7/8" x 1 3/16" long. Bulletin 120

SS motor and planetary gear reducer. Ratios 3.82:1 to 36873:1. Torque to 900 oz.in. Dia. 7/8" x 2-17/64" to 3-11/64" long. Bulletin X-7

MM and LL permanent magnet d.c. motors. Speeds to 22000 rpm. 4 to 70 volts. Nominal rating to 1/50 h.p. Dia. 1-3/16" x 1 3/4" or 2-3/32" long. Bulletins 100, 110

MM or LL motor and planetary gear reducer. Ratios 4-1/3:1 to 21808:1. Torque to 3500 oz.in. Dia. 1¼" x 2-7/16" to 4-9/64" long. Bulletin 1000

SC sub-miniature hysteresis-synchronous or induction motors. 400 cycle, 8000 to 24000 rpm. 60 cycle, 1200 or 3600 rpm. Torque to 0.6 oz.in. Dia. 1-1/16" x 1.32" long. Bulletin 1160

SC motor and planetary gear reducer. Ratios 3.82:1 to 36873:1. Torque to 900 oz.in. Dia. 1-1/16" x 2-5/16" to 3-7/32" long. Bulletin X-10

MC hysteresis-synchronous or induction motors. 400 cycle, 12000 or 24000 rpm. 60 cycle, 1800 or 3600 rpm. Torque to 0.8 oz.in. Dia. 1¼" x 2¼" long. Bulletins 1110, 1150

MC motor and planetary gear reducer. Ratios 4-1/3:1 to 21808:1. Torque to 3500 oz.in. Dia. 1¼" x 2⅞" to 3-25/32" long. Bulletin 1220

SS actual size

Axial and centrifugal blowers. Sub-miniature and miniature sizes, a.c. or d.c. Up to 50 cfm. Excellent reliability and life. Bulletins 500, 520, 1500, 1550

Globe's precision, quality-built *Moto-Mite** miniature motors are furnished in d.c. permanent magnet types, and a.c. hysteresis-synchronous or induction types, 400 or 60 cycle. They are custom-built in hundreds of size and design variations for specific applications where high performance, small size and lightweight are important considerations.

They may be furnished with planetary or concentric spur gear reducers for a broad selection of speeds and torque characteristics. Governors, clutches, brakes, filters and other controls may be incorporated in most units. Globe's pioneering experience in precision, miniature motor manufacturing, provides a broad resource of specialized know-how to solve your power problems. Globe's miniaturized components include servos, gyros, gear trains, blowers, fans, governors, generators, vibrators, actuators, switches, clutches, brakes, and motorized devices. Call a Globe sales engineer located in all principal manufacturing centers.

**trademark*

write on your letterhead for catalog, or bulletin describing the unit in which you are interested.

INDUSTRIES, INC.

1784 stanley avenue, dayton 4, ohio
precision miniature motors and motorized devices
dedicated to the best in product and in service

NEW VARO* 400 CPS FREQUENCY METER

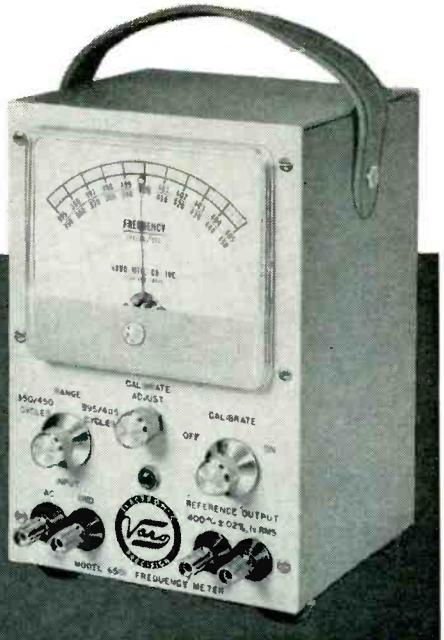
DESIGNED FOR GREATER ACCURACY AND VERSATILITY IN LABORATORY USE

The VARO* 6501 FREQUENCY METER is a compact precision laboratory 400 cps frequency standard and frequency meter with center scale accuracy of .02%.

The calibrator circuit incorporates the VARO* precision tuning fork. An output terminal is provided for external use of the 400 cps signal, as well as one for the operation of a recorder for permanent record.

Signal input impedance is 100,000 ohms so that there is no appreciable loading of circuit under measurement. The input signal wave form does not affect the measurement accuracy provided half periods are symmetrical.

The VARO* 6501 Frequency Meter has two easy-to-read scales, 395 to 405 cycles and 350 to 450 cycles to cover small as well as wide frequency ranges. Your inquiry for further information will receive prompt attention.



See us at Booth 21, Palace

SPECIFICATIONS

Center Frequency	400 cps
Full Scale Accuracy (395-405)	0.1%
Full Scale Accuracy (350-450)	1.0%
Reference Frequency Accuracy	.02%
Input Signal Range	2.0 to 250 volts
Power Requirement	105-125 volts 60 cycle AC
Dimensions	8¾ in. high, 5⅝ in. wide, 6⅛ in. deep

*Reg. Trade Mark

VARO Mfg. Co., Inc. 2201 WALNUT STREET, GARLAND, TEXAS

FACTORY REPRESENTATIVES

J. B. Steed
P. O. Box 459
Utica, New York

Ray Gilmer
638 South Van Ness
Los Angeles, California

R. H. Bouchard
941 North Highland
Arlington, Virginia

Phil McDaniel
P. O. Box 553
Far Hills Branch
Dayton, Ohio

EXPORT

Steven P. Nagel
1625 "Eye" St., N. W.
Washington, D. C.

New, low cost,

INDUSTRIAL

MEASURES FREQUENCY, SPEED, RPM, RPS, RANDOM EVENTS

MEASURES WEIGHT, PRESSURE, TEMPERATURE, ACCELERATION*

WIDE RANGE, 1 CPS TO 120 KC

DIRECT NUMERICAL READINGS

HIGH ACCURACY, SIMPLE TO USE

COMPACT, RUGGED, DEPENDABLE

-*hp*- 521A ELECTRONIC COUNTER — $475.00

SPECIFICATIONS

Range: 1 cps to 120 KC.
Accuracy: ±1 count ± accuracy of timing frequency. (Approximately ±0.1% when power line used, ±0.01% with crystal standard installed.)
Registration: 4 places. Total count capacity 9,999.
Input Requirements: 0.2 v rms. minimum above 10 cps; 0.3 v 1 cps to 10 cps.
Input Attenuator: Adjusts sensitivity from 0.2 v to 100 v rms.
Input Impedance: Approximately 1 megohm, 50 μμf shunt (½ megohm on "Phototube" jack).
Gate Time: 1/10 and 1 second. Panel neon lamp indicates that gate is open.
Manual Gate: Controlled by "Open-Closed" switch or external contacts.
Display Time: Variable from 1/10 to 15 seconds; or display can be held indefinitely.
Reads In: Cps or directly in rps or rpm with -*hp*- 506A or 508A/B Tachometer Accessories.
Self-Check: Counts line frequency for any selected gate time.
External Standard: Can be operated from any multiple of 10 cps, 10 cps to 100 cps.
Phototube Input: Supply voltage for 1P41 (or equal) phototube provided at phone jack on rear.
Power Supply: 115v ±10%, 50/60 cps, 170 watts.
Size: Cabinet Mount: 9¾" wide, 13⅞" high, 13⅜" deep. Weight: 25 lbs. net; shipping weight 40 lbs.
Accessories Available: -*hp*- 521A-95B Crystal Controlled Time Base for field installation, $100.00.
Price: $475.00.
**With transducers*

The new -*hp*- 521A measures frequency, speed, rpm, rps, and counts random events within a selected time interval. With transducers, it measures weight, pressure, temperature, acceleration and many other phenomena which can be converted to frequency. Operation is so simple the instrument can easily be used by non-technical personnel. Readings are direct in cps, rpm and rps. Period of count is 0.1 or 1 second; display time can be varied. A convenient internal check circuit is provided. There are accessory power supplies of —150 volts dc, +300 volts dc and 6.3 volts ac. Connections are also supplied for photocells and an external standard.

Model 521 uses the 50/60 cycle power circuit as a time base. For most applications, the accuracy of this power frequency is adequate. Where higher precision is required, a plug-in crystal controlled electronic time base is available at extra cost.

In measurements of speed, rps and rpm, the 521A is particularly useful with -*hp*- Optical Tachometer Pickups and Tachometer Generators shown on the opposite page.

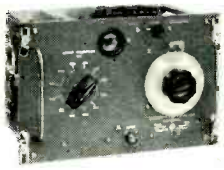
Your -*hp*- field representative will gladly demonstrate the compact, portable 521A in your plant or laboratory. Or, write direct for complete details.

hp® ELECTRONIC MEASURING INSTRUMENTS

versatile
COUNTER

OTHER -hp- COUNTERS

-hp- 524B Electronic Counter
with plug-in units to fit your exact measuring need



-hp- 525B
Frequency Converter

-hp- 526A
Video Amplifier

-hp- 526B
Time Interval Unit

-hp- 524B Counter with
-hp- 525A Frequency Converter

Frequency 10 cps to 220 MC, interval 1 μsec to 100 days, and period 0 cps to 10 KC—all are measured instantly, automatically and directly by the revolutionary -hp- 524B and its plug-in units. You buy just the instrumentation you need now; later add inexpensive plug-ins to double, triple the usefulness of this versatile, complete coverage counter. -hp- 524B without plug-ins, $2,150.00[Δ].

Instrument	Primary Uses	Frequency Range	Characteristics	Price
-hp- 524B Electronic Counter	Wide range highly accurate frequency, period measurements	10 cps to 10 MC	Without plug-in units measures frequency 10 cps to 10 MC, and period 0 cps to 10 KC, 1 volt rms minimum input	$2150.00[Δ]
-hp- 525A Frequency Converter	Extends -hp- 524B range to 100 MC	10 cps to 100 MC	10 mv rms minimum input 10 MC to 100 MC .1 volt from 10 cps to 10 MC	250.00
-hp- 525B Frequency Converter	Extends -hp- 524B range 100 to 220 MC	100 MC to 220 MC	.1 volt rms minimum input	250.00
-hp- 526A Video Amplifier	Increases sensitivity of -hp- 524B	10 cps to 10 MC	App. 10 millivolt rms minimum input	150.00
-hp- 526B Time Interval Unit	Used with -hp- 524B to measure time interval	Range: 1 μsec to 10^7 seconds	Start and stop channels separately adjustable for triggering from −192 v to +192 v	175.00

-hp- 522B ELECTRONIC COUNTER

Compact, moderately-priced, versatile instrument for frequency, period *or* time measurements. Range 10 cps to 100 KC. Reads direct in cps, KC, seconds or milliseconds. Count automatically reset, action repetitive. Stability of time base 5/1,000,000. Display length variable. Easily used by non-technical personnel. $915.00[Δ].

-hp- TRANSDUCERS

-hp- 506A OPTICAL TACHOMETER PICKUP

Versatile, flexible light source and pickup for measuring rotational speeds 300 to 300,000 rpm. Ideal for use on moving parts which have small energy or can not be connected mechanically to measuring devices. Output voltage at least 1 v rms, 300 to 100,000 rpm, into 1 megohm or greater impedance. 21 candlepower, 6 v bulb; type 1P41 phototube. $100.00.

Data subject to change without notice. Prices f.o.b. factory.
[Δ] Rack mounted instrument available at slightly lower price.

HEWLETT-PACKARD COMPANY
3333A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
Cable "HEWPACK"
Field representatives in all principal areas

-hp- 508A/B TACHOMETER GENERATORS

Transducers for use with electronic counters or frequency meters in making direct reading rpm measurements, 15 to 40,000 rpm. Relationship of shaft speed to output voltage is linear to 5,000 rpm. -hp- 508A produces 60 cycles output frequency per shaft revolution. (-hp- 508B is identical, except produces 100 cycles output frequency per revolution.) -hp- 508A or 508B, $100.00.

QUALITY, VALUE, COMPLETE COVERAGE

RCA "Special Reds" provide that extra "life-line" you need in industrial electronic equipment, air, marine, and land-mobile communications, and unattended relay and transmission circuits—that extra margin of safety and dependability that *keeps things going!*

RCA "Special Reds" feature remarkable *stability*, excellent resistance to shock and vibration, exceptional *uniformity* of characteristics from tube to tube—and are backed by RCA for 10,000 hours minimum life!

RCA "Special Reds" are recommended for initial designs in industrial electronic equipment. They are excellent as replacements in existing circuits where there is a prototype operating under conditions within the ratings of the "Special Reds."

CONTACT YOUR LOCAL RCA TUBE DISTRIBUTOR TODAY. Ask for your free copy of the booklet "RCA Receiving Type Tubes for Industry and Communications" (form RIT-104).

RCA-5690—Full-Wave Vacuum Rectifier with separate heaters and cathodes.

RCA-5691—High-Mu Twin Triode. Similar to the RCA-6SL7-GT, but has twice the heater current.

RCA-5692—Medium-Mu Twin Triode. Similar to the RCA-6SN7-GTB.

RCA-5693—Sharp-Cutoff Pentode. Similar to the RCA-6SJ7.

RCA ELECTRON TUBES
RADIO CORPORATION OF AMERICA

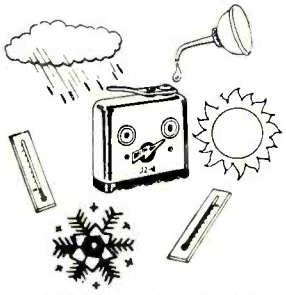
Now...SEALED DEPENDABILITY IN AN EXCLUSIVE DOUBLE-POLE SWITCH

MODEL J2-4
ACTUAL SIZE

New ELECTRO SNAP

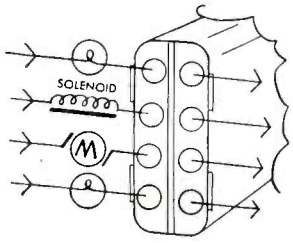
HERMETICALLY-SEALED DOUBLE-POLE SWITCH

Seals Out Moisture, Dirt, Oil, Corrosion, Condensation from Temperature Cycling



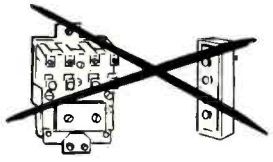
With switch mechanism hermetically-sealed in a dry, inert gas, switch is dependable at any altitude, moisture or temperature condition. Use it on aircraft, machines where oil is a problem, in areas subject to freezing or extreme heat or corrosive atmospheres.

Controls FOUR Circuits with ONE Snap



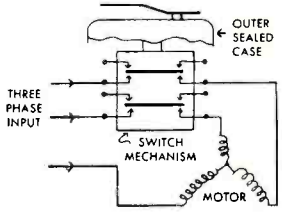
Eight separate contacts and terminals permit many unusual circuit combinations. May be wired externally for D.P.D.T., 2 circuit; D.P.S.T., normally open; D.P.S.T., normally closed. Movable poles may also be wired externally in series to increase current capacity of switch or number of contact breaks for high voltage switching.

Eliminates Expensive and Bulky Relays, Extra Switches



J2-4 can control circuit combinations that were formerly possible only with complicated relays or a number of separate switches. Saves money, weight and space.

Starts, Stops or Reverses Three-Phase Motors



Simultaneous action of two movable poles permits switch to break or reverse current flow through two windings of a three-phase motor. Movable poles are interlocked by unique design of switching mechanism, eliminating need of adjustment.

SPECIFICATIONS

Electrical Rating—10 amps @ 125/250v AC/ 30v DC Ind.

Operating Force—2½ lbs.

Weight—2½ oz. (4 oz. with actuator)

TOGGLE ACTUATOR
(constant or momentary contact) can be furnished on switch. Fits AN-type toggle switch mountings.

WRITE FOR CATALOG DETAILS

ELECTRO-SNAP SWITCH & MFG. COMPANY
Attention HJN-3 ● 4226 Lake Street, Chicago 24

Please send full information on new J2-4 Hermetically-Sealed Simultaneous Double-Pole Switch.

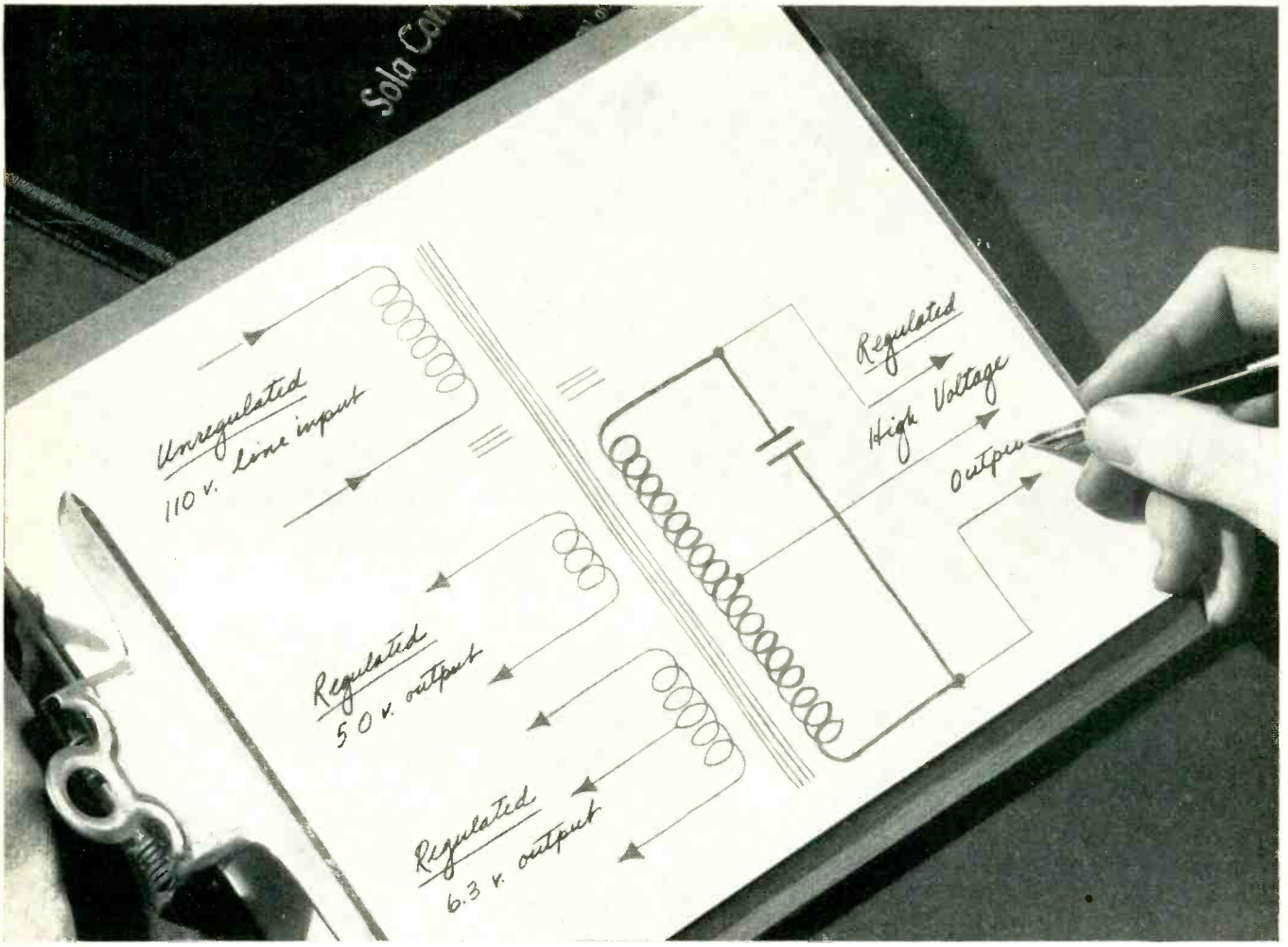
Name.....

Company.....

Street.....

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

Want more information? Use post card on last page.



SCHEMATIC DIAGRAM OF SOLA CIRCUIT modified to supply regulated plate and filament voltages. Regulation on one stepped-up output and two stepped-down outputs is within ±3% for input variations of ±13%. Other units available regulate as close as ±1% for input variations of ±15%.

YOU GET VOLTAGE REGULATION AND MORE FROM A SOLA:

Closely Regulated Voltage Plus Transformer Step-Up or Step-Down with Sola Constant Voltage Transformers

Today's complex electrical and electronic equipment, with its narrow limits for adequate performance, makes a fixed level of input voltage virtually essential. There are many fine voltage regulators available for this duty alone. However, the Sola Constant Voltage Transformer delivers one-to-one, stepped-up, or stepped-down voltages closely regulated. One Sola unit may replace both voltage-regulating circuit or component, *and* conventional power transformer.

The Sola Constant Voltage Transformer is a static-magnetic voltage regulator. It offers many important advantages over other stabilizers which depend solely upon saturation of core materials for their regulating action; or electronic types employing tubes.

To meet the exact requirements of many load devices or service conditions, Sola voltage regulators are available in stock models, or custom designs in production quantities. Your Sola representative will be happy to provide you with information on their feasibility for your particular application.

SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 7C-CV-170
SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

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** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., BIgelow 4-3354 • CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554 • Representatives in Other Principal Cities*

Collins New 66J heat reduction tube shields*

Increase equipment reliability

by reducing bulb temperature to 55% of former values

DESCRIPTION

Collins 66J consists of an outer case coated with a conducting black finish, a corrugated liner of plated beryllium copper and a base liner of the same material.

It is available for both backfitting and new equipment applications in 7-pin and 9-pin short, medium and long miniature tube sizes.

More than half of equipment failures are attributed to tube failure, a primary cause of which is heat.

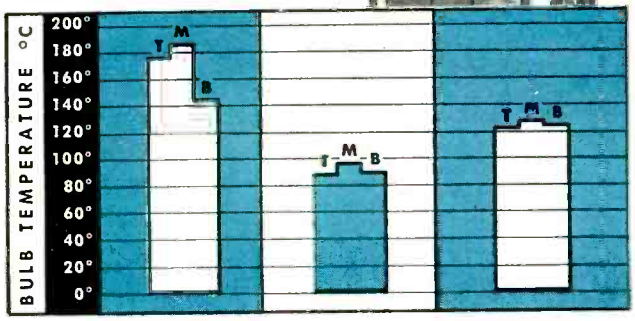
Now you can buy reliability insurance at a practical cost with Collins new 66J Heat Reduction Tube Shield, which reduces bulb hot spot temperature rise above ambient to 55 per cent of the value obtained with JAN shields. The 66J not only protects at the top and middle of the bulb, but also in the critical base area where electrolysis occurs.

The shield is interchangeable with the standard JAN shield, and therefore can be used in current designs and on a retrofit basis without modification. Due to the resiliency of its beryllium copper liner, it provides improved protection against shock and vibration — another guard against failure.

Write to the Collins office nearest you for price and technical data.

*Patent Pending

COMPARISON



COLLINS RADIO COMPANY

See the 66J Tube Shield and other new Collins products at the New York IRE Show, March 19-22.

855 35th St. N.E., CEDAR RAPIDS, IOWA

1930 Hi-Line Drive, DALLAS 2, TEXAS
2700 West Olive Avenue, BURBANK, CALIFORNIA
261 Madison Avenue, NEW YORK 16, NEW YORK
1200 18th Street NW, WASHINGTON, D.C.
COLLINS RADIO COMPANY OF CANADA, LTD., 11 Bermondsey Rd., TORONTO 16, ONTARIO
COLLINS RADIO CO. OF ENGLAND, LTD., Sunflex Works, Colham Mill Road, WEST DRAYTON, MIDDLESEX, ENGLAND

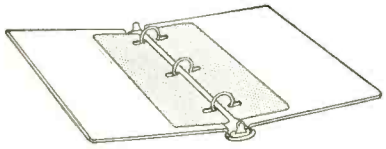
TAYLOR Shop Talk

Laminated Plastics
Vulcanized Fibre

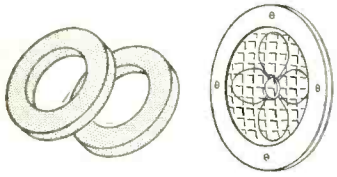
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

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

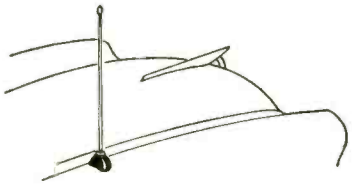
Tips for designers



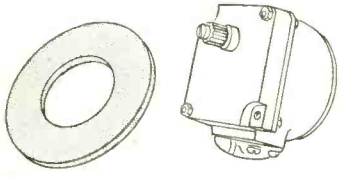
Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.



Large exhaust fans use Taylor Paper Base Phenolic washers to help absorb thrust . . . an inexpensive arrangement, with long life.



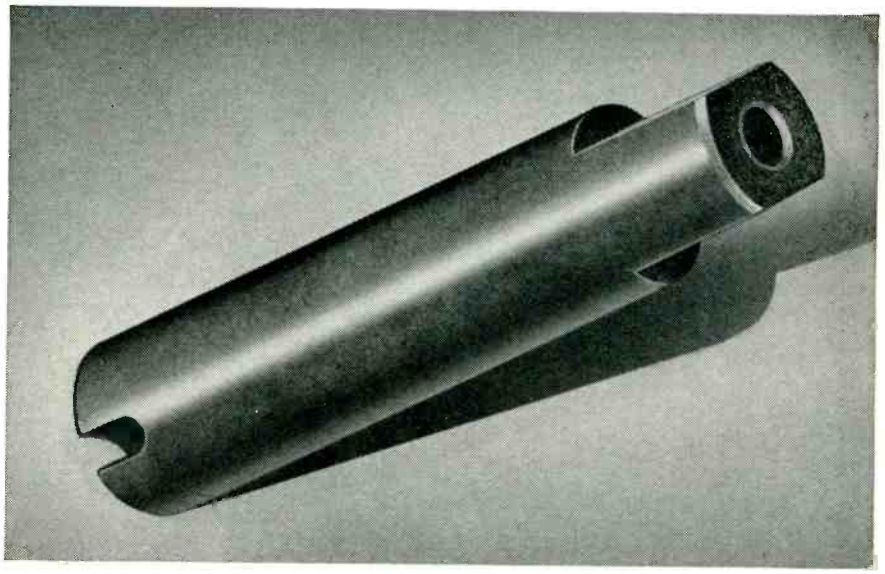
Radio antennas for the colorful, new cars may be made from equally colorful Taylor Polyester Glass Rod, with a copper wire center.



Self-balancing servo motor has stator case insulator which is cold-punched from 1/64" thick Taylor Paper Base Phenolic Laminate sheet.

VISIT WITH TAYLOR AT THE I.R.E. SHOW

Qualified technical personnel will be on hand in the Taylor booth (#675) at the I.R.E. Show in New York's Kingsbridge Armory, March 19 through 22. Visit with Taylor while you're at the show and discuss your application requirements as well as the latest advancements in high-performance laminates.



This impeller shaft, used in the famous Hotpoint Dishwasher, is easily and economically fabricated from Taylor Paper Base Phenolic Tubing.

Fabrication ease holds down costs —when you use Taylor laminates

Economy-minded designers and production managers are discovering plus qualities in the excellent fabricating properties of Taylor phenol, melamine, silicone and epoxy laminates. In addition, the large sheet size and choice of forms in which these materials are supplied make for further economy in utilization . . . through maximum yield of purchased stock.

This outstanding ease of fabrication is not happenstance . . . for all Taylor laminates are the result of resin formulations and production techniques designed to facilitate economical conversion to completed parts. Punching, staking, milling, sawing, drilling . . . you'll find it's easier when you use a Taylor basic material.

Included in the broad selection of Taylor laminates are a great variety of different bases and different grades . . . each with its own combination of electrical and physical properties, qualifying it for a specific application at a reasonable price.

And, here's another *plus!* Your production problems can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced . . . by having your finished parts prepared to your specifications in the Taylor Fabricating Division. Valuable experience coupled with complete facilities are ready to serve you. Call on Taylor for a discussion of your particular requirements.

Want more information? Use post card on last page.

5 NEW HIGH-WATTAGE H-H Rheostats

Now the full Hardwick, Hindle line includes H-50, H-75, H-100, H-150, *H-225*, *H-300*, *H-500*, *H-750* and *H-1000*.

Our H-50 -75 -100 and -150 watt models have established in the field a great reputation for unusual ruggedness under abnormal conditions. They have proved themselves to be thoroughly dependable in service.

Their many improvements are all incorporated in these 5 *new* models, together with added new features including our recently patented contact arm.

All are designed to comply with current standards of:—

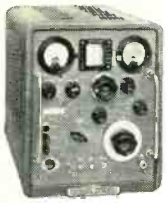
- **Military Specifications MIL-R-22**
- **R.E.T.M.A.** • **N.E.M.A.**
- **Underwriters' Laboratories, Inc.**

Write today for Rheostat Bulletin 355

HARDWICK, HINDLE, INC.

Rheostats and Resistors • **NEWARK 5, N.J., U.S.A.**

The mark of quality for more than a quarter of a century

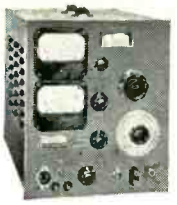


-hp- 608D vhf Signal Generator

10 to 420 MC, highest stability. Very low incidental FM or frequency drift. Calibrated output 0.1 μv to 0.5 v full range. Crystal calibrator frequency check accurate within 0.01% each 5 MC. Master oscillator, intermediate and output amplifier circuit. Premium quality performance, direct frequency and output calibration. $1,050.00

-hp- 608C vhf Signal Generator

10 to 480 MC. High power output (1 v max.). Master oscillator-power amplifier output circuit. Direct calibration of frequency and output power. Constant internal impedance, broad modulation capabilities. Ideal for measuring gain, selectivity, sensitivity or image rejection of receivers, amplifiers, other vhf equipment. Also drives bridges, slotted lines, antennas, etc. $950.00



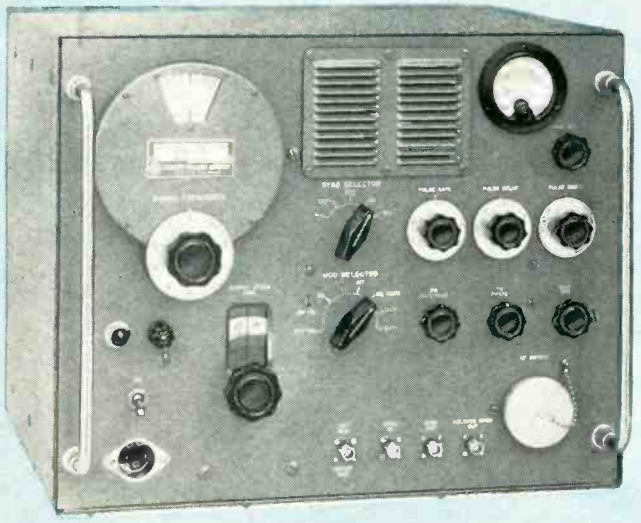
-hp- 612A uhf Signal Generator

450 to 1,220 MC. Master oscillator—power amplifier generator for uhf and TV measurements including gain, selectivity, sensitivity, image rejection. Directly set and read; no charts or interpolation. Low incidental FM high quality broad band sine wave or TV modulation to 5 MC. Pulse modulation, good rf pulses 0.2 μsec or longer. $1,200.00

Direct reading, wide range,

hp SIGNAL

World's most complete



NEW! 10 to 21 KMC

-hp- 626A/628A shf Signal Generators

10 mw output. SWR 1.2

High accuracy, high stability

Direct output, frequency control

No calibration charts required

Wide modulation, pulsing facilities

BRIEF SPECIFICATIONS -hp- 626A/628A

Frequency Range: -*hp*- 626A, 10 to 15 KMC, -*hp*- 628A, 15 to 21 KMC. One band. Automatic repeller voltage tracking and mode selection.

Frequency Calibration: Direct. Accuracy better than ±1%.

Output Range: 10 mw to 1 μμw. (+ 10 dbm to —90 dbm, 0 dbm = 1 mw) SWR better than 1.2 at 0 dbm and lower.

Output Accuracy: Better than ± 1 db.

Modulation: Internal or external pulse, FM, square wave.

Internal Pulse Modulation: Repetition rate variable 40 to 4,000 pps; pulse width variable 0.5 to 10 μsec.

Sync Out: Signals: 20 to 50 v into 1,000 ohms; rise time better than 1 μsec.
a. Simultaneous with rf pulse.
b. Advance of rf pulse 3 to 300 μsec.

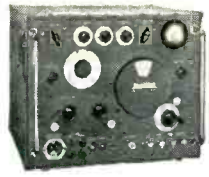
External Sync: a. Sine wave 40 to 4,000 cps, amplitude 5 to 50 v rms.
b. Pulse: 0 to 4,000 pps, amplitude 5 to 50 v rms. Pulse width 0.5 to 5 μsec, rise time 0.1 to 1 μsec.

Modulation:
Internal Square Wave: Variable 40 to 4,000 cps.

COMPLETE COVERAGE | **HEWLETT-PACKARD**

-hp- 614A/616A uhf Signal Generators

800 to 2,100 MC (614A); 1,800 to 4,000 MC (616A). Frequency accuracy ± 1%, calibrated output 0 to —127 dbm, output accuracy ± 1 db, —10 to —127 dbm. Provides internal or external pulse modulation, also FM, CW and square wave output. Simple operation, direct tuning, no calibration charts. $1,950.00.



-hp- 618B shf Signal Generator

3,800 to 7,600 MC. Frequency accuracy ±1%, 0 to —127 dbm. Output accuracy ±2 db, —7 to —127 dbm. SWR 2. Offers internal and external pulse and square wave modulation, internal saw-tooth FM sweep, external FM, and CW. Rep rate variable 40 to 4,000 pps, variable pulse widths, pulse sync circuits. $2,250.00

-hp- 620A shf Signal Generator

7,000 to 11,000 MC, output 0.1 μv to 0.071 v into 50 ohm load. Virtually identical to -hp- 618B in operation, circuitry, convenience features. Carrier frequency directly set and read; no voltage adjustment during operation. Rf output also directly set and read; no calibration charts or frequency correction. Compact; quality construction. $2,250.00.

high power, outstanding value!

GENERATORS

high quality line

New -hp- 626A/628A are the first commercial signal generators to bring to the 10-to-21 KMC range the wide range, high power, direct-reading convenience and accuracy heretofore available only at lower frequencies.

Operation of the new instruments is identical with that of other -hp- generators. Frequencies are directly set and read on a single tuning dial. No calibration charts are required. Output voltage is directly set and read, and the unique 10 db output is 10 to 20 db better than that provided by the best spot-frequency generators now available. SWR is extremely low—better than 1.2 at 0 dbm and lower. Internal pulse, fm, or square wave modulation is provided, as well as facilities for external pulse and FM modulation. Both instruments employ a rotary vane attenuator which is unaffected by temperature or humidity.

vhf versatility for shf

The wide range, high stability and accuracy of -hp- 626A/628A make them ideal for almost all types of microwave measurements requiring precisely known and controlled shf signals. The instruments are particularly designed for speed and convenience in microwave receiver sensitivity measurements, in determining selectivity or rejection, signal-to-noise ratio, SWR and antenna gain.

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

See your -hp- field engineer or write direct for details

HEWLETT-PACKARD COMPANY
3329A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
Cable "HEWPACK"
Field engineers in all principal areas

Internal FM: At power line frequency, deviation to ±5 MC.
External Pulse: Requires amplitude 15 to 70 v peak, pos. or neg.; width 0.5 to 2,500 μsec.
External Frequency: Capacitive coupling to klystron repeller. Max. deviation approx. ±5 MC.
Output Connector: Waveguide, flat cover flange. -hp- 626A, 0.850" x 0.475" (WR-75), -hp- 628A, 0.590" x 0.335" (WR-51).
Power: 115 v ±10%, 50/60 cps, approx. 200 watts.
Size: 19" wide, 14" high, 13" deep. Net wt. 65 lbs.
Price: -hp- 626A, $3,250.00; -hp- 628A, $3,000.00.

HEWLETT-PACKARD COMPANY
3329A PAGE MILL ROAD • PALO ALTO, CALIF.

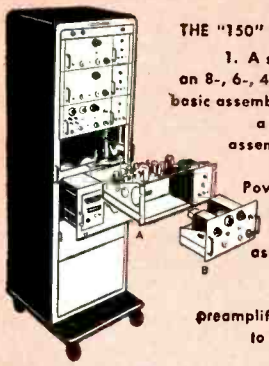
Please send information on:

☐ 608C ☐ 608D ☐ 612A ☐ 614A
☐ 616A ☐ 618B ☐ 620A ☐ 626A/628A

Name_____
Company_____
Street_____
City_____ Zone____ State_____

hp INSTRUMENTS | **COMPLETE COVERAGE**

Want more information? Use post card on last page.



THE "150" DESIGN CONCEPT

1. A system starts with an 8-, 6-, 4-, 2- or 1-channel basic assembly which includes a complete recorder assembly, and a Driver Amplifier and Power Supply (A) for each channel.
2. To this basic assembly are added interchangeable plug-in type preamplifiers (B) according to the measurement requirements.

HERE'S REAL oscillographic RECORDING VERSATILITY

DEMONSTRATED AT BOOTHS 455 AND 457 ELECTRONICS AVENUE I.R.E. SHOW

A Sanborn "150 Series" System can be set up to record any of these inputs in any of the channels

AC or DC Signals,

AC-DC Preamp

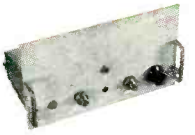
balanced or single-ended, with sensitivity of 1 mv to 2 v/cm (AC), 1 mv to 2 v/mm (DC).

Logarithmic Level Signals

LOG-AUDIO Preamp

Audio signals (20 cycles to 20 KC) or DC voltages recorded in logarithmic fashion on 50 decibel chart.

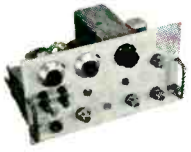
Higher Level Signals,



INPUT COUPLING NETWORK

where maximum sensitivity of 1 v/cm, and input impedance of about 200,000 ohms are adequate.

Magnitude and Direction of Physical Variables,



CARRIER Preamp

with variable resistance, differential transformer or variable reluctance transducers.

Extremely Low Voltages and Currents,

LOW LEVEL Preamp

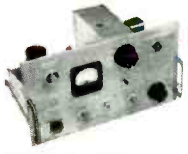
at sensitivities of 100 μv and 1 μa per cm. (with external shunt of 100 cycles), by means of DC chopper circuit.

RMS Values of AC Voltages, Currents,

VOLT/AMMETER Preamp

from 25-250 volts, 50 ma — 1 amp.

AC Voltage Components



SERVO MONITOR Preamp

in phase or 180° out of phase with a reference voltage (e.g., servo error signal).

Low Level Signals,

STABILIZED DC Preamp

with extreme stability, high gain, and greater bandwidth than with 150-1500 Low Level Preamplifier.

Symmetric or Asymmetric Wave Form Inputs,

FREQUENCY DEVIATION Preamp

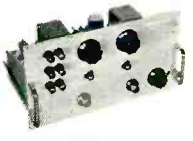
in 350-450 cycles (2 cycles/mm) and 375-425 cycles (1 cycle/mm) ranges.

DC Signals

DC COUPLING Preamp

(push-pull, single-ended or difference between two). Basic sensitivity 50 mv/cm to 50 v/cm.

Average Value of AC Watts in a Circuit,



AC WATTMETER Preamp

in ranges from 25 volts x 40 ma to 250 volts x 2 amps. (with internal multipliers and shunts which can handle up to 4 amps).

INTRODUCED AT I.R.E. SHOW

COMPLETE, SELF-CONTAINED EIGHT-CHANNEL SYSTEM ADDED TO 150 SERIES

Model 158-5490 is intended primarily for use with analog computers but capable of other types of recording. Features include 0.1v/cm sensitivity, push-pull or single-ended input, 5 meg. input impedance each input lead to ground. Frequency response is flat to 20 cps, down 2 db at 60 cps for all amplitudes to 4 cm peak to peak.

AND, in addition to this great versatility, *equally valuable* to the user are the basic design features of Sanborn oscillographic recording systems, many of them available *only* in Sanborn equipment. They include inkless recording in true rectangular co-ordinates; improved overall linearity; numerous chart speeds; a choice of vertical mobile-cabinet or portable-case packaging; availability of 2-, 4-, 6- and 8-channel systems especially designed for recording analog computer outputs.

Sanborn engineers will be glad to help you select the equipment best suited to your needs. Contact them with confidence, and ask for a copy of the new and complete "150 Series" catalog.

SANBORN COMPANY, CAMBRIDGE 39, MASSACHUSETTS

Dimensions: 10½" long x 3½" deep x 6⅜" high over converter.

For your servo circuits

use Brown Amplifiers

PROVED in thousands of *ElectroniK* instruments, Brown Amplifiers are now available as separate units for use in servo circuits.

As a basic link in the servo loop, the Brown Amplifier takes a d-c microvolt input signal, converts it to a-c, and amplifies it sufficiently to drive a two-phase balancing motor. The unit is readily adaptable to any number of measuring, balancing, and positioning applications.

Extremely low stray pick-up, excellent stability, optimum sensitivity, and fast response are outstanding design features. Three stages of voltage amplification are followed by the power output-phase discriminator stage, which supplies the required power for a two-phase reversible balancing motor.

Typical applications include: computers, integrators, photometer shutter movement, grid bias adjustment, null positioning, coordinate transformation.

SELECT FROM THESE BASIC MODELS

Gain	Sensitivity (Microvolts)	Nominal Input Impedance (Ohms)
10^6	4.0	400, 2200, 120,000*
4×10^6	1.0	400, 7000
12×10^6	0.4	400, 2200, 7000
40×10^6	0.1	2200

*Special for high impedance sources.

Power supply—115 v., 60 cycles (fused power line).

Output—2 to 18 ma. into 12,000 ohm load.

Sensitivity—Continuously variable screwdriver adjustment. Recessed slot protects setting.

Mounting—Operation unaffected by mounting position.

Optional Features—(a) thermocouple burnout protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles, (h) 220-110 volt transformers.

Order now! Write or phone for immediate quotation. Fast, dependable delivery. Priced as low as $98.50. (Even more attractive prices on quantity purchases.)

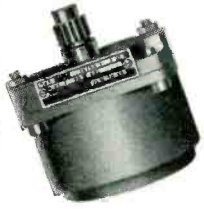
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

Other Brown components for servo circuits

Brown Convertors

Long-lived, low-noise, thoroughly shielded "choppers" for d-c to a-c conversion. SPDT switching action. Applicable to voltages as small as 1×10^{-3}. For 25, 40, 60, 400 cycles. Prices from $35.75.



Brown Servo Motors

2-phase reversible motors. High torque. Fully enclosed. Self-lubricating. No-load speeds of 27, 54, 167, 333, and 1650 rpm available. Operate from 115-volts, 60-cycles. Numerous variations in pinion, shaft, leadwires, and materials available for special requirements. Prices from $40.50.

Prices and specifications subject to change without notice.

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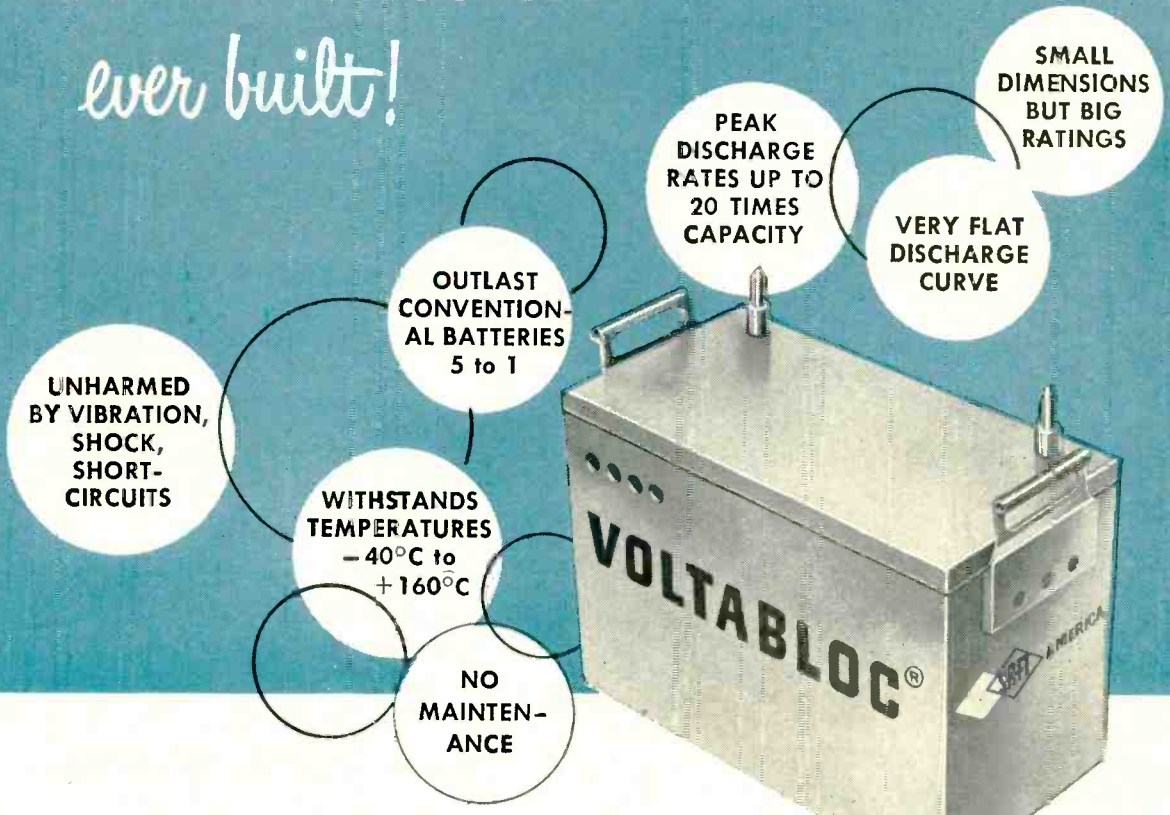
the most VERSATILE BATTERY ever built!



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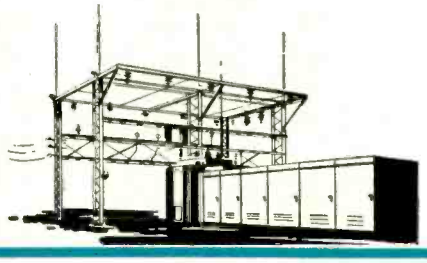
For the first time VOLTABLOC'S® hermetically sealed cells make practical the application of rechargeable batteries in electronic design.

VOLTABLOC'S patented construction of sintered, nickel and cadmium plates compressed tightly in a hermetically sealed, metal case is the secret. They cannot leak or gas—can be stored indefinitely in any state of charge or discharge.

Their high quality and outstanding characteristics have introduced new standards of battery performance and economy. Send today for complete information on your specific applications. Write to SAFT Corporation of America, 2 Gregg St., Lodi, N. J.

A COMPLETE LINE FROM 0.8 a.h. TO LARGEST PEAK DISCHARGE REQUIREMENTS.



SAFT AMERICA

VOLTABLOC®—
THE HERMETICALLY SEALED BATTERY

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After the Great Ford Foundation Gift . . .

What Still Remains To Be Done To Provide Decent Faculty Pay

The Ford Foundation's gift of a half billion dollars to our privately supported colleges, medical schools and hospitals, now being distributed, is magnificent. But it will be much more magnificent if it inspires completion of the job to which it gives a lift. So far as the colleges and universities are concerned, this job is primarily to rescue their faculty members from being second-class citizens economically.

Even in a period when we have become accustomed to astronomical financial figures, a half billion dollars remains an eye-popping gift. In fact, it is so imposing that a good many people who don't read the fine print are apt to conclude that it must just about solve the financial problem to which it is addressed.

Goes Only a Small Way

However, we have allowed college professors to fall so far behind the parade financially that the share of the Ford half billion dollar gift going directly to the improvement of faculty salaries ($210 million) will go only a small way financially toward doing what is necessary to provide adequate salaries.

Completion of this job for our privately supported colleges and universities calls for:

1. An increase in faculty salaries at least five times as great as that made possible by the Ford gift merely to restore salaries to their 1939 purchasing power level and an increase fifteen times as great to provide adequate salaries today.

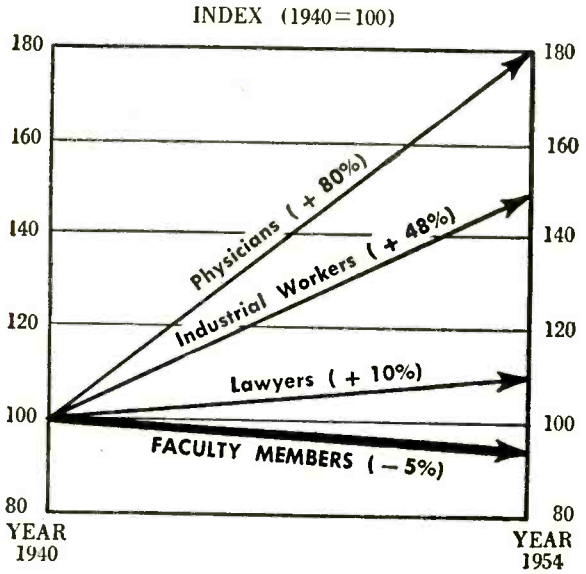
2. Some difficult and courageous decisions by the heads of the colleges and universities in apportioning the grants received by them.

Terms of Gifts to Colleges

The $210 million of the Ford Foundation gift going specifically to improve faculty salaries is being distributed on the following basis: Each of 615 privately supported, regionally accredited liberal arts and science colleges and universities receives a gift about equivalent to its last year's teaching payroll. For ten years only the income from these gifts is to be devoted to raising faculty salaries. After that all the money can be spent in any way the institutions receiving it see fit. There is no requirement that universities having other than liberal arts and science schools limit use of the gifts to improving salaries in these schools alone. They can spread it right through all their faculties if they wish.

In addition to the gift of $210 million specifically directed to increasing faculty salaries, another gift of $50 million goes to a group of 126 institutions selected for specially noteworthy leadership in improving

What's Happened to College Faculty Salaries*



* Real Income before Taxes.

Source. Council for Financial Aid to Education; U. S. Dep't of Commerce: U. S. Dep't of Labor.

the status and pay of teachers. For these schools the individual gifts add about 50% more to the amounts coming from the $210 million fund. They can be used to improve faculty salaries if the institutions choose to do so, but this is not required by the terms of these gifts.

The $210 million plus the $50 million should yield an income of $10-$13 million a year. Even if all this is used to raise salaries, it will be only a small step, however worthy, toward the $200 million per year the colleges need to meet their salary requirements adequately.

Helps Some Who Need It Most

In focussing its gift to improve faculty salaries in privately supported liberal arts and science colleges, the Ford Foundation aims at least part of the help at the spot where it is most desperately needed. Numerous surveys have indicated that the most poorly paid of all college and university faculty members are those in small, privately endowed liberal arts colleges.

But the overshadowing fact is that the teachers in our colleges and universities as a whole are badly underpaid. Just how badly is indicated by the chart above which first appeared in an earlier editorial. (Figures later than those for 1954 are not available.)

The Ford gift will turn the indicator of faculty salaries, which now lies far below the general salary trend, upward a few points. And it will do this in some places where salaries are below the wretched average shown by the chart.

But the Crucial Test Remains

College and university administrators will have the opportunity to extend further the process of getting the help provided by the Ford Foundation gifts where it is most needed. In general, this will mean giving it to senior faculty members, in order to hold experienced teachers and make college teaching attractive as a career. But to make such a division in many schools will take extraordinary fortitude.

The crucial test of the success of the enterprise of the Ford Foundation in raising faculty salaries will lie in whether it prompts the rest of us — college alumni, individuals, business firms and legislators alike — to see that it is a great beginning, not a signal for a recess.

Even with the Ford gifts providing $10-13 million a year, our privately supported colleges and universities must have an increase of about $190 million a year to provide decent faculty salaries.

This is a job far beyond the capacity of the Ford Foundation, imposing though that is. It is a job far beyond the capacities of a few hundred large corporations and a few thousand wealthy individuals. If it is to be done, it is a job at which all of us must work with a will.

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Donald C. McGraw

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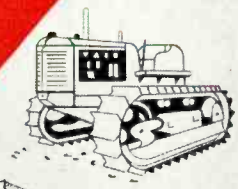
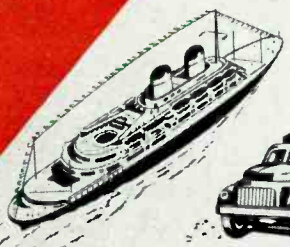
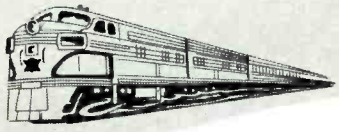
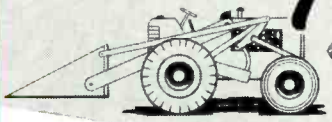
world's lightest, smallest, mightiest storage battery for every industry!





for every industry!





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Wherever weight or space is a problem . . . audio, radio, TV and electronic equipment electric power installation, maritime and aviation . . . applications are now possible with this revolutionary, new silver-zinc storage battery developed by Yardney's world-wide team of scientists and engineers . . .

- **MINIMUM WEIGHT AND SIZE** — six times lighter and five times smaller than conventional batteries of equal capacity
- **LOW INTERNAL RESISTANCE** — designed to meet high current discharge requirements
- **FLAT VOLTAGE CHARACTERISTIC** — no discharge dip at any current drain to end of capacity
- **HIGH SAFETY FACTOR** — Spillage and leakage hazards eliminated; no fumes during charge and discharge cycles
- **MECHANICAL STRENGTH** — High resistance to shock, vibration, rapid acceleration and deceleration
- **WIDE TEMPERATURE RANGE** — Efficient at 160° F. and as low as −60° F.

Table of Yardney High-Rate Models

Yardney Silvercel	Nominal Capacity	Peak Pulse Dischatge	Weight (ounces)	H. (all in inches)	W.	D.	Used in
HR 01	0.1 AH	3 amps	0.15	1.38	.61	0.20	Instrumentation
HR 05	0.5 AH	30 amps	0.70	1.52	1.10	0.55	Telemetering
HR 1	1.0 AH	45 amps	0.79	1.98	1.08	0.54	Motor-Driven Recorders
HR 3	3.0 AH	75 amps	2.98	2.86	1.72	0.59	Tow-Target Drones
HR 5	5.0 AH	75 amps	4.24	2.95	2.08	0.80	Photo-Flash, Camera Drives,
HR 10	10 AH	220 amps	7.88	4.78	2.32	0.74	Portable Lights, Missile Guidance
HR 20	20 AH	500 amps	13.82	4.28	2.05	1.73	Missile Power Sources and
HR 21	20 AH	500 amps	15.02	7.56	2.31	0.81	Servo Controls
HR 40	40 AH	600 amps	23.20	7.0	3.25	0.99	Torpedo Propulsion
HR 60	60 AH	1000 amps	31.85	4.50	2.75	2.38	Portable TV
*HR 85	100 AH	1900 amps	52.30	9.44	2.81	1.81	Aircroft Power Sources
HR 90	100 AH	1800 amps	51.40	7.0	3.25	2.16	Tow-Target Drones
HR 100	100 AH	2000 amps	44.10	4.78	3.43	2.79	

Write for technical literature describing physical and electrical characteristics of the complete SILVERCEL line

A FEW NAMES FROM OUR SALES LEDGER:

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Silvercel

YARDNEY ELECTRIC CORPORATION

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VOLTMETERS, AMMETERS, MILLIAMMETERS, MICROAMMETERS, WATTMETERS, GALVANOMETERS, VOLUME LEVEL INDICATORS, SEALED & RUGGEDIZED METERS, METER RELAYS

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YOUR ELECTRONIC PARTS DISTRIBUTOR HAS HUNDREDS IN STOCK!

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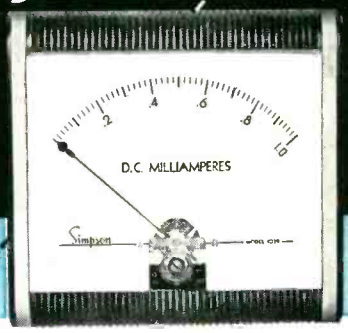
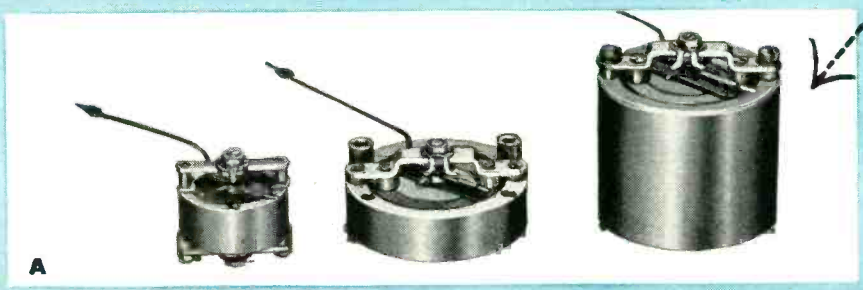
Simpson INSTRUMENTS THAT STAY ACCURATE

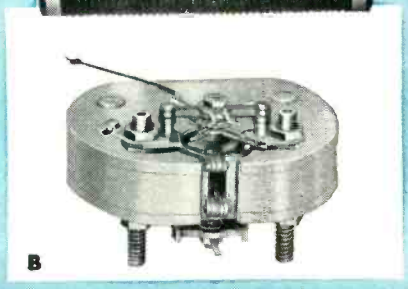
..sizes and types to meet your exact requirements!



5 ACCURATE METER MOVEMENT TYPES



(A) NEW CORE TYPE—A superb new movement that is *self shielded*, remarkably small and lightweight. Instruments now equipped with it meet the various Military Specifications for Sealed and Ruggedized Meters. Shallow, medium, and deep sizes.



(B) EXTERNAL MAGNET TYPE—The magnet structure of this time-proven movement is an independent part, permitting a choice of magnet material to match specific requirements.

(C) DYNAMOMETER TYPE—This fine movement features a high torque to weight ratio. With it, Simpson is the only manufacturer producing a two-inch wattmeter. Movement is air damped, sturdily built.

(D) MOVING VANE TYPE—The preferred movement for A-C measurement. Consumes remarkably little power. Features Simpson three-way balancing and patented balance weight locking clips.

(E) NEW BIFILAR SUSPENSION TYPE*—Represents a brilliant, new adaptation of the D'Arsonval principle with bifilar suspensions that *eliminates all friction due to pivots and jewels.*

*Simpson-Greibach Movement

Shunts and Current Transformers available to your specifications.

Send for Technical Manual 17

Simpson ELECTRIC COMPANY

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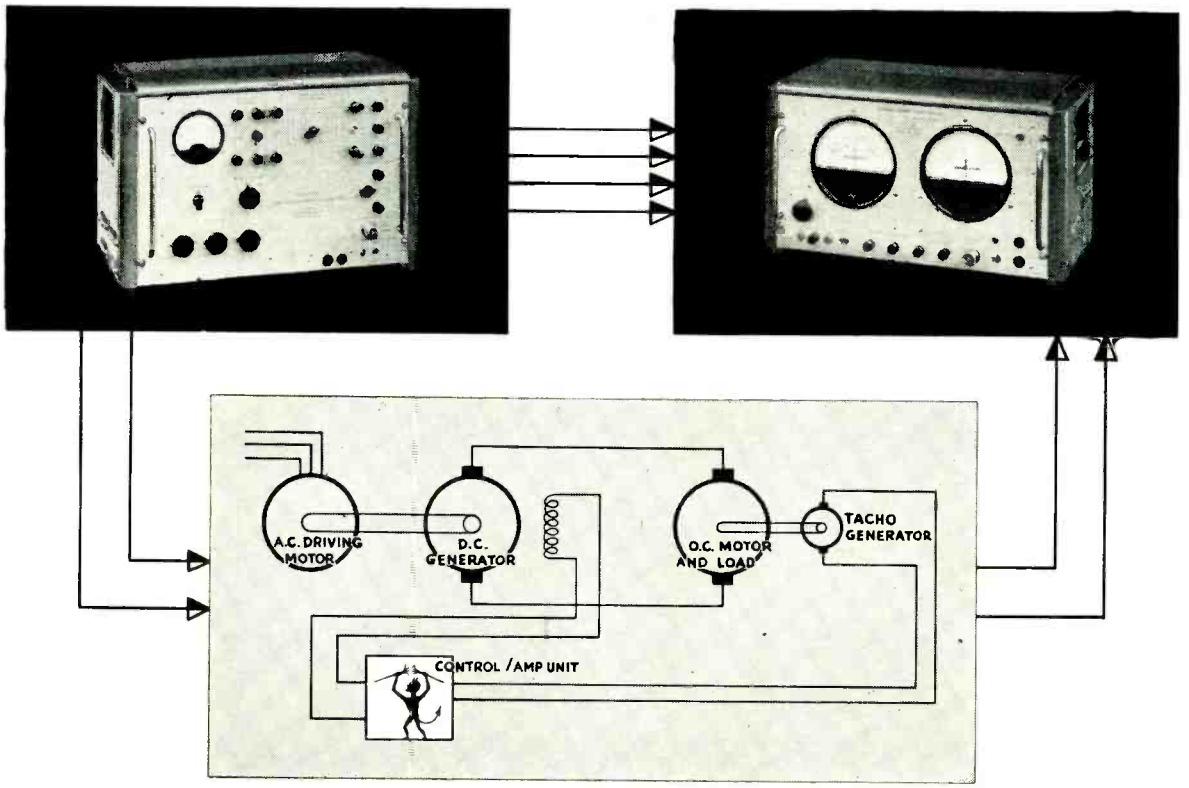

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Instability, backlash, underdamped response—all these problems can be identified, measured and rectified with the aid of the Solartron T.F.A. Now adopted as the standard British test equipment for all Guided Missile development and testing. It has recently been hailed in the U.S.A. as the world's foremost servo test equipment.

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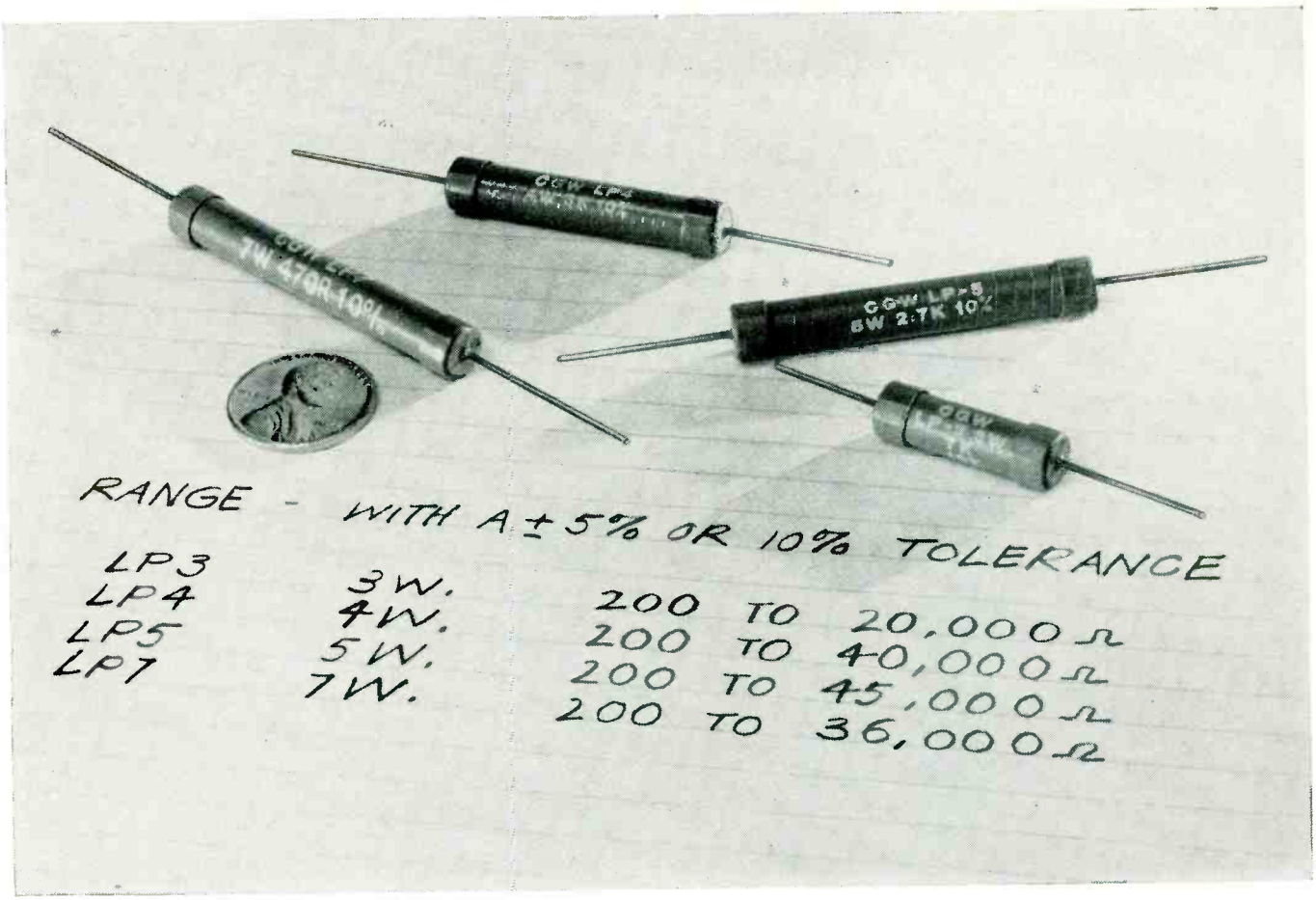

Build better radio and TV circuits with low-price, high-resistance Corning LP Resistors

When we say these low-power resistors are for radio and television circuits, we hasten to add that you can *afford* to use them.

Even though they're the highest-resistance range, low-power resistors around, they're priced within the narrow limits dictated by such mass production requirements as radio and TV.

Corning Low-Power Resistors are designed for your toughest circuits. They are stable and noninductive. They are impervious to moisture and dirt. The tough conductive metallic oxides bonded to the glass blanks are so rugged that special handling is never required. As a result, you can often cut down on handling costs and speed up production—not to mention cut down on rejects.

The tolerance of these low-power resistors is within plus or minus 5 or 10%. Resistance spiralling is automatic and is electronically controlled. You can get these superlative Corning Low-Power Resistors in the values illustrated.

Power rating is based on 40° C. ambient temperature for the 3-, 4-, and 5-watt sizes, and 25° C. ambient for the 7-watt size. Our LP resistors operate to 150° C. ambient with derating.

For detailed specifications, prices and samples, use the reader service number in this publication, or write to us direct.

Ask for information on these other Corning Resistors:

Type S • Stable performance to 200° C. Meet MIL-R-11804B specs. Values to your order.

Type R • High-power 2% or 5% resistors, 7 to 115 watts. Range from 10 to 1,000,000 ohms.

Type H • High-frequency 2% or 5% tolerance—Standard ranges from 10 to 1,000,000 ohms and ratings from 7 to 140 watts.

Type HP • High-power resistors. 17, 30, 70, and 150 watts. Tolerances of 2% or 5%. 20 to 500,000 ohms.

Type WC-5 • Water cooled. Range—35 to 300 ohms. Versatile and adaptable.

Type N • Accurate grade. Made to meet all requirements of MIL-R-10509A. Characteristic X and R.

Other products for Electronics by Corning Components Department:
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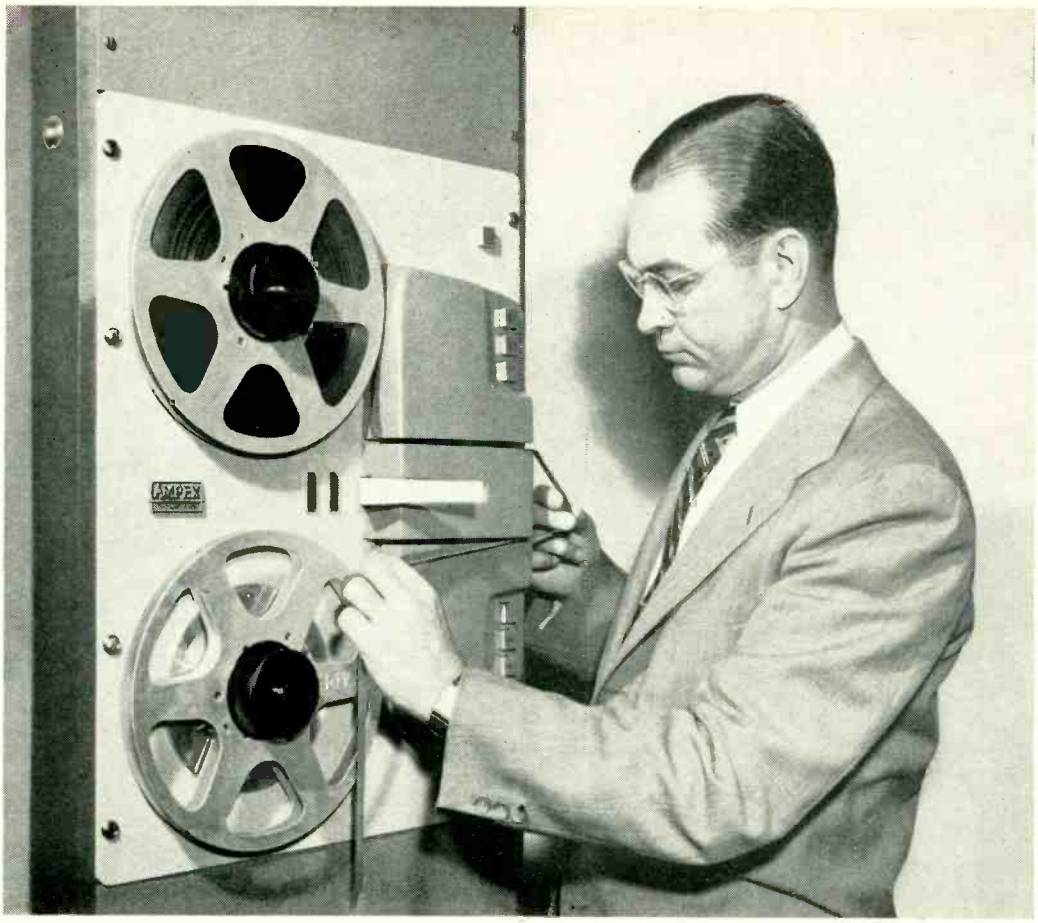
CORNING GLASS WORKS, 94-3 Crystal Street **CORNING, N. Y.**

Components Department, Electrical Products Division

Corning means research in Glass

new digital magnetic tape transport



the **AMPEX FR200** for digital handling provides new performance standards, new convenience features and an unmatched excellence of design

NEW EASE OF TAPE CHANGE...
The time saving feature of single loop threading is provided by a lever which moves the idlers into a straight line. This arrangement eliminates chance of faulty threading by unskilled personnel.

NEW MACHINE-TO-MACHINE TAPE COMPATIBILITY...
All Ampex FR200 Tape Transports are manufactured to exact standards that permit tapes recorded on one to be reproduced on any other. Ampex-to-Ampex compatibility is guaranteed — *and at no extra cost.*

NEW PLUG-IN HEADS TO MATCH OTHER TAPE TRANSPORTS...
The Ampex FR200 uses self aligning plug-in head assemblies. These can be furnished to match other digital or analog tape recorders to permit tape interchange. A second head stack for monitoring or "off-tape" parity checking can also be added if desired.

HIGH-SPEED START AND STOP...
On the Ampex FR200 the tape attains full speed or full stop within less than 5 milliseconds to provide high information storage density. A remote control provision is provided, as well as pushbuttons on the topplate.

NEW STANDARD OF EXCELLENCE...
The FR200 brings to digital applications the reliability, durability and adherence to specification that have made Ampex Tape Recorders the most widely used in instrumentation.

NEW LOW PRICES BEGINNING AT $2675
The base price of $2675 is for a complete FR207-TB tape transport, with 7-track head, for ½-inch tape operating at 30 ips tape speed. Prices will be quoted on machines with other tape speeds, multiple speeds, other tape widths and other heads.

FULL SPECIFICATIONS ON THE FR200 *and description of its features and accessories are given in descriptive literature. For your copy, write Dept. E 2539.*

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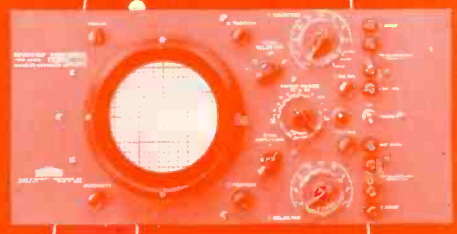
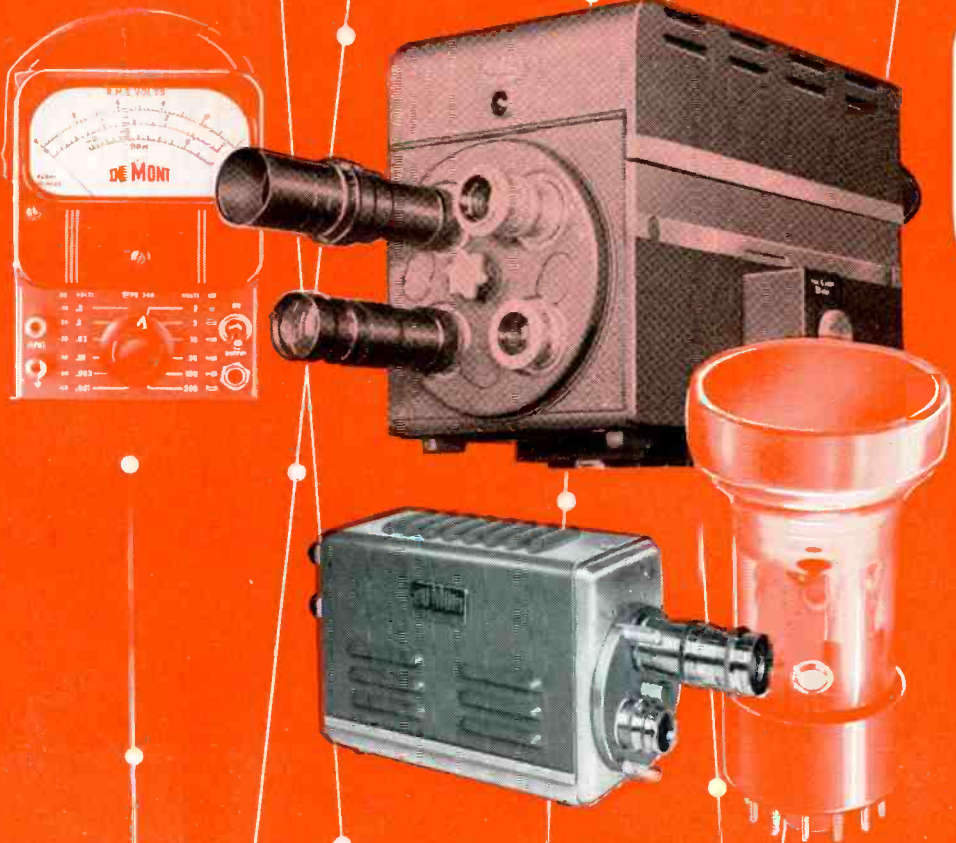


DU MONT
TECHNICAL PRODUCTS

ELECTRONICS AT WORK

The following pages show a representative group of **electronic tools** and systems for industry, research, commerce and military needs now being produced by Du Mont. These products are the result of concentrated skills, knowledge and experience drawn from a wide variety of fields.

Du Mont also offers electronic engineering services in developing systems and solving industrial problems. Products and services offered by Du Mont represent ELECTRONICS AT WORK.



ALLEN B. DU MONT LABORATORIES, INC., 760 BLOOMFIELD AVE., CLIFTON, N. J.

21 NEW INSTRUMENTS

featuring...

TYPE 350

Sets a new standard for general-purpose cathode-ray oscillographs with many features of high-cost laboratory instruments; identical X- and Y- amplifiers; Y-amplifier sensitivity 0.02 d-c volts per inch; response extends from d-c to within 30% at 150 kc; **both** amplifiers have internal, independent calibration, four decade from 0.8 to 1000 volts full scale at each amplifier input; exceptional stability provided by regulation of all operating potentials including high voltage; wide sweep ranges with beam gate; 3 kv acceleration assures bright trace.

TYPE 333

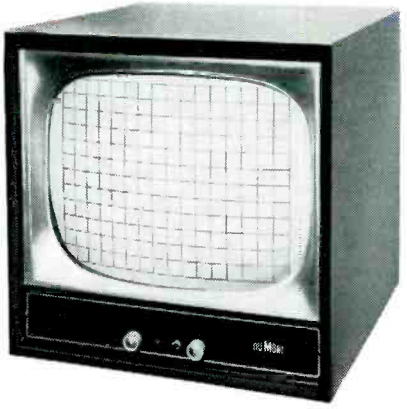
Dual-beam cathode-ray oscillograph unparalleled in price for performance; offers high-precision observation, comparison and measurement of two related a-c or d-c signals; has two complete very-high-gain, stable vertical amplifiers with response from d-c to within 30% at 300 kc; 16 amplitude-measuring ranges on both channels extend from 4 millivolts to 400 volts full scale; very low drift is less than 1 millivolt per hour after warmup; high-level, accurate, linear calibrated sweeps range from 1 second per inch to 2 μsec per inch.

TYPE 329-A

The last word in precision laboratory oscillography; amplifier rise time .035 μsec; response from d-c to 3 db down at 10 mc; gain-bandwidth switch permits choosing full bandwidth, or double sensitivity at reduced bandwidth; precisely-calibrated, continuously-variable sweeps range from 1 second to 0.1 μsec per major scale division; variable rate notch sweep permits writing rate increase of selected portion of sweep of up to 100 times on some ranges; amplitude-calibration system provides ranges, 0.2 to 400 volts full scale.

TYPE 345 AND TYPE 2628

Large-screen 21-inch indicator, Type 345, and Type 2628 Amplifier and Sweep Adaptor together make up a complete cathode-ray oscillograph with excellent performance; identical X- and Y-amplifiers; 80 millivolts drives beam to limits vertically; hard-tube sweeps have beam blanking; sweep rates from 0.2 cps to 6.0 kc; rack-mounted 17" Type 345 Large-screen indicator can also be used with Type 2628.



TYPE 351

Wide-range pulse generator provides high-quality rectangular pulses at 50 ohms impedance; convenient calibration of width, repetition rate and amplitude; rise time 0.018 μsec; pulse widths, 0.05 μsec to 100 μsec, with repetition rates **up to 100 kc** restricted only by a 10% duty cycle; automatic overload protection; amplitude variable from 50 volt level to 60 db down from this level in precise ½ db steps; pulse shape independent of attenuator setting; jitter-free trigger delay or advance permits oscillograph sweep triggering before pulse.

And...

these new instruments...

Type 336-A	d-c to 18 mc CRO
Type 340	d-c to 100 kc, identical amplifiers
Type 331	d-c to 4 mc, portable 3" CRO
Type 324	d-c to 300 kc, highly sensitive CRO
Type 300	Time Calibrator
Type 330	Electronic Switch
Type 326	1.5 to 10,000 μsec Time Delay Generator
Type 346	Sensitive Amplifier-Voltmeter
Type 347	18 cps to 1.1 mc Extended-Range Oscillator
Type 348	Low distortion sinewave generator, 0.9 cps to 510 kc.
Type 349	Millimicrosecond pulse generator, pulse rise time of less than 0.5 millimicrosecond
Type 2611	Line control unit

A complete line of oscillograph-record cameras including...

Type 321-A	For moving film recording
Type 296	For economical 35 mm records
Type 298	For high-speed recording
Type 299	For general-purpose recording
Type 302	For print-a-minute, on-the-spot recording
Type 339	For print-a-minute recording from 3" oscillograph

ENGINEERING SERVICES

Du Mont's more than 25 years experience in the design, development, and production of electronic tools are at your disposal. Our engineering staff stands ready for consultation on any problem related to electronic instrumentation, systems engineering, inspection, or production control.

The combined resources of Du Mont's Technical Products Division offer the most extensive experience in electronic and optical-electronic devices. For example, Du Mont solved the extremely complex problem of counting irregularly sized particles with the development of the Du Mont ICONUMERATOR area scanner. This instrument can count up to 1,000,000 particles per second. The unit is packaged as a single console, and may be operated by semi-skilled personnel.

A quite different industrial problem found its solution in the Du Mont PANTODRILL, a device which drills precision-located holes in sheet material for such applications as the preparation of printed wiring boards. The capabilities of the PANTODRILL may be seen in the fact that 100 holes, located accurately to 0.005 inch, may be drilled in 70 seconds.

These are but two recent examples of the manner in which the technical skills of Du Mont have been applied to general industrial problems.

Learn how Du Mont can help you. Write, outlining your problem, to the Industrial Sales Department, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

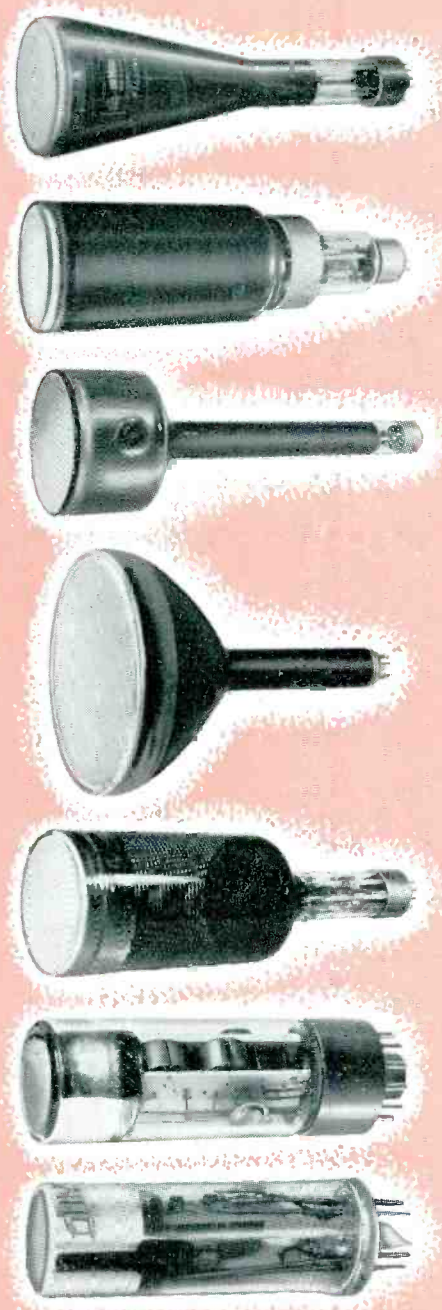
CATHODE-RAY and MULTIPLIER PHOTOTUBES

Unparalleled experience in application, as well as design and manufacture of cathode-ray tubes is yours when you specify Du Mont. Recent electrical and mechanical developments have added many new types to the comprehensive Du Mont line. In addition to our complete line of RETMA tubes, Du Mont also offers facilities for the design, development and production of special tubes. Our applications engineering department is ready to work with you on your own cathode-ray tube problem.

Du Mont makes available a wide selection of multiplier phototubes of all standard sizes and electrical characteristics to meet practically any application. Moreover, Du Mont will design and produce multiplier phototubes having special spectral, mechanical and electrical characteristics to your specific requirements.

When it comes to cathode-ray or multiplier phototubes — come to Du Mont. If we don't have it, we'll make it!

Shown below are a few examples of Du Mont Tubes typifying the broad range available...



TYPE 5AQP — Excellent resolution, freedom from field distortion, and superb deflection linearity characterize this electrostatically deflected and focused, general-purpose medium-voltage oscillographic tube.

TYPE 5ARP — Two wholly independent electron guns in a single 5-inch tube represent a substantial accomplishment since tracking errors, field distortions and other problems associated with multigun tubes are brought within limits thoroughly compatible with laboratory-quality, single-gun tubes.

TYPE K1207 — Magnetically deflected and focused 5-inch tube. High light output and superb spot size (Down to 1 mil under specific operating conditions) make this outstanding tube particularly well suited for industrial flying-spot scanner applications.

TYPE 5BCP — One of Du Mont's new line of "space savers." Magnetically deflected and focused, this radar tube provides savings of better than 30% in overall length for applications where space is at a premium, but where performance must not be compromised. Other "space savers" are available with 7- and 12-inch diameters.

TYPE K1355 — 5-inch electrostatically focused and deflected tube for high-voltage oscillography. Spiral intensifier and special gun and deflection plate design permit operation with A_2A_3 ratios of up to 5 to 1 with minimum field distortions.

TYPE 6292 — Two-inch end window multiplier phototube offers excellent sensitivity combined with outstanding stability, cathode-uniformity, and excellent signal-to-noise ratio.

TYPE 6365 — ¾-inch diameter, end-window type multiplier phototube offers all the features such as excellent sensitivity, stability and signal-to-noise ratio in a miniature envelope.

Du Mont offers standard RETMA multiplier phototube types in sizes from ¾" to 5", and special sizes up to 16" or larger.

DU MONT

Write for complete catalog . . .

TECHNICAL PRODUCTS

Allen B. Du Mont Laboratories, Inc.
760 Bloomfield Avenue, Clifton, N. J.

COMPLETE LINE of INDUSTRIAL TELEVISION SYSTEMS

Du Mont offers the first complete line of Industrial Television equipment ranging from the simple, compact, Tel-eye camera to ultra-high definition pickup systems, and systems for service in the areas of process inspection and control monitoring. A wide selection of equipment and accessories plus the ability to design and install the complete system results in custom-fitted industrial television for every need.

TEL-EYE CAMERA

Simple, compact, low-cost television camera that utilizes ordinary TV receivers as monitors. No larger than a 16mm camera, and just as simple to operate. Sets up in minutes—operates unattended. Designed for the rugged use expected of industrial tools.

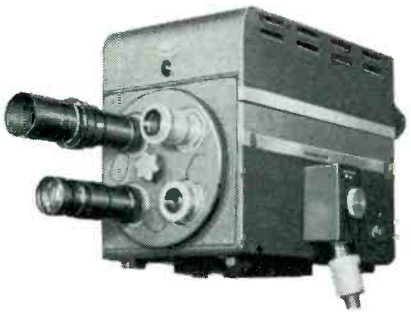


IMAGE-ORTHICON CAMERA

For the most critical industrial applications — the ultimate in precise, high definition television pickup. Operates under extremely low light conditions. Proved dependable by both broadcasters and industrial users. Available as single or dual camera systems. Used with standard monitors.

VITASCAN CAMERA

The amazingly simple, inexpensive color camera developed by Du Mont. Used by broadcasters and industry alike as a reliable, high-quality source of full-color pickup. Costs a fraction of other color systems in both initial costs and operating expenses. Designed for use in enclosed areas of operation.

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The fastest growing name in two-way radio for industrial and emergency applications. Du Mont offers a complete line of equipment and accessories for mobile and fixed installations in every available frequency range. Special LPI (Low Power Industrial) units available for intra-plant materials handling operations.

Advanced designs, plus superior workmanship have resulted in equipment selected by the most critical buyers as "the best buy." Tell us your type of business and your communications needs. We will send you literature and quotations covering the necessary equipment.

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Years of efficient, economical performance result in new installation of No. 107 machines

For many years the Wico Electric Company has enjoyed an enviable reputation for its manufacture of magnetos, distributors, complex ignition systems and other allied precision products. During that time the company has found Leesona Coil Winders to be thoroughly satisfactory in every respect, meeting every need for fast, accurate, low-cost winding on a wide range of jobs.

So when the time came to expand their coil winding production, Wico made certain that their new machines would be Leesonas.

These new machines are Leesona No. 107 Automatic Coil Winders, the last word in automatic coil winder design, which produce 4 to 30 compact, uniform paper-insulated coils simultaneously — in fastest time — with minimum operator attention.

Investigate

how Leesona No. 107's in your own production can eliminate human error, reduce wire breakage to a minimum and cut production time to its shortest. The coupon will bring you complete details, together with other helpful coil winding information. Why not check and mail it today?

New Leesona No. 107 Automatic Coil Winders, shown in the plant of Wico Electric Company, West Springfield, Mass., were selected because of this firm's long, satisfactory experience with Leesona machines. Leesona No. 107 Winders, featuring speed and accuracy in automatic winding, are enabling many plants to boost production and cut costs. Inset shows a cutaway of a Wico Model XH Magneto. Coil at top of unit is precision wound on Leesona No. 107's.

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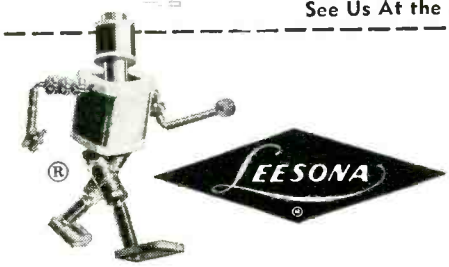

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Miniaturization takes a big step forward as Driver-Harris announces...

.0005 ENAMELED KARMA* WIRE

rated 3200 Ω/ft.

What this development can mean to resistor manufacturers is here dramatically illustrated. The large wire-wound resistor is rated at 1 megohm. The infinitely smaller one, wound with .0005 Enameled Driver-Harris Karma is rated at *1½ megohms.* In this particular application 50% more resistance or ½ megohm has been put on a ceramic spindle 1/5 the size of the original bobbin.

Even though we have succeeded in drawing Karma down to this fine size, its outstanding electrical and physical properties are maintained. Most important of these are:

- Low Temp. Coeff. of Resistance less than ± 20 parts per million
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- Low thermal EMF against copper (equalled only by Manganin)
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Add to these advantages the fact that the final cost per ohm is lower than in heavier sizes. Available now in commercial quantities. Complete data mailed on request.

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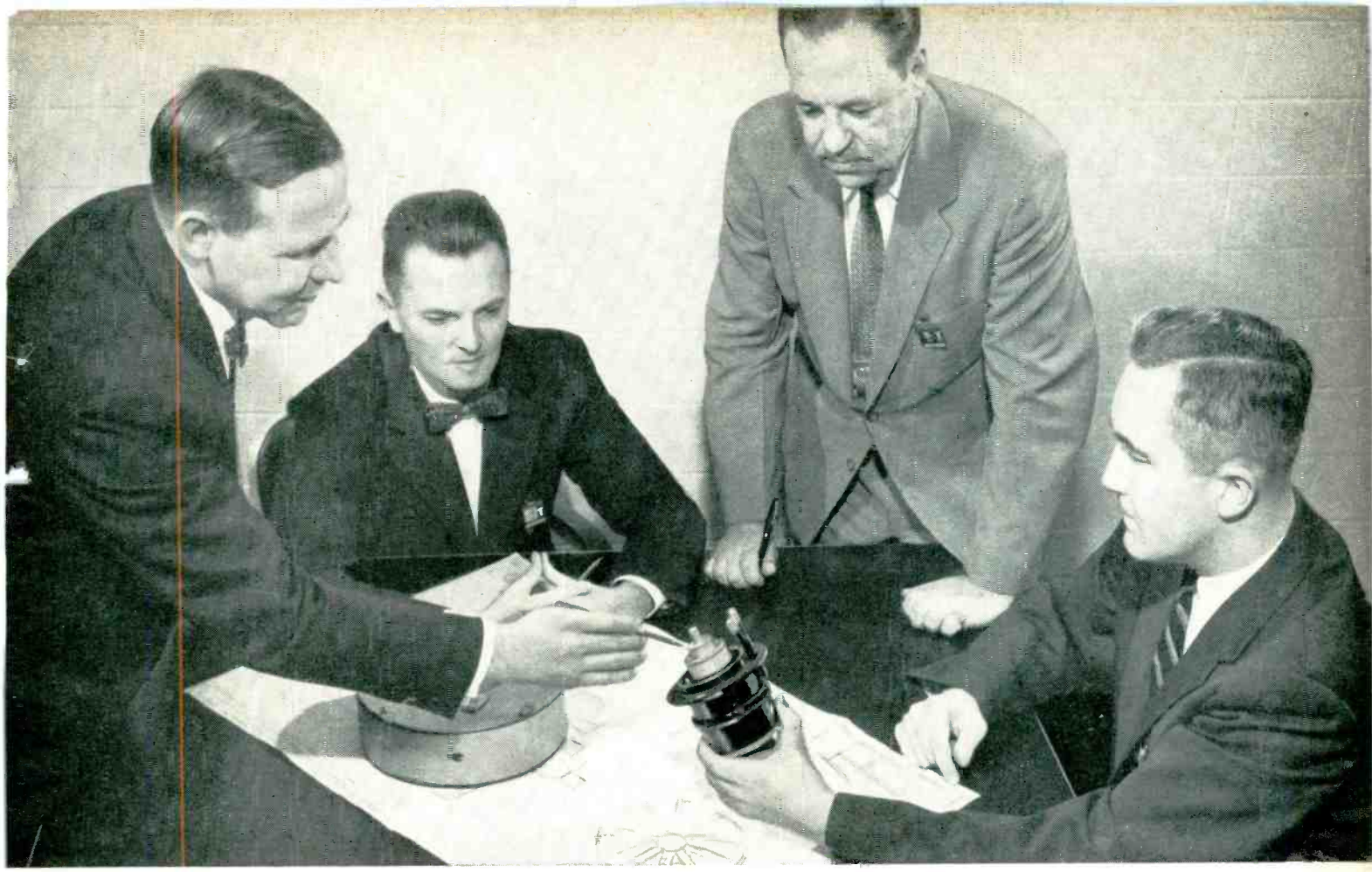


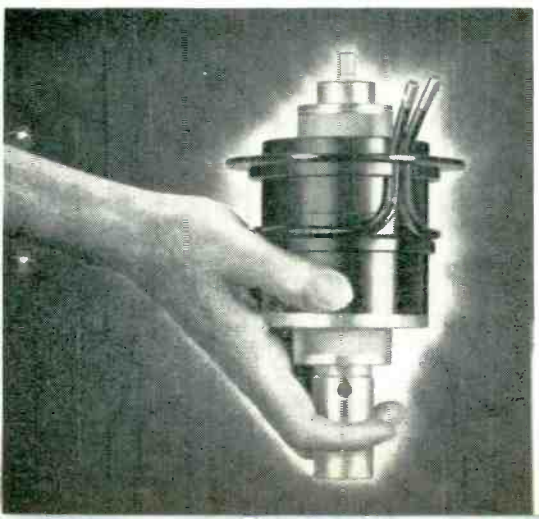
DES GNERS OF THE GENERAL ELECTRIC COOKING MAGNETRON INSPECT A FINISHED TUBE

New deep-heating oscillator for food ovens accents G-E leadership in magnetron tubes!

GL-6787

G-E u-h-f magnetron for dielectric heating applicat ons

Frequency . . . . . 915 mc
CW power output . . . . . 2,500 w
Anode voltage, typical . . 3,700 v
Anode current . . . . . 1.1 amp



Independent research studies show that 915 mc—the frequency of General Electric's GL-6787 cooking magnetron—is in that area of the spectrum where (1) cooking speed, (2) depth of heat penetration, combine for optimum efficiency.

This new tube, now in successful use, cooks fast—up to 600% faster than conventional methods . . . it converts energy that will heat deeply, uniformly. Designed and built by General Electric, the GL-6787 highlights G.E.'s continued progress in magnetrons as applied to an ever-widening list of commercial, industrial, and military circuits.

Since 1921, when G-E research pioneered magnetron tubes, General Electric has developed magnetrons for many applications. Here is your primary source for these tubes whose compactness and high electrical efficiency adapt them ideally to modern electronic needs!

Commercial and military radar . . . . . dielectric heating of plastics, glass, plywood . . . . . defrosting and cooking foods . . . . . the useful applications of magnetrons are multiplying as new microwave equipment is developed.

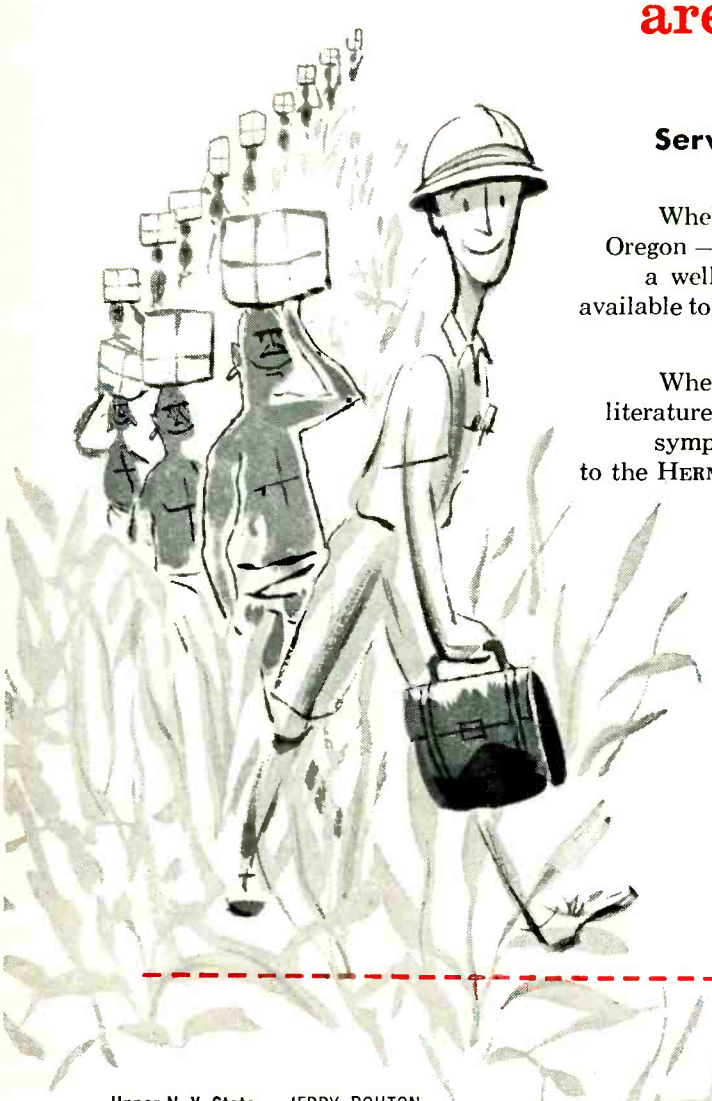
For magnetrons in equipment now on your boards—for advice on magnetron applications—come to General Electric! 35 years' experience in the magnetron field is yours on request. *Tube Department, General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-182

Hermetic's men are everywhere



Service is HERMETIC'S component!

Whether you're in Texas, Puerto Rico, Ohio or Oregon — north, south, east or west — you'll find a well qualified HERMETIC Sales Representative available to furnish the quickest and most economical solution to your hermetic sealing problems.

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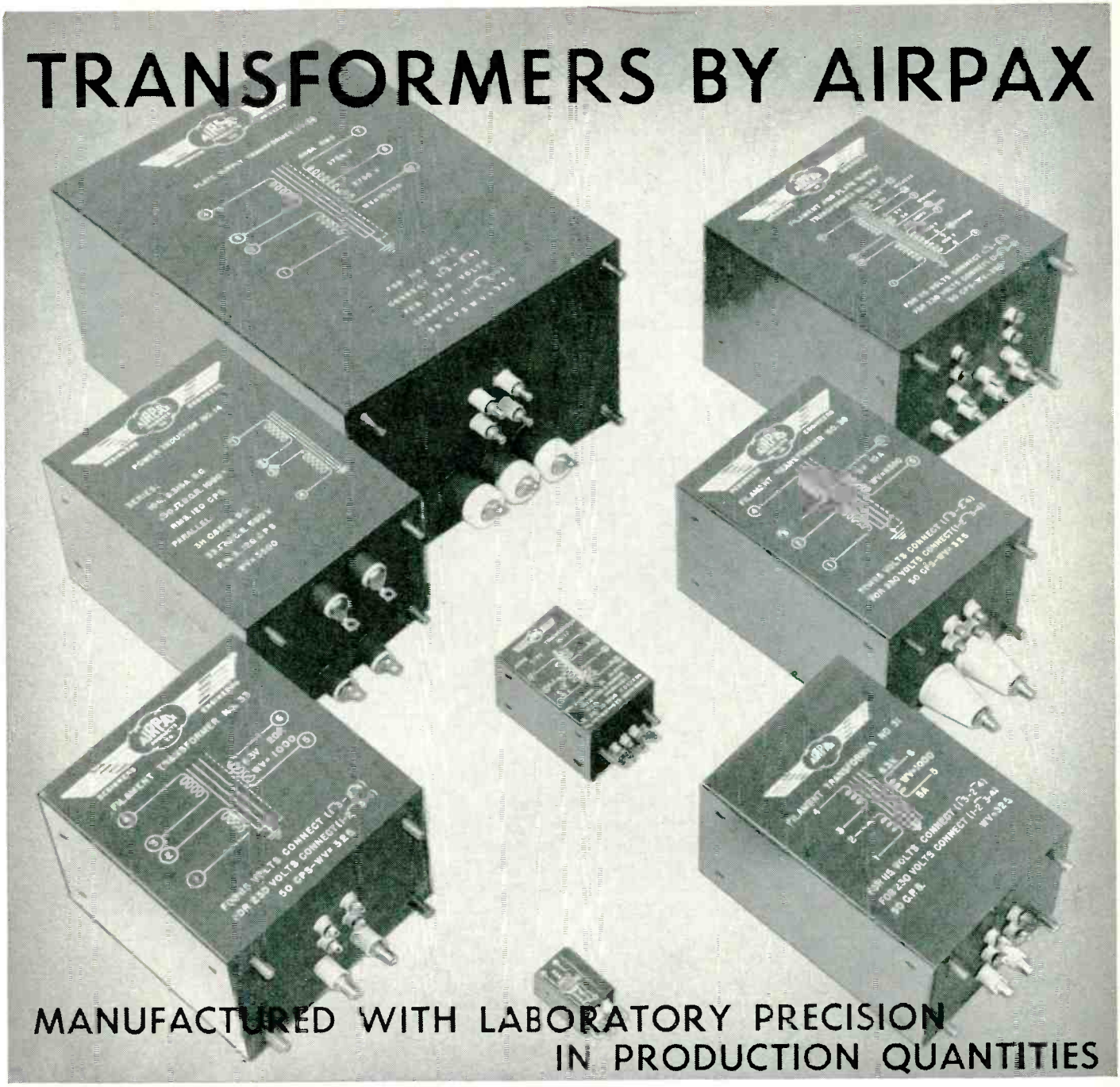
TRANSFORMERS BY AIRPAX



MANUFACTURED WITH LABORATORY PRECISION IN PRODUCTION QUANTITIES

Airpax manufacturers transformers with laboratory precision in production quantities. Engineers who need expertly designed transformers regularly send their specifications to Airpax.

The eight transformers shown here are typical of the hundreds of designs that Airpax regularly produces to customer requirements. These particular units meet MIL-T-27A. We will gladly send you copies of the drawings for them, which give complete mechanical and electrical ratings. Other Airpax transformers are going into industrial controls and test equipment.

Airpax superiority is the result of two ingredients: thorough design with attention to every detail, and careful production under close supervision. Transformers containing these ingredients cost little more and take only a trifle longer to design and build but give greatly improved performance, which after all, is what interests you most. Companies that value their reputation for quality equipment buy transformers from Airpax.

When your equipment depends on an especially reliable transformer designed and manufactured to the highest standards, turn to

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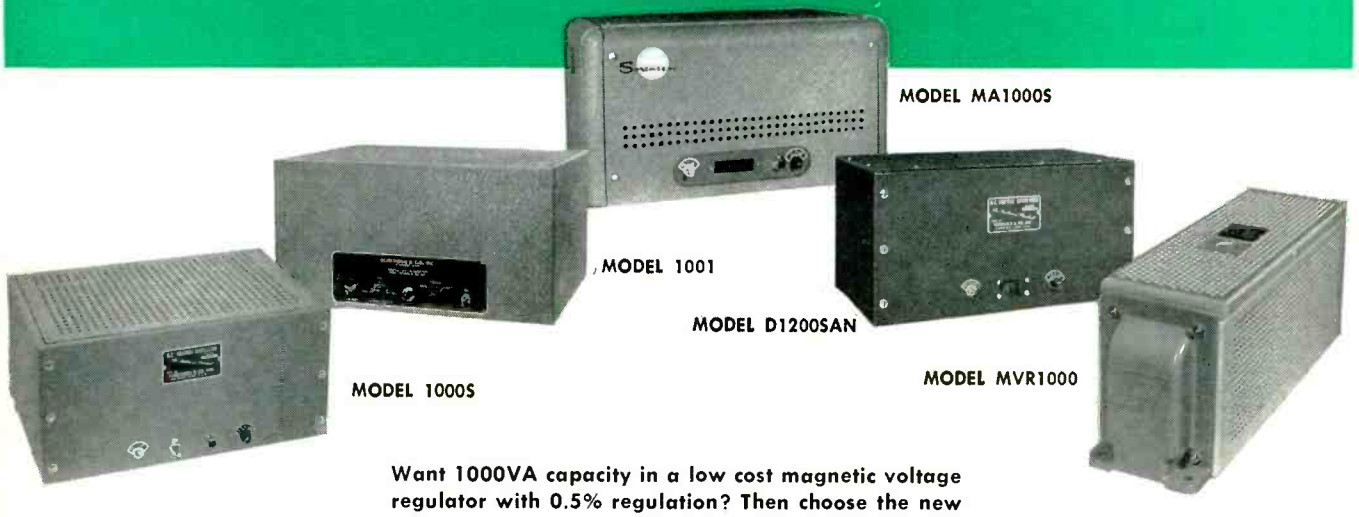
DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

SORENSEN

ENGINEERS *STANDARD* MODELS TO MEET *SPECIAL* REQUIREMENTS

to illustrate this flexibility, engineers can now choose from five 1000VA regulators!



MODEL 1000S — Automatic wide-range electronic regulation with the original Sorensen frequency insensitive circuit incorporating the safety diode. Regulation ±0.1%.

MODEL MA1000S — For unattended installations requiring extremely dependable automatic line regulation. This tubeless unit offers stable long-life performance with minimum maintenance. Regulation ±0.5% over wide frequency range.

Want 1000VA capacity in a low cost magnetic voltage regulator with 0.5% regulation? Then choose the new Sorensen MVR1000; compact, economical. Need 1000VA, but with 0.01% regulation? Then choose Model 1001. For any requirement, any application, there's a Sorensen 1000VA unit engineered with you in mind.

And the same thing is true for practically any specified requirement in the field of regulated power — whatever you need, Sorensen makes it now or will make it to do exactly the job you want done, within the limits of your particular application. Sorensen offers you the widest possible range characteristics. For research or industry, call on Sorensen — *the world's authority on regulated power.*

SEND FOR 1956 CONDENSED CATALOG

New and more complete — gives condensed specifications on a wide range of units for a variety of applications. Be sure you have all available information when you specify — send for your copy today!

MODEL 1001 — Developed from unique, dependable Sorensen regulating circuit, refined for ultra-precise ±0.01% regulation.

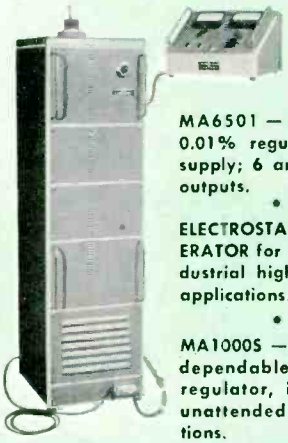
MODEL D1200SAN — ±0.25% regulation for 400 cycle industrial and aircraft requirements up to 1200VA.

MODEL MVR1000 — New low cost compact magnetic voltage regulator for less exacting applications. Fully automatic ±0.5% regulation with fast response time.

Sorensen

SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

MA6501



MA6501 — tubeless 0.01% regulated DC supply; 6 and 2 volt outputs.

•

ELECTROSTATIC GENERATOR for lab or industrial high-voltage applications.

•

MA1000S — tubeless, dependable 1000VA regulator, ideal for unattended installations.

MA1000S

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MR3215 5-32VDC AT 0-15 AMPS
new, tubeless, magnetic amplifier

WIDE RANGE REGULATED DC POWER SUPPLY

for versatile, trouble-free performance in countless design & test applications

Different outside . . . and *inside!* The latest design in magnetic amplifier regulation. A silicon diode is used as reference element and a transistor amplifier provides the control current for the magnetic amplifier. Wide range, continuously adjustable voltage at high current. Regulation ±0.5% against line or load, ripple 1% RMS. Versatile, dependable, rugged, economical.

VISIT BOOTH 646 CIRCUITS AVENUE, I.R.E. SHOW

Also see these other new products plus computer power supplies and Sorensen's developments in industrial ultrasonics.

Sorensen

SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

They cast their lot with SCOTCHCAST!

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Before settling on "SCOTCHCAST" Resin to encapsulate their coils, Coil Winders, Inc., Westbury, New York, tried many variations of standard insulating methods. They wanted something *better* than just good. They wanted extremely high moisture resistance, superior physical and electrical properties. So they cast their lot (over 30,000 coils in the last year) with "SCOTCHCAST"!

"SCOTCHCAST" is a two-part liquid epoxy-type resin which when combined with a suitable hardener, quickly cures into a solid, shock-resistant, moisture-resistant plastic. It is available with a wide range of properties, in rigid, semi-rigid and flexible forms.

And remember this: Unlike other resins, "SCOTCHCAST" sticks tight to terminals and leads, most metals, plastics and conductors, yet it's unaffected by acids, alkalies, solvents, oils and water.

For complete information, write Minnesota Mining and Manufacturing Company, Dept. CA-36, St. Paul 6, Minn. Learn how "SCOTCHCAST" can save you time and money, how it can do things you'd never dream an insulating material could do! Write today!

PRODUCT OF 3M RESEARCH

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SCOTCHCAST Resin
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The term "SCOTCHCAST" is a registered trademark of Minnesota Mining and Manufacturing Company, St. Paul 6, Minn. Export Sales Office: 99 Park Ave., New York 16, N.Y. In Canada: P.O. Box 757, London, Ontario.

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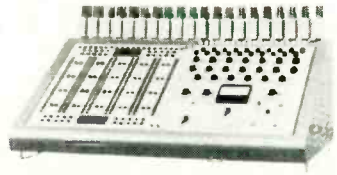
You can also expect the same high standards that have made the name Hall-Scott synonymous with dependability in research and development for industry and government over the past 40 years.

No matter what your electronic project may be, write for complete information on how Hall-Scott Electronics can assist you... 2950 North Ontario Street, Burbank, California, Dept. E-356.



Desk-top **Analog Computer,** rapid and economical system synthesis.

Plug-in DC **Amplifier,** a system building-block.

Work now in process includes Ground Control Components for Missiles, Sensing Devices, Electronic Analyzers, Transistorized Power Packages, Plug in DC Amplifiers, Pre-flight Test Equipment, and Analog Computers.

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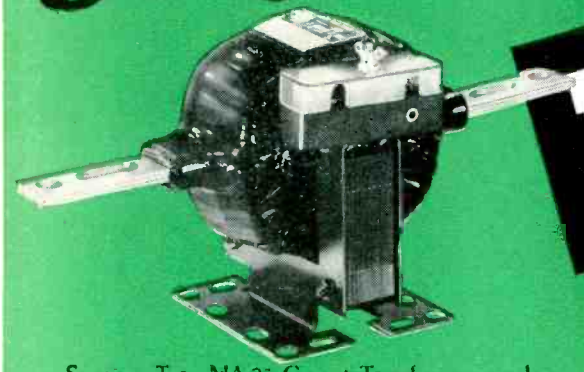
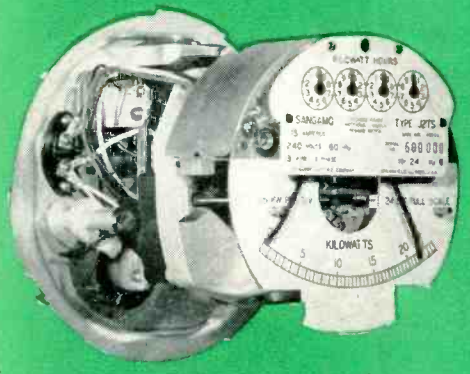
SANGAMO

Safeguards Performance with NATVAR 400



Sangamo Type MA-25 Current Transformers are designed for indoor service on metering applications. They are wound type with single primary and single secondary, and meet A.S.A. 2.5 KV insulation class test requirements—15 KV at 60 cycles and 45 KV full wave impulse. Natvar 400 Extruded Vinyl Tape is used "because of high insulation value, resistance to heat and ability to form itself to the shape of parts being insulated."



Sangamo Single phase combination Watthour and Demand Meters like the Type J2TS illustrated are built and tested for sustained accuracy under varying temperatures, ease of calibration and repair, resistance to corrosive atmosphere, and ample capacity to measure heavy loads. Natvar 400 Extruded Vinyl Tubing is used for insulation because it meets the requirements with plenty to spare.

Sangamo is one of the most respected names in the electrical industry. For more than fifty years Sangamo meters have measured electricity with great accuracy, have required little maintenance, and have been easy to test and repair. Meters and associated equipment are made in the Sangamo Electric Company plant in Springfield, Illinois.

They safeguard performance through good design for each requirement, individual tests at various stages of manufacture, and careful selection of materials. Natvar 400 Extruded Vinyl Tubing and Tape are used because of their uniformly good electrical and physical properties—particularly the ability to resist heat, oil, corrosive atmosphere and abrasion.

All Natvar flexible insulations are uniformly dependable no matter where or when purchased. They are available either from your wholesalers' stock or direct from our own.

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- Styroflex® flexible polystyrene tape
- Extruded identification markers

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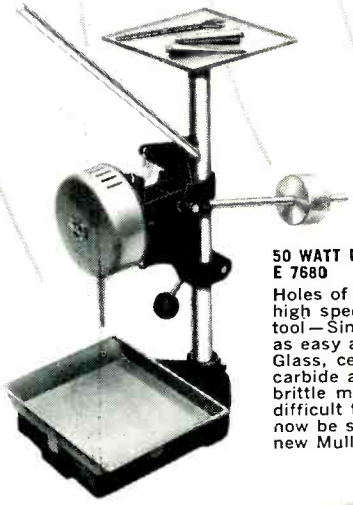
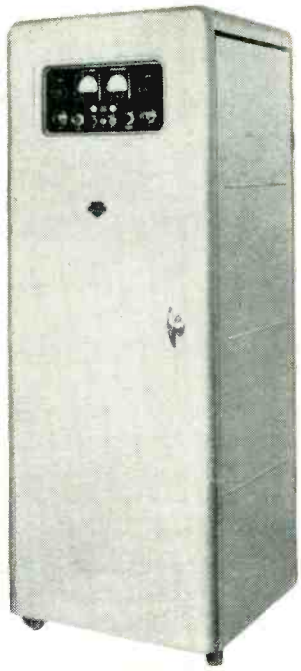


50 WATT ULTRASONIC DRILL E 7680

Holes of any shape cut by high speed reciprocating tool—Simple to operate—as easy as a rotary drill. Glass, ceramics, tungsten carbide and many other brittle materials normally difficult to machine can now be shaped with the new Mullard 50 Watt Drill.



2 KW ULTRASONIC GENERATOR E 7696

Heavy duty low frequency ultrasonic generator with magnetostrictive transducers for low frequency cleaning, soldering, tinning and drilling. Output continuously variable in frequency between 10 and 30 KC/s. Power continuously variable up to 2 KW.

Mullard, pioneers in ultrasonics and in the application of ultrasonic power to Industry, now have available the first complete range of ultrasonic HF and LF generators that provide from 50 Watts to 2 KW ultrasonic power at frequencies in the range of 10 KC/s to 2 MC/s. Mullard ultrasonic equipment is being successfully used by Industry in such processes as the tinning and soldering of aluminum without flux, rapid cleaning of small engineered parts, drilling, shaping and cutting brittle materials such as glass, precious and semi-precious stones, ceramics and tungsten carbide and many other materials. In addition to these proved applications, high power ultrasonics offers interesting possibilities in research projects where cavitation phenomena or high particle velocities are required. Research and Development Departments desiring additional information, are invited to visit us at the I.R.E. Show or write to the address below.

RUGGED 50 WATT ULTRASONIC POWER GENERATOR

Model E 7685 powers ultrasonic drill.

Model E 7595M powers ultrasonic iron and tinning bath.

ULTRASONIC SOLDERING IRON MODEL E 7587M

For fluxless soldering and tinning of aluminum and other metals that form refractory oxides. Soldering Bath Model E 7588M, ¾" Deep, ⅞" in diameter, also available.

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INDIANA
PERMANENT MAGNET
DESIGN INFORMATION

published for industrial and consumer product engineers and designers

HOW PERMANENT IS A PERMANENT MAGNET?

Permanent magnets *are* permanent. Proof of permanence is substantiated by many practical applications over long periods of years.

The continued accuracy of some of the most exacting scientific electrical measuring instruments, or of the familiar house-type, watt-hour meter depends upon a permanent magnet.

The speedometer in your car, the magneto in your power lawn mower, or your wife's magnetic knife rack in the kitchen may be consigned to the junk pile in time because of mechanical failure or obsolescence . . but definitely not because of magnetic failure.

There is a common belief . . which is incorrect . . that a permanent magnet supports its external magnetic field by dissipating some of its *internal* magnetic energy. This definitely is not the case.

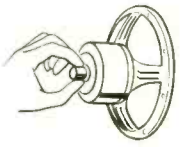
Adverse Factors on Remanent Magnetism. The magnetism of a permanent magnet can be adversely affected by any one, or a combination of, the following:

Elevated Temperatures can cause very appreciable initial losses in magnetism, up to complete demagnetization, even though metallurgical properties are not affected.

External Magnetic Fields from electro-coils, high electrical currents, or even other permanent magnets can partially or completely demagnetize the permanent magnet, and obviously, if the field is sufficiently strong, completely reverse the polarity.

Contact with Ferromagnetic Material by a permanent magnet in such a way that the normal internal field pattern is distorted can adversely affect the remanent magnetism. This is an important condition to avoid in the handling of magnetized magnets.

Changes in the Magnetic Circuit such as to produce a larger air gap than that on which it was initially magnetized, will reduce the strength of the magnet instantly and it is not recovered by reassembly to the original gap. A typical radio loud-speaker magnet, if removed from its associated steel circuit, then reassembled without remagnetizing, may lose as much as two thirds of its initial strength.



Vibration and Shock have little effect in most applications.

In all of these cases where only the remanent magnetism has been affected, losses can be recovered by remagnetization.

This article is a condensed version of a recently published feature article carrying the same title. Reprints of the full length article are available on request.

For assistance in designing the most efficient magnet for your product, consult our design engineers—without obligation, of course.

Magnetic Materials Exhibit at IRE Radio Engineering Show

Members of the magnetic materials design and application engineering staff of Indiana Steel Products Company will man the company's exhibit at the forthcoming IRE Radio Engineering Show in New York, Monday, March 19 through Thursday, March 22.

The exhibit, located in Booths 2 and 4 at Kingsbridge Palace, will feature a full line of permanent magnets including Cast Alnico . . Sintered Alnico . . Indox Ceramic Magnets . . and Cunife.

New manual discusses selection of permanent magnet materials

This newly published, 12-page manual entitled, "Permanent Magnet Materials and Their Selection," discusses physical and magnetic characteristics and the applications of Cast Alnico Magnets (Grades I, II, III, IV, V, VI, XII); Sintered Magnets (Alnico II, IV, V, VI, Indalloy and Indox I); Ductile Magnets (Cunico and Cunife I) and Formed Magnets (Chromium and Cobalt).

Also included is a selector-type chart which lists magnetic characteristics, design factors, material characteristics, and manufacturing methods and limitations of the various magnetic materials. In addition, special sections present a "Glossary of Magnetic Terms" and a list of magnetic "Symbols."

Copies of this publication are available on request. Ask for Manual 5-A-3 on your company letterhead.

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Valparaiso, Indiana

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

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To speed fulfillment of your orders, CAC has stockpiled standard inductances of molded plastic toroids. They are in inventory, ready for shipment *hours* after receipt of your orders.

Additionally, our new small orders department facilitates speedy manufacture and handling of special prototype quantities which are not stockpiled.

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Standard Inductances listed therein are available for immediate delivery.

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IF YOU USE semimetals in your products, you will be glad to know that Sylvania is now a dependable source for both silicon and germanium.

Sylvania's new silicon facilities are producing the semimetal in needle and densified forms, of spectrographic purity. Full production is expected during the spring. At present, transistor-grade samples are available for your evaluation on a letterhead request basis.

Sylvania has long been a primary refiner of high-purity germanium. Specifications include ingot as-reduced (guaranteed 5 ohm cm resistivity) and polycrystalline ingot (guaranteed minimum 30 ohm cm resistivity). Whichever grade you prefer, you can be sure of continuing high quality and uniformity when you order from Sylvania.

Write for technical specifications and quotations on Sylvania silicon and germanium. Remember, too, that our engineering staff is always ready to help you solve semimetal application problems.

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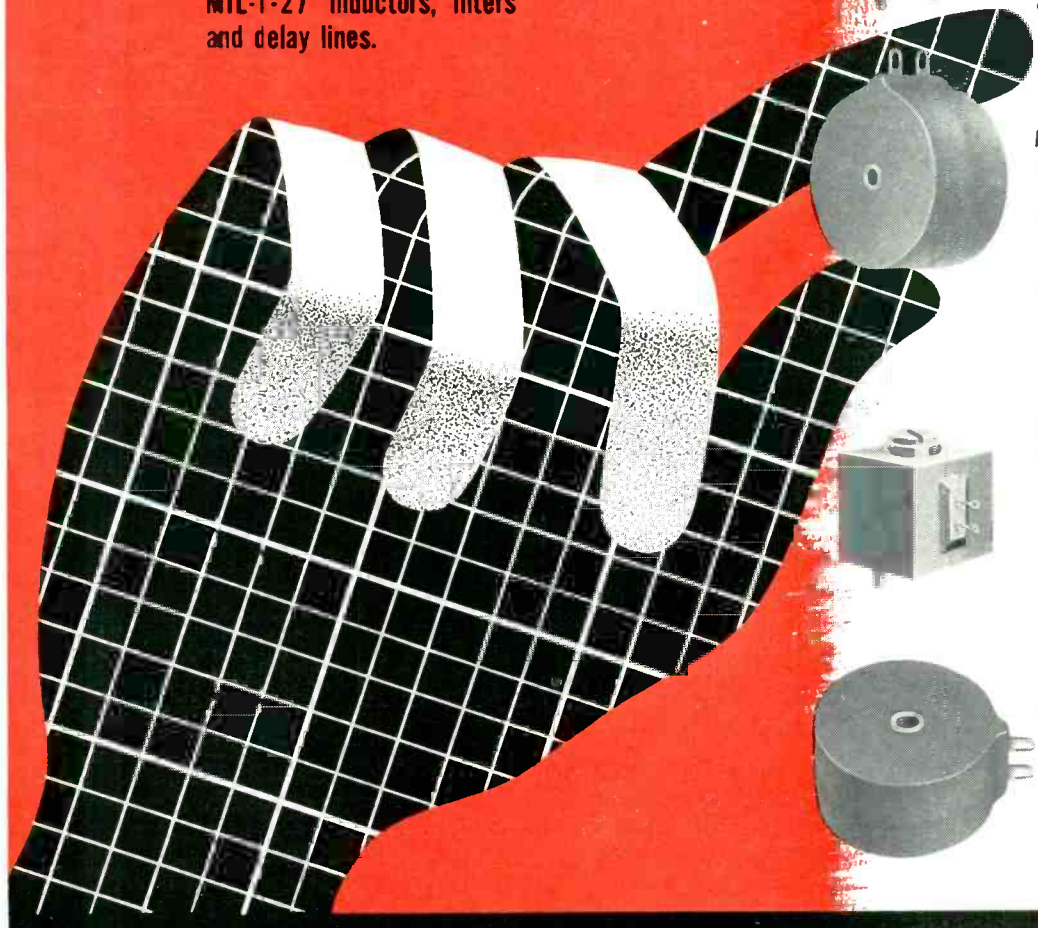

Variable Inductors
- inductance values up to 1000 henrys
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- for low-frequency tuning applications

Molded Toroids
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- miniaturized for guided missiles
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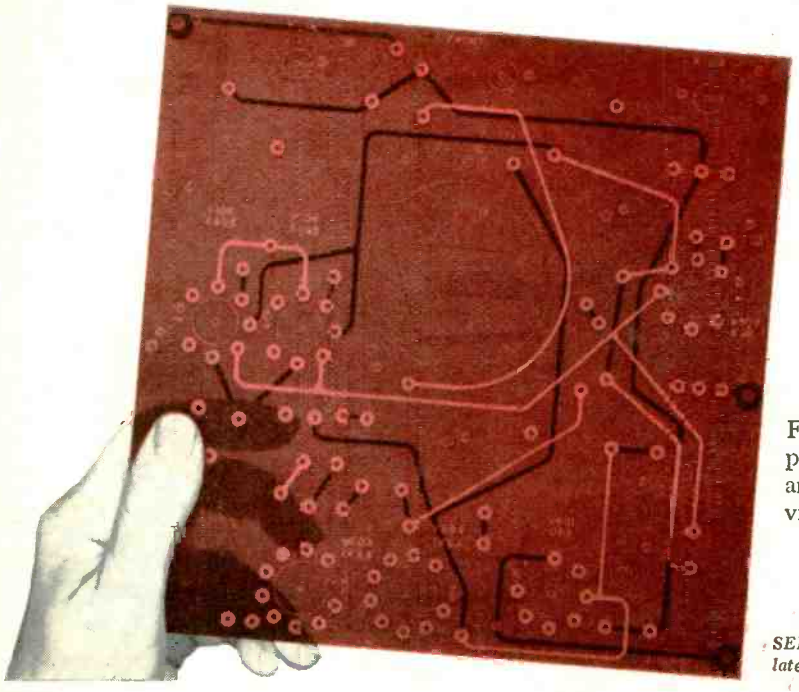
new Formica watermark

The watermark now appearing in every sheet of the new Formica XXXP-36 laminated plastic positively and permanently identifies it as the high IR, cold punching sheet you purchased.

No other laminate carries such a seal of guarantee. Only Formica XXXP-36 gives you such a convenient visual check on quality control throughout your entire circuit fabricating process.

Here's why the new watermark is so important to you: design engineers specify Formica XXXP-36 because it alone offers the double value of (1) cold punching up to and including 1/16" thickness, and (2) one million megohms insulation resistance after 96 hours at 95° F at 90% relative humidity. Obviously production must be able to separate the cold punching XXXP-36 from the ordinary hot punching grades, and this is done simply by visual on-the-spot inspection.

The watermark is useful to electronics manufacturers in many other ways, too.



Cold punching high IR and translucency combined in new XXXP-36

Formica's new paper base XXXP-36 combines cold punching with a million megohms insulation resistance. Translucency is a plus value that permits a visual check on the accuracy of circuit register.

SEE YOU AT THE IRE SHOW! Visit us in booth 835-837 for latest developments in laminated plastics for the electronics industry.

guarantees highest copper clad quality

It identifies XXXP-36 as the sheet with the accuracy so indispensable to automatic printed circuit assembly.

Identification with the Formica watermark is so quick, easy and positive, it will save you real money by eliminating undependable stickers, labels and office records.

The XXXP-36 watermark is another Formica quality service that delivers *quality you can see,* for better printed circuitry. For complete information on XXXP-36 and Formica's 12 other outstanding copper clad grades, send for free bulletins 599 and 457 and Data Sheets.

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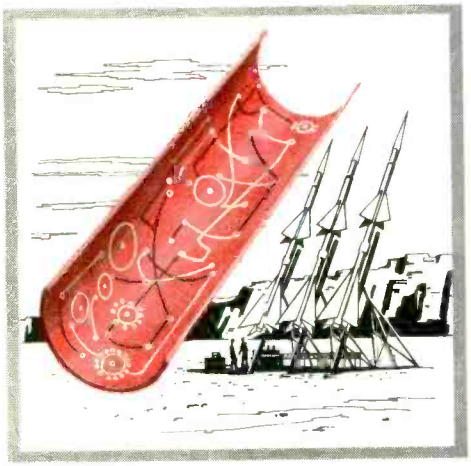
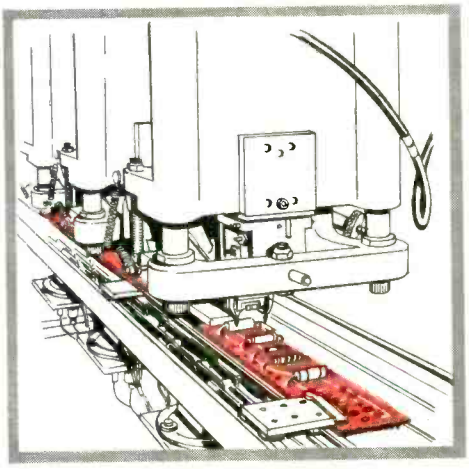
Pays in Performance

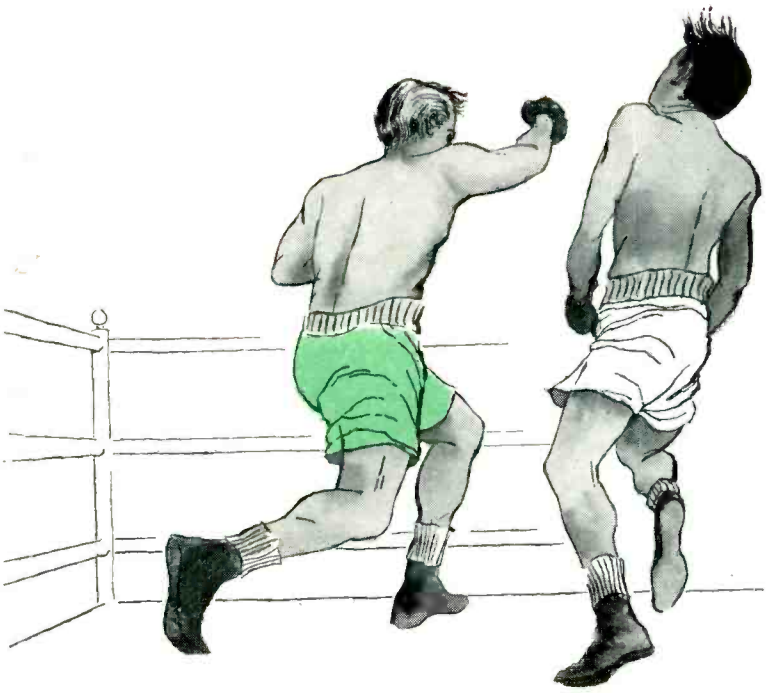


Super heat resistance
—necessary for guided missiles—now available in Formica's new FF-91 epoxy type copper clad which also offers super IR, better bond strength and better all around circuit performance. (The 180° arc shown is molded.)



Automation accuracy
The uniformity required for automatic circuit assembly is provided by XXXP-36 and Formica's other cold punching copper clad laminates. Cold punching eliminates dimensional change resulting from heating.

Circuits by the yard
Formica copper clad laminates are available in more and larger sheet sizes. This greater selection eliminates unnecessary cutting, reduces waste, assures economy in fabrication no matter how large the circuit.



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Your confidence is well placed in Constantin's *Proven Designs, Advanced Manufacturing Skills,* and *Prompt Delivery.*

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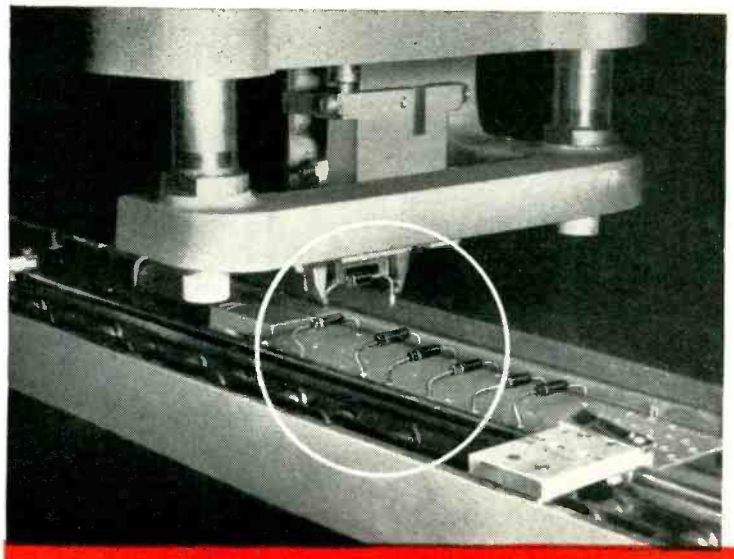
Unique method of anchoring IRC leads keeps them from being twisted or pulled out in automatic bending and insertion operations.



HOW TO BE SURE OF TERMINAL SECURITY

No matter how you assemble or solder them, IRC resistors provide the extra terminal security that prevents termination failures in the production line or in the field. Leads of IRC Type BT Resistors, for example, are uniquely anchored in the resistor body so that they won't twist or pull out. A new IRC alloy coating which overcomes copper migration also assures improved and more uniform solderability. Together, these features speed up production, cut inspection costs, and assure reliable long-range performance. For more information, send coupon today.

Why Leads Won't Come Loose

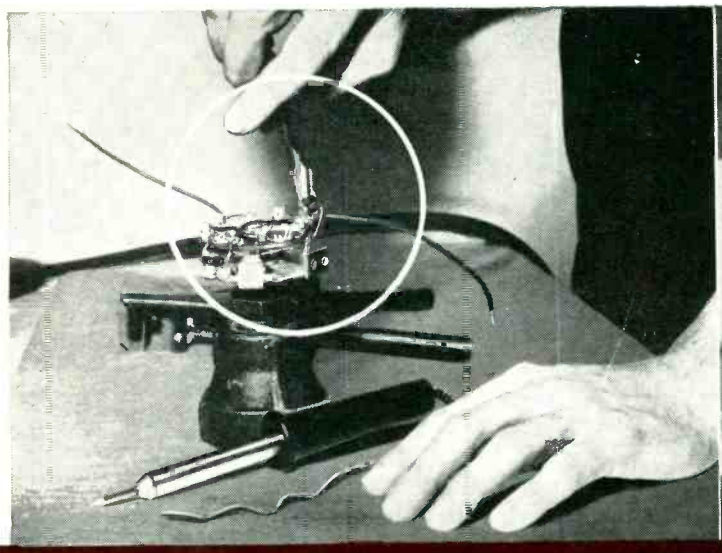
Leads of IRC Type BT Resistors are so securely joined to the element that even the unmolded assembly exceeds the standard 5-lb. pull requirement. For still greater strength, leads have a crimped collar which provides a tooth-and-notch effect when the assembly is molded as a unit.

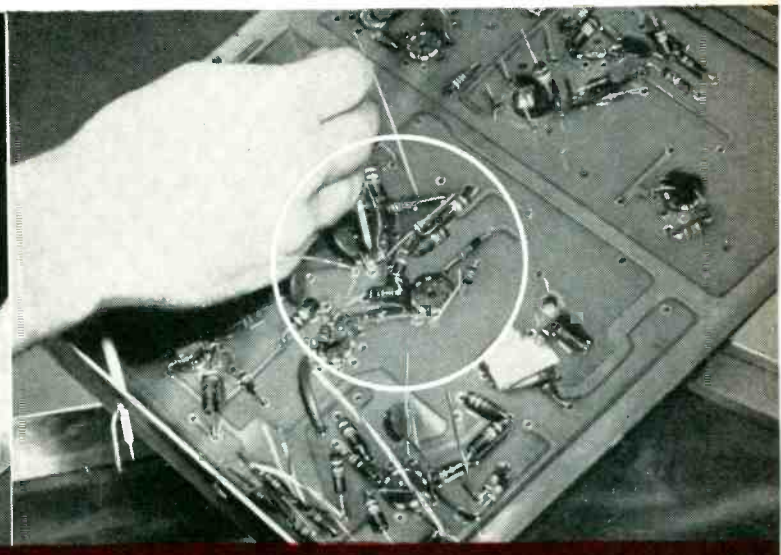
Straight Leads Speed Automation

The IRC Automation Package assures you of consistently straight leads suitable for automatic feed. This permits automatic, trouble-free feed to holding devices or into inserting heads of printed wiring lines.

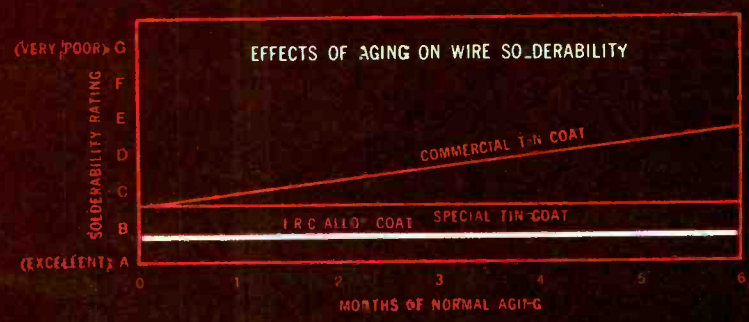
Because they can be bent up to resistor body, IRC leads solve special "fit" problems and simplify production and soldering operations.

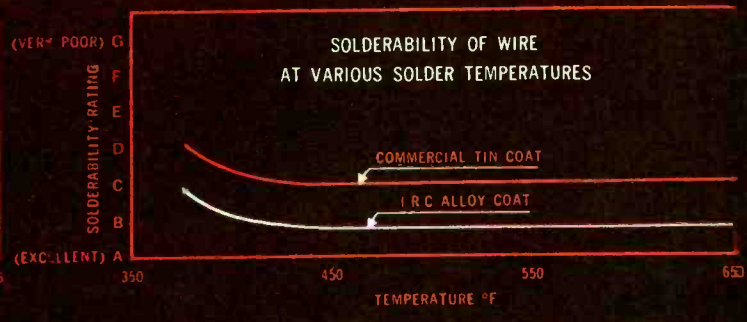
New alloy surface on leads overcomes tendency of copper to migrate toward coating. This assures superior solderability by any method, with low or varying temperatures.



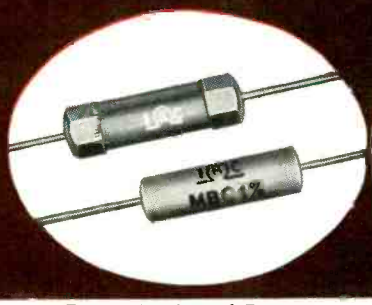


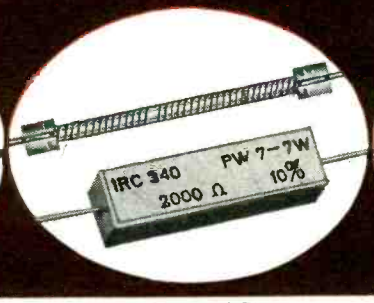
here's how much IRC's new alloy coating improves solderability

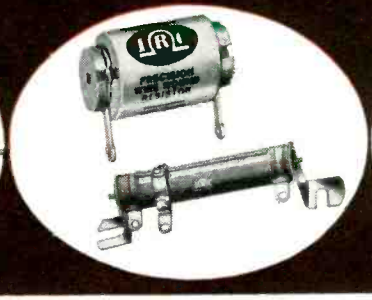




EXTRA TERMINAL SECURITY ALSO FEATURES OTHER IRC RESISTORS







Be sure to visit IRC at the I.R.E. show, Booth 553-555 Components Ave.

Deposited and Boron-Carbon Resistors

The metal used in terminations passes ASTM tests for season cracking. In addition, terminations are automatically assembled for uniform strain strength.

Wire Wound Low Wattage Resistors

Through machine assembly, the element, terminal clips, and leads are assembled simultaneously. No other method assures such uniformly high resistance to twisting or pulling.

Wire Wound Precision and Power Resistors

Legs can't turn or twist and break the fine resistor wire. This also eliminates any "strain gauge" effect which would change the resistance value.

IRC Subsidiary Companies also invite you to visit their I.R.E. exhibits

HYCOR Division of International Resistance Co., Booth 369, Microwave Ave.
CIRCUIT Instruments Inc., Booth 555, Components Ave.

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Controls and Potentiometers • Low Wattage Wire Wounds • Germanium Diodes

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INTERNATIONAL RESISTANCE CO.
Dept. 232, 401 N. Broad St., Philadelphia 8, Pa.

Send data on resistors checked:
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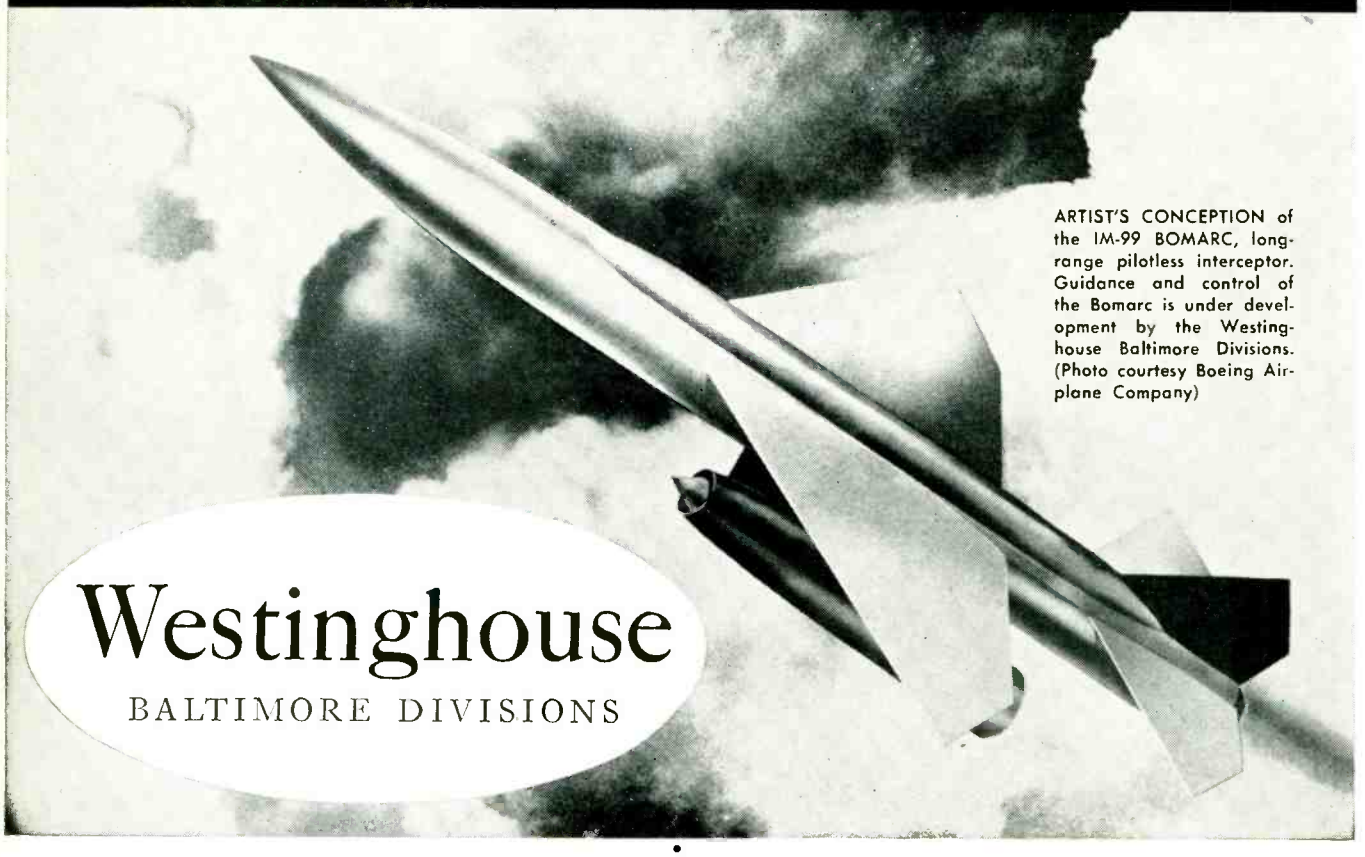

ARTIST'S CONCEPTION of the IM-99 BOMARC, long-range pilotless interceptor. Guidance and control of the Bomarc is under development by the Westinghouse Baltimore Divisions. (Photo courtesy Boeing Airplane Company)

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BALTIMORE DIVISIONS

are active in advanced projects like **BOMARC...** are you?

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Send resume of education and experience to Technical Director, Dept. 302 Westinghouse Electric Corp., 2519 Wilkens Avenue, Baltimore 3, Maryland

BOMARC is typical of the many interesting projects "in the works" at Westinghouse. Such projects are more than a "one-shot" challenge to the engineer . . . they are the true steps forward in his career, and the broadening of knowledge that enriches his value to himself and to his profession. If you are interested in this type of project, Westinghouse is interested in you!

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Introducing the NEW

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HIGH CONDUCTANCE GERMANIUM GLASS DIODES

Newest development of Radio Receptor engineering skills are these efficient and long lived glass diodes. They're built for top performance and remarkable endurance in a wide variety of applications.

STABILITY These are true "junction" diodes formed by alloying with exceedingly high electrical and mechanical stability and no dependence upon whisker pressure.

TRUE HERMETIC SEAL Glass envelope has fused glass-to-metal seals impervious to moisture and chemical contaminants.

CHARACTERISTICS Close control over metallurgical properties of the material and geometry of the junction results in forward currents of the order of several hundred milliamperes at one volt with low reverse saturation currents.

Here are a few of the new Radio Receptor glass diode types. Many others are available . . . For the complete list, fill out the coupon below and mail it to us today!

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1N68A
1N89
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1N95
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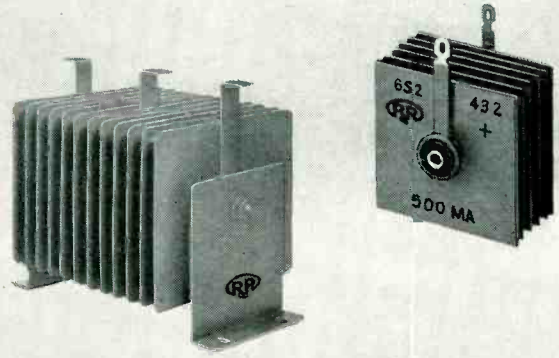
1N118A
1N126
1N127
1N128
1N198
DR301
DR302
DR303
DR305
DR306
DR307
DR310
DR311
DR312
DR314
DR315
DR316
DR317
DR319
DR321
DR322
DR323
DR324
DR325

DIMENSIONS

Diameter	.098" max.
Length	.265" max.
Lead diameter	.025"-.019"
Lead length	1.125" min.

RADIO RECEPTOR SELENIUM RECTIFIERS

RRco. conducts continuing laboratory research to maintain highest standards for existing types of selenium rectifiers as well as newer products. RRco. rectifiers include industrial and radio types, embedded stacks, hermetically sealed units, high temperature types and the new snap-in "Qui-Klip" rectifier. If you have a problem involving rectification, write today for full information.



In Radio and Electronics Since 1922

Semiconductor Division, Radio Receptor Co., Inc.
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☐ Please send me your new glass diode bulletin no. G-57.
☐ Please have your representative call on me.

Name..... *Position*.....
Company.....
Address.....
City..... *Zone*..... *State*.....

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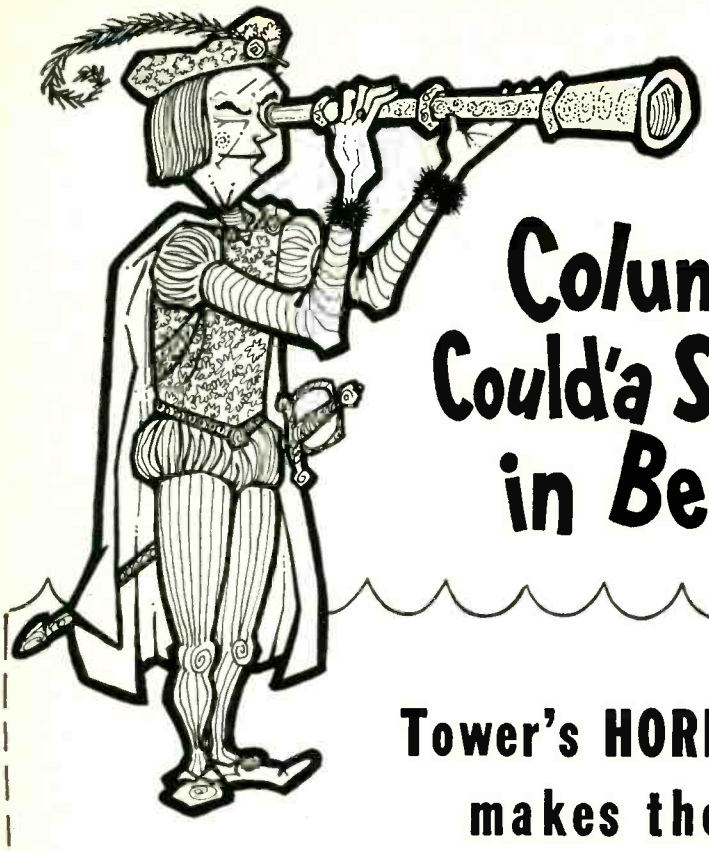
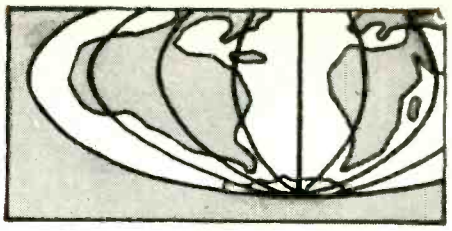
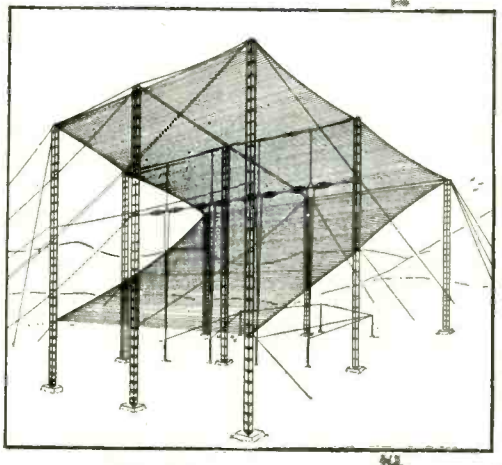
Want more information? Use post card on last page.





Columbus Could'a Stood in Bed...

Tower's HORIZON STRETCHER makes the earth FLAT



POOR CHRIS went to a heap of trouble to prove that the Earth was not flat, then TOWER came along and "flattened" it out again. Mr. C's "round" earth caused too many problems with FM signals. They just couldn't be "read" beyond the horizon. That is, until TOWER engineered, fabricated, and erected the first successful High Gain Corner Reflector Antenna installation (insert) to receive FM radio and TV signals far beyond yesterday's horizons.

A pioneer in "Scatter Propagation," TOWER has proven again that knowledge, gained through experience, sets the pace for TOMORROW . . . today!

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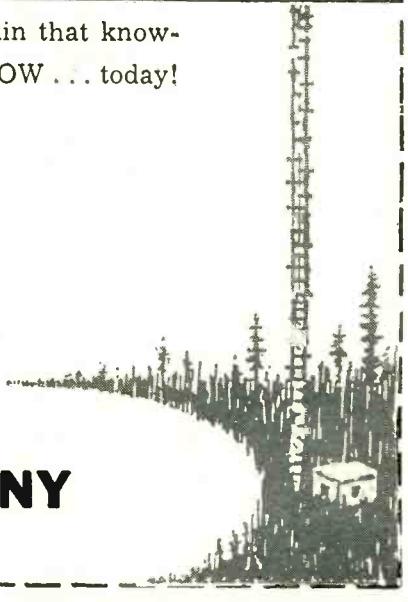

LOOK!

here's what it takes

THE HAYDU BEAM SWITCHING TUBE offers these other unique advantages for various equipment including:

VARI COUNT
complete versatility...can use arbitrary numbers of positions

COUNTER DISTRIBUTOR
operate singly...or one tube will operate others in unlimited combinations

BEAMPLEXER
can be operated by DC, sine wave or pulsed inputs

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reduce overall circuitry and related costs

AIRCRAFT CODER
decrease space, weight and heat—a new standard in high vacuum reliability

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TO EQUAL ONE BEAM SWITCHING TUBE!

20 pentodes—2 triodes—22 sockets—10 condensers—98 resistors. *152 separate components plus related circuitry* are required to duplicate all the functions of a standard MBS Tube circuit!

The Haydu Magnetron Beam Switching Tube* permits drastic reductions in the total number of tubes and other components required in most electronic systems. It is compatible with transistors and magnetic core circuitry . . . while performing a greater number of functions at much higher frequencies! In an unlimited number of electronic applications, the new Haydu MBS Tube switches between multi-outputs many times faster, more simply and more reliably than standard vacuum tubes, diodes or transistors . . . and in any sequential, simultaneous or random switching pattern. Each position is capable of producing a functional output able to operate relays *without amplification.*

*MBS (Trademark)

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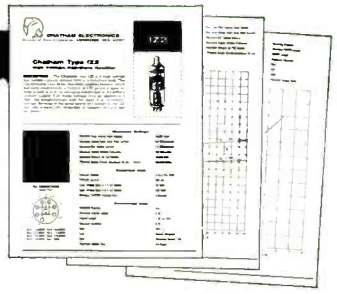
Designed with the future
CHATHAM

Reliable Tubes– Pioneered by Chatham



Offering the utmost in electronic tube dependability, these Reliable types are a product of Chatham research and development. Today, the Chatham line of Reliable Tubes is an industry standard for both military and commercial tube applications. For complete information consult the new Chatham Bulletins available on request.

Engineering Service for Special Requirements

Where unusual requirements indicate the use of special purpose tubes, these can be designed and produced to your specifications. Chatham's Tube Division is equipped to handle both large or small production runs efficiently and economically. Chatham engineers are available for special tube problems.

THYRATRONS

Type 2D21W
Ruggedized Xenon filled, shield grid thyratron for relay-pulse and grid controlled rectifier service. Conforms to MIL-E-1B specifications.

Type 3C23
Mercury Vapor Argon filled thyratron for grid controlled rectifier service. Wide ambient temperature tolerance. Medium 4 pin phenolic base.

Type 323B
Same as 3C23 but has medium shell 5 pin base. Heater 2.5 volt 7.0 amperes; peak inverse anode volt. 1250 v. average anode current 1.5 amps.

Type 5594
Xenon filled, operates in ambient temp. from –55° to +90°C. Filament 2.5 v., 5 amps. Peak inverse anode volt. 4500, aver. anode current 0.5 amp.

Type 884
Argon filled, for sweep circuit oscillator in CRT circuits. Heater 6.3 volts, 0.6 amp. Peak forward anode voltage 300, aver. plate current 75 ma.

Type 395-A
Cold cathode, requires no filament supply. For grid controlled rectifier, relay applications. Max. D.C. anode volt. 150, Max. anode current 10 ma.

Type 5696
Xenon-filled, shield grid thyratron with low filament drain. Heater 6.3 volts, 150 ma. Peak inverse anode voltage 500, average anode current 25 ma.

Type 6D4
Miniature thyratron used as a relay tube or gas tube oscillator. Also extensively used as an RF noise source. Average anode current 25 ma.

Type 2050W
Ruggedized Xenon filled shield grid thyratron for grid controlled rectifier service. Provides longer service in presence of shock, vibration.

HYDROGEN THYRATRONS

Type VC-1257
Hydrogen filled, zero bias thyratron with hydrogen generator for generation of pulse power up to 33 megawatts.

Type 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

Type 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

Type VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW.

DECADE COUNTERS

COLD CATHODE DECADE COUNTER TUBE
Chatham Type 1047 is a cold cathode decade counting tube intended for use in medium speed applications such as scalers and computers operating from 0 to 2000 pps. Type 1047 features high current handling capacity per count cathode. It has ten individual cathode outputs. D.C. Supply Voltage – 340; Output Voltage – 45; Transfer Pulse Amplitude (Volts) – 150; Transfer Pulse Width Microseconds – 150; Cathode Current 4.5 ma.

SPECIAL PURPOSE TUBES

Type 719-A
High vacuum tube for clipper diode service in hard tube modulator circuits. Filament 7 volts, 7 amps. Peak inverse anode volt. 25 kv. Max. peak anode current 10 amps.

HIGH VOLTAGE VACUUM FUSES
These are supplied by Chatham to customers' specifications if ordered in reasonable quantity. Full particulars and quotations supplied promptly

HIGH VOLTAGE VACUUM SWITCHES
Available in two standard types for high voltage switching at high altitude.
Glass enclosed, mechanically actuated, these switches feature extremely long operating life.

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ENGINEERS and
MANUFACTURERS

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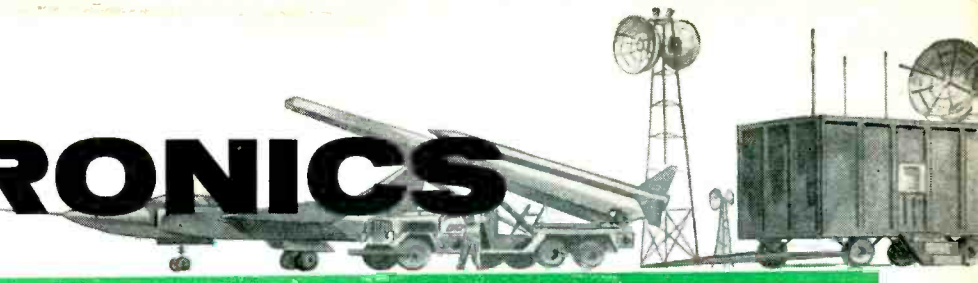
ELECTRONICS



TWIN POWER TRIODES

Type 6336
Low mu, high perveance twin power triode for use as a series regulator tube in D.C. power supplies. Plate Dissipation 30 watts per sect.

Type 6AS7G
Low mu, high perveance twin power triode for use as a regulator tube in D.C. Power Supply Units. Plate dissipation 13 watts per sect.

Type 6520
Same as 6AS7G for use where utmost reliability is required in triode balance, absence of excessive plate current drift, high grid to plate insulation.

Type 5998
Similar to 6080 and 6AS7G but with higher amplification factor. Mu 5.5. transconductance 14,000 micromhos, plate dissipation 13 watts per plate.

Type 6080WA
Ruggedized Twin Power Triode made under reliable tube program. Plugs directly into any socket using 6080 or 6AS7G regulator tubes.

Every Chatham Tube is Rigidly Tested to Insure Dependable Performance

All tubes manufactured by Chatham are thoroughly tested for periods up to 30 hours. Many tube types are held for a minimum of 96 hours and retested to determine the effect of storage. Test equipment employed includes small table type sets and large hydrogen thyratron units with inputs up to 100 KW. Chatham test equipment is continuously checked for accuracy of calibration by technicians specializing in calibration and maintenance of equipment. Tube types are life tested on a year round basis to insure maximum performance and service life.

RECTIFIERS

Type 1Z2
A high voltage vacuum rectifier for constant supply circuits. Filament 1.25 volts, 275 ma., Peak inverse anode voltage 15,000. Aver. anode current 1.5 ma.

Type 3B25
Half wave, Xenon Rectifier. Wide ambient range —75° to +90°C. Filament 2.5 volts, 5.0 amp. Peak inverse anode voltage 4500. Aver. anode current 0.5 amp.

Type 3B28
Half-wave, Xenon rectifier. Wide ambient range of —75° to +90°C. Filament 2.5 volts, 5.0 amps. Peak inverse anode voltage 10,000. Aver. anode current 250 ma.

Type 4B32
Half-wave, Xenon rectifier. Wide ambient range —75° to +90°C. Filament 5 volts, 7.5 amps. Peak inverse anode voltage 10,000. Aver. anode current 1.25 amp.

Type 583
Small size high vacuum clipper diode and high voltage rectifier. Clipper ratings: Peak inverse voltage 15 KV, peak anode current 8 amps; average anode current 20 ma.

Type 5R4WGY
Full wave rectifier ruggedized to stand 980 g shock. Max. inverse voltage 2800 volts at 165 milliamperes or inverse voltage 2400 volts at 275 milliamperes.

Type 5R4WGA
Same as 5R4WGY but designed to operate at full inverse ratings up to 40,000 ft. altitude and at reduced rating to 60,000 ft. altitude.

Type 5R4WGB
A reliable version of the 5R4WGA designed and manufactured to MIL-E-1B reliable tube specifications.

Type 6AL5W
Ruggedized miniature twin diode. Heater 6.3 volts, 0.3 amp. Peak inverse anode voltage 330, D.C. output current per plate 9 ma. max.

Type 6H6WGT
Ruggedized twin diode with octal base. Heater 6.3 volts 300 ma. Peak inverse anode voltage 465 volts. D.C. output current, 8.8 ma. per plate.

VOLTAGE REGULATOR & REFERENCE TUBES

Type 0C3W
A ruggedized glow discharge tube. Maintains D.C. voltage constant at 105 volts. Max. regulation 4 volts. Operating current 5 to 40 ma.

Type 0D3W
A ruggedized glow discharge tube. Maintains D.C. voltage constant at 150 volts. Max. regulation 5.5 volts. Operating current 5 to 40 ma.

Type 5651
Miniature Cold Cathode Gas Discharge Tube for voltage reference. Maintains voltage of approx. 87 v. at a current range of 1.5 to 3.5 ma. Reliable type 5651WA.

Type 6627/0B2WA
Miniature cold cathode glow discharge tube for use as a voltage regulator. Regulating voltage is approx. 108 volts at a current range of 5 to 30 milliamperes.

Type 6626/0A2WA
Same as Type 6627/0B2WA with regulating voltage of approx. 150 volts at a current range of 5 to 30 milliamperes.

Consult CHATHAM on *all* four!

- HIGH PERFORMANCE ELECTRONIC TUBES
- AIRBORNE CONVERSION EQUIPMENT
- kotron SELENIUM RECTIFIERS
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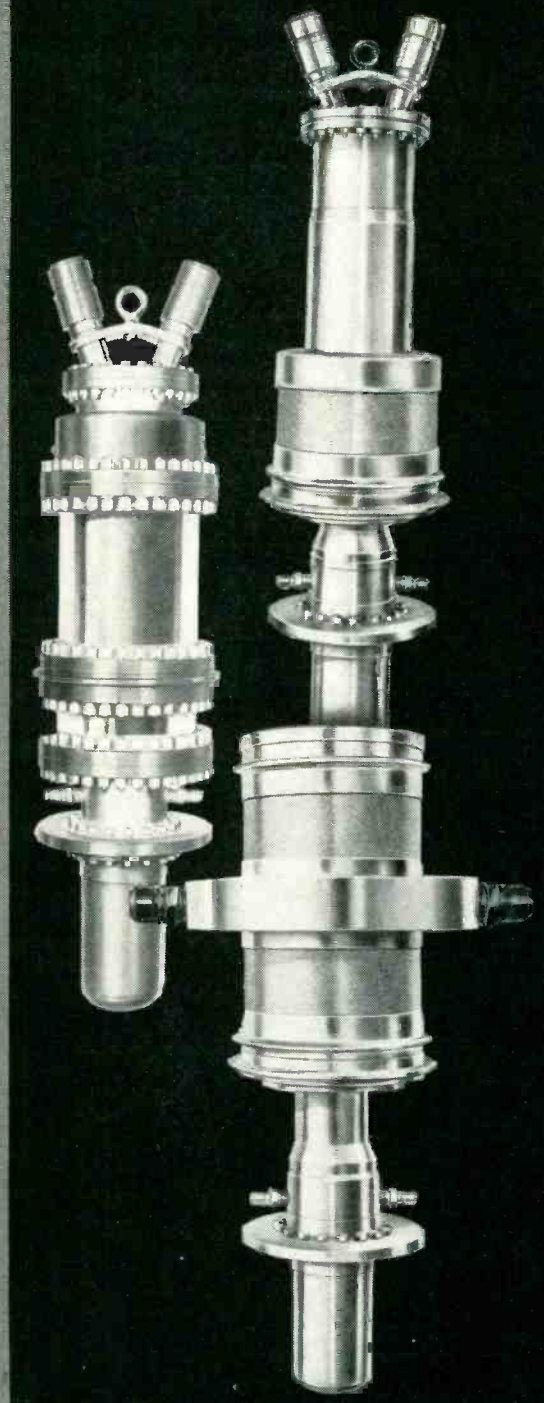
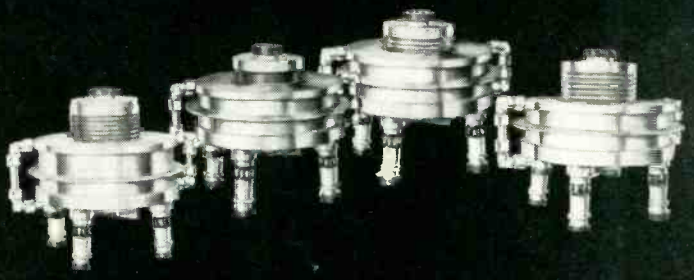
RCA DATA FOR





NOW...UNPRECEDENTED HIGH POWER OUTPUTS

. . . with RCA super-power tubes

Visualized by the Radio Corporation of America over two decades ago . . . and since then under a continuing development and field-testing program . . . RCA Super-Power Tubes are now being offered to progressive industries looking ahead to rf applications requiring higher and higher power at higher and higher frequencies.

Using concepts unusual in vacuum-tube design—including unique principles of electron optics, interelectrode shielding, and tube geometry—RCA Super-Power Tubes begin their work where conventional power tubes leave off.

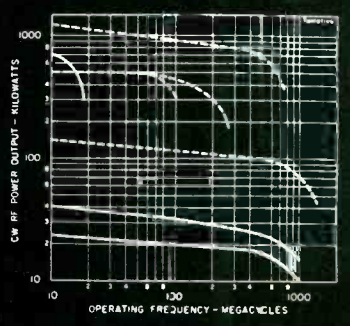
Ingenious internal liquid cooling of tube electrodes and unitized coaxial design make it practicable to generate higher power at much higher frequencies.

Thoriated-tungsten or matrix-type cathodes provide exceptionally high emission, economical power consumption, and long life.

Efficiency of rf transfer is assured through the use of high-conductivity seals and low-loss ceramic bushings.

Mechanical configurations—heretofore considered impossible—provide a new twist to vacuum-tube design to accomplish super-power generation. The ability of these tubes to handle high average power in cw operation permits unusually high power outputs in pulse and hard-tube modulator operation. All tubes are designed for single or multiple operation—for exciting new applications where higher and higher power extends the use of electronics.

RCA is ready to discuss with equipment manufacturers their present and future needs for Super-Power Tubes. Information may be obtained from the nearest RCA District Office—or write RCA, Commercial Engineering, Harrison, N. J.



DESIGNERS

ELECTRON TUBES
SEMICONDUCTOR DEVICES
BATTERIES
TEST EQUIPMENT
ELECTRONIC COMPONENTS

NEW TUBES — FOR BETTER TV-RECEIVER PERFORMANCE

RCA-2BN4,-6BN4 . . . 7-pin miniature-type high-g_m medium-mu triodes for rf amplifier service in vhf TV tuners. Reduced inductance and rf lead resistance contribute to high gain. Basing arrangement facilitates neutralization.

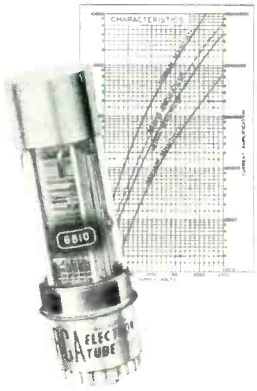
RCA-5CG8,-6CG8 . . . 7-pin miniature-type triode-pentode converters for oscillator-mixer service in vhf TV tuners. Feature two cathode leads with separate base-pin terminals to minimize input loading effects of pentode mixer unit, and interaction between input and output circuits.

RCA-6CU5,-12CU5 . . . 7-pin miniature-type beam power tubes for audio output stages. Because of their high power sensitivity and high efficiency, these types can provide relatively high power output at low plate and screen voltages.

NEW LOW-NOISE TRANSISTOR FOR AF PREAMPLIFIERS OPERATING FROM LOW-LEVEL LOW-IMPEDANCE SOURCES — WITHOUT INPUT TRANSFORMER

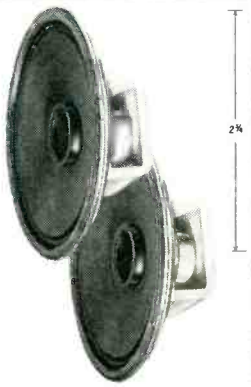
RCA-2N175 . . . low-noise germanium-alloy junction transistor of the p-n-p type; intended primarily for preamplifier or input stages of transistorized audio amplifiers which operate with extremely small input signals. Features an exceptionally low wide-band noise factor of 6 db (max.), current amplification ratio of 65, and a matched-impedance power gain of approximately 43 db. Stability and uniformity of characteristics are excellent throughout life. The low-noise factor and low-input impedance characteristic of RCA-2N175 permit the design of audio amplifiers in which the transistor is directly operated from low-impedance, low-level devices such as magnetic microphones and magnetic pickups without an input coupling transformer.

NEW 14-STAGE MULTIPLIER PHOTOTUBE



RCA-6810 . . . the most sensitive phototube in the RCA line . . . multiplies feeble photoelectric currents approx. 66,000,000 times when operated with 2300 volts supply potential—is a head-on type designed for scintillation counters, spectrophotometers, and other applications involving unusually low-level light sources. Featuring fast response, high current gain, relative freedom from after-pulses, and small spread in electron-transit time, RCA-6810 is particularly useful for fast coincidence scintillation counting. Because of the capability of delivering pulse currents up to 0.5 amp in magnitude without appreciable deviation from linearity, the need for an associated wide-band amplifier is eliminated in many applications.

TWO NEW MINIATURE-TYPE HIGH-SENSITIVITY SPEAKERS NOW AVAILABLE FOR COMPACT PERSONAL RADIOS



RCA generic designs XS-7659 and XS-7744 . . . only 2¾" in diameter . . . for use where limited space and high sensitivity are important design considerations. Both are p-m types. They provide good frequency balance and are designed to work into the air load provided by small, portable receiver cases. Voice-coil assemblies are encapsulated, making them impervious to damage from moisture and temperature changes. Voice-coil leads are brought out directly to the voice-coil terminals—not cemented to the cone—thus avoiding cone warping. Alnico V magnets are incorporated.

For complete technical data, write RCA, Commercial Engineering, Section C-19R, Harrison, N. J. or call the RCA District Office nearest you:

EAST: . . . . HUmboldt 5-3900, 744 Broad Street, Newark 1, N. J.

CENTRAL: WHitehall 4-2900, Suite 1181 Merchandise Mart Plaza Chicago 54, Ill.

WEST: . . . . RAymond 3-8361, 6355 E. Washington Blvd. Los Angeles 22, Cal.

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RADIO CORPORATION of AMERICA

TUBE DIVISION — SEMICONDUCTOR DIVISION

HARRISON, N. J.

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NEW NEW NEW

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CMC

Model 201A Frequency and Period Counter—$700.00

setting the pace for modern industry...

America's Finest Instruments

Advanced Design

ELECTRONIC COUNTING and CONTROLLING INSTRUMENTS

by computer-measurements

Improved Readability
—new, wide-angle display minimizes parallax

Improved Sensitivity
—more than 500% over the usual operating range

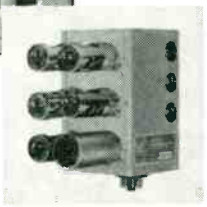
Greater Stability
—crystal oven as standard equipment at no extra cost increases stability to .0001%

Quick Time Base Alignment
—without auxiliary equipment

Completely Regulated Power Supply

The **all-new** CMC line of electronic counting instruments has been designed and engineered to meet the rigid requirements of science and industry and, at the same time, offer functional layout to simplify operation, reduce eye fatigue and enhance equipment appearance. Years ahead engineering utilizing proven developments make it possible to include features usually available only as optional accessories. Exacting test and laboratory requirements make the CMC line...the standard in excellence for the industrial world.

Model 200A Frequency Counter $425.00



Model XD-100A Crystal Time Base $100.00

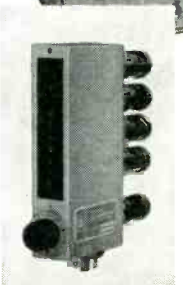
frequency and period counters

Compact, streamlined, easily portable—used for precise frequency and period measurements, production line testing, telemetering, calibration, etc. Direct digital read-out.

Exclusive features of the Model 201A are the inclusion of a crystal oven to bring the accuracy to .0001%...*plus* .1 sec., 1 sec., 10 sec., and 1 cycle time bases *at no extra cost.*

The *economy* Model 200A is designed to permit the use of a *plug-in* Crystal Time Base *at any time in the field* to increase accuracy from .1% to .0001%. It is also available with five decade display at $75.00 additional.

preset controllers



Model 314A Preset Controller (4 digit) $495.00

High speed counters used to automatically control any operation after a preselected count has been reached. Batching and packaging of pills, bottles, caps, machine parts, etc., are a few of the many applications. Sweeping design changes offer many new features...

COINCIDENT TYPE
ABSOLUTE ACCURACY
DIRECT SETTING
DIRECT READ-OUT
EXCEPTIONAL VERSATILITY

Pulse Output • Relay Contact Closure • Variable Contact Closure Time • Automatic or Manual Relay Hold • Totalizing Count

OPTIONAL FEATURE: Mechanical register to indicate batches (gross, dozen, etc.) or total count.

Model 101A Preset Decade Counting Unit—$75.00

CMC

CC-5

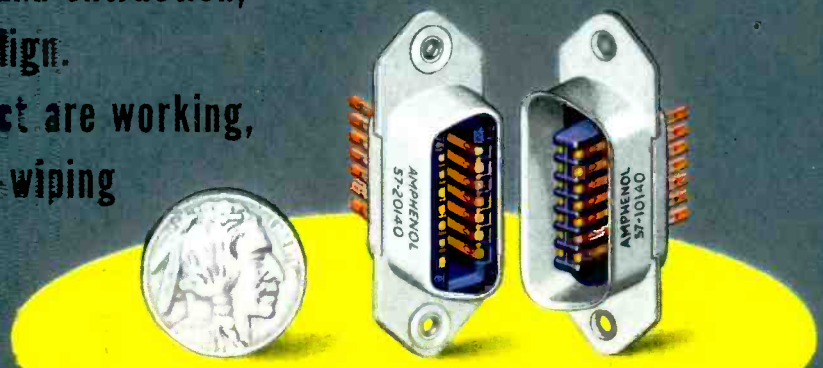
Complete catalog data available from factory or nearest representative

Nationwide engineering representation including Canada and export markets

Computer-Measurements Corporation

5457 Cleon Avenue • North Hollywood, California • Dept. 78-C

Miniaturization
plus increased reliability,
easy, smooth insertion and extraction,
no pins to bend or misalign.
Both sides of the contact are working,
flexing members...self-wiping
and self-cleaning.



14 CONTACTS

new! Micro-ribbon connectors

AMPHENOL

Micro RIBBON

24 AND 36 CONTACTS

New Micro-Ribbons are the first miniature connectors to provide reduction in size with increase in reliability. Utilizing an improved 'ribbon' contact, Micro-Ribbons provide easy insertion and extraction even in blind entrance locations. Both mating contacts are self-wiping, self-cleaning, active, flexing members—provide double contact action at all times. Send card for Catalog R2!

Micro-Ribbons
illustrated
actual size

American Phenolic Corporation, Chicago 50, Illinois

☐ send me R-2 catalog which includes a complete listing of available MICRO-RIBBON CONNECTORS.

☐ send new Hermetic Seal brochure.

I would like ☐ your periodical "Amphenol Engineering News"
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THIS CARD TEARS OUT

AN CONNECTORS

165 SERIES CONNECTORS

AMPHENOL AN connectors are the 'workhorses' of electronics, providing dependable service in literally thousands of applications. From the basic AN design have evolved AN connectors for potting (pioneered by AMPHENOL) and the 165 Series of Miniature AN-type connectors, also available in potting and pressurized constructions. ANs, 165 Series and all AMPHENOL electrical Connectors are listed in Catalog A4.

RF CABLES

Teflon and polyethylene RG-/U coaxial cables, miniature and Aljak cables—send for Catalog W1, a complete and informative catalog and manual, listing all AMPHENOL cables.

HERMETIC SEAL PRODUCTS

Brand new Headers join AN-type receptacles in the Hermetic Seal group. All have superior compression seal glass for best hermetic performance. Send for product literature!

AMPHENOL

product groups

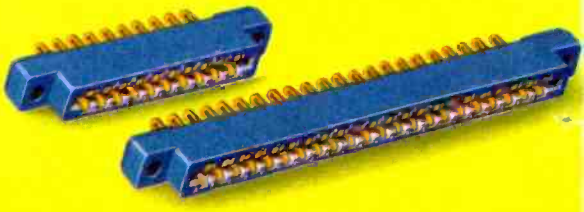
The AMPHENOL product line is comprised of thousands of electronic components—many are included in the major product groups illustrated. Not described are Cable Assemblies & Harnesses, Sockets, Plugs and the many 'specials' produced by AMPHENOL. General Catalog B4 summarizes the complete AMPHENOL product lines.

American Phenolic Corporation, Chicago 50, Illinois

Amphenol Canada Limited, Toronto 9, Ontario

RF CONNECTORS

All standard UG-/U types and many special application RF connectors including the new Subminax miniatures bear the AMPHENOL quality imprint. Request RF Catalog D3.



RACK & PANEL CONNECTORS

For rack & panel applications AMPHENOL offers famous Blue Ribbons, miniature and standard pin & socket types and a complete line of Princir (printed circuit) connectors. Designed and manufactured to AMPHENOL standards. Catalog R2.

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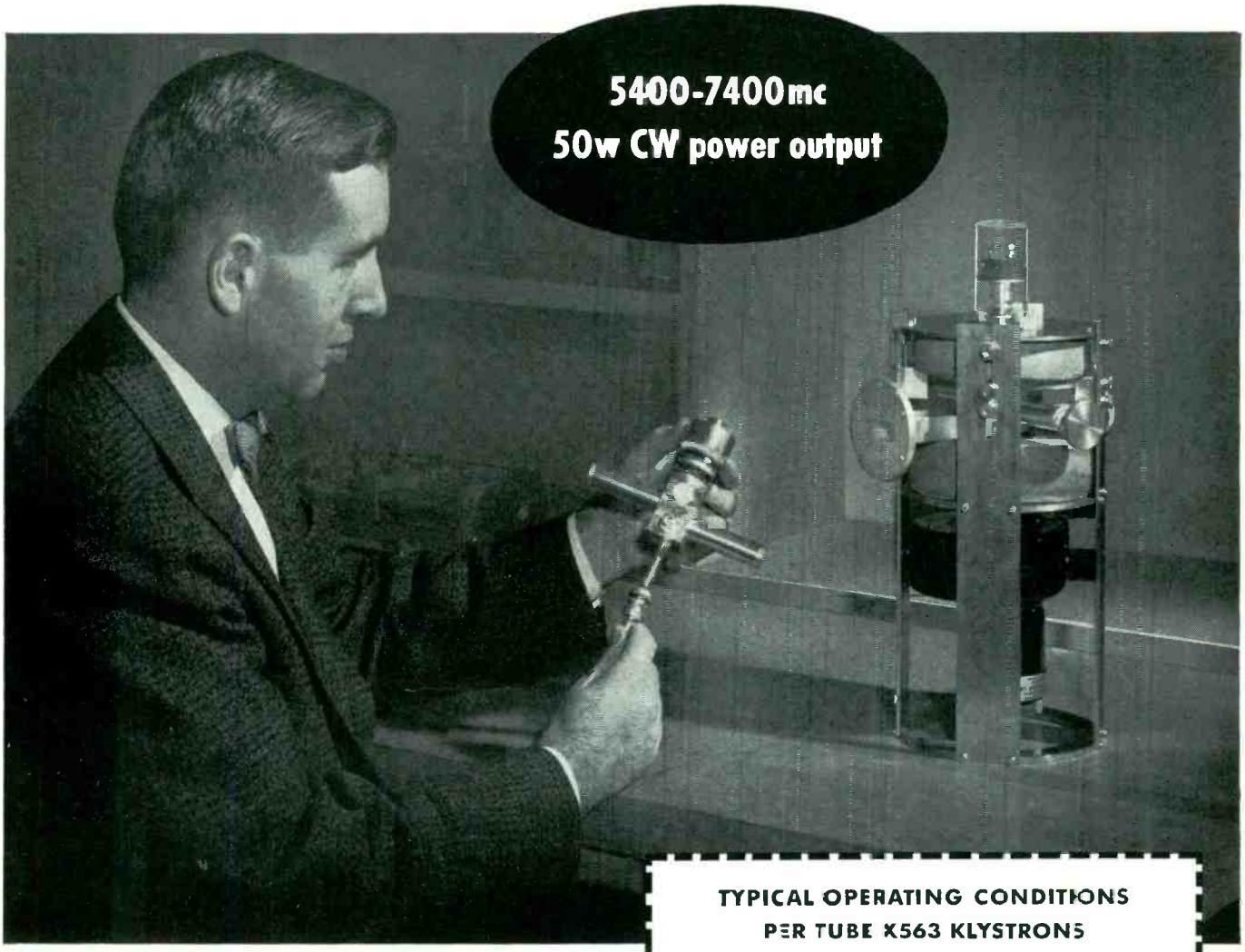

Eimac X563E, 5900-6400mc, and amplifier circuit assembly.

TYPICAL OPERATING CONDITIONS
PER TUBE X563 KLYSTRONS

D-C Beam Voltage . .	2750v	Power Output	60w
D-C Beam Current . .	110ma	Efficiency	20%
D-C Focusing Voltage . .	—50v	Driving Power	5mW

Eimac X563 amplifier klystrons make 50 watt CW power output commercially available at 5400-7400mc. A bonus feature of the X563 is its adaptability to present C-Band systems. Existing milliwatt equipment is sufficient to drive a conservatively rated X563 to power gains of 10,000 times and efficiencies of 20-25%.

Single adjustment tuning knobs make each of the X563's four integral cavities as easy to tune as a standard AM broadcast receiver.

The Eimac X563 is also available with magnetic circuit components, output waveguide fitting and collector and cathode sockets comprising a suitcase-size amplifier assembly weighing only 20 pounds.

See the X563 and other new Eimac klystron, ceramic and negative grid tube developments at booth 549-551 during the I.R.E. Show and Convention in New York City, March 19-22.

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
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HYCOR has a new home

We've just moved into a beautiful new plant . . . to serve you even better. Increased production facilities, larger space and extra personnel all add up to maximum production economy, faster delivery, better service all around. Stop in for a visit . . . you're cordially invited!

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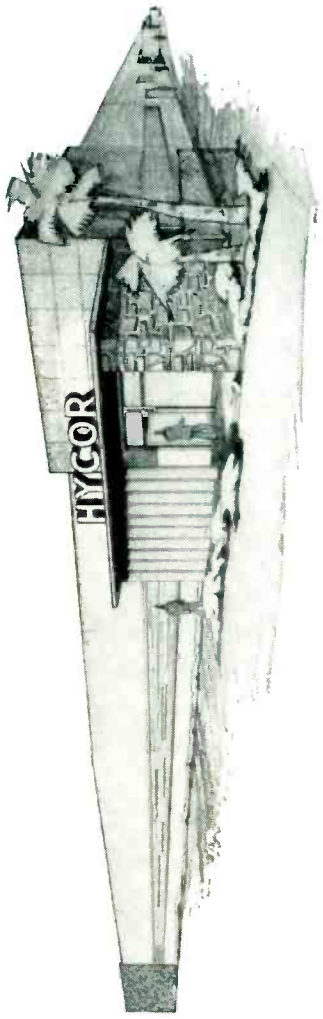

Excellent working conditions contribute to the happiness and productivity of personnel in Hycor's newly-built, air-conditioned plant in Los Angeles.

HYCOR

ENCAPSULATED
precision wire-wound
RESISTORS

NEW Sub-miniature Type 128A, .160 dia. x .50 long. 0.1 watts dissipation at 125° C. ambient. Max. resistance: 50 K ohms. Tolerances to 0.05%.

Miniature Type 83, .25 dia. x .75 long. for **MECHANIZED PRODUCTION**, for use in printed wiring assemblies.

The **NEW** Series "PH"

The New Series "PH" wire-wound resistors include over 50 types . . . from the sub-miniature (illustrated) to the 4 watt units, 20 megohms. Axial and radial leads and lug types in a wide variety of physical shapes are described in the new Bulletin PH.

Series "PH" resistors are encapsulated in a tough epoxy resin for protection against extreme humidity, mechanical and thermal shock. The plastic is filled with heat-conducting mineral which dissipates heat and equalizes "hot spots" in winding. Sealed-in terminal connections are welded.

SPECIFICATIONS:
MILITARY: Performance characteristics satisfy all requirements of MIL-R-93A.
TEMPERATURE COEFFICIENT: ±0.0022% per degree C.
OPERATING TEMPERATURE: −65° C. to +125° C.
RESISTANCE ACCURACY: Tolerances to 0.05%.
WATTAGE RANGE: From .25 watt to 4.0 watts.
RESISTANCE RANGE: 1.0 ohm to 20 megohms.

Hycor products are manufactured under precise quality control in new air conditioned factory and laboratory facilities.

send for Bulletin PH

HYCOR *Division of International Resistance Company*
12970 Bradley Ave., Sylmar 1, California

REPRESENTATIVES IN PRINCIPAL CITIES

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from the 102-year world leader in elevatoring . . .

THE BRAINS

the brawn

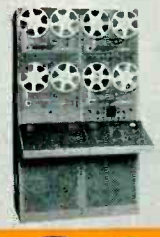
THE VISION

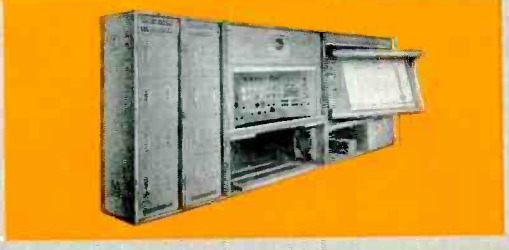
the skills

THE EXPERIENCE

the tools

INTEGRATED for defense electronics





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OTIS ELEVATOR COMPANY
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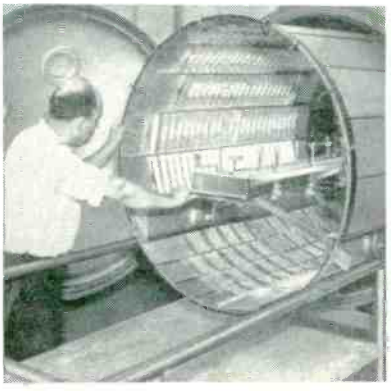
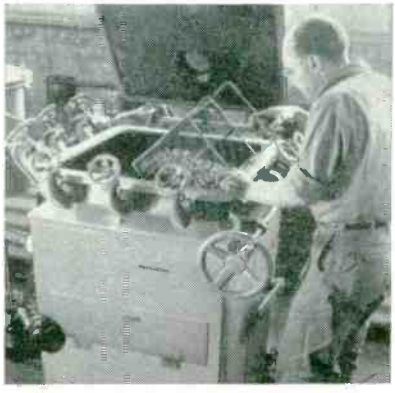
ELECTRONIC DIVISION

New Stokes dual-tube in-line aluminizing system is setting high standards of economy and productivity at Thomas Electronics, Inc., Passaic, New Jersey.

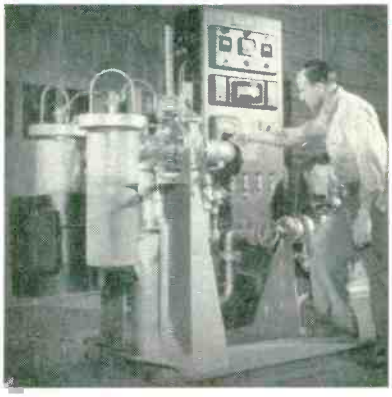
Electronic equipment manufacturers are profiting from other STOKES Vacuum Equipment...



Vacuum Metallizers. Stokes manufactures a complete line of vacuum metallizing equipment to plate selenium rectifiers, printed circuits and other conductive coatings on non-conductive materials.



Vacuum Impregnators. Manufacturers of electronic equipment use Stokes vacuum impregnation systems to obtain improved characteristics of coils, condensers, capacitors and other components.



Vacuum Furnaces. Stokes melting and heat-treating furnaces permit electronic manufacturers to pre-process raw and semi-finished materials with less contamination, for increased life and performance.

5 Cart In-line TV Dolly System Aluminizes 96 Tubes Per Hour

New system at Thomas Electronics, Inc.—largest independent manufacturer of cathode ray tubes — affords increased production . . . reduces initial cost . . . requires less floor space and maintenance

TODAY's big news in TV picture tube production is the new Stokes aluminizing system. This high-production equipment evacuates and aluminizes *two tubes per cart* with one pumping system. The new design affords several cost-cutting and production-boosting advantages:

Greater production. Using a mechanical pump and 4-inch high speed "Ring-Jet" booster, overall cycle time is 6½ minutes with 21-inch tubes—96 per hour with the standard five cart system.

Lower first cost. Fewer carts are needed . . . the basic unit, consisting of five carts with ten dollies, costs less than comparable single-tube systems.

Lower maintenance. There is only *one* pumping system for every *two* tubes.

Less floor space. Circular track is only 17 feet in diameter.

Flexibility. Five additional carts can be added to the standard dollies to produce 21-inch tubes at a rate of 192 per hour. Tubes up to 27-inch can be accommodated.

The system is fully automatic. Operator loads . . . and then unloads completely aluminized tubes. Filament replacement is simplified by removable holders. Internal cooling coils provide for rapid cooling of oil in the booster pump before vacuum is released.

A Stokes engineer will be glad to discuss how this new system for black and white or color tubes can be integrated into your production line. He'll also welcome the opportunity to talk over your specialized requirements . . . to apply Stokes' extensive experience in high vacuum engineering and automatic production technology. F. J. STOKES MACHINE COMPANY, 5503 Tabor Road, Philadelphia 20, Pa.

Reference Data:

Microvac Pumps—Catalog 750
Diffusion and Booster Pumps
Specification and performance data
Story of the Ring-Jet Pump
How to Care for Your Vacuum Pump—
Booklet 755
Vacuum Impregnation—Catalog 760
Vacuum Furnaces—Catalog 790
Vacuum Metallizing—Catalog 780
Vacuum Calculator Slide Rule

STOKES

DIGITAL VOLTMETERS

MODEL 451 – STEPPING SWITCH TYPE

RACK MOUNT STYLE **5¼" high by 19" wide by 15⅛" deep**

NOW! ACCURATE AUTOMATIC MEASUREMENTS FOR VARIED INDUSTRIAL APPLICATIONS...

Now every feature you want in a precise, automatic Digital Voltmeter is available in these new Non-Linear Systems models. Their *performance* features automatic measurement from zero to ± 999.9 volts d-c with high accuracy and resolution. *Fast readings* are presented in a brilliant, in-line luminous numerical display. *Automatic features* simplify operation, make possible use of non-technical employees. Assured *long life* results from the unique NLS *oil-sealed* stepping switch system, plus the use of top quality components. Thorough *quality control* ensures reliable operation. And unitized construction results in *simplified maintenance* which saves you time and money.

Yet NLS Model 451 Digital Voltmeters are priced far below instruments offering only a fraction of these advantages! These low initial costs are possible because NLS, as the originator of the Digital Voltmeter, has the advantage of pioneering design and production techniques. Furthermore, NLS is building Digital Voltmeters in quantity, resulting in additional savings.

You can save time and money, and assure automatic accuracy in precision measuring, with an NLS Digital Voltmeter. Mail coupon today for more information on how these quality instruments can assist your operations.

YOU GAIN THESE ADVANTAGES

- AUTOMATIC OPERATION – Simple operation plus brilliant numerical readout and recording allows use of non-technical personnel.
- EXHAUSTIVE QUALITY CONTROL – Sustained accuracy assured by systematic testing procedure throughout all phases of engineering and production.
- UNITIZED, STANDARDIZED CONSTRUCTION – Each instrument can be quickly disassembled into three functioning subassemblies.
- QUALITY COMPONENTS – Including mercury cell reference standard, stepping switches built to NLS specifications, precision resistors and other high standard components.
- OIL-SEALED STEPPING SWITCH SUBASSEMBLY – Cuts maintenance, boosts switch life, ensures reliability under all operating conditions.
- LONG-LIFE STEPPING SWITCHES – Life tests corresponding to 21,000,000 readings completed – with switches still operating!
- SIMPLIFIED MAINTENANCE – Resulting from unitized construction, saves you time and money.
- NO-LOST-TIME SERVICE – Interchangeable subassemblies and complete instruments available promptly when needed.
- AUTOMATIC RECORDING – By electric typewriter, printer or summary punch.
- LOW INITIAL COST – Based on NLS integrated, efficient production and on advanced engineering developments.
- NEW! AUTOMATICALLY-STANDARDIZED REFERENCE POWER SUPPLY – Eliminates manual adjustment; available instead of internally-mounted mercury-cell battery pack.

PORTABLE STYLE
10⅞" high by 8⅜" wide by 15⅛" deep

APPLICATIONS

Automatic measurement, display and recording of d-c voltage in digital form, for:

MANUFACTURING — development, production and process control testing by non-technical personnel.

LABORATORIES — precision standardization procedures.

INSTRUMENT SECTIONS — high accuracy for instrument calibration and testing.

ANALOG COMPUTER INSTALLATIONS — problem setup and solution digitizing.

DIGITAL COMPUTER INSTALLATIONS — converting analog data into digital form.

SPECIAL TEST EQUIPMENT — analog computers, missile components, automation components and control systems.

INCOMING INSPECTION — increased volume, fewer personnel and sustained accuracy.

Can an NLS Digital Voltmeter solve your problem? Our application engineers are available to work with you.

ENGINEERING REPRESENTATIVES
THROUGHOUT THE UNITED STATES

CHARACTERISTICS

RANGE (AUTOMATICALLY SELECTED)	ACCURACY, RESOLUTION AND MAX. DEV. FROM LINEARITY
Zero to ± 9.999 volts d-c	± 0.001 volts d-c
± 09.99 to ± 99.99 volts d-c	± 00.01 volts d-c
± 099.9 to ± 999.9 volts d-c	± 000.1 volts d-c

READING RATE: One reading per second average.

CHOPPER SAMPLING RATE: 60 cycles per second.

INPUT IMPEDANCE: 11 megohms.

CALIBRATION VOLTAGE: Nine internal Weston Standard Cells in series supply 9.1673 volts d-c at 20 degrees centigrade.

REFERENCE VOLTAGE SOURCE: Internally-mounted mercury-cell battery pack. Or automatically-standardized power supply.

POLARITY INDICATION: "+" or "—" automatically prefixes the numerical display.

READOUT DECIMAL POINT: Positioned automatically.

STYLES: Rack mount: 5¼" high by 19" wide by 15⅛" deep
Portable: 10⅞" high by 8⅜" wide by 15⅛" deep.

WEIGHT: 40 pounds.

POWER: 115 ± 10 volts, 60 cycles, 75 watts.

OPTIONAL ACCESSORIES: Remote readouts with cables.
Manual-command recording controls.
Automatic recording controls to record each reading at completion of balance.

NLS DIGITAL VOLTMETER USERS INCLUDE:

CONVAIR, MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND MORE THAN 30 OTHER KEY GOVERNMENT OPERATIONS, AIRCRAFT COMPANIES, RESEARCH ORGANIZATIONS, OIL REFINERIES AND EDUCATIONAL INSTITUTIONS

NON-LINEAR SYSTEMS, INC.
Dept. B-356, Del Mar Airport, Del Mar, California

Please send me your new 1956 catalog with information on your complete line of precision instruments and current price list.

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DATA REDUCTION SYSTEMS · PEAK READER SYSTEMS
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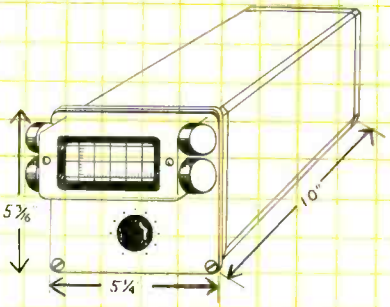
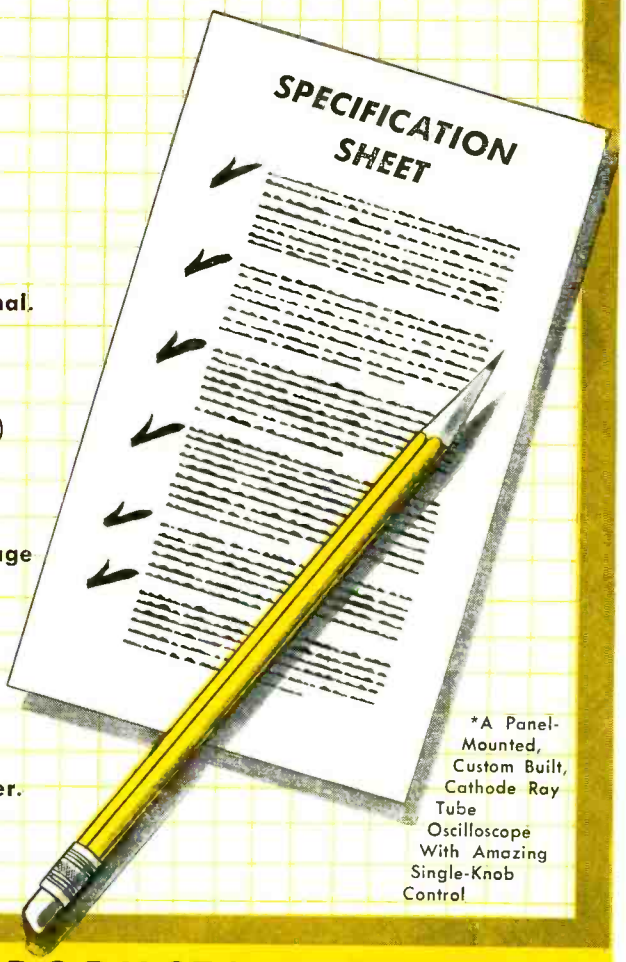
A component for mobile and stationary units — land, sea, air. . . .

There is a place in your equipment for PANELSCOPE* by Waterman



- A single control for automatic portrayal of desired signal.
- Specification limits within following range:
  - Signal amplifier; from DC to 10 mc with sensitivities from 20 mv
  - Time base; ½ cycle to 500 KC (2 seconds to 2 μs)
  - Synchronization; repetitive and/or trigger
  - Input selector; up to 11 sources with desired amplitude portrayal
  - Power supply; 50 to 400 cycles: built-in high voltage . . . other voltages from your equipment or accessory power pack.
- Optional delay line; 0.25 μs.
- Direct deflection plate connections available . . . frequency limited only by impedance of the driving equipment.
- Edge lit graticule allows varying intensities.
- Two rear mounted an connectors for signals and power.
- Custom built at production prices.
- Panelscope Premier Showing: Booth 158-160 IRE Show, New York.



*A Panel-Mounted, Custom Built, Cathode Ray Tube Oscilloscope With Amazing Single-Knob Control

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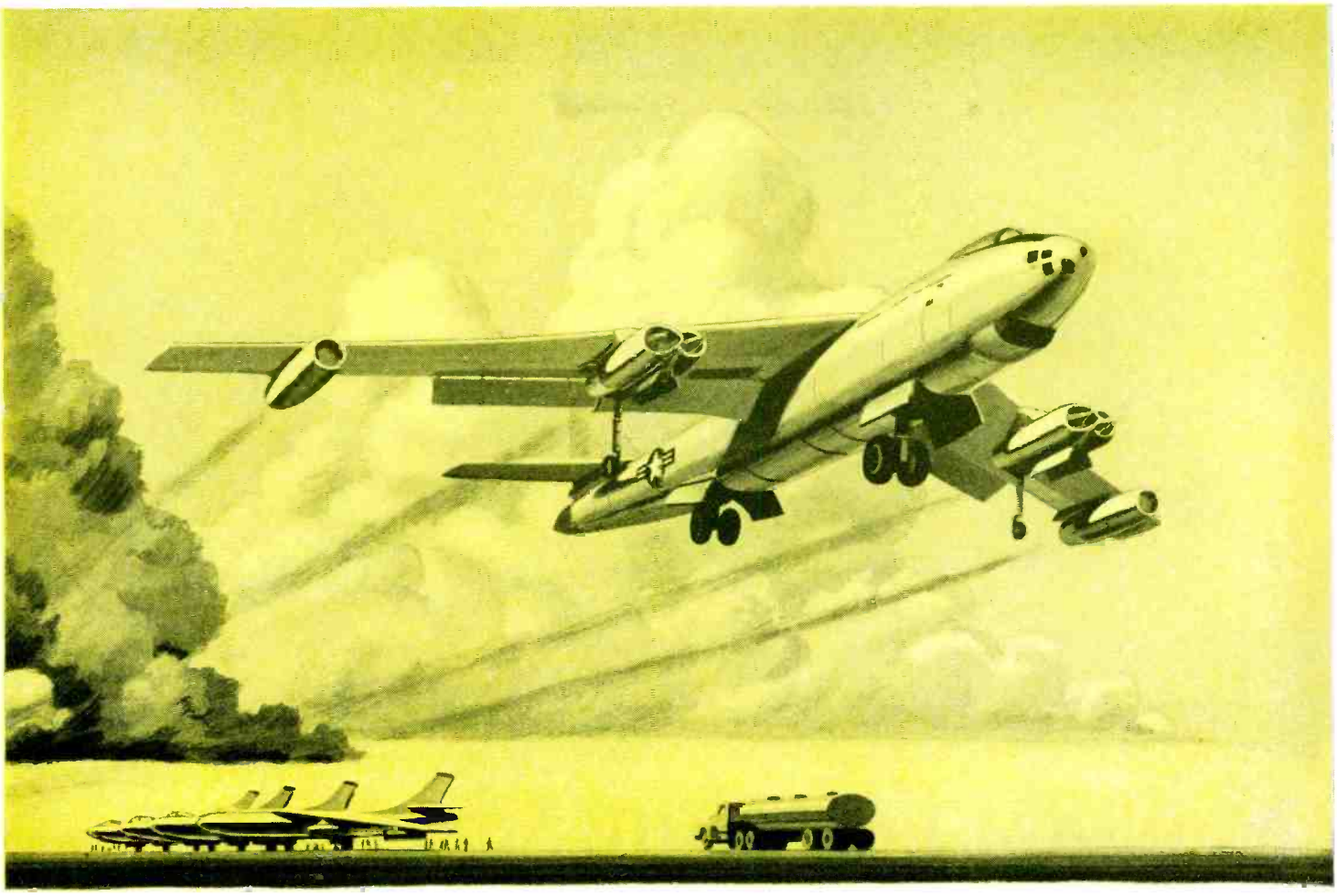


SO MANY JOBS SO WELL!

Highly exacting electronic devices are an old story to Kearfott Company, Inc., a leading manufacturer of miniature remote-control systems for aircraft and industry. One of Kearfott's synchro units (the smallest of its type on the market) is only ¾" in diameter. This unit requires components made of a material with unusual talents. These include: 1. great strength and dimensional stability 2. arc-resistance and dielectric strength 3. resistance to humidity, fungus, shock and vibration.

After much experimentation, reinforced PLASKON Alkyd Molding Compound was found to be the *one* material that had all the required properties. It has replaced *all other plastic materials* in this application.

In motor housings, end forms, brush holders and blocks where strength, dimensional stability and insulating properties are essential, PLASKON Alkyd has proved itself to be indispensable. Why not find out more about this unique material? Write today for complete technical data on our glass or mineral-filled Alkyd formulations.

Barrett PLASKON®

Ask for Pamphlet entitled:
"PLASKON® Alkyd Molding Compounds"

For further information on PLASKON Plastics and Resins, address BARRETT DIVISION, Allied Chemical & Dye Corp., 40 Rector Street, New York 6, N. Y. HAnover 2-7300.

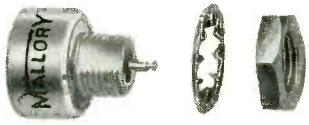
MALLORY

At temperatures from —55° to +200° C, Mallory XT Tantalum Capacitors maintain stable capacity, series resistance and impedance . . . and provide long life.

Mallory Tantalum Capacitors

lead in long, stable life at extreme temperatures

New Mounting Designed for heavy shock and vibration



Mallory XT tantalum capacitors are now available in a design which will withstand severe shock and vibration. A flatted neck with ½-20 threads fits through a keyed slot in the chassis . . . is held in place by a lock washer and hex nut. Assembly takes only seconds . . . requires no strap or other hardware. This design is supplied in a variety of ratings, with cases up to 2¼" in height. Write for information.

WHEN YOU design for extreme temperatures . . . in military electronic equipment, miniaturized apparatus and the like . . . be sure to choose capacitors that you *know* will meet severe conditions.

Specify Mallory XT tantalum capacitors . . . proved by test and field usage to give consistently long, stable service across an extremely wide temperature range. Pioneered by Mallory, these units embody design and production techniques developed during twelve years of research and manufacturing in the high temperature capacitor field.

Standard XT's cover the range from —55° C to +175° C. When specified, they can be supplied rated for continuous operation at 200° C. A complete selection of capacitance and voltage values is available.

Representative performance data, based on sampling tests representing hundreds of thousands of capacitors, is now available on Mallory tantalum capacitors. To see for yourself the specifications which these units can be relied upon to meet, write today for our latest Technical Bulletin.

Expect more . . . get more from

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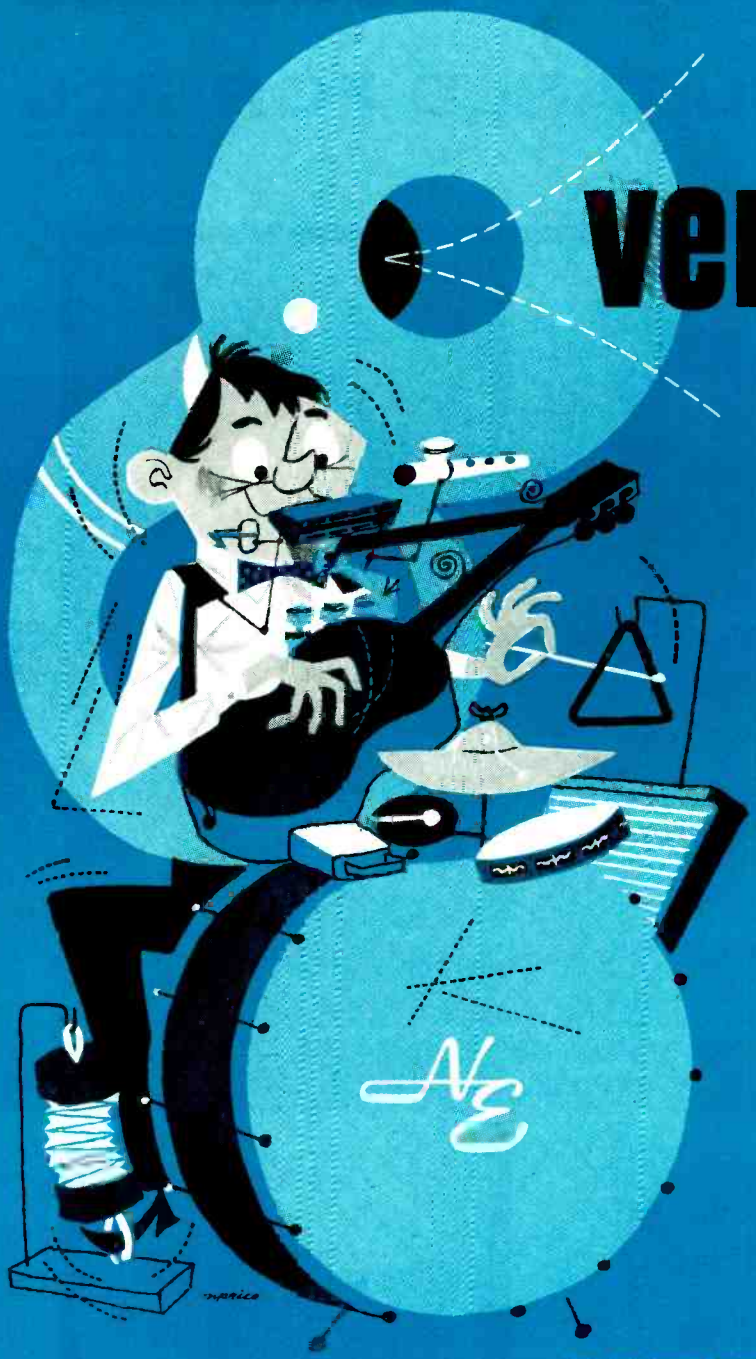

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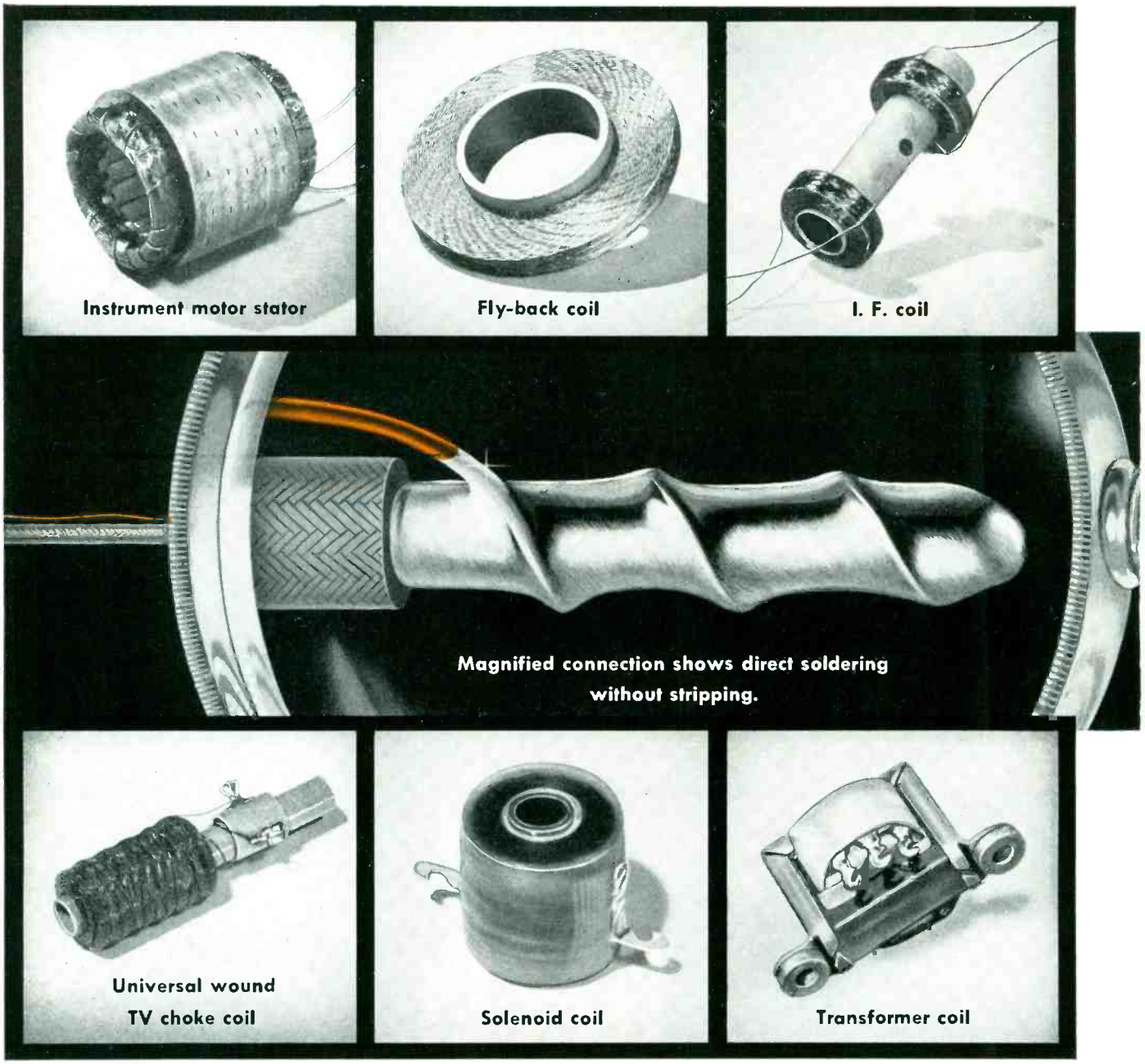

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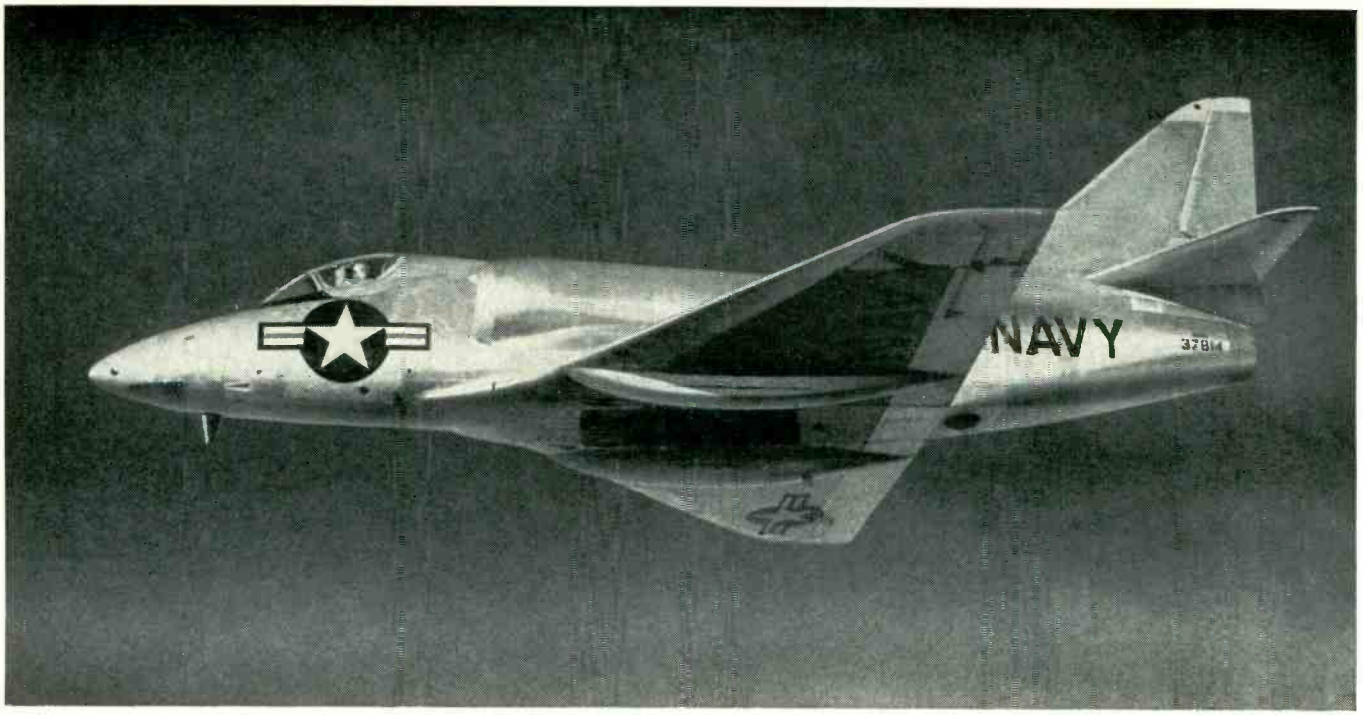

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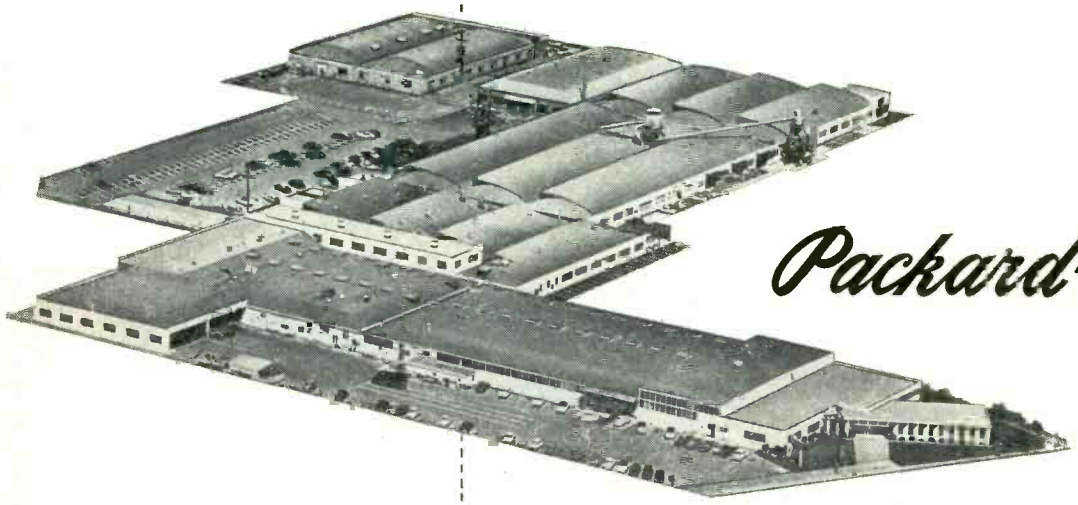

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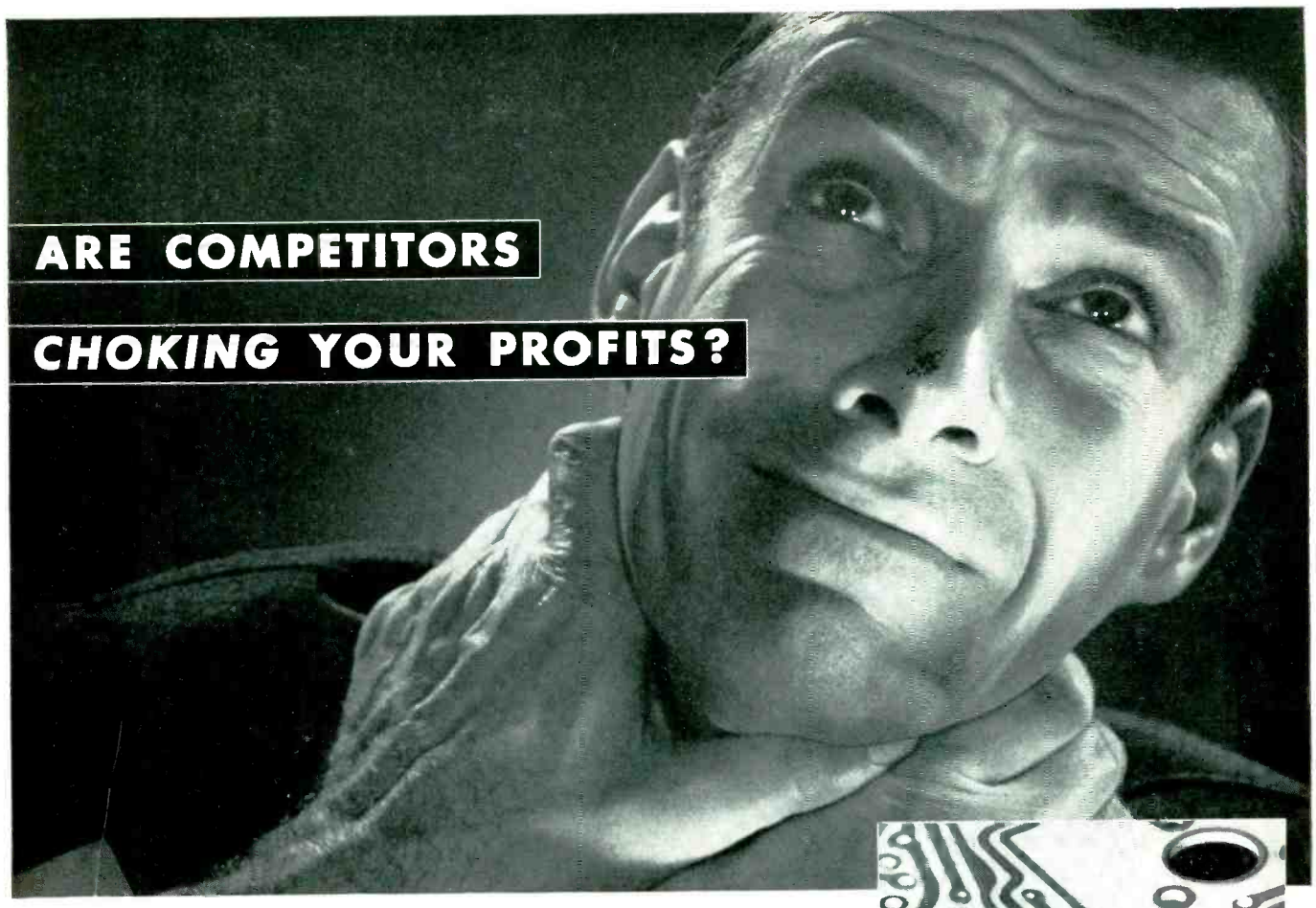

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New engineering study shows that 7 out of 10 electronic and electrical products can gain important savings

Automation is the magic cost-cutting word in industry today. Along with it—*printed circuits,* using G-E "Thru-Con" Boards. Thru-Con is helping to turn in impressive cost reductions for a wide range of industries. Manufacturers of lamps, radios, fans, street lighting systems, television, kitchen appliances, and control units now use G-E "Thru-Con" to save money.

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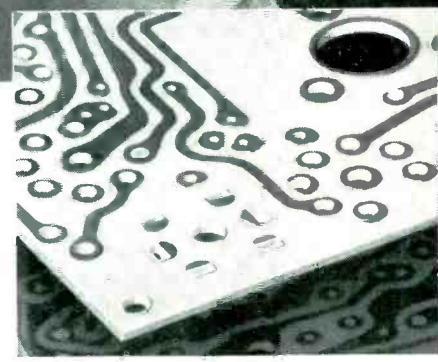

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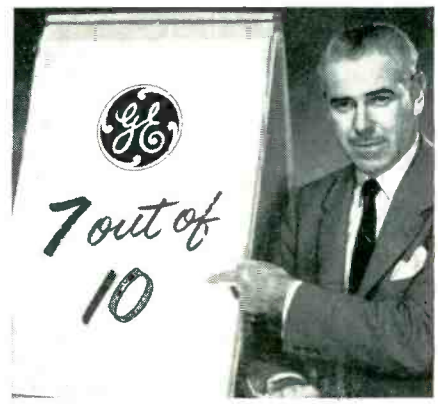

Recent Engineering Study shows that 7 out of 10 electronic and electrical products may benefit from printed circuitry. The General Electric "Thru-Con" man is available, without obligation, to survey your circuitry, recommend specific uses of Thru-Con Boards for *your* product. Call him in, today.

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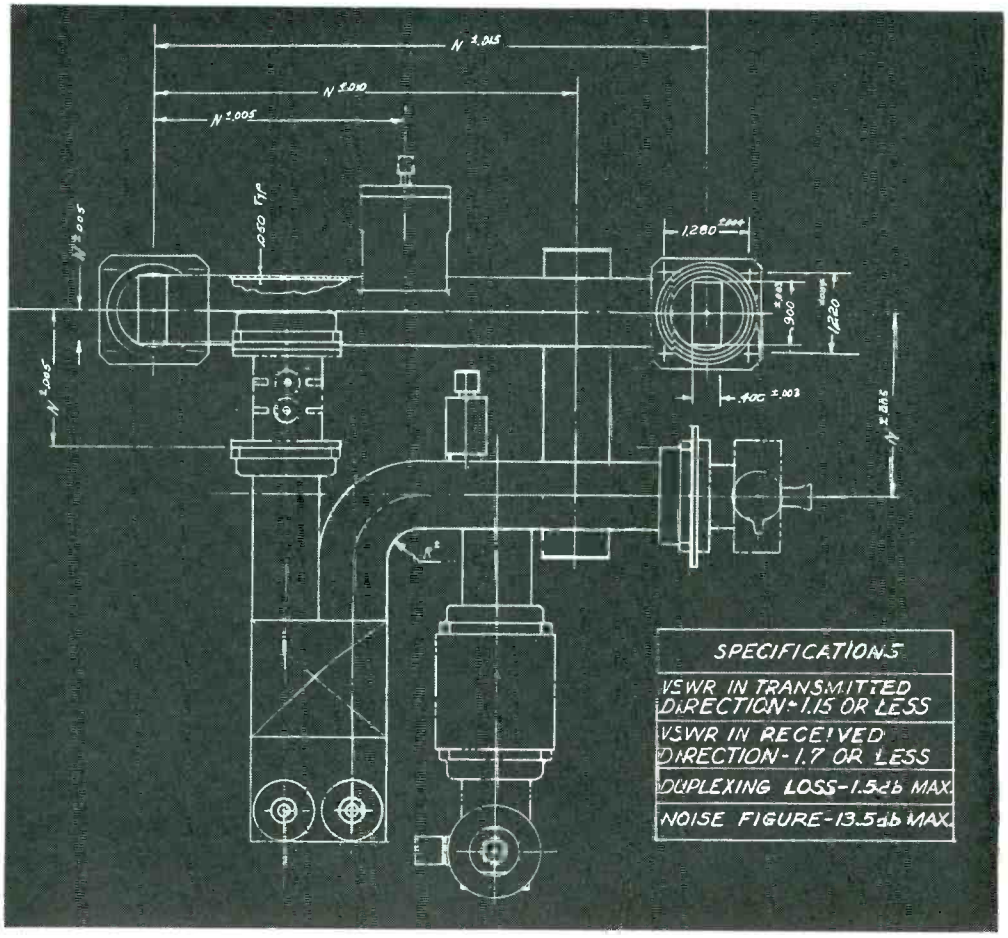

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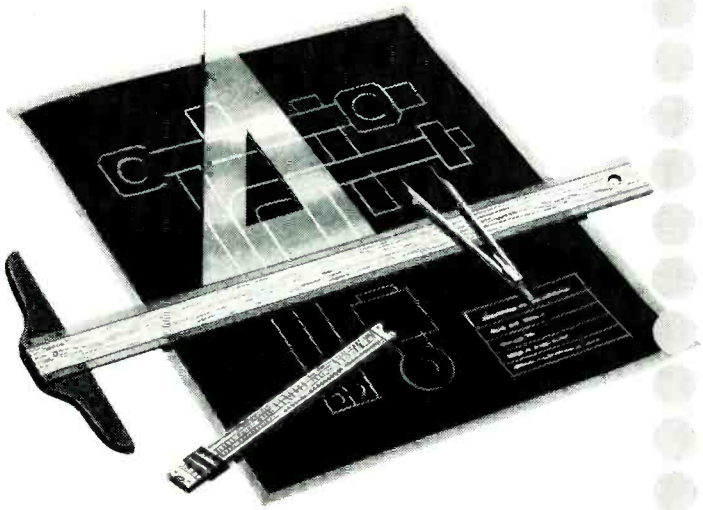

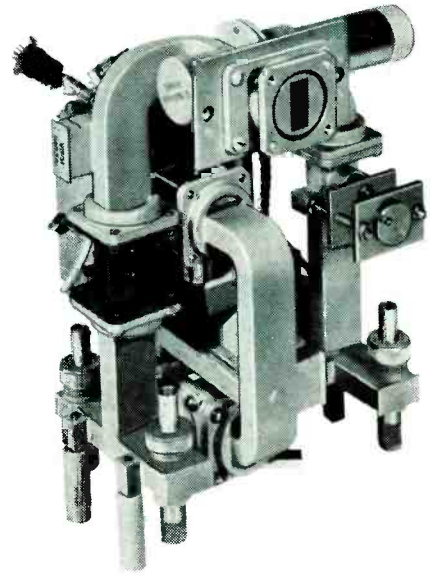

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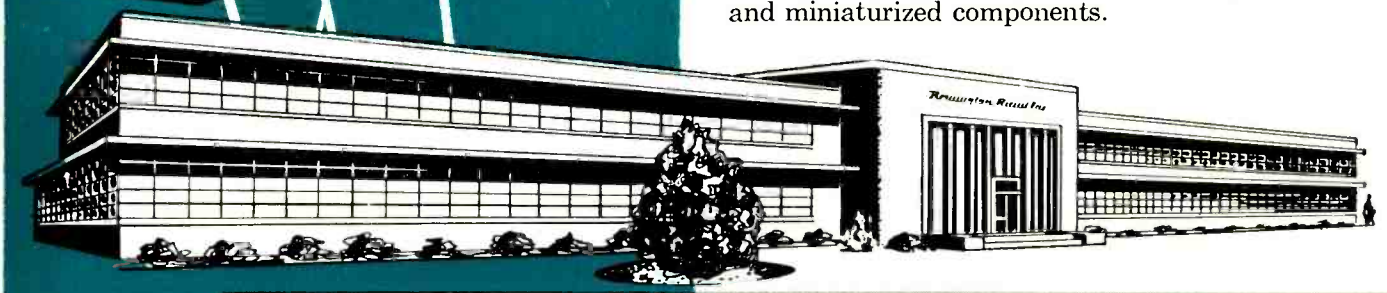

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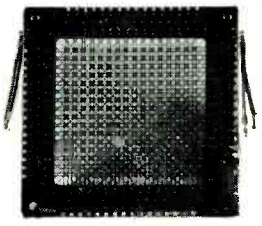

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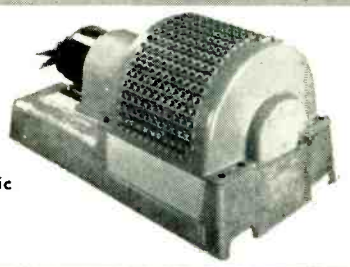

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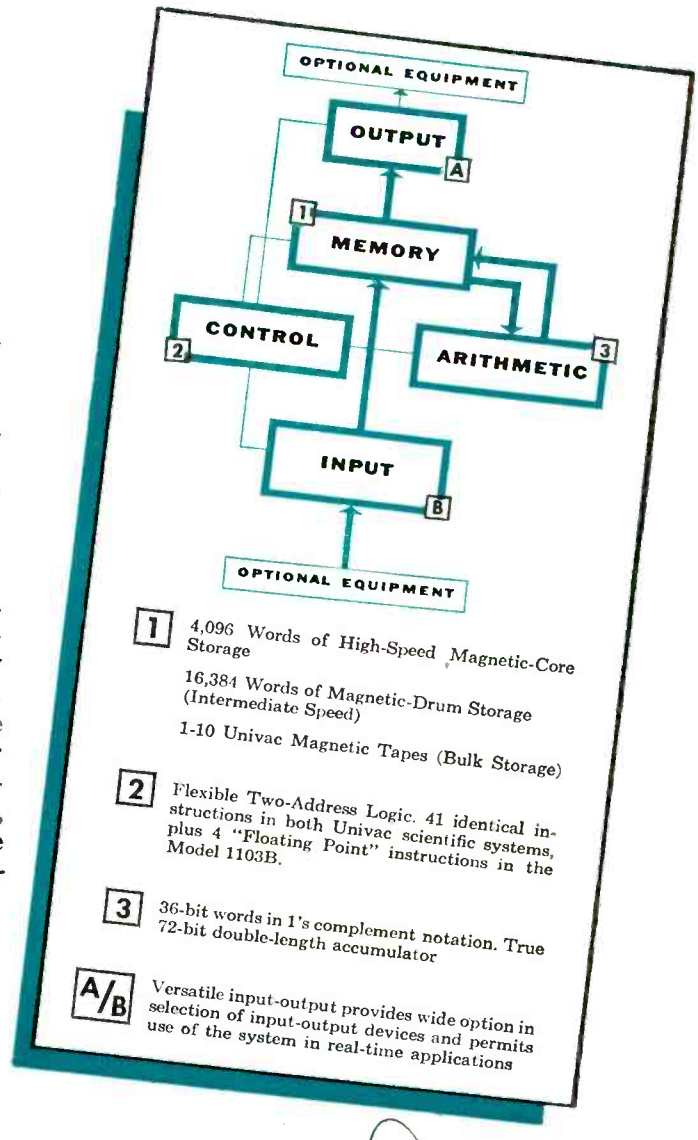

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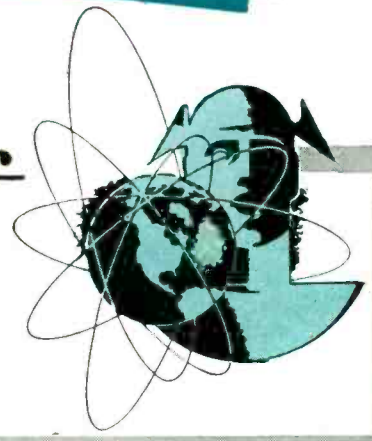

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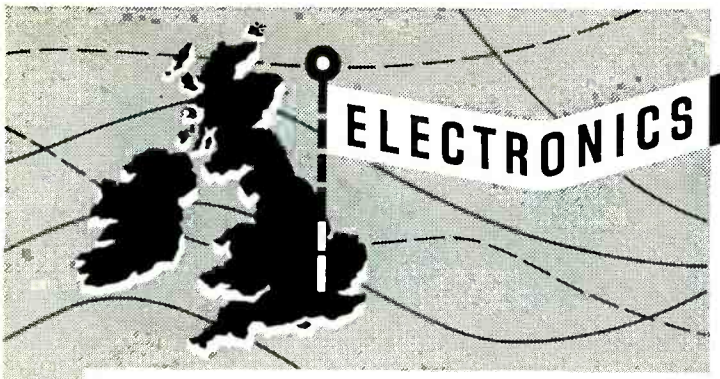

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

For medium power equipments

British high fidelity experts choose the

EL84

The Mullard range of high fidelity tubes is accepted in Britain as the standard by which others are judged. This is because many years of research and development have been spent in producing a range that will meet the requirements of high fidelity sound reproduction in all respects. Take the Mullard EL84 for example. A pair of these tubes provide a power output of 10W at a distortion level of less than 1%. Furthermore, their transconductance of over 11,000 μmhos results in an exceptionally high sensitivity.

The EL84 may be used for higher powers too. Two tubes in push-pull will provide outputs of up to 17W at an overall distortion of 4%.

At maximum ratings one EL84 has a plate dissipation of 12W and gives an output of 5-6W for an input signal of less than 5V r.m.s.

Supplies of the EL84 for replacement in British equipments are available from the companies mentioned below.

Principal Ratings

Heater	6.3V, 0.76A
Max. plate voltage	300V
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Max. screen voltage	300V
Max. screen dissipation (max. signal)	4W
Max. cathode current	65mA

Base
Small button noval 9-pin

Supplies available from:—
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MEMO

FROM: THE ENGINEERING STAFF AT NJE

TO: ENGINEERS AND PURCHASING AGENTS IN THE ELECTRONICS INDUSTRY

SUBJECT: **HEARTBREAK...**

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If you have an old NJE catalog, it's not too tragic, but you're missing data about hundreds of new models.

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If you don't have any of our catalogs, not even an old one, frankly, we don't know how you're getting along at all. What do you do when you need a power supply....build it yourself?....or buy it (heaven forbid!) from one of our competitors?

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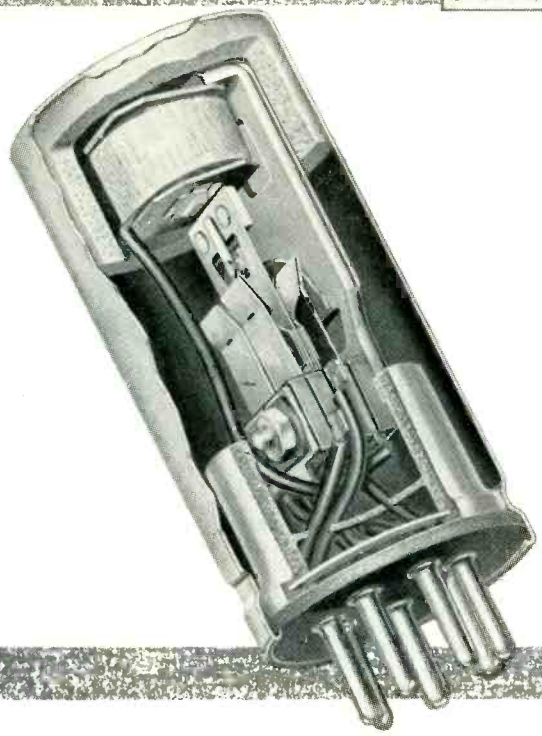

New 1700 series Mallory split-reed vibrator uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is greatly increased, constancy of output improved, and driving power reduced.*

**Patent Applied For*

New Heavy Duty Mallory Vibrator

gives far longer life, constant output

For the peak in dependability and performance, plan to use this newest Mallory vibrator in your communications equipment. A completely new idea in vibrator design eliminates conventional contact buttons. The spring leaves themselves . . . made of special contact alloy . . . act as contacting members. This design provides greatly increased contact area, with these important advantages:

Consistently Longer Life. Tests made on heavy duty cycles prove up to 100% greater service can be expected . . . with a high degree of consistency.

Steadier Output. The decreased rate of erosion means less change in contact spacing, less variation in voltage.

Flare-Proof Starting. The new low-mass design permits wider contact spacing to prevent start-up flare . . . without need for greater driving power.

Exceptional Uniformity of characteristics is made possible by the simplified design.

Minimum Size for heavy duty ratings.

The new design is available in the split-reed type shown here, for 6/12 volt service, and in the Duplex heavy duty model without the split reed construction. For full technical data, and for a consultation on your specific power supply requirements, write or call Mallory.

COMPLETE POWER SUPPLIES

It may be that you can save time and reduce over-all costs by employing a complete Mallory Vibrapack® power supply. Vibrapacks can be engineered around the new heavy-duty 1700 series vibrator to give long, reliable service. Design includes precise balancing of critical components. Normal ratings are conservative. Compact-sized Vibrapacks fit readily into crowded layouts. For further information, advise Mallory of your specific requirements.

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electronics

W. W. MacDONALD, Editor

MARCH • 1956

CROSS TALK

► **GUEST** . . . We were recently a guest of the National Bureau of Standards in Washington and found it a very stimulating experience.

The Bureau is expert on the subject of measurement, which of course involves the use of advanced electronic techniques. These techniques in themselves were interesting but we were even more impressed by the scope of the operation.

In the measurement of mass alone the Bureau has ranged all the way from the electron ($9{,}099 \times 10^{-31}$ gram) to the earth itself ($5{,}975 \times 10^{24}$ grams). Or, if you prefer it in English, a cube of sugar looks to an electron about like the earth looks to the cube.

► **COMPONENTS** . . . As companies in the field of electronics grow larger, or merge, more and more are setting up component evaluation departments. There is nothing new about the idea but it seems to be developing into a trend.

Centralized testing of parts can have profound effects upon the market, not the least of which is a slowing down of the speed with which new components can be sold for incorporation in new equipment models. Also, we think it could bring about a general tightening up on specifications.

► **SERVICE** . . . As American industry shifts from mere mass production to more automatic production the inadequacy of service facilities for the ultimate consumer becomes increasingly apparent.

This is true all the way from household items to many products used by industry itself. Fix-it-yourself is not a passing fad but a necessity. And the reasons are clear. There has been more money in sales than in service, and men didn't have to get their hands dirty.

A certain amount of service is grudgingly made available in the interest of good public relations. But it is not enough to keep pace with expanding production and sales. Nor will it be until businessmen stop thinking of service as just a necessary evil.

We may be ahead of the times but do think service can now once again represent a very real opportunity to *make money*, not on the small catch-as-catch-can basis in which it is conducted today but organized as are other branches of big business.

► **REMINDER** . . . On the average, man is a 0.25-megohm, 1-watt resistor.

At 1 milliampere, shock is perceptible.

At 10 mils you can't let go.

100 is generally fatal.

And engineers are already in short supply.

► **LANGUAGE** . . . A friend of ours uses a word we think has merit; *autofacture*. He uses it to describe automatic manufacturing systems now coming into prominence.

LOOKING AHEAD . . .

Simplification of color-tv receiver circuits is now proceeding at an accelerated pace; engineering advances will be rapid in the next few months

Electronic data processing equipment designed for use in business offices works economically around the clock; this could ultimately change the hours of office workers

Transistorized car radios working on their own batteries could be readily removed from instrument panels or glove compartments for use as portables; you'll probably see several like this soon

noise

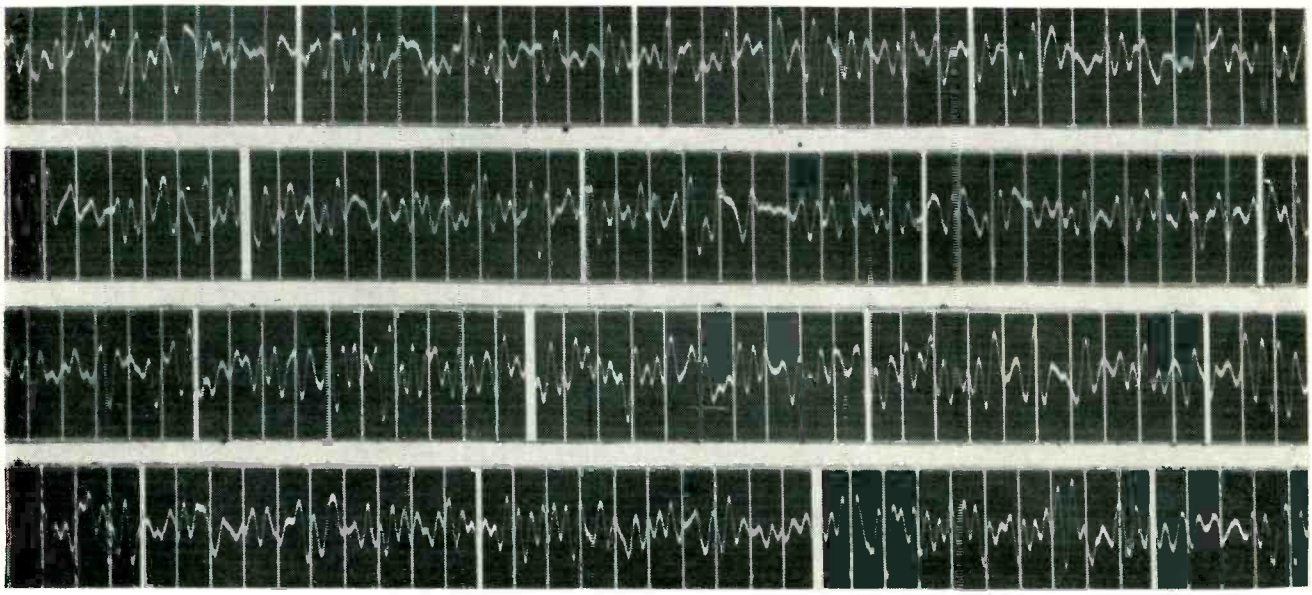

FIG. 1—Wide-band thermal noise—200 to 3,000 cycles

Characteristics and

SUMMARY —— Electrical noise imposes the ultimate limit on the performance of any communications system. This article, the first in a series dealing with noise, discusses such types as thermal, vacuum-tube, contact and ignition noise, static, interference and quantizing noise originating in analog-to-digital conversion systems

By W. R. BENNETT
Bell Telephone Laboratories, Inc.
Murray Hill, New Jersey

IN MOST present-day usage the meaning of the general term noise is aptly summarized by Ambrose Bierce's definition:[1] "A stench in the ear." A more extended application has evolved, however, for the specific term electrical noise.

In the early days of telephone and radio, acoustic effects were a chief concern. It was natural then to use the same name for both a sound effect and the electrical wave which caused it. Later when similar waveforms were encountered in electrical systems which did not have audible outputs, the name noise had become so well-entrenched that substitutions were not found necessary.

Noise is said to accompany the picture signal in television even though the ultimate offense is against the eye rather than the ear. In teleprinter and radar, the effect of noise may best be described as a delivery of wrong information rather than any esthetic fault. The development of efficient testing procedures based on the use of a noise wave as input to a system, however, has shattered the concept that noise is inherently evil.

The term noise may be regarded as merely a signpost leading to a variety of electrical phenomena which can best be described individually. The types include thermal noise arising from Brownian motion of electrons in kinetic equilibrium with the molecules of a conductor, tube noise of various kinds characteristic of thermionic devices, contact noise associated with fluctuating conductivity, static from electrical disturbances in the atmosphere, interference from unwanted transmission and quantizing noise arising from errors in analog-to-digital signal conversion.

Thermal Noise

Thermal noise, which is also called resistance noise and Johnson noise,[2,3,4] is a basic form inherent in all systems operated at a temperature exceeding absolute zero, at which all molecular motion ceases.

Any conductor contains a cloud of moving electrons which tend toward thermal equilibrium with the molecules of the conducting substance. In the classical picture, which is a sufficient model for explaining noise effects so far observed, the mean square velocity of the electrons is proportional to the absolute temperature. The electrons collide frequently with the molecules of the substance, thereby

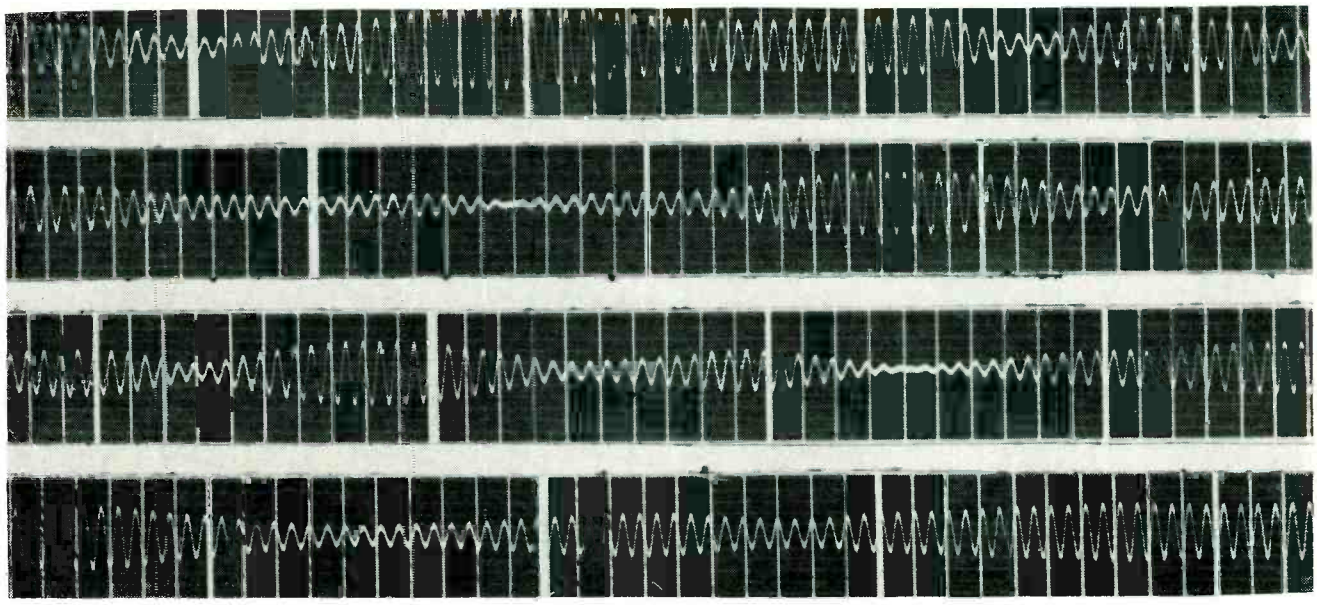

FIG. 2—Narrow-band thermal noise—midband at 1,955 cps, width 120 cps

Origins of NOISE—Part I

exchanging kinetic energy.

Each flight between collisions constituts a short pulse of current. The duration of each pulse is so short and the number of pulses a second is so large that no available measuring instrument would be capable of resolving the resultant wave into individual pulses.

In the widest-band receiver so far attainable, the responses to individual electron flights are smeared out over a time that includes an enormous number of pulses. The average or d-c component is zero, but there is a small a-c component which constitutes the observable noise.

In all reported measurements, the mean amount of total power has been found to be proportional to bandwidth over any range from d-c to the highest microwave frequencies yet explored. Tuning a receiver with fixed bandwidth does not change the average noise power output but only alters the rapidity of the oscillations.

A noise source which has such a uniform distribution of mean power versus frequency is called white from the analogy with white light which contains all colors. Thermal noise is an outstanding example of white noise.

What happens at still higher frequencies has not yet been investigated experimentally but there are theoretical arguments based on quantum mechanics which predict a falling off of power at frequencies beyond about 10^{13} cycles at ordinary room temperatures.

For practical purposes, all electrical apparatus is subject to an inherent thermal noise power input directly proportional to the product of bandwidth and absolute temperature. The amount is 4×10^{-21} watt per cycle of bandwith at 17 C or 204 db below 1 watt per cycle.

The constant of proportionality is equal to Boltzmann's gas constant, $k = 1.38 \times 10^{-23}$ joule per degree C. This represents a minimum amount of noise power which must ultimately limit the fidelity of amplification when the input signal is weak.

Noise Waveforms

The photographs illustrate thermal noise as a voltage or current wave plotted against time.

A waveform for any specific range of frequencies serves equally well for any other range in which all frequencies are multiplied by a constant factor, provided that the time scale is divided by the same factor.

The photographs shown were taken by C. B. Feldman in 1940 with the rapid-record oscillograph,[5] an instrument designed to show a con-

WHY ENGINEERS SHOULD KNOW ABOUT NOISE

Thirty years ago it was recognized that spontaneous current fluctuations caused by random electron motion could become a serious problem for electronic engineers. As increasingly sensitive instruments became available, noise correspondingly advanced as a major problem. Along with the ubiquitous thermal noise are arrayed atmospherics, man-made interference and other disturbances.

Today engineers agree that amplification itself is an insufficient criterion of system performance. An information-handling scheme is effective only to the extent to which it distinguishes the desired information from noise.

In the future, increasingly sensitive instruments will be devised. Communications systems of ever greater range and information-handling capacity will be undertaken. More and more electronic and electrical equipment will be used.

These trends all will identify noise, both natural man-made, as the engineer's major antagonist. This series of articles is intended to help him understand what noise is, how it is produced and how its injurious effects can be minimized

tinuous record of aperiodic phenomena in the range from zero to about 10 kc. The long record has been cut in pieces arranged in order like the sentences on a page.

Figure 1 shows a typical wide-band noise record, in which the ratio of highest to lowest frequency passed is large compared with unity. The limits are those of a telephone channel passing from 200 to 3,000 cps. The light vertical lines are 1 millisecond apart. If the time scale were divided by one million, the record would serve equally well for a range from 200 mc to 3,000 mc.

The scale of magnitudes depends on how much amplification is used and could fit all thermal noise waveforms by replacing the instantaneous values by their ratios with respect to the rms value. Peaks of various heights occur, the wave never repeats itself exactly and the spacing of axis crossings is irregular at frequencies which may be anywhere within the band.

Figure 2 shows a narrow-band case. The selective circuit is a carrier-telegraph filter with midband at 1,955 cycles and bandwidth 120 cycles between 7-db discrimination points. The noise has characteristics like an amplitude-modulated wave in that the oscillations are near the midband frequency and the successive peaks define a low-frequency envelope which itself shows variations with time at frequencies comparable with the bandwidth. The axis crossings are not regular but are frequency-modulated at rates comparable with the bandwidth.

Figure 3 shows a still narrower band. Here the midfrequency is 1,500 cycles and the bandwith is 6 cycles between 6-db discrimination points. The modulation rate is so slow that to show a representative record the individual oscillations are blurred.

Gaussian Noise

The magnitudes occurring in a thermal noise wave have the gaussian or normal distribution. This distribution is approached by any phenomenon which is the sum of a large number of independent components. In statistical theory, the statement of this property is known as the central limit theorem.[6]

In thermal noise, the independent components are the individual current pulses associated with the electron flights between collisions. The form of distribution once established is not upset by any subsequent linear operations and therefore holds for thermal noise as received through any linear selective circuit. Linear filtering can change the time scale and the mean square value but does not change the relative occurrence of the different magnitudes expressed relative to the root-mean-equare ordinate.

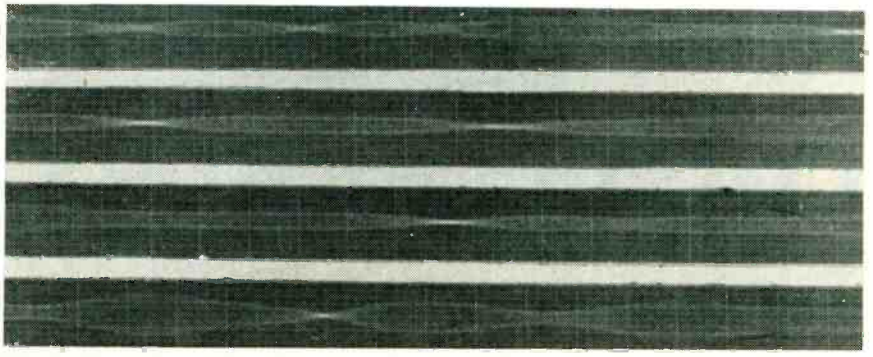

FIG. 3—Narrow-band thermal noise—midband at 1,500 cps, width 6 cps

The gaussian distribution holds approximately for many other kinds of noise beside thermal. Figure 4A shows the cumulative distribution curve. The ordinate presents the fraction of time the thermal noise voltage or current remains less than specific instantaneous ratios relative to rms. This curve would be obtained by monitoring noise output with level recorders set at various threshold levels and evaluating the percentage of time each one is not operated.

At minus infinity, the probability is zero since all values exceed this amount. The magnitudes are symmetrically distributed about zero and hence the 50-percent point is the division between negative and positive values. The curve for positive values is symmetrical with that for negative values and reaches 100 percent at plus infinity.

The curve of Fig. 4B is the probability density function indicating the relative portions of time the voltage spends near specific values. It is the derivative or slope of the curve of Fig. 4A. Its equation is

$$p = \exp[-E^2/(2\sigma)^2]/\sigma(2\pi)^{1/2}$$

where E is the magnitude under consideration and σ is the rms value. Its meaning is that the product $p\ \Delta E$ gives the probability of finding the magnitude within a small interval of width ΔE centered at E. The probability density is greatest at $E = 0$, meaning that values near zero are found relatively most often. The equation of the curve in Fig. 4A is the integral of p with respect to E and is

$$P = \tfrac{1}{2}\{1 + \text{erf}[E/(2\sigma)^{1/2}]\}$$

where P is the cumulative distribution and erf stands for the error function defined by

$$\text{erf}\ z = [2/(\pi)^{1/2}] \int_0^z \exp(-x)^2\, dx$$

The error function is tabulated in Pierce, "A Short Table of Integrals."

The fact that the curve of Fig. 4A approaches 0 percent and 100 percent probabilities asymptotically shows that it is impossible to define a unique peak factor for thermal noise. By waiting long enough and having apparatus of sufficient linear range, there is no limit to the magnitude which can be reached.

Instead a qualified peak factor can be defined as the ratio of the peak exceeded only a specified percentage of the time to the rms value. It is convenient to express peak factors in db above rms versus probability of excess, as in Table I. The percentages include the times both positive and negative excursions have absolute magnitudes exceeding those specified.

A common value for the peak factor of thermal noise is 4, which is equivalent to 12 db. This excludes greater peaks reached

about 0.01 percent of the time. Inclusion of 0.001 percent peaks would only increase the peak factor by about one db.

Another quantity of interest is the form factor or ratio of rms to average absolute value. This is the ratio of the rms to the full-wave rectified d-c output. The form factor of gaussian noise is $(\pi/2)^{\frac{1}{2}} = 1.253$, equivalent to 1.96 db, which is 1.05 db greater than the corresponding value of $\pi(2)^{\frac{1}{2}}/4 = 1.111$ or 0.91 db for a sine wave. This difference is of practical significance if a rectifying meter calibrated to read rms values for a sine-wave input is used. The rms value indicated for thermal noise will be 1.05 db too low if the rectifier is linear.

Rayleigh Noise

If a narrow band of gaussian noise is applied at high level to an envelope detector consisting of a diode in series with a parallel R-C cricuit, the waveform of the output follows smoothly through the positive tips of the input wave without executing the intervening oscillations.

The wave obtained has the Rayleigh distribution, shown graphically in Fig. 5A for the cumulative distribution and in Fig. 5B for the probability density. Since only positive values are obtained the curves start as zero and proceed to the right. The equations are

$$p = (E/\sigma^2)\exp(-E^2/2\sigma^2)$$
$$P = 1 - \exp(-E^2/2\sigma^2)$$

The probability density is maximum at the rms value of the wave. The peak factors for percentage probabilities of exceeding various peaks relative to rms differ from those of the gaussian case and are given in Table II. The reference is the rms value of original noise wave and not the rms envelope, which is $2^{\frac{1}{2}}\sigma$.

The Rayleigh distribution is important in the narrow-band case in which an envelope detector is often a part of the receiving apparatus.

Equivalent Circuits

Unlike the mean power, the mean square voltage or current associated with thermal noise depends on the impedance level at which the observation is made. Since the available power from a generator with open-circuit rms voltage E and internal impedance $Z = R + jX$ is $E^2/(4R)$, the equivalent circuit of a thermal noise source associated with an impedance Z is formed by inserting in series with Z a voltage source of rms voltage E such that

$$E^2/(4R) = kTb \text{ or } E^2 = 4RkTb$$

where k is Boltzmann's constant, T is the temperature on the Kelvin scale and b is the bandwidth in cps. To find the rms thermal noise voltage E_2 which would be supplied from Z to any other impedance to which it is connected as in Fig. 6A, calculate the absolute value of the gain ratio $E_2/E_1 = g$, and write

$$E_2^2 = g^2E_1^2 = 4g^2kTRb$$

If g and R vary with frequency, an integration must be performed with respect to frequency f, giving

$$E_2^2 = 4kT\int_0^\infty g^2R\,df$$

In the most general case this calculation would have to be performed for every resistive component associated with the network and the separate power contributions added to form the total noise power. In the more usual high-gain amplifier case, the gain factor g is high enough to matter only between earliest amplifier input stages and the output. All other contributions to thermal noise may then be neglected.

Instead of a voltage generator in series with an impedance, a current generator I in shunt with an admittance $Y = G + jB$ as shown in Fig. 6B can be used. The corresponding equations are

$$I_1^2 = 4kTGb$$
$$I_2^2 = 4g^2kTGb \quad \text{(for } g \text{ and } G \text{ constant)}$$
$$= 4kT\int_0^\infty g^2G\,df \quad \text{(for } g \text{ and } G \text{ variable with frequency)}$$

Noise Bandwidth

The equations for gain variable with frequency enable the definition of a noise bandwidth b_n, for a transmission system which does not have a flat transmission band. For this purpose R is constant with f.

The idea is to find an equivalent transmission characteristic of rectangular form such as shown in Fig. 7 which would give the same total amount of noise. The maximum value of g is set equal to g_0. The area of the rectangle of height g_0^2 and width b_n is set equal to the area under the curve of g^2 versus f. In Fig. 6A

$$E_2^2 = 4\,kTR\int_0^\infty g^2\,df = 4\,kTR\,b_ng_0^2$$

The noise bandwidth is defined by

$$b_n = \frac{1}{g_0^2}\int_0^\infty g^2\,df$$

Amplifier Noise

Thermal noise contributes an irreducible minimum amount of

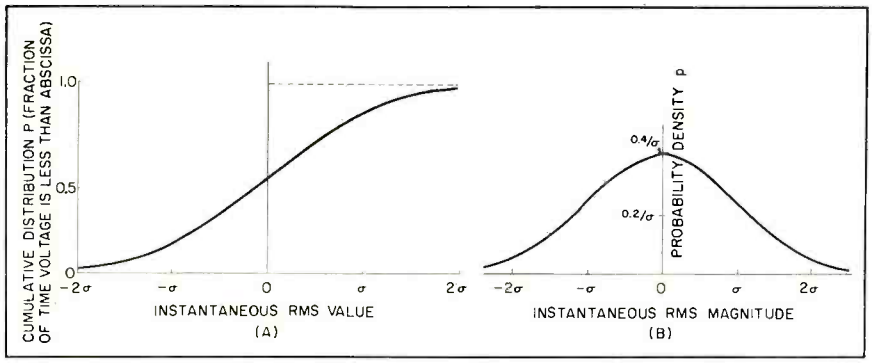

FIG. 4—Distribution of instantaneous gaussian noise voltages or currents (A) and density of gaussian noise distribution (B)

Table I—Peak Factors for Gaussian Noise

Percent of Time Peak is Exceeded	Peak / rms	Peak Factor in db = 20 $\log_{10}$ (peak/rms)
10.0	1.645	4.32
1.0	2.576	8.22
0.1	3.291	10.35
0.01	3.890	11.80
0.001	4.417	12.90
0.0001	4.892	13.79

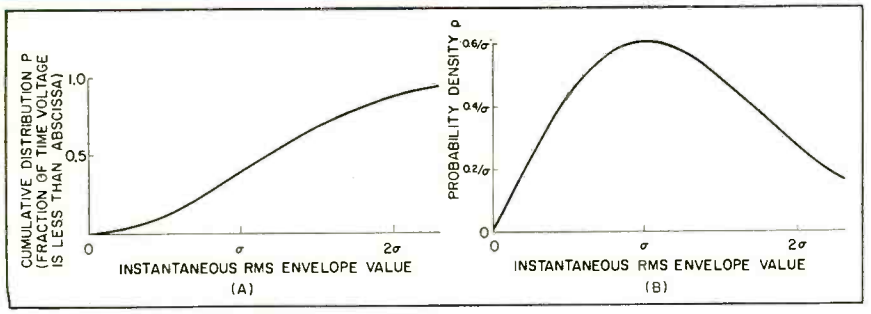

FIG. 5—Distribution of instantaneous Rayleigh noise voltages or currents (A) and density of Rayleigh noise distribution (B). This distribution occurs when a narrow band of gaussian noise is applied at high level to a detector

noise power to the output of an amplifier. The amplifying elements themselves introduce additional noise peculiar to their operation.

In vacuum-tube amplifiers, the contributions in addition to thermal noise are mostly included under tube noise. Except at very low and very high frequencies, tube noise is like thermal in that it is white and gaussian.

In transistors, a form of contact noise sometimes called excess noise, flicker noise and $1/f$ noise is an important offender. Instead of being white its power density on the frequency scale varies inversely with frequency over an extensive range. It may also be quite nongaussian in its distribution of magnitudes.

A similar kind of nonwhite nongaussian noise found at very low frequencies in vacuum tubes is called flicker effect and is thought to be caused by slow fluctuation in cathode emission.

Tube Noise

The basic model for explanation of tube noise starts with the shot effect based on the random emission of electrons from the cathode. In temperature saturation in which all emitted electrons are immediately drawn to the anode a calcuable amount of noise power arises since the anode current is made up of a spatter of discrete charge arrivals instead of a steady flow. The result due originally to Schottky[7] may be expressed by a white gaussian noise current generator with mean square given by

$$I^2 = 2\,e\,I_0 b$$

where e is the electronic charge 1.60×10^{-19} coulomb, I_0 is the d-c value of anode current and b is the bandwidth.

Comparison with the corresponding thermal noise formula shows that $2eI_0$ corresponds to $4kTG$. Hence shot-noise effects can be calculated in the same way as thermal noise with this substitution.

In amplifiers the tubes are usually operated at currents below temperature saturation. Under such circumstances the accumulated space charge exerts a smoothing effect and substantially reduces the shot noise below the amount given by Schottky's formula. The latter formula is applicable to so-called noise diodes, which are deliberately operated at temperature saturation to give a controlled noise source having an amount of power suitable for measuring purposes.

In addition to space-charge-limited shot noise, vacuum-tube amplifiers are subject to partition

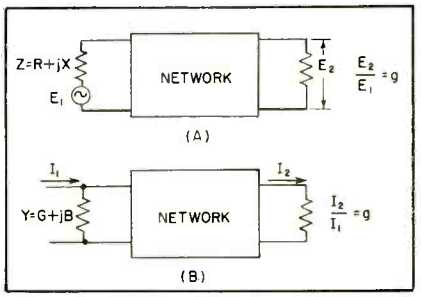

FIG. 6—Equivalent voltage (A) and current (B) generators for thermal noise source in a linear network

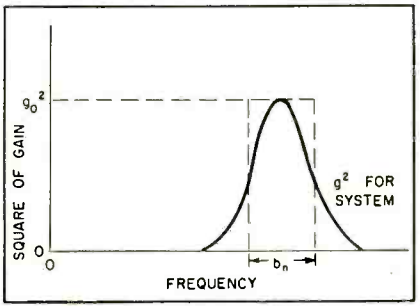

FIG. 7—Relation between noise bandwidth of network and its gain-frequency curve

Table II—Peak Factors for Rayleigh Noise

Percent of Time Peak is Exceeded	Peak / rms	Peak Factor in db* = 20 $\log_{10}$ (peak/rms)
10.0	2.146	6.63
1.0	3.035	9.64
0.1	3.618	11.40
0.01	4.292	12.65
0.001	4.798	13.62
0.0001	5.198	14.32

* Rms of gaussian noise wave

noise in multigrid tubes caused by random distribution of electrons between the anode and other electrodes, noise from secondary emission from electrodes and noise from ionization of small traces of gas.

At very low frequencies, the flicker effect occurs and at high frequencies, the problem is complicated by electron transit-time effects which bring about a departure from a white-noise source.[8]

Quantitative Noise Criteria

The equivalent saturated diode current is obtained by measuring or calculating the equivalent noise current source I in bandwidth b and equating its square to $2eI_0b$. The resulting value of I_0 given by

$$I_0 = I^2/2eb$$

is the saturation current of a diode which would generate the same shot noise power as the entire amount of noise power generated by a tube from all sources.

The equivalent noise resistance R_n is the resistance which, acting as a thermal noise voltage source in the grid circuit of a vacuum-tube amplifier stage, would produce the measured output noise power. If the output noise of the tube is represented by a current source I in bandwidth b and the transconductance of the tube is g_m

$$4\,kTR_nbg_m^2 = I^2$$
$$R_n = I^2/4\,kTR_nbg_m^2$$

The noise ratio n of any two-terminal linear device is defined as the ratio of the available noise output power P_n in bandwidth b to the available thermal noise power. That is

$$n = P_n/kTb$$

If the device contains no noise sources except its own thermal noise, n is unity.

The noise figure F of a four-terminal network is defined[9] as the ratio of the available signal-to-noise power ratio at the input to the available signal-to-noise ratio at the output when the only noise source in the input is thermal noise. It is unity if the four-terminal network is noise-free.

It is commonly measured by introducing a calibrated noise source at the input and adjusting until the noise output power is just doubled. The noise power N_a delivered by the auxiliary source is then just equal to the equivalent input noise power of the network. The noise figure F is given by

$$F = N_a/kTb$$

If the network introduced no noise of its own, the added noise N_a would be just equal to the thermal noise power kTb from the input and $F = 1$ as before stated. In general the value is greater than one and the magnitude indicates the relative noisiness contributed by the circuit.

Contact Noise

Contact noise includes an extensive variety of sources having a fluctuating conductivity. In relay or switch contacts, the fluctuations occur at an imperfect junction between two conductors.

A similar condition exists in the discontinuous conducting path formed by the discrete particles in a carbon microphone. Transistors and semiconductor devices tend to be plagued by phenomena which act like bade contacts.

The amount of noise thereby contributed has been substantially reduced as more knowledge and experience have been brought to bear on the problem. The low-frequency flicker effect in vacuum tubes is a species of contact noise.

Two important properties of contact noise are that the amount of noise power is proportional to the d-c current flowing through the device and that the density of power on the frequency scale varies as the reciprocal of the frequency, giving the so-called $1/f$ spectrum.

The proportionality with d-c is understandable since a varying conductivity in itself would have no outward observable effect until a current is made to flow. In this respect contact noise is like shot noise. The $1/f$ spectrum remains mysterious despite much theoretical analysis.

It is apparently a fundamental property but explanations to date have been too complicated to describe in a few sentences.[10] Its practical significance is that the noise figure of semiconductor devices varies inversely with frequency in the range of low frequencies over which contact noise predominates over thermal noise.

Contact noise observed over a considerable bandwidth may also be nongaussian in its distribution of magnitudes. A relatively narrow band tends to become gaussian because the instantaneous response becomes influenced by a large part of the past history and the central limit theorem then takes hold.

Static and Ignition Noise

The noise from atmospheric static differs from the noise sources previously discussed in that it has a much more highly variable nature. It may consist of isolated bursts or continuous rumbling and the amount received can change enormously with atmospheric conditions. It tends to taper off with frequency and is much stronger in the a-m broadcast band of radio frequencies than in the vhf band used for tv and f-m.

The pulse-like character often observed in static is also associated with ignition noise, which may arise by induction from any man-made electrical discharge of short duration. The important difference between noise pulses and steady noise is that the time scale of the primary cause in the former case is so slow that receiving circuits resolve independent events.

A further narrowing of the bandwidth would eventually cause the distinct pulses to merge into a steady noise wave. Before this merger takes place, however, the heights of the noise peaks tend to vary directly with bandwidth while the rms noise follows the square root. This is because the isolated peaks represent addition of nearly equal in-phase components uniformly distributed in frequency. Band reduction lops off a proportional number of equal contributors. The rms value is proportional to the square root of the average power which is directly proportional to bandwidth.

It is thus possible to change the peak factor of ignition noise by filtering. Considerable reduction in the effects of ignition noise on a narrow-band circuit can be achieved by using a wide-band peak-chopping circuit ahead of the band-limiting part of the system. It is better to chop while the peak factor is high than to wait until the pulses have been spread over more time. This

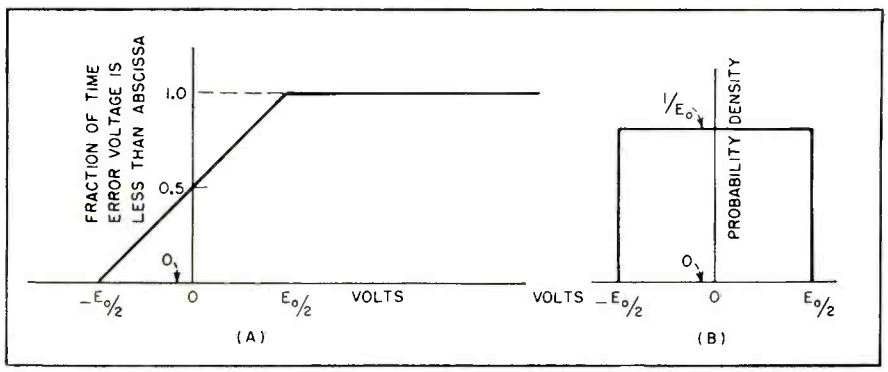

FIG. 8—Distribution of instantaneous quantizing noise voltages (A) and density of quantizing noise distribution (B)

Table III—Signal-to-Noise Ratios Obtained with Various Quantizing Levels

Quantizing Levels	Binary Digits In Coded Representation	Signal-to-Noise Ratio in db
8	3	21
16	4	27
32	5	33
64	6	39
128	7	45
256	8	51
512	9	57
1,024	10	63

is the principle of the Lamb noise suppressor.[11]

Interference

The term interference includes mainly man-made disturbances. It is difficult to enforce mutually exclusive occupation of communication channels. When the interference consists of direct pickup from another like channel the term crosstalk is often applied, by extension of the use of a word originally coined for speech systems.

Since crosstalk has properties similar to those of the wanted signal its effects cannot be diminished by filtering operations. The best remedy is to reduce the crosstalk coupling by shielding and balancing. Increasing the signal power is of no help because the reciprocal nature of the coupling would then call for a corresponding increment in the crosstalk source to override the increased interference in the other channel.

When a large number of crosstalk contributions are superimposed, a gaussian type of noise is approached in accordance with the central limit theorem. Such a superposition occurs in a cable containing many pairs of telephone wires. The expressive name babble has been given to the noise picked up in a typical pair when the other pairs are carrying telephone conversations.

If the coupling is nonlinear, as in a multichannel amplifier, the interference becomes a distorted version of one or more signal waves. Such interference has been called nonintelligible crosstalk in telephone systems, but it is more properly called cross modulation. The requirements on its suppression are not as severe as on the intelligible variety of crosstalk, but may be more so than on the smoother gaussian noises.

The term c-w interference is applied to cases in which the interfering source is principally a sine wave, as for example from the unmodulated carrier wave of a radio channel. The effect is a beat frequency wave which in the audio case is observed as a whistle accompanying the wanted signal. A sharp suppression filter can sometimes be used to remove it without appreciable harm to the signal band. If the beat frequency is variable or occurs at a vital location in the band, reduction of the coupling is the only cure.

Power hum consisting of harmonics of 60 cycles or some other a-c power frequency is a familiar constituent of amplifier outputs. It can be suppressed to any prescribed extent by filtering and shielding, but the procedure required may be onerous and expensive. To get down to thermal noise only in a high-gain amplifier the use of battery-powered tubes for at least the earlier stages is often necessary.

Quantizing or Rectangular Noise

A deliberately manufactured kind of noise of increasing importance is that originating when analog signals are converted to digital form. In pulse-code modulation samples of the signal are represented by discrete numbers so that telegraphic transmission by binary code groups can be used.

Such representation can be right only when the sampled value coincides with one of the discrete numbers. For all other values there is an error which may be anywhere from a negative half unit to a positive half unit. These errors occur practically at random, for if enough steps are used to make the quality adequate, there can be little tendency for the values to favor any location within a step.

The result is a noise which has a uniform or rectangular distribution in magnitude throughout the range $-E_0/2$ to $E_0/2$ as shown in Fig. 8. Voltage E_0 is represented by a unit step.

Noise of this type is called quantizing or rectangular noise. It is analogous to the rounding-off error in digital computation caused by carrying a fixed number of digits in the arithmetic.

Digital transmission systems must accept the quantizing noise penalty when the original signals occupy a continuous range of magnitudes. In return for this slight degradation, which can be made as small as desired by making the step size sufficiently small, an enormous advantage is obtained—namely, a guarantee that no more noise need ever be added no matter how long the transmission path may be. The latter is accomplished by the use of regenerative repeaters which replace distorted or noisy code pulses by clean ones before their recognition becomes doubtful.

The quantizing noise contributes a mean square value of one-twelfth the square of the step size. The resulting noise wave occupies a frequency band equal to half the sampling rate. The peak factor is $3^{\frac{1}{2}}$, equivalent to 4.8 db.

If a narrower band is selected the gaussian form is approached with mean power proportional to bandwidth. Table III indicates the signal-to-noise ratios obtainable with various numbers of quantizing levels on the assumption that three-fourths of the ideally realizable channel band of half the sampling rate is attained. The signal-to-noise ratio in db is 10 times the common logarithm of the ratio of mean full-load sine-wave power to mean quantizing noise power. Each added binary digit improves the signal-to-noise ratio 6 db.

In speech systems, the effects of quantizing noise are subject to reduction by preliminary compression and subsequent expansion of the amplitude range just as for other forms of noise encountered in transmission.[12]

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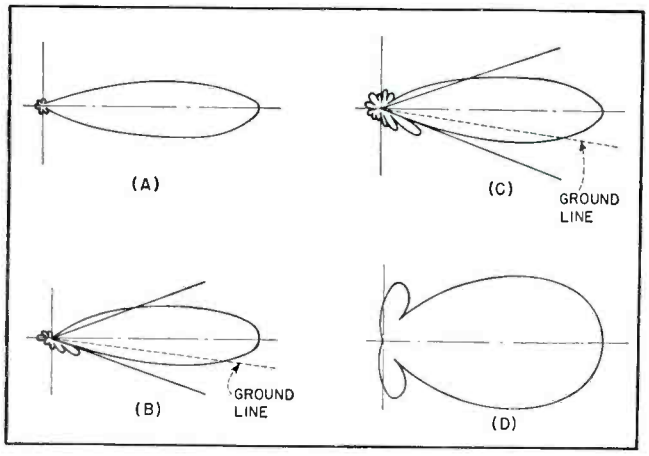


FIG. 1—Radiation patterns for 1/6-scale model in vertical plane without (A) and with (B) phasing and top shield. Vertical (C) and horizontal (D) plane patterns are for full-size antenna

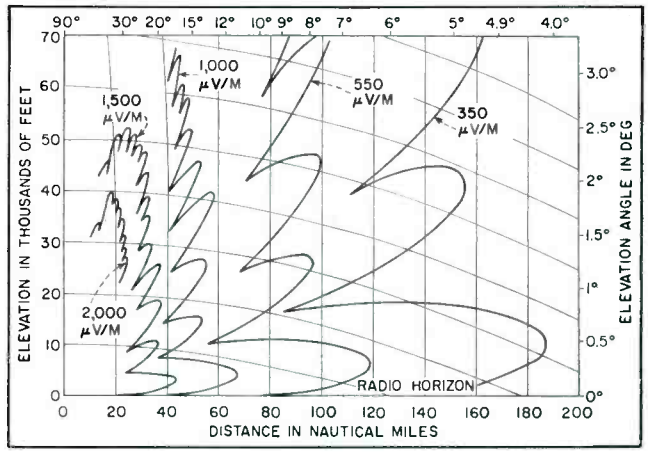


FIG. 2—Propagation pattern for helical array. Distance scale is corrected to a value of 4/3 earth radius to account for atmospheric refraction

Ground-to-Air Antenna Uses Helical Array

SUMMARY —— Multielement phased helical array provides either linear or circular polarization for ground-to-air communications. Design uses ported support members to obtain rigidity with minimal wind loading in overwater operations

By V. J. ZANELLA

Physical Research Staff
Seattle Division
Boeing Airplane Co.
Seattle, Washington

EXCELLENCE of the helix antenna as a directional device for the uhf band coupled with its compactness and simplicity of construction makes extensive application possible.

During the preliminary search for an antenna configuration which would best meet the design requirements given in Table I, special consideration was given to the problem of reducing the physical size of the radiator to meet the requirements of environmental conditions.

These conditions placed particular premium on ease of handling and mounting the antenna, simplification of its fabrication and reduction of wind loading. A study of basic types of antennas indicated that a vertical array, utilizing some form of reflecting ground plane, would be the most feasible design for this application.

Further investigation revealed that an antenna consisting of a vertical array of helical elements fed through the reflecting ground plane would be ideal, for in addition to possessing the required electrical characteristics, such an array possessed the additional advantage of allowing the size of the physical aperture to be reduced, a condition attributed to the gain

inherent in the individual helical elements of the array.

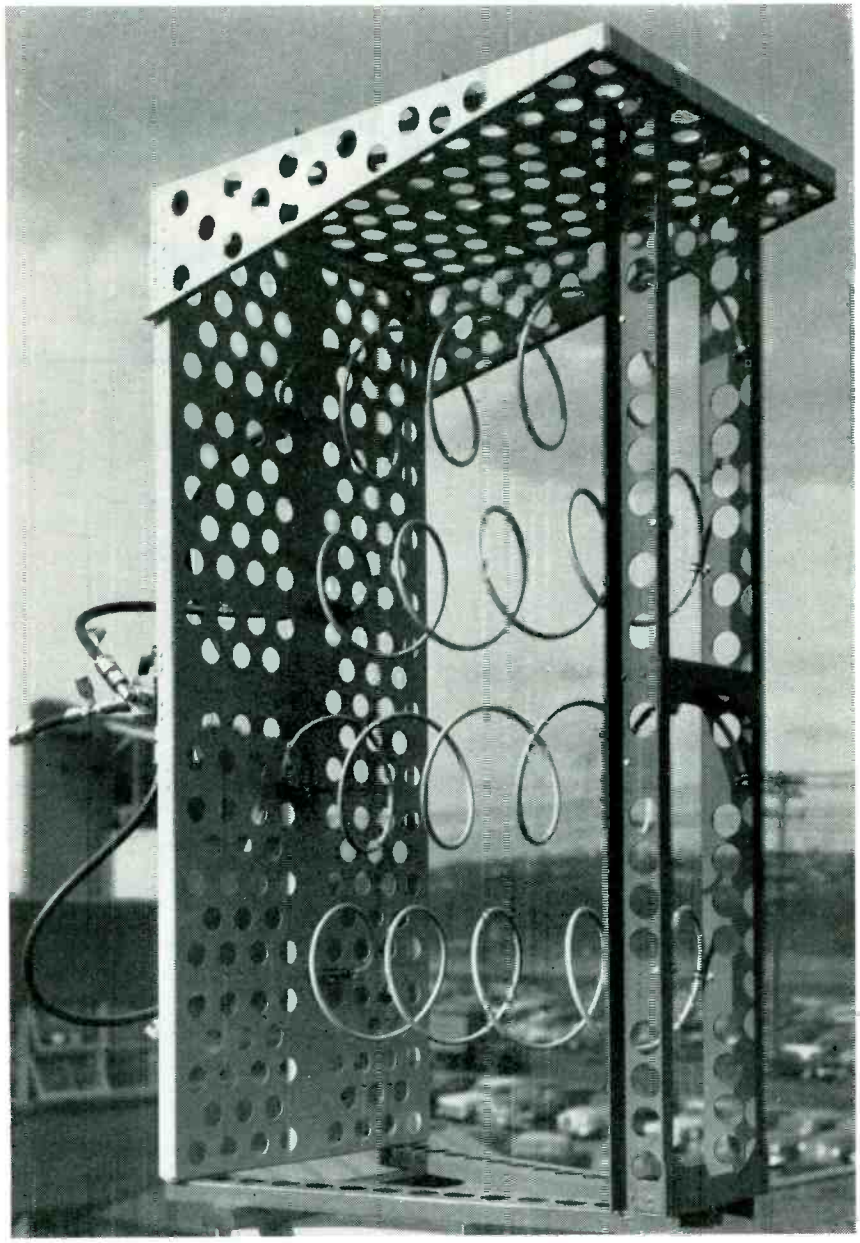
Design

Since the specifications required vertical polarization, a means of producing a linearly polarized wave from the array of helices was required. Linear polarization can be produced from two helices by locating the elements adjacent to each other and winding them in opposite directions.[1] The right and left circular polarization combine on the axis between the elements to produce a resultant linearly polarized beam, and the plane of polarization can be changed by rotating either one of the helix elements 180 deg on its axis.

Although it was known that the two helical elements would not provide a beam sufficiently narrow to meet specifications, a 1/6-scale two-element helical array was constructed to determine whether or not the polarization theory would provide the desired characteristics. Once this was determined, the next problem was to reduce the beam width to meet the vertical pattern requirements.

This was accomplished by adding two more elements to obtain a configuration consisting of a stacked four-element array. The resulting radiation pattern was vertically polarized with a 50 deg beam width in the horizontal plane and a 20 deg beam width in the vertical plane, as shown in Fig. 1A.

The absence of side lobes on the radiation pattern was notable. To obtain the desired pattern shape, it was necessary to increase the high-angle energy content. The helical array proved to be particularly adaptable to beam shaping, for it was possible to produce a satisfactorily asymmetrical pattern by adding a reflecting ground plane and by adjusting the relative phase angle to which the linearly polarized pairs of elements were added. This changed the pattern from that shown in Fig. 1A to that shown in Fig. 1B. Adapting the beam shape not only provided the desired increase in high-angle energy content but reduced ground reflections as well.



Four-element antenna array uses ported support members to minimize wind resistance while providing rigid support for helices

Electrical Characteristics

Investigation with the 1/6-scale model indicated that it was both practical and feasible to construct the full-scale antenna, shown in the photograph. Radiation patterns for the full-scale model agree, in general, with the measurements made on the 1/6-scale version with the exception that the side lobe off the main beam of the vertical elevation pattern was somewhat greater than recorded in the model measurements. The vertical-plane pattern half-power beam width is 23 deg and the horizontal plane is 52 deg as shown in Fig. 1C and 1D.

Since the spring-out of the aluminum elements after winding was less than anticipated, the diameter of the coils was slightly under size resulting in increased pattern beam widths. The slight loss in gain resulting from this condition, however, was not significant.

A value of 14.1 db above an equivalent isotrope was estimated as the gain for the full-scale antenna, based on full-scale principal-plane patterns and conic measurements obtained with the 1/6-scale antenna.

Propagation patterns, obtained according to the two path propagation theory[2], furnished the basis

for determining the optimum mounting height and tilt angle of the antenna. Since the antenna was to operate over water, the effect of reflections from such a body on the radiation coverage was calculated to determine the magnitude and shape of the propagation pattern, shown in Fig. 2. To predict the range and performance of the antenna, it was estimated that the power losses in actual operation would total approximately 18.0 db, with connectors and cables contributing 2.0 db, environment and equipment deterioration 6.0 db and atmospheric anomalies 10.0 db.

Radiation Pattern

The magnitude of the radiation lobes is dependent upon the free-space range r_{fs} of the transmitting system. The expression for this particular range is

$$r_{fs} = \frac{K}{E}\sqrt{30 G_t P_t} \qquad (1)$$

Where E = designated field strength of the desired propagation pattern contour in microvolts per meter, G_t = power gain of transmitting antenna (including system losses), and P_t = power radiated from transmitting antenna in watts.

The altered field strength E_a of points along the propagation pattern lobes is the vector sum of the free-space field strength E_{fs} and the ground-reflected field strength E_r as given by

$$E_a = E_{fs} + E_r \qquad (2)$$

The values of E_{fs} are represented by the measured free space radiation pattern shown in Fig. 1C. The actual range r_a of points along the radiation lobes is directly related to the free space range r_{fs} of the transmitting system as shown by

$$r_a = r_{fs}\frac{E_a}{E_{fs}} \qquad (3)$$

where r_a is the range in nautical miles.

The calculations were simplified by determining only the maximum and minimum points of the propagation lobes. The intermediate points along the contours of the lobes were then determined by interpolation. The optimum (minimum reflections) propagation pattern, shown in Fig. 2, resulted from

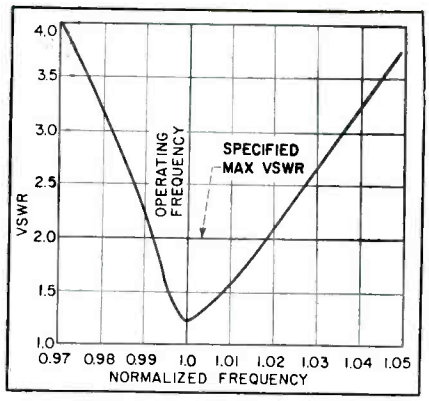


FIG. 3—Plot of vswr of helical array at operating frequency

an assumed antenna mounting height of 40 feet and a tilt angle of 7 degrees above horizontal, operating at a power rating of 1 kw.

The sharp energy lobes located above 30,000 feet at a distance 20 to 30 miles from the antenna site are caused by the side lobe 24 degrees below the ground line in the free-space pattern. These sharp energy lobes represent a desirable condition in that the high-angle energy content of the pattern is increased.

Impedance

Little effort was made to achieve an impedance match through adjustment of the individual helical elements since the impedance presented at the point of measurement, the junction box, was largely affected by the length of the phasing lines.

While the power distribution to the individual antenna elements was affected by their mismatch, the desired radiation pattern was achieved without matching by means of phase adjustments and the addition of the reflecting ground plane shown in the photograph.

The design problem was considerably simplified by the fact that the impedance matching to a vswr of less than 2 was required through an extremely narrow band. To meet this vswr specification, an external compensation in the form of a shorted shunt stub was utilized. This shunt compensator, designed to operate at the transmitted power of 1 kw, was fabricated according to computations based on the impedance plots of the uncompensated antenna. Utilizing this compensator achieved a vswr of 1.18 to 1 at the operating frequency of the antenna. The vswr characteristics at and near the operating frequencies are shown in Fig. 3.

Table I—Specifications of UHF Ground-to-Air Antenna

Width of vertical elevation pattern (at half power points)	20°
Width of horizontal plane pattern (at half power points)	45°
Polarization	Vertical
Continuous power rating	1 kw
Input transmission line	50-ohm coaxial
Maximum vswr	2.0:1

Physical Characteristics

Since the antenna was to be installed at a site where high winds are common, the problem of reducing wind loading required attention. Again the helical array proved particularly adaptable. The photograph shows the minimum amount of wind resistance inherent in the physical configuration of the antenna.

The use of 24ST aluminum rather than copper for the helical windings themselves not only provided greater strength and rigidity of shape but reduced the weight of the antenna elements. Thus the helical elements required support only at the ends, eliminating the need for a dielectric supporting structure, again significantly reducing the weight. Tests have proved that vibration of the individual elements by the wind has no measurable effect on the electrical characteristics and performance of the antenna.

The author wishes to acknowledge the suggestions of R. E. Perry during the development of the antenna and comments of J. W. Souther during the preparation of this article.

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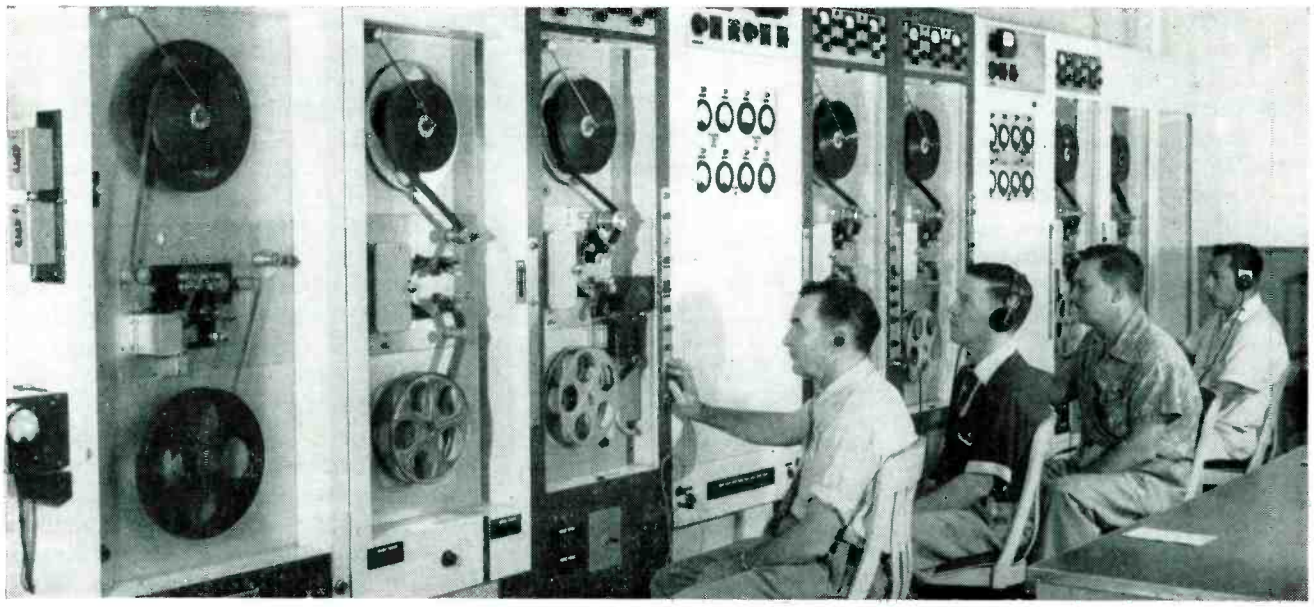
(2) Henry R. Reed and Carl M. Russell, "Ultra High Frequency Propagation", John Wiley & Sons, Inc., New York, 1953.



Complete CinemaScope printing system in operation for printing four magnetic sound tracks on each print

Automatic Inspection of

SUMMARY——System compares magnetic-sound-track print levels with master-track level and gives direct visual indication of error; buzzer gives aural warning when deviation exceeds desired level. System may also be used to duplicate audio and video tape recordings

By JEROME W. STAFFORD

Sound Department
Metro-Goldwyn-Mayer Pictures
Culver City, California

BEFORE THE ADVENT of magnetic sound tracks, inspection of one optical track on each reel was a relatively simple matter. Since magnetic modulation is not visible and there are four separate tracks on each reel of CinemaScope film, a change in control and inspection procedure became a necessity.

The obvious method of actually running all prints in a projection room was considered to be too slow and costly. Development of an automatic electronic method seemed to be most practical.

By adding monitor heads to both the master reproducer and the copying recorder (printer), in the same relative positions, audio signals can be compared and differences indicated. Since the photographic picture is already on the film in the sound printing procedure, a stroboscopic viewer installed in the correct position on the printer permits checking of synchronism of sound and picture. In this manner, prints are automatically inspected during the printing operation at little cost and with no loss of time.

System Operation

Figure 1 is a block diagram of the complete printing system. Since the signal path is the same for all four tracks, only one track is traced all the way through the system and, although the master magnetic reproducer generates signals for several printers, only one is shown. Except for the comparator section with its error indicator and the stroboscopic generator, standard components are used.

The master reproducer has two sets of reproducing heads. One set feeds into the normal transfer channels comprised of reproduce amplifiers, Y-pads, recording attenuators, recording amplifiers and recording heads at the printers.

About 2 inches below the normal reproducing heads is placed a set of monitor heads. These heads serve the dual purpose of supplying audio signals as standards for the comparing circuits and for direct audio monitoring. A set of monitor heads on the printer, in the same relative position as above, feeds signals from the print to the comparing

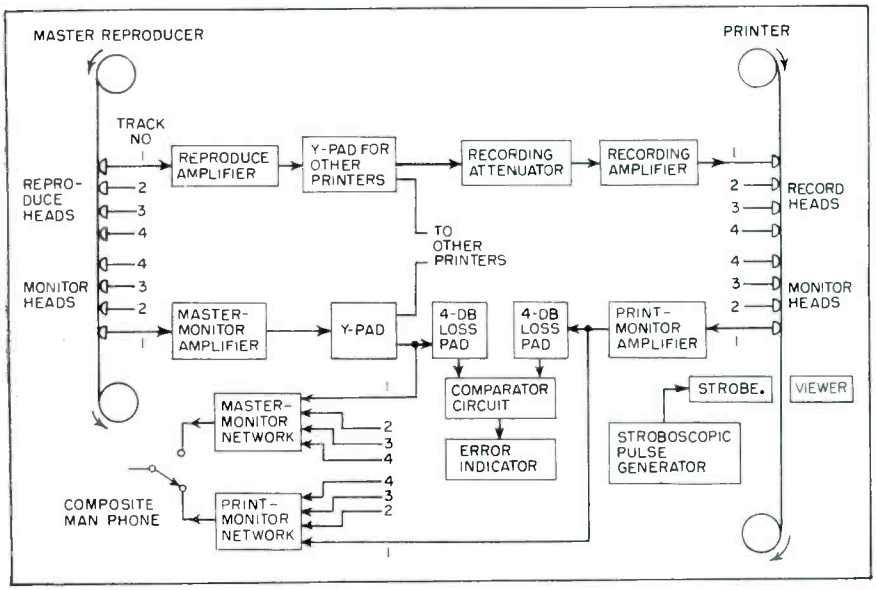


FIG. 1—Each track of system has its own channel, recording head, monitoring head and comparitor unit; all tracks use the same composite monitor circuit. Sets of heads are in line perpendicular to film-travel path

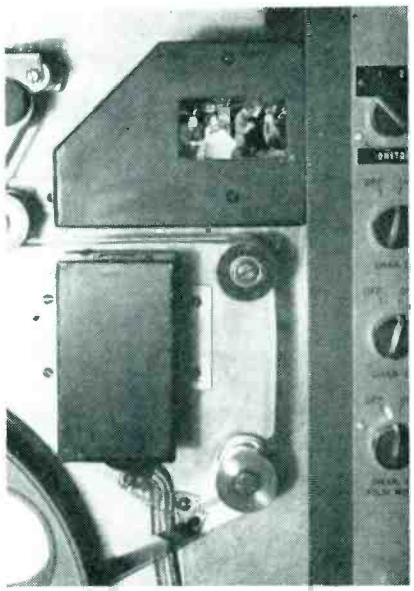


Image obtained with stroboscopic print viewer. Picture is viewed 28 frames below monitor head to assure synchronism

Magnetic-Sound Prints

circuit as well as the print-monitor network. The 4-db loss pads isolate the comparing and monitoring sections.

The stroboscopic generator pulses the Strobotron at 24 cps so the picture can be viewed while printing. The Strobotron is placed exactly 28 frames below the printer monitor-head assembly so the audio monitor will be in exact synchronism with the picture observed. This displacement corresponds to the standard CinemaScope offset between sound and picture.

Comparator

Details of the comparator are given in the block diagram, Fig. 2, and the circuit diagram, Fig. 3.

This circuit accepts the master monitor and print monitor signals through identical channels, each consisting of a constant-sensitivity control ahead of the input transformer, a diode rectifier and an R-C integrating network. The algebraic difference of these integrated voltages is impressed on one grid of the differential amplifier while

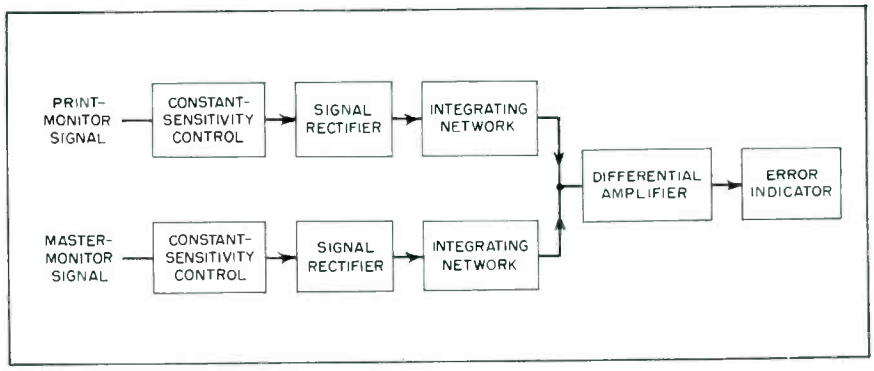


FIG. 2—Block representation of comparator-unit circuits

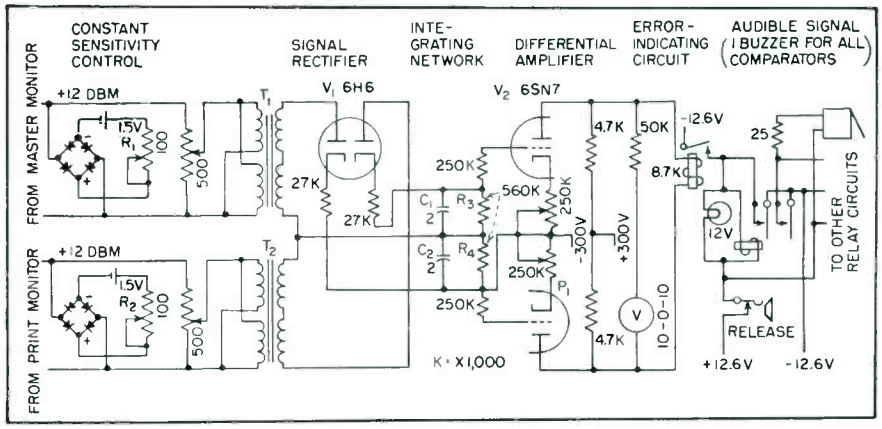


FIG. 3—Comparator and error-indicating circuits. Input level to comparators is +12 dbm when magnetic track is modulated 100 percent

the other grid is held constant by the voltage drop in its corresponding cathode resistor.

A sensitive relay, together with a zero-center voltmeter in series with a resistance, is connected between the two plates of this amplifier. The meter indicates the sense and amount of error voltage continuously, while the relay operates a buzzer and signal light when the error exceeds a predetermined value.

The constant-sensitivity controls serve the dual purpose of compressing signals above the 3-percent harmonic-distortion point of the magnetic film as well as making the amplitude response approximately a logarithmic function of the output voltage.

The selenium rectifiers, 1.5-v batteries and R_1 and R_2 perform a biased-clipping action that gives the desired logarithmic approximation. This relationship is shown in Fig. 4 where the abscissae give input in dbm plotted against the integrated output voltage across R_3. In obtaining the desired curve, advantage is taken of the nonlinear characteristic of the selenium rectifiers. The different values of R_1 show how the high-level portion of the curve can be varied, 20 ohms proving to be a satisfactory operating value.

Since the 3-percent harmonic-distortion point of the magnetic film

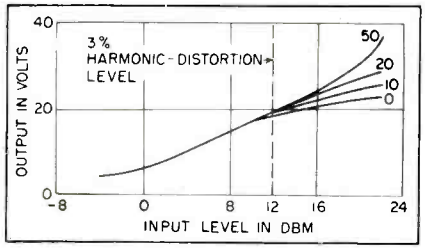


FIG. 4—Logarithmic relationship between comparator input level and rectified, integrated output voltage across R_3 with R_1 as parameter

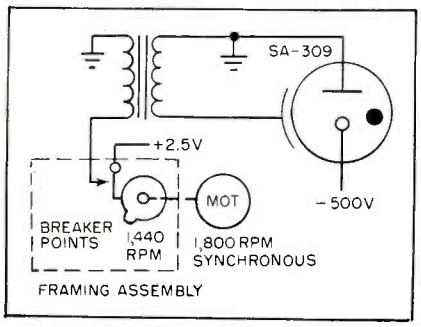


FIG. 5—Stroboscopic-viewer details

falls at about +12 dbm, there is a level range of about 15 db below the film overload point with linear db response. As the level continues to decrease, the response decreases to vanishing at roughly 30 db below 100-percent modulation.

Coupling transformers T_1 and T_2 give a voltage step-up of about 5½ to 1. The outputs of rectifiers V_1 are integrated by C_1 R_3 and C_2 R_4 and their algebraic difference is impressed on one grid of V_2, the differential amplifier. The other grid of V_2 is held at a constant value determined by the i-r drop in P_1, its cathode resistance.

A sensitive 8,700-ohm relay, adjusted to operate at roughly a 2.5-volt differential, as well as a zero-center voltmeter in series with a 50,000-ohm resistor, is connected between the two plates of V_2. The meter shows the integrated error continuously, while the relay operates the warning buzzer and signal lamp when the error exceeds 2.5 volts, which corresponds to about 2 db for signals in the upper 15-db-level range. Once the error relay operates, the holding relay continues to hold the warning until released by the push switch.

The differential amplifier operates near unity gain serving as an impedance changer and driver for the indicating system.

Viewer

Details of the stroboscopic viewer are given in Fig. 5.

The 24-cycle triggering pulse, necessary for proper stroboscopic viewing, is obtained by driving a standard automobile distributor breaker and ignition coil with a small synchronous motor geared to 1,440 rpm. The mechanical arrangement of cam and breaker points is such that their relative angular position can be varied to frame the picture in the field of view.

The optics of the viewing system have been kept very simple.

Light-flashes from the SA309 are focused on the film by a plano-convex condenser lens. A slight amount of diffusion between the lamp and the condenser lens improves the uniformity of light distribution over the frame. A virtual image of the print is formed by a cylindrical lens close to the film followed by a plano-spherical magnifying lens. The cylindrical lens restores the anamorphic image on the film to normal proportions. This normal virtual image is then magnified two times.

To reverse and invert this magnified image two plane mirrors are used. The operator thus views, in synchronism with the audio monitor, an erect virtual image of normal proportions about 1.5 inches high by 3.75 inches wide, as shown in the photograph.

Auxiliary Sync Checker

A final track-checking unit, Fig. 6, independent of the printer proper, checks exact synchronism of sound and picture and measures relative signal amplitude at fixed positions of magnetic tracks. A 60-cycle solenoid causes a magnetic-reproduce head to oscillate parallel to the direction of film travel (Fig. 7). This oscillatory motion of the reproduce head scans the magnetic modulation for approximately ⅛ inch along the sound track. Therefore a signal is generated in the head, wherever there is modulation, whether the film is in motion or stationary. Output from this head is amplified by a conventional four-stage magnetic-playback amplifier.

The rectified output of V_5, obtained from V_6, controls V_7 which in turn operates the relay and 6-watt lamp. Level and overall gain are such that track signals greater than approximately 15 db below overload will operate the relay and light the indicator lamp.

At the end of each reel of master-negative track, three frames (2¼ inches) of a 1,000-cycle high-level tone are spliced into the roll in a position exactly opposite three designated picture frames. After printing, assuming all footages and threading loops were correct throughout the reel, this short tone section will be exactly opposite the three corresponding picture frames. If this check section of print is moved slowly over the oscillating head, the lamp will light when the designated frames are in the viewing window. As the film is moved on past the window the light will go off just as the third frame leaves the field of view. If the viewing light fails to go on and go off at the correct position, lack of perfect

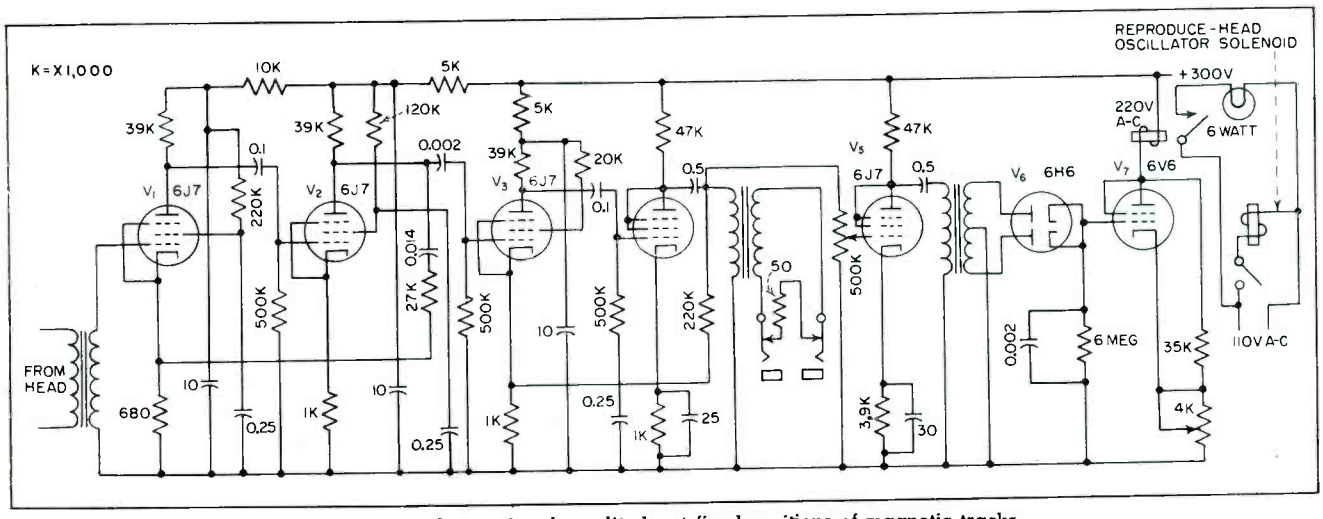


FIG. 6—Auxiliary sync checker measures relative signal amplitude at fixed positions of magnetic tracks

synchronism is indicated and the amount can be measured.

The relative amplitudes of two magnetic track signals can be determined by placing first one and then the other on the oscillating head and measuring output level at the test jack. This substitution method of measuring track level has been very useful in standardizing sound tracks.

Simplifications in Design

In the design of this inspecting system, simplicity of both equipment and its operation has been a first consideration.

Each print has four separate sound tracks and the system has four printers, making a total of sixteen tracks to be inspected. In the comparator design, therefore, two simplifying assumptions were made: if in a sound-transfer operation voltage amplitude from the original signal integrated over approximately 0.04 second equals the same integrated voltage amplitude of the copy, the two signals will be practically the same; if in a transfer operation audio signals of original and copy match throughout the top 30-db range, the probability is they will match satisfactorily over the entire useful range.

If exact phase relation of original and copy signals throughout the usable frequency range could be maintained, instantaneous amplitudes could be compared so that the first assumption would be unnecessary. However, a small amount of phase shifting due to mechanical filtering, slight changes in film

FIG. 7—Auxiliary sync checker with oscillating reproduce head mounted alongside amplifier chassis

pitch, lack of perfect adjustment of recording and reproducing heads, and variations in the elastic properties of the film is always present. Also present are slight amplitude variations due to changes in track sensitivity, head sensitivity, film weave in passing over the heads and position of magnetic stripes on the film.

As long as the summation of all these discrepancies is below a certain value, the prints will be completely satisfactory. Standardization has been reached on holding the average overall level of each track within 1 db and total momentary (approximately 0.04 sec) discrepancy to about ±2 decibels. Prints held within these tolerances are essentially perfect.

The amplitude range of comparison depends on gain and how elaborate a system is desired. It was assumed that, if audio signals matched accurately in level throughout the top 15-decibel range and if below this level the sensitivity of comparison decreases to vanishing at approximately —30 db, the resulting prints would be completely satisfactory.

The above simplifying assumptions were justified by use of the comparator in the automatic inspection of release prints. As of September 15, 1955 some 48-million feet of film had been processed and sent out to the exchanges with the gratifying result that there has been no report of defective sound whatsoever. Moreover inspection time and costs have been negligible.

Since the error indication on the meter is continuous during printing, the operator can correct throughout the reel for small discrepancies caused by slight changes in film sensitivity or amplifier drift. This type of correction insures more uniform sound tracks than could otherwise be obtained. If the amount necessary to center the meter exceeds plus or minus approximately 2 decibels, the probability of unsatisfactory magnetic striping is indicated and the print is set aside to ascertain cause.

Video-Recording Use

Possible future applications of the comparator include inspection of video recordings for television when they become prevalent. The system could be made as elaborate as necessary. The frequency spectrum being compared could be divided into smaller bands with individual comparison of each band. If necessary, phase could be compared in some sort of discriminator circuit. Finally, error voltages, within limits, could be used to automatically correct discrepancies.

Radar display signals from long-range search radars (left) and airborne early-warning units (right) are transmitted to central computer control station for interpretation and evaluation

Radar Warning Net

SUMMARY —— Increase in speed of aircraft and guided missiles made necessary development of SAGE coordinated control system for continental defense. Radar tracks of planes are correlated with flight plans by computer to identify unknown objects

COORDINATION of data from a number of early-warning radar stations formerly required relaying of information from each station to the control center by voice. Development of the SAGE (Semi-Automatic Ground Environment) system by Lincoln Laboratory of Massachusetts Institute of Technology under sponsorship of the USAF has eliminated the dependence on voice communication and interpretation of tracks by individual operators. A centralized computer installation coordinates the data from a number of radar stations and, under control of the weapons officer, guides intercepting aircraft or missiles to unidentified tracks.

Depicted in Fig. 1A is a block diagram of the old warning system. When an aircraft flies within the radar range, it must be detected by the operator. He then must determine the location of the target in space, its direction, altitude and speed. When this information is determined, it is passed to a direction center by voice where the track is plotted manually on a board. It then must be determined whether the target is a friend or enemy. This requires manual computation and correlation of known friendly tracks. If it is determined that the target is hostile, it becomes immediately necessary to alert interceptor planes and then control the interceptor to its target. All of this is done by voice communication.

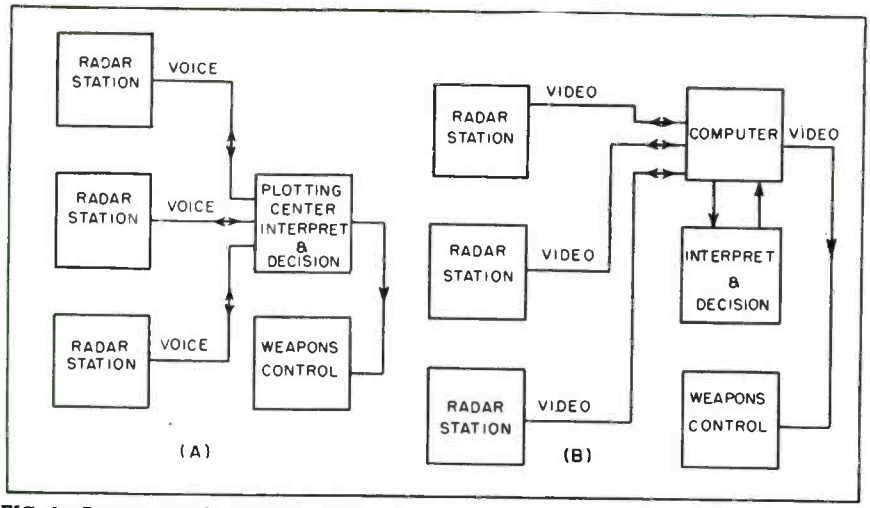
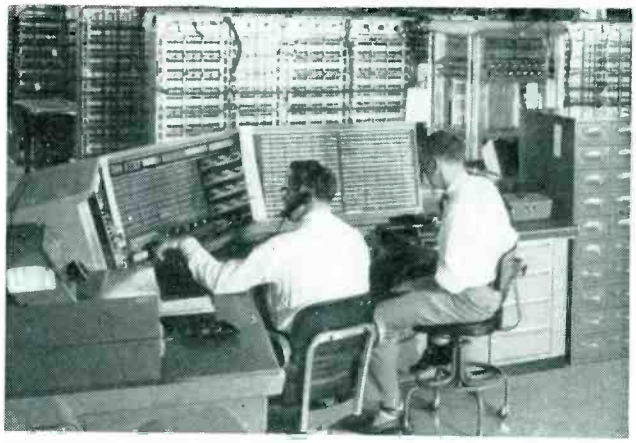


FIG. 1—Previous early-warning system (A) depended on voice relay of data interpreted by radar operator. New SAGE system transmits video from radar to computer (B) for interpretation and action

Computer Processing

The initial work on the SAGE system was concentrated on electronic computer developments—in particular, Whirlwind I, the Navy-financed all-purpose digital computer in operation at MIT. This computer quickly demonstrated its capability to process large amounts of assorted types of air-defense data in milliseconds and some tasks in microseconds, with the complete information available in seconds. The digital computer cleared the



Identification officer and weapons director (left) make decisions on unidentified tracks and guide weapons for interception. Computer maintenance boards (right) check operation of computer circuits

Uses Centralized Control

By JOHN L. LOMBARDO

Major, USAF
Assistant for Special Projects
Office, Deputy Chief of Staff, Development
Washington, D. C.

way for more centralized handling of air-defense data.

Figure 1B, shows how the SAGE system, with centralized control, enlarges the control area of responsibility. Several radars are tied into one centralized computer for assignment and control of a number of air defense weapons.

Information Flow

The flow of information in and out of the SAGE computer is shown in Fig. 2. Radar information is available from a variety of sources—search and height-finding radar, Texas towers, picket ships and airborn early-warning planes. This information is fed to the input buffer drum, being monitored to insure that the data is clean.

Manual information is also put into the input buffer drum by punch cards. The information from the drum is fed to the digital computer for processing and is then made available to the operators for necessary decisions. The first decision, from information presented to him by the computer, is made by the identification officer. Next is the responsibility of the weapons assigner. From the information presented to him by the computer, he must determine whether to use interceptor aircraft or missiles.

After the assigner makes his decision, responsibility is passed to the weapons director. The weapons director alerts the necessary interceptors and from then on his job is largely one of monitoring the action of the hostile track and the interceptor, since the midcourse guidance of the interceptors is under automatic control of computer-generated directions transmitted by ground-to-air data link.

The processing steps in the computer, are indicated in Fig. 3. When an aircraft signal is in radar range the position is located and sent to the computer, automatically, over telephone lines. Owing to the bandwidth limitation it is necessary that radar information be

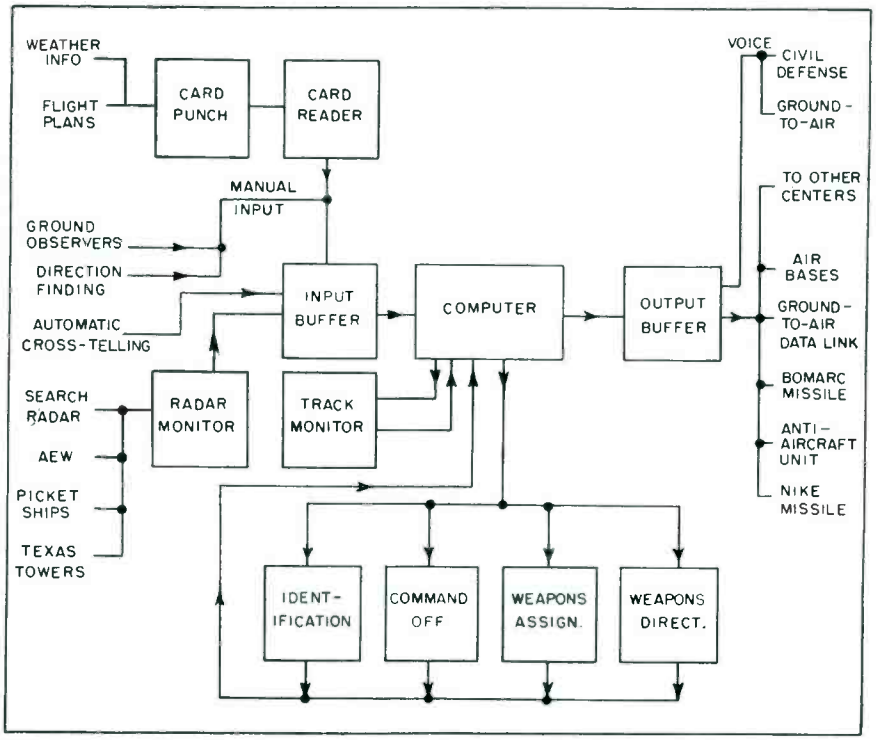


FIG. 2—Information flow in computer control center. Decisions made by identification and weapons officers are relayed to interception units through computer

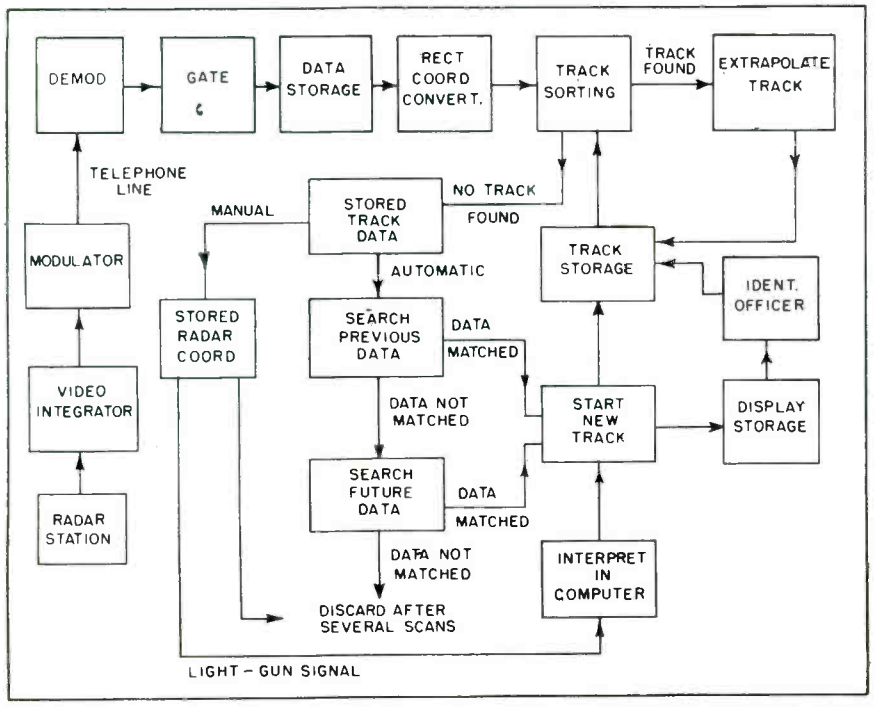


FIG. 3—Tracks not matching stored flight-plan tracks or previously identified tracks are presented to observer for interpretation and decision. Noise signals will not match tracks and are discarded after several scans

modulated to be passed over telephone lines. Upon reaching the computer, this information is demodulated and passed through a gate before going to the input buffer storage drum.

This information is then stored in the input buffer storage drum until time to process the radar data. This data is converted to rectangular coordinates, then sorted to find if the data fits an existing track. From this point, there are two routes that this data can take depending on whether or not a track is found. If a previous track is found, the computer smooths the track and extrapolates its position to the next scan period. This information is available for display in track form and is also available for correlation for continuance of the track when the next signal is received.

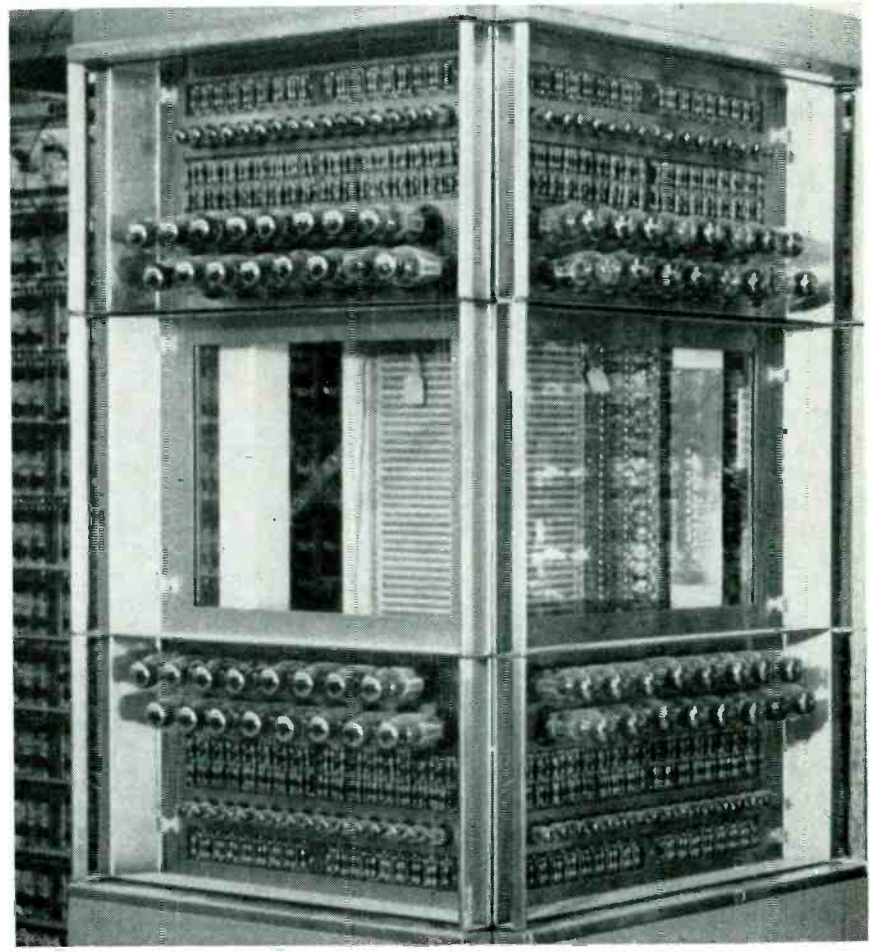
Track Identification

If no track is found, the data is again split into two routes; either manual or automatic initiation area. While taking the automatic route, the computer will search uncorrelated previous data to see if a new track should be started.

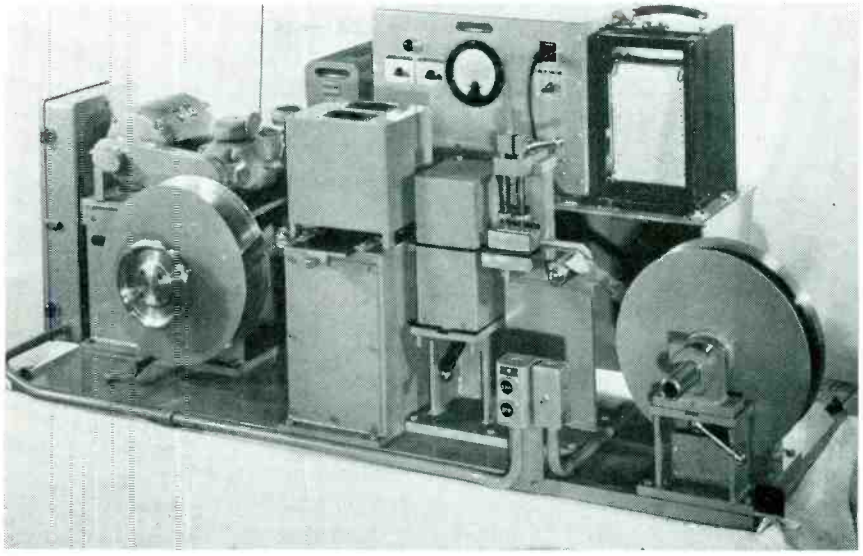
If previous data matches, the computer starts a new track in storage, assigns a track number and then sorts identification information to be made available to the Identification Offiicer. If the previous data does not match, the computer will store this information for several scans to see if future data matches. If the future data does not match, the signal is discarded as noise after several scans.

If the manual initiation route is taken, the information on radar coordinates is placed in display coordinates and either discarded as noise or, if interpreted as a signal by the computer, a new track is placed in storage and a new track number assigned. This complete cycle of processing and evaluating radar data is completed in a matter of seconds.

Using the manual initiation route, the operator can indicate the location of the track to be stored by placing a gun-like light source over the track on the crt display. A grid behind the screen translates the light point into coordinates for the computer. This method is used when weather conditions or noise present a large number of signals in the area of the track.



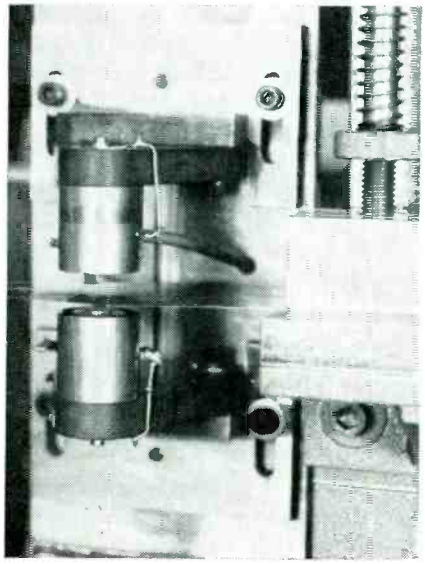
Three-dimensional ferrite-core array is used for radar track information storage



Thickness gage for copper strip has accuracy of 2 percent of full scale

Noncontacting Gages for Nonferrous Metals

SUMMARY —— Two thickness-measuring circuits gage copper and aluminum from 0.003 to 0.5 in. thick by electromagnetic absorption. Copper strip passing pickup head is gaged and recorded at rate of 300 feet per minute



Transmitting and pickup heads for noncontacting thickness gage are made from 5,000-ohm relay coils

By ROBERT B. COLTEN

Senior Project Engineer
Process Development Section
General Motors Corp.
Detroit, Mich.

IN A SEARCH for a noncontacting method of measuring the thickness of dead-soft copper strip a useful gaging technique for nonferrous materials has been developed. Measurement is based on the electromagnetic energy absorption phenomenon known as skin effect.

When a conducting material is placed in an alternating magnetic field eddy currents are induced in it. These induced currents are greatest at the surface, decreasing exponentially with depth. The depth at which the magnitude of the current has decreased to $1/e$ or 37 percent of its value at the surface is known as the skin depth. Figure 1 shows the calculated values of current ratio versus depth for copper at three frequencies, and the skin depth for each. These curves fit measured values very closely.

The current at depth Z is related to the current at the surface of the material by

$$\frac{I_z}{I_s} = e^{-\frac{z}{\delta}} \qquad (1)$$

where I_z is current at depth Z in

centimeters, I, is current at surface and ϵ is skin depth in centimeters. The skin depth ϵ can be computed from

$$\epsilon = \frac{1}{2\pi}\sqrt{\frac{\rho\,(10^9)}{\mu f}} = 5{,}033\sqrt{\frac{\rho}{\mu f}} \quad (2)$$

where ρ is resistivity in ohms per cu cm, f is frequency in cps and μ is the permeability of the material.

Equation 1 is usually recognized as valid only when the effective thickness of the conductor is more than three or four times the skin depth. However, in the case of the copper strip, this equation seems to hold true for the case where the thickness of the material is only about one-eighth of the skin depth value.

The photograph shows copper strip being gaged between two 5,000-ohm iron-core relay coils. The copper is between 0.003 and 0.006 inch thick and passes the sensing head at about 300 feet per minute. One coil is excited with a 6,000-cps signal and the other receives the energy not absorbed by the copper. The thicker the copper, the less current induced in the receiving coil. Power output required for this thickness of copper is about one watt.

The circuit of the copper gaging unit is shown in Fig. 2. It consists essentially of an oscillator and a vacuum-tube voltmeter. Tube V_1 is a twin triode in a simple version of the Wien-bridge oscillator which provides adequate frequency and amplitude stability. The frequency is determined by the values of $R_1 = R_2$ and $C_1 = C_2$ where $f = 1/(2\pi R_1 C_1)$. These components should be of sufficient quality to retain their values with temperature change and aging effects.

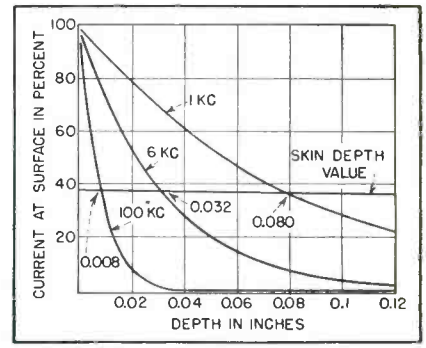


FIG. 1—Calculated skin-depth values for copper at three frequencies

This oscillator is amplitude-stabilized by negative feedback, by the regulating effect of the lamp in the first cathode circuit and by degeneration in the second cathode circuit.

A buffer power amplifier stage, V_2, excites the transmitting coil. The cathode of this stage is unbypassed to increase stability and compensate for tube aging. To get fine control of output, necessary for accurate calibration of the gage, only part of the grid resistor is adjustable.

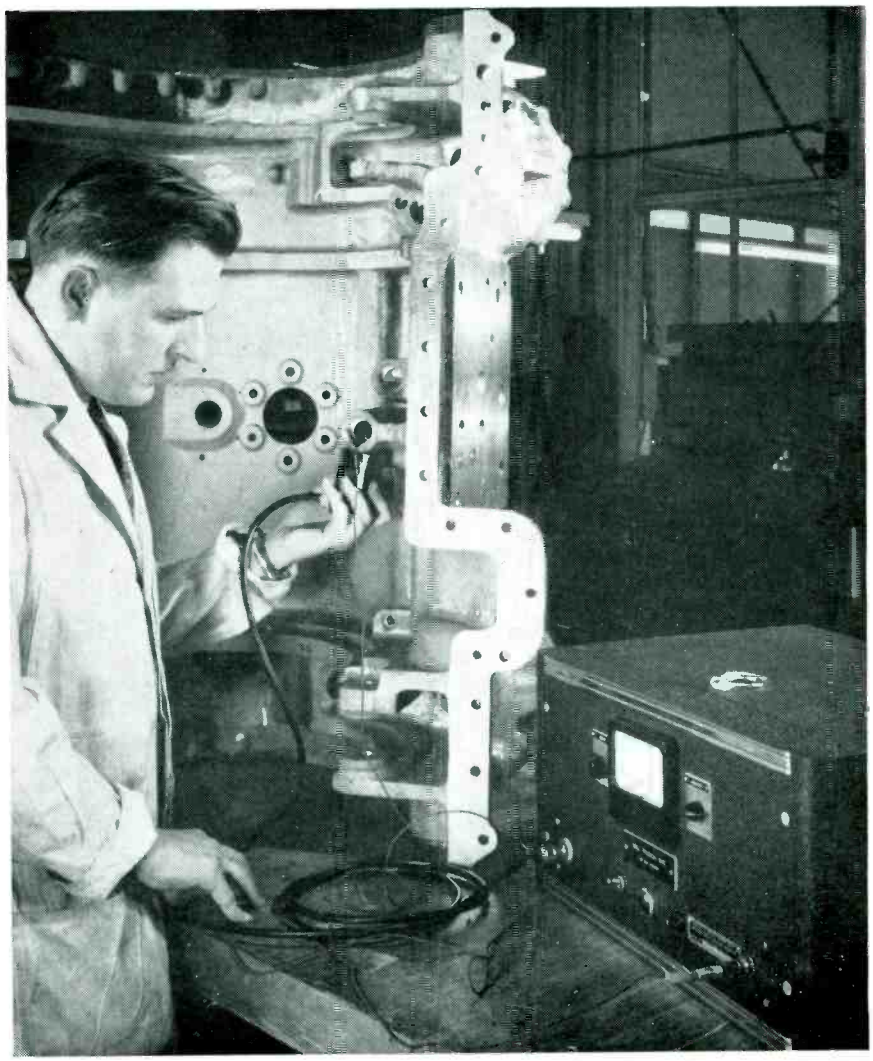
Measuring Circuit

The receiving coil is connected directly to the grid of a high-gain pentode amplifier V_3. Capacitors in this stage were selected to get poor low-frequency response, eliminating the problem of ac-pickup. Voltage-doubler rectifier V_4 converts the 6,000-cps signal into a d-c voltage which is a function of the thickness of the copper. This voltage is of the order of 100 volts, and it is desired to observe changes of a few volts for the full range of measurement. This was accomplished by comparing the output of V_4 with a reference voltage.

Tube V_5 has a conventional balanced-plate voltmeter circuit except that the cathodes are connected to a reference voltage instead of ground. A strip-chart recorder is used with a 0-1 milliampere movement. Accuracy of gaging is approximately ±2 percent of full scale.

Aluminum Gaging

A second application of the same principle has been made to measurements of wall thickness of cored



Gage for aluminum has 5-watt output for measuring castings from ⅛ to ½ inch thick. Transmitting coil is shown inserted in screw hole

holes in large aluminum castings. The range of thickness covered is roughly from $\frac{1}{8}$ to $\frac{1}{2}$ inch.

A frequency of 18 cps is used with an output power of 4 to 5 watts to get enough energy through the thicker material being measured.

Figure 3 shows the circuit of the aluminum thickness gage. Tubes V_1 and V_2 are two pentodes in a Wien-Bridge oscillator circuit essentially similar to V_1 of Fig. 2. Power amplifiers V_4 and V_5 are connected in push-pull to excite the transmitter coil.

The transmitter coil consists of 2,000 turns of No. 30 enameled wire on a U-shaped core made up of transformer lamination stock. The core thickness is approximately $\frac{1}{2}$ in. by $\frac{1}{2}$ in. The legs are 2 inches apart and about 2 inches long. The receiving coil is wound with No. 38 wire on a soft steel bobbin $\frac{1}{4}$ in. in diameter and $\frac{3}{4}$ in. long. The bobbin is scramble-wound and potted. The transmitting coil is connected to the cathodes of V_4 and V_5, providing impedance matching without the use of an output transformer.

Phase inverter V_3 feeds the grid of V_5 with a signal identical to that on the grid of V_4 but 180 degrees out of phase. Potentiometers R_1 and R_2 are adjusted to equalize the signals on the grids of V_4 and V_5. These tubes are biased by a tap off their respective cathode resistors.

Decoupling

Precautions were taken to decouple the B + sources of various stages to prevent motor boating. Examples of this technique are the combinations of R_3 with C_1 and R_4 with C_2. Likewise, R_5 and the power supply filter capacitor decouple V_4 and V_5 from the rest of the gaging circuit.

The pickup coil is connected to a simple a-c vacuum-tube voltmeter. This circuit consists of a two-tube amplifier with a milliammeter in a plate-to-cathode feedback circuit. This simple and stable vacuum-tube voltmeter circuit performed well here.

This measuring technique is also applicable to ferrous materials but is less satisfactory due to the variation in magnetic effects resulting from differences in chemical composition and metallurgy.

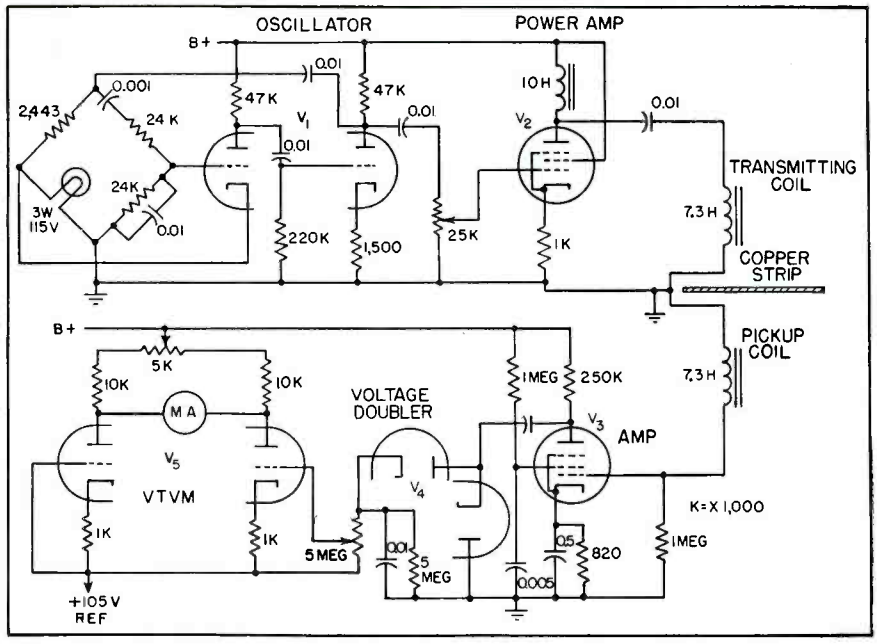


FIG. 2—Copper-strip thickness gage can measure metal moving at 300 ft per min

The author wishes to thank General Motors and G. R. Fitzgerald, director of process development, for permission to publish this material. A considerable portion of the work on the two circuits discussed was done by P. J. Willson and R. B. Allured.

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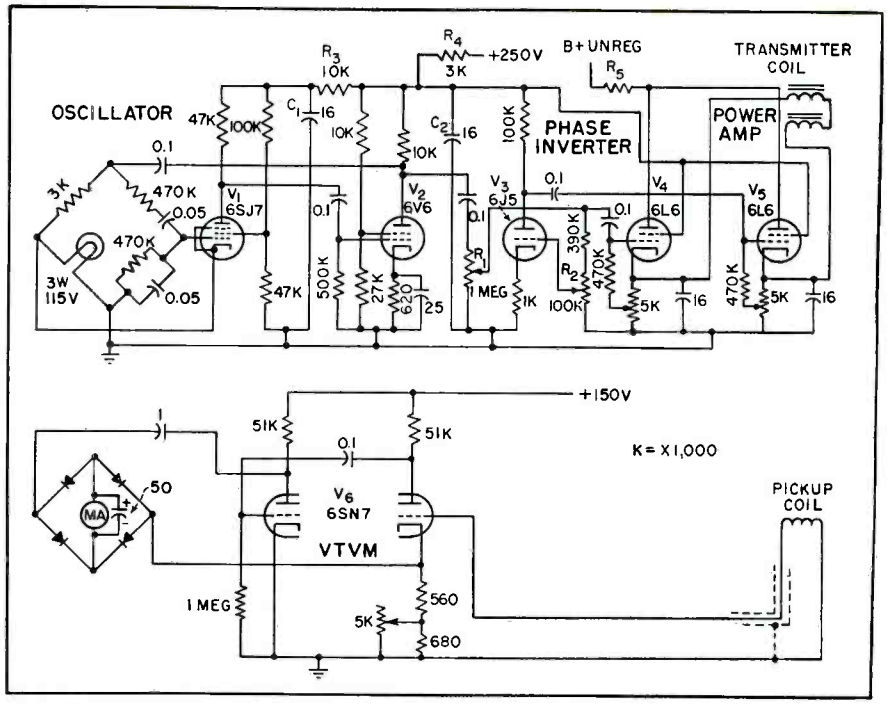

FIG. 3—Aluminum gage used for measuring castings from ⅛ to ½ inch in thickness is a higher power version of copper gage

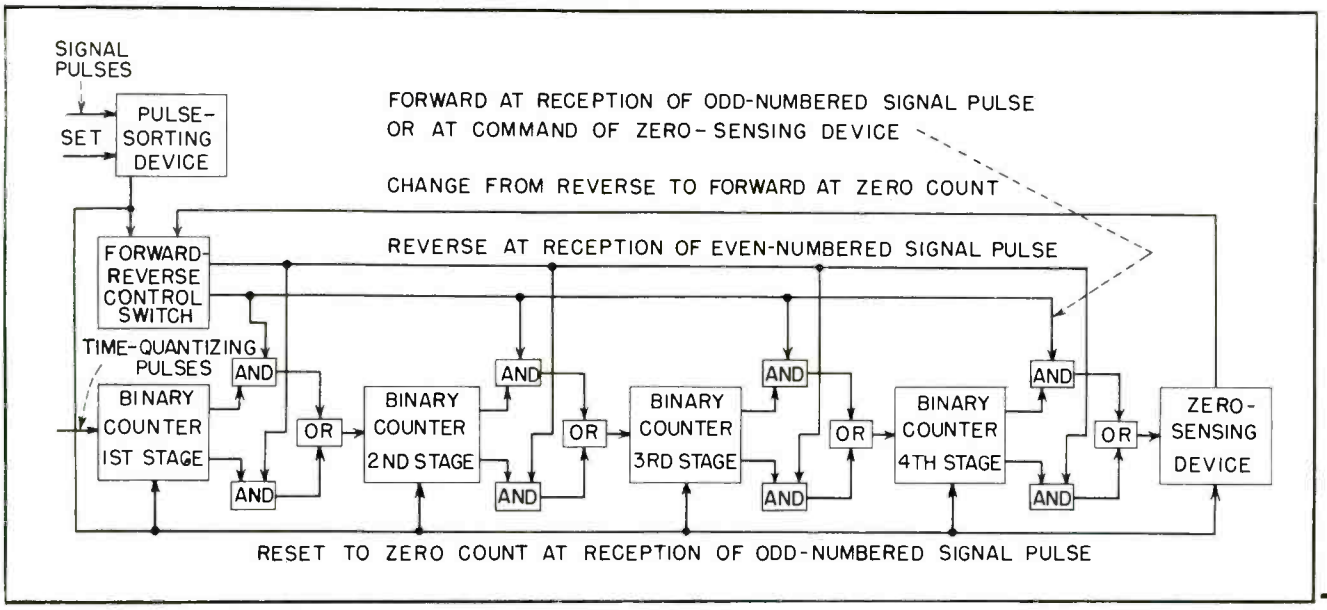

FIG. 1—Block diagram of reversible binary counter using surface-barrier transistors

High-Speed Counter Uses

SUMMARY — Characteristics of surface-barrier transistors permit design of a 6-mc reversible binary counter used in pulse-code modulation to determine the variation in pulse count between successive groups of pulses. This fluctuation carries the intelligence being transmitted

MODULATION in the pulse repetition rate of a received ensemble of signal pulses can be determined by measuring the time interval between successive pulses.

For the quantization of such time intervals, a series of pulses is started at the end of each received pulse and ended at the beginning of next received pulse. A high-speed reversible binary counter is then employed to count the number of these time-quantizing pulses. If the resulting counts vary more than a predetermined amount, then modulation is said to exist.

If several groups of pulses are fed into this counter, it is able to count the number of pulses in the first group and then subtract from the sum the number of pulses in the second group. The result is the difference in number of pulses between the two groups regardless of which group has the larger number of pulses. For the third and fourth groups the same process will be repeated, and so on. The percent fluctuation between successive pulse intervals is analyzed in this way.

The surface-barrier transistor was chosen for this counter because it has the highest alpha cut-off frequency, f_{α}, among all the alpha-less-than-unity transistors presently available. With such a transistor attention can be directed entirely to the passive circuit elements to achieve high-speed counting.

Operation

The highest speed at which this counter has been operated is 6 megapulses per second. This was the fastest repetition rate obtainable from the breadboard pulse generator.

A block diagram of the counter is shown in Fig. 1. Seven flip-flop circuits are employed in this counter. They are the four counting stages, the zero-sensing and the pulse-sorting devices and the forward-reverse control switch (or simply the switch). Basically these seven circuits are identical. Only minor differences in the arrangement of power supplies and input circuits exist among them. In addition, there are eight *and* circuits and four *or* circuits. Two *and* circuits and one *or* circuit form an *and-or* group between some of the flip-flops.

Among the six *and* circuits between the four counting stages, three are for forward counting while the other three are for re-

By EUYEN GOTT

Research Associate, Radiation Laboratory
Institute for Cooperative Research
The Johns Hopkins University
Baltimore, Maryland

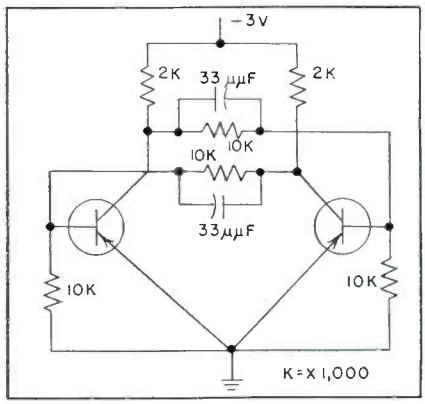

FIG. 2—Flip-flop transistor circuit which is essentially Eccles-Jordan multivibrator

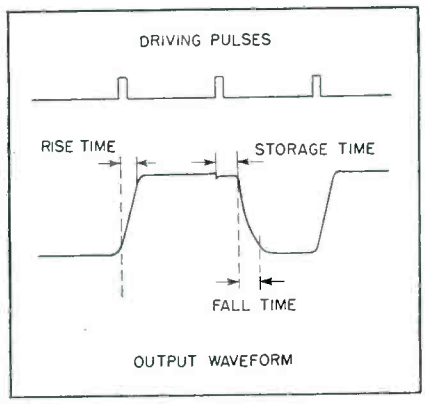

FIG. 3—Time relationship between the driving pulses and the output waveform

Surface-Barrier Transistor

verse counting. The remaining *and-or* circuit cooperates with the zero-sensing device to change reverse counting to forward counting as soon as the reverse count reaches zero. This is necessary whenever the number of pulses during a reverse count is greater than that of an immediately preceding forward count. In this way, the number remaining in the counter at the end of a reverse count is always the difference number between the preceding two groups of pulses. It is not necessary to indicate whether the difference is positive or negative, although this can be done readily.

When the zero-sensing device decides that it is necessary to change from reverse to forward, it sends a pulse to trigger the switch which immediately changes the conditions at all the *and* circuits. The zero-sensing device cannot make the switch change from forward to reverse. On the other hand, at the command of the pulse-sorting device, the switch does change from forward to reverse and vice versa.

The pulse-sorting device separates the signal pulses into two groups, the odd-numbered and the even-numbered ones. At the reception of an odd-numbered pulse, this device resets all the counting stages simultaneously to the odd state. At the same instant, it drives the switch to the forward state. For an even-numbered pulse, it merely passes the pulse on to the switch to reverse the condition.

Flip-Flop Circuit

The fundamental arrangement of a flip-flop circuit is shown in Fig. 2. It is essentially an Eccles-Jordan type bistable multivibrator, except that surface-barrier transistors are used instead of vaccum tubes.

There is no need to apply any

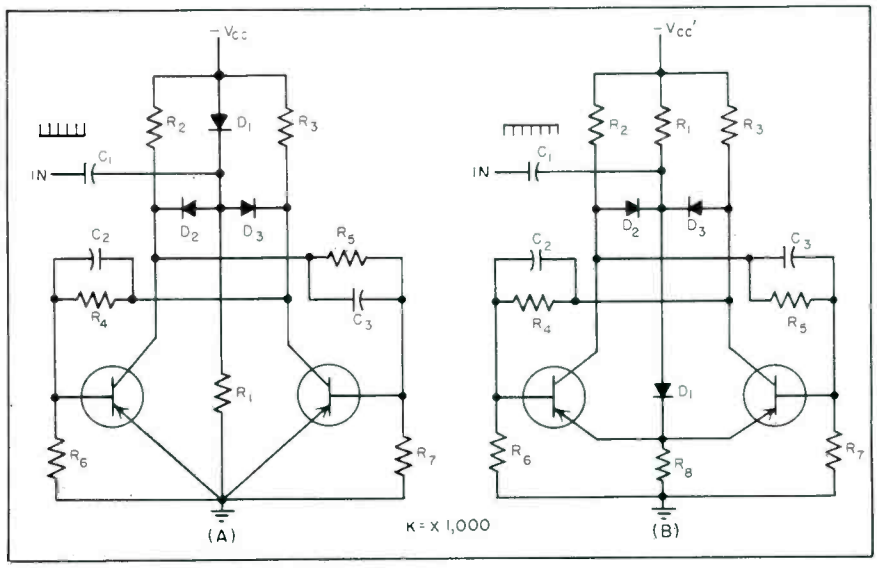

FIG. 4—Collector-driven flip-flop with positive input pulses (A) and negative input pulses

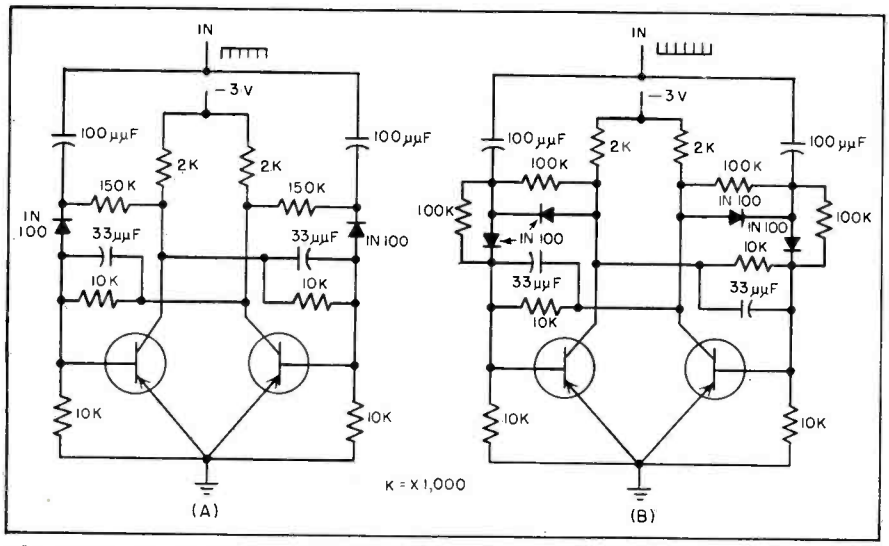

FIG. 5—Base-driven flip-flop with negative input pulses (A) and positive input pulses (B)

bias voltage to the base terminals of the two transistors. No advantage can be gained by inversely biasing the emitter diode of the off transistor, in which collector current is approaching zero. In fact, it is easier to drive a transistor from *off* to *on* or *on* to *off* if its emitter diode is always biased in the forward direction.

Figure 3 shows the time relationship between the driving pulses and the output waveform of a flip-flop when the *on* transistor is highly saturated. There is a considerable time lapse between the occurrence of the second driving pulse and the time when the output waveform starts to fall. It is due to the storage of minority carriers in the base region. This time varies with the degree of saturation of the collector diode. It can be reduced to zero by designing the circuit such that the *on* transistor will stay in the active region, instead of going into the saturation region of the transistor.

Surface-barrier transistors can be operated at very high frequencies even when driven into saturation. In general, therefore, the simple fundamental circuit should always be used. For interchangeability of transistors, one must employ $\beta = 10$ in design formulas. In the special case when exceedingly fast operation is required, high resistance in the cross-coupling network should be used to reduce the storage time. In addition, let $\beta = 20$ (this assumes that a higher percentage of transistors would have a β close to 20) and restrict this circuit to those selected few transistors with β close to this value.

To reduce the storage time still further, a driving pulse with an amplitude higher than necessary can be used for triggering the circuit. In this way, not only the storage time, but also the rise time and the fall time are reduced.

Rise time and fall time can be further reduced by careful circuit layout during construction and the use of miniature components and plastic chassis, so that the capacitance between collector, base and ground is at a minimum. The col-

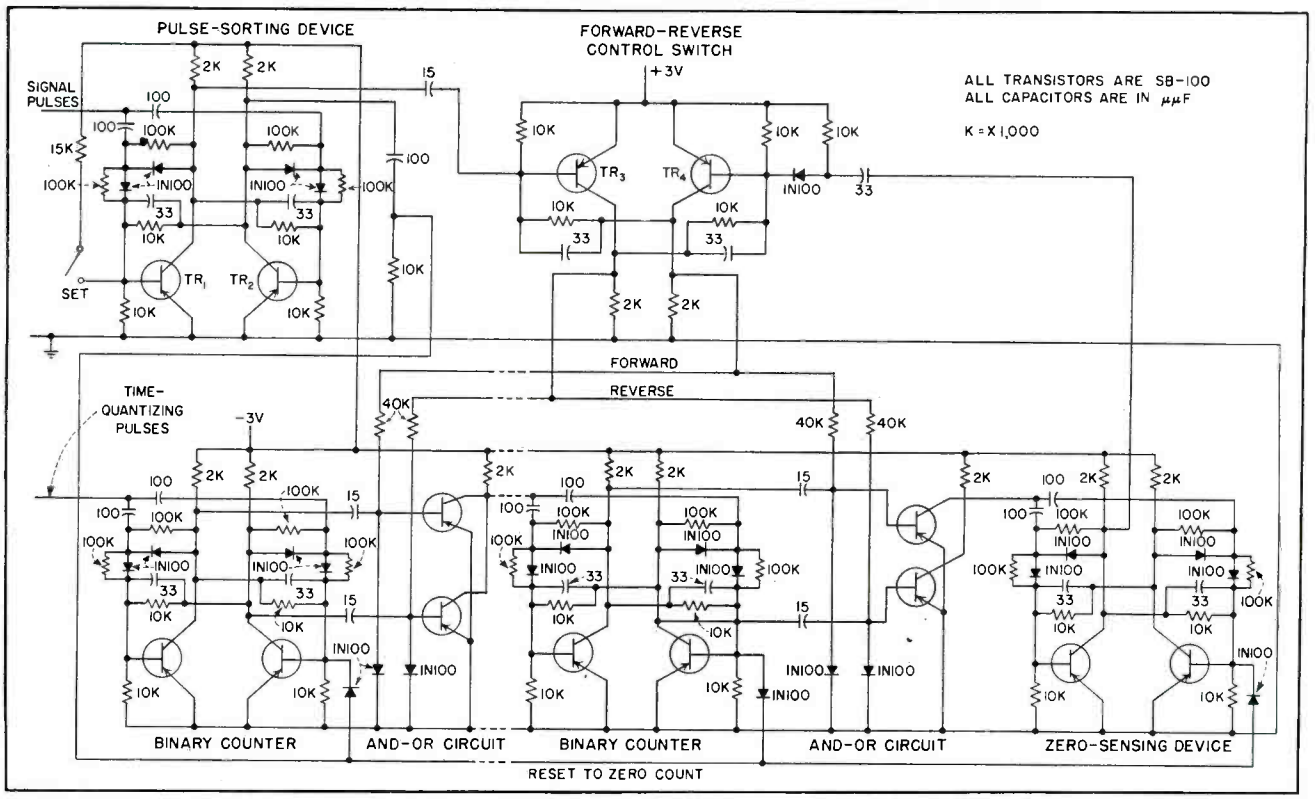

FIG. 6—Complete schematic of the high-speed reversible binary counter. Operation of this counter includes adding, subtracting, zero-sensing, pulse-sorting and switching

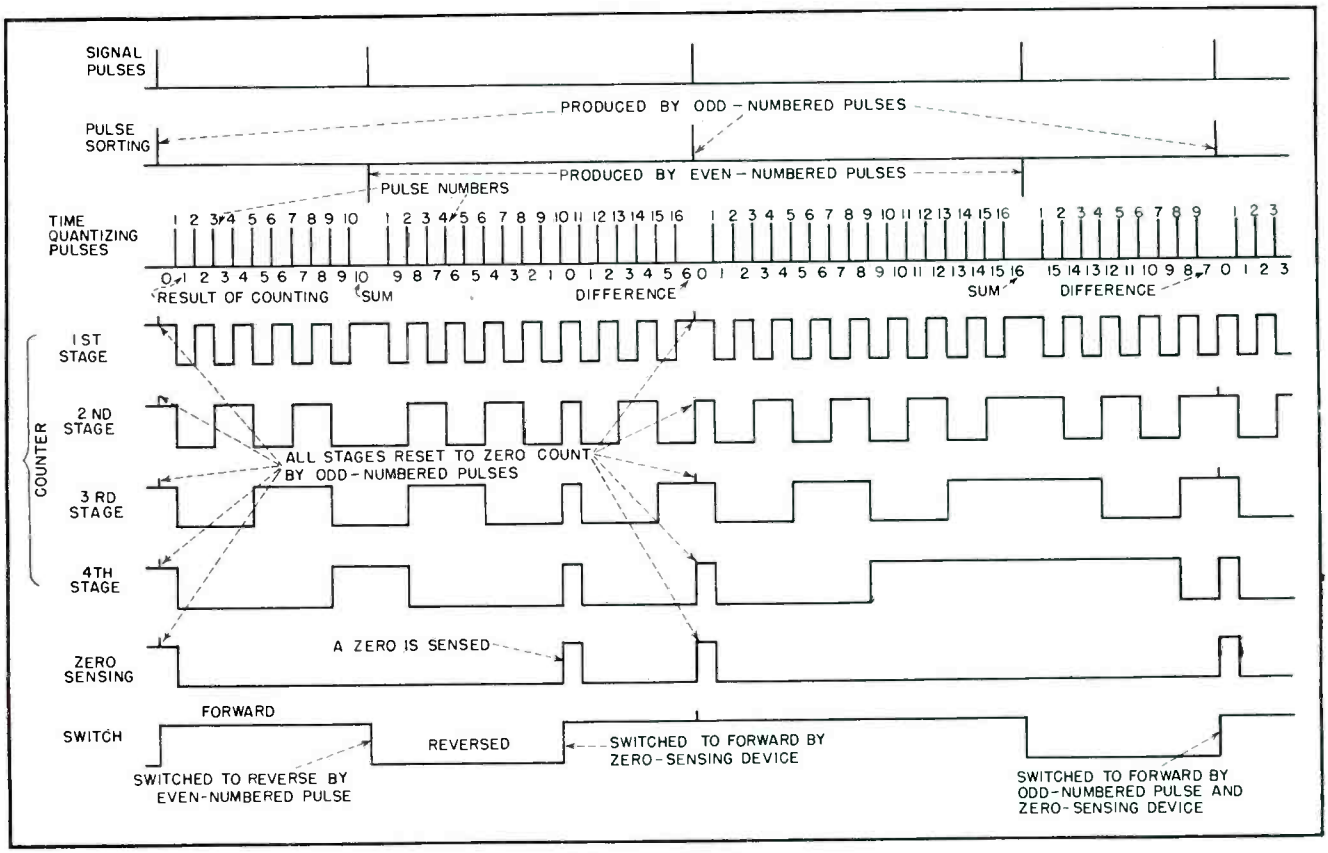

FIG. 7—Waveforms taken at various points in the circuit of the reversible binary counter

lector resistors should also be as small as possible without exceeding the current limit of the transistor.

It is always easier to drive a flip-flop if the circuit has reached its steady state. This necessitates the use of smaller cross-coupling capacitors, provided they are not so small as to impede the regeneration needed for proper functioning of the circuit.

Input Circuits

Several arrangements of the input circuits using steering diodes to relax the input requirements are shown in Fig. 4 and 5. For collector-driven flip-flops (Fig. 4), positive pulses are preferable for surface-barrier or any *pnp* transistors. If negative pulses are used, resistor R_s should be connected between the emitters and ground as in Fig. 4B, otherwise the driver would be heavily loaded by the conducting transistor before any trigger action takes place. Resistors R_1 in Fig. 4 are inserted as a d-c path for a steady current to flow through the conducting diodes. This reduces the dynamic resistance so that the circuit may be more sensitive.

For high-frequency operation, diode D_1 is necessary to provide a quick-charging (Fig. 4A) or discharging (Fig. 4B) path for input capacitor C_1. Thus the correct biasing voltages for the two steering diodes can be maintained. Without D_1, the sensitivity of the circuit will be decreased considerably when the pulse repetition rate is increased. An alternate method is to make the time constant, R_1C_1, small compared with the shortest interval between pulses. This method reduces the sensitivity at low frequencies.

Sensitivity

As a rule, base-driven flip-flops are far more sensitive than the collector-driven ones, but a different way of biasing the two diodes must be used here. If the two diodes are connected together as in the case of the collector-driven flip-flops, the range of usable input-pulse amplitude is vary small. This is due to the small difference in voltage between the two bases.

A better way is to make use of the collector voltages for biasing the two diodes, as shown in Fig. 5. For negative input pulses the circuit is simpler, as in Fig. 5A, but its sensitivity gradually decreases as the pulse repetition rate increases. If the input pulses are positive, it is necessary to use two diodes in series between collector and base instead of one diode and one resistor to match the sensitivity of the circuit in Fig. 5A.

Two resistors, each in parallel with one diode, are added to the circuit as shown in Fig. 5B. This is made necessary by the fact that the voltage division between two diodes of the same type connected in series is unpredictable when they are inversely biased with a small voltage (about 2 volts in this case). The resistor used is small compared with the backward resistance of the diode, and yet so large as not to

Table I—Number Representation

Numeral	Code	Numeral	Code
zero	1111	eight	0111
one	0000	nine	1000
two	0001	ten	1001
three	0010	eleven	1010
four	0011	twelve	1011
five	0100	thirteen	1100
six	0101	fourteen	1101
seven	0110	fifteen	1110

put an appreciable load between collector and base.

This circuit is sensitive to 0.5 volt of input pulse amplitude, but pulses up to 4 volts can also be used. These limits are practically constant over the whole range of pulse-repetition rate. The output wave has an amplitude of about 2.5 volts.

It is also possible to trigger the circuit in Fig. 5B with negative pulses. In this case, the sensitivity is low and the loading of the driver is considerable. Since such a possibility exists, precautionary measures must be taken to insure that no strong negative overshoots are present with the desired signals.

And-Or Circuit

The schematic of the *and-or* circuit can be seen in Fig. 6. Owing to the high speed required for changing from forward to reverse and vice-versa, any integrating effect on the square wave coming from the switch must be reduced to a minimum. Hence, coupling capacitors of small capacitance are used. The diode, which is never cut off unless a pulse comes from the preceding stage, further reduces the integrating effect of the capacitor. The switching time of this *and-or* circuit is approximately 0.4 μsec.

Because of the attenuation of the small coupling capacitor, a pulse amplifier is necessary to boost the signal before applying it to the input circuit of the next stage. A surface-barrier transistor in the configuration of a grounded-emitter amplifier is used. This amplifier derives its bias voltage from the square wave of the switch and is biased highly beyond cutoff for a half-cycle and slightly beyond cutoff for the other half-cycle. The input of this amplifier is a part of the *and* circuit while its output, sharing a common load with another amplifier, is a part of the *or* circuit.

Switch

Figure 6 shows the forward-reverse control switch and its input circuits in the complete reversible binary counter. Because of the bias requirements of the *and-or* circuits, the power-supply connection of the switch is different from the rest of the flip-flops. The collector resistors and the negative terminal of the power supply are grounded, while the positive terminal of the power supply is connected to the emitters and the base resistors.

The switch does not have any of the input circuits mentioned previously. Instead, the base-terminal of TR_3 is connected to the pulse-sorting device while that of TR_4 is connected to the zero-sensing device. The square wave generated by the pulse-sorting device is first differentiated; the resulting positive and negative pulses drive the switch off and on. As for the zero-sensing device, due to the presence of the diode only positive pulses can come to the switch and drive it off. The negative pulses are not used.

Pulse-Sorting Device

In addition to driving the switch, the pulse-sorting device also drives all the counting stages and the zero-sensing device simultaneously. It uses the same kind of circuit as that between the zero-sensing device and the switch.

A pulse generated by any of the counting stages as a result of being triggered by the pulse-sorting device must not have any effect on the next stage. Otherwise, dependable results cannot be obtained from the zero-resetting process. Thus, the pulses generated by the pulse-sorting device must have a longer duration compared with those at the output of the *or* circuits. This is done by employing a bigger RC time constant for the differentiating circuit at the output of the pulse-sorting device. In this way, the pulse-sorting device can hold all the other flip-flops under its control until the transients have practically ceased.

A set button is provided at the base terminal of TR_1 of the pulse-sorting device. A push of this button insures that the whole circuit is in a condition suitable for the reception of signal pulses.

Zero-Sensing Device

The zero-sensing device is identical to a fifth counting stage. A slightly different system for the representation of numbers must be employed so that it can be used for zero-sensing. In this system, zero is represented by 1111 instead of the conventional 0000. A complete list from zero to fifteen is shown in Table I.

In this way, during reverse counting the fourth stage will generate a pulse when one is changing to zero. This pulse triggers the zero-sensing device which in turn triggers the switch. During forward counting, the fourth stage also produces a pulse for a change from zero to one, and triggers the zero-sensing device. This time the pulse at the output of the zero-sensing device has a different polarity and does not affect the switch. The pulses generated by the fourth stage for changes from eight to nine, or nine to eight, do not trigger the zero-sensing device.

The operation of the reversible binary counter can be seen from the waveforms at different points of the circuit as shown in Fig. 7.

Note that the second interval, between the second and third signal pulses, is longer than the first, while the fourth interval is shorter than the third. Thus, the difference in number between the first two groups of pulses is the result of a forward count while that between the third and the fourth groups is the result of a reverse count. If an indicator is connected to and controlled by the switch, the first difference can be shown as positive, while the second one can be shown as negative. In addition, the positive sign remains as long as the counter is adding. It immediately changes to negative when the counter performs subtraction.

Thanks are due to H. Blasbalg and J. H. Park, Jr. for their suggestions and constructive criticisms. The help of F. W. Schaar in the building and testing of circuitry has been invaluable. This work was done with the support of the U. S. Air Force under contract No. AF 33(616)-68.

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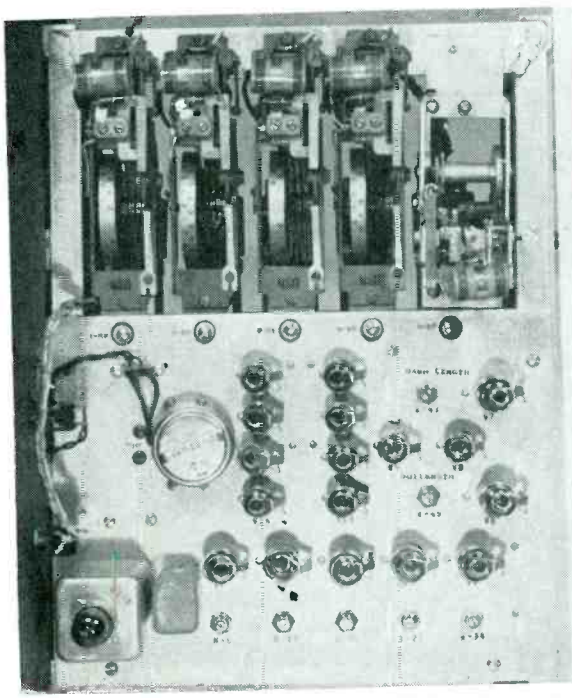
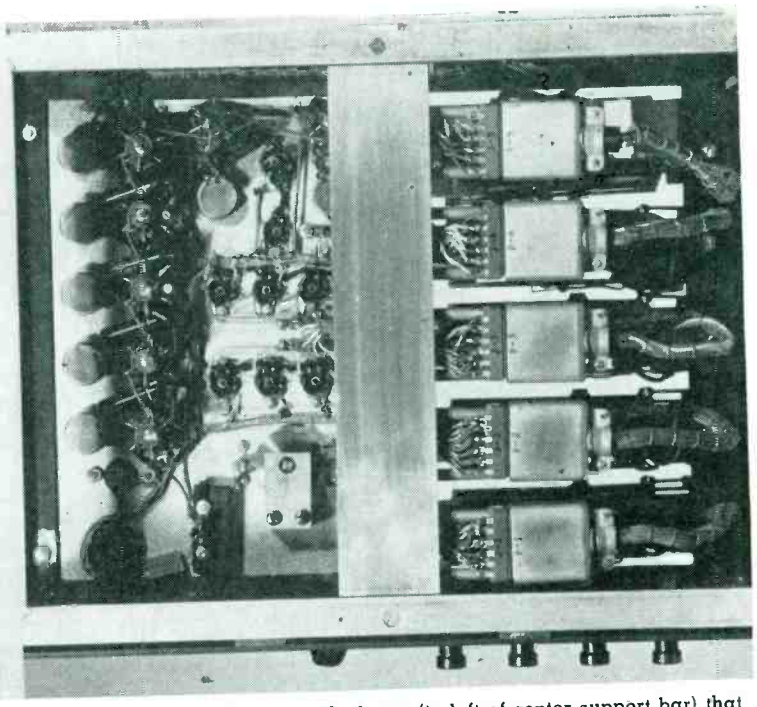


Top of clock chassis shows driver motor (left center) and stepping switches (top)



Underside of chassis shows notched cam (to left of center support bar) that actuates snap-action switches

Time Generator Gives Direct Readout

SUMMARY — Time signals applied to charts or magnetic tape recordings generally indicate accurate intervals of time, but cannot be quickly interpreted in terms of absolute time. This device uses a minimum of equipment to produce coded signals giving 24-hour notation accurate to 6 seconds

By WILLIAM L. BLAIR

Haller, Raymond and Brown, Inc.
State College, Pa.

MANY methods of obtaining relative time intervals are available, but the system described below produces absolute time reference signals. This time signal generator system is an electromechanical device that generates a coded time signal for use in applications where a moderately accurate time reference is required. The signals lend themselves to magnetic tape recording, chart stylus recording, oscilloscope display or for simple audio indication of time.

For example, it might be desired to record police radio transmissions on magnetic tape. A dual-track tape recorder mechanism could be set into operation every time the transmitter carrier is turned on and the voice signal recorded on one track while the time signal is recorded on the other. The result would be a compact record of the exact transmissions and their time.

The time signal is presented as a group of five digits corresponding to the 24-hour clock notation. An example of a sequence of readouts might be 1 1 2 8. 8, 1 1 2 8. 9 and 1 1 2 9. 0.

The digits are produced electronically in the form of an audio tone, keyed according to a modified dot and dash Morse code as follows

Digit	Code	Digit	Code
1	.	6	-
2	..	7	--
3	...	8	---
4	....	9	----
5	.....	0	-----

The system consists of three sepa-

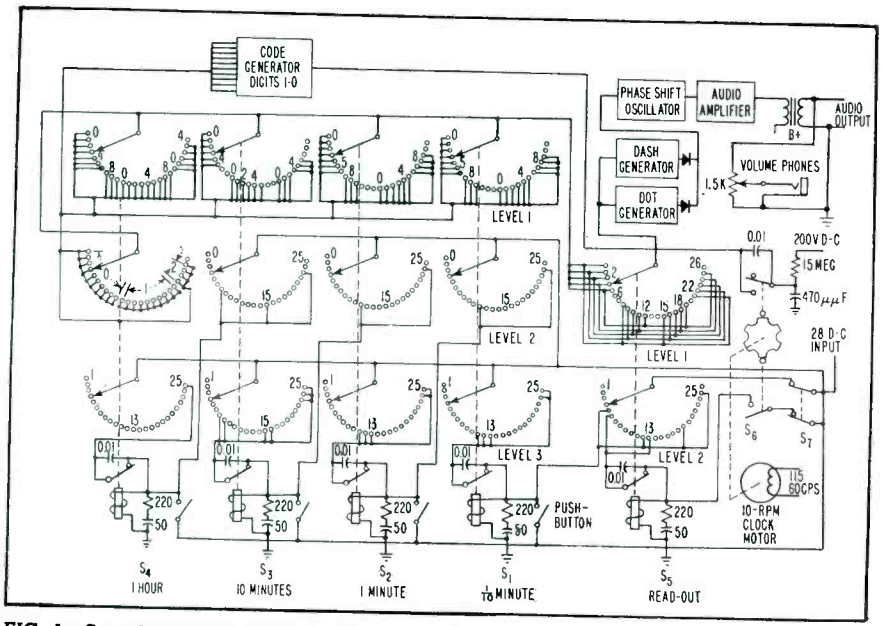


FIG. 1—Stepping switch clock circuit can be driven from power line or through accurate 60-cps standard unit

rate rack-mounted units. The time signal generator contains the time-keeping mechanism and the electronic circuits that produce the digit codes. The power supply delivers 200 volts at 65 milliamperes and 28 volts at 1 ampere.

The third unit of the system is a standard frequency power supply, manufactured by American Time Products, Inc., which delivers 115 volts, 60 cps, at 10 watts, with a frequency accuracy of 0.001 percent. It drives a synchronous motor in the time signal generator when the supply line frequency is not accurate.

Basic Driver

The synchronous motor accomplishes the basic timing within the system. The choice of operating it from the line or from the frequency standard is made by a switch located on the front panel of the time signal generator. The output of the motor is geared down to 10 rpm and turns a cam. This cam has cut in its surface six notches of equal width spaced at 60-degree intervals around the periphery.

Two switch actuators ride on the surface of the cam. Each switch closes when the actuator falls into a notch. These snap-action switches are so placed that one circuit is completed and broken a fraction of a second before the other is completed. The first circuit to close advances the first stepping switch of the time-keeping mechanism. Closing the second circuit, triggers the electronic code generator. Since the cam makes one revolution every 6 seconds (1/10 minute) and there are 6 notches in the cam, each pair of contacts completes a circuit once each second.

The time-keeping mechanism (Fig. 1) consists of four stepping switches, S_1 through S_4, which register the accumulation of time and a fifth stepping switch, S_5, which accomplishes the function of sequential read-out of the first four. The two-level, 26-position S_5 is advanced once each second by the action of S_6 riding on the timing cam.

Each time S_5 completes a group of six steps it supplies, through its second level, a trigger pulse to S_1, which advances one step to record the accumulation of 6-second groups or tenths of minutes. When S_1 completes ten steps, the equivalent of 60 seconds, it in turn supplies a trigger pulse to S_2.

An accumulation of minutes up to ten is registered on S_2 at which point a pulse is sent to S_3 that records groups of 10 minutes up to six. After S_3 has advanced six positions, the equivalent of 60 minutes, a pulse is sent to final stepping switch S_4, which records hours. Since none of the stepping switches has an integral multiple of ten or six positions, the last level in each switch provides for self-stepping to make up for the difference.

When the right-hand clock motor input switch S_7 is turned off it interrupts the trigger pulse from cam-driven S_6 to S_5 and permits the stepping switches to be set individually by pushbuttons.

Levels 1 and 2 of S_5 and level 1 of S_1, S_2 and S_3 each select the proper coded digit, which is produced once each second by the code generator and connect it to level 1 of S_6. Level 1 of S_5 then accomplishes the read-out function. It

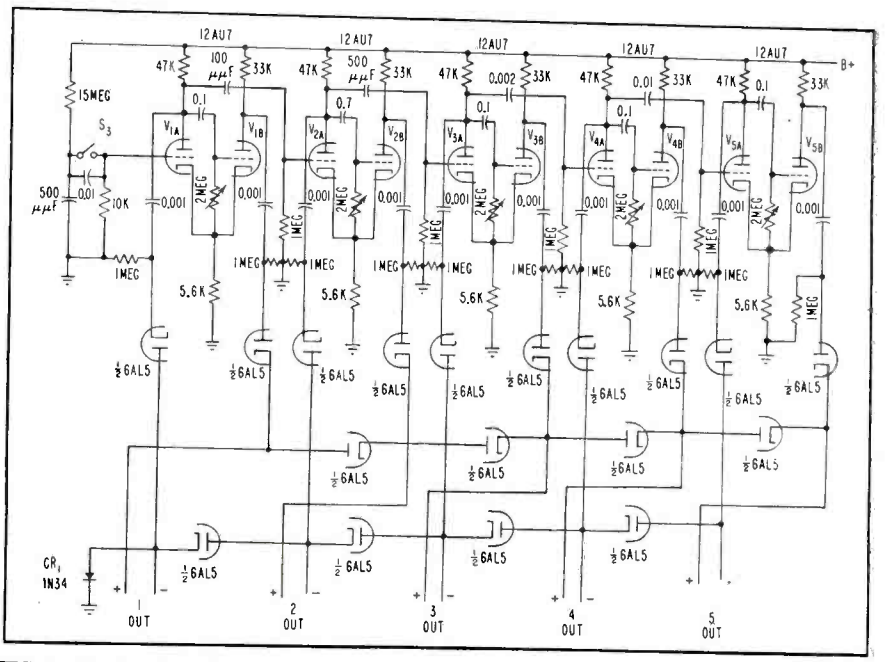
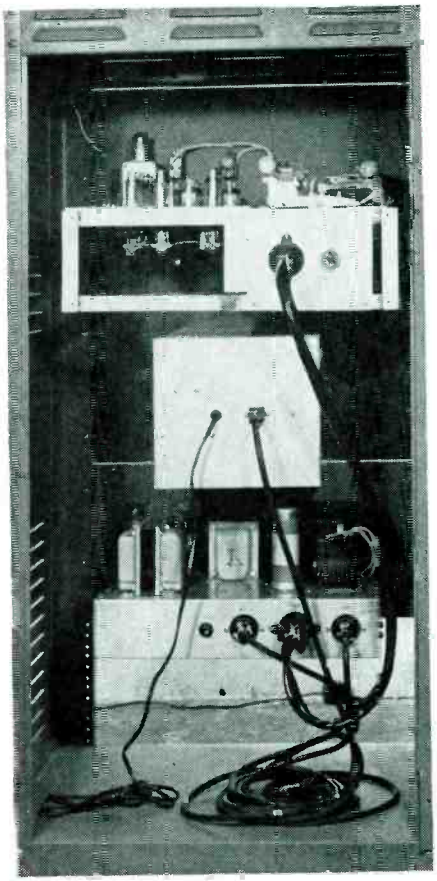


FIG. 2—Electronic code generator produces a series of impulses having either polarity and later modified



Rear view of equipment as set up for use in relay-rack cabinet

listens for 1 second to the levels of the other switches in proper digital sequence with the result that its wiper arm carries the five digits of time information within a total time interval of 5 seconds. Since 0.1 minute equals 6 seconds, there is then silence for 1 second before the next read-out begins.

Code Generator

The electronic code generator is fairly simple in principle. Its operation is explained by reference to Fig. 2. In producing the codes for the digits, positive pulses, (later converted to dots for digits 1 to 5) and negative pulses (converted to dashes for digits 6 to 0) are developed in a series of five multivibrators, V_1 through V_5.

Five monostable multivibrators are connected so that as one returns to its stable state a positive pulse is fed to the next one in line, causing it to cycle. Thus every time the first multivibrator is triggered by S_5, a chain of events is initiated in which each of multivibrators V_1 through V_5 cycles in sequence down the line. Since the period of each multivibrator is adjusted by a potentiometer to approximately 0.2 second, a chain of cycles is completed within the 1-second interval between triggers.

Pulse Adding

A negative pulse is taken from the (*A*) plate and a positive pulse from the (*B*) plate of each multivibrator, differentiated by an *RC* network and passed through a diode that clips the pulses of undesired polarity. Coupling diodes are placed between the five outputs carrying positive pulses and between the outputs carrying negative pulses. These coupling diodes pass the pulses to the right in each case, but not to the left.

Therefore, pulses are added in outputs to the right in proportion to the number of outputs preceeding it. For example, at the output marked +4, four positive pulses appear in each 1-second interval and are spaced about 0.2 second apart. These are the pulses produced by V_1, V_2, V_3 and V_4. The diodes just to the right of output +4 keep the pulse of V_5 from appearing in output +4.

Ten outputs from the code generator, each with a different number of either positive or negative pulses, correspond to the digits from 0 to 9. These are connected in parallel to the first level of each stepping switch so the wipers contact each digit in proper sequence.

Dot-Dash Conversion

After the digits have been read out by S_5, the positive and negative pulses must be converted to dots and dashes respectively. This step is accomplished with two monostable multivibrators, V_6 and V_7, whose inputs are combined as shown in Fig. 3. One multivibrator cycles only on positive digit pulses and the other only on negative pulses.

It is possible for the positive pulse appearing on the plate of V_{7B}, when it returns to its stable state following a cycle, to trigger the grid of dot generator V_6. For this reason, crystal diode CR_1, in Fig. 2, is connected from the negative side of output 1 of the code generator to ground. With respect to positive pulses this point is common with all outputs 6 through 0.

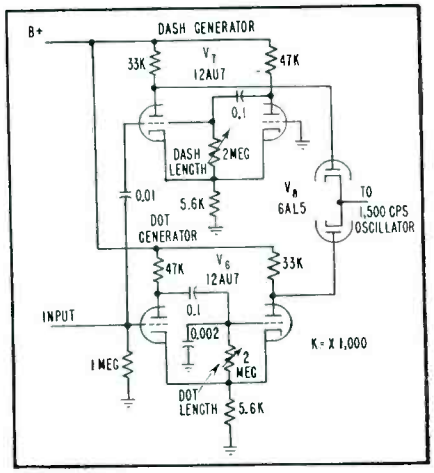


FIG. 3—Dots or dashes are generated depending upon input polarity

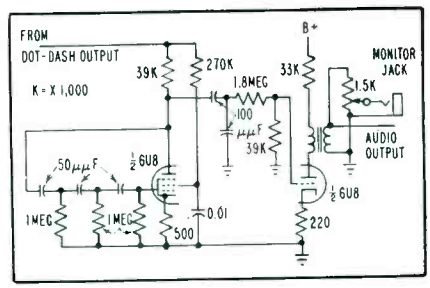


FIG. 4—Audio oscillator and amplifier for 1,500 cps

Consequently, whenever the dot and dash generator input is connected to any digit from 6 through 0 the positive pulse that would otherwise trigger the dot multivibrator when the dash multivibrator returns to its stable state is passed to ground through this diode.

The period of the dot generator, which is adjusted by the dot length control, is made short compared with that of the dash generator. The dash length control adjusts the period of the dash generator. The outputs from these multivibrators are coupled through diodes V_{8A} and V_{6B} so they do not trigger each other.

The rise in plate voltage of the low half of either multivibrator, when it is cycled, is applied to the plate of a phase-shift audio oscillator, shown in Fig. 4, and keys it on and off in the special code system. The frequency of this oscillator is approximately 1,500 cps. The second half of the tube is a standard audio output amplifier.

The author expresses appreciation to David E. Harris and John C. F. Walker, III, for helpful suggestions during the development of the time signal generator.

Coupled Cavity Tunes

SUMMARY — Pulsed magnetron for airborne radar tunes from 9,000 to 9,600 mc and delivers 140 kw. Cavity is section of double-ridged waveguide. Micrometer controls tuning plunger. Vane-type anode provides high Q with simple and rugged construction

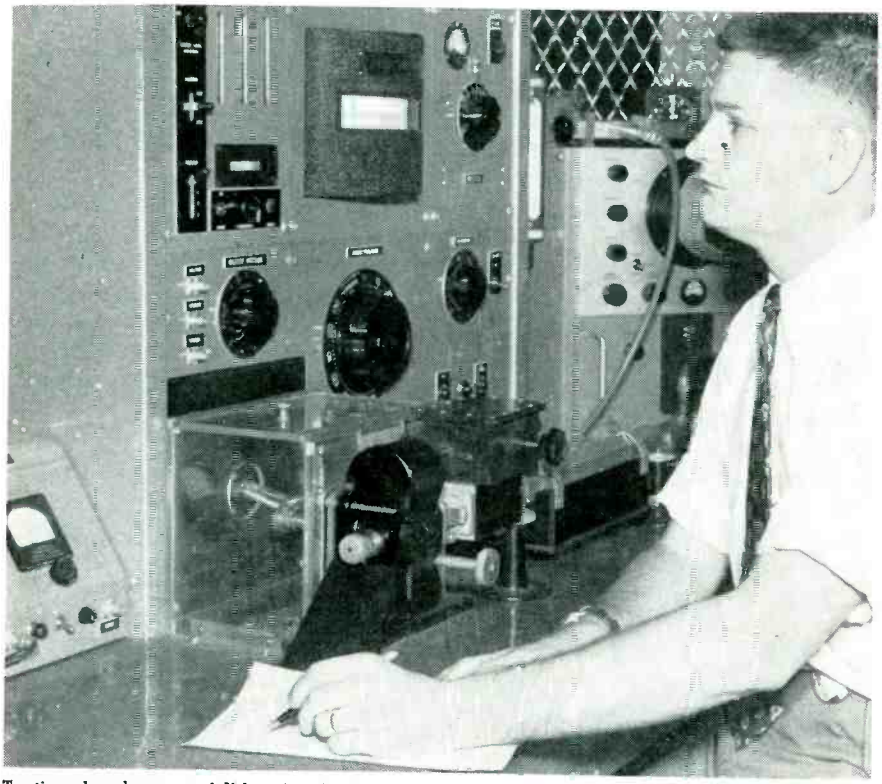
By W. F. BELTZ

Tube Division
Radio Corporation of America
Harrison, New Jersey

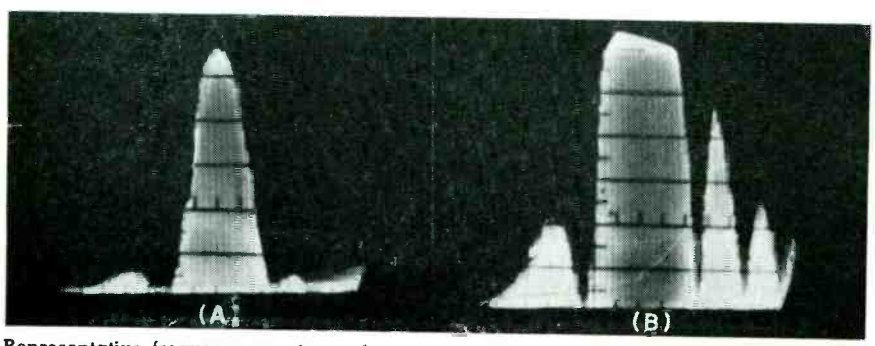
SIMPLE, RELIABLE and efficient tuning of a developmental X-band pulsed magnetron is accomplished by a coupled tuning cavity. The auxiliary cavity, coupled tightly to the magnetron resonator system, determines the operating frequency. The tuning cavity increases the Q of the magnetron and affords stable operation.

Because this construction requires no close spacing between points of high r-f voltage, it elminates the voltage-breakdown problem. There are no extraneous resonances to cause discontinuous operation within the tuning range.

Since the r-f fields become distorted, a drop in electronic efficiency may occur at the low-frequency end of the tuning range. This drop can be minimized by proper design of the tuning cavity. The output coupler can be designed to increase the circuit efficiency as the electronic efficiency decreases, providing a flat power-output curve.



Testing developmental X-band pulsed magnetron



Representative frequency spectrum of magnetron (A) and expanded portion of same (B)

Construction

The vane-type anode shown in Fig. 1A has a slightly higher Q than the hole-and-slot type and is a simple, rugged assembly. The interaction-space dimensions were scaled directly from the 4J50 magnetron. A slight change was made in the end-space dimensions to improve the electronic efficiency.

The tuning cavity is a section of double-ridged waveguide, arranged as in Fig. 1B. Its resonant frequency is varied by adjustment of a short-circuiting plunger at one end of the cavity. A multiplicity of plunger positions, each separated by a half wavelength, will produce the same resonant frequency. The tuning cavity is operated in the $N = 0$ mode to conserve space.

The cathode is an oxide-coated sintered-nickel matrix type. The input connections to the tube are the same as those used in the 4J50. The cathode is supported at both ends of the anode and is capable of withstanding severe vibration and shock. Getters are mounted on the cathode stem to achieve and maintain a good vacuum.

The tube utilizes a standard 1¼ by

X-Band Magnetron

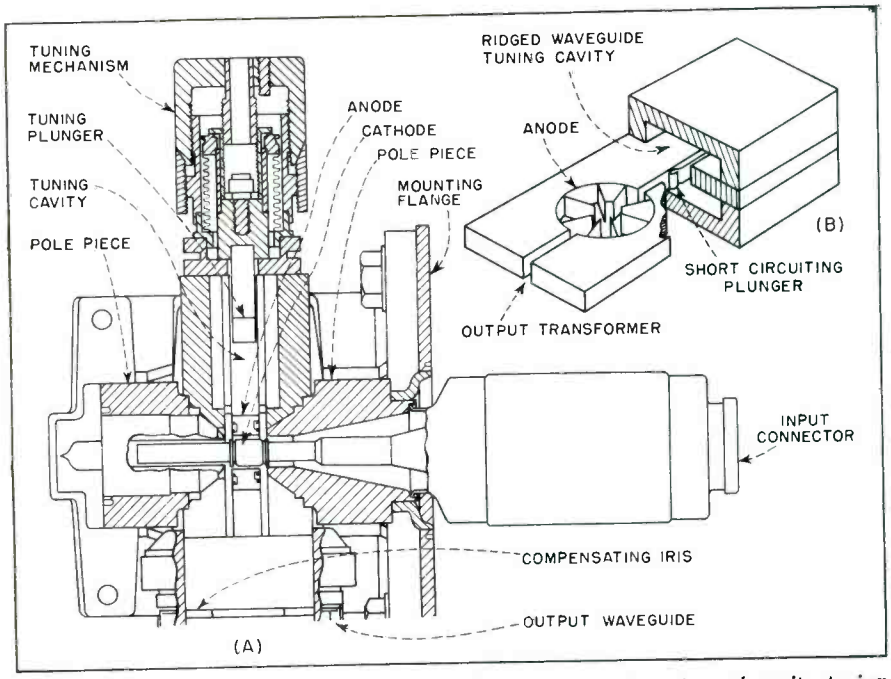


FIG. 1—Cross-section of tunable magnetron (A) and perspective view of cavity tuning arrangement (B) illustrating use of double-ridged waveguide

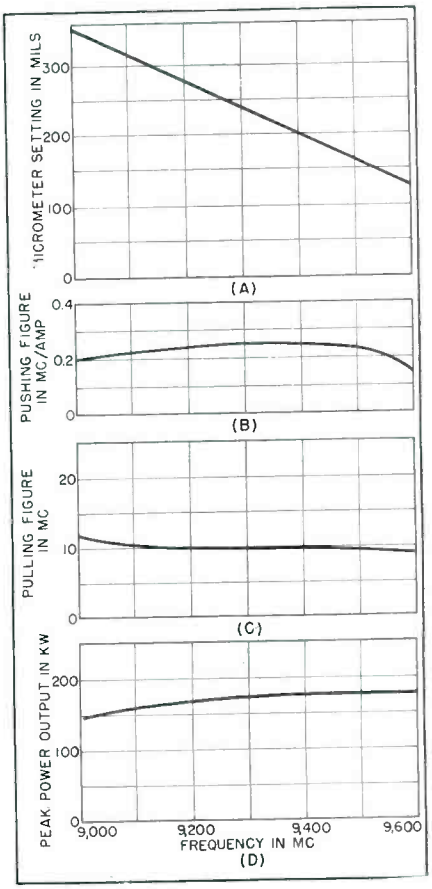


FIG. 2—Behavior of magnetron over frequency range, showing tuning curve (A), pushing figure (B), pulling figure (C) and power output (D)

⅝-in. RG-51/U output waveguide, which can be coupled to an RG-52/U flange.

Performance

The magnetron was designed for good performance over a moderate tuning range rather than for moderate performance over a greater tuning range. A tuning range of 600 mc was found adequate for most applications.

Typical operating conditions are given in Table I. Tube operation is not limited to these conditions. If the duty cycle is lowered to 0.0005, the tube can be operated at peak plate currents up to 27.5 amperes with an equivalent increase in power output.

A tuning curve for the magnetron is shown in Fig. 2A. Tuning is linear with tuner movement. The average tuning rate is 2.75 mc per thousandth inch on the micrometer head.

One of the advantages of the stabilizing effect of the tuning cavity is the reduction of the change in frequency caused by a change in anode current. This effect is commonly referred to as pushing. Figure 2B shows the variation in pushing figure over the tuning range. The pushing figure is relatively flat over the tuning band, and is below 0.25 mc per ampere of anode current. The lower pushing figure results in less frequency modulation due to pulse-voltage variations. The waveform photograph shows a representative spectrum for the tube. The zeros go down to the base line. The first side lobes of this spectrum are about 12 db below the main lobe. An enlarged view of a portion of the spectrum is also shown.

A further advantage of coupled-cavity tuning is that the coupling between the tube and the load is lower for the same circuit efficiency than with most other types of tuning. Figure 2C shows the pulling figure as a function of frequency. The pulling figure varies from about 9 to 12 mc over the tuning range.

Figure 2D is a curve of power output as a function of frequency. This curve is relatively flat, with the power varying about ±1 db over the tuning range. The efficiency over this band varies from 30 to 39 percent.

Louvered cooling fins are used to increase the cooling efficiency. At sea level, an air flow of 50 cfm is adequate to keep the anode temperature within safe limits. The thermal factor, or change in frequency with temperature, is less than 0.3 mc per degree C. After a 10-minute warmup, frequency drift is negligible.

Table I—Tube Performance

Peak anode voltage	22 kv
Peak anode current	21 amp
Pulse duration	1 μsec
Pulse repetition rate	1,000 pps
Duty cycle	0.001
Peak power output (nominal, over entire frequency range)	165 kw
Tuning range	9,000–9,600 mc

Automatic Plotter for

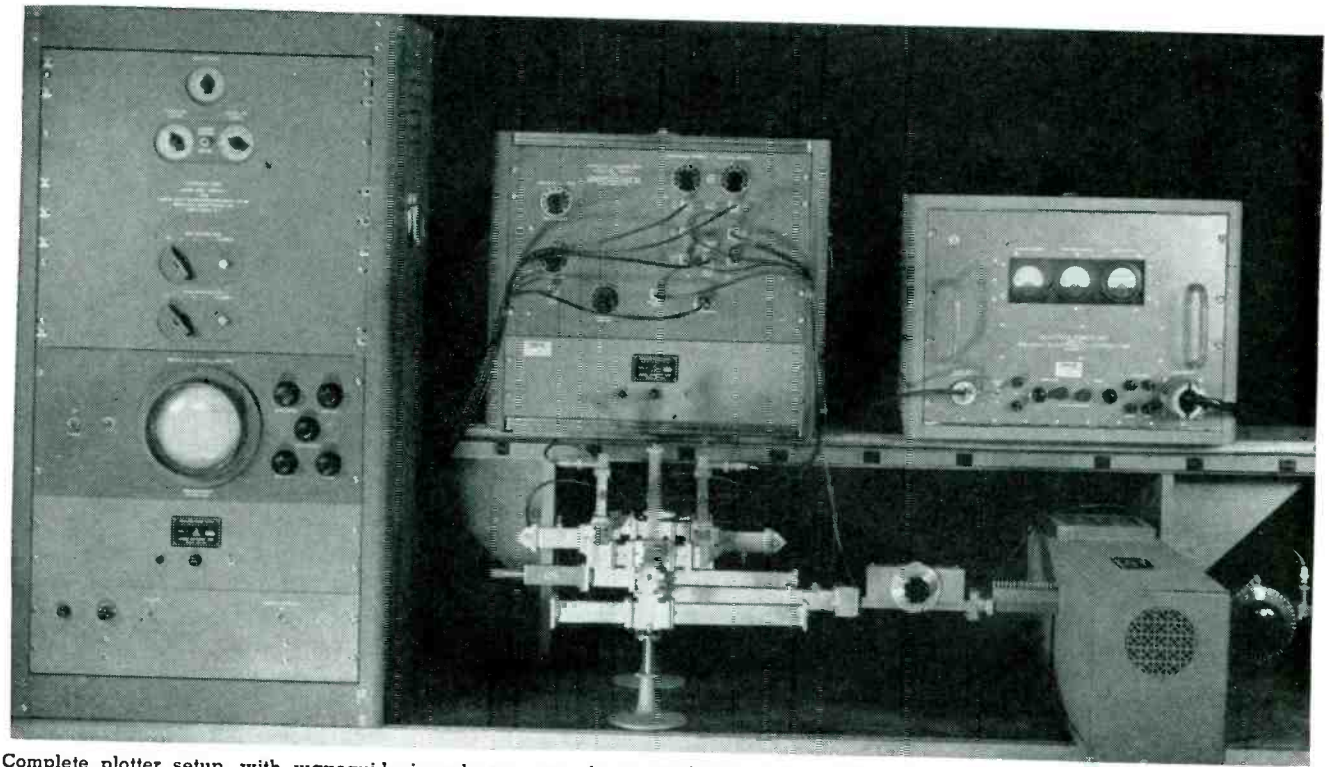
SUMMARY — Input impedance of waveguide component is measured rapidly and automatically throughout range of 8,500 to 9,600 mc and resulting impedance locus in reflection coefficient plane is displayed on screen of cathode-ray oscilloscope. Marker pulses give frequency calibration of plot

By HENRY L. BACHMAN
Wheeler Laboratories, Inc.
Great Neck, N. Y.

POINT-BY-POINT measuring of frequency variations of the input impedance of microwave components can consume considerable time and effort. For this reason, automatic impedance-measuring devices have been developed.[1,2,3,4]

The automatic impedance plotter to be described provides for the rapid automatic measurement of the input impedance variations of a waveguide component and an oscillographic display of these variations in the reflection coefficient plane. The impedance plotter comprises an X-band rapid-sweep oscillator, a waveguide impedance meter and display and control circuits. Measurements may be performed continuously throughout the frequency range from 8.5 to 9.6 kmc on any microwave component that can be adapted to the 1¼-inch by ⅝-inch RG-51/U waveguide input port of the impedance meter. The impedance variations of components operating in other frequency bands may be observed with the X-band impedance plotter by building scaled X-band models of these critical components.

Since the rapid-sweep oscillator sweeps back and forth through the 12-percent X-band at the rate of 12 cps, the cathode-ray tube display of the impedance locus is visually continuous. This feature insures the observation of any anomalies in the impedance locus caused by spurious resonances or other similar effects which may be overlooked in the point-by-point method of measuring. The speed of the measure-



Complete plotter setup, with waveguide impedance meter in center foreground and X-band rapid-sweep oscillator at its right. Display and control circuits are in cabinet at left. Klystron power supply and cabinet for display blanking and adding circuits are on shelf

Waveguide Impedance

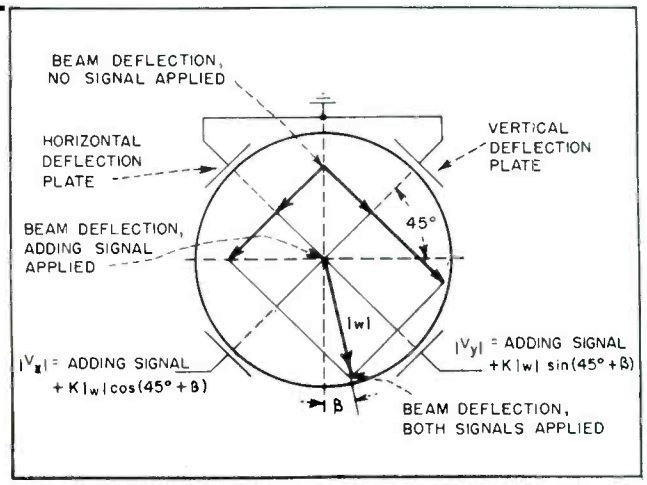


FIG. 1—Interpretation of display obtained on oscilloscope screen

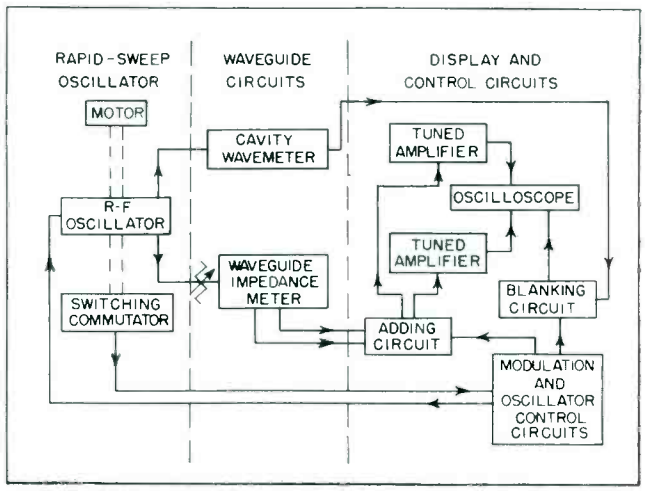


FIG. 2—Principal sections of complete automatic impedance plotter

ment also permits observations of changes in the impedance locus as the microwave component is adjusted.

Reflection Chart

The impedance locus of a component with a varying parameter, such as frequency, may be plotted in the plane of the reflection coefficient. The map of impedance in the reflection coefficient plane is a reflection chart. This plot has an advantage over a plot in the plane of the impedance, since all points of positive resistance are plotted within a circular area on the reflection coefficient plane. An additional advantage is the ability to calculate the effects of varying transmission line length simply by angular rotation of the impedance locus on the reflection chart. Well known types of reflection charts are the Smith and Carter charts.

The Wheeler Laboratories reflection chart[5], which is used with the automatic impedance plotter, differs from these charts in the manner in which the axes are oriented. The vertical axis is the locus of pure resistance, which increases from zero at the bottom to infinity at the top. To the right and left of this axis are plotted all values of impedance having a positive or negative reactive component respectively, for most convenient use.

The polar form of the complex reflection coefficient $w = |w| \angle \beta$ can be described by the two orthogonal components, $|w| \cos \beta$ and $|w| \sin \beta$. The waveguide impedance meter generates signals proportional to these components. The signals are amplified, detected and applied to the appropriate plates of the cathode-ray tube by the display and control circuits. The resultant beam deflection traces on the face of the cathode-ray tube the impedance variation of the component in the reflection coefficient plane.

Impedance Meter

The waveguide impedance meter is a novel waveguide network comprising RG-51/U components. It has been shown[6] that the output signals of the impedance meter are given by

$$|V_x| = K|w| \cos(\beta + 45°)$$
$$|V_y| = K|w| \sin(\beta + 45°)$$

These signals are proportional to the orthogonal components of the complex reflection coefficient provided that the orthogonal axes are rotated 45 degrees relative to the axes of the reflection coefficient plane.

A special feature of the waveguide impedance meter is the provision for choosing at will the reference plane at which the impedance is measured, simply by moving a short-circuiting plunger in a waveguide adjacent to the component under test. This feature simplifies locating the best plane for the insertion of a matching device or for performing other studies of impedance characteristics.

Display Circuits

The essential functions of the display and control circuits[7] are to amplify and display the output voltages from the waveguide impedance meter and to provide the operating voltages for the X-band rapid-sweep oscillator.[7]

The output signals of the impedance meter, which vary at the modulating frequency of the rapid-sweep oscillator, are amplified by high-gain tuned amplifiers and then detected. The operation of the display circuits is complicated by the fact that the detectors in the display and control circuits are not phase-sensitive; therefore, an expedient method is employed to allow the unipolar voltages applied to the deflecting plates of the oscilloscope to deflect the cathode-ray trace to all quadrants in the reflection coefficient plane.

The method is illustrated in Fig. 1. A coherent signal is added to the output signals from the waveguide impedance meter at the input to the

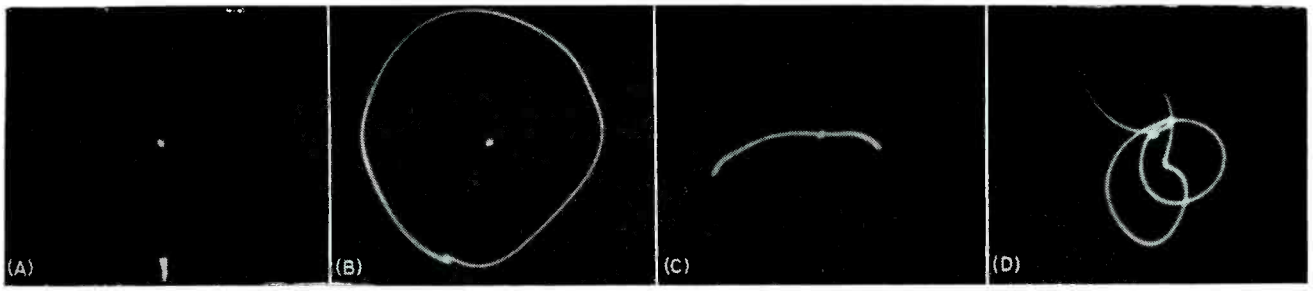


FIG. 3—Examples of oscilloscope presentations for short-circuit (A and B), resonant iris (C) and multiple-tuned waveguide filter (D)

tuned amplifiers. The coherence of the signals is insured by using a signal from the oscillator modulator as the adding signal. The phase of the adding signal must be either in phase or 180 degrees out of phase with the output signals of the waveguide circuit. The beam is initially deflected by the adding signal; then, by adding or subtracting the output signals from the waveguide impedance meter, the cathode-ray trace may be deflected to all quadrants in the reflection coefficient plane.

The block diagram in Fig. 2 illustrates the relation of the display and control circuits to the entire system.

It was considered advantageous to have the cathode-ray trace return to the center of the tube face following each sweep through the frequency band, to indicate the center of the reflection coefficient plane. This was accomplished during the return cycle of the rapid-sweep oscillator by removing the modulation signal to the oscillator. This operation is performed by a switching commutator mechanically coupled to the sweeping oscillator. The adding signal is not affected by this operation, and the trace is deflected by this signal alone to the center of the cathode-ray tube, as shown in Fig. 1.

Sweep Circuits

A feature of the oscilloscope display is the ability to select any desired degree of expansion. The entire plane of the reflection coefficient (maximum radius equal to unity) may be presented; alternatively, some smaller range may be chosen to expand the impedance locus for better observation of small reflections. By photographing the cathode-ray tube trace, a permanent record may easily be obtained.

The rapid-sweep oscillator output level, which may be adjusted to be flat within 0.5 db over the frequency band from 8.5 to 9.6 kmc, varies considerably over the small portion of the sweep range out of this band. This variation of the oscillator output level results in an anomalous plot of the impedance locus.

To improve the oscillographic display, a blanking circuit has been provided which is triggered from the repeller tracking voltage generated in the oscillator control circuits. The blanking circuit generates a blanking pulse which is synchronized with the sweep frequency and applied to the control grid of the oscilloscope to blank the cathode-ray tube trace during the period when the rapid-sweep oscillator is swept outside of the 8.5 to 9.6-kmc frequency band.

Provision has also been made to frequency-calibrate the impedance plot by a marker-blanking pulse applied to the control grid of the oscilloscope. The blanking pulse is triggered by the output of a transmission-type wavemeter which is coupled to a second output of the rapid-sweep oscillator. The duration of the blanking pulse is made adjustable because of the wide variations of writing speed encountered when impedance loci of varying complexity are measured.

Performance

The impedance locus of a short-circuit measured with the plane of the reference at the short-circuit is given in Fig. 3A, as plotted on the reflection chart. The oscillographic display in the plane of the reflection coefficient is a short curve along the vertical axis of the reflection chart. Ideally, the plot is a point on the real axis corresponding to zero resistance for all frequencies. The impedance locus of a short-circuit, with the plane of the reference far enough from the short-circuit so that the resulting locus forms one complete circle when the frequency is swept through the 8.5 to 9.6-kmc frequency band, is given in Fig. 3B.

The oscillographic displays of the impedance loci of a short-circuit indicate that the maximum size of the full-scale display is a 2¼-inch diameter circle. The size of the cathode-ray tube display is limited by amplifier overload. If a larger display is desired, the expedient method of using the adding signal to obtain deflection of the cathode-ray tube trace over the entire reflection coefficient plane must be abandoned, and the second detectors at the output of the display amplifiers must be replaced by phase-sensitive detectors.

Oscillographic displays of several impedance loci are plotted on an expanded portion of the reflection coefficient plane in Fig. 3C and 3D, where full-scale deflection corresponds to $|w|_{max} = 0.33$ (6-db swr reflection). The impedance locus of a single-tuned circuit (resonant iris) measured with the reference plane at the plane of the iris is given in Fig. 3C.

The oscillographic display resulting from the impedance measurement of a multiple-tuned waveguide filter circuit having a complex impedance locus is given in Fig. 3D. A measurement of this impedance locus by slotted line techniques takes at least one hour; the measurement is performed instantaneously by the automatic impedance plotter following a setup time of about 10 minutes. In addition, the measurement by the impedance plotter insures that all of the de-

tails of the impedance locus will be observed since the measurement is performed continuously over the frequency band.

Accuracy

The accuracy of the automatic impedance plotter was determined by comparing the oscilloscope display with precision slotted line measurements. For measurements of large reflections, full-scale display corresponding to unity reflection coefficient, the maximum observed errors of the magnitude and phase of the reflection coefficient as measured by the waveguide circuit were 10 percent and 5 degrees respectively. These maximum errors occurred for measurements performed at the ends of the 8.5 to 9.6-kmc frequency band. The average errors of the magnitude and phase of the reflection coefficient were 2.5 percent and 2 degrees respectively. For measurements of small reflections, with the oscillographic display expanded to $|w| = \frac{1}{3}$ full scale, the maximum observed deviation of the impedance plotter measurements from the slotted line measurements was 8.5 percent and the average deviation was 3.5 percent. The maximum errors again occurred at the ends of the operating frequency band.

The errors resulting from the use of the impedance plotter can be attributed to three principal effects. One is the effect of variations of the output power of the rapid-sweep oscillator; the second is the effect of amplitude and phase asymmetries in the waveguide impedance meter; the third is the effect of multiple reflections in the waveguide circuit.

The variation of the oscillator output power could be practically eliminated by the use of some type of agc system. The waveguide circuit has never been tested to determine the extent of amplitude and phase asymmetries; however, work in that direction would be expected to be profitable in improving the accuracy of the impedance plotter.

To minimize the errors caused by multiple reflections in the waveguide circuit, the best matched components existing in the present state of the art have been employed in the system. Padding of individual components to further reduce multiple reflection effects is not sound since pads introduce serious asymmetries.

Because of the complexity of the automatic impedance plotter system, it cannot be expected to yield results as accurate as the slotted line method for measuring impedance. However, the accuracy is sufficiently high to insure reliability of the results; the speed with which the impedance data is obtained more than compensates for slight inaccuracies in this data.

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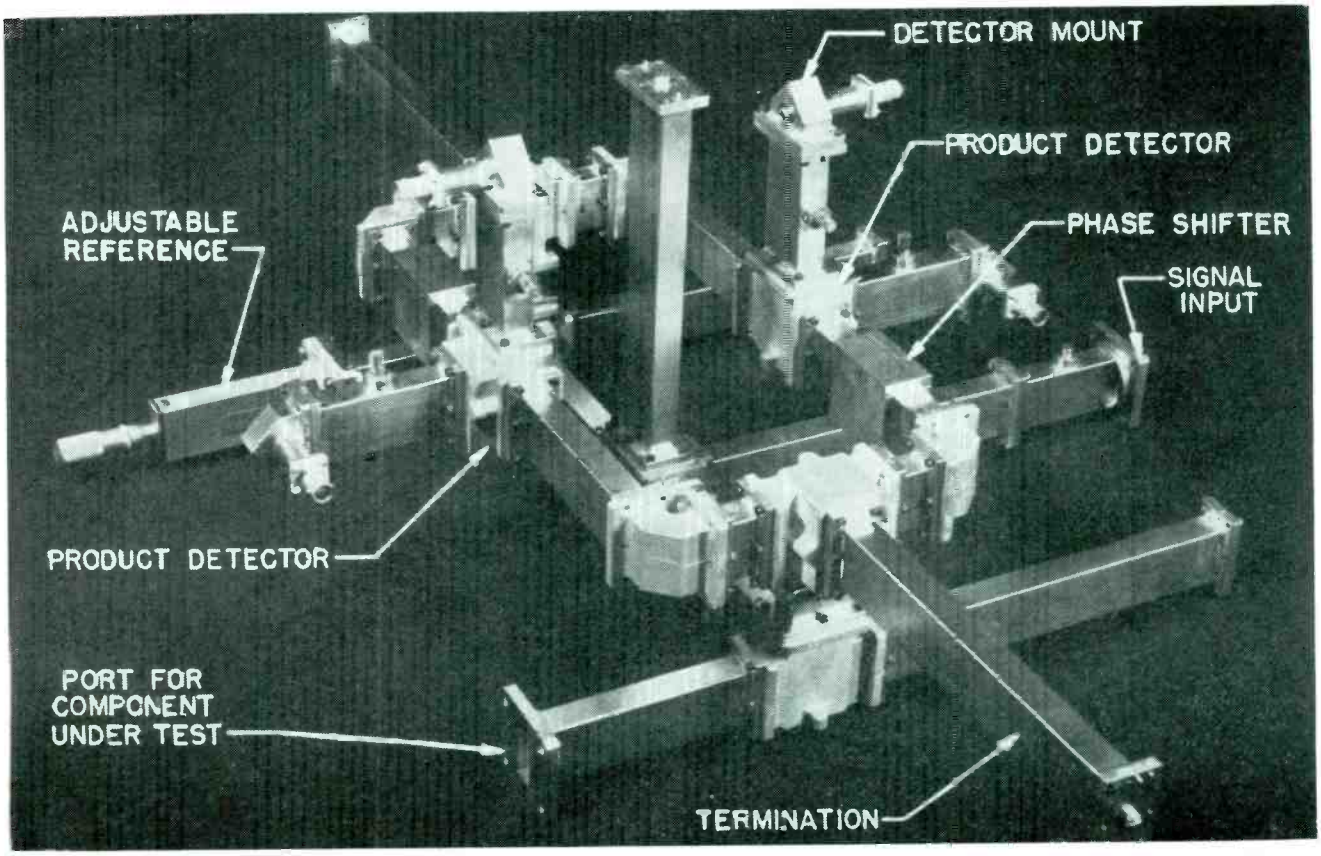


Waveguide impedance meter, showing r-f signal input port at right center and adjustable reference short-circuit at left center. The two output signals are obtained from combined output of each pair of detector mounts

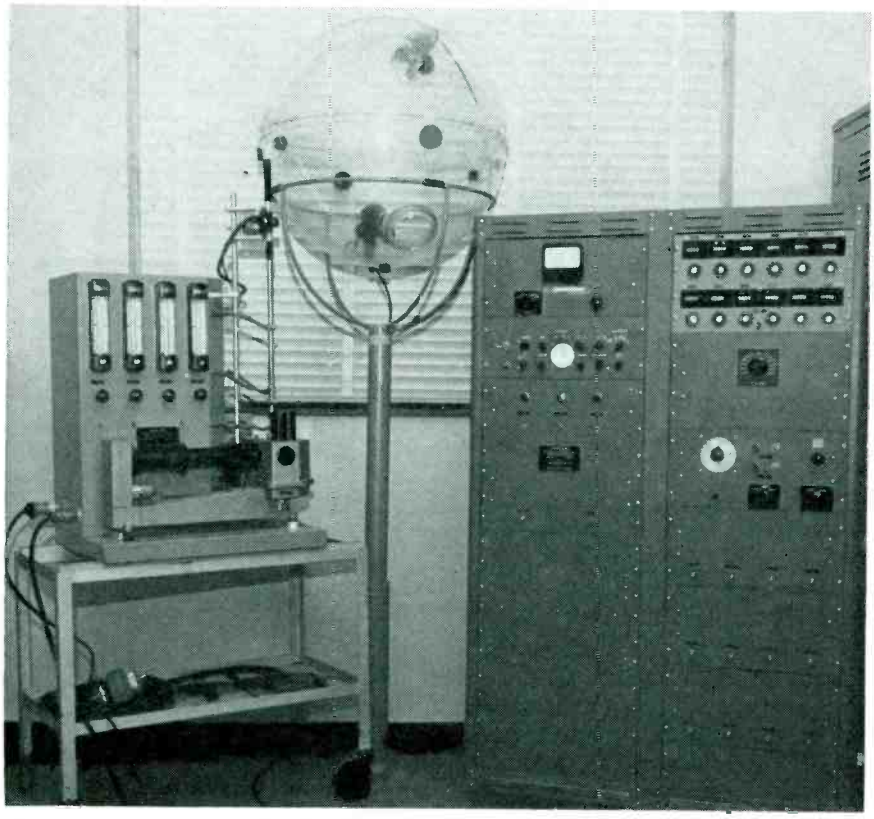
Aerosoloscope Counts

SUMMARY — Chemist is relieved of tedious job of counting and sizing aerosol particles under a microscope. Glow-transfer-tube counter and unique pulse-height discriminator count and size particles after scattered light is received by multiplier phototube

AN AEROSOL is a suspension of finely divided solid or liquid particles such as smokes, dust or pollen in a gas. In the present method of analysis, the minute particles are collected on a surface and then counted and sized under a microscope. However, the aerosoloscope in one operation automatically detects particles from 1 to 64 microns in diameter and classifies them into 12 adjacent size groups within this range. It counts and classifies at a maximum rate of 100 particles per second and accepts aerosols of concentrations up to 10,000 particles per cc.

Operation

Light-scattering is utilized for particle detection. A thin aerosol stream intersects a high-intensity light beam and a portion of the light energy scattered by the particles is received by a 5819 multiplier phototube. The optical system is indicated schematically in Fig. 1. In the plan view, a 108-watt ribbon filament lamp *A* is focused upon a 1-mm by 3-mm slit and imaged at point *Z*.



Aerosoloscope developed by the Armour Research Foundation for particle detection in gaseous mediums utilizes scattered light received by phototube

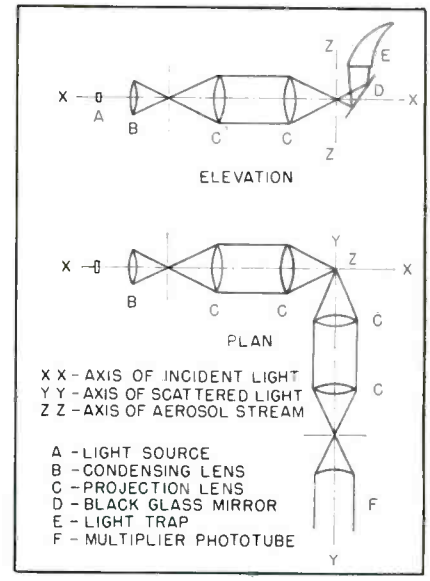


FIG. 1—Layout of optical system

A 1-mm diameter aerosol stream after dilution is directed vertically downward through the image at point *Z*. Light scattered at 90 deg by the particles is gathered by an identical lens system along the axis *Y-Y* and channeled to the multiplier phototube *F*. Thus a sensitive volume 3 by 3 mm horizontal by 1 mm vertical is established which is illuminated by the source and viewed by the detector.

At the maximum counting rate, an average of 95 percent of the aerosol particles pass through the sensitive volume one at a time. Thus, for each particle traversing the field, a nearly square pulse of light is transmitted to the multiplier phototube. The aerosol veloc-

Particles in Gas

By

E. S. GORDON
Armour Research Foundation of Illinois Inst. of Tech. Chicago, Illinois

D. C. MAXWELL, JR.
Crosley Division Avco Mfg. Co. Evendale, Ohio

N. E. ALEXANDER
Chemical Corps Biological Labs. Camp Detrick, Md.

ity is approximately 5 feet per second. This value, coupled with the 1-mm vertical dimension of the sensitive volume, yields a signal-pulse duration of 650 microseconds.

The intensity of the light impulse varies with the square of the particle diameter for particles within the 1 to 64-micron range. The dynamic range of signal voltages therefore is 64^2 or 4,096-to-1.

The random voltage pulses from the phototube are amplified in a preamplifier and fed to a pulse height discriminator, where they are classified into the 12 adjacent size groups and tallied on a counter within each group. The 12 particle groups, or channels, were chosen to be equal logarithmic steps so that for each channel the ratio of upper-to-lower boundaries is $\sqrt{2}/1$. Therefore, channel 1 has a range of 1.0 to 1.414 microns, channel 2 of 1.414 to 2.0. Inasmuch as the response to the particles is proportional to the square of the particle diameter, the ratio of maximum-to-minimum amplitude of the voltage pulses corresponding to each channel is $(2)^2$ or 2.0/1.

Pulse-Height Discriminator

Figure 2 illustrates the operation of the pulse-height discriminator. A five-channel system is discussed for simplicity. Amplifiers 1, 2, 3, 4 and 5 are connected in

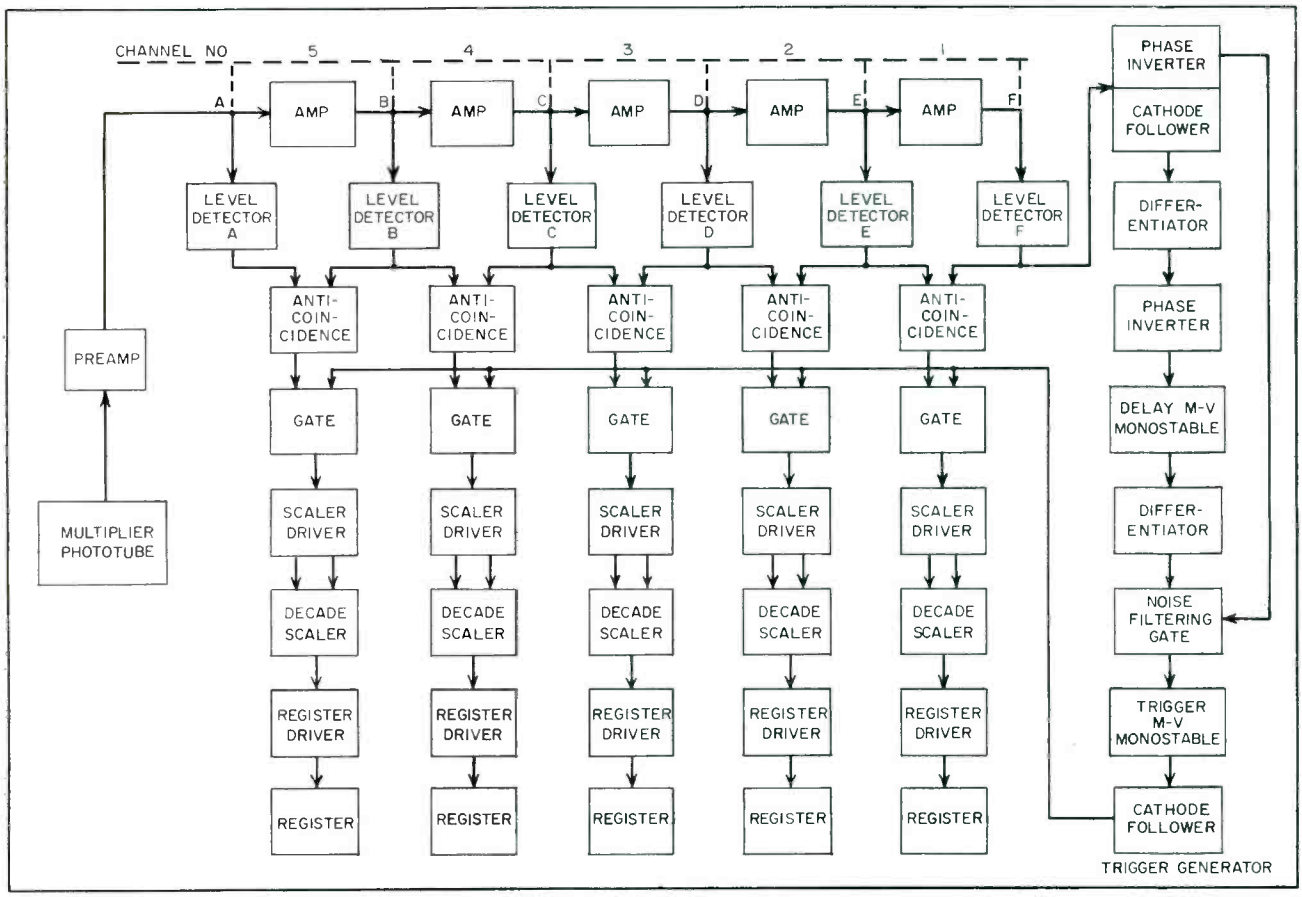


FIG. 2—Five-channel system illustrating the operation of the pulse-height discriminator

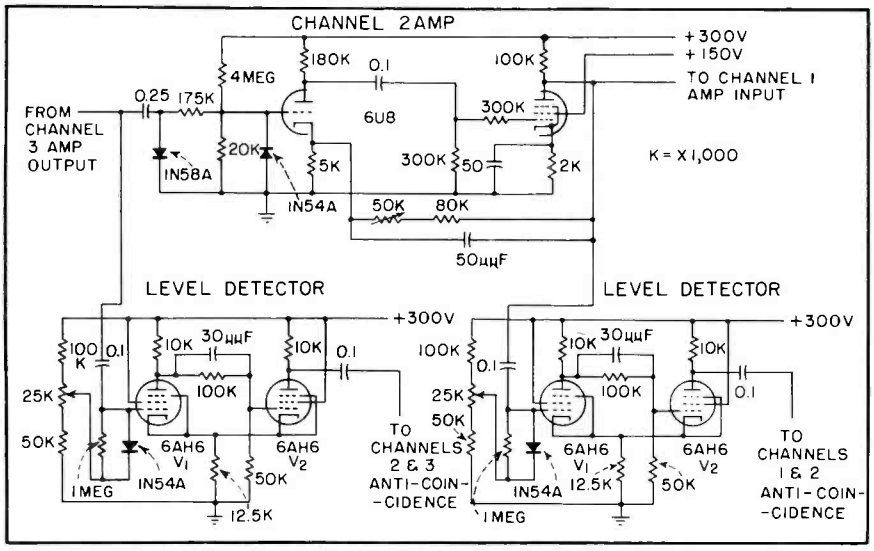


FIG. 3—Typical channel amplifier and level detectors

tandem, each having a gain of 2.

At the output of the preamplifier and at the output of each channel amplifier, a level-detector circuit is connected. These circuits are adjusted to produce a fixed-amplitude output pulse when receiving an input pulse of 20 v or greater. The outputs of each two adjacent level detectors are fed to an anticoincidence circuit.

Each anticoincidence circuit generates an output pulse when receiving a pulse at one of its two input points. The output of each of the anticoincidence circuits is fed to a register system corresponding to that channel, where the channel tally is made.

Assume that a particle of a size falling in channel 3 passes through the illuminated field and that this particle causes a 4-volt pulse to appear at point *A*. The pulse heights at points *B*, *C*, *D*, *E* and *F* are 8, 16, 32, 64 and 128 volts, in that order, since each amplifier has a gain of 2. Level detectors *D*, *E* and *F* trigger and produce outputs since each of their inputs is over 20 volts.

The only anticoincidence circuit which generates an output is that of channel 3, since only this circuit receives a pulse from one of its inputs and not the other. Therefore the register in channel 3 tallies a count.

The signal pulse has a rise time and fall time each approximately 15 percent of total pulse duration. This would cause false counts were it not for a special gating system.

Consider the particle of channel 3 in Fig. 2. As the pulse rises toward its ultimate value, the input to level detector *E* will exceed 20 volts and cause it to trigger for a finite time before detector *D* triggers. Thus anticoincidence circuit No. 2 would produce a short-duration pulse to register No. 2 where a false count would be tallied. A similar action would occur on the trailing edge of the pulse where another false count would be tallied in channel 2. Register 1 would similarly receive two false counts.

To prevent these false counts, and also to prevent counts due to the short-duration noise spikes originating at the multiplier phototube, a trigger-generator was developed. This unit generates a short-duration triggering pulse of 100 μsec beginning about 250 μsec after the leading edge of each signal pulse. The trigger generator is utilized with gate circuits interposed between the anticoincidence circuits and the register circuits of each channel.

Gating System

Each channel gate has two input points, one from the trigger-generator and the other from its anticoincidence circuit. The channel-gate allows passage of a pulse from the anticoincidence circuit to the counting circuits only if the pulse is present when the short-duration trigger-generator pulse arrives. Since the triggering pulse occurs during the flat portion of the signal pulse, only the true anticoincidence pulse will be passed.

In Fig. 2, the input to the trigger generator is obtained from the level detector following amplifier No. 1. Since this level detector triggers from a 1-micron pulse or larger, the trigger generator will receive an input for every particle to be counted. This input signal, which is 650 μsec long coincident with that from the amplifiers, as inverted and applied to the noise-filtering gate.

It is also differentiated, inverted and applied to the monostable delay multivibrator. The leading-edge spike triggers the multivibrator which is adjusted to generate a 250-μsec pulse. This circuit furnishes the 250-μsec delay for the 100-μsec triggering pulse. The trailing-edge positive spike of the differentiated delay-multivibrator output is inverted by the noise filtering gate and applied to the monostable trigger multivibrator, which generates the 100-μsec trigger pulse. The noise-filtering gate will not pass this spike, however, unless its other input, the inverted trigger-generator input pulse, is present when the spike comes through.

If the input signal had not been a particle pulse but had been a noise pulse of less than 250-μsec duration, it would be over before the trailing-edge spike reached the gate and no output would be transmitted by the trigger generator.

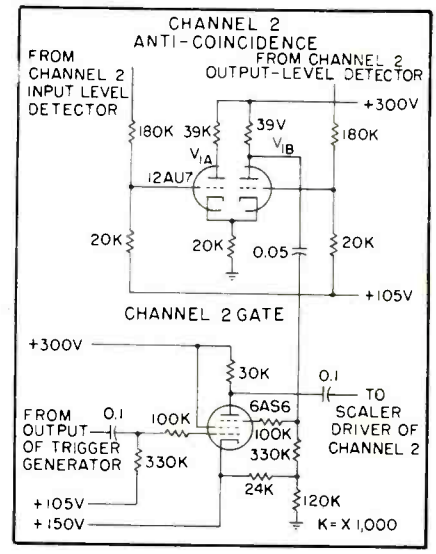


FIG. 4—Representative anticoincidence and gate circuit

The pickup system is calibrated by a fine horizontal wire which is motor driven up and down through the light beam at the center of the sensitive volume. This wire crosses the beam at the speed of the aerosol particles. By its scattered light it simulates a particle of 8 microns, the boundary value between channels 6 and 7.

In calibrating, the multiplier phototube supply voltage is adjusted so that the counts from the chopper wire fall at the boundary between these two channels, with some counts registered in channel 6 and some in channel 7. Thus, the phototube-voltage adjustment compensates for changes in output of the lamp and in the sensitivity of the multiplier phototube. After calibration, scattered light from a 1-micron particle generates a 1-millivolt pulse at the anode. Each type of aerosol under test, however, has a different index of refraction and thus a different light-scattering power. This property does not vary by an overall factor of more than 4-to-1. It is compensated for by a gain control in the preamplifier which is set to a predetermined value for each type of aerosol under test.

A special electronic pulse generator was developed and built into the equipment for accurate calibration of the pulse-height discriminator.

The preamplifier contains a two-stage capacitance-coupled circuit of conventional design. It employs a 12AX7 twin-triode and has a maximum gain of 20, stabilized by about 27-db of voltage feedback. It has a passband of 1.5 cycles to 10 kc. This response, in conjunction with that of the cascade channel amplifiers, allows adequate passage of the 650-μsec pulse.

Channel Amplifiers

A schematic diagram of one of the channel amplifiers with two adjoining level detectors is shown in Fig. 3. The channel amplifiers, level detectors, anticoincidence and gate circuits of the 12 channels are nearly identical. The channel amplifier is two-stage capacitance-coupled using a 6U8 triode-pentode.

The three resistors and the 1N54A germanium diode at the input grid limit the pulses to 30 volts at the amplifier output. The 175,000 and 20,000-ohm resistors of this limiter form a 10-to-1 voltage divider. The two-stage amplifier yields a gain of 20, with about 27 db of feedback, so that the overall gain of the channel amplifier is the required 2. Gain is adjusted with the 50,000-ohm resistor in the feedback network. The frequency response of the amplifier is flat from 4 cps to 32 kc. However, in alternate amplifiers a capacitance of 0.13 μf is located in series with the 80,000 and 50,000-ohm feedback resistors.

The low-frequency boost caused by the capacitance helps to reduce the pulse distortion from upper-range input pulses in the later amplifiers. This distortion is due to the large dynamic range of the system. The 1N58A diodes at the inputs of the channel amplifiers were also necessary owing to this range problem.

Level-detector circuits are of the Schmitt type, and consist of two 6AH6 pentodes. In the quiescent state, V_1 conducts due to the positive value of its grid return and tube V_2 is cut off due to voltage divider action of the 100,000 and 50,000-ohm resistors at its grid. If the grid potential of V_1 is lowered to a certain value, the conduction of this tube will be decreased to the point where tube V_2 will begin to conduct. This is due to the drop in the common cathode voltage and the rise in V_1 plate voltage. Thus regenerative action takes place and the conduction abruptly changes from V_1 to V_2. When the grid voltage of V_1 is now raised by a small amount the action reverses and the original state is restored.

Thus, a negative square output of uniform amplitude is obtained at the plate of V_2 for every negative pulse at the grid of V_1 which is large enough to cause the triggering action. The 25,000-ohm potentiometer of the voltage divider in the grid return of V_1 is adjusted so that a pulse of 20 volts or more will trigger the circuit. The 1N54A diode acts as a d-c restorer to prevent the baseline from rising owing to a rapid pulse rate.

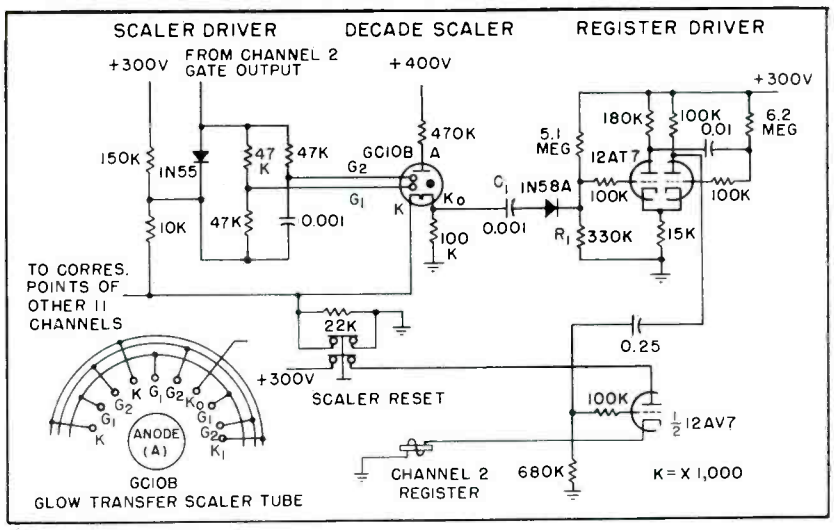


FIG. 5—Typical decade scaler and register circuitry. Partial schematic of cold-cathode glow-transfer tube GC10B, lower left

Anticoincidence

The schematics of one of the anticoincidence circuits and a channel gate circuit are shown in Fig. 4. In the anticoincidence circuit the common-cathode point of the two triodes is slightly greater than 105-v positive in the quiescent state; both sections conduct about equally. In the gate circuit, both the control grid and the suppressor grid of the pentode are biased well below cutoff due to the relative grid and cathode returns.

Assume that a pulse is sent through the amplifier chain which is large enough to trigger both the channel 2 output-level detector and channel 2 input-level detector. An equal negative pulse would appear at each 12AU7 grid of an amplitude decreased 90 percent by the

180,000 to 20,000-ohm a-c dividers. Each triode would then conduct slightly less and a small positive pulse would appear at each of the plates, not large enough to bring the gate-suppressor grid out of cut-off, this grid being coupled to the plate of V_{1B}. Therefore, no output would be produced by the gate to be sent to the channel scaler driver.

Now, assume that a smaller pulse is sent through the amplifier chain, this pulse value being large enough to trigger the channel 2 output-level detector but not the channel-2 input detector. In this case, a negative signal would appear only at the grid of V_{1B}. Due to cathode coupling, a positive pulse would appear at the plate of V_{1B} of a value large enough to drive the suppressor grid to zero bias. When the delayed triggering pulse from the trigger generator arrives at the gate control grid, it drives this grid to zero bias. Now plate current flows and a pulse is sent to the scaler driver of channel 2 for registration.

A schematic diagram of the decade scaler and register circuits is shown in Fig. 5. The decade scaler, which utilizes the cold-cathode glow-transfer tube GC10B, divides the number of input pulses by a factor of 10 reducing the maximum counting rate required of the electromechanical register to 10 a second.

The pulse-pair resolution of the tube is about 250 μsec so that the instrument can easily respond to a train of up to 19 closely spaced particles of the same channel. This depends upon the position of the glow at the beginning of the train.

Each time the glow arrives at the output cathode, the positive step of voltage which occurs at this point is differentiated by C_1R_1 and applied to the 12AT7 monostable multivibrator. This multivibrator forms a 20-millisecond positive pulse which, through the $\frac{1}{2}$ 12AV7 cathode follower, actuates the register. The 1N55 diode of the scaler driver acts as a d-c restorer.

The 1N58A diode in the differentiator circuit blocks the negative spike which is caused by the glow moving from the output cathode to the next position. Thus, the multivibrator will not be switched back to its monostable state before the end of the 20-millisecond period.

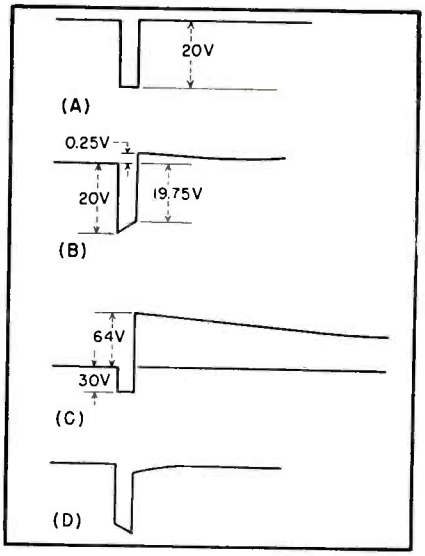


FIG. 6—Waveforms relevant to high dynamic range showing pulse at discriminator input due to 64-micron particle (A), pulse at output of first coupling circuit (B), pulse after eight stages of amplification (C) and effect on input waveform (D) of series capacitor in amplifier feedback loop

The chief problem encountered in the development was associated with the large dynamic range of the instrument. At one operation the pulse-height discriminator must classify signals of an overall ratio of 4,096-to-1. The twelve cascaded amplifiers of the discriminator, in addition to their overall amplification of 4,096, must adequately limit the amplitude and preserve the shape of pulses of up to 20 v at the input.

Coupling Circuit

With this input assumed to be perfectly square as shown in Fig. 6A, the capacitor of the R-C coupling circuit at the input of the system will discharge about 0.25 volt. The pulse shape passed by this circuit is shown in Fig. 6B. Succeeding coupling capacitors have a similar but lesser effect.

The 1N54A diode limiters of the amplifiers limit the negative amplitude, but have no effect upon the positive overshoot following the trailing edge. This overshoot is amplified throughout the chain and results in a waveform as shown in Fig. 6C.

Pulse distortion of this magnitude causes both amplifier blocking and improper functioning of the level detectors. A combination of three techniques was used to limit this distortion. One was the addition of the positive-connected shunt diodes after the coupling capacitors, see Fig. 3; these diodes provide a low-impedance recharge path and thereby reduce the size of the positive pips. Another technique was the addition of the series capacitor in the feedback loop of alternate amplifiers. The counterbalancing effect of this capacitor is shown in Fig. 6D. The third and most elaborate technique was bypassing the first four amplifiers with a d-c coupled nonblocking amplifier of the equivalent gain of the four amplifiers. Thus, amplifier No. 8 receives its input from this auxiliary amplifier instead of from amplifier No. 9.

The principal source of background noise of the instrument system is light scattering of the air molecules in the 3 by 3 by 1-mm sensitive volume. This phenomenon produces a constant background level of light flux at the photocathode. The resulting d-c multiplier-phototube current has superimposed upon it a random a-c component due to shot-effect.

While the peaks of this noise are of larger amplitude than pulses from a 1.0-micron particle, they are not registered as the noise spikes are of much shorter duration than the signal pulses and are effectively filtered by the noise-filtering gate of the trigger generator. The gain of the system can be increased by a factor of from 2.5 to 3.5 before the output noise due to air scattering is of a value great enough to be registered, providing a good signal-to-noise factor for normal operation.

The noise caused by the multiplier-phototube dark current is approximately one-fourth of that from air scattering. The contribution to the total random noise by the amplifier is negligible.

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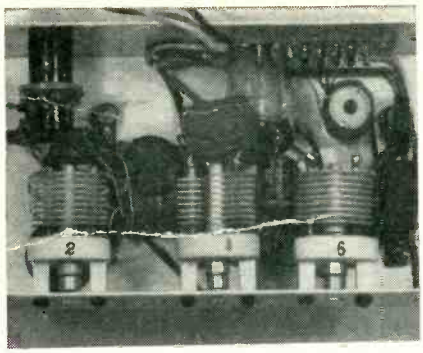
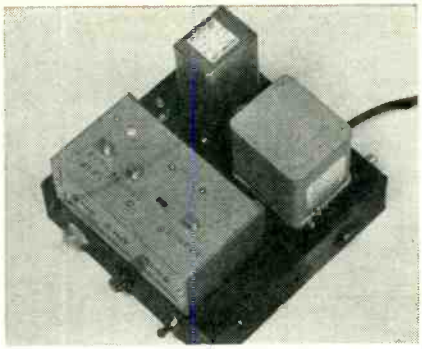
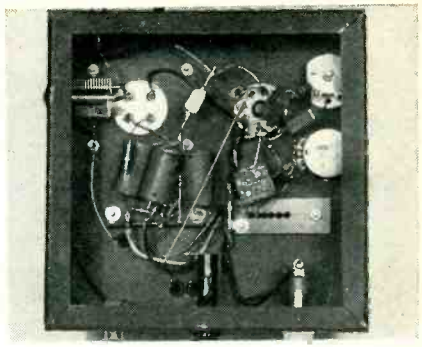

Underside of amplifier chassis and top and bottom views of complete junction-transistor oscillator

Transistorizing Meacham-Bridge Oscillators

By SAMUEL N. WITT, JR.

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia

SUMMARY — Circuits have been designed using both point-contact and junction transistors. Operating at one megacycle, oscillators provide good long and short-time frequency stability. They are stable with respect to temperature and supply-voltage changes

DEVELOPED to provide exceptional stability, the transistor Meacham-bridge oscillator provides a reliable standard for measuring the performance of other transistor oscillators.

Electron-Tube Oscillator

The Meacham oscillator[1] consists of a bridge circuit and an amplifier. Most analyses assume that the amplifier is characterized by relatively constant gain and phase shift, zero initial phase shift and high amplifier input impedance. Maximum amplitude and frequency stabilities are obtained when all of the arms of the bridge are equal.[2]

Frequency instability is given by

$$\Delta f/f_0]_\theta \approx 2\,\Delta\theta/(KQ) \qquad (1)$$

where Q is the quality factor of the resonant circuit, K is the magnitude of the amplifier voltage gain with the bridge connected and $\Delta\theta$ is the incremental phase shift of the amplifier.

The stability is directly proportional to the amplifier voltage gain and is $K/4$ greater than would be calculated on the basis of the Q of of a resonant circuit without the bridge.[3]

When a transistor amplifier is used, power gain becomes important since the input impedance of most transistor amplifiers is low.

For all bridge impedances approximately equal to the input and output impedances of the amplifier, frequency instability is given by[3]

$$\Delta f/f_0]_\theta \approx 8\,\Delta\theta/[Q(|\mu| + 8)] \qquad (2)$$

where μ is the open-circuit gain of the amplifier.

In terms of amplifier voltage gain with the bridge connected, Eq. 2 becomes

$$\Delta f/f_0]_\theta \approx 4\,\Delta\theta/[Q(K + 4)] \qquad (3)$$

which shows that the stability is approximately one-half as great as obtained with infinite amplifier input impedance.

The frequency variation as a function of gain is

$$\Delta f/f_0]_K \approx -\,4\theta\,\Delta K/[Q(K + 4)^2] \qquad (4)$$

where θ is the phase shift of the amplifier and ΔK is the magnitude of the incremental change in amplifier gain.

Equation 4 shows that if the amplifier phase shift is zero, changes in gain will have no effect on frequency.

Equations 1 through 4 neglect the frequency-pulling effects of harmonic distortion. This is permissible with most electron-tube amplifiers since the amplitude is maintained relatively low. However, when transistors are used, harmonic

distortion may be of considerable importance.

Point-Contact Transistor

It was desirable to design a transistor oscillator to have a short-time instability of less than 1 part in 10^7. On the basis of Eq. 3 and 4 it was concluded that the minimum voltage gain should be 25. Frequency of operation was to be one megacycle. Available crystals had a series-resonant impedance of 100 ohms. An investigation of suitable thermistors with a resistance of 100 ohms indicated that at least 4 mw would be necessary to drive the bridge. The oscillator in Fig. 1 was designed using two Western Electric type 1729 transistors.

This amplifier was capable of supplying about 8 mw to the bridge with low distortion. The output impedance was adjusted to 100 ohms by selection of the transformer turns ratio for maximum power transfer to the bridge. The input impedance was approximately 100 ohms. With the bridge connected, the overall voltage gain of the amplifier was about 25.

Crystal CR_1 is connected in series with the amplifier input to prevent uncontrolled oscillations. Crystals CR_1 and CR_2 must be series resonant at nearly the same frequency. The series crystal acts as a band-pass filter and has little control over the frequency of oscillation.

Oscillator Performance

Relative band-pass characteristics for three portions of the circuit are shown in Fig. 2. The passband of the amplifier was broad because of the low values of Q resulting from the circuit loading. The passband of the amplifier and crystal combination is determined primarily by the characteristics of the crystal. The effective loaded Q is approximately one-half of the measured crystal Q. Maximum voltage gain is reduced one-half by the equivalent series resistance of the crystal.

Although the two crystals have approximately the same Q, the passband of the bridge circuit is narrower than that of the amplifier because of the effective Q multiplication of the bridge.

The relative phase characteristics of the circuit are also shown in Fig. 2. The amplifier without the series crystal would oscillate uncontrollably through the negative-feedback path of the bridge while with the series crystal it will not.

The oscillator performed satisfactorily, but it was not suitable for continuous laboratory use because of the unpredictable nature of point-contact transistors and because of the circuit changes and adjustments necessary when the transistors were replaced.

To obtain maximum power gain when a transistor was replaced, it was usually necessary to change the transformer turns ratios. The effective amplifier gain with the series crystal was only 12.5, zero amplifier phase shift did not occur at the transformer tuning which produced maximum gain and an isolated output capable of supplying appreciable power was not provided. Nevertheless, the oscillator compared favorably with an electron-tube oscillator[4] constructed for comparison. Table I shows the comparison of the two oscillators.

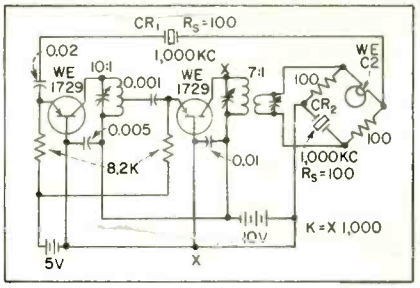

FIG. 1—Point-contact transistor oscillator using Meacham-bridge circuit

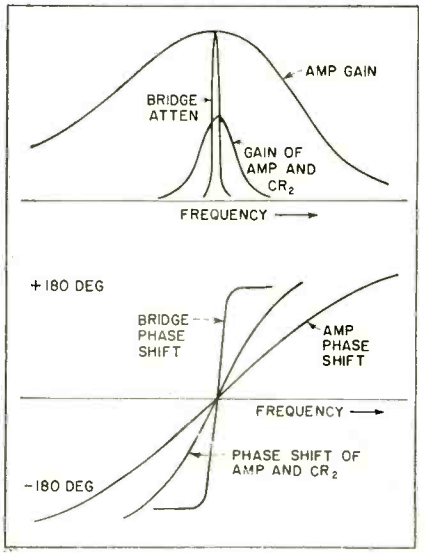

FIG. 2—Characteristics of point-contact transistor oscillator

Short-time stability was not comparable, for either oscillator, to the voltage stability. The short-time instability was obtained as the maximum frequency change over a 4-hour period with the ambient temperature varying approximately 5 degrees centrigrade. The same crystal was used for both oscillators.

Junction-Transistor Oscillator

Of eight junction transistor types (more than 50 individual transistors), only the Germanium Products type RDX-300A was found suitable for the amplifier-output stage. The Texas Instruments type 904A silicon transistor was found suitable for the first amplifier stage.

The oscillator using junction transistors is shown in Fig. 3. The bridge amplifier is of conventional design using transformer coupling and includes a bias network to permit operation from a single power source. Measured input impedance

Table I—Comparison of Electron-Tube, Point-Contact and Junction-Transistor Oscillators

Item	Electron-Tube Osc	Point-Contact Transistor Osc	Junction Transistor Osc
Amplifying element	1-12BY7; 1-6S4	2-WE 1729	1-RDX-300A; 2-TI 904A
Frequency control	crystal in JK03 oven	crystal in JK03 oven	crystal in Lavoie oven
Frequency	1 mc	1 mc	1 mc
Output	3 v p-to-p to high impedance	3 v p-to-p to high impedance	5 v p-to-p to high impedance
Power supply	200 v d-c reg 6.3 v a-c	9 1.5-v batteries	15 to 20 v at 6 ma
Power required	16 w (less oven)	0.12 w (less oven)	100 mw (less oven)
Permissible voltage variation	±25 percent	±25 percent	±25 percent
Freq-voltage instability	2 parts in 10^9 for 1 percent	2 parts in 10^9 for 1 percent	3 parts in 10^9 for 1 percent
Short-time instability (4 hr)	3 parts in 10^7	4 parts in 10^7	4 parts in 10^8

at 1 megacycle was greater than 100 ohms. Overall voltage gain with a 100-ohm load on the secondary of the output transformer was 50. The undistorted output to the bridge was 2 volts peak-to-peak or 5 milliwatts.

The bridge is not an equal-arm bridge. This was necessitated by the choice of the lamp thermistor. The Western Electric K1 switchboard lamp was chosen for its good nonlinear characteristics with minimum power consumption. One arm of the bridge was made variable so that crystals of different characteristics could be accommodated.

No attempt was made to compensate against temperature variations except for placing the crystal in a Lavoie type K00000005 oven. The series-resonant frequency of the CR-18 crystal was more than 100 cps below 1 megacycle. Therefore, it was necessary to raise the resonant frequency with a 30-$\mu\mu$f series capacitor. The capacitor was made variable from 28 to 32 $\mu\mu$f to permit precise adjustment.

Bypassing the RDX-300A second base had little effect on the gain or phase shift of the amplifier. When the second base was not bypassed, a signal voltage of 0.5 v peak-to-peak was observed at the second base terminal. Therefore, it was decided that this point could be used as an output since changes in loading would have little effect on the frequency of oscillation. The 904A output stage was added to provide additional isolation and greater output than was available directly from the second base of the tetrode. With the transformer, the open-circuit output voltage from the power-output stage was 5 v peak-to-peak. The voltage dropped to 0.5 v with a 1,000-ohm resistive load. With 6 feet of unterminated coaxial cable, approximately 2 v was obtained.

Several decoupling capacitors, not shown in Fig. 3, were necessary to eliminate spurious oscillations.

Construction

So-called miniature components were not used. All of the components were randomly chosen from a stock of standard tolerance components. The winding of the transformers was one of the major problems in the amplifier construction. The two transformers in the bridge amplifier were wound with tapped secondaries so the impedances could be matched to obtain maximum gain. The turns ratios shown are the ones which gave best results.

The two transformers of the bridge amplifier were placed at right angles to minimize coupling. The transformer of the power-output amplifier, at the upper left of the chassis, could not conveniently be placed at right angles to the other two transformers. As a result, some mutual coupling exists between the power-output stage and the bridge which accounts for a change in gain and phase shift of the bridge amplifier when the power-output stage is tuned. This has a slight effect on the frequency.

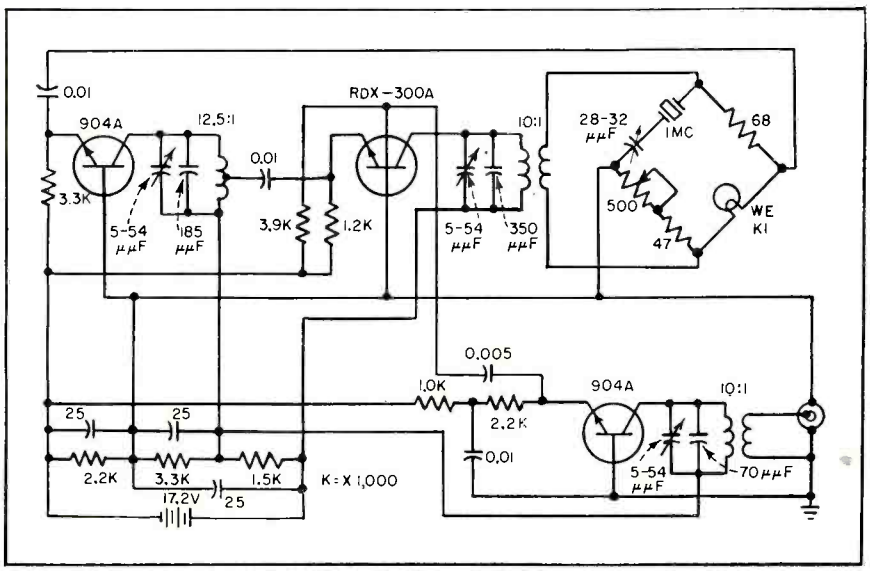

FIG. 3—Junction-transistor Meacham-bridge oscillator has three amplifier stages

A regulated Transpac power supply is used with the equipment.

Table I shows that the voltage stability for this oscillator was slightly worse than that of the point-contact oscillator. The power required was less for the junction oscillator, which exclusive of the bias network and crystal oven required only 70 mw. The transistor oscillators and electron tube oscillator all operated satisfactorily over approximately the same range of voltage variations.

Stability

Short-time stability of the junction-transistor oscillator was much better than that of either of the other two oscillators. This was in part due to the excellent temperature characteristics of the 904A silicon transistors. Use of a better crystal oven also resulted in some improvement over the other circuits. The same crystal was used with all of the oscillators.

When the junction-transistor oscillator was operated continuously for six weeks on a battery power supply, the total drift in frequency was only 1 part in 10^7. This drift was caused primarily by crystal aging. The instability for periods of a few minutes was 1 part in 10^8

The transistorized Meacham bridge oscillator was developed as a part of a study by the Engineering Experiment Station of the Georgia Institute of Technology.[5] The program was sponsored by the Frequency Control Branch of the Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey. The author expresses appreciation to B. J. Dasher and D. L. Finn of the Georgia Tech School of Electrical Engineering for their help in the preparation of this paper.

This paper was presented at the 1955 National Electronics Conference.

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Self-Balancing Magnetic

SUMMARY — Positive magnetic and negative electric feedback improve performance of single-stage magnetic servo amplifier driving two-phase 400-cps induction motor and standard position servomechanism

By W. A. GEYGER
U. S. Naval Ordnance Laboratory
Silver Spring, Maryland

IN MAGNETIC amplifiers of the self - balancing potentiometer type[1,2] positive external feedback or self-saturation produces an effectively infinite gain that is highly degenerated by negative feedback resistance-coupled into the control-circuit loop.

The self-balancing single-stage magnetic amplifier exhibiting high speed of response, unusual stability, linearity and freedom from drift satisfies the requirements of a high-performance servo amplifier. It acts as an operational amplifier[3,4] and does not impose its own characteristics on the feedback control system.

As a result of a large amount of negative feedback, asymmetry zero-drift errors caused by deviations from perfect symmetry in the saturable reactors and rectifiers of push-pull circuits are practically eliminated.

In d-c voltage-controlled single-stage self-balancing magnetic amplifiers, the signal voltage is balanced by several voltages. These are supplied in time sequence by the voltage drop across feedback resistors carrying the full-wave unidirectional output current and by voltages induced in the control-winding elements from nonfired core components during their gating half-cycles.

Therefore, when operating a two-phase induction motor from such an amplifier, it will be necessary to apply a d-c controlled push-pull magnetic-amplifier circuit which supplies the motor and also the feedback resistors producing negative feedback resistance-coupled into the control-circuit loop.

The balanced control circuit demands practically no energy from the d-c signal source, a phase-sensitive rectifier supplied from a synchro-control transformer. The effective input resistance is about 100 to 1,000 times higher than the input-circuit resistance.

To convert a push-pull magnetic amplifier with two equally rated saturable reactors utilizing either external feedback or self-saturation into a self-balancing circuit, two feedback resistors and the control windings of the two-phase motor may be connected with the two saturable reactors in such a way that the resultant d-c and a-c components of the four variable half-cycle pulses are polarity-reversible and are zero at zero input.[5] Thus, the separately excited two-phase motor is efficiently operated by the phase-reversible fundamental - frequency component of the unidirectional full-wave output-currents.[6,7,8]

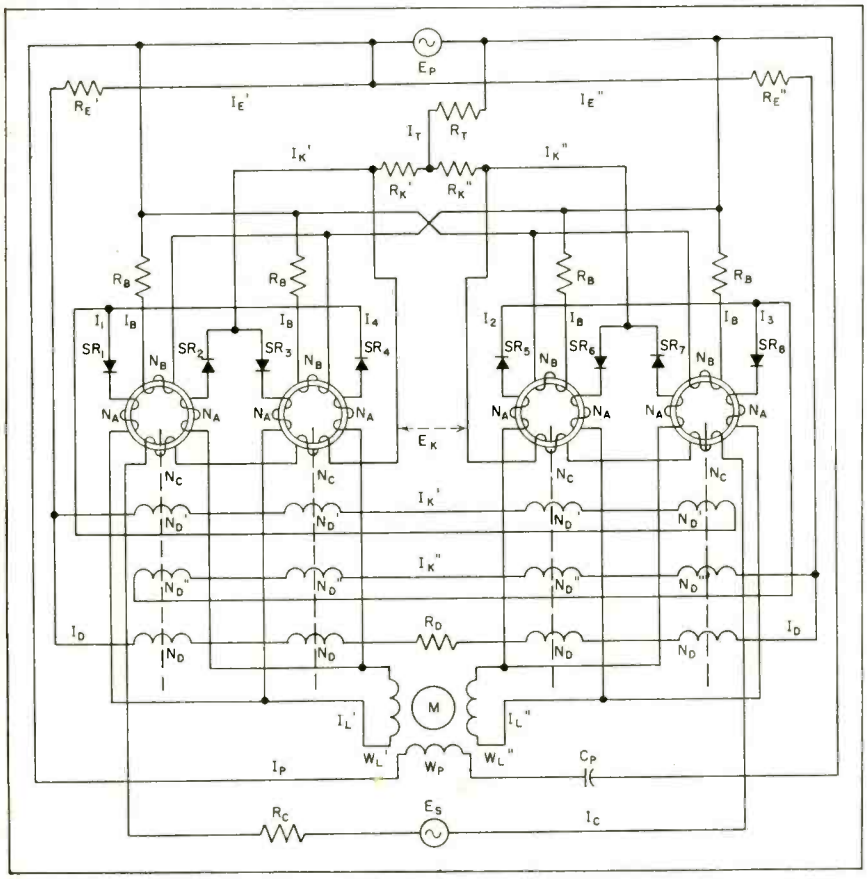
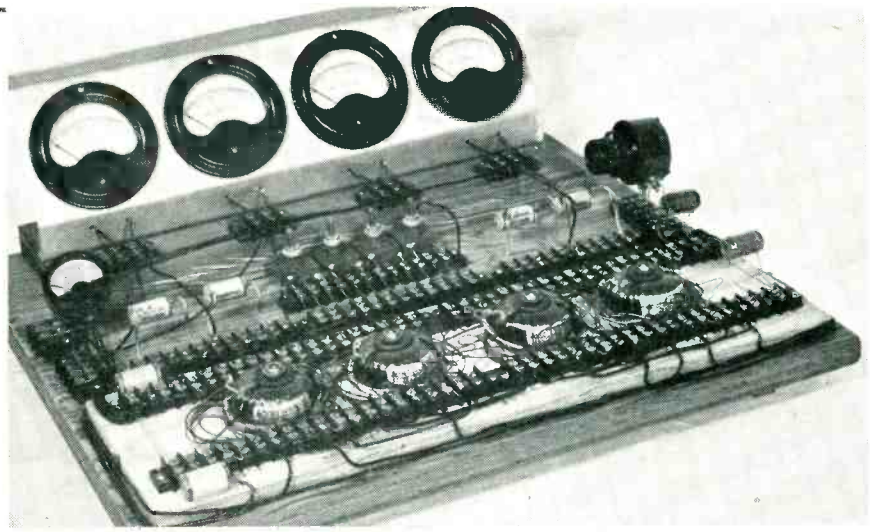


FIG. 1—Single-stage self-balancing magnetic servo amplifier for 400-cps operation provides half-cycle response

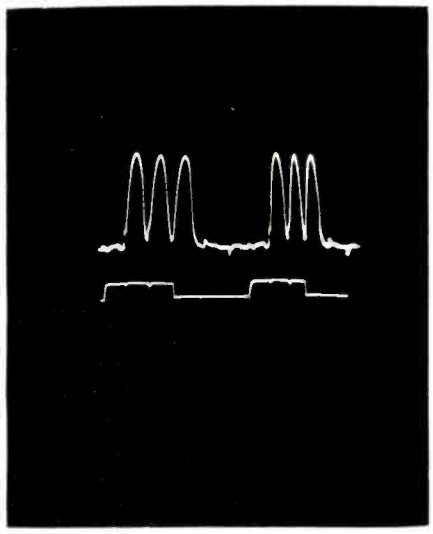
Magnetic-Amplifier Circuit

In Fig. 1, a comparatively large power-supply transformer used in similar circuits[5] has been elimi-

Servo Amplifier



Breadboard model of amplifier with test instruments mounted on panel at the rear. Four saturable reactor elements with Orthonol tape cores are in the foreground



Half-cycle transient response showing signal and negative feedback

nated. This was made possible by employing a double-bridge self-saturating push-pull amplifier with two pairs of feedback resistors, R_K'-R_K'' and R_E'-R_E''. Gate windings N_A of the four saturable reactors are divided into two equally rated parts.

The circuit is operated from a 115-v, 400-cps line voltage E_P in connection with a standard 400-cps two-phase squirrel-cage motor. This motor has two separate 58-v control windings W_L' and W_L'' (maximum output power 3 w or 20 v-a) and the 115-v line-field winding W_P, with series capacitor C_P securing proper phasing of auxiliary current I_P.

The 2-mil Orthonol® tape cores of the four saturable reactors are $1\frac{3}{8}$ in. o-d, $1\frac{1}{8}$ in. i-d and $\frac{1}{4}$ in. wide. Each core has multilayer toroidal windings of enamel-insulated copper wire. See Table I.

Four center-tapped selenium rectifier sets each having 2 by 4 cells with one-square-inch plates have been used successfully, but silicon diodes may be used equally well. When employing an output transformer having two separate center-tapped primary windings, one center-tapped rectifier set on each side of the push-pull circuit may be eliminated and simple gate windings, 3,600 turns instead of 2 by 1,800 turns, may be provided.

The resistance values of a-c bias resistors R_B and feedback resistors R_K', R_K'', R_E' and R_E'' are not critical.

Mode of Operation

Rectifiers SR_1, SR_2, SR_7 and SR_8 are conducting simultaneously during the first half-cycle of power-supply voltage. Rectifiers SR_3, SR_4, SR_5 and SR_6 conduct simultaneously during the second half-cycle. The feedback resistors and the motor control windings are supplied with variable unidirectional full-wave currents I_K', I_K'', I_E', I_E'', I_L' and I_L'' in such a way that the resultant d-c and a-c components of the four half-cycle pulses I_1 to I_4, are polarity-reversible and are zero at zero input.

Resistors R_K' and R_K'' and positive-feedback windings N_D' and N_D'' carry unidirectional currents having the average values $I_K' = I_1 - I_4$ and $I_K'' = I_2 - I_3$. Motor control windings W_L' and W_L'' are supplied with unidirectional currents $I_L' = I_1 + I_4$ and $I_L'' = I_2 + I_3$. A common a-c line resistor R_T may be provided to limit magnitude of total alternating current I_T.

Figure 2 illustrates the mode of operation with regard to the two-phase motor, feedback resistors and series-connected positive-feedback windings N_D' and N_D''. They show the variations of the average values of the four half-cycle pulses I_1 *to* I_4 and the waveforms of load currents I_K', I_K'', I_L' and I_L''. With no-signal conditions, pulses I_1 to I_4 have 50 percent of their maximum value. That is, the firing angle of the four saturable-reactor elements is 90 degrees; I_1 to $I_4 = 50$ ma.

With $E_S = 0$, the average values of I_1 and I_4 and those of I_2 and I_3 are equal. The fundamental-frequency components of I_L' and I_L'' are zero, and $I_L' - I_L'' = 0$ (Fig. 2A).

The d-c components of I_K' and I_K'' are zero (Fig. 2B) and feedback voltage $E_K = 0$.

Reversible Signal

When a positive signal voltage is applied, pulses I_1 and I_2 will increase, while pulses I_3 and I_4 will decrease. Consequently, there is a positive fundamental-frequency load current $I_L' - I_L''$ and a corresponding d-c component $I_K' + I_K''$.

However, with negative signal voltage, pulses I_1 and I_2 will decrease and pulses I_3 and I_4 will

increase. There is a negative fundamental-frequency load current $I_L' - I_L''$ (Fig. 2A) and a d-c component $I_K' + I_K''$ (Fig 2B).

Thus, the push-pull circuit will operate the separately-excited two-phase motor by pure phase-reversible alternating current $I_L' - I_L''$. Feedback resistors R_K' and R_K'' will produce the unidirectional full-wave polarity-reversible negative-feedback voltage $E_K = I_K'R_K' + I_K''R_K''$ in the control-circuit loop. With $R_K' = R_K'' = R_K$, the term $(1/R_K) = (I_K' + I_K'')/E_K$ represents the transconductance of the circuit with regard to the negative-feedback resistors.

Positive-feedback windings N_D' and N_D'' and the additional feedback windings N_D will carry polarity-reversible d-c components corresponding to actual magnitude and direction of the polarity-reversible signal voltage.

These windings are provided for producing an effectively infinite internal gain of the amplifier. The positive-feedback windings N_D' and N_D'' acting as boosting windings produce 100-percent positive feedback to compensate for imperfections of the saturable reactors and rectifiers. The additional feedback windings N_D with series resistor R_D make it possible to adjust the additional positive or negative magnetic feedback of these windings in such a way that the control-winding current I_c is substantially reduced to zero. These windings offer the possibility of providing positive

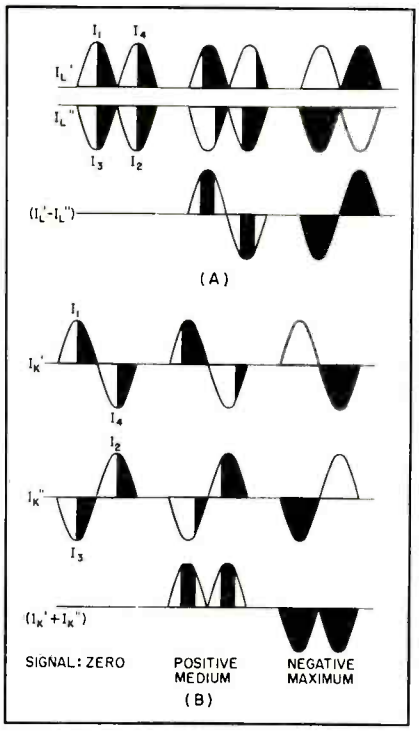


FIG. 2—Four half-cycle pulses and resultant motor currents (A) and feedback currents (B)

or negative fractional turns to obtain optimum adjustment. With $R_E' = R_E'' = R_E$, the effective positive-feedback ampere-turns will be $I_K'N_D' + I_K''N_D'' + (I_E' \pm I_E'')\ N_D\ [R_E/(R_E + R_D)]$.

Performance Characteristics

The effective input resistance of the control circuit is dependent on the magnitude of control-winding current I_c. Since the amplifier does not contain any rectifier components in its control-circuit loop, the control magnetizing current is capable of assuming any magnitude and direction necessary to support the magnetic-flux conditions imposed by the applied voltages.

Average value of control-winding current has been measured by a shunted mirror-type galvanometer. Figure 3A shows I_c as a function of signal voltage when a properly rated feedback-control resistor R_D is provided to secure critical regeneration.[1]

Current I_c varies from zero to ± 100 microamperes and the a-c component of I_c may be reduced to values of the same order by introducing a choke into the control circuit[10] without affecting the transient response of the amplifier.

Dynamic response is dependent on the number of turns of the control windings N_c. The response time may be reduced to one half-cycle of the power-supply frequency by making turns ratio N_c/N_A approximately equal to resistance ratio R_K/R_o, where $R_K = R_K' = R_K''$ is the resistance of the negative-feedback resistors and R_o is the total resistance of each output circuit including load-resistance, resistance of gate windings N_A and forward resistance of the half-wave rectifiers.

The dynamic properties of the circuit have been studied by applying a synchronous square-wave signal voltage derived from a magnetic-switch transient analyzer.[11]

The oscillogram shows the transient response of this circuit operating under the following conditions: $R_K = 10$ ohms, $R_o = 180$ ohms, $R_K/R_o = 1/18$; $N_c = 200$ turns, N_A (total) $= 3{,}600$ turns, N_c/N_A (total) $= 1/18$; $R_T = 0$; $R_B = 30{,}000$ ohms.

The lower trace indicates the unidirectional square-wave signal voltage. The upper trace shows the transient response of the full-wave negative-feedback voltage E_K across resistors R_K', R_K''.

The response time is one half-cycle of the power-supply frequency. Thus the amplifier reaches 100 percent of its final steady-state output current 1.25 milliseconds after the transient signal voltage is applied and the output current drops to zero 1.25 milliseconds after E_s is removed.

The half-cycle transient response

Table I—Winding Data for Saturable Reactors

Windings	Wire Size	Turns	Resistance in Ohms
Gate N_A	31	2 × 1,800	2 × 40
Bias N_B	31	400	12
Control N_C	31	200	6
Positive feedback N_D', N_D''	28	each 5	2 × 0.1
Additional feedback N_D	31	100	3

Table II—Core and Winding Data for Transformers of Phase-Sensitive Rectifier

		Reference-Voltage Transformer T_P	Signal-Voltage Transformer T_{CT}
Core	Material	¼ × 0.002 Orthonol tape	¼ × 0.002 Supermalloy tape
	Size (in.)	1⅛ i-d 1⅜ o-d	1⅛ i-d 1⅜ o-d
Primary	Wire Size	No. 33	No. 33
	Turns	4,000	4,000
Secondary	Wire Size	No. 33	No. 33
	Turns	4 × 400	2 × 800

reduces the stabilization problems that usually accompany use of magnetic amplifiers in closed-loop servo systems. Dynamic performance has been investigated by operating the amplifier with a 400-cps position servomechanism and a phase-sensitive rectifier acting as a demodulator in the input circuit.

The star-modulator[12] full-wave phase-sensitive rectifier of Fig. 4A contains reference-voltage transformer T_P with ordinary core material and two center-tapped secondary windings, signal-voltage transformer T_{CT} with Supermalloy 2-mil tape core and one center-tapped secondary winding, four silicon diodes and mixing resistors R_E' and R_E''.

If reference voltages $E_1 = E_2 = E_3 = E_4$ = constant $\times$ E_P are in phase or 180 deg out of phase with the signal voltages $E_A = E_B =$ constant $\times$ E_{CT} and if the reference voltages are slightly larger than the maximum value of the signal voltages, the polarity-reversible d-c signal voltage applied to the input circuit of the amplifier will be proportional to the phase-reversible a-c error-signal voltage E_{CT} of the synchro-control transformer. Table II gives winding data for these transformers.

Measurement of bandwidth on a 400-cycle position servomechanism using a servoscope have shown that the bandwidth is about 20 cycles when a tachometer generator is employed for stabilizing the servo system. Bandwidth values of the same order have been obtained when eliminating the tachometer generator by introducing frequency-sensitive components such as integrating circuit C_FR_F of Fig. 4B into the negative-feedback channel of the magnetic amplifier.

The value of the asymmetry zero-drift error, expressed in terms of d-c signal voltage, has been measured. The voltage gain of the amplifier was held constant in all cases, but with various total-resistance values R_C of the control circuit and with various amounts of asymmetry. Well-defined amounts of asymmetry have been introduced by varying only bias resistor R_B from 30,000 to 40,000 ohms, while the other three bias resistors (30,000 ohms) remained unchanged.

Figure 3B presents the measured values of drift error in terms of signal voltage as a function of bias-resistor variation ΔR_B, with the control-circuit resistance R_C as a parameter.

Results show that when reducing the total control-circuit resistance from 10,000 ohms to about 100 to 200 ohms and applying self-balancing operating conditions (effective input resistance E_S/I_C at least 10,000 ohms), the magnitude of the asymmetry zero-drift error is reduced to about 1/40 its original value.

This is also true when the asymmetry of the push-pull circuit is caused by variations of the characteristics of the saturable-reactor and rectifier components. Therefore, the requirements on grading and matching of these components are greatly reduced.

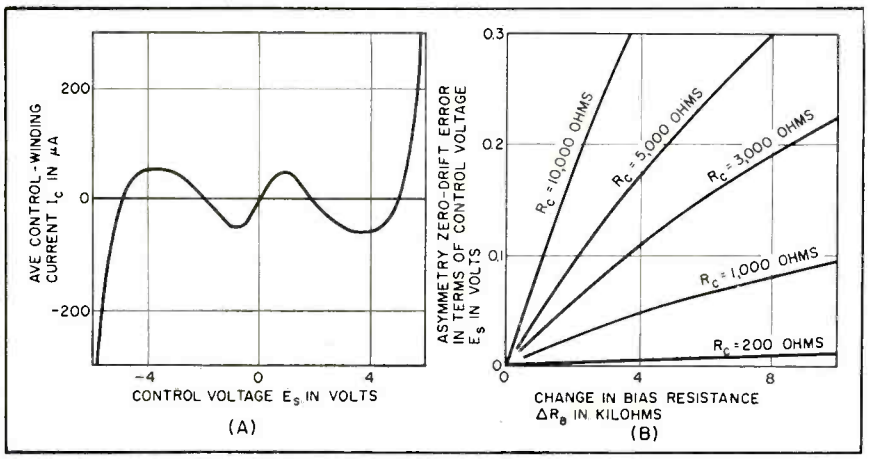


FIG. 3—Control-winding current as a function of d-c signal voltage (A). Asymmetry zero-drift error in terms of d-c signal is shown as a function of bias variation with control-circuit resistance as a parameter (B)

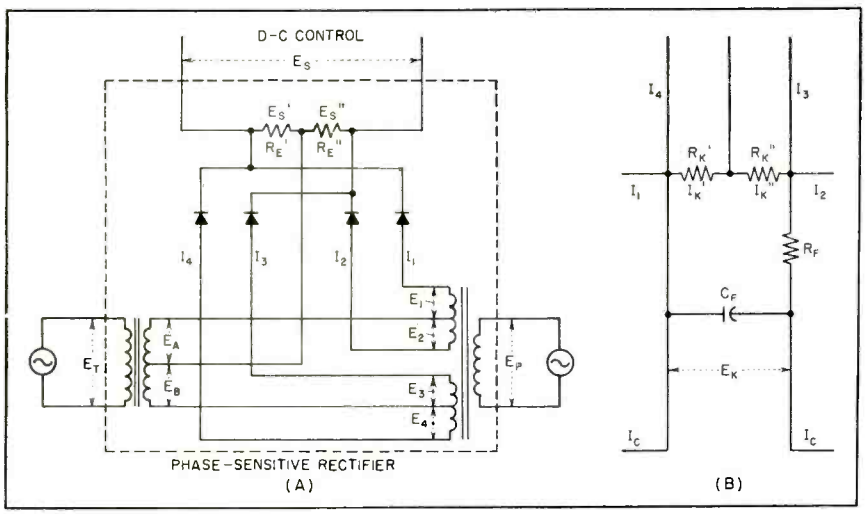


FIG. 4—Star modulator phase-sensitive rectifier for applying polarity-reversible d-c signal (A). Use of frequency-sensitive components in degeneration network (B)

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Normalized Filter Design——

By SAMUEL D. BEDROSIAN* and R. McCOY, Jr.

Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

SUMMARY —— Design chart for composite low-pass filters permits predetermining decibels of rejection from trial design. Six normalized designs are presented as examples to cover a practical range of stop-band loss

THERE IS NEED for a simple means of predetermining the rejection in decibels to be expected from a trial design of a composite filter to meet specific requirements.

Six normalized precut designs which cover a practical range of stop-band loss are presented.

Equal-ripple or Chebychev behavior of the stop band of a low-pass filter is illustrated in Fig. 1. The attenuation loss of the filter in the stop band is always greater than a prescribed minimum loss.

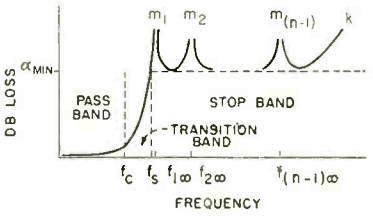


FIG. 1—Ideal Chebychev stop-band response

The normalized curves shown in Fig. 2 are derived by conventional Zobel design to give such equal-ripple attenuation loss. Each curve is related to a ladder-filter structure consisting of one k section and a number of full m-derived sections as shown in Fig. 3A. Note that the curve numbers in Fig. 2 indicate the number of elements in the com-

* Presently with Burroughs Corp., Research Center, Paoli, Pa.

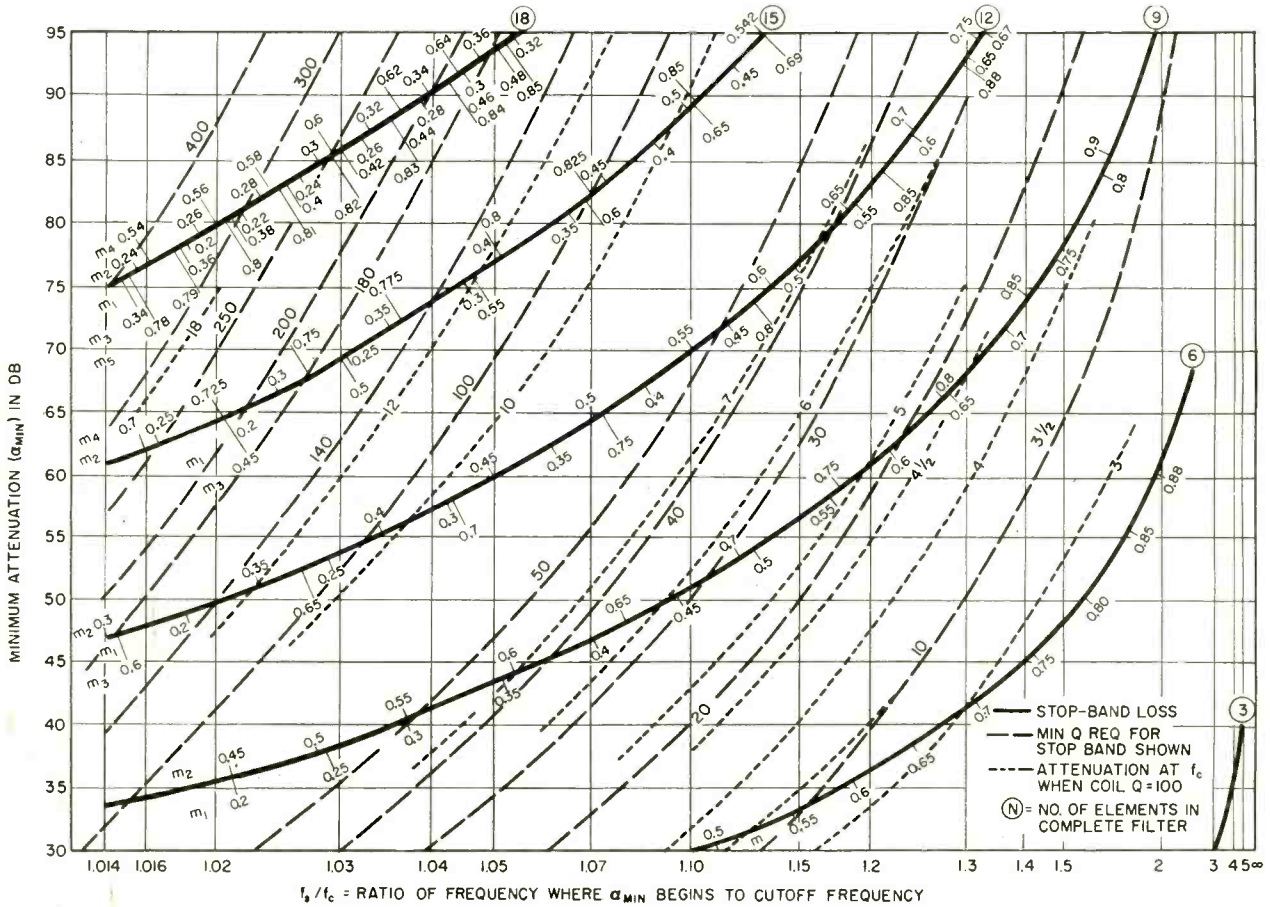
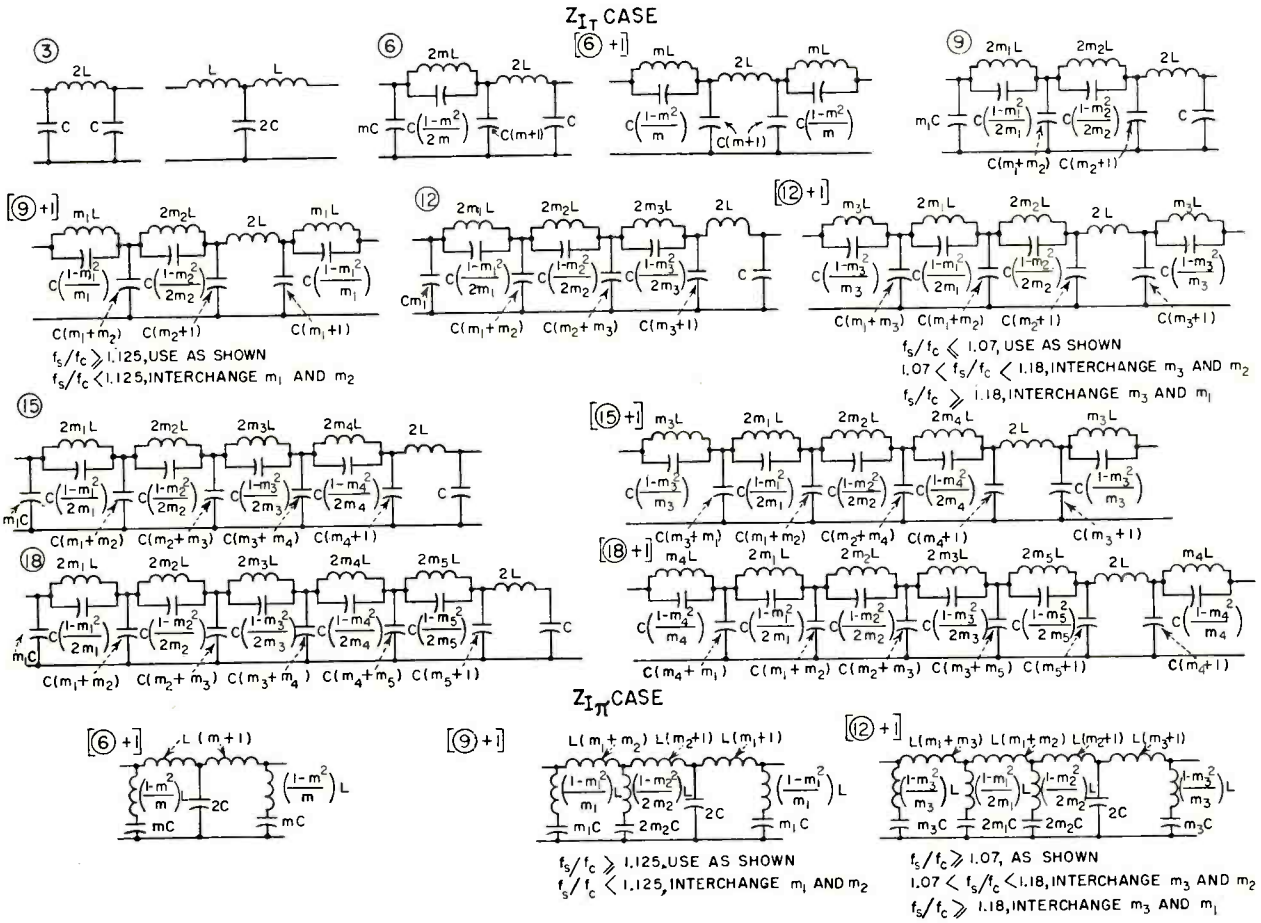


FIG. 2—Design chart. Encircled numbers on curves represent number of elements in complete filter

Table I—Filter Configurations



plete filter. Figure 3B gives the image-impedance characteristic of this network in the pass band.

To obtain a better impedance match with resistive circuits, while maintaining the same attenuation-loss characteristic, the filter section having an m value closest to 0.6 may be divided and used as terminating half-sections at each end. This will result in a complete filter network with only one additional element as shown in Fig. 4A. Various image-impedance characteristics may be obtained depending on the choice of m for the end section as shown in Fig. 4B.

Other variations in network configuration are possible, some of which are given in Table I.

Since image-parameter filters are being considered, corrections must be made to theoretical attenuation to give the insertion loss of the network for resistive circuit applications. Insertion loss is the sum of attenuation, reflection and interaction losses.

Corrections to the stop-band loss due to reflection loss at both ends of the filter are given in Fig. 5 for the k (or $m = 1.0$) and $m = 0.6$ types of termination. Note that the reflection effect does not assist in providing the desired net loss. Thus it indicates the basis for the rule of thumb which calls for a 6-db safety factor in the attenuation characteristic when designing conventional filters.

Interaction loss is negligible for attenuation losses greater than 15 db. It is not important in the pass band, but is a factor near the cutoff frequency.

Loss Characteristic

Two design conditions must be known or established before using the curves which give the constants needed in low-pass filter design equations. The first is the minimum attenuation loss (α_{MIN}) desired in the stop band. The second is the steepness of the transition band as expressed by f_s/f_c, the ratio of the frequency at which the minimum attenuation begins (f_s) to the cutoff frequency (f_c). The use of these two values as coordinates locates a point on Fig. 2, on or near one of the solid stop-band attenuation loss curves.

If the nearest stop-band attenuation-loss curve, with appropriate allowance for reflection loss, does not meet the design conditions either or both design conditions must be changed so the point selected will be located on an attenuation loss curve. The particular stop-band attenuation loss curve selected determines a specific filter network

(Continued on p 202)

Normalized Filter Design

(Continued from p 201)

given in Table I. The required m values can be read at the point selected on the curve.

The long-dash curves in Fig. 2 indicate the Q necessary in the tuned circuit, giving the first peak in the attenuation-loss characteristic to obtain the desired minimum attenuation loss in the stop band. If the necessary Q is too high to be readily obtainable, one or both design conditions must be altered to find a new point on the same or a higher-order curve. It is possible to use active circuits employing Q multipliers or transistors if the filter application warrants this added complication. Figure 6 permits calculation of loss at the nominal cutoff for other values of Q.

Figure 7 provides data to permit determination of the effect of Q on the theoretically infinite loss at the critical frequencies when additional discrimination against particular frequencies is required.

In filter work it is usual to employ essentially lossless capacitors so the Q value of the filter network is the Q of the coils used measured at the cutoff frequency. In the event that all the coils do not have approximately the same Q, the m sections with theoretically infinite frequency closest to cutoff frequency are the most critical.

The previous procedure refers to the filter configurations of Table I. Actual choice of network depends on such considerations as the terminating impedance to be matched and the availability of inductors and capacitors. Note that the preferred combination of m values is indicated in the table for the $[(N)+1]$ element case to give terminating half-sections closest to $m = 0.6$.

Since impedance and cutoff frequency of a normalized filter are both unity, the transformation required to get a practical filter is accomplished by making R equal to the desired nominal filter impedance in ohms and setting f_c equal to the desired cutoff frequency in cps. The data in Fig. 2 and 6 should be used as a guide to adjust the nominal cutoff frequency to get the effective cutoff frequency of the low-pass filter.

The element values for the normalized filter networks of Table I are given by $L = R/(2\pi f_c)$ in henrys and $C = L/R^2 = 1/(2\pi R f_c)$ in farads. The m-parameter values are read from Fig. 2.

The value of $(1 - m^2)/(2m)$ which appears for every full m-derived section is given in Fig. 8.

Examples

(1) A low-pass filter is required with 40-db rejection in the stop band. The pass band extends to 2.2 kc (3-db point) and the stop band starts at 3.1 kc. Nominal impedance is 500 ohms.

Compute the steepness factor

(Continued on p 204)

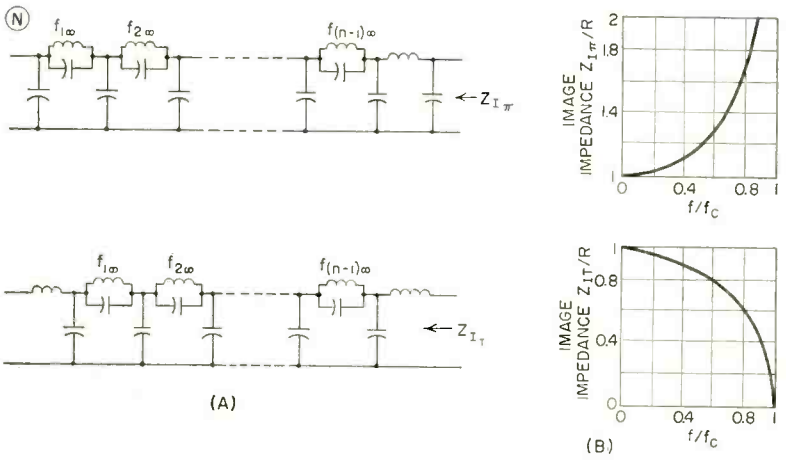


FIG. 3—Filter networks with N elements (A) and impedance characteristics (B)

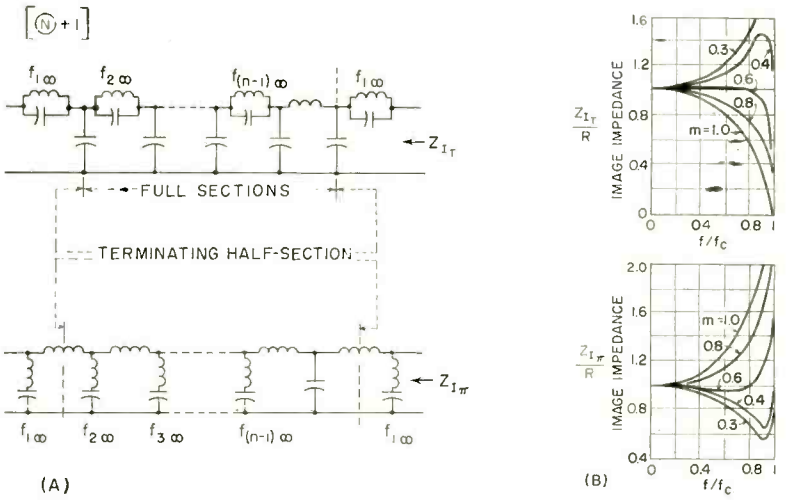
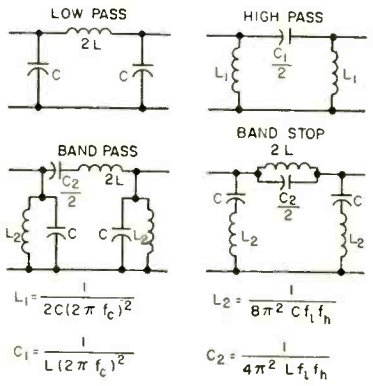


FIG. 4—Filters of Fig. 3 with additional element as terminating half-section at ends

Table II—Transformations of a K Section



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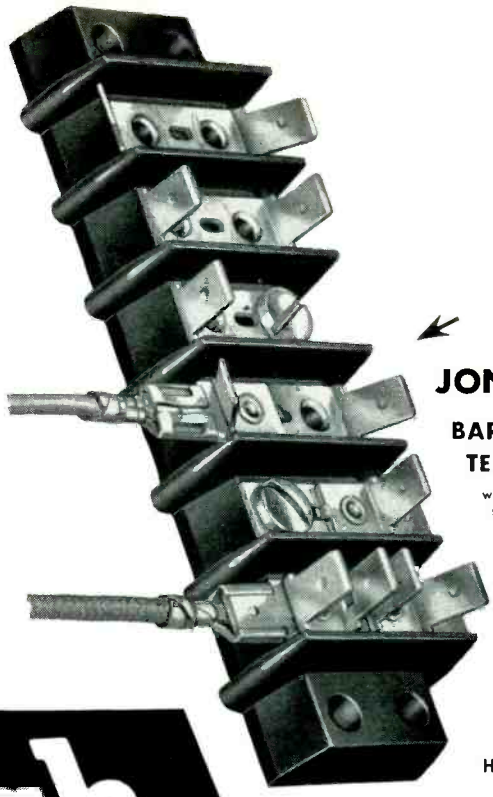

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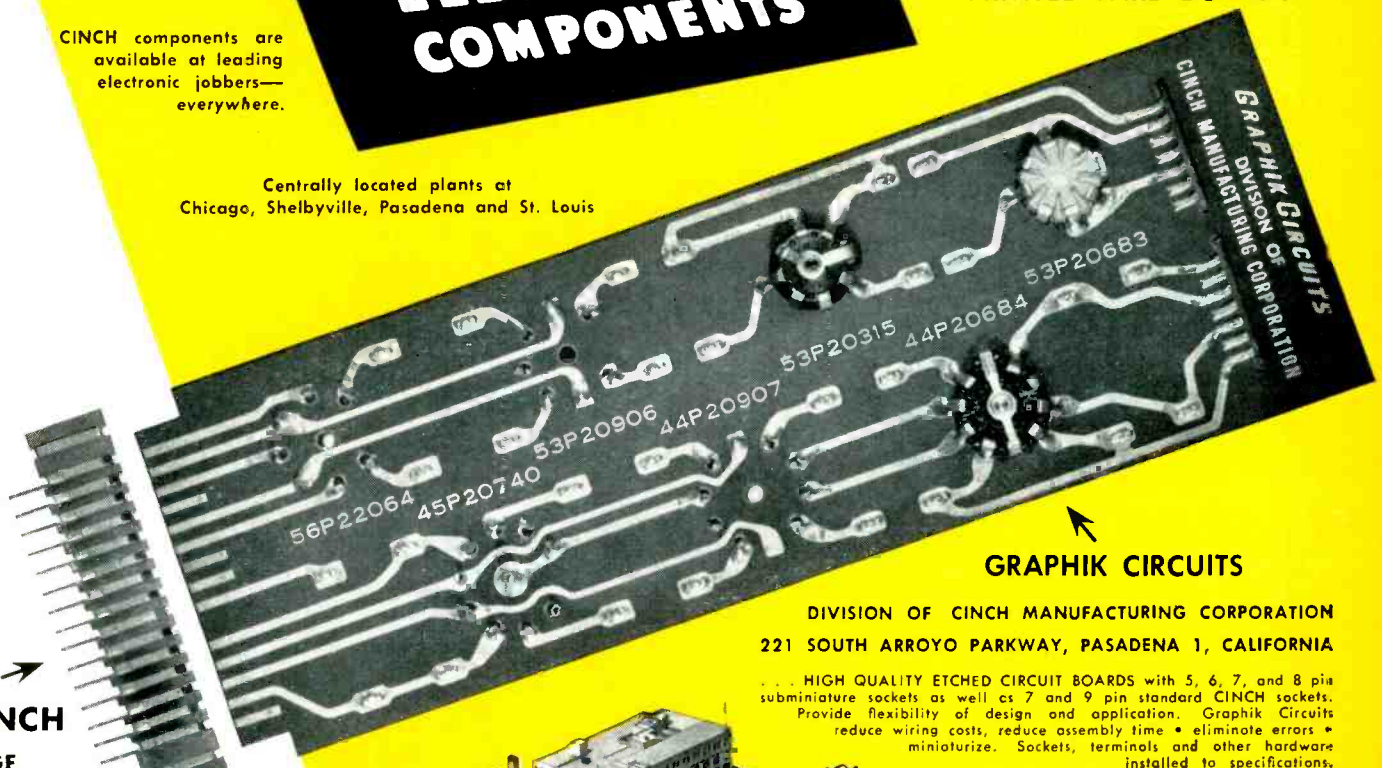

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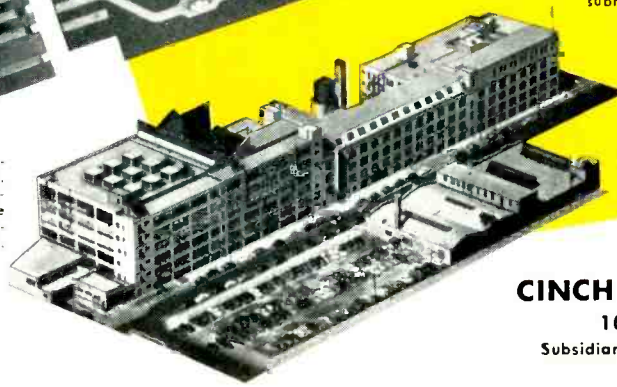

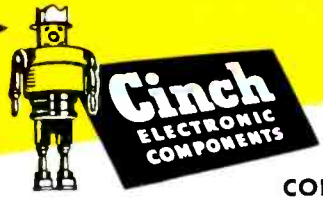

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Normalized Filter Design

(Continued from p 202)

$f_s/f_c = 3.1/2.2 = 1.41$. Use the rule of thumb of 6-db additional loss in the stop band since no specific details are available on the impedance requirement.

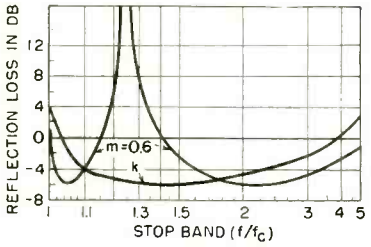

FIG. 5—Stop-band loss due to reflection loss at ends of filter

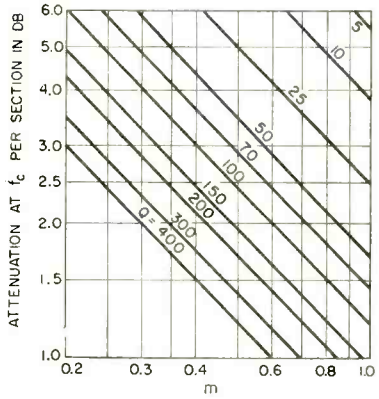

FIG. 6—Loss at cutoff frequency

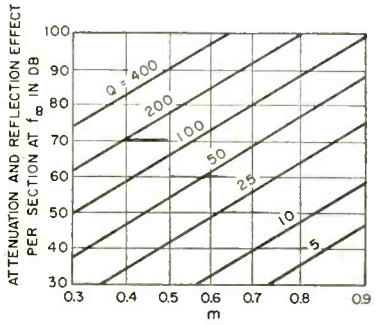

FIG. 7—Effect of Q on infinite loss at critical frequencies

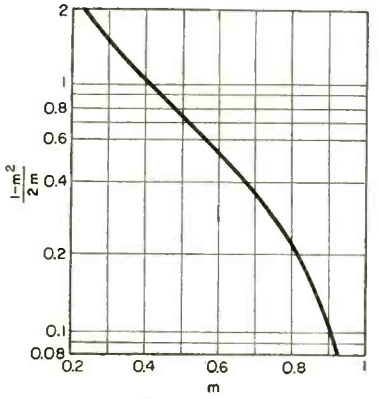

FIG. 8—Magnitude of $(1-m^2)/(2m)$ vs m

Keeping Fig. 5 in mind refer to Fig. 2 where the requirement of 46 db is met by curve 6.

Note also from Fig. 2 that the required Q is less than 10, which imposes no problem. The loss at cutoff is less than 3 db for coils with a Q of 100. Reading the curve, $m = 0.74$ for $f_s/f_c = 1.41$.

Figure 8 shows $(1 - m^2)/(2m) = 0.305$ for $m = 0.74$. For a terminating half-section, this factor is twice as large or 0.611.

Calculate the prototype inductance and capacitance, $L = 500/(2\pi \times 2{,}200) = 36.171$ mh and $C = 0.03617/(500)^2 = 0.1447\ \mu f$.

The complete filter is shown in Fig. 9A and the measured characteristics are shown in Fig. 9C. Coil Q is 50 to 55 at 2.2 kc.

(2) A low-pass filter is required to pass up to 4 kc (3-db-down point). The stop band with a minimum of 40-db rejection starts at 4.85 kc. The nominal impedance is 600 ohms.

Checking the curves in Fig. 2, it is found that curve (9) looks promising for 46 db attenuation (40 + 6), in that it gives 1.06 for steepness factor f_s/f_c; therefore $f_c = 4.45$ kc.

Proceeding as in the previous example, calculate the element values after reading off the m parameters. The complete filter for [(9) + 1] elements (Z_{IT} case) with $m_2 = 0.62$ and $m_1 = 0.375$ is shown in Fig. 9B. The loss at the theoretical cutoff equals 6.3 db using data found on Fig. 6 for $Q = 100$. Measured characteristics for this filter are given in Fig. 9C. Coil Q is 90 to 100 at 4 kc.

Network Transformation

Ordinary reactance-frequency transformations can be utilized to convert a low-pass filter into a high-pass, band-pass or band-stop filter. For low pass to high pass, change every coil to a capacitor and every capacitor to a coil; for low pass to symmetrical band pass, change every coil to a series-tuned circuit and every capacitor to a parallel-tuned circuit; for low pass to a symmetrical band stop, change every coil to a parallel-tuned circuit and every capacitor to a series-tuned circuit. This is shown for a k section in Table II. The low-pass frequency scale, f_s/f_c, is transformed to f_c/f_s for high-pass, to $[f_{sm} - (f_l f_h/f_{sh})/f_h - f_l]$ for band pass and to $(f_h - f_l)/(f_{sh} - f_h f_l/f_{sh})$ for band stop.

Note in Fig. 10 that $f_c = f_h - f_l$; $f_s = f_{sh} - f_{sl}$ and $f_l f_h = f_{sl} f_{sh}$.

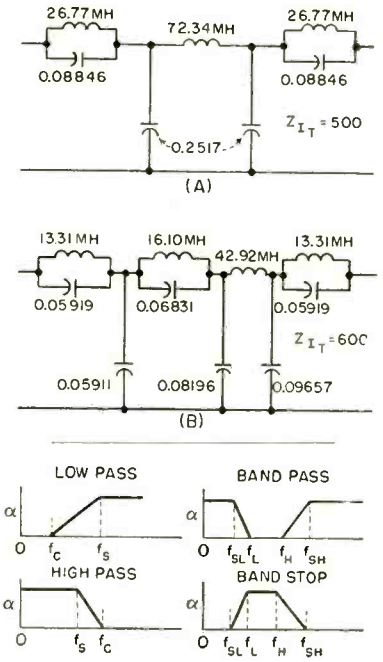

FIG. 9—(above) Filter configurations (A and B) for examples in text and characteristics (C). Coils wound on molybdenum Permalloy toroids with 0.8-in. diameter and permeability = 125

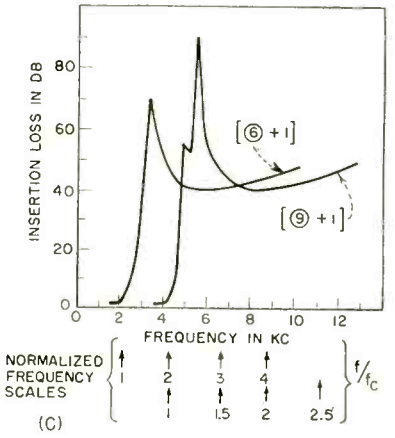

FIG. 10—(left) Converted filter characteristics

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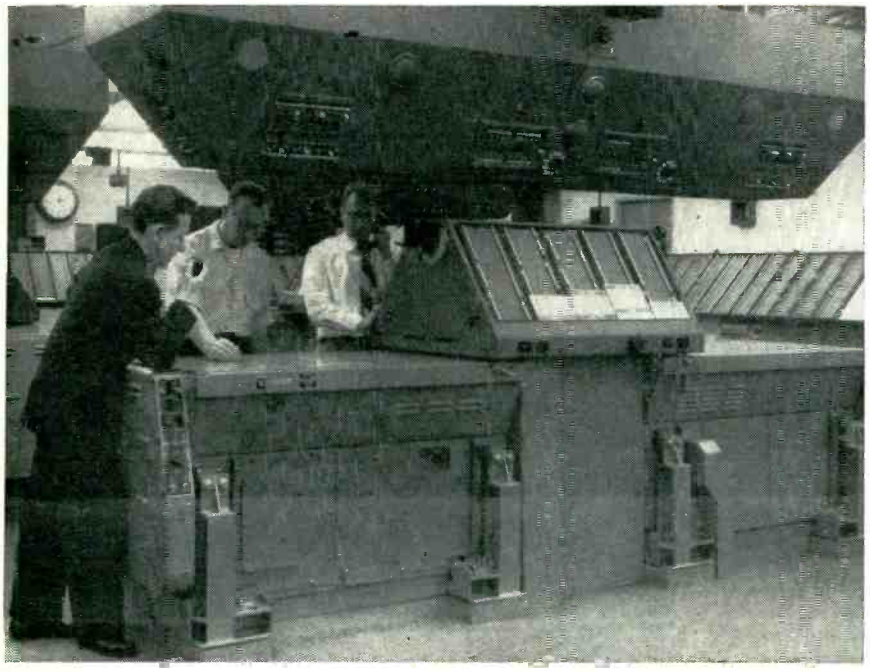
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Idlewild Gets New Search Radar



Installation at New York International Airport of GE FPS-8 radar gives Civil Aeronautics Administration traffic controllers a long-range look. The control of aircraft in all weather can now be extended to over 100 miles. Video presentations from the radar are projected onto the horizontal glass plates (left). Transmitter-receiver building is located at the base of the radar antenna (right)

Jeep Radio Increases Communications Span

Versatile new communications equipment mounted in Army jeep

LONG-RANGE communications equipment up to four times more powerful than models previously in use has been designed by Army Signal Corps Engineering Laboratories and Collins Radio Co.

Equipment for jeeps, tanks and trucks can be put on the air within moments after being parachute-dropped in its vehicle. Voice and radio teleprinter signals can be transmitted and received at the same time. If desired, the transmitter can be remotely controlled from 75 feet away.

There are seven preset channels that are actuated by a selector switch and the microphone button. Releasing the microphone button cuts the receiver in automatically. Other channels can be selected by

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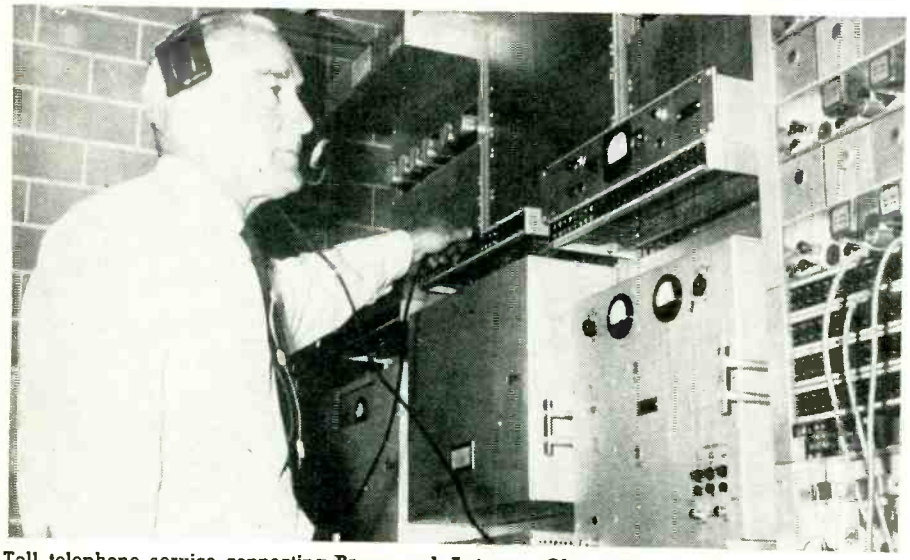
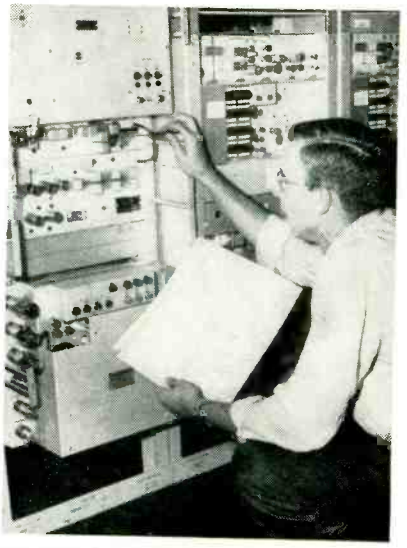
a direct-readout indicator. When the automatic tuning equipment has completed its cycle, a red light signals readiness.

Servicing is simplified by use of plug-in replacement parts. The new equipment is powered from the vehicle's battery and it works at temperatures from −40 to 149 F.

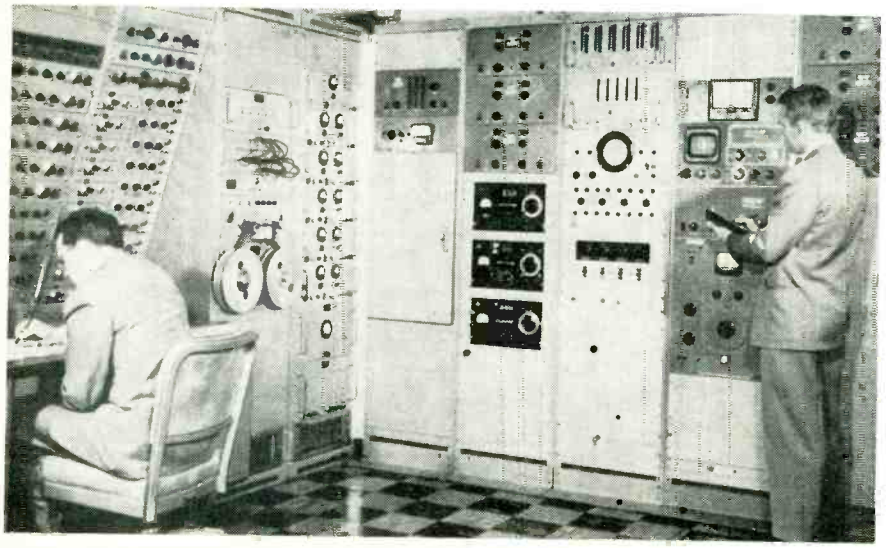
Microwave Telephone System Links Ohio and Indiana





Toll telephone service connecting Bryan and Antwerp, Ohio with Fort Wayne, Indiana uses 900-mc microwave equipment recently put into operation. A joint project between General Telephone Co. of Ohio and The Home Telephone and Telegraph Co., the system has been arranged for initial capacity of 48 channels with possible expansion to 72. Equipment is designed for eventual expansion to 360 channels. Antwerp equipment is undergoing post-installation test (left) while radio modulator panel receives adjustment (right)

Data Reduction System Aids Gas Turbine Development



Previously recorded data from many channels is subjected to analysis

MECHANICAL and aerodynamic phenomena in jet engines are evaluated at General Electric's Cincinnati plant. Data fed into a magnetic tape recording is later put through a reduction system where analysis is effected electronically.

In the system, multiple channels of information such as stress, vibration, pressure, temperature, speed and flow can be recorded simultaneously at a test site. The data may be steady or it may vary up to 30 kc.

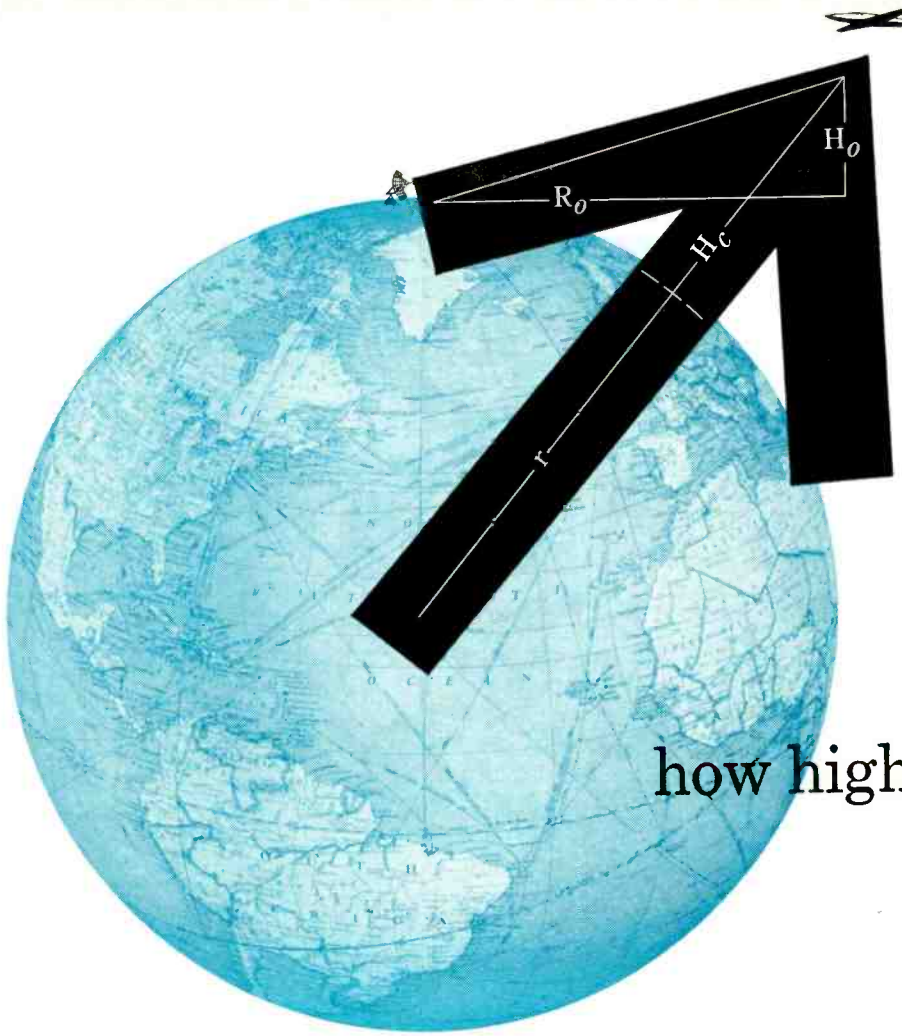
Output of the system comprises various suitable devices, such as function plotters, direct-writing oscillographs, recordings in terms of instantaneous amplitude and frequency or by oscilloscopes.

Linear Electrostatic Loudspeaker

By J. H. JUPE
Chorleywood West
Rickmansworth
Hertfordshire
England

ELECTROSTATIC loudspeakers have been designed many times in the past but they are usually made with two plates and become square-law devices, which must inevitably introduce distortion. For this reason, and perhaps because high voltage d-c sources necessary to operate them are fairly expensive, such loudspeakers have never been popular in the radio field.

A new type of electrostatic loudspeaker developed in Britain entirely overcomes the distortion problem and has a linear response from



how high is up?

A child's conundrum becomes a matter of life and death... when radar tells a lie. When our radar tracks attacking aircraft... or an incoming missile... the lives of all of us on target balance on the pinpoint of a mathematical riddle.

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Electronic Engineering Company of California has designed an analog computer that makes this vital correction... converting radar observation into true altitude above sea level. The computer continuously solves the equation

$$H_c = H_o + (R_o^2/\ 2r)$$

The mathematics are complex. The mechanism, with a two-gang HELIPOT* series A precision potentiometer at its heart, is beautifully simple. Both are fully described in a new application data sheet... write for Data File **301.**

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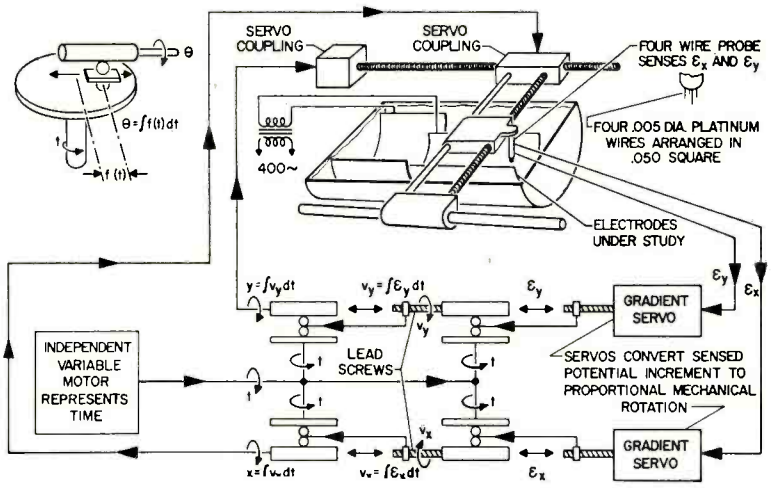
THE FRONT COVER



THE automatic electron trajectory plotter shown on the cover and represented schematically in the drawing is used in the Philco research laboratories to determine the electron trajectories produced in developmental electron-optical structures. The plotter drastically shortens the time that would otherwise be required by the construction and testing of these new structures in vacuum.

New electron-gun designs are built in a large-scale version and inserted in the tank so that the water level represents the plane of symmetry of the structure. When potentials are applied to the electrodes, the potential gradients produced in the electrolyte (tap water) are identical with those produced in the smaller structure in vacuum. Unlike other plotting tanks, which plot merely the equipotential lines of the structure, this equipment plots the whole electron path in a single automatic operation, eliminating laborious hand computation and achieving an accuracy unattainable otherwise.

Electron Optics For Apple Tube

IN the automatic trajectory plotter, a four-wire probe senses the potential gradients in the plane of symmetry, the surface of the tap-water electrolyte. These gradients, measured along the two axes of the tank, are applied as the inputs of an analog computer. Its output continuously positions the sensing probe so that its path conforms to the equations of the motion of an electron in the same field. The computer itself is a small differential analyzer; its chief components are four ball-disk integrators.

Unlike electrical integrators, which integrate their inputs with respect to time, the ball-disk mechanism integrates with respect to an independent variable that is the total rotation of its disk. Hence, it can be started, stopped or slowed down in mid-solution without in any way affecting the accuracy of the solution.

Following are the equations of the motion of an electron in a plane of symmetry, expressed in integral form

$$x = \int_0^t \left(\sqrt{x_0} - \frac{e}{m}\int_0^t E_x dt\right) dt$$

and

$$y = \int_0^t \left(\sqrt{y_0} - \frac{e}{m}\int_0^t E_y dt\right) dt$$

where $\sqrt{x_0}$ and $\sqrt{y_0}$ are initial velocities in the x and y directions respectively. To conform to these equations, the potential increments measured by the probe are translated to mechanical displacement by an appropriate servomechanism and fed into the ball-disk integrators, in two independent computing channels.

▶ **Combining** — Doubly integrated outputs are fed to the probe-positioning leadscrews. To minimize integrator error, the output shafts of the integrators should be loaded as lightly as possible. For this reason, servomechanisms are used throughout the computer as coupling elements between the integrators. Thus employed, the computing elements maintain an

zero frequency up to the limit of hearing. The device has three, flat parallel electrodes and between the outer ones, which are made of open mesh grids to allow the movement of air, a high d-c polarizing voltage is maintained.

▶ **Linear**—Between-grid potential is therefore linearly related to the distance from one of them. If now a third electrode of very thin polyethylene, covered with colloidal graphite to make it conducting and kept at a fixed voltage V is placed between the other two, no force will exist on it if it is placed in the electrostatic field at the point where the voltage of the field is also V.

In fact, if a voltage is applied to the polyethylene diaphragm it will move to the equipotential region. Consequently if an alternating voltage is applied to the diaphragm the force tending to move it will be proportional to the applied voltage.

In a moving-coil loudspeaker the force on the cone is applied by the coil and it is assumed that the cone moves as a whole. At least at the higher frequencies it fails to respond and distortion results. With the present electrostatic device this limitation does not apply, as the force is applied evenly over most of the area from which the sound radiates.

Also, because the operation and fidelity of the loudspeaker does not depend on the stiffness of the diaphragm, it may be made extremely light and flexible: a soap bubble would be quite satisfactory, although impracticable for other reasons. The diaphragm needs no restraining forces, except a suspension to stop it from falling downwards.

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accuracy of better than 0.1 percent.

Focal lengths determined in the tracer on test problems have been found to have 1-percent accuracy and aberration coefficients have been determined to within 30 percent. Since the independent variable of the solution is a shaft rotation representing time and not time itself, the solution can be halted as often as desired for the recording of velocities, position and accelerations.

These variables can be read from dials in the computer to four places. This feature permits the accumulation of much additional information about optical systems beyond the mere trajectories themselves. For example, the rate of accumulation of aberration can be determined along the axis of a lens under consideration, thus contributing much basic information to the art of electron gun design.

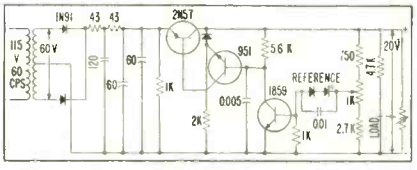
A complete trajectory can be plotted in about five minutes. Another five minutes are necessary to set in the initial conditions for the next trajectory; hence, a set of trajectories completely describing the structure under test can be run in one to two hours. In this way, a new design can be optimized in a week or two which might otherwise have taken months of development.

The plotter is currently being used in electron optical studies of the electron gun of the Philco Apple color television tube, shown to the right of the ray tracer equipment in the cover photograph.

Regulating Voltage With Transistors

EMPLOYING a *pnp* power transistor, the circuit shown serves as a voltage-regulated power supply for transistor circuits. The type 2N57 unit is placed in series with the rectifier and load.

A two-stage direct-coupled amplifier is employed in the feedback



Voltage-regulated power supply for transistor circuits

MEMO

TO Engineering Dept

SUBJECT

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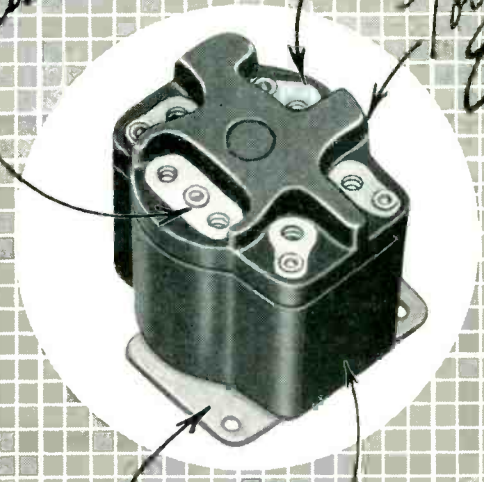

Operates in any Position

Variety of Mountings

Construction—Snap action contacts, totally enclosed, extra insulated terminals for terminal board use. This relay is available in a variety of mountings, operates in any position, and may be mounted on a grounded surface without additional insulation. Standard contact arrangement is single pole normally closed. Can furnish single pole double throw where extra normally open contact is required.

Operation—When power is applied to the motor a voltage is generated in the motor phase winding by the run winding as the motor accelerates in speed. The relay coil in parallel with the phase winding has the generated voltage of the phase winding across its terminals. When this voltage reaches a predetermined value . . . corresponding to the speed at which the phase winding can be disconnected . . . the relay picks up, opening the relay contacts and disconnecting the phase winding from the line.

Application—R-B-M Potential Type Motor Starting Relays are used to start single phase capacitor type motors where it is impractical or impossible to use a centrifugal switch. Such applications as hermetically sealed refrigeration and air conditioning motors, garbage disposal units and deep well submersible pump motors usually require relays of this type.

ENGINEERING DATA

Specifications	Potential Motor Starting Relay 91255 Type
Contact Forms Available	S.P.N.C., S.P.D.T.
Contact Current Rating	35 Amps. Max. Locked Rotor Start Winding Current
Contact H.P. Rating	3 H.P. Max.-N.O. Contact Rated 1½ H.P.-230 Volts
Contact Material	Silver Alloy or Tungsten
Continuous Coil Volts	Up to 500 V.
Underwriters and C.S.A. Status UL File Nos. SA1984 and E12139 CSA File No. LR 13360	Component Approval. Must be approved on Specific Application.
Life Expectancy	250,000 Operations

For characteristics other than the above, please consult the factory.

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ESSEX WIRE CORPORATION, *Logansport, Indiana*

loop. Reference voltage is obtained from the reverse-biased breakdown characteristic of silicon-alloy junction diodes. In the diagram, two diodes produce a reference voltage of 15.6 volts.

Output voltage is varied from 20 to 25 volts using the potentiometer. Quiescent current bias for the power transistor is supplied by the silicon transistor used in the output stage of the direct-coupled amplifier. Bias for the silicon transistor is obtained from the breakdown voltage of the silicon diode in the emitter circuit of the type 951 transistor, together with the 5,600-ohm resistor connected to the base lead.

The capacitor connecting the collector to the emitter of the type 1859 unit suppresses high-frequency oscillations. Frequency response of the voltage regulator is essentially flat to 10 kc.

This material has been abstracted from a *Quarterly Progress Report* of the Research Laboratory of Electronics at MIT.

Converter for Twin Single-Sideband

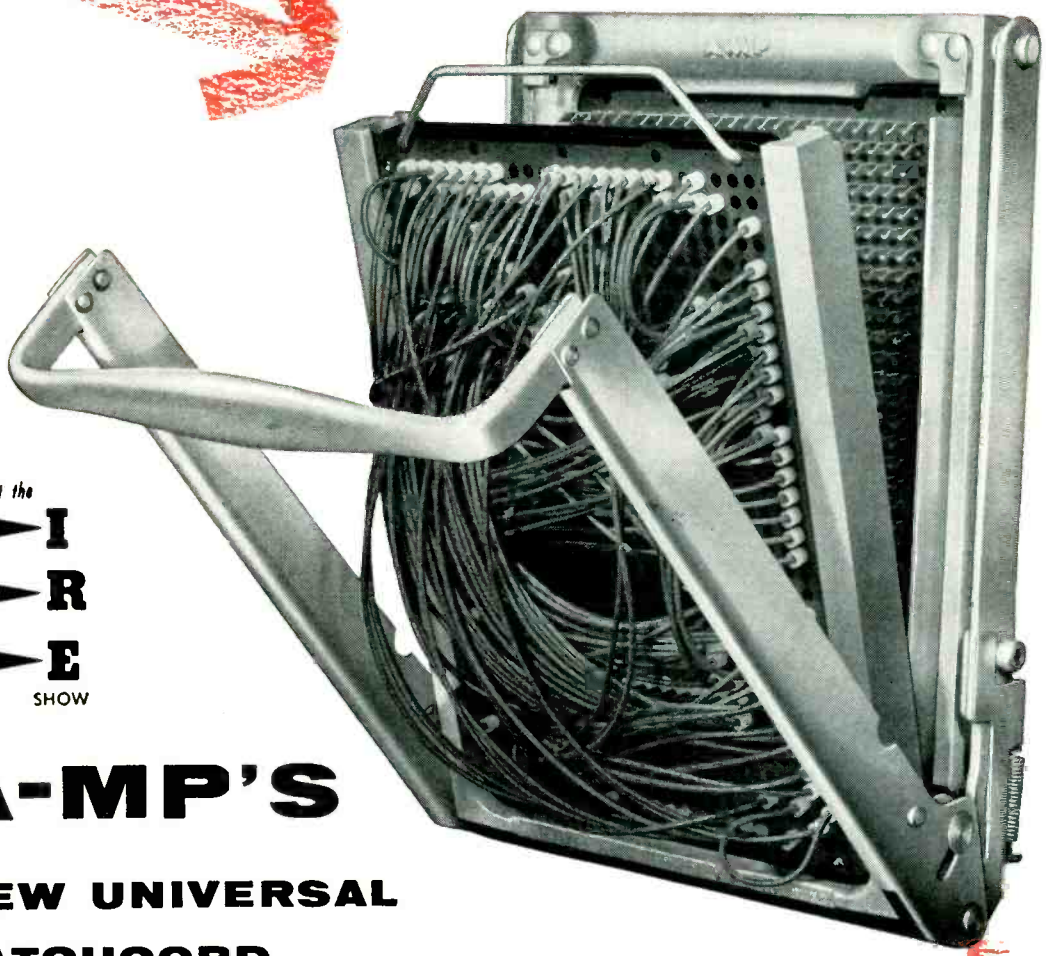
By SPENCER B. VARIAN

Communications Equipment Engineering Dept.
Hoffman Laboratories, Inc.
Los Angeles, California

TRANSMITTED power in a conventional a-m system is distributed among carrier and sideband frequencies on the basis of modulation depth. Under 100 percent modulation by a sine wave a maximum of one-third of the total energy appears in the two sidebands while at least two-thirds remain in the carrier.

Although the information is contained wholly in the fluctuations within a single sideband, only one-sixth of the total energy is used in transmitting that sideband. The singular principle of single-sideband communications is the economical use of power and frequency spectrum through transmission and reception of only the information-bearing sideband frequencies.

Modulation is accomplished in the conventional manner in a single-sideband system. However, a filter following the modulator circuits rejects all frequencies except one



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sideband group. In the classic single-sideband system, all transmitted power appears in the sideband while simulated carrier energy is reintroduced at the receiver.

Variations on the single-sideband technique include suppressed carrier communications, twin single-sideband systems and the combination of these. The carrier frequency is not completely removed from the transmitted power distribution in suppressed carrier systems, but is transmitted at an attenuated level. The transmitted vestige is reconditioned at the receiver, reintroduced in demodulation circuits and used as a control element for an afc system.

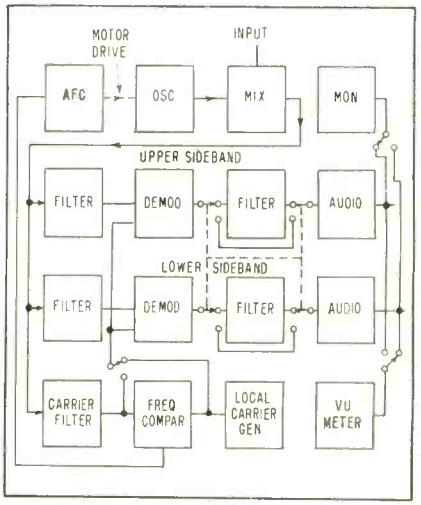

FIG. 1—Separate channels are provided in twin single-sideband converter for demodulation of upper and lower sidebands

Twin single-sideband communications offer the advantage over conventional a-m systems of double the amount of information for a given bandpass. The method depends for effectiveness on the combination of filtering, both following modulation at the transmitter and preceding demodulation at the receiver, which utilizes one pattern of information in one sideband and a second intelligence pattern in the other sideband.

The combination of twin single-sideband and suppressed carrier represents a practical r-f system application. The single-sideband converter described here has been designed to accept, from the i-f amplifier of an associated radio receiver, signals consisting of either a suppressed or normal car-

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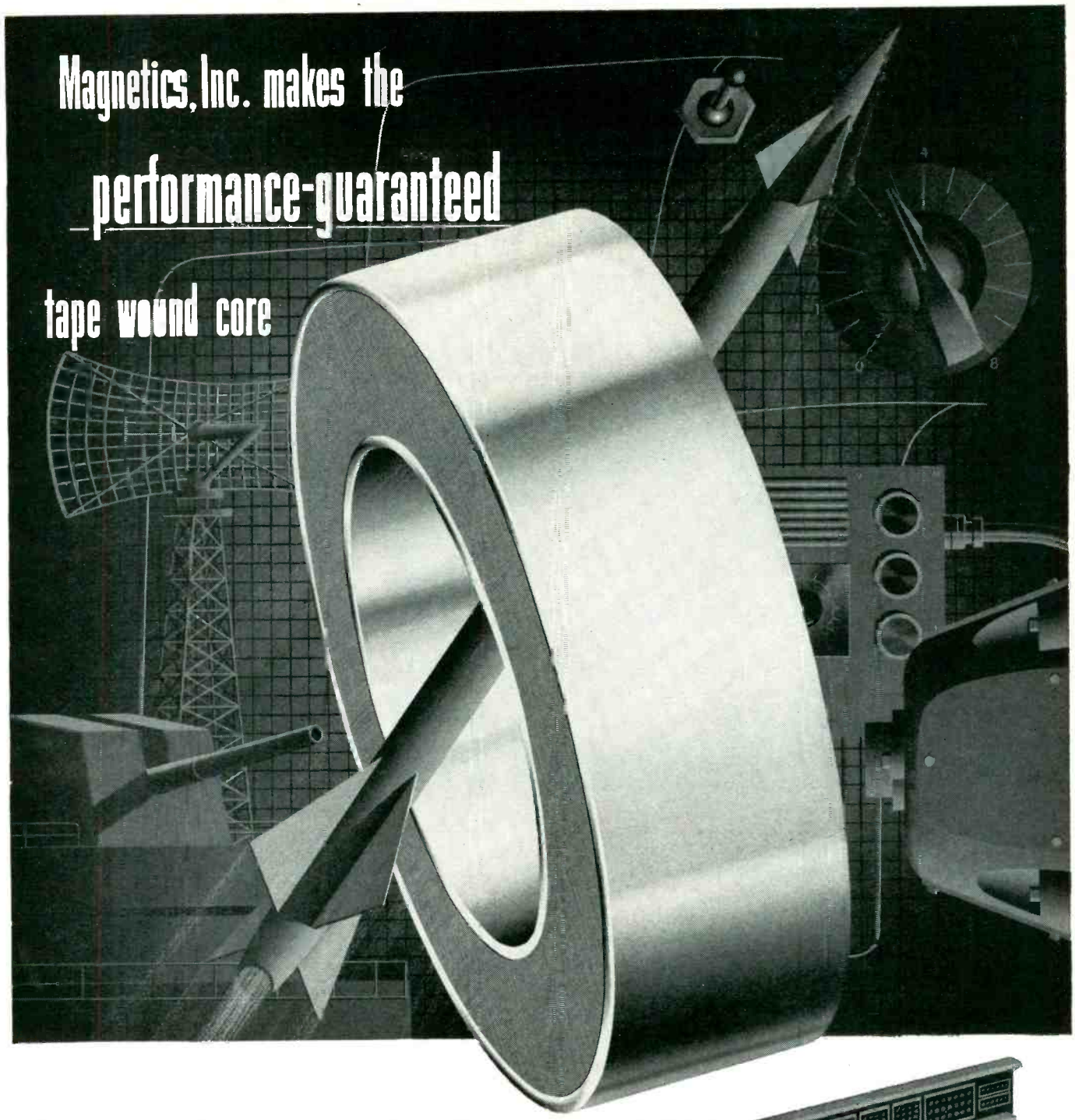

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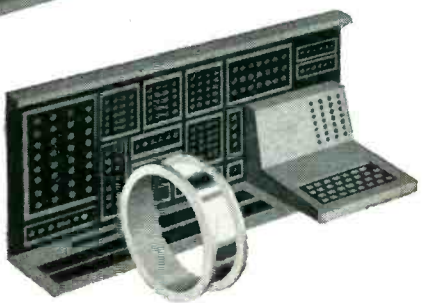

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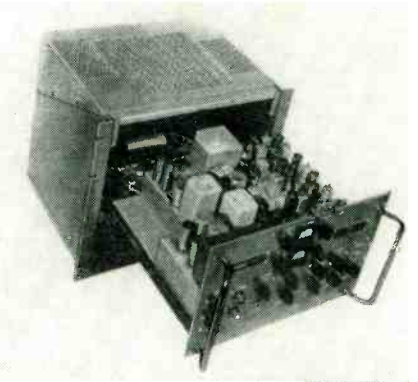
rier plus either or both sidebands and to convert any such combination of energy into audio signals.

Maximum utilization of the converter is realized during reception of twin single-sideband supressed carrier signals consisting of multiplexed teletypewriter messages impressed upon the carrier by frequency-shift keying.

Applications employing transmitting and terminal equipment



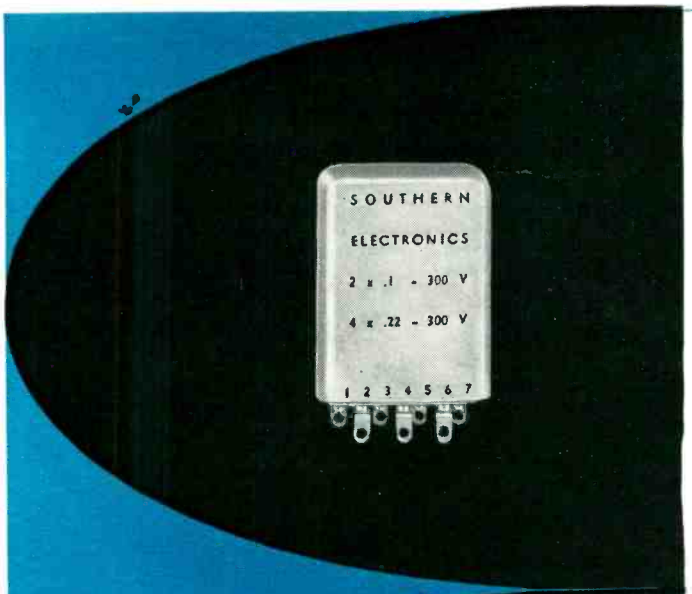
Rack-mounted converter has separate outputs for twin-single sideband operation

include reception from 1 through 12 teletypewriter channels using two-tone converting terminal equipment or from 1 through 16 channels using audio frequency-shift keying (fsk) converting terminal equipment; reception from one or two channels of facsimile or voice; reception through combinations of the above types of intelligence.

In addition, the converter is useful for space diversity, frequency diversity or voice-frequency diversity systems. In applications involving voice-frequency diversity it is only necessary to use one converter and one receiver, as both sidebands of the single-sideband reduced-carrier transmission are used.

Accepting frequencies within a ± 6-kc passband, from 450-510 kc, the converter produces a 100 kc i-f that is separated in appropriate filter circuits into converted upper-sideband frequencies, converted lower-sideband frequencies and converted carrier frequency. Demodulation is effected by mixing each group of sideband frequencies either with locally generated carrier energy or with the reconditioned carrier signal.

In applications of the single-



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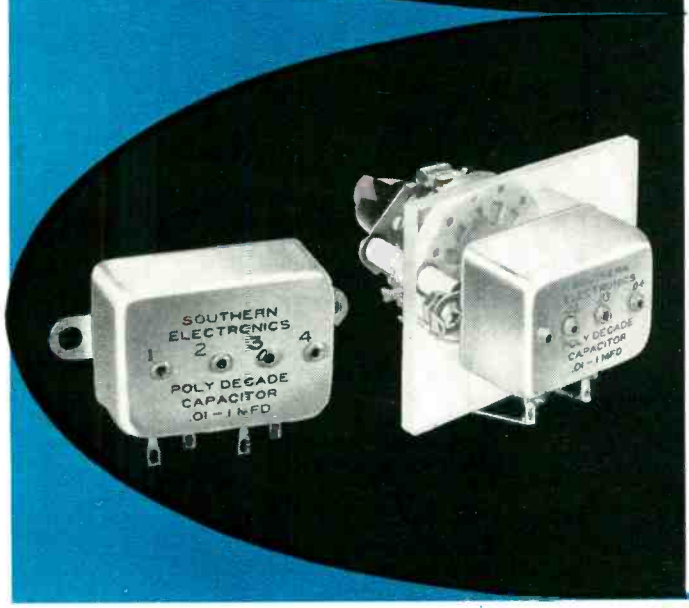

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sideband technique to multiplexed teletypewriter communications, minimum intermodulation and harmonic distortion are essential to eliminate message errors originating in the receiving equipment.

To prevent such a possibility, the demodulators and audio circuits of the converter are designed to produce no intermodulation or harmonic distortion product, measured in the output signal, at a level greater than 50 db below the desired frequency.

Two identical audio channels permit simultaneous utilization of both upper and lower sidebands. Incorporated into each channel is a 3,500-cps cutoff filter—through which the signal may be passed at the operator's discretion—for maximum intelligibility of voice during reception of weak signals. Push-pull output amplifiers deliver, with normal converter input, 100 milliwatts ± 1/4 db from 100-6,000 cps, across a 600-ohm balanced line.

▶ **Accuracy**—Good reproduction of sideband intelligence requires that the carrier energy introduced at the receiver or converter be frequency and amplitude-stable. When the transmitted carrier vestige is to be used, reconditioning is necessary.

The converter restores to the level necessary for accurate demodulation, carrier energy attenuated as much as 40 db at the input to the receiver. An independent gain control in the carrier i-f strip compensates for attenuation fixed at the transmitter.

Filters and limiting circuits insure maximum rejection of noise and undesired r-f energy. A carrier-level indicator operating prior to limiting circuits is used in conjunction with the carrier compensator control to determine the suitability of the received carrier.

Should the received carrier energy fall below the level necessary for accurate reproduction of sideband information a crystal-controlled oscillator produces a simulated carrier and also provides a frequency standard used in comparator circuits for actuating the afc system.

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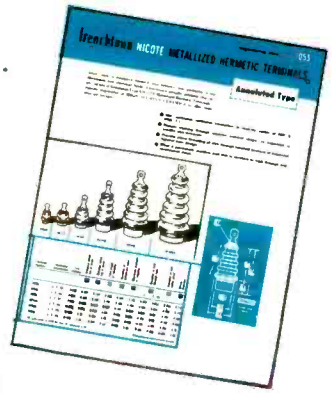

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frequencies can be obtained from the filters only when the converter i-f center frequency remains constant. Drift in the mixing-oscillator frequency or in the received signal results in potential degeneration of equipment performance. Motor control of the tuning capacitor in the mixing oscillator insures correct converter i-f center frequency despite such drift. The afc motor is actuated by a correction voltage generated as the result of a difference in frequency between the crystal-controlled local carrier oscillator and the converted received carrier.

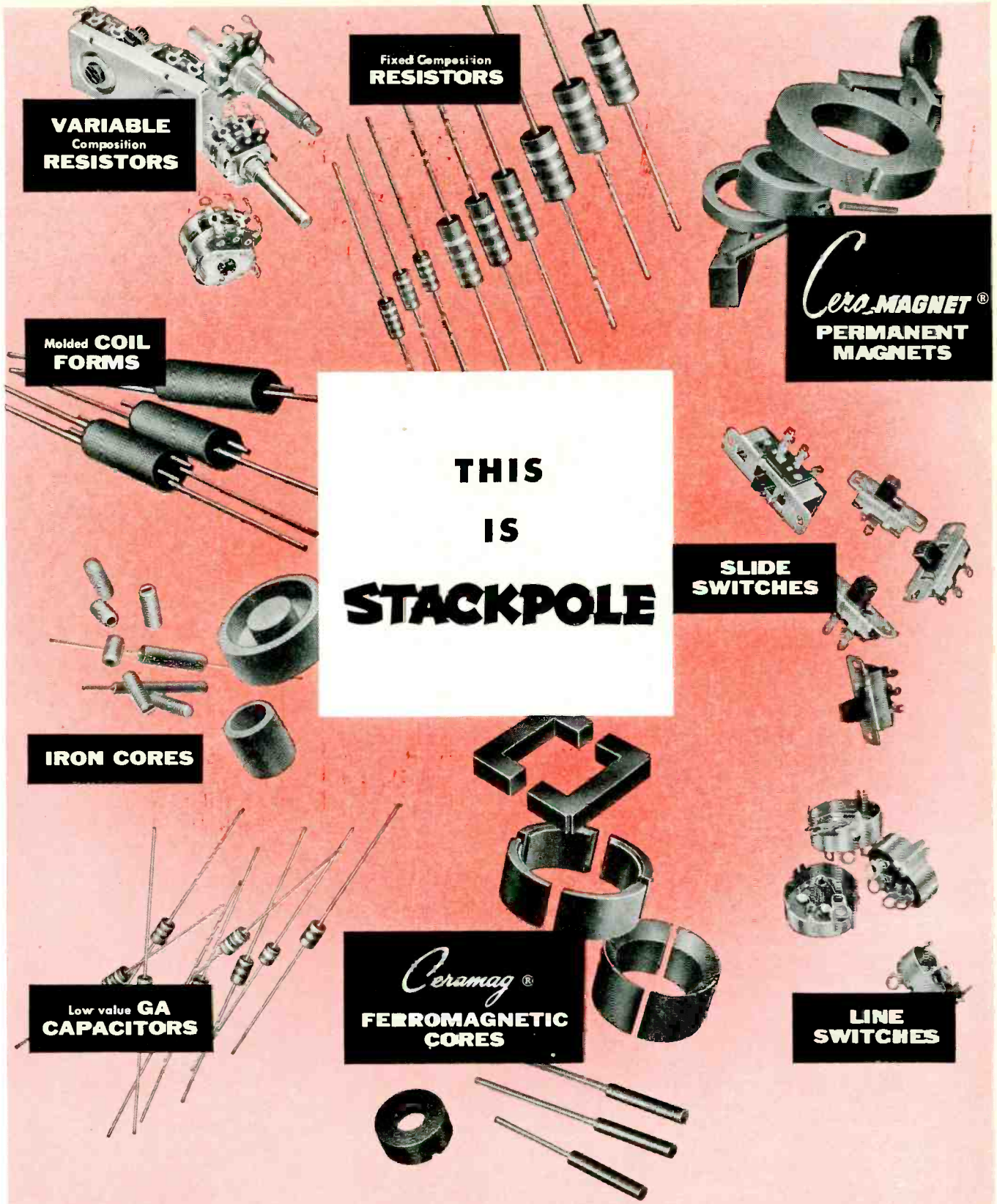
► **Drift**—System drifts as much as 2,000 cps and virtually instantaneous changes of as much as 50 cps in the transmitter frequency can be compensated by the converter afc. On the other hand, the converter afc will not lock on a sideband should the carrier fade completely. Residual error in the system is less than 1.5 cps.

Error frequency is tripled to attain maximum afc sensitivity and is amplified and shaped to trigger motor-drive stages. When no error exists, a dynamic low-impedance shunt is presented across the motor-drive stages preventing free-run or overshoot in the motor action.

► **Indication**—Maximum correction of about ± 2,000 cps is indicated by the calibration of the front-panel scale of the drift indicator knob. Over-excursion of the drift indicator capacitor beyond the ± 2,000 cps points, as the result of excessive drift, mechanically trips a snap-action switch completing an afc alarm circuit.

To prevent the possibility that the afc system erratically follows noise during periods of excessive carrier fading, a squelch circuit is provided. Operating on a dynamic signal-to-noise ratio principle, the squelch circuit produces a gating bias that disables the motor-drive circuits whenever the signal-to-noise ratio falls below a predetermined minimum.

Changes in absolute value of signal and noise, within certain limits do not necessarily result in afc disablement as long as the



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ratio of signal-to-noise remains at or above the desired level. A front-panel warning light and presence of voltage at the rear terminal strip signal the operation of the squelch circuit in disabling the afc system.

To insure constant power level at the output the converter incorporates an agc system applying control bias to the circuits of the associated receiver. In setting the front-panel agc select switch, the operator determines whether receiver gain is to be controlled by energy developed in one or the other sideband, by carrier energy (reconditioned but not limited), by total received signal or by its internal agc circuit.

During tuning of the converter or under circumstances in which converter agc is inoperative, r-f gain of the associated receiver is controlled by its internal agc voltage.

When the accurate reproduction of the information in one sideband becomes more important than reproduction of the alternate sideband, the operator has the option of controlling receiver gain on the basis of voltage developed by the desired sideband. Should both sidebands contain voice modulation, varying in frequency and amplitude, the carrier alone, as a constant-level source, should be used for receiver gain control.

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A 20 kw pulse transmitting tube featuring space-charge focusing. This tube is used in low power radars, for airborne as well as ground equipment. It can also be used as a driver for higher power Klystrons, in navigational aids, distance measuring equipment, beacons and pulsed communications systems.

This tube has extremely long life. It has integral resonant cavities and tuners and is thermally compensated for changes in ambient temperature and duty cycle.

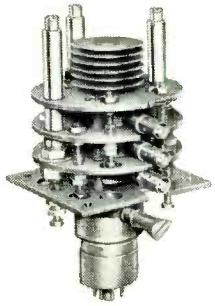
Frequency Range	1215 to 1365 mc
Power Output	9 to 21 kw
Power Gain	23 db

SAS-61

A 10 kw pulse transmitting tube with space-charge focusing which eliminates magnetic structures. This medium power amplifier is used for low power radar systems. Can be used as a driver for higher power Klystrons in radar and linear accelerator systems.

This tube has extremely long life. Integral tunable cavities, with one tuning screw for each cavity, permit rapid tuning over a ±30-mc range with additional adjustments to cover entire frequency range.

Frequency Range	2700 to 2900 mc
Heating Time	90 sec.
Peak Power Output	0.5 to 15 kw
Maximum Drive Power	30 w
Power Gain	20 to 30 db



SAS-60A

Cascade Amplifier Klystron especially for use in cw doppler radars. Can be used as a driver for higher power Klystrons, in laboratory test equipment, as frequency standard, and in beacons and MTI radar.

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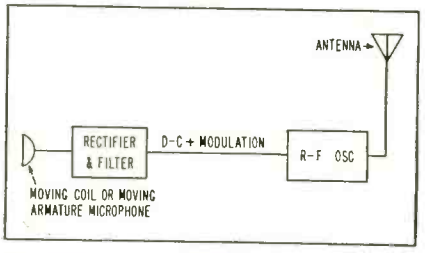
appears in both sidebands, agc voltage developed by the converter from total input energy is used to control receiver gain. The agc voltage developed by the converter is superior to that produced solely by the receiver since the selectivity of additional tuned circuits tends to minimize the adverse effects of noise and interfering signals.

The agc circuit of the converter, designed to reproduce the characteristic of the associated receiver, is provided with the alignment adjustments including threshold and output level controls and a selection of agc delay time, insuring minimum change in audio output for a wide r-f input range.

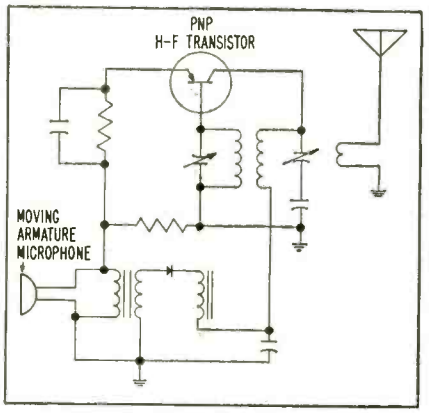
Voice Powers Transmitter

VOICE-POWER for a radio transmitter has been accomplished in an experimental device developed by the Signal Corps Engineering Labs at Ft. Monmouth, N. J. The fundamental elements shown in the block diagram comprise several parts. A moving-coil or armature type microphone is the source of alternating current.

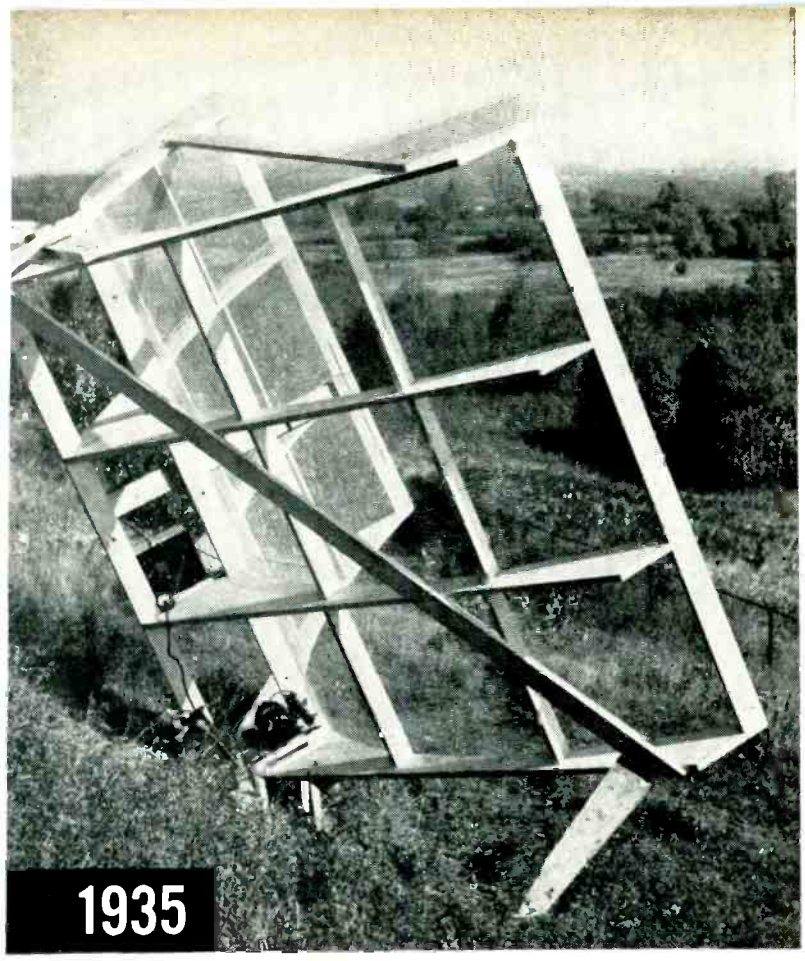
The rectifier and filter section includes a transformer that serves to match the microphone impedance



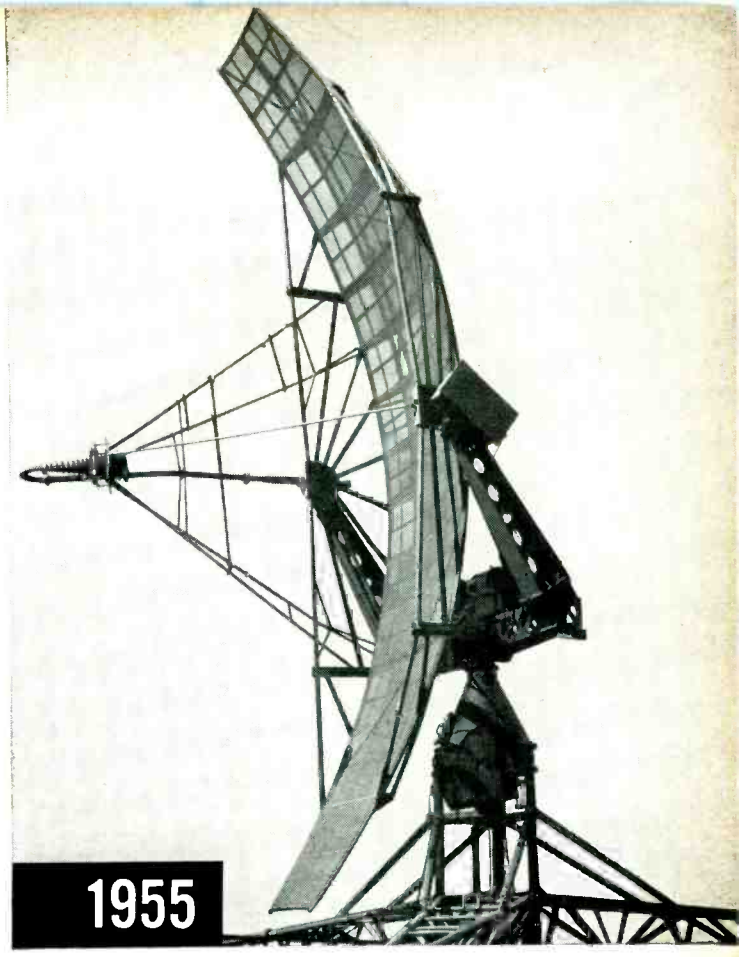
Elements of the simple voice-operated transmitter



Basic circuit of the voice-powered radio transmitter



EARLY RESEARCH AND DEVELOPMENT EXPERIENCE with electronic location equipment at G.E. began in 1935 when this first system, with an output of 1½ watts, located planes up to five miles away.



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2. **Small, portable systems** for weather balloon tracking were developed and produced for the Army and Navy in 1948.
3. **Powerful heightfinding antenna,** FPS-6XW1, developed by G.E. for USAF in 1949, was an advancement in long-range detection.
4. **Giant shipboard search antenna,** largest in use today, was G-E developed and produced for Navy early-warning ships.
5. **Long-range search antennas** (FPS-7) were designed and built by G.E. using advanced construction techniques.
6. **One of the first combination antennas** (allows both search and elevation detection), the Navy's SPS-8 was designed and produced to give a precise beam pattern.

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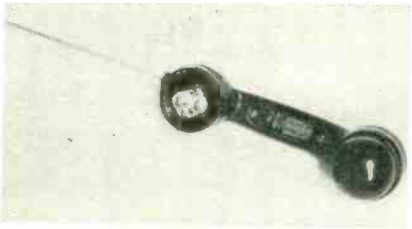

Experimental unit is housed in handle and receiver cavity of telephone handset

to that of the transistor oscillator load. The crystal rectifier and filter is included in this section.

The radio-frequency oscillator comprises a transistor operated in a circuit of the tuned plate-tuned grid circuit as shown in the circuit diagram. Other circuits can be used provided losses are kept low.

The antenna is a quarter-wave dipole, its dimensions depending upon the operating frequency of the oscillator.

British Corona Triode

AN UNUSUAL type of experimental electronic valve called a corona valve has been developed in Britain. It is unique in that it needs neither a vacuum nor a glass envelope.

The principle of the valve can best be understood by considering the diode form, which is made by taking a sharp point and a blunt electrode and putting a high voltage between them. Corona will then develop around the sharp electrode.

This corona discharge will depend on the strength of the electric field in the neighborhood of the sharp electrode. It will be clear then, that if another blunt electrode, such as a ring, is placed around the sharp point, a small voltage between the point and the ring may affect the electric field at the point and inhibit or promote the electric discharge.

An electronic valve made in this manner shows all the properties of the ordinary thermionic valve except that its constants are markedly different in value.

For example, the mutual conductance will be about 25 μamp per kv, the amplification factor will be about 5 and the internal resistance about 200 megohms. In other words, the valve is suited for

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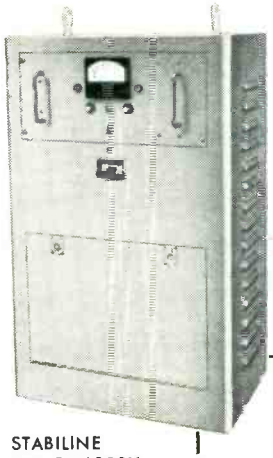

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handling low currents at high voltages—microamps and kilovolts.

Using a pair of needles, spaced a little, as the anode load resistance, it is possible to make an amplifier with this type of valve.

Bistable Circuit Uses Single Triode

By R. W. HOFHEIMER

Staff Member, Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Massachusetts

A SIMPLIFIED bistable circuit is shown in Fig. 1 using a single triode and an external source of a-c. A number of such circuits can share a common source of a-c.

The operation of the circuit is as follows. Assuming a grid voltage of $-E$, which is below cutoff, the plate is quiescent at B+, and voltage at the output is $-E$. Since the output is connected to the grid, the grid is held at $-E$. The circuit is therefore stable under these conditions.

If the grid is brought to ground

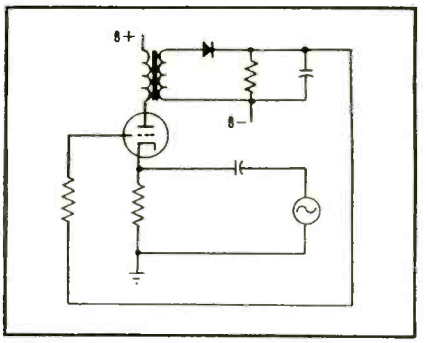

FIG. 1—Basic configuration of single-triode bistable circuit

potential, the a-c voltage injected in the cathode circuit will be amplified by the tube. The a-c appearing at the plate is rectified and filtered so that the output consists of a positive d-c voltage. This voltage is delivered to the grid, thus maintaining the circuit in this stable state. The circuit can be returned to its original state by a negative pulse on the grid or by interrupting the oscillator voltage.

The complete circuit is shown in Fig. 2. The transformer has been replaced by R-C coupling. The input pulses required to change the stable state were of several hundred microseconds duration. The use of a higher oscillator

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—¼" thick for high impact. Fully insulated.

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Balanced double-spring tension grip assures permanent contact.

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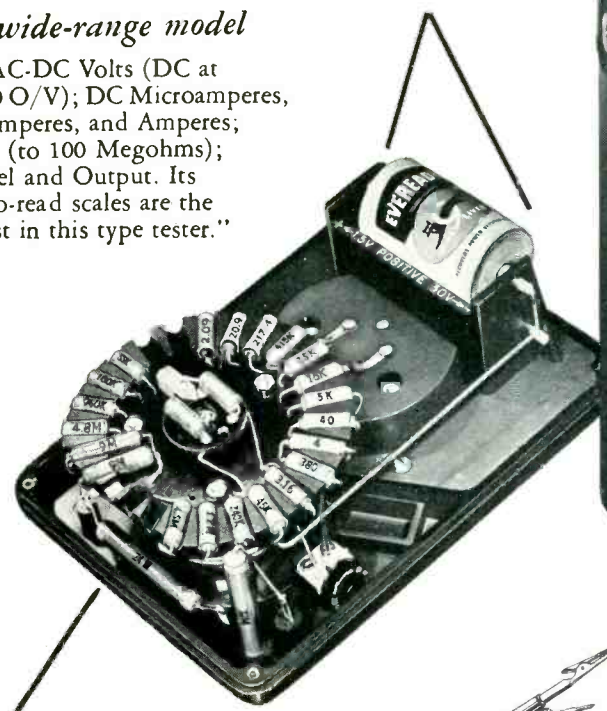
tests AC-DC Volts (DC at 20,000 O/V); DC Microamperes, Milliamperes, and Amperes; Ohms (to 100 Megohms); Decibel and Output. Its easy-to-read scales are the longest in this type tester."

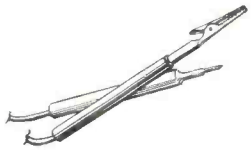


streamlined design

No protruding knobs on switch or ohms control—both are flush with the panel.

king size recessed knob

—Only one switch; (fully enclosed) selects both circuit and range. Just turn the switch and make your reading.



for quick positive connections

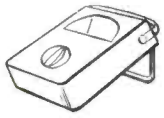
—Banana jacks and plugs on test leads are best. Alligator clips are provided to slip on test prods for extra convenience.

for most efficient meter use

—With every Model 630 you receive complete, simplified instructions on how to use and maintain most efficiently.

advanced engineering

—Molded mounting for resistors and shunts allow direct connections without cabling. No chance for shorts. Longer life and easy-to-replace resistors in their marked positions.



for convenience in reading

—Available as an extra (only 50c), this special stand tilts meter at best angle for easy reading

no slip feature

Four rubber feet furnished as standard equipment fit in back of the case to prevent slipping on smooth surfaces.

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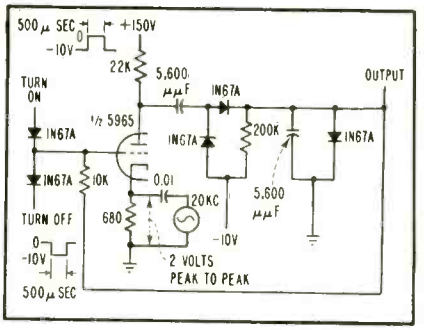


FIG. 2—Practical arrangement of bistable circuit uses R-C coupling network in place of transformer

frequency should permit shorter switching times.

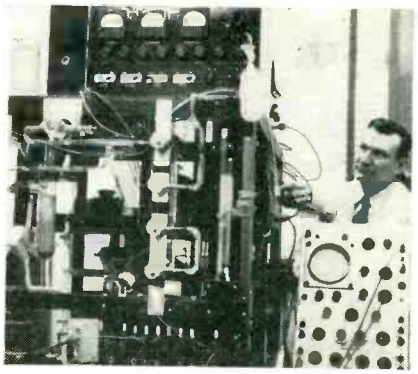
Some advantages of this circuit are that a-c coupling is employed, making it easy to achieve wide margins in design without using precision components; the output varies between the same d-c levels as the input; and only a single triode is required.

Disadvantages are that a source of a-c is required, switching speed is less than that of flip-flops, and the circuit is noncommutative and therefore not suited for binary counters.

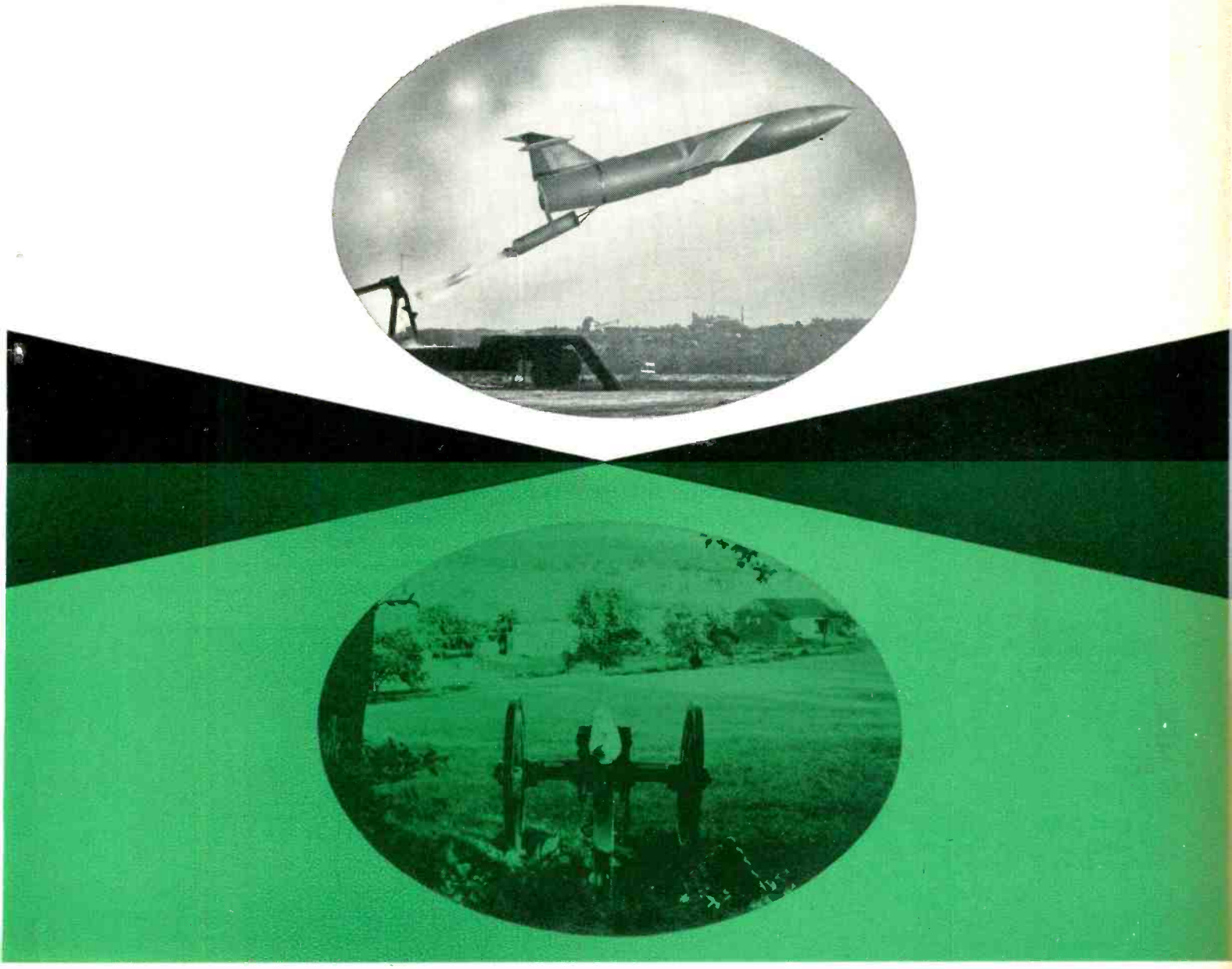
The single-triode bistable circuit seems best suited for storage register use in relatively slow-speed digital computers. In such an application, binary information to be stored can be delivered in pulse form through an isolating diode to the grid of the circuit. Resetting can be accomplished with a pulse of the opposite polarity introduced through an oppositely-poled diode.

The research work described in

Electronic Sponge



Sulphur hexafluoride is a sponge for low-energy electrons, soaking them up by forming negative ions of low mobility and velocity, preventing further ionization. Tests at Westinghouse laboratories indicate the cross-section of the sulphur hexafluoride molecule to be much greater than that previously measured



THE FORTUNES OF PEACE

America's first successful long-range pilotless bomber—the TM-61 Martin Matador—is a major weapons system conceived and developed in peacetime. And it is helping to keep the peace in an important way.

For the Matador is in quantity production, and already widely deployed. As the first aircraft having complete interchangeability of parts, it is transportable by air and can be delivered unassembled for stockpiling in critical outpost areas.

The new engineering concept that produced the Matador has already revised many design and production standards in the aircraft industry. For this versatile weapons system is being produced at the lowest cost-per-pound for comparable production, despite performance requirements more severe than those for most piloted aircraft.

Today, the new Martin engineering concept is revising the calendar on some of the most advanced flight and weapons systems projects now in the research and development stages.

These are among the Fortunes of Peace!

MARTIN
BALTIMORE

this article was supported by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

INCLUDED in this month's selection of inventions are details of a radar speed trap, an improved cathode-follower circuit and a reference standard of frequency based upon resonance absorption effects of gases.

Speed Trap

Travelers by automobile are becoming increasingly familiar with radar speed traps. A U.S. patent 2,695,404 was recently awarded to J. L. Barker for a "Speed Detector",

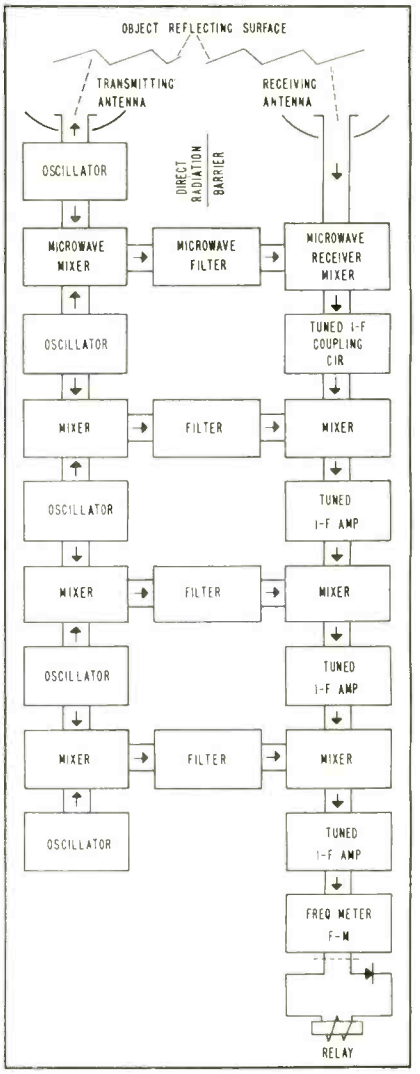
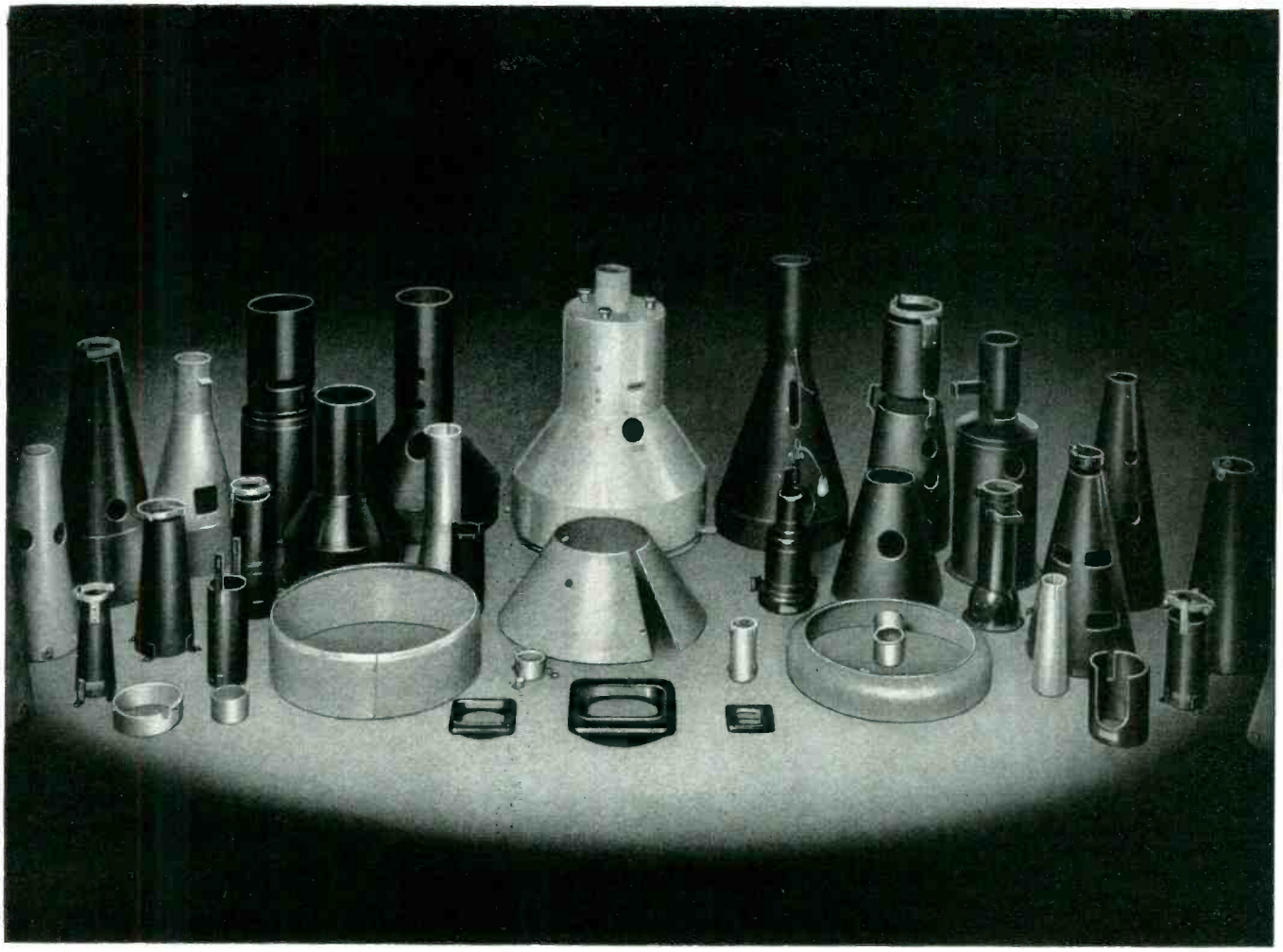


FIG. 1—Quadruple heterodyne system is used to measure vehicle speed



Designed for Application

Mu Metal Shields

The James Millen Mfg. Co. Inc. has for many years specialized in the production of magnetic metal cathode ray tube shields for the entire electronics industry, supplying magnetic metal shields to manufacturing companies, laboratories and research organizations. Stock shields are immediately available for all of the more popular sizes and types of cathode ray tubes as well as bezels for 2″, 3″ and 5″ size tubes.

Many production problems, however, make desirable special shields designed in conjunction with the specialized requirement of the basic apparatus. Herewith, are illustrated a number of such custom built shields. Our custom design and fabrication department is at the service of our customers for the development and manufacture of magnetic metal shields of either nicoloi or mumetal for such specialized applications.

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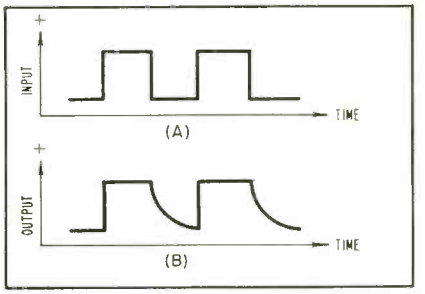


FIG. 2—Cathode-follower input (A) and output (B)

which is assigned to Eastern Industries of East Norwalk, Conn.

In Fig. 1 is shown a block diagram of the complex quadruple heterodyne system used by inventor Barker to accomplish the speed measurement.

A microwave radar transmitter and receiver are employed at 2,455 mc. By a series of successive heterodyning actions employing both the sum and the difference frequencies generated at each successive heterodyne operation a final result is obtained involving a frequency- modulated difference frequency having a center frequency of 1 kc.

The successive intermediate frequencies are respectively 10 mc, 465 kc, 20 kc and 1 kc. A discriminator is employed to indicate the deviation from the final center frequency of 1 kc. The indicating device is calibrated in miles per hour and can be made to indicate either approaching or receding speeds of automobiles.

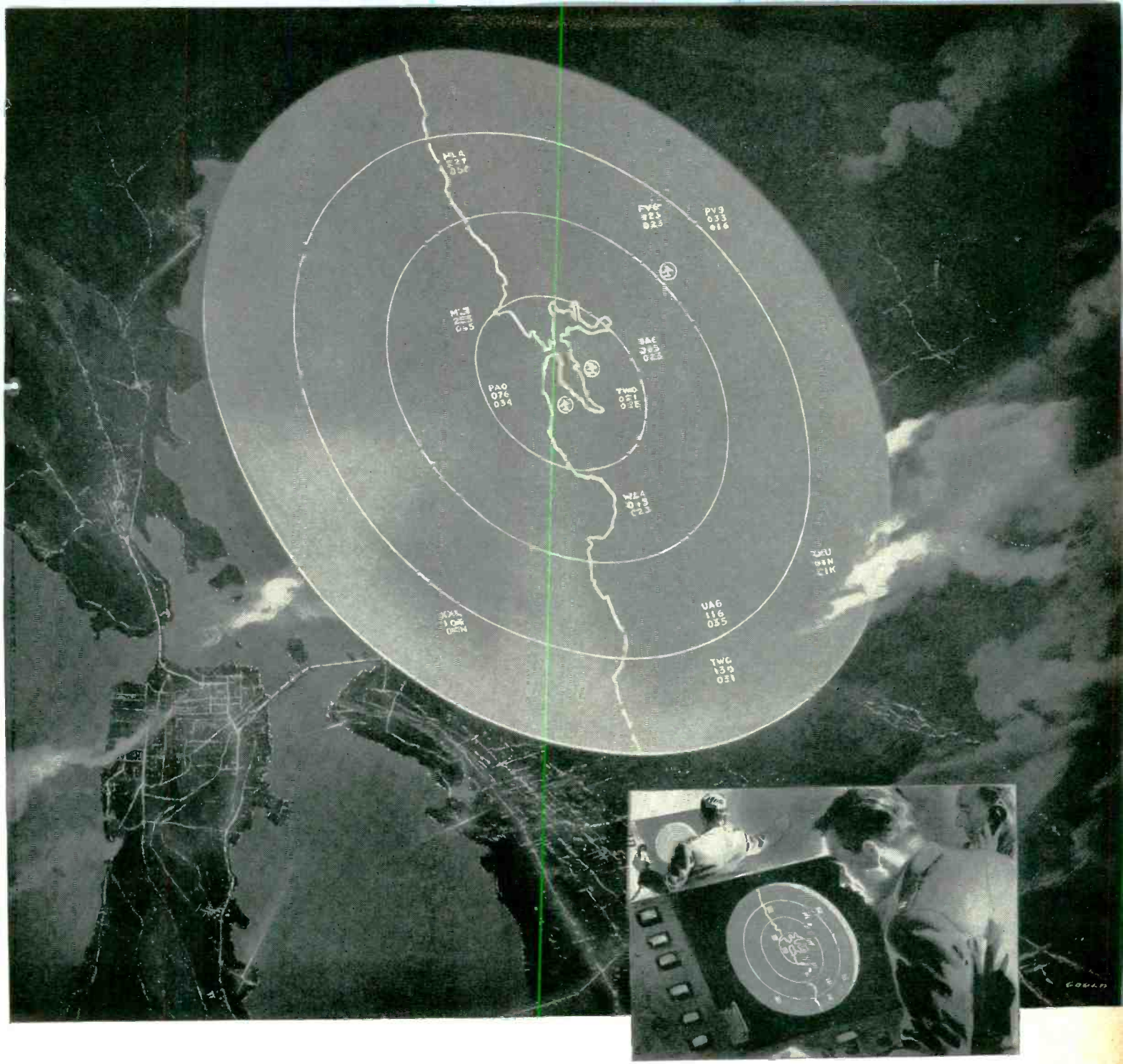
By employing a relay in the output, a predetermined speed indication can be made to result in the operation of an alarm, or to illuminate a warning sign.

When the legality of such devices has been generally established, the device could be made to produce punched card records and a photograph of the offender's automobile which shows the license number and speed of the car.

Improved Follower

A cathode follower normally responds only linearly to a rising or positive-going pulse amplitude change when square waves are applied to the input thereof. On negative-going amplitude changes the wave shape is usually distorted as shown in Fig. 2B.

Jerry B. Minter 2nd of Boonton, New Jersey has been awarded



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This new tool, the *Charactron*® electron optic tube, has many applications besides that of air surveillance. We'd welcome the opportunity to consider any problem of *yours* which this latest development of precision work in electron optics might well help to solve.

STROMBERG-CARLSON COMPANY

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patent 2,700,704 for a circuit that overcomes this deficiency of cathode followers. The patent, entitled "Electron Tube Circuit" is assigned to Measurements Corp. of Boonton, New Jersey.

Figure 3A illustrates an embodiment of the Minter circuit employing triode tubes. A phase-inverter triode is employed to drive a cathode-follower stage whose cathode load is in parallel with a

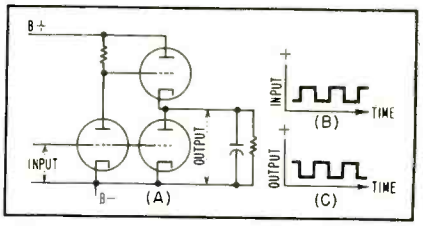

FIG. 3—Improved cathode follower using triodes (A) with input (B) and output (C) waveforms

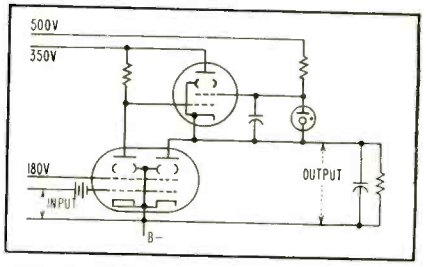

FIG. 4—High-power version of cathode follower

second triode. The second triode and the phase inverter grid are driven in parallel.

Figures 3B and 3C, respectively, illustrate the input and output waveforms of the circuit.

A high-power version of the Minter cathode-follower circuit is illustrated in Fig. 4. The circuit employs a dual-beam pentode as a combined phase inverter and parallel cathode load tube for cathode follower.

Frequency Standard

Patent 2,707,235 awarded C. H. Townes of Chatham, New Jersey, is assigned to the Bell Telephone Laboratories, Inc. This patent is for "Frequency Selective Systems". The frequencies involved are primarily in the microwave regions where the resonance absorption effects of certain gases such as ammonia are prevalent. There are chemically alike but isotopically different forms of these gases such as ammonia ($N^{14}H_3$) or heavy am-

Notable Achievements at JPL

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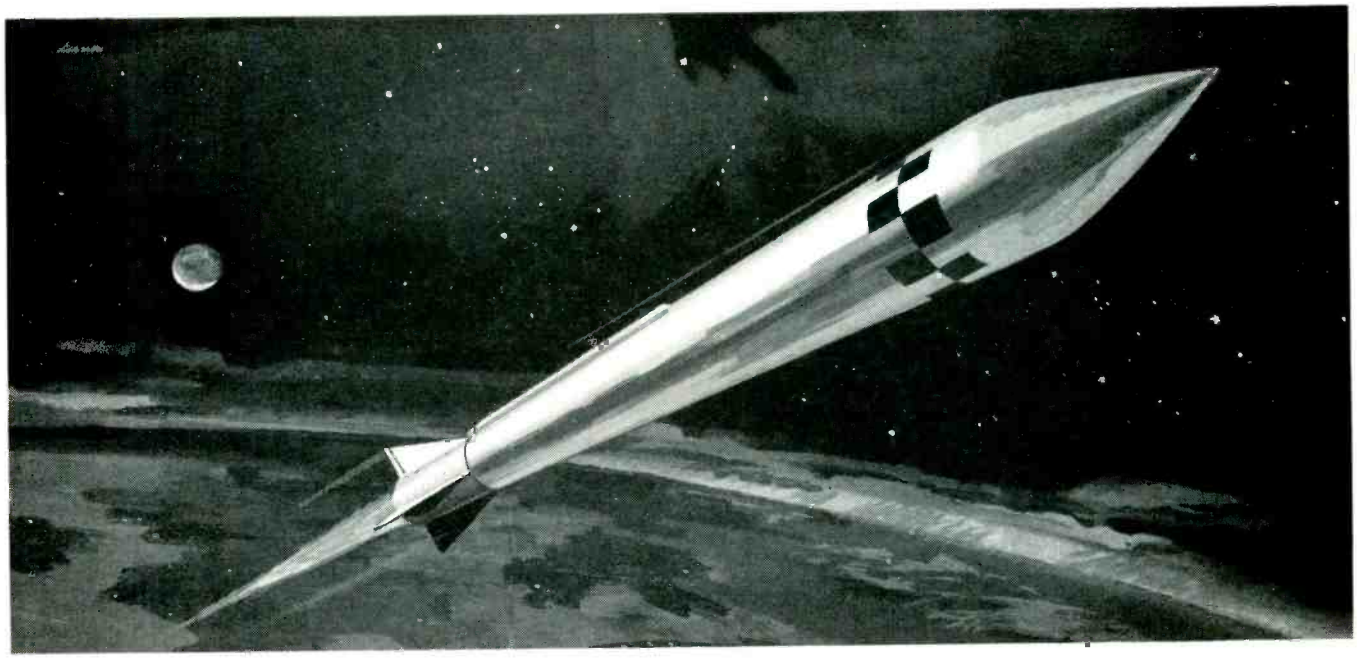
This missile, now in production elsewhere, can be found "on active service" wherever needed in the American defense pattern.



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The success of the Corporal is typical of the progress in guided missile technology which had its beginnings at JPL in the first early rocket experiments in 1940. Since then the Laboratory has grown to occupy an 80 acre site in the San Gabriel mountain foothills north of Pasadena and is staffed by the California Institute of Technology.

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monia ($N^{15}H3$). These two isotopes have similar resonant characteristics but at nearby frequencies.

In the Townes invention this phenomenon provides reference standards of frequency. A mass of gas or a mixture of gases having resonant absorption bands at a desired

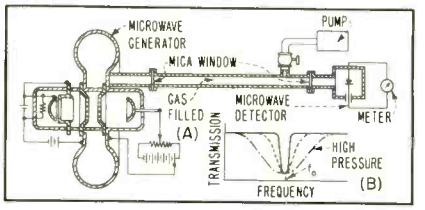

FIG. 5—Device for generating absorption pattern (A). Low-to-high pressure transition affects frequency response as at (B)

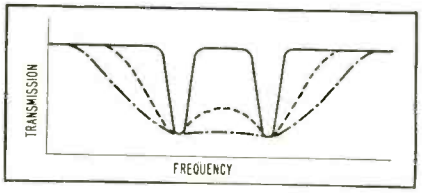

FIG. 6—Condition resulting from gas having two isotopic forms mixed together

frequency or frequencies is confined in a suitable chamber at some pressure wherein the gas is exposed to a microwave field.

The microwave energy after passing through the gas in the chamber is detected and suitable indicating apparatus used to display a pattern of the resultant absorption characteristics.

Figure 5 illustrates a particular configuration for generating a characteristic absorption pattern. A microwave generator having a frequency range tunable over the molecular absorption bands of the gas in the chamber shown is employed to excite the gas. In Fig. 5B a plot of the absorption characteristic under various pressures of the gas is shown.

Under low pressure a very sharp resonance only in a narrow region of the spectrum is shown. Under high pressure the absorption pattern covers a much wider range. In Fig. 6 a condition that results from the use of a gas having two isotopic forms mixed together is shown.

Under low pressure two distinct absorption responses are shown. As the pressure increases, the differentiation between the two responses is less until at high pressure no dif-

SEE Bendix IN ELECTRONICS

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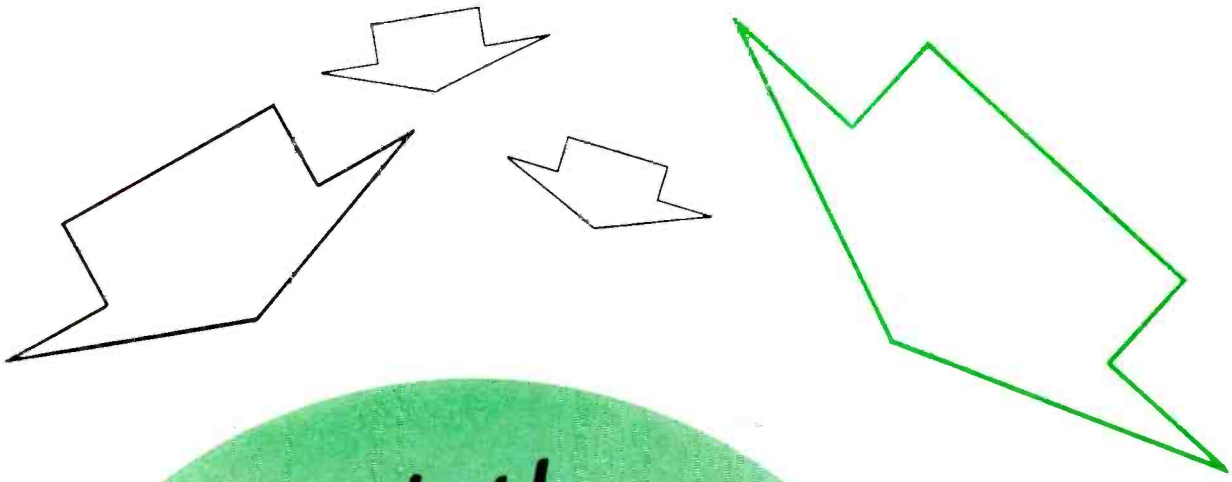

at the

Bendix

exhibit

RADIO ENGINEERING SHOW
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March 19-22, 1956

Booth Nos. 128-130-132-134-136-138-140

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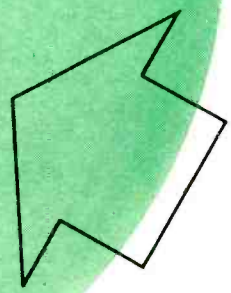

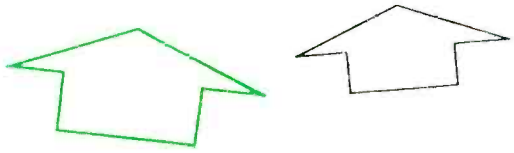

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Bendix
AVIATION CORPORATION

ference at all is observed.

In the Townes patent many variations and detailed refinements of this technique are shown, all based on the primary principle above described. Common ammonia, for example, has its primary resonance in the region of 24,000 mc.

The strongest is at 23,870 mc. The bandwidth of the response at the half-power points is 10^4 megacycles

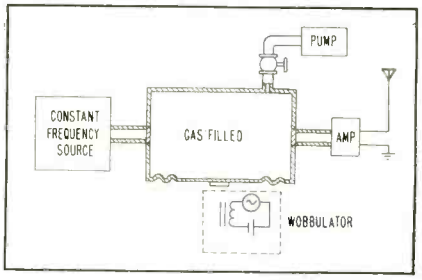


FIG. 7—Constant-frequency source connected to gas-filled chamber

at atmospheric pressure. At a pressure of 10^{-5} atmospheres the bandwidth is 10^5 cycles. This represents a Q of about 3×10^5.

The patterns shown in Fig. 5B and 6 may be generated for display on an oscillograph with a sweep type of modulation for the microwave generator.

An example of a practical application of the principles of this invention is shown in Fig. 7. A constant-frequency source is connected to a gas-filled chamber. The gas may be a mixture that has an absorption frequency band or bands near the source frequency.

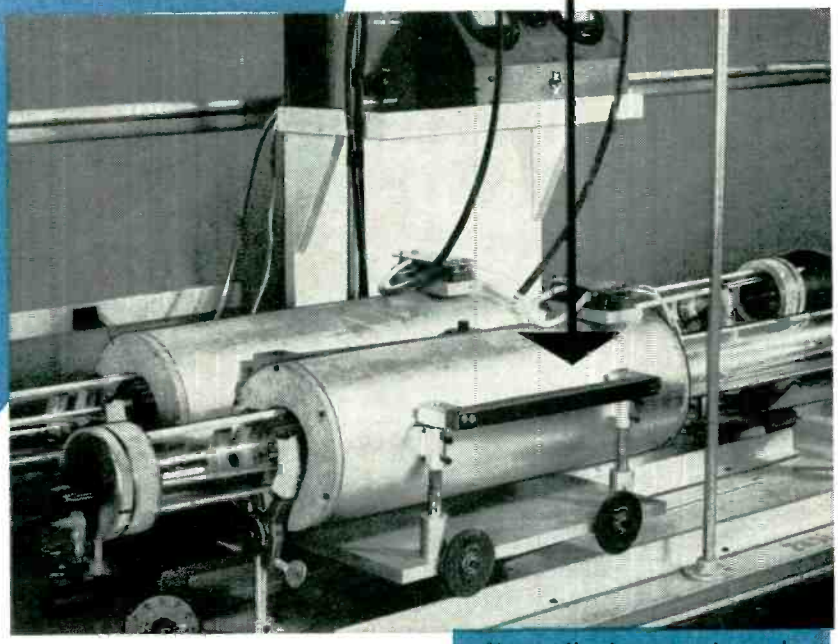
A wobbulator moves a diaphragm on the gas-filled chamber to compress and rarify the gas alternately. Under these conditions the absorption pattern expands and compresses to generate the pattern in Fig. 6.

Under increased pressure one waveform is observed; under low pressure the other waveform is observed. The inventor claims from this that the system of Fig. 7 displays band-pass characteristics of a broad band-pass filter. The system in this form lends itself to an amplitude-modulation technique for a microwave transmitter.

There are a number of other applications of the absorption resonance phenomenon as employed in this invention described in the patent.

Lawrence Lindgren, Assistant Manager of Operations at P.S.I. . . . is in charge of all manufacturing operations. Here, he holds the "dry-tube," an important factor in PSI diode dependability. Below, he tells how important dryness is.

"WE BUILD DIODES IN A SUPER DESERT"

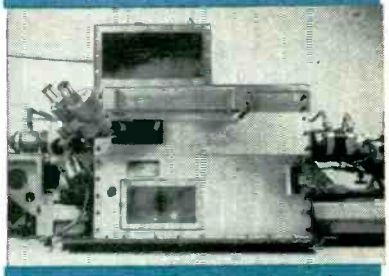


Chemically cleaned parts are degassed in this vacuum bake-out furnace immediately prior to final assembly to remove the last traces of harmful contamination.

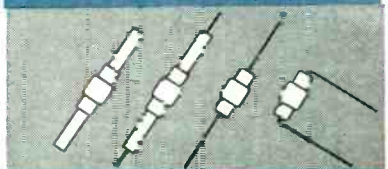
"In diodes, moisture's one of the greatest enemies; it materially shortens diode life. So, at PSI we take extreme measures to be *sure* that every part is dry . . . really dry . . . before sealing. Components are chemically cleaned and vacuum baked, then hermetically sealed in an atmosphere so dry that we would have just .056% relative humidity at room temperature (80°F) . . . equal to only about *22 parts of water per million parts of air!*

"Transfer from bake-out to sealing unit is accomplished with this dry-tube. Nothing but inert gas or dry air ever contacts a PSI diode part prior to final sealing.

"Why all that trouble to prevent contamination? We find it pays off handsomely in terms of unit stability and long-term reliability . . . both of which we feel are the *most important characteristics* we can build into every PSI diode."



Final assembly and hermetic sealing is accomplished automatically in the above unit while subjected to a 5-CFM flow of filtered, dried air.



PSI diodes (here, actual size) are offered with these basic lead arrangements.

PACIFIC SEMICONDUCTORS, INC.

10451 WEST JEFFERSON BOULEVARD

CULVER CITY, CALIFORNIA

Production Techniques

Edited by JOHN MARKUS

Press Pushes Sockets Into Etched-Wiring Board

SOCKETS are inserted in a radio etched-wiring board four at a time with the aid of a simple air-operated press in the Metuchen, N. J. plant of Westinghouse Electric Corp. The operator inserts the sockets upside down in keyed holes of a metal slide, places the board over these sockets and pushes the slide under the press. She then operates a foot air valve to push the board down over the sockets. Metal positioning pegs on the slide fit into mating holes of the board to insure correct seating of the board over the sockets.

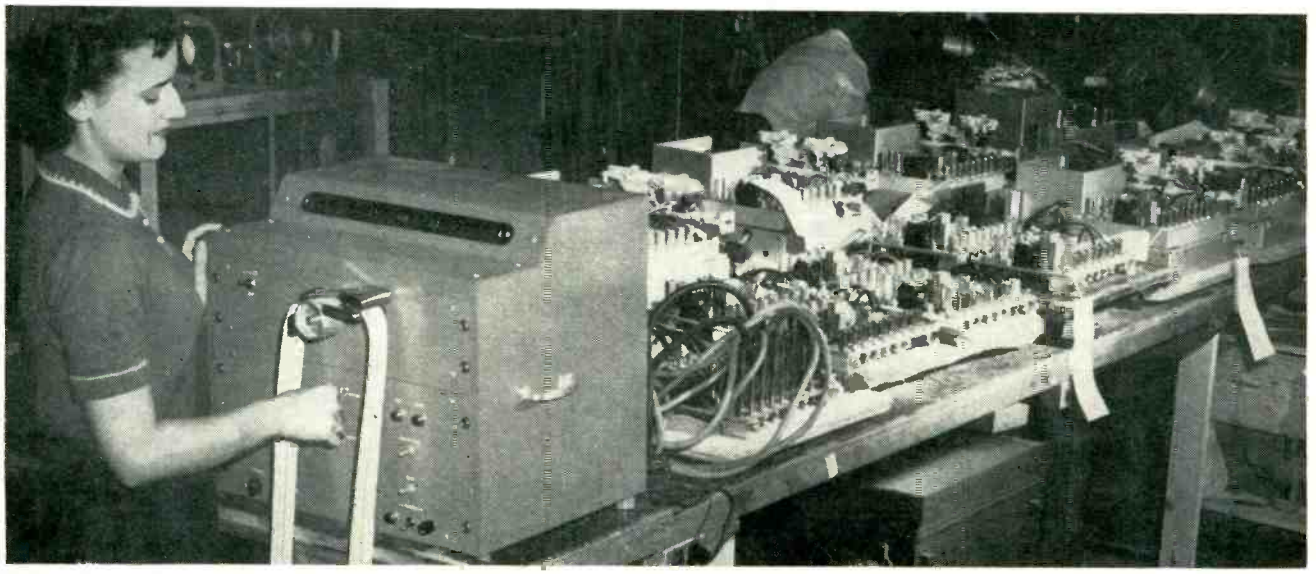
Placing radio board over four sockets loaded into metal slide of press

Tape-Programmed Automatic Tester for Subassemblies

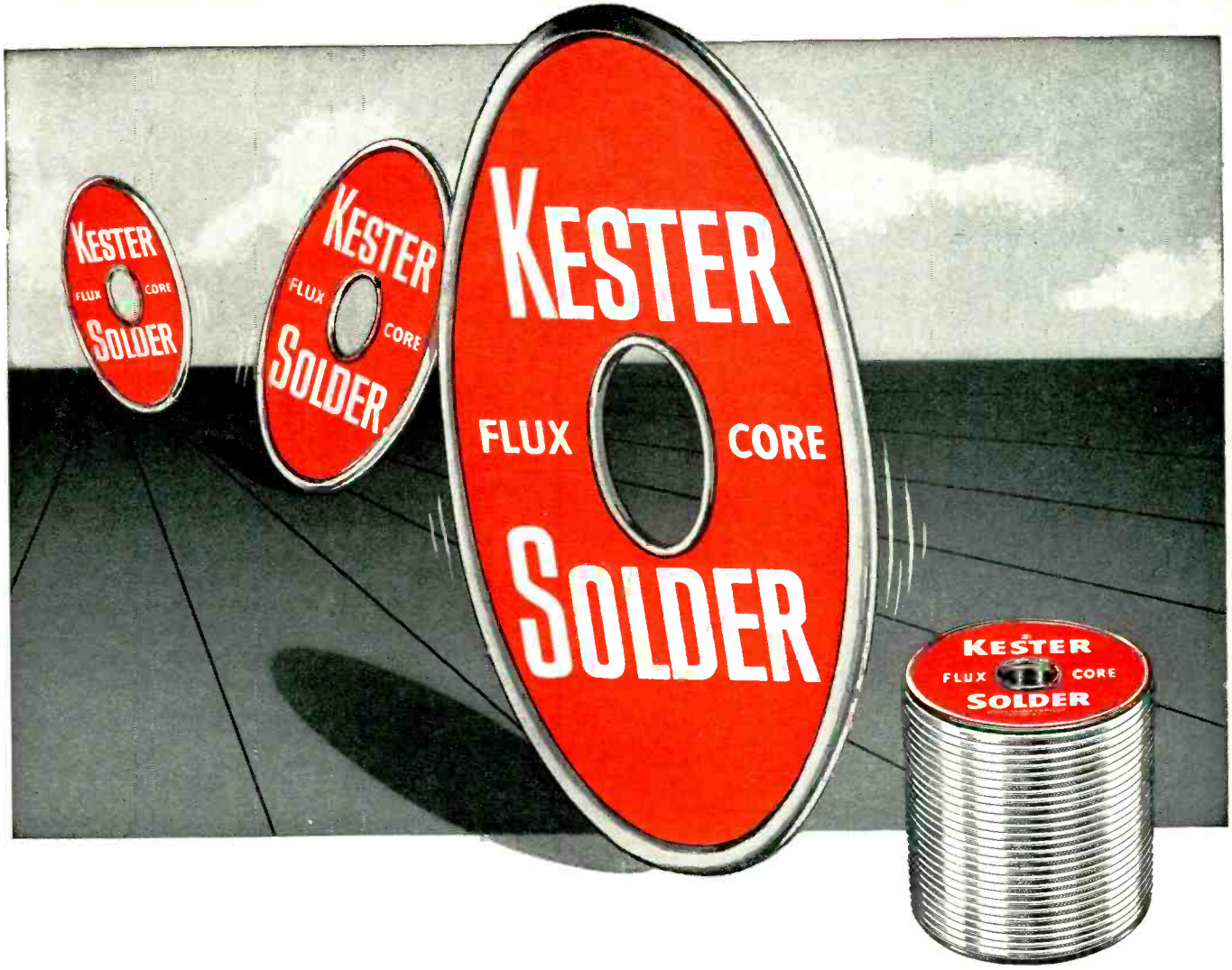
USING A PUNCHED TAPE to program test points and parameters, a new Robotester developed by Lavoie Laboratories, Morganville, N. J. automatically performs up to 120 complete circuit measurements per minute. Production test capacity is 240 test points per setup. Between any two of the 240 points, over 57,000 possible measurements or tests can be called for by appropriately punching the programming tape. From 70 to 90 percent of failures or defective parts will be picked up, excluding tubes or gross breakage through a dropped or smashed chassis.

Originally developed for testing radar equipment, the automatic tester will also test television sets, radios, computers, broadcast equipment, telephone switchboards, relay racks, aircraft cabling harnesses, underground cables, communication and fire-control networks, railroad control systems, gun directors and virtually any other electronic equipment operated by wires or tubes.

▶**What It Does**—The function of the tester is to determine whether correct connections have been made, correct components installed, and whether parts are defective. It checks resistance to ground at each tube socket or terminal strip point in sequence, passing to the next point if within preset tolerance, stopping and warning if in error. The strip tape used for the checks is prepared by an engineer and sets the format for the tests for the particular equipment. Tolerances



Testing Lavoie Bat marine radar units for small fishing boats with automatic tester programmed by endless loop of punched tape



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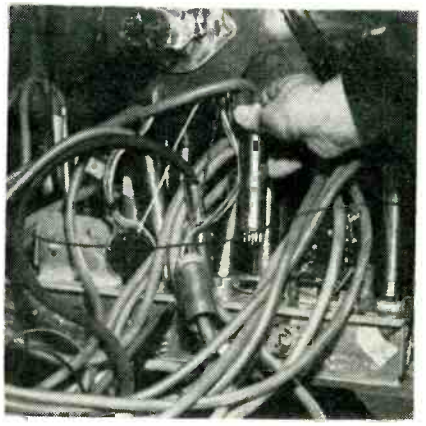
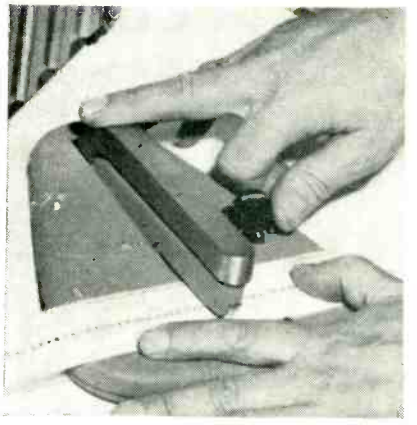
KESTER SOLDER

COMPANY **4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada**

Ends of punched tape are glued to form endless belt as shown. This is easily loaded under contact fingers and sprocket



For production testing of television receivers, cables of tester terminate in standard octal plugs fitting into sockets on chassis



Twelve-position knob on simple tape punch is set to position where hole is desired and lever is pressed

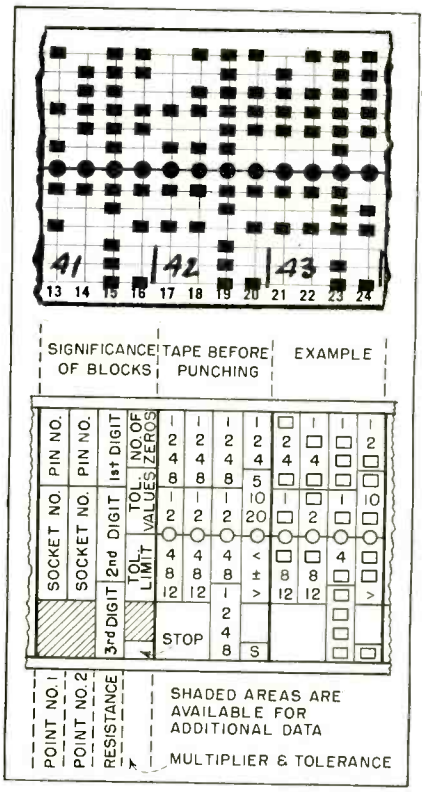
from 5 to 20 percent or wider can be set to reject or pass.

Once the tape is prepared, the operator merely inserts the plugs in the sockets of the equipment to be tested, then pushes the start button and watches for error signals. Time on subassembly tests is reduced from 20 to 40 percent on most units. Fast toolup in widely separated factories is possible because test data can be supplied as punched tapes.

▶**How It Works**—Tape for programming is prepared on a simple hand punch producing one rectangular hole at a time. The 12-hole tape is $1\frac{5}{8}$ inches wide and four rows of holes are used per test, so that each test requires slightly over $\frac{5}{8}$ inch of tape length. A form of binary coding is used to designate numerical values such as socket numbers, pin numbers and resistance value, as indicated on the diagram. Thus, any one of 24 sockets is selected by punching the appropriate combination of positions representing 1, 2, 4, 8 and 12.

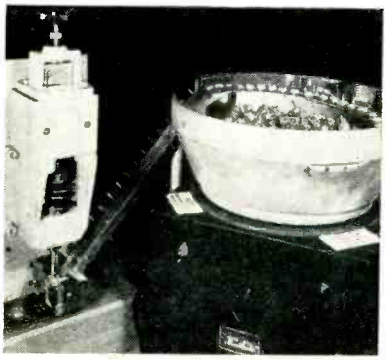
For resistance value, the first three digits are punched from three 1-2-4-8 groups and the number of zeros to be added is punched from a 1-2-4 group. Three additional holes permit specifying 5, 10 or 20 percent tolerance and three more designate whether this can be both ways or just above or below.

Twelve contact fingers serve to read tape holes and set up relays or stepper switches as the tape is run through by a feed mechanism.



Actual-size reproduction of tape as punched for three tests, and diagram showing significance of each punched hole. Punched example on diagram sets up machine for continuity test from pin 6 of socket 21 to pin 5 of socket 22 (read unpunched locations) for at least 150,000 ohms minus 10 per cent

Socket-Inserting Head For Automatic Assembly Machine

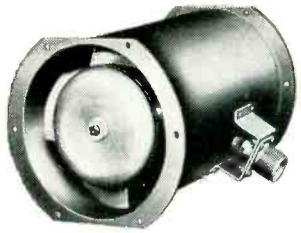


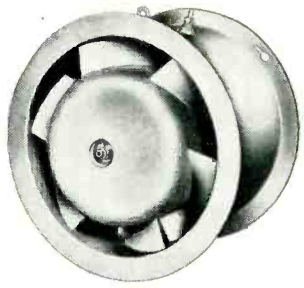
Demonstration setup of socket head

AUTOMATIC insertion of tube sockets in etched-wiring boards is achieved without preliminary preparation of sockets by combining a Syntron vibratory elevator with a special feed chute and insertion head developed by Elco Corp., Philadelphia. A standard vibrator is equipped with appropriate guides on its raceway to accommodate a flat, a missing pin or any other keying arrangement of the particular socket to be inserted.

Oriented sockets feed down a partially enclosed chute to the head, with the grounding strip projecting up through the open side of the chute. Sockets can thus be dumped in bulk lots into the hopper of the vibrator.

Each operation of the insertion head pushes the lowest socket of the chute down into the socket hole of the etched-wiring board. Retraction of the head allows another socket to drop into position by





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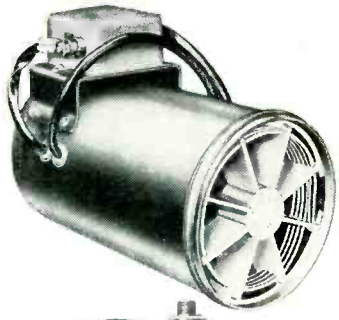
Only JOY AXIVANE® FANS Offer All These Advantages



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Precision construction insures performance that gives you great power in so compact a unit.

COMPACT DESIGN

Joy's axivane design permits installation of Axivane fans as part of the duct . . . requires no extra space.

LIGHT WEIGHT

Axivane fans are light in weight as well as compact because they are built from precision aluminum or magnesium castings produced in our own foundry under JOY engineering supervision.

AERODYNAMIC ENGINEERING

The airfoil blades and stationary vanes of JOY fans are made with power-saving, efficient airfoil cross-section. AXIVANE design provides equal pressure and velocity distribution across the fan outlet . . . eliminates turbulence . . . and produces the greatest cooling effect with the least expenditure of power.

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Joy AXIVANE fans are durable because the outer casing, stationary vanes, and inner casing are precision-cast as a single unit, giving extra strength and maximum resistance to shock.

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Joy's unmatched experience as the world's largest manufacturer of Vaneaxial fans and blowers is a bonus that costs you nothing extra . . . JOY'S leadership is due solely to the multitude of customers who are now enjoying the benefits of outstanding engineering. Why not join the number of satisfied JOY customers . . . you'll be in the best company.

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Joy offers a large selection of fans in the standard line . . . as well as custom-designed types that are available to your specifications. The Joy line includes fans for all purposes ranging from 1/500 HP to 3000 HP. You'll find a fan to suit your needs in the JOY line. Let us work with you. ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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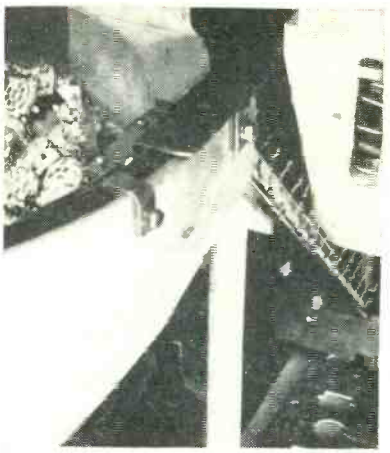
gravity, ready for insertion.

Although the model of this assembly head employs an electric solenoid as an actuator, the design can readily be adapted for air-cylinder operation. The chute can be lengthened and curved as required for mounting the vibrator and hopper directly above the head, to permit use on an automatic in-line assembly machine.



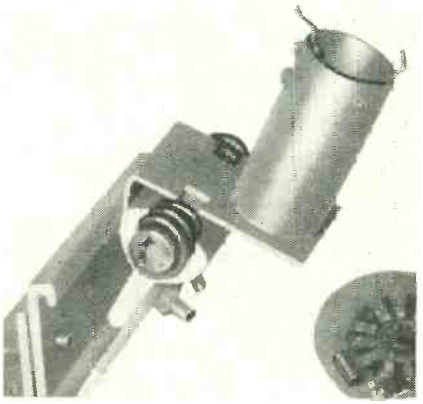
Rear view of socket-inserting head, showing how grounding strips of sockets project up out of open rear side of chute that connects hopper to head

Flexible-Screw Conveyors For Subassemblies

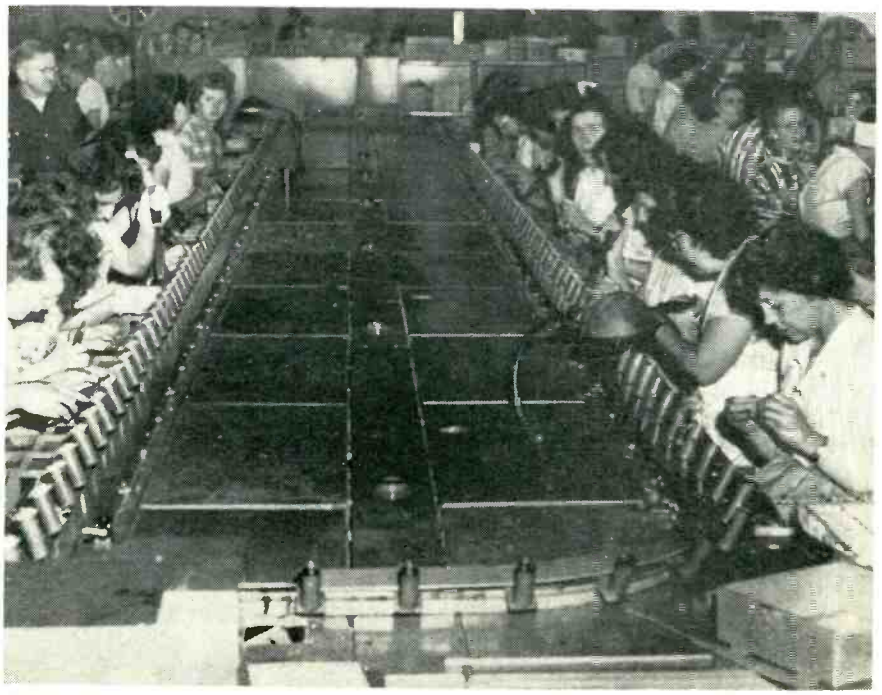
BENCH-LEVEL flexible-screw conveyors aid in assembling television tuner switch wafers in the Croyden, Pa. plant of Philco Corp. Simple wafer-holding fixtures ride on the conveyor. Changing the entire line from one job to another merely involves lifting off the set of fixtures and dropping a new set into position.

The entire conveyor line was designed and built by the firm's production and engineering staff, using standard Monoflow conveyor components made by M-H Standard Co., 513 Communipaw Ave., Jersey City, N. J.

The conveyor is arranged in the



Simple fixture holding wafer support rides on top of conveyor screw. Spring clips on cylinder serve to hold wafer. Other end of fixture rides in channel



U-shaped screw-conveyor line being used for assembling television tuner wafers

NEW 5-IN-1 TEST SET

Simplifies Radar Maintenance

MICROLINE MODEL 570
(AN/UPM-32) 8,500—10,500 mc

Power Meter	
Input	+ 5 to + 30 dbm
Accuracy	± 1 db
Frequency Meter	
Absolute Accuracy	± 2.5 mc (8500-9600 mc)
Relative Accuracy	± 1 mc in 60 mc
Spectrum Analyzer	
Sweep Frequency	3 to 30 cps, adj.
R-F Sensitivity	−55 dbm for a 1" deflection
Pulse Width	0.2 to 3.0 μ sec.
Synchroscope	
Deflection Sensitivity	0.5 v per inch min.
Sweep Length	5, 20, 50, 250 and 4000 μ sec.
Pulse Length	0.1 to 1000 μ sec.

A new combination test set is now in production which combines in one compact and portable unit the functions of a signal generator, power-frequency meter, spectrum analyzer and synchroscope. This Microline® Model 570 is adapted to checking multi-pulse systems as well as standard single pulse radar systems. Special gating feature permits selection, identification and observation of the spectrum of any pulse in a pulse group. Model 570 meets the requirements of Specification MIL-T-945A for military test equipment.

Signal Generator	
Output	Cal. −5 to −100 d bm Uncal. +3 to −5 d bm
Accuracy	± 1 d b
Freq. Mod.	0 to 30 mc adj.
Pulse Mod.	0.25 to 10.0 μ sec.
Ext. Pulse Mod.	0.2 to 125 μ sec. 100 to 4000 pps
Power Requirements	115 v ±10%, 50 to 800 cps, 250w
Size	16 5/8" l, 15 5/8" w 15 7/8" h

Supplied with transit case and accessories

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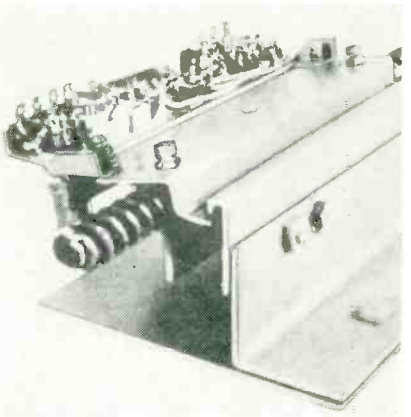
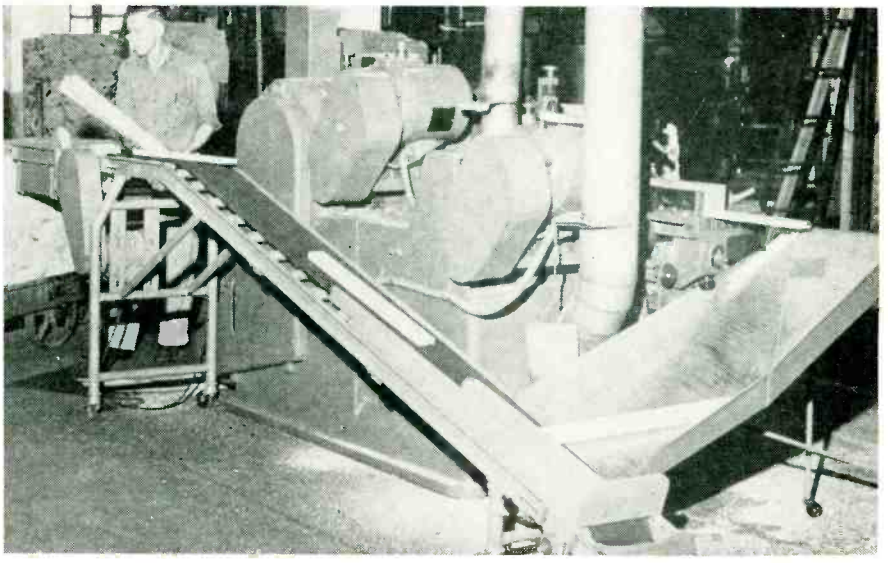
form of a U on the assembly bench, carrying the fixtures in front of the operators seated along the sides of the bench. An operator at the open end of the U unloads a finished wafer and puts on a new blank as she picks up the fixture coming off the end of the line and transfers it to the start of the line. The line is powered at both ends through a variable-speed drive, hence the need for manual transfer of fixtures.

By using a somewhat longer fixture having appropriate holding clips, an entire chassis can be assembled equally well.



Chassis-holding fixture on screw conveyor, loaded with assembled radio chassis using conventional wiring

Conveyor is Added to TV Cabinet Shaper



Conveyor returns shaped cabinet members to loading end of machine

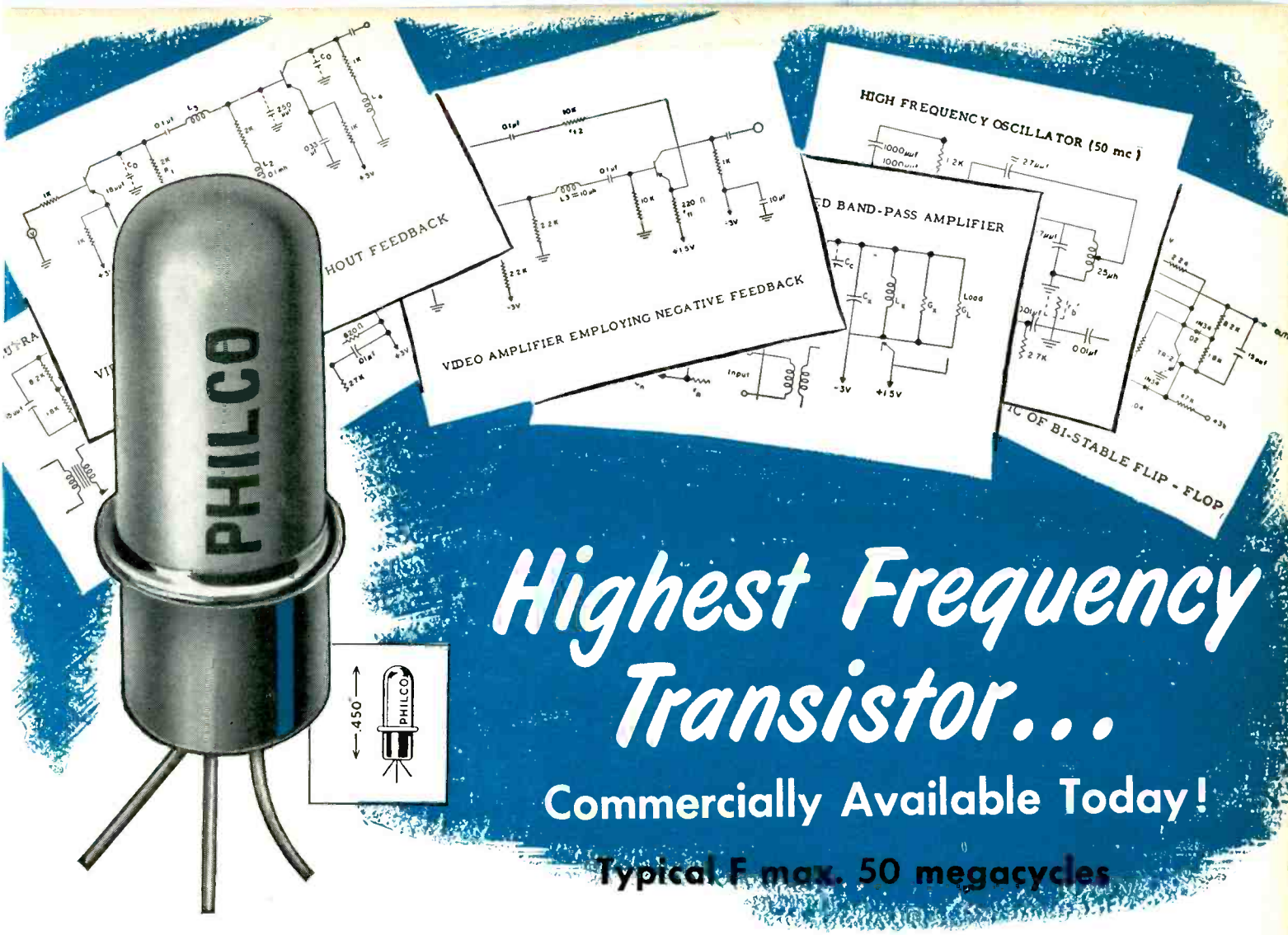
TYPICAL MECHANIZATION feature on wood-finishing machines at the G-E Rockford, Ill. cabinet plant is a belt conveyor paralleling a wood molding machine which shapes parts for television cabinets. After the molding operation, the wood pieces slide down a transverse chute onto the conveyor for return to the front of the machine, so one operator may both load and unload them.

Automatic Preparation of Glass-Braid Wire

GLASS-BRAID WIRE used in modern jet fighters is difficult to end-strip to required quality specifications using conventional rotary bench stripping equipment. A new automatic machine does this job at North American Aviation's Los Angeles plant in one-sixth the time formerly required and in addition, imprints the wire at each end. The machine was designed and built by Artos Engineering Co. of Milwaukee, Wis., under an Air Material Command contract. It is now being used in North American Sabre Jet and Super Sabre production.

In addition to the savings realized in man-hours and time, the Artos machine has cut waste resulting from rejected parts to almost zero.

Estimated annual saving based



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For complete technical information on the PHILCO SB Transistor

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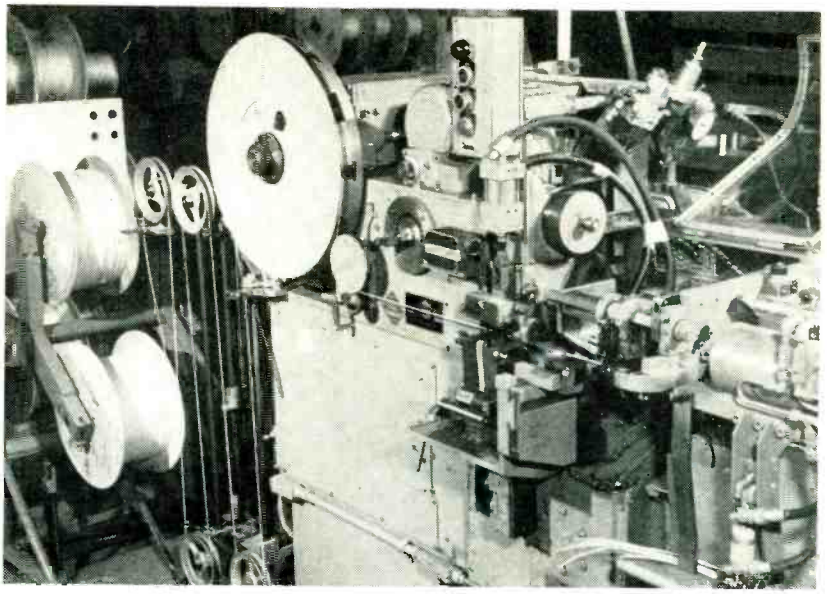


Printing attachment (center of picture) numbers wire ends just before cutting and stripping. Large wheel at upper left is measuring wheel

on wire production runs for modern jet fighter planes at North American by one machine are $42,240, if the machine is used 40 hours a week. Waste resulting from rejected parts has been reduced almost to zero.

The machine requires one operator who does his own setting-up for a production run. Spools holding various gages and types of wires are mounted at one end of the machine. The operator threads wire from one of these spools through a series of four weighted pulleys to the measuring wheel and from the measuring wheel to the numbering heads which mark the wire at both ends and on two sides. The wire then is pulled through the cutting and stripping knives and deposited in a long rack ready for bundling.

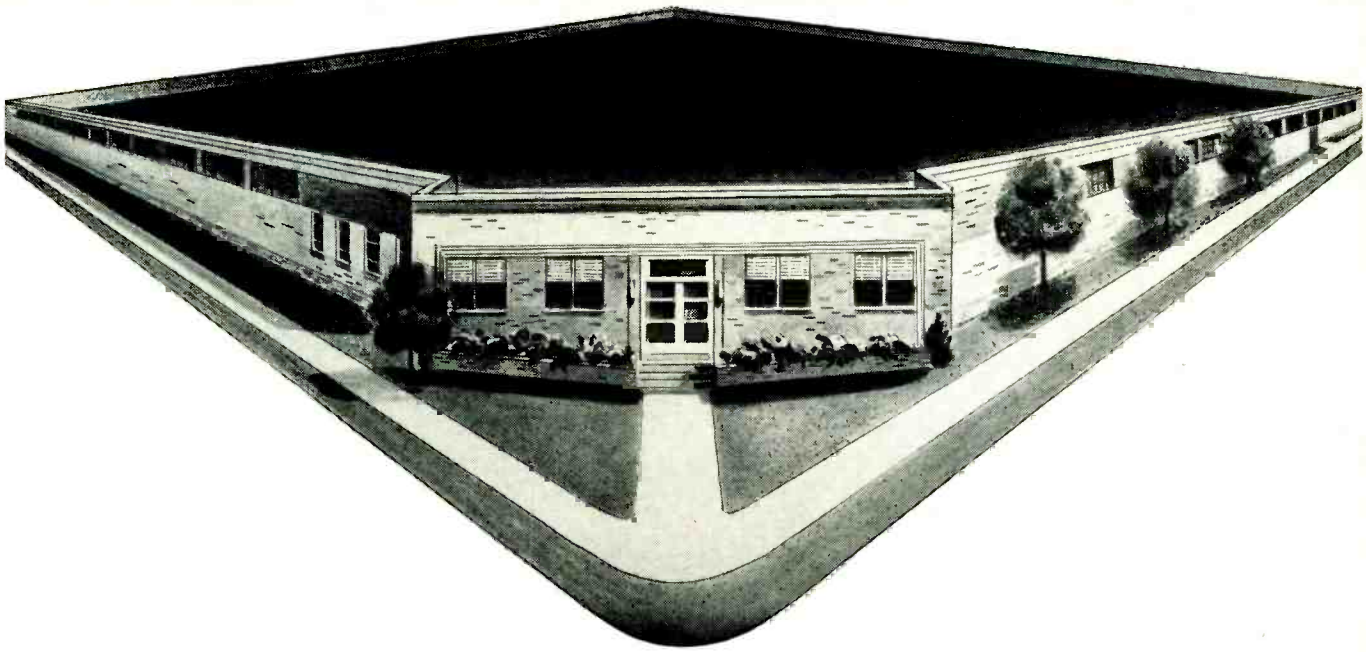
Changing from one order run to another takes about 1 minute. To change from one gage wire to another takes about 5 minutes because the stripping knives have to be replaced. Once adjusted, the machine can run unattended.

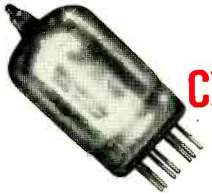
Tightening Screws Through Soldering Iron

Method of tightening or loosening solder-sealed screw by working through hole in soldering iron

WHEN screws previously soldered to a hermetically sealed housing require further tightening, a special soldering iron having a pass-through hole for a screwdriver is used in the Ford Instrument Co. plant in Long Island City, N. Y. The 300-watt iron has copper tubing set into the tip at an angle, with the hole of the tubing extended up through the entire tip. The working tip of the iron thus melts the solder around and under the head of the screw so that it can be readily turned by inserting the screwdriver through the hole. The solder solidifies to anchor and reseal the screw when the iron is removed.

Other forms of contoured solder-



here's what's behind the  crystal that's so far ahead

The Midland Factory shown above is the world's largest plant devoted exclusively to producing crystals for frequency control. It is equipped with the finest and most complete production and testing machinery ever developed for this purpose. Here Midland pioneered development of crystals for color television, and in all-glass holders of which one type is pictured above.

All this is important to you for just one good reason: Every Midland crystal you use has been produced by such advanced techniques and under such rigid quality controls that you can be sure it will prove its completely reliable quality under every operating stress.

Midland Critical Quality Control extends through every step of crystal production, and includes precise angular control by X-ray. Uniform accuracy is maintained to the millionth part of an inch.

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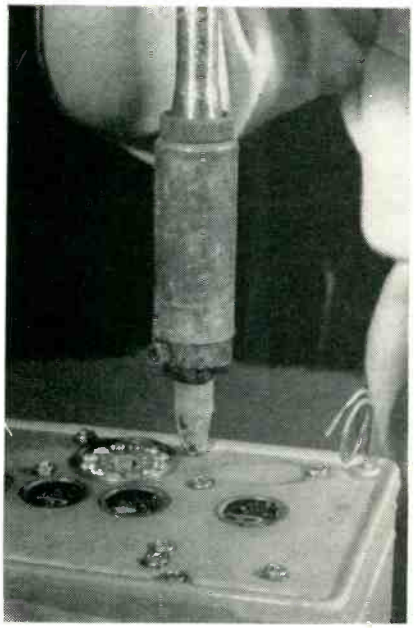
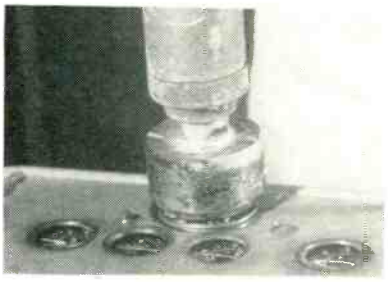


Using hollow-tip soldering iron to fuse solder preforms for sealing screws and acorn nuts to housing of hermetically sealed electronic control box. Because tip is hollow, vent hole is provided in its side to permit escape of hot gases that would otherwise force molten solder away from joint



Using special soldering iron with self-positioning tip to fuse solder preform for sealing delicate deviation cam to top cover of computer. Similar tips of different sizes were used to seal windows; here water was first placed on glass to prevent damage from heat

ing irons are used for sealing the screws initially and for solder-sealing larger circular inserts.

Applying Dielectric to Printed I-F Coils

ETCHED wiring boards currently being used for the i-f amplifier in RCA's black-and-white television receivers are produced with the i-f transformer windings etched out directly on the board. To prevent leakage between turns, it is necessary to place a protective dielectric sheet over each of the three transformers.

In the firm's Indianapolis plant,

The precise answer
to an exacting cable problem

• Special 111-conductor telemetering and instrumentation cable developed for guided missile work . . . Cables of the type used for instrumentation and telemetering must operate faultlessly. Dielectric requirements are especially exacting in preventing attenuation of low-level signals.

The project engineers at North American Aviation, Inc., designed a 111-conductor cable that would have the necessary low-loss characteristics, provide trouble-free operation and adequate service life. The cable was used by North American for guided missile work at the Air Force Missile Test Center in Florida.

Electrical characteristics

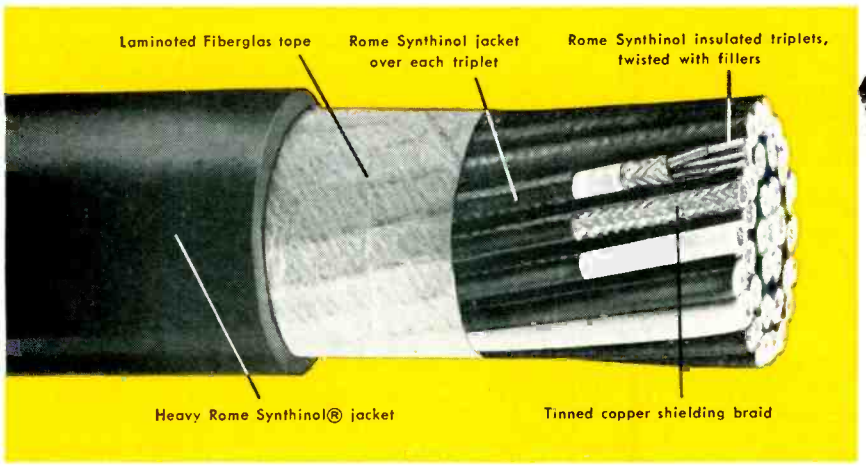
Rigid control of electrical characteristics is of primary importance in the manufacture of this cable. A polyvinyl chloride insulating compound, Rome Synthinol® adequately meets specifications and provides *an economical solution* to specification requirements. Capacitance is controlled by strict adherence to the specified wall thickness of the insulation and by controlled cabling which properly spaces the conductors comprising each of the 37 individually jacketed triplets.

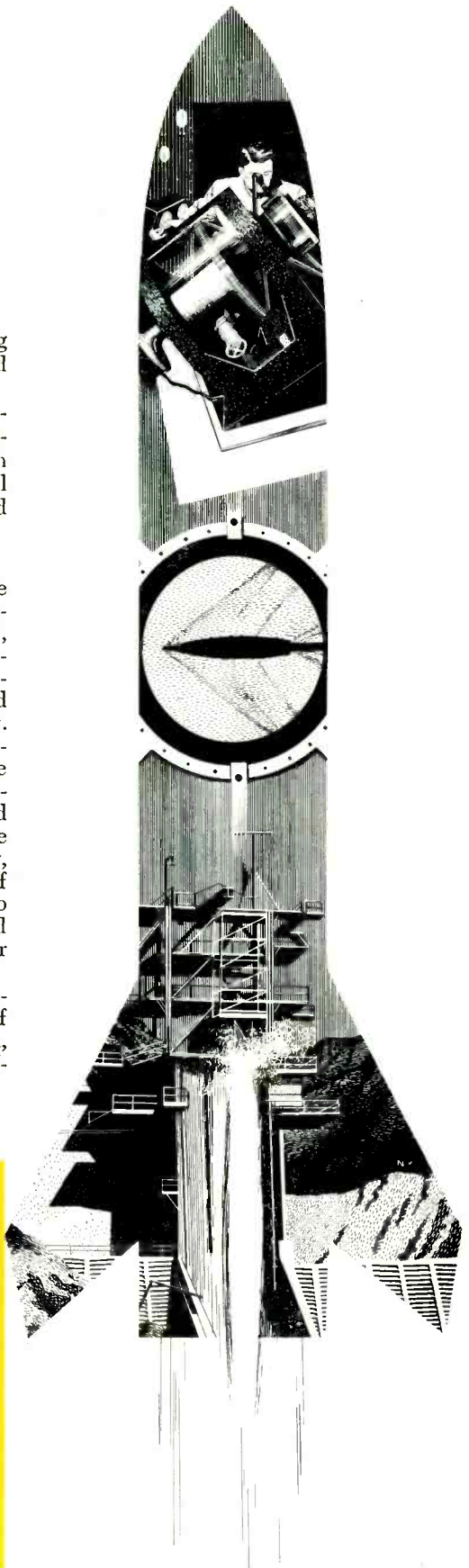
These components and their controlled fabrication prevent attenuation of the low-level signals which this cable is designed to carry—a vital design factor in instrumentation and telemetering cables.

The ingredients of success

Three organizational factors enable Rome to handle tough cable specification problems like this regularly. First, comes engineering competence—experience with electronic circuit problems. Next, production facilities and uncompromising control of quality. (For example, Rome utilizes a photoelectric gauge to maintain close control of diameter limits on insulations and sheaths. This control proved to be especially valuable with the cable described here.) And, finally, comes the unmeasurable factor of production know-how which is so important in meeting exacting and unusual design requirements for multi-conductor constructions.

Designing and manufacturing special cables is a regular occupation of ours. To see how Rome can help you, contact your nearest Rome Cable office or write us direct.





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Placing etched i-f strip on fixture in which dielectric pieces for i-f coils were previously positioned. Strips of sponge rubber on fixture position guides for pieces

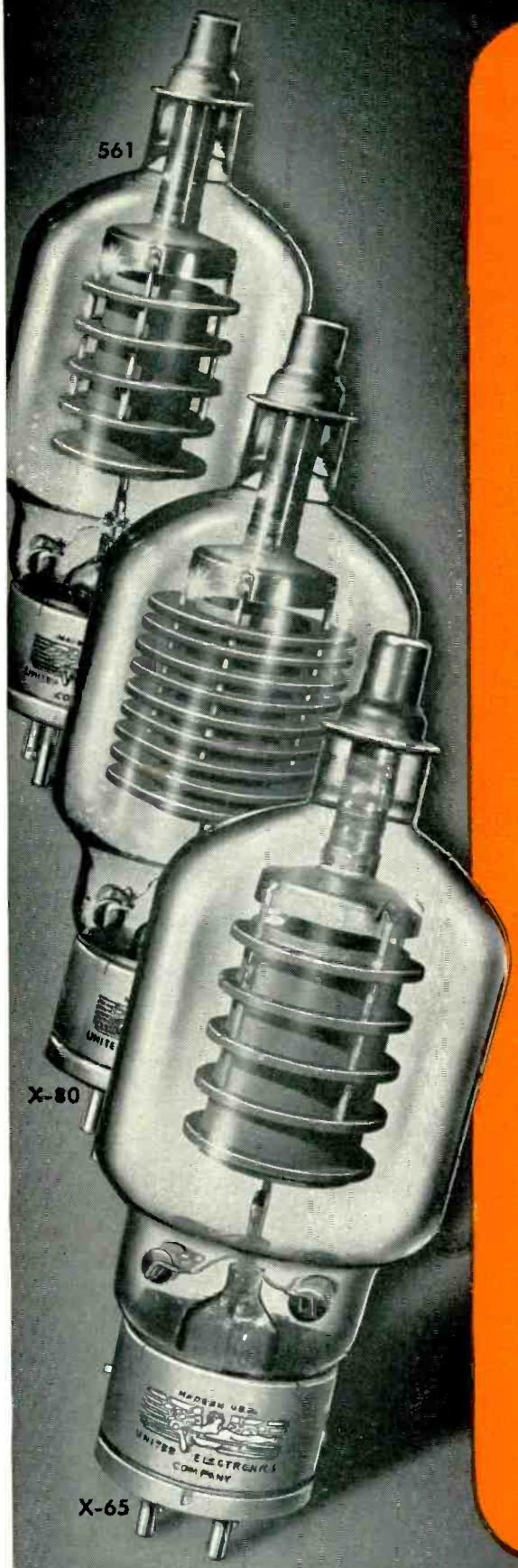
the thin plastic dielectric sheets are die-cut out of long strips having a special adhesive backing, to produce pieces corresponding in size to the windings that must be covered. Strips of linoleum are used as carriers for the punched strips.

An infrared lamp arrangement at the right of the operator preheats a loaded linoleum strip. When ready for more pieces, the operator pulls the heated strip closer to her and picks off the pieces one at a time with a pointed tool. These pieces are placed adhesive-side-up in nests on a metal fixture having positioning pins for the wiring board. An etched and punched wiring board is then dropped over the positioning pins, wiring down. This insures precise positioning of the dielectric pieces over the three windings.

The wiring board, with the pieces adhering loosely, is then transferred to a heated die controlled by a Fenwal Thermoswitch on the bed of a Denison Midget Multipress. Operating the valve of the hydraulic press gives the required combination of heat and pressure to fuse the dielectric pieces in position.

Prestripping Heater

AUTOMATIC STRIPPING of plastic insulation on wire is facilitated by placing a preheater ahead of the Artos or other stripping machine. The preheater developed for this purpose by Stakwhite Co., Tyler Park Station, North Bergen, N. J. is mounted on a metal frame having a positioning scale on the crossarm. This permits setting the



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NEW TUBES for HIGH POWER RADAR

Graphite Anode Rectifier-Diodes

For their size, these new tubes have greater power handling capacity than any other high vacuum convection cooled types, when used either as power supply rectifiers, clipper, hold-off or charging diodes.

Custom designed, they can supply the main basic diode needs for efficient tube performance in the functional as well as protective areas of new heavy radar circuitry.

Type	Code	Filament Vac	Filament Aac	epx kv	Anode ib a	Ib Adc	Maximum Dimensions Length Inches	Maximum Dimensions Diameter Inches
561	A B	11.5	15.5	30 30	2.7 80	.860 .075	9.750	3.630
X-80	A B	11.5	15.5	40 40	2.5 80	.800 .075	9.750	3.630
X-65	A	5.0	11.5	65	1.0	.250	9.750	3.630

CODE: A) Rectifier B) Clipper Diode

ALSO UNDER DEVELOPMENT

Several additional high vacuum diodes are being designed by UNITED ELECTRONICS which will extend the new MAJOR series with tubes of much higher power stature. If you will advise us of your rectifier-diode needs for equipment you are now designing we may be able to be of great help to you.

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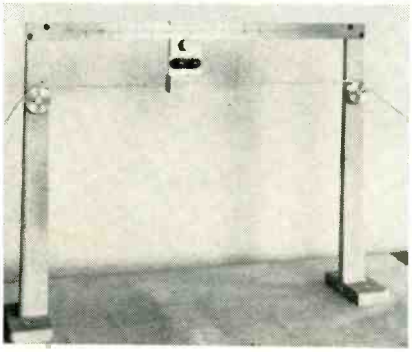
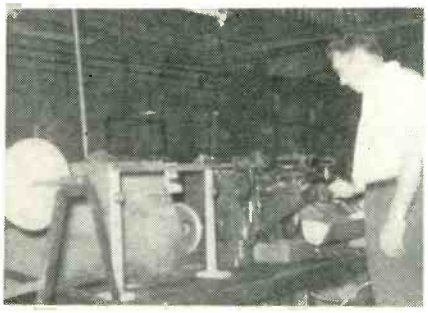


Pulleys on vertical supports guide wire through preheater mounted on thumb-screw-locked rider on calibrated scale



Installation of preheater on bench between reel of wire and automatic cutting and stripping machine

heater accurately at the position where the wire will be cut and stripped a few moments later. A knurled locking screw permits changing the position of the preheater quickly when changing the setup for a different wire length.

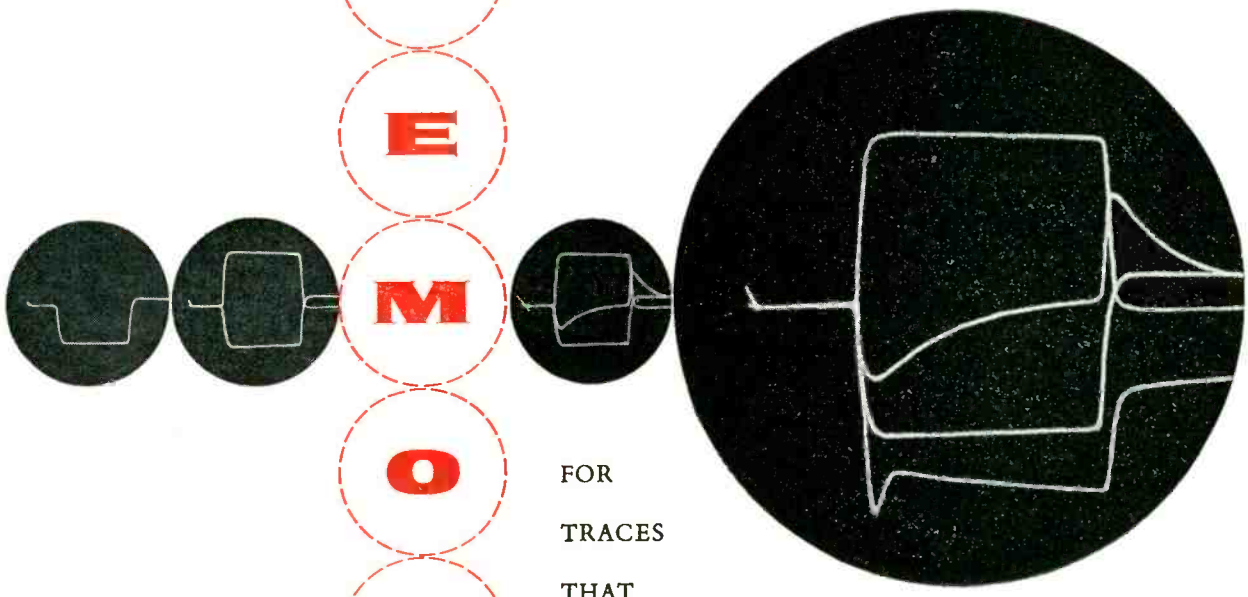
Heating serves to expand the insulation so that the wire strips freely without untwisting of strands. With preheating, adjustment of the cutting and stripping blade is no longer critical, making it easier to set the blade so there is no nicking of solid wire or cutting of strands.

Oval Water Pan Washes Tube Pins Better

CHANGEOVER from a rectangular to an oval water pan alongside a tube-pin solder pot greatly improved water circulation around the pins, thus giving better cleaning of flux or residue from the soldering operation. The change was suggested by Leslie C. Lamphere of Sylvania's Emporium plant, and resulted in a suggestion award of $20.

With the new pan, water enters

HUGHES MEMOTRON



Successive traces of waveforms associated with one-shot multivibrator, visually stored by MEMOTRON.

FOR TRACES THAT STAY

HUGHES PRODUCTS *announces the* MEMOTRON *—first in a series of direct-display cathode ray storage tubes available for laboratory and industrial applications.*

MEMOTRON *direct-view storage tubes capture and retain waveforms visibly until you erase them intentionally. Now non-recurrent phenomena can be held and studied directly on the viewing screen.*

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RESOLUTION...60 written lines per inch.
WRITING SPEED...at least 50,000 inches/sec.
(For selected tubes: up to 1/4-in./μsec.)
BRIGHTNESS...50 foot-lamberts.
USABLE SCREEN DIAMETER...4 inches, minimum.
DIMENSIONS...Over-all length: 18 3/4 inches, ± 1/2-inch.
Bulb diameter: 5 5/8 inches, maximum.
Neck diameter: 2 1/4 inches, ± 3/32-inch.

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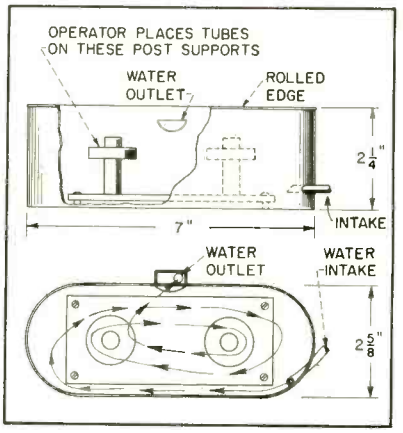


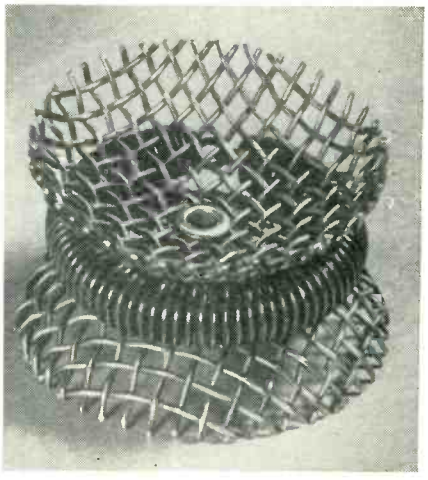
Sketch showing construction of oval water pan used for washing tube pins after soldering

at the bottom and is directed along one long side of the pan. The outlet for water is at the top center of the other long side, so that water circulates many times around the pins when tubes are placed on the two post supports. As a result of this change, a tendency for tube pins to corrode under certain conditions has been eliminated.

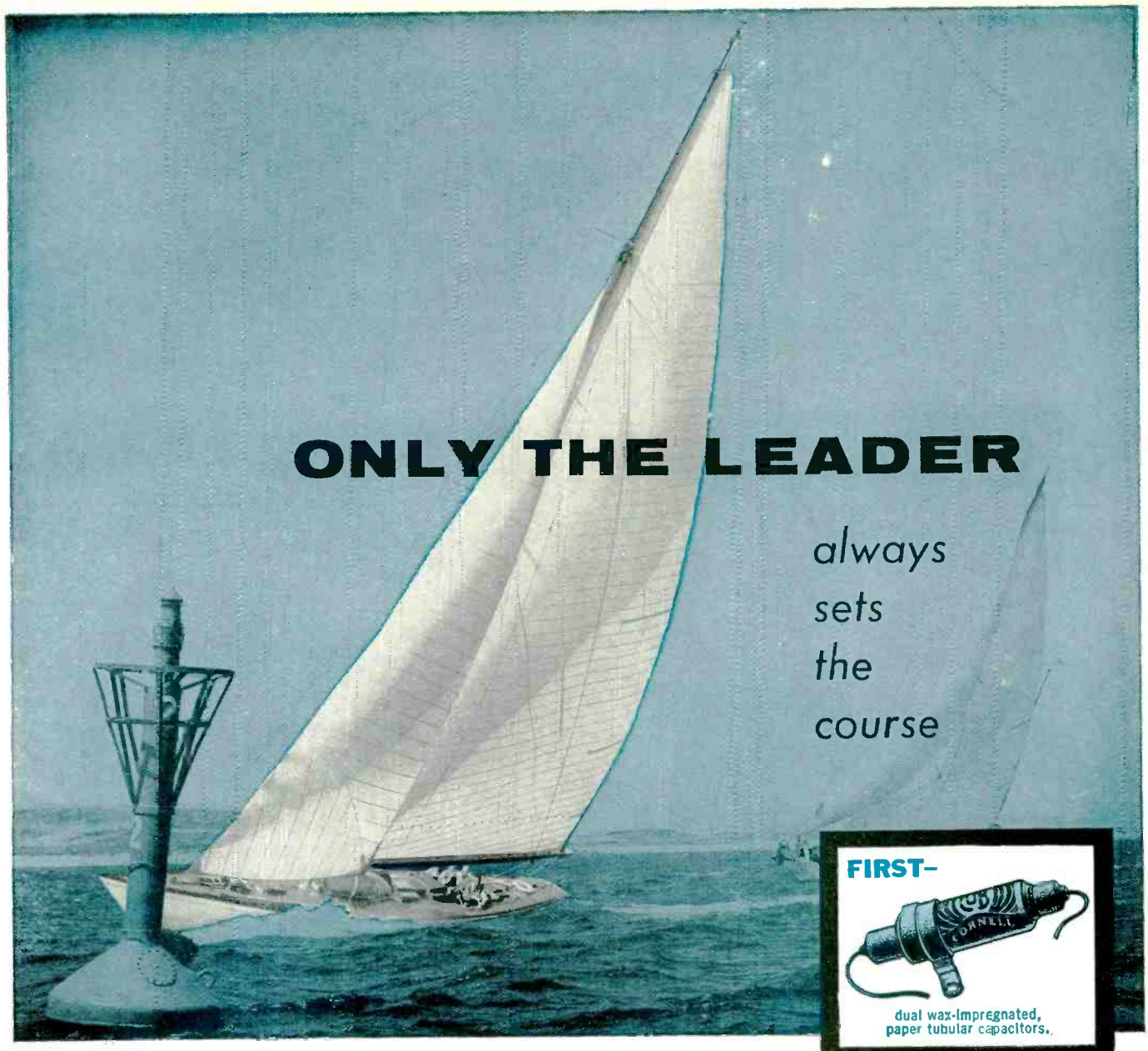
Shock Mount Springs Made from Wire Cloth

COMBINATION OF CIRCULAR and convex-concave spring damping in a shock mount made for airborne electronic units by K. W. Johnson & Co., Inc., Dayton, Ohio, has boosted the efficiency of the damping to 95 percent and at the same time appreciably reduced the weight of the mount.

▶ **Construction** — The convexed



Double-reacting spring arrangement, with circular spring between two concave-convex springs



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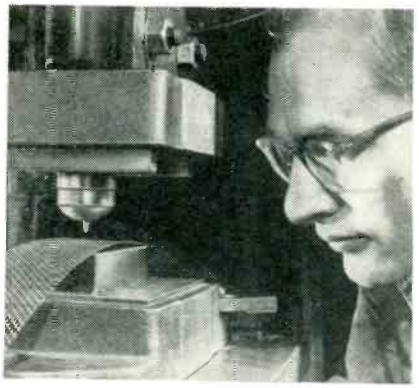
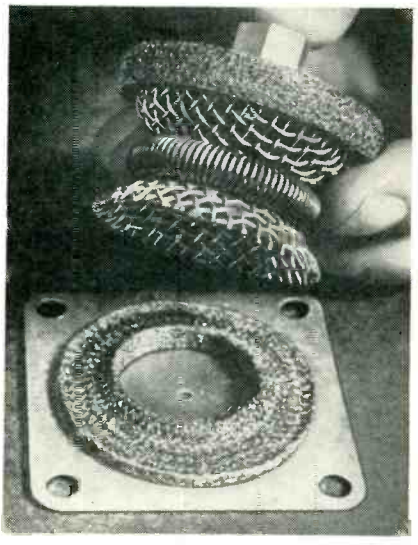


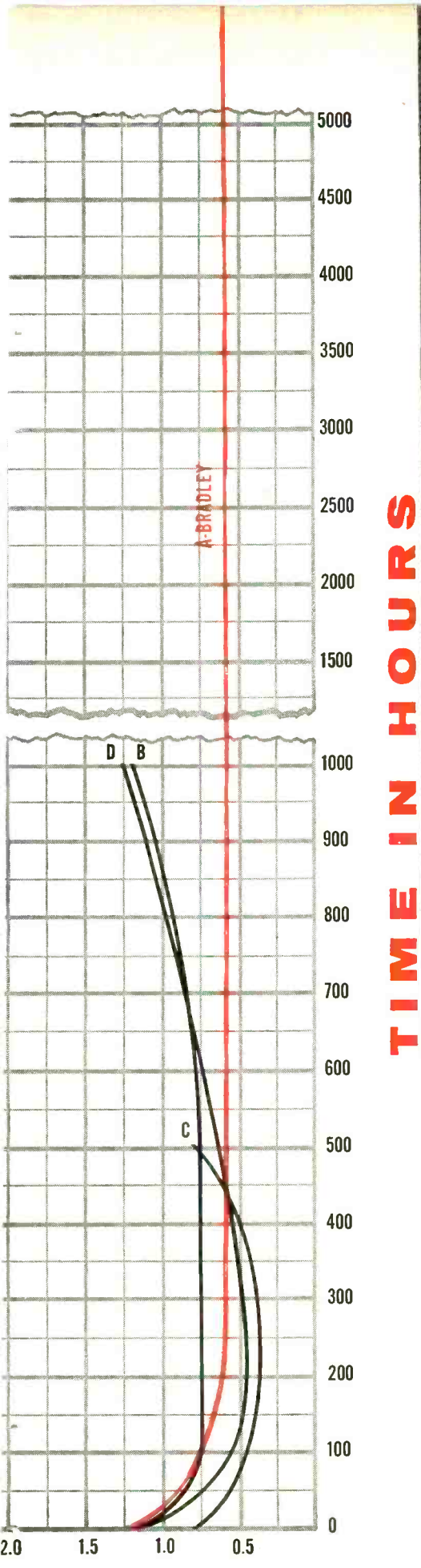
Special die used on punch press to form, cut and pierce the concave-convex spring from beryllium copper wire cloth

springs are fabricated of beryllium copper wire cloth, purchased in 100-foot rolls 2⅛ inches wide. The springs are formed and cut in one operation with a special die on a punch press to give a disk-like dish of beryllium copper wire cloth. After heat-treating, two of these disks are fastened together back-to-back, so the convex surfaces face each other. A brass eyelet in the center binds them together. A circular coil spring made of stainless steel is fitted around the assembly in the V made by the joining of the two beryllium copper disks. This forms the main spring action which absorbs the shock in a vertical and radial pattern.

▶ **Performance**—Addition of the coil spring prevents prolonged uncontrolled cycling. As a shock is encountered, the motion of the beryllium copper spring is resisted by the friction of the coil spring



Ends of wire-cloth springs rest in wire pads of mount



Life test curves comparing reverse leakage of Bradley vacuum processed selenium rectifiers with units produced by different processes by other manufacturers.

THE LONGER LIFE TEST PROVES the greater superiority of Bradley RECTIFIERS

Bradley LABORATORIES, INC.

What happens when you test a rectifier? You get an indication of forward and reverse current and power characteristics. But, the ultimate value of a selenium rectifier must be determined as a function of time plotted against electrical characteristics and environmental conditions.

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Write for a set of life test curves. They prove the superiority of Bradley Laboratories' vacuum processed selenium rectifiers.

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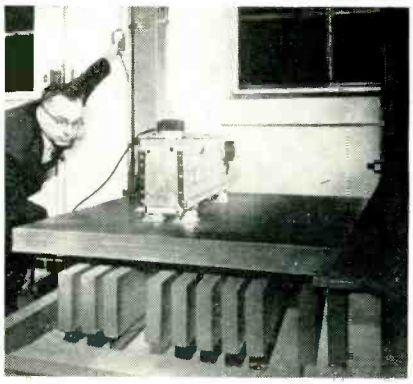
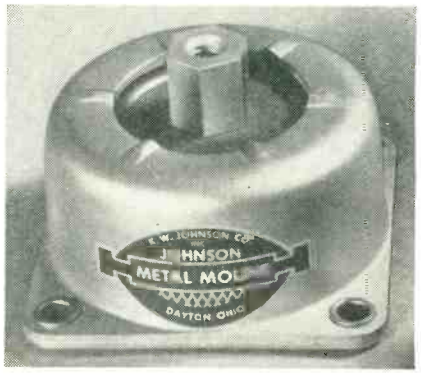
against the convex surface of both surfaces. It cushions the downward action as it expands, and contracts to level the upward surge. This double damping action holds magnification at resonance down to about 1.5.

The combination of a stainless steel spring and the beryllium copper alloy cloth gives practically in-



Testing mounts on sand drop machine to simulate variable-duration shock conditions. Dummy electronic equipment used on mounts can be adjusted to duplicate any type of unit by adding or subtracting weights



Finished metal mount has natural frequency of approximately 10 cps. No separation occurs with 30 g shock at 11 millisecond duration

finite life, resistance to salt spray, high fatigue life and metallic compatibility that eliminates electrolytic action.

In addition to the vertical shock that the spring must withstand, there is also the problem of horizontal movement stemming from a rolling action. Many of the electronic units are up to 10 inches high. Even the slightest displacement at the bottom will result in a magnification of the top movement of the unit. This means that units must be spaced so they don't collide in an exaggerated sway or roll condition. With the beryllium copper

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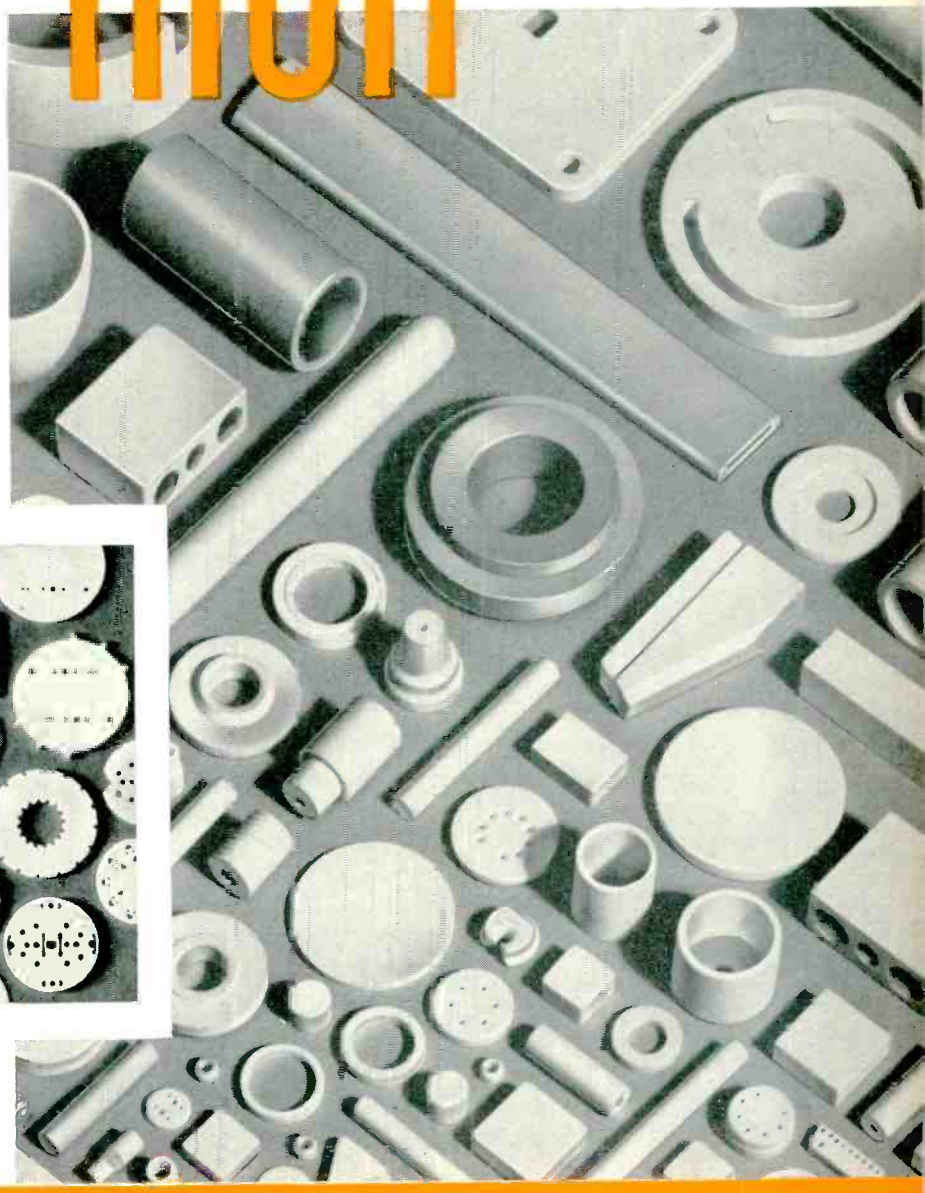

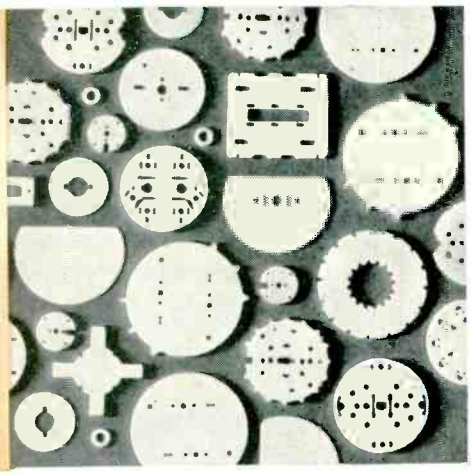

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spring system, the horizontal transmissibility at resonance is controlled to approximately 1.0, so that an instrument 7½ inches high has a top movement of but ⅝ inch.

▶ **Advantages**—The weight characteristics of the components used in the mount are another definite advantage. The finished beryllium copper mounts weigh only 3½ ounces, as compared to 4 ounces and up for other types of mounts. Use of between 2,000 and 3,000 such mounts in an average bomber makes this weight saving impressive because each pound of weight saved in aircraft construction is equal to about $8,000.

The beryllium copper wire used in this application is supplied by Little Falls Alloys, Inc., of Paterson, N. J. The wire cloth is obtained from the Cleveland Wire Cloth and Mfg. Co., Cleveland, Ohio. The beryllium copper alloy is produced by The Beryllium Corp., Reading, Pa.

Tumbling Tube Parts Gives Precision Finish

By A. W. KOLLOSCH
Product Engineer
Sylvania Electric Products, Inc.
York, Pa.

CAREFULLY controlled tumbling procedures smooth off the burrs and rough edges of tiny precision stampings in Sylvania's metal parts plant. Millions of tiny parts are produced per day from sheet stock varying from 0.005 to 0.015 in. thick for use in receiving tubes. Some parts are so small that 50,000 of them can be held in the palm of one hand. The metals used include stainless steel, plain carbon steel,

As delivered from stamping press, grid cups have nearly imperceptible burrs around their edges

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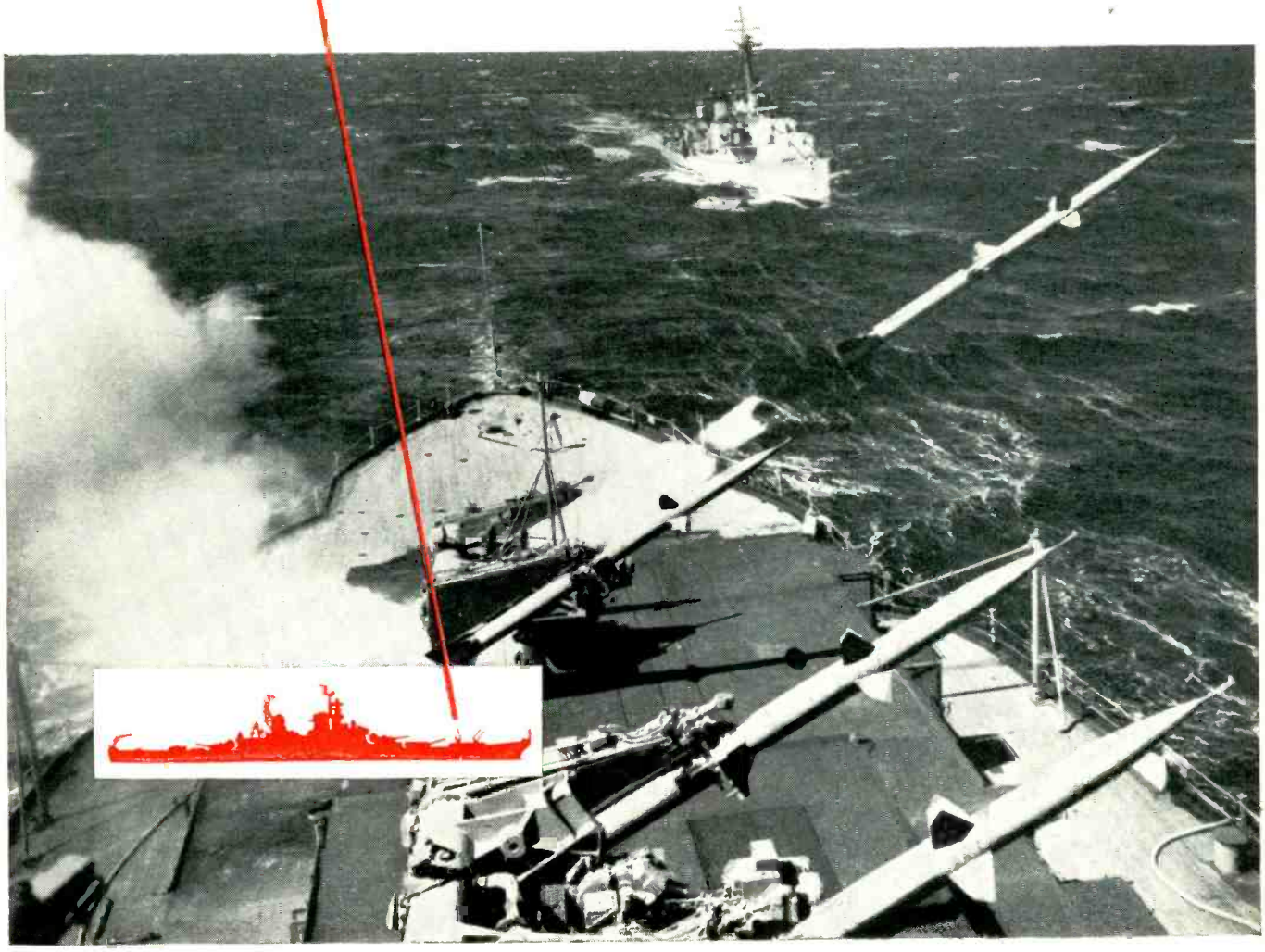

aluminum, brass, pure nickel, phosphor bronze, nickel-plated steel, copper, tungsten, molybdenum, tantalum and even gold. On some parts the tolerance may be ±0.0005 in., on others, as small as ±0.0002 in.

► **General Procedure**—Before being placed in the barrels for precision barrel finishing, the parts are given a thorough degreasing treatment to remove every trace of the heavy chlorinated oil with which they were coated during

Tumbling machine used in finishing grid cups for electron guns

stamping. The appropriate barrel (rubber-lined or steel) is then loaded in five steps: (1) place the designated number of parts in the barrel; (2) add chips to the listed percentage of the load; (3) add the correct amount of water; (4) add the specified tumbling compound; (5) place the lid in position and start tumbling.

The aluminum-oxide tumbling chips (Lorco) are mostly No. 4, the size of fine gravel. They must be cleaned twice a week and are screened weekly on a shaker screen to eliminate the chips that have worn undersize since the previous screening. When re-screening is done, an operator picks out all foreign substances, using a hand magnet to remove the particles of magnetic material that have found their way into the chips. The twice-a-week cleaning is done in the tumbling barrels, using Lorco GW degreasing compound.

Unloading of a barrel after tumbling must be done with ex-

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Transmitter	CGC-8-A-7	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.23	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.09	67+ j270	59.5	Rotor 1 Phase	24.0	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.27	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26.0	39	.43	280+ j600	230	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	30*
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36.0	9.0	200	7 Rotor 7 Stator

Total Null max. 30mv for each unit

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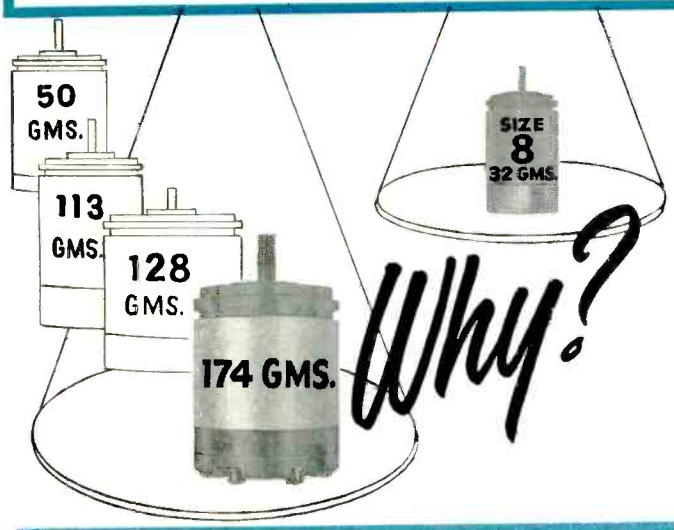
*Torque 2400 mg.-mm./degree from CGC-8-A-7



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CLIFTON HEIGHTS **PENNSYLVANIA**

treme gentleness to avoid marring the delicate parts. On grid cups and other fragile parts, the chips and parts are dumped together into one 10-inch-square box at a time. The contents of each box are then turned out carefully on a shaker screen for separation.

Tumbling procedures vary a great deal because of the myriad variations in the parts being processed. Two typical examples, one simple and the other very complicated, will be given.

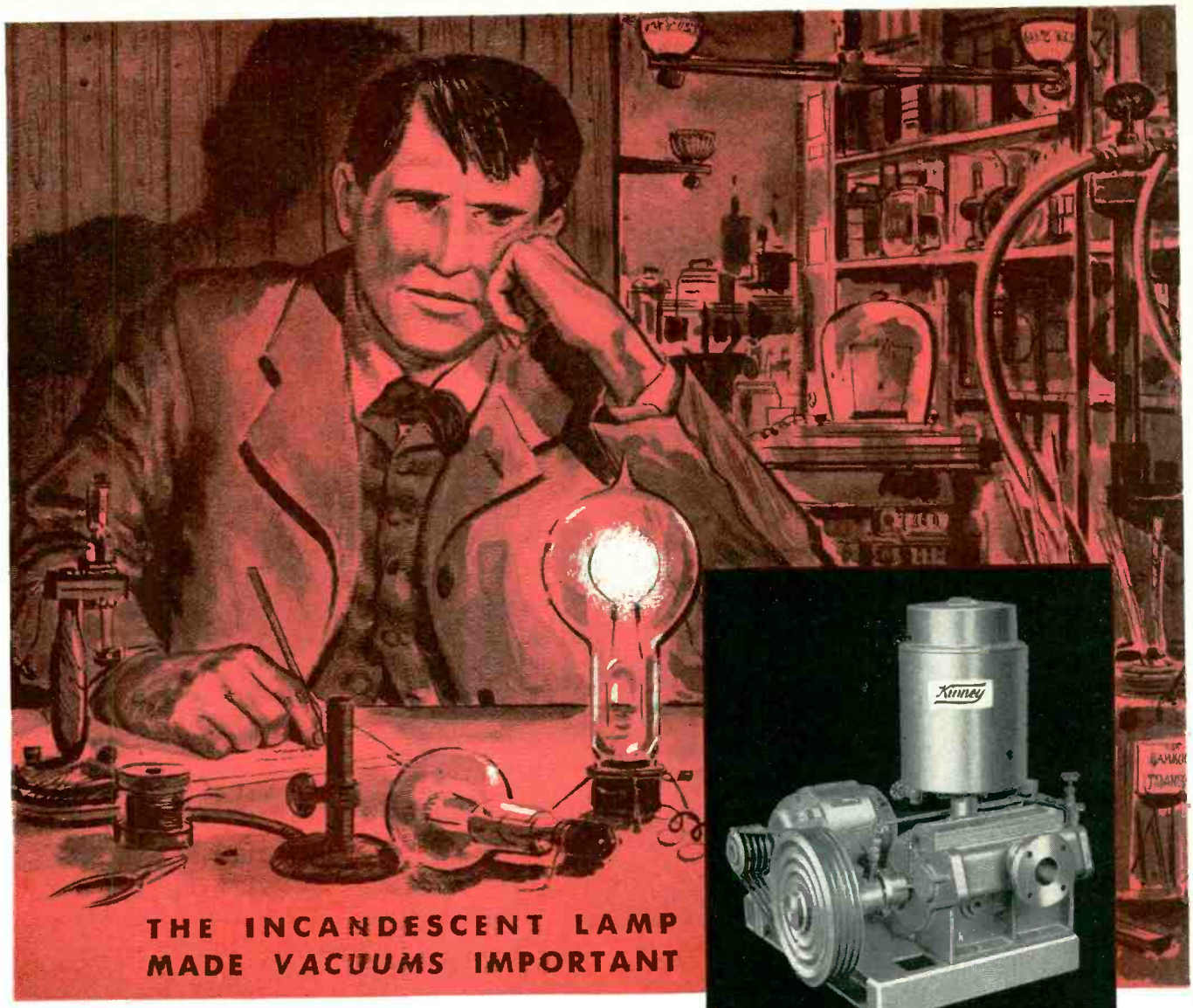
Inspecting parts that have been dried by tumbling in sawdust

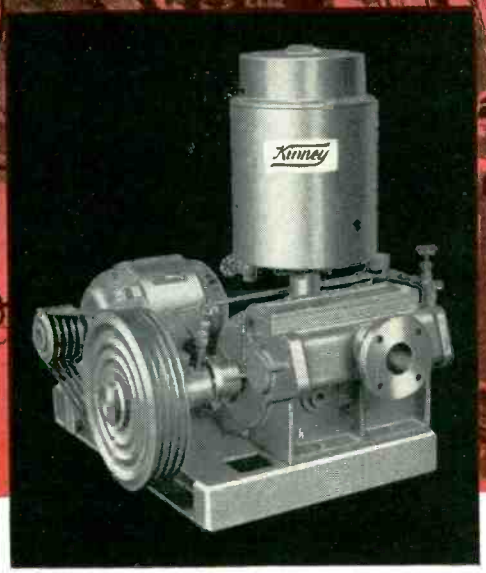
►**Tumbling Grid Cups**—One part requiring dimensional exactitude is the small stainless-steel cup, roughly ½ in. in diameter by ⅜ in. high, that serves as the lens of a television picture-tube electron gun. A small hole 0.025 in. in diameter is punched precisely in the exact center of the cup, to pass the desired beam of electrons.

The finished parts are required to have smooth edges, no burrs on the edge of the cup or the tiny hole, a bright, clean surface and no water stains. The latter two requirements are considered to be the most difficult.

Tumbling is done in a two-compartment barrel. Two full 10-inch-square boxes of the thimblelike parts are loaded into each of the 2-cu-ft compartments, and No. 4 chips are added to constitute 60 percent of the total load. Hot water is added to a depth of 2 in. above the level of the load and finally a cup of liquid descaling compound (Lorco DL). This is a concentrated liquid acid compound, used here to assure a bright, shiny finish.

The load of parts and chips is tumbled for 1½ hours at 16 rpm. After tumbling, the parts are





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given a hand dip rinse in cold running water and then dried with hot air in a centrifugal drier. Though this is a simple job in theory, in practice it has proved quite difficult to develop a procedure that would secure satisfactory results. Insignificant scratches, tiny dents or specks of minute discoloration are all causes for rejecting the tiny cups.

▶**Tumbling Top Caps**—The anode cap for a high-voltage rectifier is a thimble roughly $\frac{5}{8}$ in. in diameter by $1\frac{3}{16}$ in. high, having a

Finished and approved parts after tumbling. Grid cups are below.

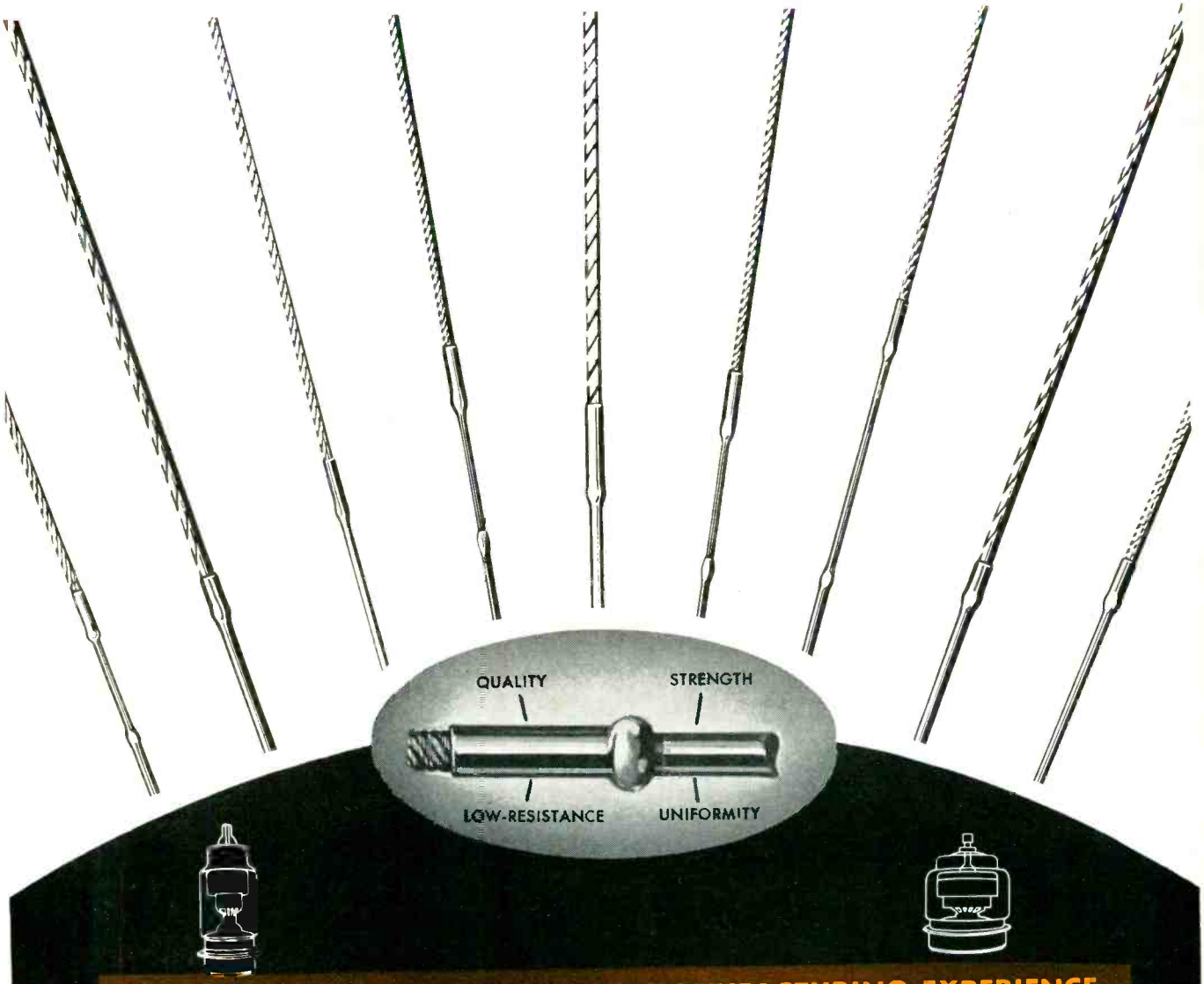
flanged base $\frac{1}{2}$ in. in diameter. A row of six holes runs around the bottom of the tube, just above the base. This deceptively simple part is formed from a special alloy that has the same coefficient of expansion as glass. In subsequent processing, the cap will be fired for $\frac{1}{2}$ hour at 2,300 F in wet dissociated ammonia and will then receive a glass seal.

Unless the part emerges from the tumbling barrel in an almost perfect state of cleanliness, the thin band of glass will not properly adhere. To avoid peeling and to assure a perfect seal, a complicated four-stage tumbling procedure has been carefully worked out. Parts not tumbled by this method may look just as bright and clean to the eye, but unless all details of the procedure are faithfully followed, the parts will be rejected later on.

In the first stage, no parts are tumbled. The chips, which will in later stages constitute 40 percent of the total load, are placed in one 4-cu-ft compartment. Cold water is added to a level of 3 in. above the chips, then $1\frac{1}{2}$ cups of Lorco GW degreasing compound. This viscous, pale-amber liquid is a highly concentrated detergent and wetting agent. The chips are tum-

QUALITY LEADS FOR QUALITY TUBES

HAYDU lead-in wire



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Checking dimensional accuracy of a ten-fold-magnified shadow of a grip cup, using optical magnifier

bled for 5 minutes at 19.5 rpm and then rinsed with cold water.

Before the parts are added, everything else is prepared for the next run. The water level is low —1 inch under the chip level. Three and a half cups of tumbling compound are added to the water. The compound is Lorco 3A, which contains a fine abrasive and a strong cushioning agent to soften the cut. Tumbling is done for 1 minute at 19.5 rpm without parts in order to secure uniform suspension of the powder compound before the parts are added. Normal load includes 24,000 parts. Tumbling is done for 4 hours at 19.5 rpm, followed by a cold water rinse.

The third stage is again a degreasing and cleaning run. The water level is restored to 3 in. above the chip level and 1½ cups of Lorco GW degreasing compound added. Tumbling is done for 2 minutes at 19.5 rpm. The parts are then rinsed with cold water, taken from the barrel and separated from the chips.

The parts are transferred to two compartments of another barrel for the fourth stage, which is purely for drying. Sawdust is added to constitute 80 percent of the total load and the parts are tumbled until dry at 18 rpm.

These two procedures may be taken as representative of the detailed tumbling procedures that

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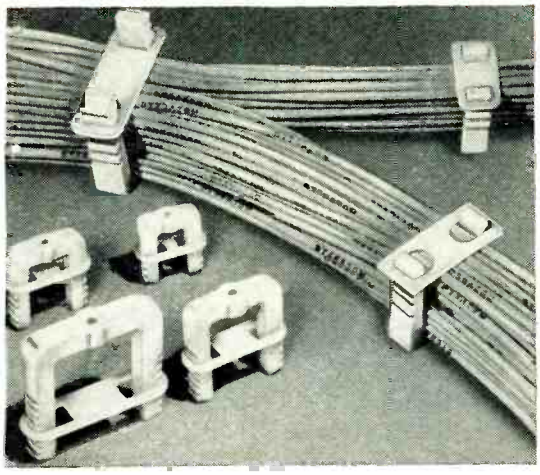
ELECTRONIC DESIGN NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 3-56



Type-U clamps manufactured by Dakota Plastics Co., Compton, California.

Type-U clamps of "Zytel" save time and money in wire bundle installations

Combining the characteristics of heat stability, flexibility and impact strength, Du Pont's "Zytel" nylon resin is now being molded as a clamp assembly for holding wire bundles. This clamp makes it unnecessary to tie the bundles, a practice which often resulted in cutting through the insulation.

These clamps cut installation and rewiring costs by simplifying application and reducing tool requirements. Fuel resistance of "Zytel" makes these clamps especially useful in aircraft and automobile manufacture.

Du Pont "Zytel" may be just the material you need to solve a design or operation problem. Further data on this engineering material—property tables, typical applications, and production techniques — are available.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

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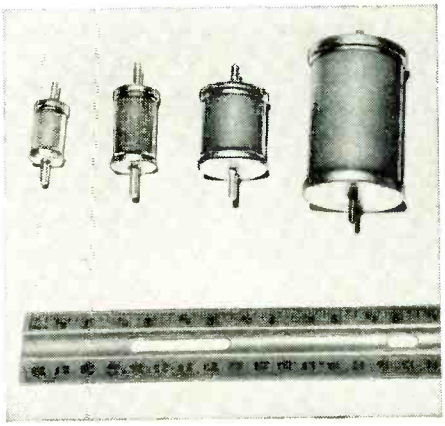
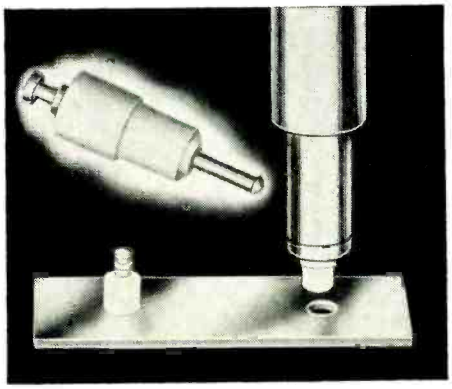


These typical capacitors of "Teflon" range in size from .001 mfd at 24,000 volts to .0004 mfd at 6,000 volts. (Manufactured by Condenser Products Co., Division of New Haven Clock and Watch Co., New Haven, Connecticut.)



Standoff and feed-through terminals of "Teflon" are constructed in both miniature and sub-miniature sizes. They provide economy by reducing installation time and assembly costs. These terminals of "Teflon" are one-piece construction and can be simply and permanently mounted into chassis holes by press fitting, using an inexpensive insertion tool—no other hardware is needed. ("Press-Fit" terminals manufactured by the Sealectro Corporation, New Rochelle, N. Y.)

The physical, chemical, and electrical properties of Du Pont "Teflon" tetrafluoroethylene resin offer high insulation resistance at high temperatures. "Teflon" remains flexible through a wide temperature range, from a high of 500°F. to –450°F. It is inert to virtually every commercially employed chemical or solvent.

"Teflon" has zero moisture absorption by A.S.T.M. test, good mechanical strength, low dielectric absorption, small voltage-derating factor for high-temperature operation, high insulation resistance, and a low loss factor. In combination with other materials, "Teflon" is used for power and transmitting applications and for pulse-forming networks.

The properties of "Teflon" are applicable to a variety of uses in the electronic field — in applications where miniaturization and compactness of design are essential, and for uses where equipment is exposed to corrosive action. "Teflon" is unaffected by sunlight or outdoor weathering. Specific electrical uses include insulation and molded parts for all types of motors, transformers and other equipment; and coaxial cables for radar and television.

Complete property and application data on this versatile Du Pont engineering material are available.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 223 Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec

Please send me complete property and application data on Du Pont "Teflon" ☐ "Zytel" ☐

I am interested in evaluating these materials for

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have been worked out for each part. The use of specialized compounds is indispensable to the success of precision barrel finishing. Altogether, nine different compounds are used, all manufactured by Lord Chemical Corp., York, Pa.

After tumbling, a lot of 120 tumbled samples is examined periodically for flaws. If as few as 5 flaws are found in one sample lot, the entire day's production of the tumbling barrels must be hand-sorted.

Servo-Wound Pots

By P. MAGNANI and R. CECHANEK
International Business Machines Corp.
Endicott, N. Y.

USE of a tension-spring resistance element in a servo-wound air-core precision potentiometer gives a terminal linearity of 0.02 percent with a high production yield. This element is a suitable resistance wire 0.002 to 0.004 inch in diameter, wound on a 0.02-inch wire mandrel. After winding, the mandrel is removed. This leaves a self-supported spring resistance element with sufficient initial tension to keep its individual coils in contact with each other. When tension is applied to the ends of the spring, it will stretch by an amount proportional to the tension and, in doing so, will change its resistance per unit length. Thus, a means is provided for readily controlling the resistiv-

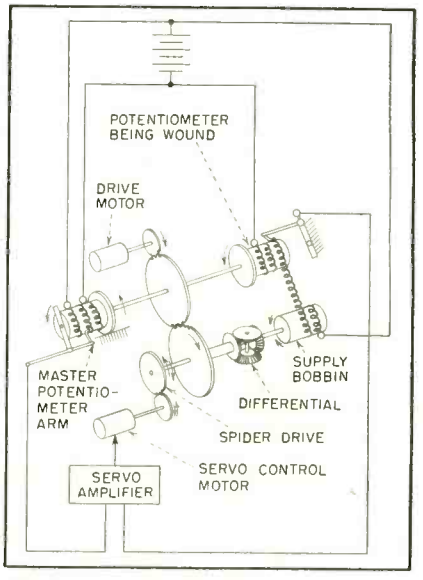

FIG. 1—Servo winding technique

RESEARCH

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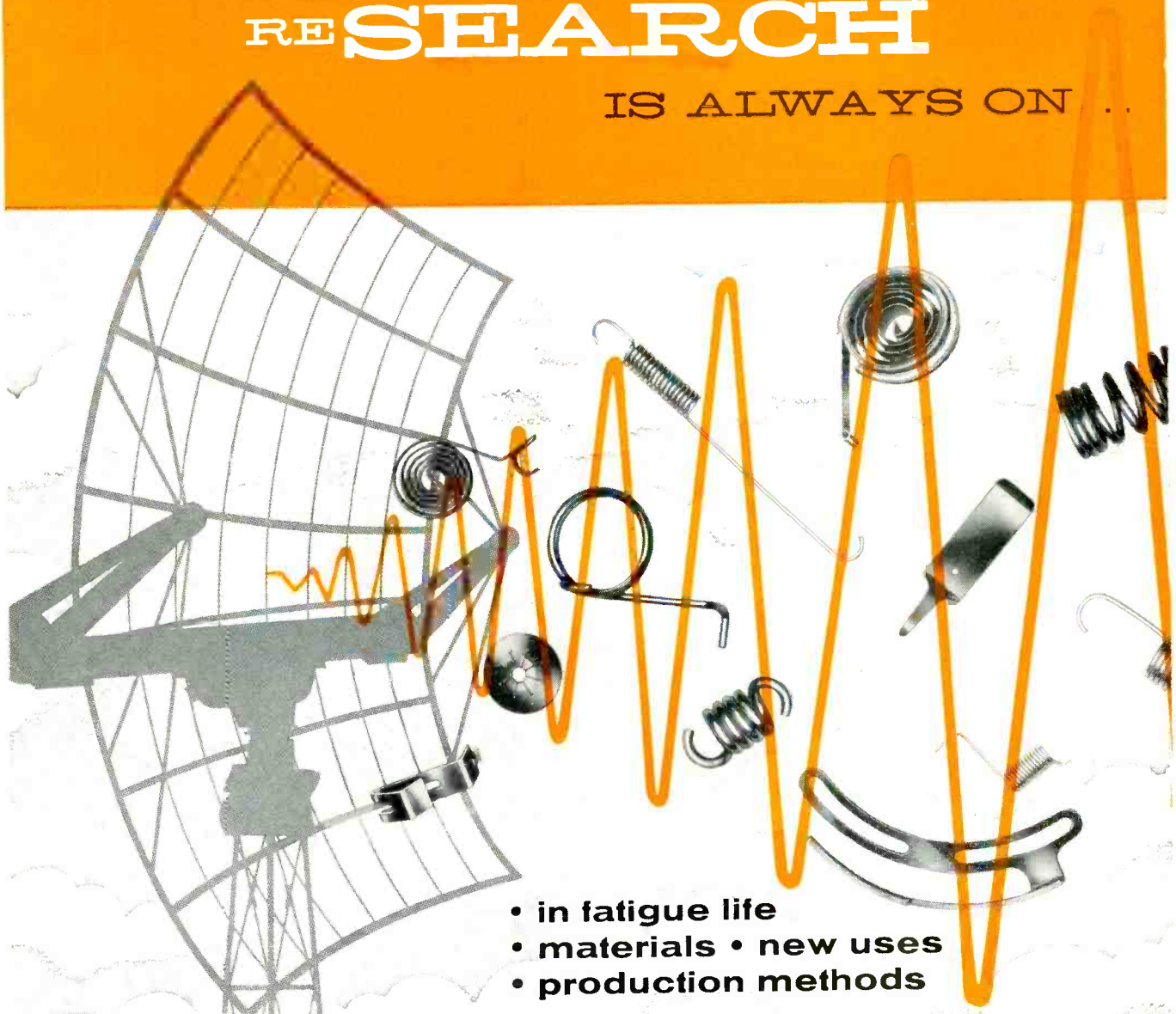

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ity of the resistance element.

The wound resistance element is placed on a supply bobbin with adjacent coils separated as indicated in Fig. 1. After one end of the element is attached to the potentiometer to be wound, the required length of resistance element is ready to be transferred from the supply bobbin to the insulated bobbin of the potentiometer.

▶ **Servo Circuit**—After loading the resistance element as described above, the final contact slider is put in place and connections are made to it and to the two ends of the element. The circuit is arranged so the spring forms two sections of a Wheatstone bridge, the slider serving as the common junction. During the winding operation, the contact slider is fixed in position and only the potentiometer bobbin is allowed to turn.

A master potentiometer is connected to complete a d-c Wheatstone bridge. Input leads to a servo system connect to the sliders in place of a null indicator.

The contact slider of the master and the bobbin of the potentiometer being wound are on the same shaft, gear-driven by a low-speed motor.

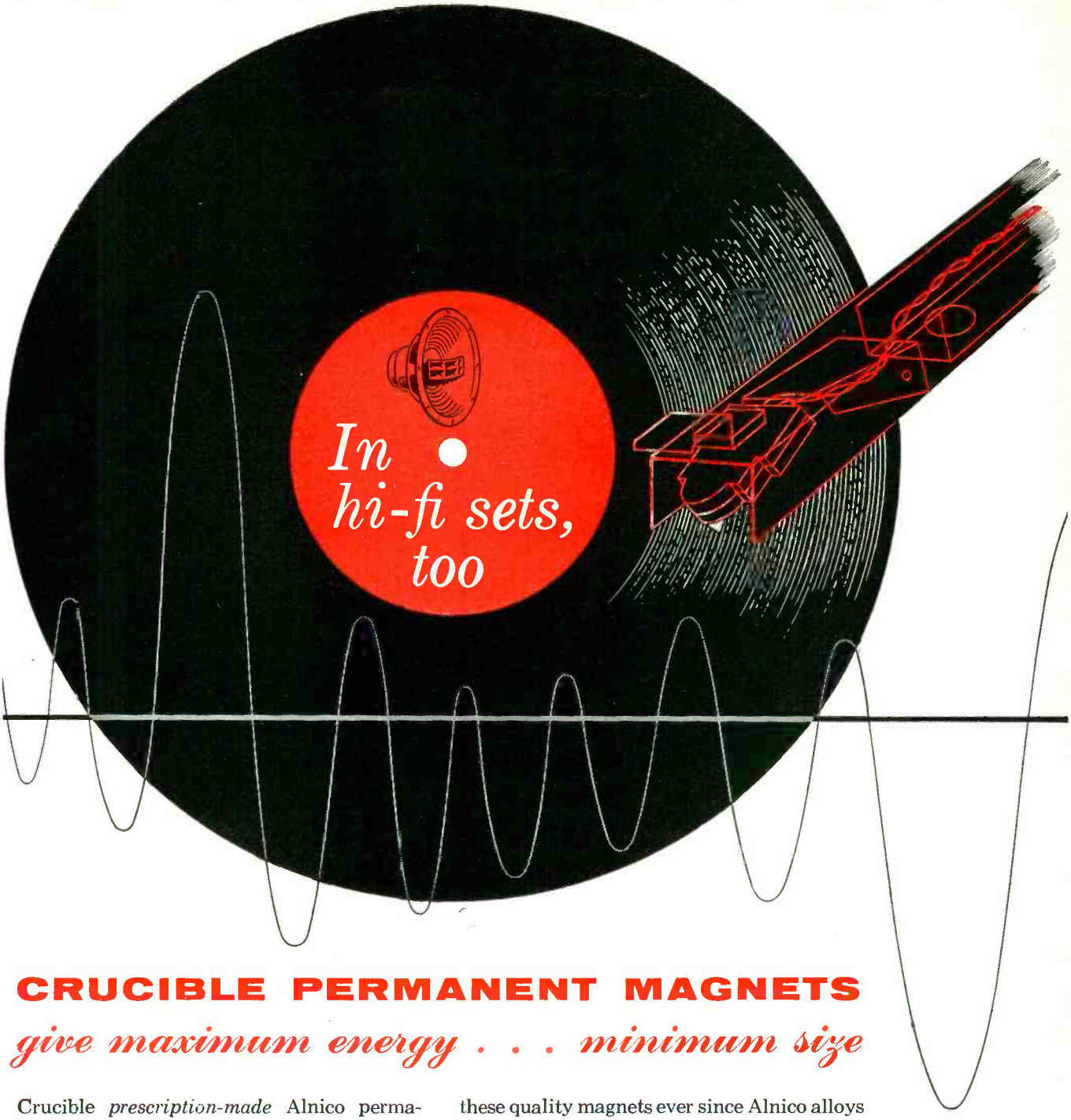
The servo motor drives the differential that alters the speed of the supply bobbin to vary the tension in the resistance element so as to maintain bridge balance. Resistance ratios are matched, hence any value of master potentiometer can be used.

The resistance element is held to the bobbin by a thermosetting cement applied before winding. After baking, this provides a secure bond.

With the servo technique, accuracy is much less dependent on the precision of components, hence manufacturing tolerances can be less stringent.

▶ **Accuracy**—Linearity is dependent only on the number of coils in the potentiometer resistance element. This means that low values of resistance can be wound as accurately as high values. Phase-shift characteristics are improved by the air-core construction of the resistance element.

The authors wish to express their appreciation for the assistance re-



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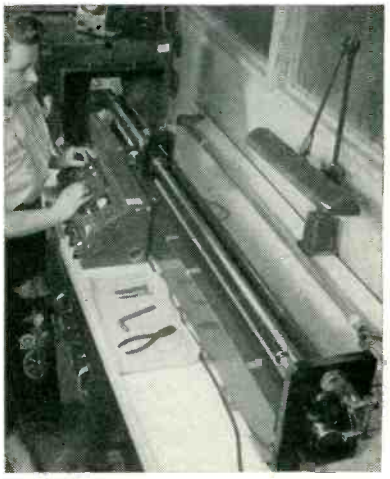
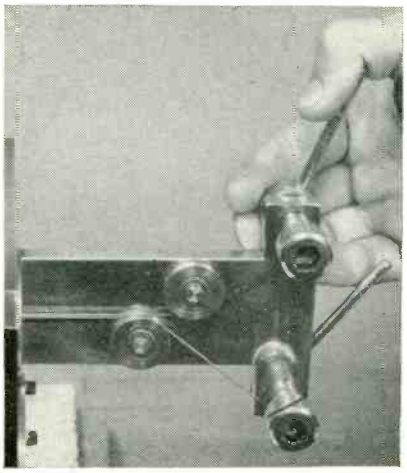
ceived from their coworkers and various members of the BDHSA staff in the development of the potentiometer winding process, based on the original efforts of C. I. Johnson, manager of the project.

Servo-Controlled Winding Machines for Precision Potentiometers

AN ELECTRONIC control unit that measures resistance during a resistance-winding operation greatly improves the linearity of ten-turn potentiometer mandrels in the Hicksville, N. Y. plant of Fairchild Controls Corp. The wound copper mandrel is later coiled around a core on a hand-operated tool setup to produce the required ten-turn



Operator at controls of mandrel-winding machine. Holder used later for transferring wound mandrel is at rear on bench



Method of tightening mandrel wires at tail end of machine

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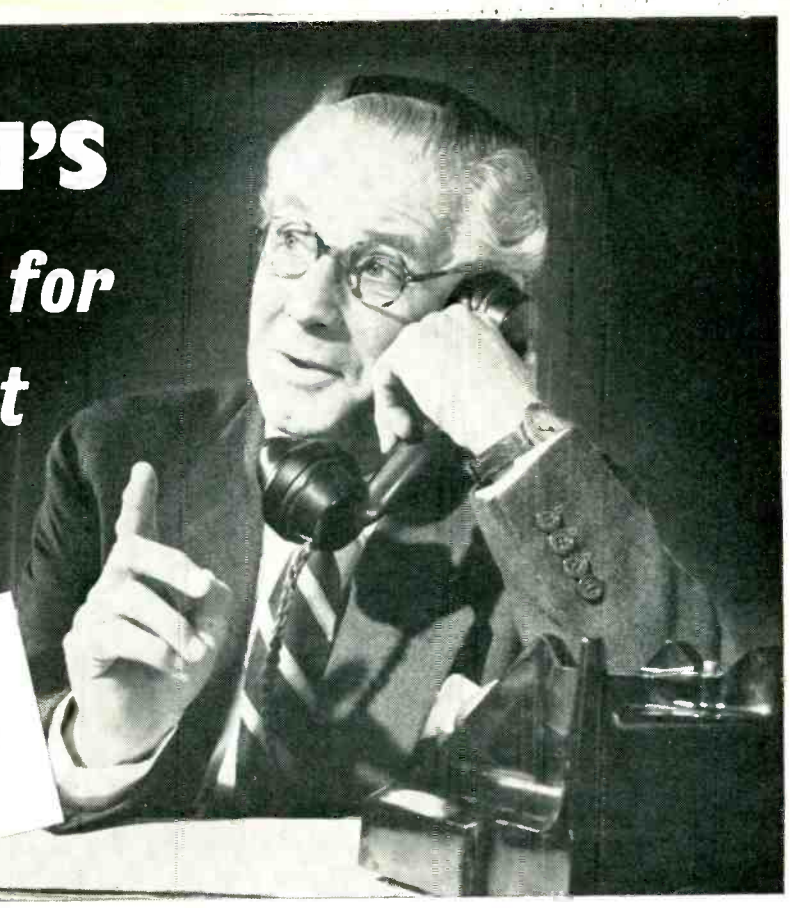

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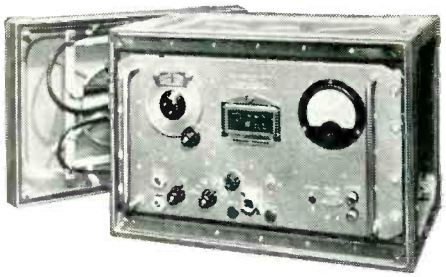

Basic carrier frequency range: *20 to 100 Mc; usable up to 500 Mc at increased input levels* ● Up to 100 Mc, an input of 55 mV is sufficient; *inputs up to a maximum of 10 volts can be accommodated* ● Deviation read from large directly-calibrated meter; *three measurement ranges: 100, 200 and 400 kc full scale* ● Accuracy of deviation measurement assured *by built-in crystal standard*

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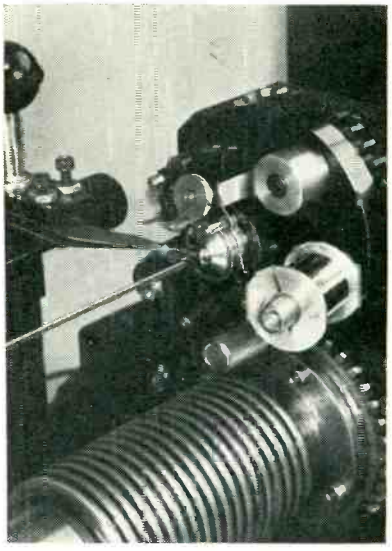

Winding head of machine, showing gear drive for revolving spool around mandrel. Contact fingers mounted on winding head measure resistance continuously as part of electronic servo

helix. The machine can be used for winding either single-mandrel or double-mandrel elements.

The first step involves loading the mandrels. These are rigidly attached at the head end, threaded through the winding mechanism and through a hole in the tail-end support, then anchored in tightening bolts that work very much like violin-string tighteners. Two mandrel wires are generally used, to give a larger area for the resistance wire.

The winding unit itself is moved

Picking finished mandrel off machine with holding rod, without releasing tension

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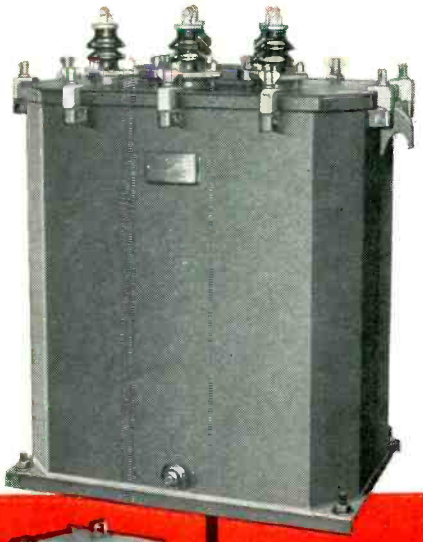

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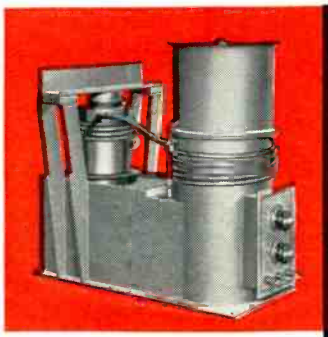

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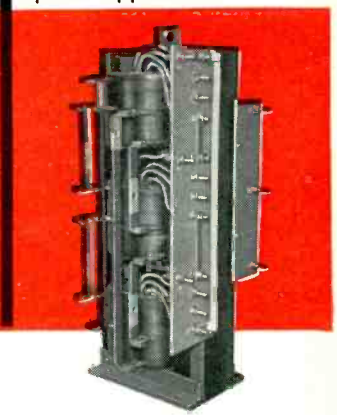

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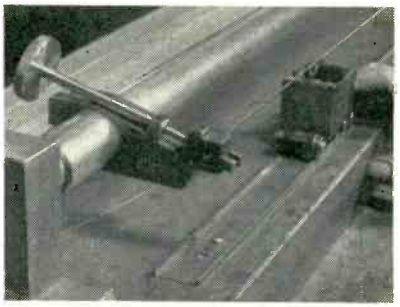
along the machine by a lead screw and is gear-driven by a sliding keyed gear on the main drive shaft. The spool of wire thus rotates around the mandrel while it advances along the machine. Carboloy wiping contacts riding about ⅛ inch apart on the winding measure the resistance continuously and act through the servo control to adjust the relative speeds and give a linear winding.

After a mandrel has been wound,



Applying varnish to finished mandrel in holder with varnish-filled trolley car

Placing holder containing wound mandrel in fixture used for winding mandrel onto core

it is transferred to a heavy holding bar without releasing its tension, then released from the winding machine. The next step is varnishing, which is done by placing the mandrel holding bar in a fixture on another table and running a tiny varnishing car under the mandrel for its entire length. This car runs on rails and has a freely rotating pulley half-immersed in the varnish. As the car is pushed down the track by the operator, the pulley applies an even layer of varnish to the lower end of the mandrel. The

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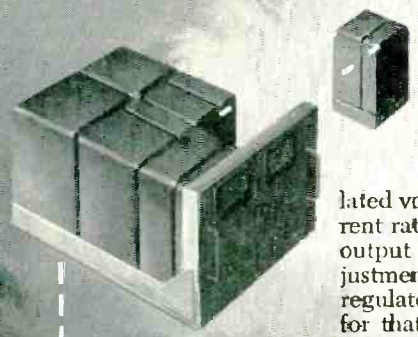

REL-200 SERIES MODULAR POWER SUPPLY

The Rheem Modular Power Supply system consists of six (6) basic power units and six (6) regulator units. These "building block" units can be used individually as required, or in any desired combination. The system is designed to meet the D.C. power supply requirements for most missile or airborne applications where 400 cps primary power is available. (Future development of basic power units is planned, using power transistor oscillators, to operate directly from 28V DC.) Unregulated voltages from 250V to 475V DC in 25V steps are available from the basic power units in current ratings of 5 to 50 ma., 20 to 200 ma., and 40 to 400 ma. The output voltage from a basic power unit is determined by the proper plug-in main power rectifier sub-unit used in the unit.

The regulator units can provide any regulated voltage from 135V to 350V DC with the same current ratings available as for the basic power units. The output voltage from the regulator is determined by adjustment of the proper plug-in control sub-unit in the regulator unit. The proper unregulated input voltage for that range is supplied from a basic power unit. In addition, the basic power unit furnishes the filament power and a floating auxiliary low voltage source which is required for the regulator units. These voltages can be used for other suitable requirements when a regulator is not used with the basic power unit. (If the floating auxiliary low voltage source is not required from a basic power unit, the unit can be supplied at a saving in cost without an auxiliary power rectifier sub-unit.)

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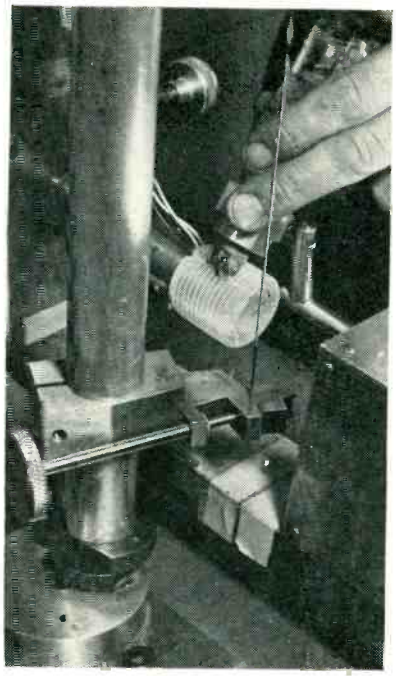
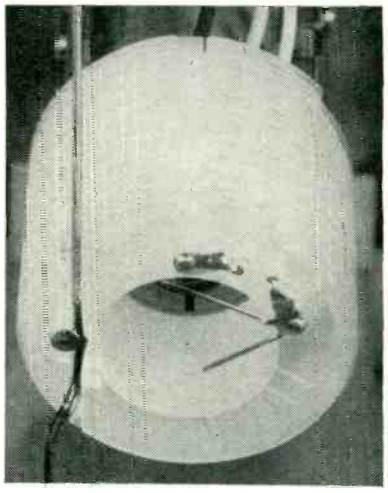
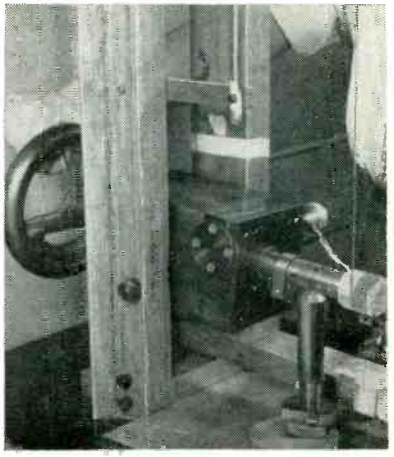


Applying varnish in grooves of plastic core while rotating core with hand wheel at rear. Mandrel-holding clamp shows clearly below core



Method of anchoring start of mandrel to core with pin



Winding mandrel on core, after removing mandrel holder

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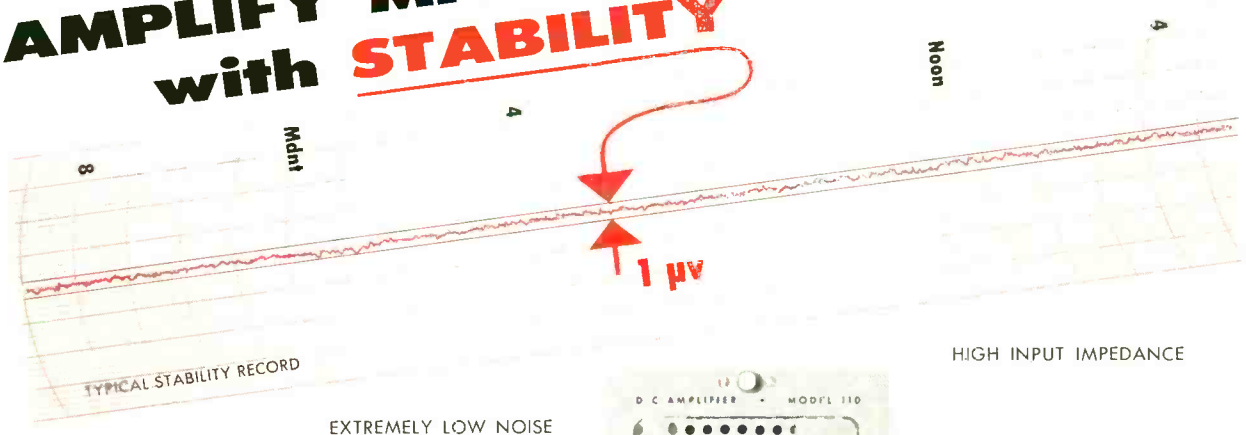

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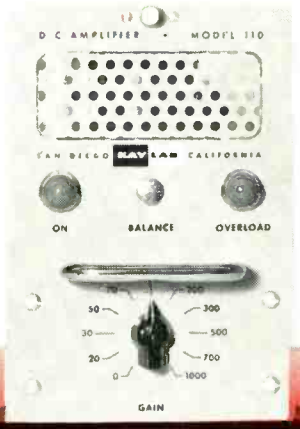

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APPLICATIONS: Ideal strain-gage amplifier . . . vibration studies . . . transducer amplifier . . . scope preamplifier . . . single or multiple channel recorder driver . . . impedance matching "DC transformer" . . . general laboratory instrument wherever precise gain is required for amplification of microvolt signals.

SPECIFICATIONS

Gain	0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000 ± 1% DC
Input Impedance	100,000 Ω
Frequency Response	± 3% DC to 10 kc, less than 3 db down at 30 kc
Phase Shift	Less than 5° to 2 kc
Equivalent Input Drift (over 40-hour period)	± 2 μv when used with regulated line voltage ± 10% change in AC input causes less than ± 5 μv change after 10-minute warm-up
Equivalent Input Noise	0 to 3 cps, less than 5 μv peak to peak 0 to 750 cps, less than 5 μv RMS 0 to 50 kc, less than 12 μv RMS
Chopper Intermodulation	Less than 0.1%
Linearity	Better than 0.1% to 2 kc
Output Impedance	Less than 1 Ω in series with 25 μh
Output Capability DC	0 to ± 25 volts with load impedance greater than 1000 Ω 0 to ± 25 ma with load impedance from 10 to 1000 Ω

POWER REQUIRED	0.9 watt each unit plus 0.6 watt each adaptor
Dimensions: Amplifier unit	5" wide, 7¼" high, 14¼" deep
Unit in cabinet	6" wide, 9⅞" high, 18⅜" deep
Rack adaptor for 3 units	19" wide, 8¾" high, 18¼" deep
Net Weight	15 lbs.
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PRICE: Amplifier Unit	$500.00
Cabinet (with fan and connector)	50.00
Rack Adaptor (with fans & connectors)	150.00

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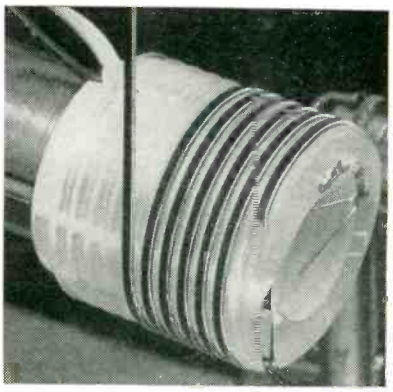
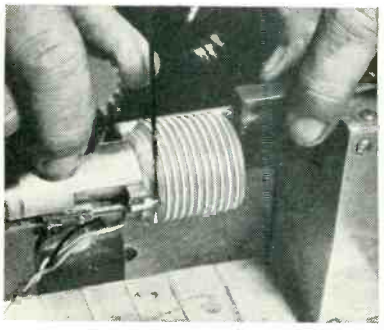
mandrel is then turned over for repeating the operation on the other side.

After varnishing, the holder containing the wound mandrel is set into a vertical fixture preparatory to winding the mandrel onto a ten-



Closeup of mandrel-winding operation

turn helical core. A coating of varnish is applied to the grooves of the helical plastic core to improve adhesion, using a conventional paint-striping tool. The mandrel holder is now swung against the



Knob at left controls rack and gear arrangement used to drive in pin to anchor end of mandrel while operator holds metal block between other end of core and fixed support

end of the core and a knurled pin is driven in to anchor the end of the mandrel to the core.

With the upper end of the mandrel picked up by holding fingers of the fixture, the holder is now removed and the helix is wound by turning a hand crank. When the ten turns are in position, another holding pin is inserted to anchor the end of the mandrel. This pin is driven in by a rack and gear arrangement

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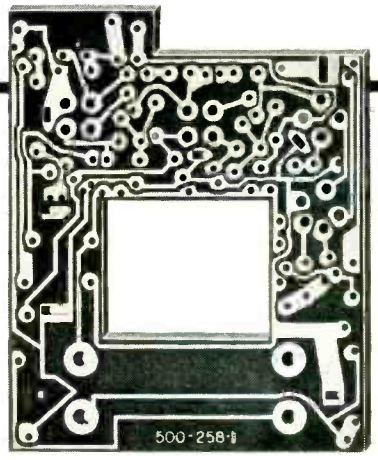
. . by INSUROK® copper-clad printed circuits!

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."

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on the headstock of the fixture, after first placing a metal bar between the core and the fixed tail support to withstand the pressure. This completes the winding operation.

Stud Welder Used in Assembling Thyratrons

By N. R. GOLDSTEIN
Tube Division
Radio Corporation of America
Lancaster, Pa.

NEW assembly methods used in the development of a new high-current thyratron include the use of a Graham stud welder in the assembly of mount supports. The structure of the developmental thyratron is shown in Fig. 1. The siderods are two-piece assemblies consisting of an upper section having a diameter of $\frac{1}{8}$ inch and a lower section having a diameter of $\frac{1}{4}$ inch. The two sections are brazed together, as shown in Fig. 2, so that the lower section provides a shoulder on which the mount is supported. The

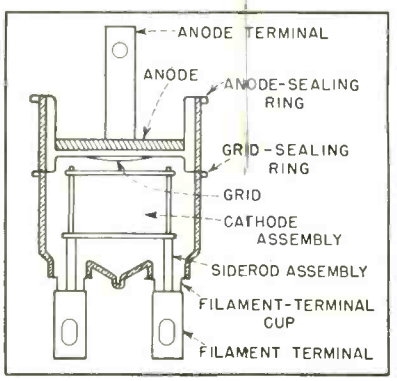
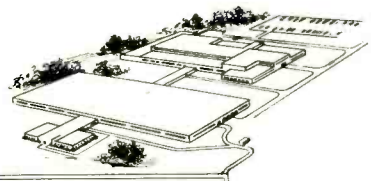


FIG. 1—Structure of developmental high-current thyratron

Stud welder setup on bench, with power supply underneath



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CONTACT FRED PTUCHA, PERSONNEL MGR.

DAYSTROM INSTRUMENT
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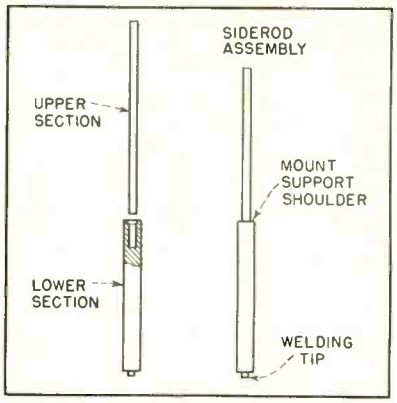


FIG. 2—Siderod assembly, showing upper and lower sections and welding tip

tip at the bottom of the assembly is used for connection to the filament-terminal cup.

▶Welder Construction Details—The Graham stud-welding unit used for the assembly of the siderods to the filament terminal cup operates on a capacitance-discharge principle. A bank of eight 17,000-microfarad capacitors is charged by a built-in motor generator in approximately 1 to 2 seconds.

An important factor in the stud-welding process is the small cylindrical tip on the joining face of the stud. The diameter and length of this tip vary according to the diameter of the stud to be welded and the materials involved. The studs or siderods are fed through a welding gun, shown in Fig. 3, which has a piston and piston rod extending downward and an appropriately sized collet attached to the end of the rod. The gun is actuated by air

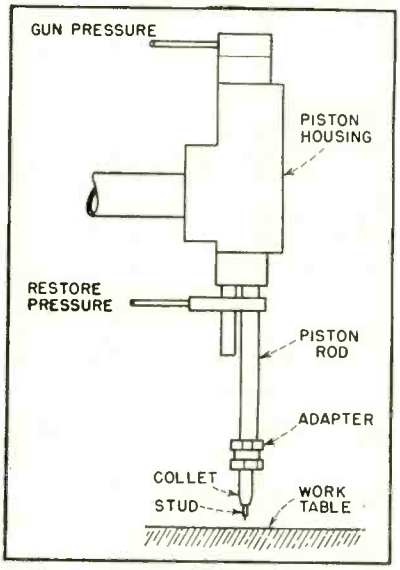
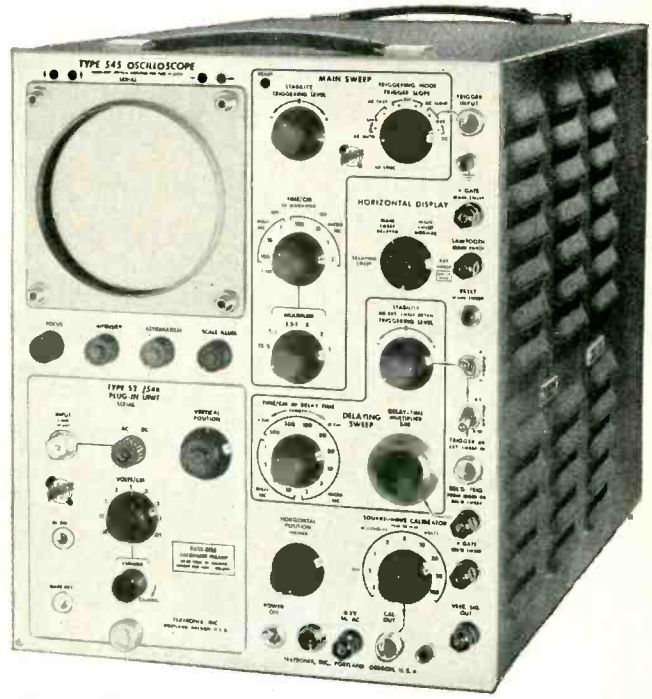


FIG. 3—Welding gun used in assembly of developmental thyratron

"ALL-PURPOSE" Oscilloscope...Type 545



The Tektronix Type 545 is a "fast-rise" oscilloscope with high-performance characteristics. It can write the answers to the most difficult problems in high-speed pulse analysis on its screen. You have only to read them off . . . with full assurance of their accuracy.

But the Type 545 is not a specialized instrument, useful only in fast-rise applications. It is easily adapted to a multitude of other applications by inexpensive plug-in preamplifiers. Along with its unique sweep-delay facility, this plug-in feature helps make the Type 545 the most versatile oscilloscope you ever hoped for. Is the Type 545 the answer to your instrumentation problem?

MAJOR SPECIFICATIONS

Sweep Range

0.02 μsec/cm to 12 sec/cm.
24 calibrated steps from 0.1 μsec/cm to 5 sec/cm.
24 additional calibrated steps with accurate 5x magnifier.
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Conventional, or triggered jitter-free delay 1 μsec to 0.1 sec in 12 calibrated ranges.
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Versatile Triggering
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Square-Wave Amplitude Calibrator
Balanced 0.2 μsec Delay Network
DC-Coupled Unblanking
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Type 545—$1450 plus price of desired plug-in units.

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With Type 53/54K Unit plugged-in — dc to 30 mc, risetime 12 millimicroseconds, sensitivity 0.05 v/cm to 20 v/cm in 9 calibrated steps, input capacitance direct — 20 μμf, with 10x probe—8 μμf, with 50x probe — 2.5 μμf.

Type 53/54K Fast-Rise Unit $125

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See the Type 545 and many other oscilloscopes at the IRE Show, Booths 129 and 131.

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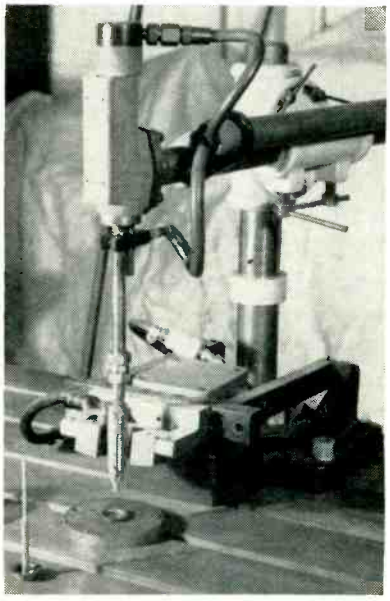
pressure, the piston rod moving the stud through the collet to the work-piece, which is held firmly on the table of the welding machine. The speed at which the stud travels toward the work may be varied by changing pressure on the rod end of the piston (the so-called restore pressure).

▶**Welding Action**—After the capacitors are charged to their rated



Details of welder, with welded stud on bench in foreground

voltage, the charge is conducted to the welding gun, the collet and the stud, all of which are traveling toward the work-piece at a rate of about 30 feet per second. The positive sides of the capacitors are connected to the worktable and then through ground clamps to the work-piece.

As the stud travels downward, the tip approaches and contacts the work-piece first. Initially, therefore, the discharge is concentrated at the small tip on the stud. Because the high current flow at this point causes overheating, the tip melts almost instantaneously. As the air surrounding the tip becomes ionized, electrons begin to flow from the stud to the work-piece and an arc occurs. During the arcing process, the face of the stud and a corresponding area on the work-piece become molten. Simultaneously, a hammer blow resulting from the inertia of the moving piston-and-collet assembly forces

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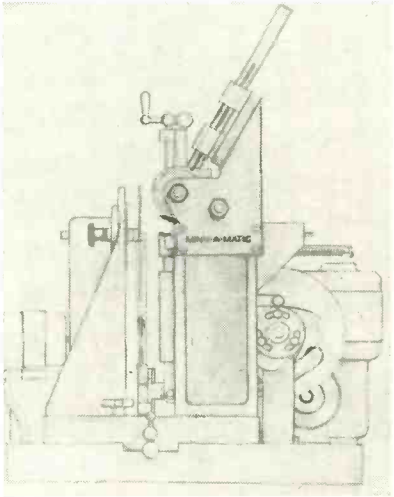
together the two parts to be welded. The time consumed for this entire process is only 0.001 second.

▶ **Advantages**—The use of the Graham stud welder affords several advantages. No complex furnace or brazing fixtures are required. In view of the short duration of the arc, the rods are welded with little or no fillet, no distortion of the work and a minimum amount of heat. Little cleaning is needed because the ionization caused by the discharge cleans both surfaces. For the same reason, there is no oxidation to impair the weld. In almost 100 tubes made by the method, no failures occurred due to poor welds.

Machine Drills Holes and Inserts Components

A SINGLE-STATION automatic assembly machine for axial-lead components, ready for delivery early this fall by Minnesota Engineering Co., Minneapolis, combines drilling of etched wiring boards with insertion and clinching. Boards are run vertically rather than horizontally through this Minn-A-Matic machine with hand loading for low-volume batch production or automatic feed and indexing for an in-line array of many heads.

Prepunching or predrilling of holes for axial-lead components is



End view of new assembly machine under development. Components are loaded into slanting chute at top. Etched wiring boards are fed in vertically, with insertion head at right of board and drills at left

GREIBACH MICROAMMETER MODEL 500

Battering Blows

. . . can't impair its accuracy

Gulton Industries' Research-on-the-Production-Line makes possible instant tailoring of basic materials, instruments or complete systems to fill difficult or unusual requirements.

THE PROBLEM: Test readings from outlying control points are **vital** to a leading processing company. Servicemen make **frequent** field trips, by truck, to obtain necessary information. But, even short rides over rough, unpaved roads caused conventional meters to lose accuracy and become damaged . . . often making it **impossible** to collect reliable information. Maintenance costs were staggering . . . the meters spent **more time** in repair than in service.

THE SOLUTION: Greibach engineers answered this and hundreds of similar problems by developing an extra tough **line** of meters with a **unique Bifilar Suspension** so rugged it withstands 500 g's shock **without damage or loss of accuracy** . . . never needs recalibration in **normal** use. Greibach meters are electrically rugged too! Accidental overloads to 100,000% can't harm them . . . full scale sensitivities to one microampere and accuracy better than 0.25% are easily attained . . . 0.1% increments are readable **without** tapping. The light beam pointer can be **viewed from any angle accurately** . . . parallax problems are ended! Greibach meters are manufactured in a wide range of sizes and types—for current, voltage, resistance measurements in standard, thermocouple, edgewise panel and differential units. Their extremely dependable operation is perfect for systems' work.

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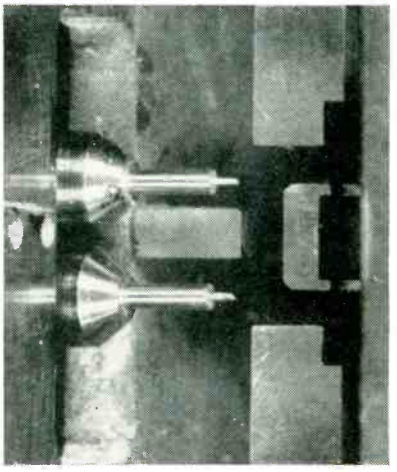
PIONEERS IN MATERIALS RESEARCH, ELECTRONIC COMPONENTS, PRECISION INSTRUMENTS AND SYSTEMS ENGINEERING

See GI Products, Booth #850 March IRE Show. Write on company letterhead for personal invitation to GI Instrument and Component Symposium, Waldorf-Astoria, March 21, 1956

eliminated. This unique cost-cutting feature is particularly advantageous for low production runs or for materials where punching is not feasible.

▶ **How It Works**—Following insertion of the wiring board and clamping in position, two holes are drilled from the left-hand side as the axial-lead component is cut and formed to the right of the board. Components may range in size from



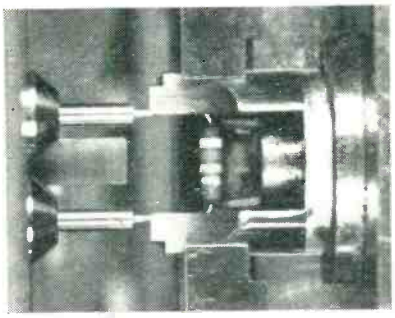
View of drills in advanced position, with no board in machine

diodes to 1 μf capacitors. As the two drills are retracted, the component is inserted and leads are clinched flat against the pattern by separate wipedown arms.

The angle of wire clinch with respect to the body of the component is adjustable in 20-degree increments throughout 360 degrees. This assures a wipeback against a portion of the pattern.

▶ **Flexibility** — Adjustments provide for any desired length of symmetrical or nonsymmetrical lead bend. This permits flexibility when using component lead wires as jumpers. Further adjustments provide for varying the length of the clinched tab, a feature that permits use of boards of almost unlimited thickness. Inexpensive drills which fabricate board holes may range in size from 0.020 inch to 0.60 inch and are easily replaced.

Companion machines now under development will insert multilead components using this simultaneous drilling-insertion technique. A gearless multispindle drilling de-



View of insertion head, without board. Drills retract as head pushes component leads into the drilled holes

vice is also under development. It will fabricate mounting holes or holes for termination and components whose insertion for low-volume runs is more economical by hand.

New Vacuum Metallizer for Capacitor Paper

FASTER metallic coating of capacitor paper is possible with a new continuous-roll vacuum metallizer made by F. J. Stokes Machine Co., Philadelphia, Pa.

Previously, continuous-roll metallizing had been done in a dual-chamber setup, with the base material being out-gassed in one vacuum chamber and then transferred to a second chamber to receive the thin coating of metal deposited by evaporation.

The new units have only a single

Metallizer with cover open

vacuum chamber and thus need only a single vacuum pumping system. Widths of 6, 24, 36, 48, 54 and 60 inches can be handled at speeds up to 500 feet per minute, on rolls up to 24 inches in diameter.

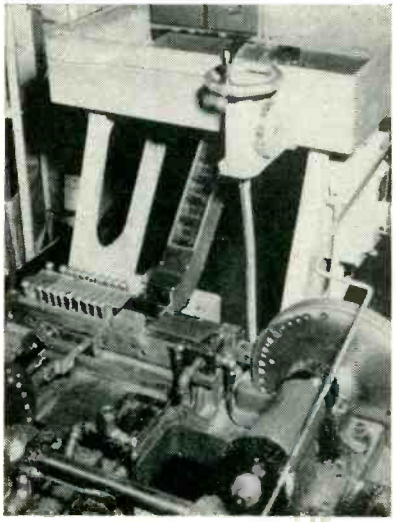
An observation port set into the cover of the unit, plus a fluorescent light source placed behind the coated film, allows the operator to check the uniformity and quality of the coating continuously during the deposition process, adjusting speed to give the desired thickness of metal deposit.

Milling Silver Inserts in Plastic Relay Bases

By RICHARD L. CAMP
Machine and Tool Designer
International Business Machines Corp.

INSERTS IN PHENOLIC moldings for relay bases are stamped from pure silver in the form of combs, for easier handling and greater precision of position in the molds. After molding, the backs of the combs are cut off by a special machine built by IBM at its Endicott, N. Y. plant.

The silver, furnished by Handy & Harman, New York, N. Y., is used for this application because of its high conductivity, ease of machining and corrosion resistance. The inserts pass through the central portion of the U-shaped base and have to be machined, usually at both ends, to insure holding the close di-

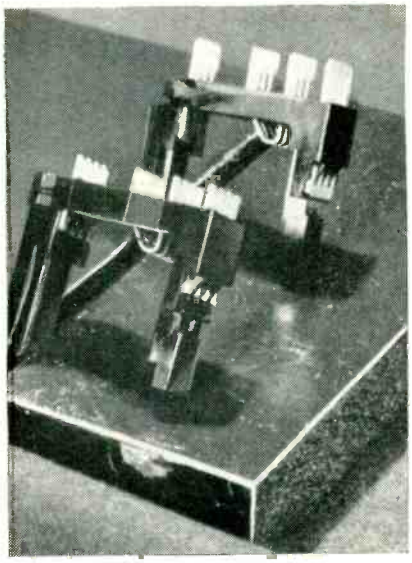


Setup for milling silver inserts in relay bases. These are fed manually, two at a time, down chute at top center

mensions specified while removing the webs.

The silver-milling machine is fully automatic except that the bases are hand-fed two at a time from the table into a gravity chute which deposits them, inserts facing downward, onto a track.

At the right end of this track,



Relay bases before machining (at rear) and after machining

there is a cam-operated reciprocating slide. Each time the slide is retracted, a pair of bases feeds from the chute onto the track. Then, as the slide moves forward, the bases are fed along the track (to the left) and under a series of spring-loaded covers that keep the relay bases seated firmly against the track.

When the bases are completely inside the covered part of the track, they are pressed against a carbide knife that is reciprocated transversely across the track. At this point the carbide knife, which is ground to an 8-degree angle, shears each silver insert cleanly, leaving the ends square.

Following this, at the next advance of the pusher slide, the two bases are advanced through a milling station at which there is a 2.050-inch diameter rotary carbide cutter driven at 10,200 rpm. This cutter mills the ends, previously sheared square, to a 45-degree angle and finishes the inserts to length. The machine cycles 50 times a minute, turning out 100 perfectly machined relay bases in that time.

New Products

Edited by WILLIAM P. O'BRIEN

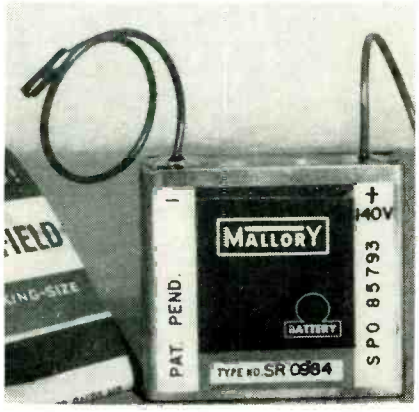
89 New Products and 54 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

SOLID-STATE BATTERY

delivers high voltage

P. R. MALLORY & Co., Battery Division, North Tarrytown, N. Y., announces a new battery which constitutes a water-free primary energy source.

In contrast to conventional dry batteries which contain some water solution and a depolarizer, the new voltage pile has no water in its makeup. It is a true solid-state energy source. Voltage is generated by the differential in contact potential between two conductors in contact with a solid electrolyte.



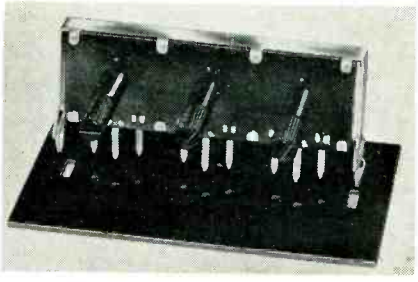
▶**Shelf Life**—The battery undergoes negligible chemical reaction when idle. On the basis of current tests, shelf life of ten years or more is expected. This characteristic indicates particular usefulness in military and civilian applications which require extremely long shelf life. Small size per volt of output is made possible by the inherent nature of the battery; 200 volts can be obtained from a unit one cubic inch in volume. As a result of its completely dry construction, the battery holds stable output voltage over a temperature range from – 65 to 165F. Efficiency does not drop at the low limit of this range.

▶**Production**—The battery is an economical energy source. Its design lends itself to automatic assembly. Costs in production quantities are estimated at a few cents per volt. Present current capacities fall in the microampere range. Work is progressing on techniques to afford higher current ratings.

Indicated applications are in high-voltage calibration equipment, ionization chambers, geiger counters and as high-voltage bias cells in electronic equipment operating at elevated ambient temperatures.

VARIABLE RESISTORS

multiple, self-supporting



CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind., has announced a new line of unique design compact, self-supporting multiple variable resistors designed specifically for printed circuits and with new external contour for automatic handling and assembly. Both the 2-control unit (series X52) and the 3-control unit (series X53) snap instantly into place with full length sturdy spring supports that lock the control rigidly to the printed panel eliminating mounting hardware and separate supports.

▶**Design Features**—Newly designed clip-off mounting supports and terminals make removal easy and fast for the serviceman, avoiding the necessity of loosening all solder joints simultaneously in a solder bath. Mounting is upright with shafts parallel to the printed panel, eliminating need for shaft protection during panel solder immersion.

They are designed for black and white tv, color tv, industrial and other applications. Internal construction design uses an integral one piece center terminal and collector ring and a one piece contact arm. The contact arm has double wiper spring tension contact paddles for both the collector ring and the resistance element with each paddle contacting a separate path.

PI FILTERS

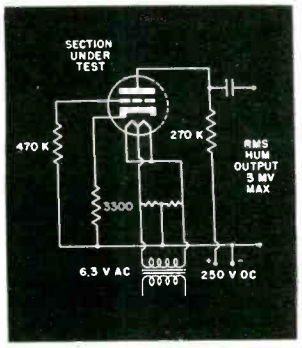
in tubular cases

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has available a new series of Quietone tubular pi filters. These metal-cased, hermetically-sealed filters in the handy, threaded-neck mounting

...for your audio designs—

First tube with "SPECIFIED HUM LEVEL"

and a new 100 ma miniature rectifier



Here is the test circuit in which the 12AD7 must produce less than 3 millivolts hum level at the plate of each triode. It's the low-hum, low-micro preamp you've been waiting for.

Type 12AD7—new low-hum preamp. Now, for the first time in any tube, "hum level" is specified in the Type 12AD7 like plate current or any other characteristic which is pertinent to the application.

By creating a hum rating under test circuit conditions, Sylvania has written a fixed, maximum hum limit into the specifications for the 12AD7. Pre-selection for low hum can be eliminated. Circuits can be designed to closer limits.

Type 6BW4/Type 12BW4—100 ma miniature rectifier. These types answer another long felt need, especially in phonograph design, for a higher powered, full-wave rectifier in a smaller package.

This exclusive Sylvania development gives you 100 ma output current capabilities in a T-6 ½ package; power previously available only in T-9 or larger packages.

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Check Sylvania first for all your audio-tube needs. Important Sylvania audio types include:

Type 12AU7A	Type 12AX7	Type 6CA5	Type 12AB5	Type 50C5
Type 6CG7	Type 6AQ5	Type 6V6GT	Type 6BF5	Type 12C5
		Type 6L6GB		

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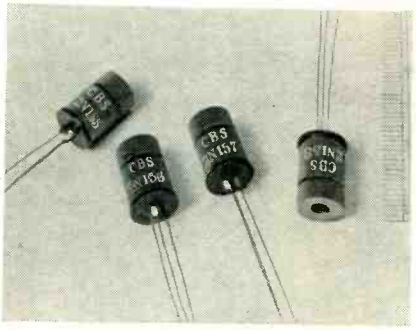
style, afford high insertion loss values for the suppression of radio noise. They are made to the smallest possible sizes and minimum weight for the ratings and attenuation characteristics.

▶**Technical Data**—Bulletin 171's listing offers a selection of current ratings ranging from 0.1 to 50.0 amperes. Voltages are 28, 50, 100, 300 and 500 d-c; and 115 and 125 a-c. Frequencies are 60, 400 and 1,000 cps.

The flatted, threaded neck provides easy, convenient mounting to a panel or bulkhead through a round or slotted hole, and simultaneously affords an excellent ground connection to shunt unwanted currents. Use of slotted hole mounting effectively prevents the filter unit from turning or jogging loose.

POWER TRANSISTORS
in four variations

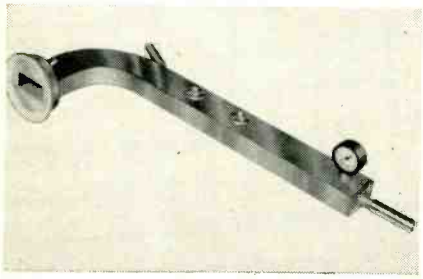
CBS-HYTRON, a division of Columbia Broadcasting System Inc., Danvers, Mass., has developed a new series of power transistors featuring high power gain and uniformity of characteristics. Four variations are available offering a wide range of current gain and operating supply voltage. This permits a considerable versatility of circuit design.



▶**Heat Dissipation**—Highly efficient heat dissipation is an outstanding feature. The use of a copper base, which is bolted to the chassis, allows the heat to flow from the power transistor to the chassis.

The types 2N155, 2N156, 2N157 and 2N158 are high-power *pnp* germanium-alloy junction transistors. In addition to audio applications, they are ideally suited for use in servo amplifiers, power converters and low-speed switching circuits.

CALORIMETER
covers d-c to 12,000 mc



ELECTRO IMPULSE LABORATORY, 208 River St., Red Bank, N. J. A direct-reading calorimeter covers the range of d-c to 12,000 mc by a series of coaxial and waveguide water loads. It is continuously self-calibrated electrically by a bridge-type circuit. To make a measurement, it is only necessary to adjust the instrument until balance is indicated by a galvanometer. The power absorbed by the water load can then be read directly in watts on a panel meter.

A thermally insulated water load is available for each waveguide up to 12,000 mc. The range of d-c to 4,000 mc is covered by 3 coaxial wide-band water loads. The input connector can be specified, and any impedance supplied.

DYNAMIC MICROPHONE
designed for broadcast use

RADIO CORP. OF AMERICA, Camden, N. J. A thumb-size dynamic microphone weighing less than 3 oz has been developed for radio and tv broadcasting.

Designed for walk-around operation, the BK-6B promises performers greater flexibility and freedom of movement in interviews, audience participation, panel and similar types of off-microphone shows. The microphone plugs directly into the studio console and requires no tubes or special power supply.

Pressure actuated, it is engineered for frequency response and directional scope which complement the characteristics of speech and provide the balance essential for efficient off-microphone broadcasting. It has a frequency response of 80 to 12,000 cps.

The miniature microphone is complete with lanyard and a 30-ft flexible cable. It measures 2⅞ in. in length and ⅝ in. in diameter.

TIME-DELAY RELAY
vibration, shock resistant

BELLTRON MFG. CO. INC., 204 Second St., Elizabeth, N. J. A tiny time-delay relay combines precision with outstanding shock and vibration resistance, due to a new toroidal thermally sensitive element. Timing may be adjusted from the outside

ELECTRO TEC SLIP RING ASSEMBLIES

At the I. R. E. SHOW!
BOOTHS #133, 135 TELEVISION AVE.
Kingsbridge Armory, New York City
March 19th to 22nd, 1956

HIGH TEMP PLASTIC!

—for high temp applications!

HARD GOLD RINGS!

24 KT. SOLID GOLD RINGS — ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINELL.*

COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings, dia. .180", ring width .020", barrier width .010". Overall length, less leads 1.763".

Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

← 72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.

Dual purpose assembly combining "V" grooved signal circuits and wide power rings.

Miniature high speed sampling switch — 24 channels.

Combining low friction torque slip rings (.060 dia.) with reference switch segments.

NEW ETC-7 (POLYESTER RESIN) WITHSTANDS TEMPERATURE RANGE FROM —60° to +500°F.

*PAT. NO. 2,696,570

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ELECTRO TEC CORP.
SOUTH HACKENSACK, NEW JERSEY

"ELASTICABLE"® ...2 ampere cable that stretches to more than twice its own length!

"Elasticable" is braided 21-strand conductor insulated with rayon, nylon or rubber, with ideal application for rack-mounted wiring; telephone, microphone cabling; electrical appliance service cords; and unlimited future uses. Can be furnished with from 1 to 6 conductors with 1000 volt insulation between conductors, with alligator clips, jacks or spade terminals. Stock sizes—2, 3 or 4 ft. relaxed lengths. Other sizes to order.

Other United products

"Selectone"® ear-protectors

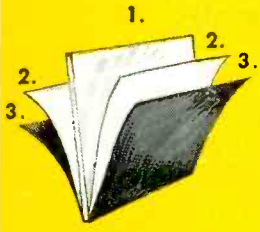
—filter out harmful high frequencies, allowing speech frequencies to pass. Protect against lethal jet-engine noise levels.

Unbreakable flexible terminal blocks.

Absorb shock, vibration and impact. 12 poles, captive screws. Capacity 380 volts, 15 amps.

UNITED CABLE CORPORATION a division of Mutual Electronic Industries Corporation

Unique "FLUSH-LETTER" panels for instruments and controls —edge-lighted to eliminate dangerous after-image —legible day or night from the widest angle!



1. A base of clear plastic.
2. A layer of bonded white vinyl, giving maximum reflection and contrast. At least — 11 units.
3. Layer of bonded black vinyl, having *less gloss* than required by MIL-P-7788.

The result is a radically new and different panel—impervious to water, temperature, altitude, abrasion, vibration and dirt. At night when lighted with red filtered lamps, exposed white translucent vinyl shows clearly in the darkness. No after-image. Flush lettering can be read from any angle. Applications: control panels in aircraft, railroad equipment, ships, tanks—wherever controls are operated in darkness.

A complete line of illluminated switch assemblies, control panels, knobs, dials

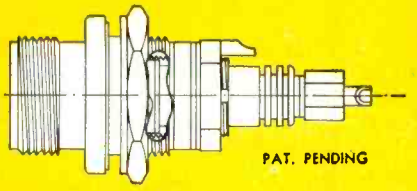
BY NIGHT

BY DAY

Also, test equipment for evaluating organic coatings

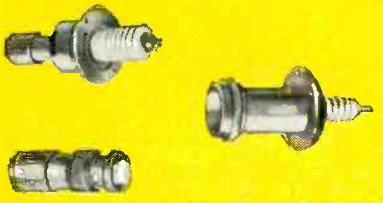
UNIVERSAL AVIATION CORPORATION a division of Mutual Electronic Industries Corporation

TRI-AXIAL-TYPE connectors...just one example of Essex specially designed connectors to solve the most exacting RF applications.



Wherever imagination and ingenuity are called for in design and production, Essex engineers solve some of the trickiest connector problems in all electronics. For example, the above high voltage tri-axial type connector for several sizes of RF cable answers a unique need in electronics.

A standard line of high quality corrosion-resistant RF connectors, along with development and production of high voltage, high altitude RF connectors



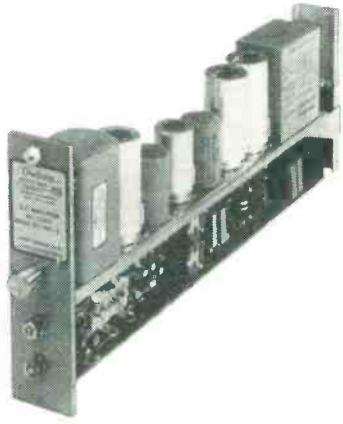
"Where the Unknown Becomes A Connector"

ESSEX CONNECTOR CORPORATION a division of Mutual Electronic Industries Corporation

SEE US AT BOOTH #214—RADIO ENGINEERING SHOW

without affecting the hermetic seal by a standard hex key applied to a set screw located in a recess at the top of the housing.

Factory set relays are available in five overlapping timing ranges from 5 to 99 sec. Standard units are mounted on 9-pin miniature plugs, operate normally open or normally closed, spst, will carry 3 amperes at 115 v a-c or 28 v d-c noninductive. Housing is only $1\frac{5}{16}$ in. diameter, $1\frac{3}{8}$ in. long; total weight, under 1 oz. Many timing ranges are carried in stock.



D-C AMPLIFIER
for data handling systems

DOELCAM, a division of Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass. Model C23125 plug-in type, wide-band d-c amplifier is designed to serve as a low-level preamplifier in data-handling systems where millivolt signals must be amplified with a high degree of linearity, stability and speed of response. It uses a second-harmonic magnetic converter as the input stage. This achieves a new level of performance and provides complete isolation of the

A BOLD APPROACH TO MISSILE ELECTRONICS

a statement by DR. L. N. RIDENOUR, *Director of Research, Lockheed Missile Systems Division*

Electronics is central to the technology of guided missiles. Dramatic improvements in missile performance require faster, more accurate perceptions and reactions of electronic missile guidance and control systems.

Here at the Missile Systems Division of Lockheed, we are aware of this requirement. We also know that electronics is experiencing the greatest revolution in its history; the vacuum tube, hitherto the cornerstone of electronic design, is being replaced by new solid-state devices which have superior performance and reliability.

Thus the times favor a bold approach to missile electronics. Past techniques will not meet requirements of the future. Experience in old-fashioned electronics is no great qualification for the present challenge. By giving the broadest responsibility to scientists and engineers, we are trying to lay proper emphasis on the new electronics.

Lockheed **MISSILE SYSTEMS DIVISION** *research and engineering staff*

LOCKHEED AIRCRAFT CORPORATION • VAN NUYS, CALIFORNIA

input from amplifier chassis and circuit ground.

► **Applications**—Typical applications are multipoint scanning of thermocouples or bridge measurements for magnetic tape recording, temperature monitoring system for nuclear reactors and analog-to-digital conversion preamplifier.

Power requirements are 300 v d-c ± 1 percent, 20 ma; −150 v d-c ± 1 percent 8 ma; 6.3 v d-c ± 5 percent, 400 cps, 1.35 amperes. Gain is 5,000 ± 0.3 percent; linearity is within 0.1 percent of full scale; stability is less than 30 μv zero drift; wide-band frequency response, less than 0.05-sec rise time to step function input; and noise, less than 20 μv as referred to the input.

FREQUENCY DETECTOR
measures a-f directly

AIRPAX PRODUCTS Co., Middle River, Baltimore 20, Md. The F-948 Magmeter is a magnetic frequency detector that measures audio frequencies directly. It is completely contained in a hermetically sealed can 1.375 in. high and 1.53 in. in diameter with a standard octal base, and weighs 3.4 oz. It can be used wherever frequency is measured: in test equipment, a-c servos, speed indicators and controls, and power frequency regulators.

► **Characteristics**—Range is 0 to 500 cps; accuracy, ± 2 percent of full scale plus temperature variation of 500 ppm/C; waveform sensitivity: less than 1 percent change in indication for sine, triangular and square waves of the same rectified average value; and tempera-

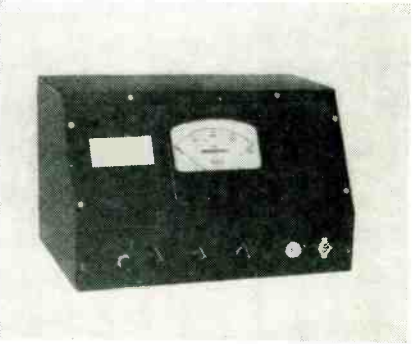
ture: −55 C to +72 C operate, −65 C to +85 C storage.

Price will be approximately $38.

TRANSCEIVER
operates on citizens band

VOCALINE CO. OF AMERICA, INC., Old Saybrook, Conn. Model JRC-400 is a 2-way radio transceiver that operates over the citizens band. It sends and receives clearly for over 10 miles when units are in line-of-sight. It operates successfully at ½ mile through almost any obstructions.

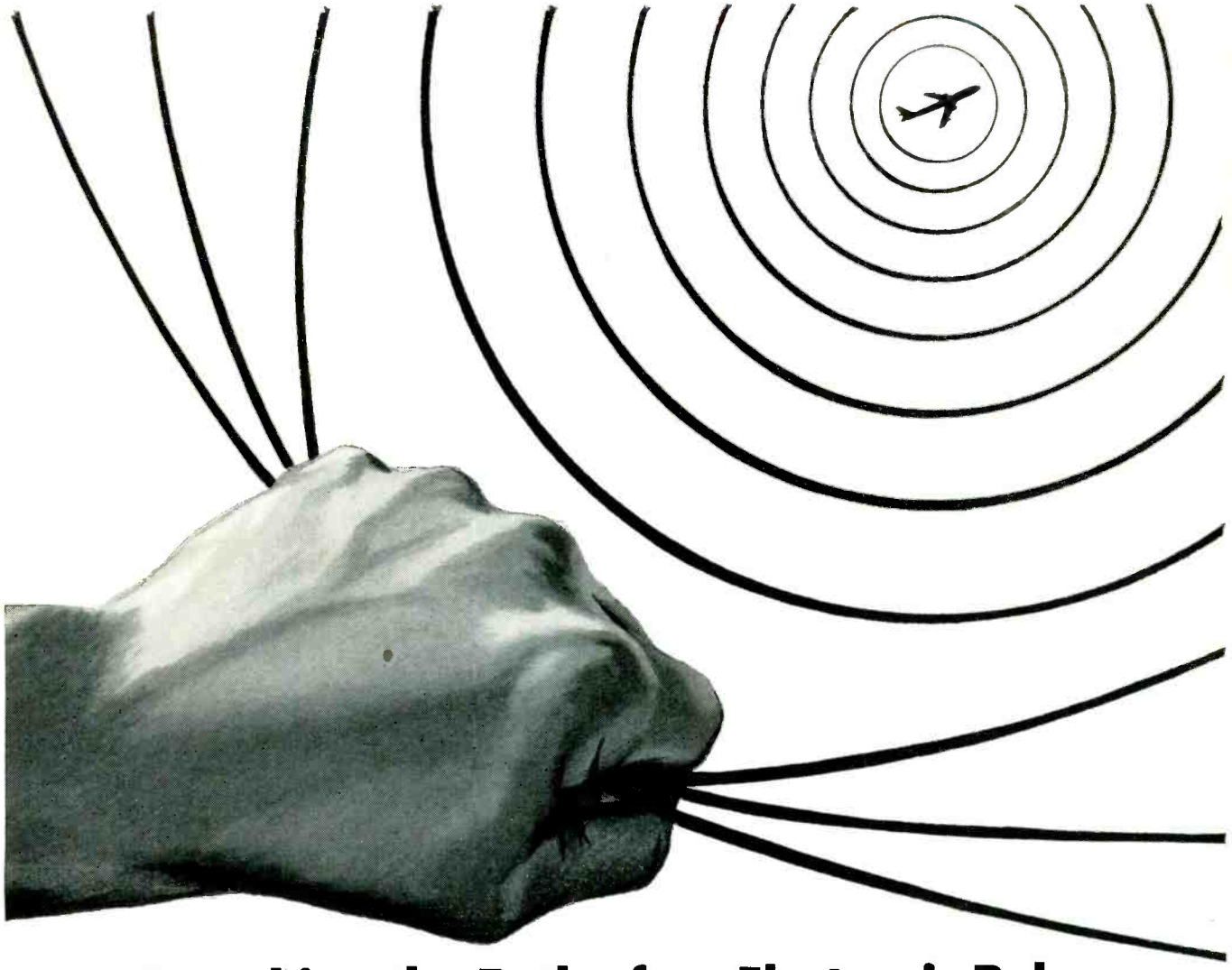
The lightweight units (around 4 lb) plug into any 115 v a-c outlet or 6 v d-c supply. Price is $59.75.



INFRARED ANALYZER
for automatic processing

AXLER ASSOCIATES, INC., 102-42 43rd Ave., Corona, N. Y. The automatic processing of pharmaceuticals, plastics, rubber, chemicals, petroleum, food, paper and cosmetics is made possible with the new infrared analyzer.

Designed to be used in conjunction with narrow-band infrared,



Stretching the Path of an Electronic Pulse

Military coding equipment takes one pulse and inserts it into a delay line and in effect sends it over a number of paths, each of different lengths. Combining the output of the paths gives a pulse train with pulses spaced in accordance with artificial length of the path. Ordinarily the flexibility of the equipment is limited by the fixed taps in the delay line and the accuracy is established by auxiliary circuitry.

Now Admiral research has developed a completely new type of delay line which is infinitely variable within its over-all capacity. It is adjustable with the greatest facility for any desired interval. The accuracy of this line is limited only by the accuracy of the measuring equipment. Moreover, the Admiral delay line requires less complicated switching apparatus. Weight and bulk are reduced. Fewer components permit faster production at lower cost. Here is one more example of Admiral's capabilities in the field of military electronics. Address inquiries to:

Admiral
CORPORATION
Government Laboratories Division
Chicago 47, Illinois

LOOK TO *Admiral* FOR

• RESEARCH • DEVELOPMENT • PRODUCTION

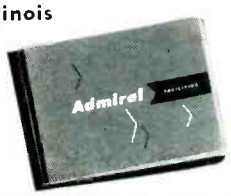
in the fields of:

COMMUNICATIONS, UHF and VHF, airborne and ground.

MILITARY TELEVISION, receiving and transmitting, airborne and ground.

RADAR, airborne, ship and ground.

RADIAC • MISSILE GUIDANCE • CODERS and DECODERS
TELEMETERING • DISTANCE MEASURING • TEST EQUIPMENT



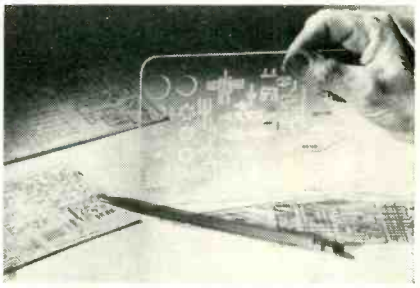
FACILITIES BROCHURE

describing Admiral plants, equipment and experience sent on request.

ENGINEERS! The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write to Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

ultraviolet and visible filters, it has universal applications studying gaseous or chemical constituents by the method of emission, transmission or absorption spectroscopy.

Rapid and spot analysis measurements can be made by nontechnical personnel by means of the narrow-band filters and the simple dial and meter arrangement. Model AA-1 analyzer is 8 in. by 8½ in. by 13 in., operates on a-c and utilizes a PbS detector and power supply.

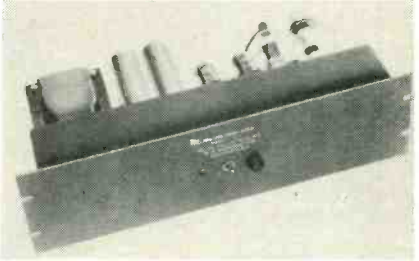


DIAGRAMMER
with electronics symbols

A. LAWRENCE KARP, 16 Putnam Park, Greenwich, Conn., has announced a new diagrammer for making any radio, tv or electronics circuit drawings. It is usable with pen, pencil or stylus.

Every necessary component of the most commonly used symbols is included on the rigid transparent vinyl template, which measures only 4¼ in. by 6½ in. by 0.040, and the sides of every symbol are beveled to provide extreme ease and accuracy.

► **Price**—The templates are $3 each postpaid. The price includes a new catalog and manual of many additional electronic and electrical templates.

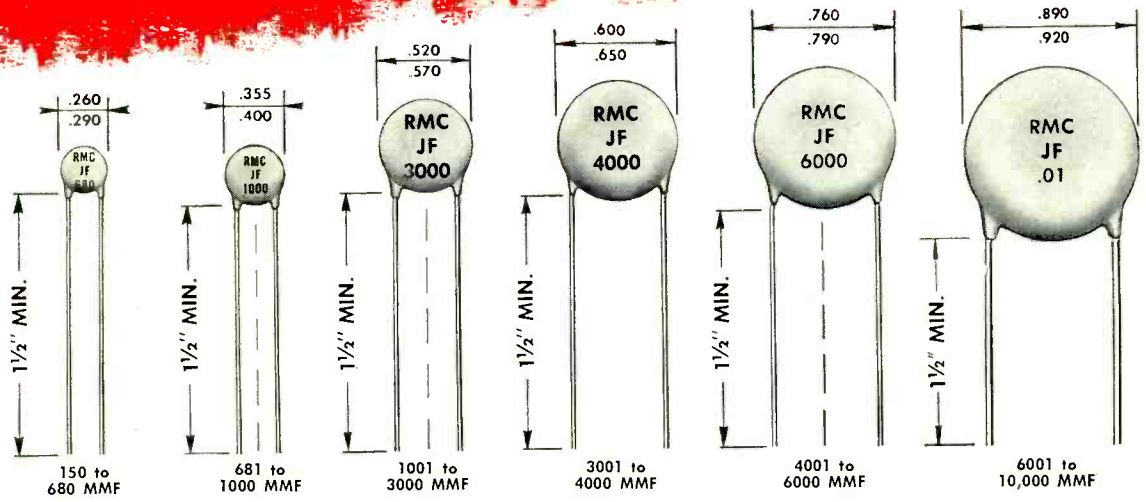


POWER SUPPLY
for multiplier phototubes

NJE CORP., 345 Carnegie Ave., Kenilworth, N. J., has available a

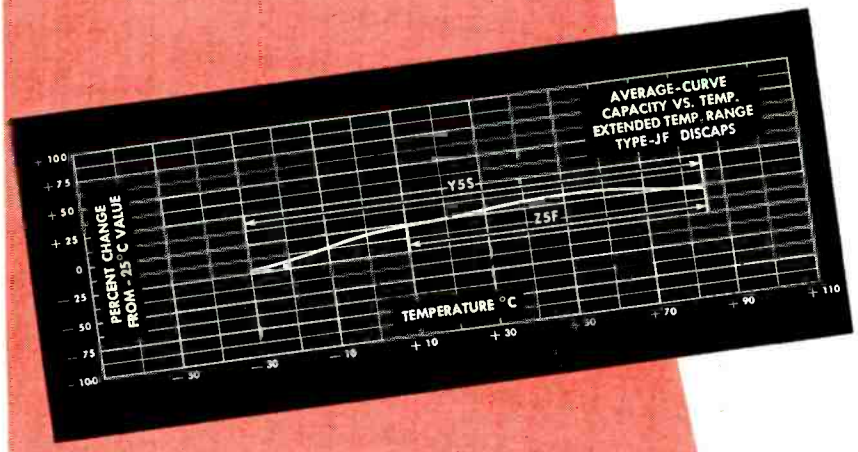
A new development from RMC

Type JF DISCAPS



SPECIFICATIONS

POWER FACTOR: 1.5% 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



Type JF DISCAPS are the result of the extensive research programs conducted in RMC's technical ceramic laboratories. These new DISCAPS extend the available capacity range of the RETMA Z5F type ceramic capacitor between + 10° and + 85° C and meet Y5S specifications between — 30° and + 85° C.

Now manufactured in capacities from 150 MMF to 10,000 MMF, type JF DISCAPS exhibit a change of only ± 7.5% over the range between + 10° to + 85° C. (See Graph). They also show a superior frequency stability over previous similar types.

Write today on your company letterhead for the answer to your questions on any type of ceramic capacitor.

VISIT BOOTH 518 I.R.E. SHOW

DISCAP CERAMIC CAPACITORS

RMC

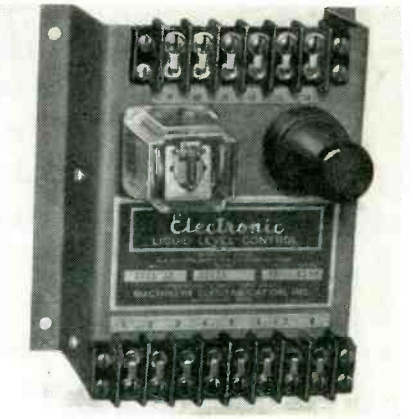
RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Want more information? Use post card on last page.

new, compact, inexpensive, high-stability multiplier-phototube power supply. Available either in basic chassis form for inclusion in optical devices, or in rack-panel/cabinet form for laboratory use, model CS-324 provides better than 0.1 percent line and load regulation without the use of a chopper or a standard-cell reference.

► **Other Specifications**—Long-term stability is better than that required for most applications, and ripple is less than 1 part in 50,000. The output voltage provided can be any 200-v range from 1,000 to 2,000 v d-c. Output current rating is 5 ma.

The stability and regulation are achieved through the use of a heavily pre-loaded, high-gain regulator operating from a relatively stiff rectifier. The reference tube is operated in a selected current region, which is maintained constant by the action of the regulator itself. Despite its high-performance characteristics, the circuit contains only five tubes, including the rectifier and reference.

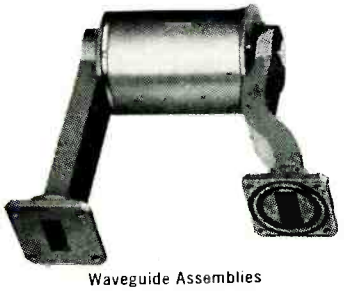


LIQUID-LEVEL CONTROL
for processing industries

MACHINERY ELECTRIFICATION, INC., Northboro, Mass., has developed the MEK-3001A electronic liquid-level control for the general processing industries. It will minimize and simplify maintenance in an industry that can not afford down time. To keep maintenance time to a minimum, it incorporates a plug-in relay encased in a transparent cover.

► **Service**—It can be connected for all types of service—pump-up,

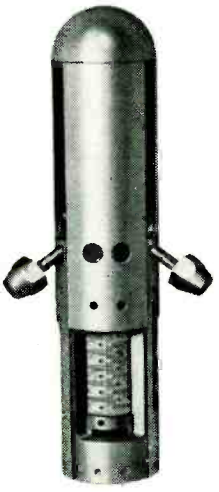
Waveguide Tubing

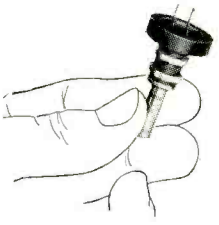


Waveguide Assemblies

Makepeace

ELECTRONIC and ELECTRICAL COMPONENTS



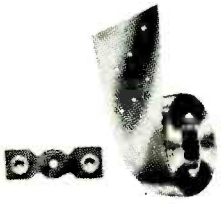


Collector Ring Assemblies

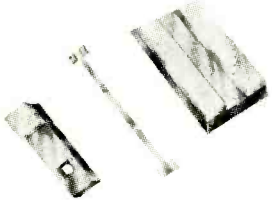
OFFER PRECISION QUALITY

Electrical Contacts

Crossbar for Relays



Spot Lay® for Rotors



Raised Lay for Switches

AT MASS-PRODUCED PRICES

D. E. Makepeace Co., originators in the art of bonding precious metals to base metals, have continually expanded their engineering and production facilities to keep pace with modern inventions and methods. The result is an ability to design and produce components to strictest specifications and closest tolerances at lowest possible quantity prices.

Send us your drawings for quotations or requirements for special design.

D. E. MAKEPEACE COMPANY

Division of Union Plate and Wire Co.

Attleboro, Mass.

ENGELHARD INDUSTRIES

See us at Booths 403-405 IRE Show

pump-down, or constant level. The control will monitor any liquid whose resistivity is between 0 and 2 million ohms per cu cm. Shock hazard is completely eliminated since the probe voltage is less than 12.5 v and is completely isolated from the a-c power supply by a transformer.

▶ **Specifications**—Input is 115/230 v, 50/60 cycles, sensitivity 0 to 2 million ohms per cu cm; relay, 5 amperes, 115 v operated either normally energized or normally de-energized; ambient temperature, 32 to 150 F.

H-V CONVERTER
is an ultracompact unit

BARRY ELECTRONICS CORP., 512 Broadway, New York 12, N. Y., announces a new ultracompact h-v converter, model 7MVT, for use in insulation breakdown testers, scintillators, Geiger counters, infrared devices, ignition purposes and portable power supplies.

▶ **Technical Data** — Input power requirements of 1 to 4 v d-c or 60 cycle a-c permit use of standard flashlight cells or proper stepdown transformer as source of power. It delivers output voltage of up to 6,000 v (low current). Compact

ANOTHER FIRST BY Amperex®

High-Power RF Oscillator Triodes SPECIFICALLY DESIGNED as INDUSTRIAL POWER OSCILLATORS

for INDUCTION HEATERS
for DIELECTRIC HEATERS

Designed to end the practice of forcing communications-type tubes into heavy-duty industrial service, these new AMPEREX triodes are engineered from the ground up to the specific requirements of RF power oscillator circuitry in industrial induction and dielectric heating installations. Their performance is virtually independent of the wide variations in load impedance encountered in industrial applications.

Outstanding Electrical Characteristics—

- low plate impedance
- low mu
- high transconductance
  for . . .
  . . . superior "loadability"
  . . . high efficiency under all loaded conditions
  . . . greater power into hard-to-heat loads
  . . . simpler circuitry eliminating special grid-current regulation devices

Outstanding Physical Characteristics—

- thoriated tungsten filament . .
  . . . for maximum life
- extra-heavy-wall copper anode . . .
  . . . to absorb short-term overloads of double the maximum ratings
- platinum-clad grid . . .
  . . . for stable grid-current operation
- coaxial grid construction and powdered-glass stem . . .
  . . . for maximum mechanical strength
- permanently bonded, flexible, heat-dissipating filament leads
  . . . to eliminate failures due to contact resistance at terminals

ON EXHIBIT at the I.R.E. SHOW Amperex Booths 273 and 275

FOR OPTIMUM PERFORMANCE WITH FLUCTUATING LOADS

Type 6756
WATER-COOLED
20 kw dissipation
$435.00
Grid Connector included
Accessory: Water Jacket (Type S-15096)

Type 6757
FORCED-AIR-COOLED
15 kw plate dissipation
$535.00
Grid Connector included
($75.00 allowance for return of radiator with order)

TYPICAL OPERATING CONDITIONS
TYPES 6756 and 6757

Oscillator, Class C—Three-Phase, Full-Wave Supply (Per Tube)

	CCS Full Load	CCS 2A Load	CCS No Load	
DC Plate Voltage	12000	12000	12000	volts DC
DC Plate Current	3.5	2.0	0.430	amps DC
DC Grid Voltage	—1220	—1380	—1710	volts DC
RF Grid Voltage	2050	2030	_____	volts
DC Grid Current *	0.210	0.238	0.295	amps DC
Grid Resistor	5.8	5.8	5.8	kilohms
Plate Input	42.0	24.0	5.16	kw
Plate Dissipation	11.25	4.9	_____	kw
Efficiency	73.30	79.4	_____	percent
Load Impedance	1755	3120	_____	ohms
Plate Power Output	30.75	19.1	_____	kw

*Note flat grid current characteristics, no load to full load, without external grid stabilization circuitry

Detailed data sheets and application information available on request.

***Retube with* Amperex**

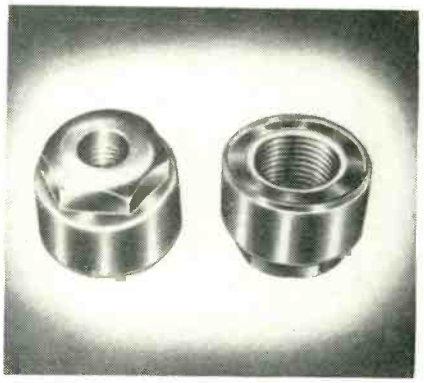
AMPEREX

Available At Your Local Parts Distributor

AMPEREX ELECTRONIC CORP.
230 Duffy Ave., Hicksville, Long Island, N. Y.
In Canada: Rogers Majestic Electronics Ltd.
11-19 Brentcliffe Road, Leaside (Toronto) 17

construction permits insertion into standard 8-prong socket.

Price of the new converter is $12.50.



SHAFT LOCK
maintains control settings

RAYTHEON MFG. CO., Waltham 54, Mass., has announced a new shaft locking device developed for use with screwdriver adjusted controls such as potentiometers. Designed to prevent control misalignment due to vibration, shock or accidental contact, the shaft lock also serves as a seal against dirt and moisture.

The unit consists of a single piece of molded nylon, containing a molded-in, threaded brass insert, and it is mounted on the control bushing in place of the standard hex nut and washer.

▶ **How It Works**—A nylon collar fits snugly around the control shaft, providing a friction drag which prevents accidental movement but which permits smooth accurate adjustment by the operator. Sealing is accomplished by this collar and by a molded lip around the circumference of the base which is compressed against the panel.

The shaft lock is available for use with both ¼-in. and ⅜-in. control shafts. List price of the ¼-in. shaft unit is $0.25.

T-W TUBES
with metal envelopes

FEDERAL TELEPHONE AND RADIO CO., 100 Kingsland Road, Clifton, N. J., has announced two new t-w tubes for use as wide-band amplifiers in microwave, radar and countermeasures equipment. They are available in quantity with metal enve-

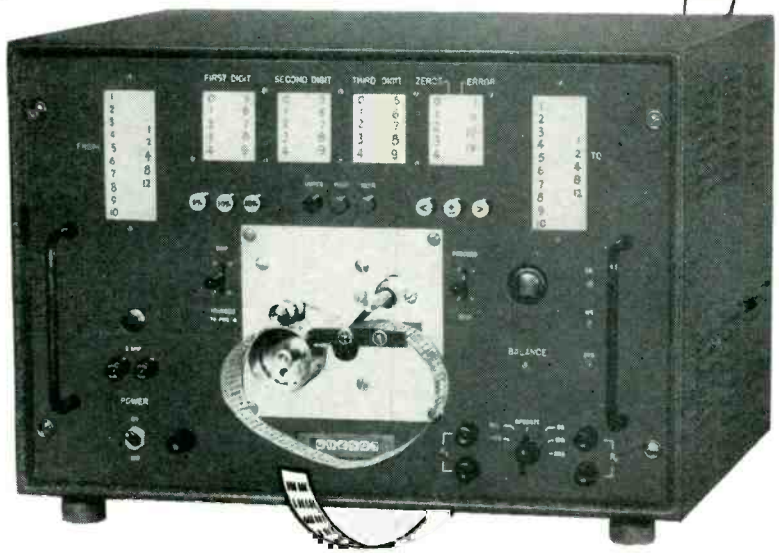
AUTOMATIC
Tape Scheduled
TESTING
with the New
LAVOIE
ROBOTESTER
for
ELECTRONIC EQUIPMENT

PRODUCTION LINE SPEED, EFFICIENCY, ECONOMY—

Light—Compact

Versatile—Accurate

SETS UP ENTIRE TEST WITHIN HALF A SECOND



SPECIFICATIONS

Measurement: DC resistance.

Range: 0 to 10,000,000 ohms in 1 ohm steps or ± 1%, whichever is greater. Internal standard resistors are ± 1%.

Tolerance: 5%, 10%, 20% with limits of either "smaller than," "±," or "greater than" selected internal standard. Will reject all resistance values outside standard tolerances. Any of the three tolerance values and three limits may be selected on the tape for any external measurement, and successive tape-programmed measurements need not have the same tolerances. (May be "mixed" in a series of measurements.)

Number of measurements: Between any two of 240 points, or over 57,000 possible measurements per set-up.

Speed: Approximately 120 measurements per minute.

Dimensions: 20" wide x 13¼" high x 18" deep (overall).

Weight: 90 pounds.

Here is an instrument that performs up to 120 complete circuit measurements per minute... with a capacity of 240 test points per set-up. Actuated by a simple punched paper tape, the Robotester eliminates the cost and bulk of special program boards, "black boxes" and sample units. It does away with tedious hours of preparation and releases engineering personnel for other work by enabling clerical-grade help to monitor intricate tests. The tapes are easily duplicated or punched on the job for multiple and remote testing at branch plants or affiliated operations. Its compact size and light weight add to its extreme versatility.

The Robotester is delivered complete, ready to operate with one complete set of plug-in cables for either octal, miniature, noval, subminiature or other standard connectors (customer's option), manual punch and a supply of blank tape rolls.

SEE *the* ROBOTESTER

in actual operation and the Complete line of Lavoie Electronic Products

400, 401, 500 PRODUCTION ROAD
IRE RADIO ENGINEERING SHOW

REPRESENTATIVES

ALBANY, J. A. Reagan Co., Albany 4-7676
ATLANTA, Southeastern Industrial Instruments, Exchange 7801
BALTIMORE, Thomas L. Taylor, Belmont 5-9126
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DENVER, Allen I. Williams Co., Main 3-0343
FLINT, Sam Robbins, Inc., Cedar 5-7310
FORT WORTH, Mitchell Spears Co.; Walnut 3-8811
HARTFORD, M. S. Coldwell, Jackson 2-5832
LOS ANGELES, T. Louis Snitzer, Webster 8-2074
MONTCLAIR, Louis A. Garten & Associates, Pilgrim 6-2900
SAN MATEO, R. L. Pflieger Co., Fireside 5-1134
ST. LOUIS, Edwin H. Murty, Jefferson 1-2075

Lavoie Laboratories, Inc.

designers and manufacturers of Electronic Equipment

MORGANVILLE 1, NEW JERSEY

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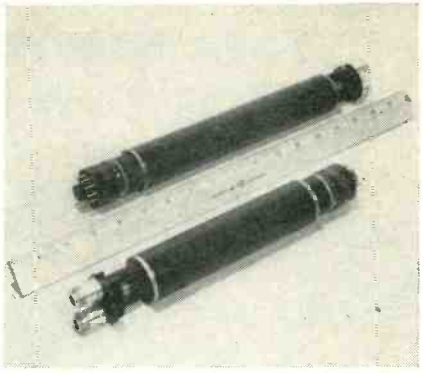


lopes that provide much greater ruggedness than conventional glass envelopes. Types F-6658 and F-6825 permit wide-band amplification in the S-band.

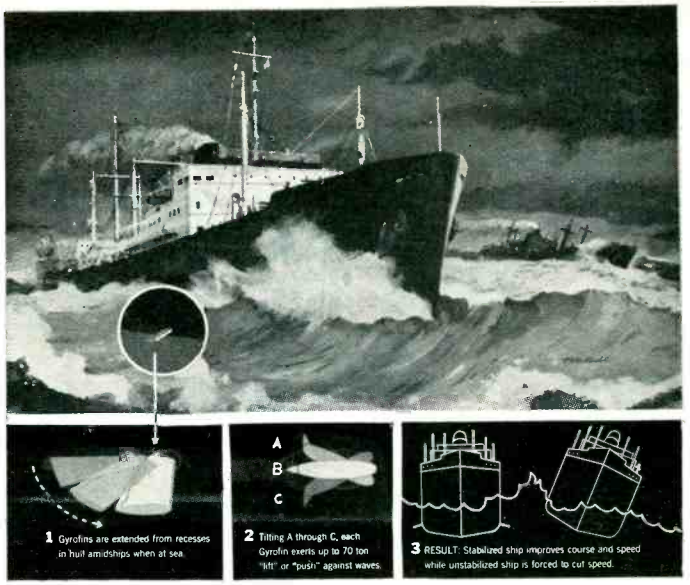
▶ **Characteristics**—Type F-6658 is for 1 w c-w, or 5 w pulse operation at S-band frequencies from 2,000 to 4,000 mc, with minimum gain of 30 db. It measures 11½ in. long and 1 1/16 in. wide at its greatest diameter. Type F-6825 is a pulse tube, designed for 1-kw output with 30-db minimum gain in the S-band from 2,400 to 3,600 mc. It measures 14⅜ in. long and 1 1/16 in. wide at its greatest diameter.

A uniform magnetic field, which is not an integral part of the tube, is used to control the electron beam in each tube.

T-W TUBE AMPLIFIERS operate to 12.4 kmc

HEWLETT-PACKARD Co., 275 Page Mill Rd., Palo Alto, Calif. From 4 to 12.4 kmc, models 492A and 494A t-w tube amplifiers give broadband amplification, choice of amplitude, pulse, phase or f-m, constant 25 to 30 db gain and constant output. Instruments are compact, simple to

PACE and Progress



FOLDING FINS TO TAME ROUGH SEAS

Stabilizer Cuts Ship's Roll Up to 90%

THE STORY BEHIND THE STORY:

"Now I'd like to take a cruise more than ever!"

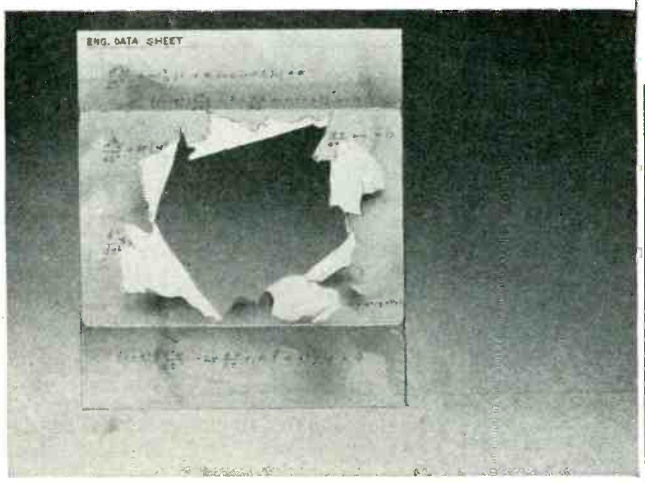
• That, probably was the reaction of most people when radio, television and the nation's press announced recently an effective way of taming rough seas. But to shipowners and shipping men the announcement meant more than passenger comfort alone. It offered substantial savings – by reducing damage to ships and cargoes, by improving course and speed in heavy weather thus saving fuel and time between ports.

• To understand how the Sperry Gyrofin* Ship Stabilizer is able to tame mountainous seas and eliminate up to 90% of the former roll, take another look at the illustrations above. The hydrofoil-type fins are constantly positioned to exert anti-roll forces of precision magnitude and timing. Controlled by sensing devices that anticipate each roll of the ship, one fin literally "pushes down" while the other "lifts up"—and even the biggest wave is subdued!

• In bringing this development to the maritime trade Sperry engaged the hydrodynamic experience and shipbuilding facilities of the Newport News Shipbuilding and Dry Dock Company. And many highly specialized Sperry skills were combined to make this development possible. The sensitive controls, for example, result from Sperry's vast experience in designing gyroscopic and electronic systems – the enormous power from Sperry's knowledge of hydraulic and servo systems.

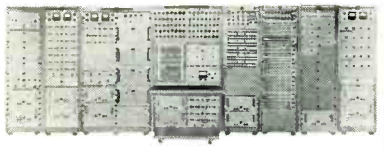
• These combined skills have also been responsible for many of our nation's most effective weapons of defense and for the most advanced instrumentation for ships of the sky and of the sea.

SPERRY GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION



Break Through The PROBLEM Barrier

More and more engineers are turning first to Electronic Associates Analog Computing Groups to conquer the problem barrier. For in these Groups they find an unparalleled accuracy, reliability and flexibility that has been proved by thousands of operational hours. These groups feature a building block method that simplifies the economical expansion of the system by the addition of standard component groups. A complete Group and staff is available for your experimentation on a rental basis at Electronic Associates Computation Center just outside of Princeton, New Jersey. We will also gladly furnish details on our new line of high-speed sounds, problem checks, high accuracy Electronic Multipliers, Function Generators and precision output equipment. Write Dept. 1A-8.



ELECTRONIC ASSOCIATES Incorporated
EAI SETS THE P PRECISION A ANALOG C COMPUTING E EQUIPMENT
LONG BRANCH, NEW JERSEY

In the development of the Gyrofin* Ship Stabilizer, Sperry Gyroscope Company's Marine Division employed EAI's Precision Analog Computing Equipment—Equipment renowned for its unparalleled accuracy, reliability, and flexibility. One more example of two foremost companies working together to break the problem barrier through progressive engineering. Write Dept. **EL3** for details on Pace Equipment and the rental of time and equipment at the EAI Computation Center in Princeton, New Jersey.

*Sperry T M.

Visit our booths which are Nos. 329, 331 and 333 at the I.R.E. Show.

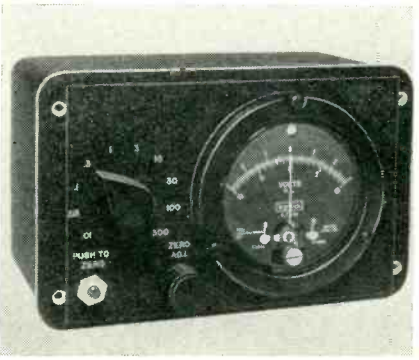
ELECTRONIC ASSOCIATES Incorporated
EAI SETS THE P PRECISION A ANALOG C COMPUTING E EQUIPMENT
LONG BRANCH, NEW JERSEY

operate, bringing convenience of l-f measurements to the microwave region.

▶ **Coverage** — Model 492A covers 4 to 8 kmc with 30 db gain, 10 mw output and 15 millimicrosec rise time. The 494A covers 7 to 12.4 kmc with 25 db gain, 5 mw output, 15 millimicrosecond rise time.

▶ **Uses** — Both amplifiers can be used for wide dynamic range antenna tests and swr measurements, generation of stable power level, and amplifying wide bandwidth signals containing complicated modulation and many routine lab measurements.

Price of $1,500 includes replaceable encapsulated t-w tube.



D-C MILLIVOLTMETER is miniature, ruggedized

TRIO LABORATORIES, INC., 3293 Seaford Ave., Wantagh, L. I., N. Y. Model J low-level d-c vtvm reads from 500 μv to 300 v d-c with an accuracy of 2 percent of full scale. The miniature panel-mounting instrument is designed to meet appropriate military specifications, including MIL-T-945A and MIL-E-5400. Its indicating meter is sealed and ruggedized to meet MIL-M-10304.

▶ **Stability** — Incorporating a unique chopper amplifier circuit, model J offers high stability over a wide range of environmental conditions. Ambient temperatures of 71 C and line voltage changes as great as 40 percent of nominal will not cause appreciable changes from room temperature readings. It is ideal for field tester use and for built-in monitoring and troubleshooting of operational equipment.

It draws less than 10 w of power

STAR PERFORMER

GOOD-ALL Capacitors contribute to the stable performance of many types of electronic equipment. Not all are as large and impressive as a TV transmitter, but their requirements for capacitor stability may be many times more exacting.

Engineers have come to rely on Good-All Mylar capacitors for their small capacity change during life. This feature, together with small size, low power factor and excellent IR, is responsible for the rapid increase in demand for our various MYLAR* types.

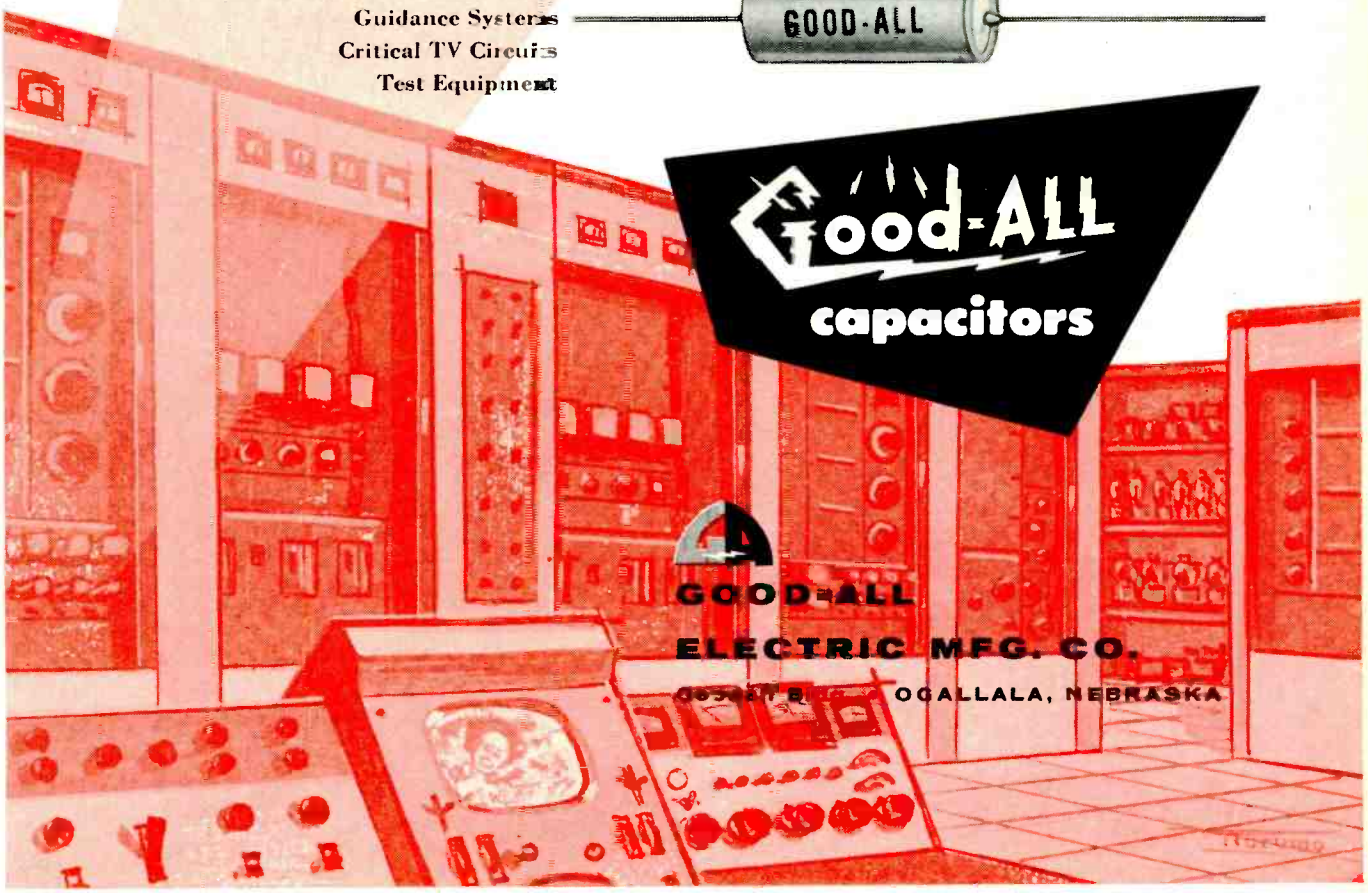
*DuPont's Trademark for Polyester Film

CLOSE TOLERANCE

The use of close tolerance capacitors becomes practical when there is assurance that later shifts will not wipe out the advantage of initial precision. Good-All Mylar types are widely applied in tolerance of 1%, 2% and 5%. *Our engineers are ready to work with you on any capacitor problem.*

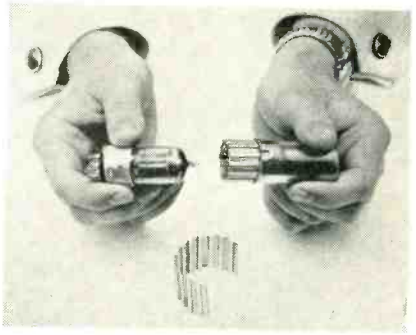
MYLAR Capacitor Applications

Computers . . . Military and Commercial
Seismic Instrumentation
Electronic Control Systems
Guidance Systems
Critical TV Circuits
Test Equipment



Want more information? Use post card on last page.

from a 115-v, 400-cps line and has 10 zero-center scales, from 10-0-10 mv to 300-0-300 v d-c. Input impedance is 5 megohms and zero drift is 0.5 percent maximum. Price is $450.



JAN SHIELD INSERT
cools miniature tubes

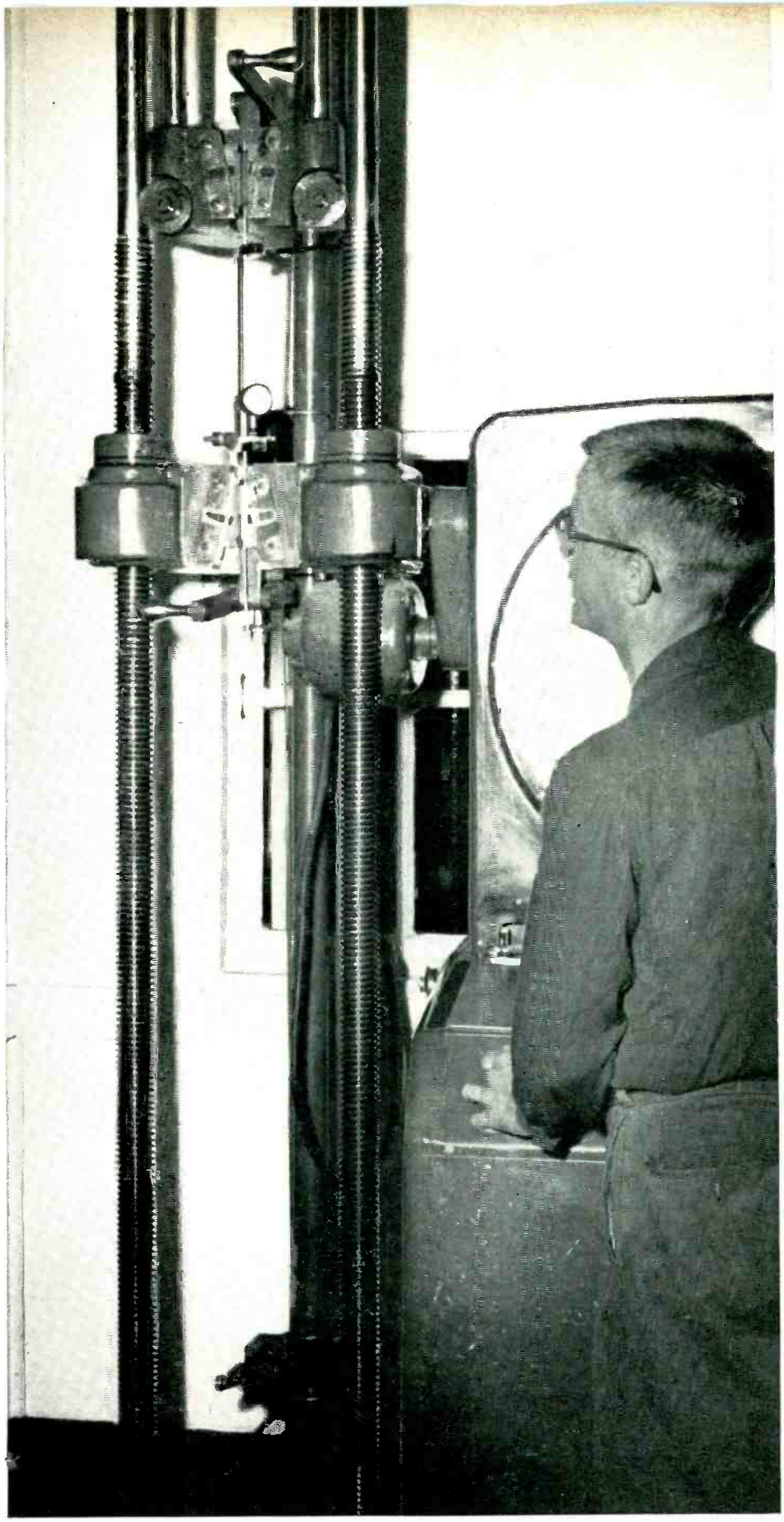
THE BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif., is manufacturing a new-type bulb cooling device for miniature tubes using JAN shields. It consists of a corrugated strip of 0.003-in. cadmium-plated spring brass, which is formed into a cylinder and inserted into the JAN shield before it is placed over the tube. Due to the corrugations, the insert contacts both tube and shield intimately, allowing heat to flow through the shield and into the chassis.

The new insert, used with a tube in the medium temperature range, will reduce bulb temperatures roughly 120 C. This temperature reduction will result in fewer tube failures, less down-time, less maintenance, greater reliability, and thousands of dollars' savings on tube replacements.

The insert is available in six sizes, to fit all 5½ and 6½ miniature envelopes.

V-R POWER SUPPLIES
in four new models

KEPCO LABORATORIES, 131-38 Sanford Ave., Flushing 55, N. Y. The 1.5-ampere KR series power supplies feature one regulated B supply and two unregulated filament outputs. Four new models have been developed to deliver 0 to 150 v d-c (KR16), 100 to 200 v d-c (KR 17), 195 to 325 v d-c (KR 18), and 295 to 450 v d-c (KR-19). Through-



Tensile and elongation tests are part of Anaconda's strict quality-control program that assures users of wire meeting the most rigid requirements.

With elongation tests
on magnet wire

He helps you get longer break-free runs in your winding room

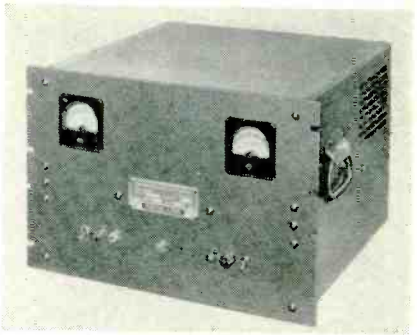
One of the best ways to get fewer breaks in winding, firmer coils, greater freedom from shorts, and fewer costly rejects, is to choose magnet wire with elongation and tensile strength properties that measure up to the strictest requirements.

In Anaconda's magnet wire mills, for example, samples of wire are taken at every machine each day for testing in the quality control laboratory—including measurements for tensile strength and elongation.

Every reel, spool or package of Anaconda wire undergoes rigid inspection and testing from raw material to finished product to packaging.

If you are not satisfied that you are getting the best results from the wire you are now using, why not give Anaconda magnet wire a trial. See the Man from Anaconda or your Anaconda distributor. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 56323

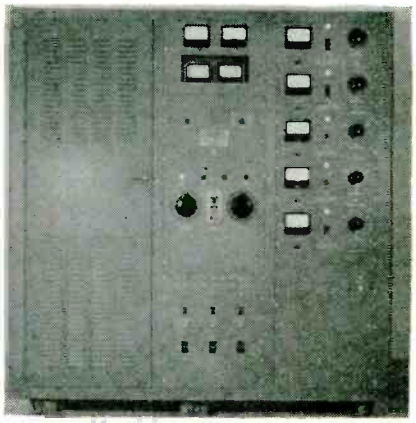
ask the man from ANACONDA® for MAGNET WIRE



out the operating range, the output voltage variation is less than 0.2 v for load variation of 0 to 1.5 amperes. Ripple voltage is less than 3 mv.

Each of the two unregulated filament outputs delivers 6.3 v, 15 amperes.

The KR series are designed for relay rack mounting or bench use. Height is 12¼ in., width 19 in. and depth 17 in. The units are available with or without meters.



RADAR TRANSMITTER
provides 50-kw peak power

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. The complete radar transmitter illustrated provides 50-kw peak power, 1-kw average power. It is designed for MTI applications with pulse-to-pulse jitter less than 0.003 μsec.

▶ **Makeup**—The equipment consists of a beam-power supply rated for 30 kv at 150 ma d-c with less than 0.05 percent voltage ripple; five independently-controlled focusing magnet supplies, each rated for 150 v d-c at 4 amperes with less than 0.1-percent current ripple; a pulse modulator with self-contained power supplies capable of supplying the power tube with pulses up to

meet us on this corner at the I.R.E. show

MICROWAVE AVENUE

booth 370 372

TRANSISTOR WAY

We'd like to see you. Our complete line of microwave tubes and components will be on display, and some of our top engineering specialists will be there to tell you about them. If you have a particular problem, in this field, come over and discuss it with us. On our staff are some of the country's leading tube specialists, and our engineering and production facilities are unmatched.

Bomac Laboratories, Inc.

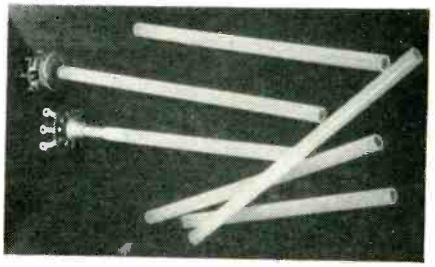
BEVERLY, MASSACHUSETTS

Positions are open for both junior and senior engineers for design and development work on microwave tubes. The work is challenging, advancement opportunities unlimited, and benefits liberal.

Offices in major cities:—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Toronto Export:—Maurice I. Parisier, 1860 Broadway, N.Y.C.

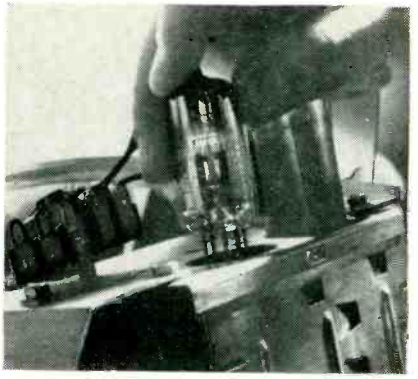
30 kv at repetition rates from 0 to 10,000 cps and continuously variable pulse widths from 0.5 to 10 μsec; air cooling system; controls; interlocks; and Eimac X616 klystron.

The unit is completely monitored by appropriate metering and indicator lamps, and all important waveforms are fed to a monitoring selector switch on the front panel for presentation on an oscilloscope.



EXTENSION SHAFT
for variable resistors

ANCHOR PLASTICS CO., INC., 36-36 36th St., Long Island City 6, N. Y., has announced the Aeroflex P flexible shaft available in any length required. The plastic material is more resistant to cracking than polyethylene. The shaft comes with or without serrations. It can be used for remote control applications or as an insulated shaft in high-voltage applications.



TWIN-TRIODE TUBES
are high gain units

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa., now offers two new sharp cutoff cascode r-f amplifiers. A 9-pin miniature tube, the 6BS8, has higher gain, lower noise and a 20-percent lower dissipation factor resulting in extended operating life. It replaces the 6BZ7 or 6BQ7-A,

BIGGER SECOND PLANT

FOR SUPERIOR TUBE CATHODES

Close to the Mid-U.S. electronics industry

NEW 55,000 SQ. FT. PLANT AT WAPAKONETA, OHIO, will duplicate manufacturing methods and quality controls used at main Norristown, Pa., plant. Completely modern in every detail, plant is being erected on a 15 acre site. Attached 2-story office building has 8000 sq. ft. Opening scheduled for November 1956.

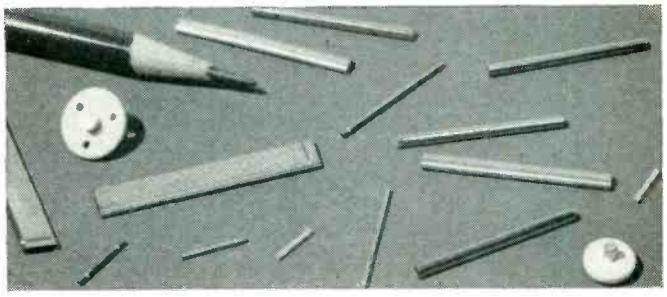
As America's largest independent producer of cathodes for vacuum tubes, Superior Tube is now building a larger *second* plant to doubly insure you—the tube manufacturer—a steady source of supply.

The production capacity of this new plant, at Wapakoneta, in Western Ohio, will greatly exceed that of the present temporary one (in operation for the past 3 years). If necessary, it will be able to take over Superior's complete production of seamless cathodes. Regular output will also include LOCKSEAM* and WELDRAWN† cathodes, and certain fabricated tubular parts.

Careful measures are being taken to insure that the cathodes made in the new plant will meet the highest quality standards. Manufacturing methods and quality control procedures will follow exactly those in use at Superior's main Norristown plant. Laboratory checks will be made on materials and finished cathodes.

With this new assurance of steady supply, there's more reason than ever to make Superior your regular source for vacuum tube cathodes. A new 20-page catalog (#50) gives complete technical details—write for your free copy. Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

SUPERIOR TUBE CATHODES. Typical examples. Seamless, Lockseam, and Weldrawn cathode sleeves are available in a wide variety of lengths and cross-section shapes. New CATHALOY† cathode materials offer new properties that yield superior performance.



I.R.E. SHOW MARCH 19-22

Visit the Superior Tube Co. booth—825 Audio Ave., in Kingsbridge Armory.

Superior Tube

The big name in small tubing

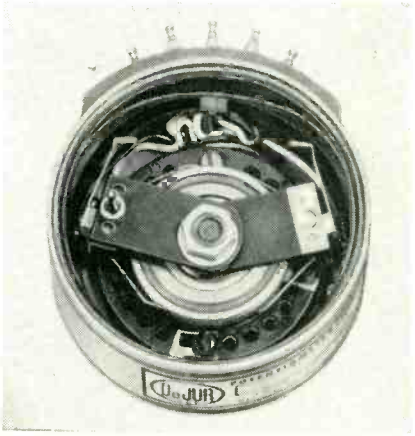
NORRISTOWN, PA.

*Manufactured under U.S. patents
†T.M. Reg. U.S. Pat. Off.—Superior Tube Co.

Want more information? Use post card on last page.

and will provide a high-cascode transconductance to plate-current ratio. The 4BS8 for series string applications has the same advantages.

► **Characteristics**—Plate supply voltage is 250 v; grid voltage, −1 v; plate current, 16 ma; grid voltage (approx) for g_m-50 μmho, −6 v; and transconductance, 10,000 μmhos.



BALL-BEARING POT with sine-cosine function

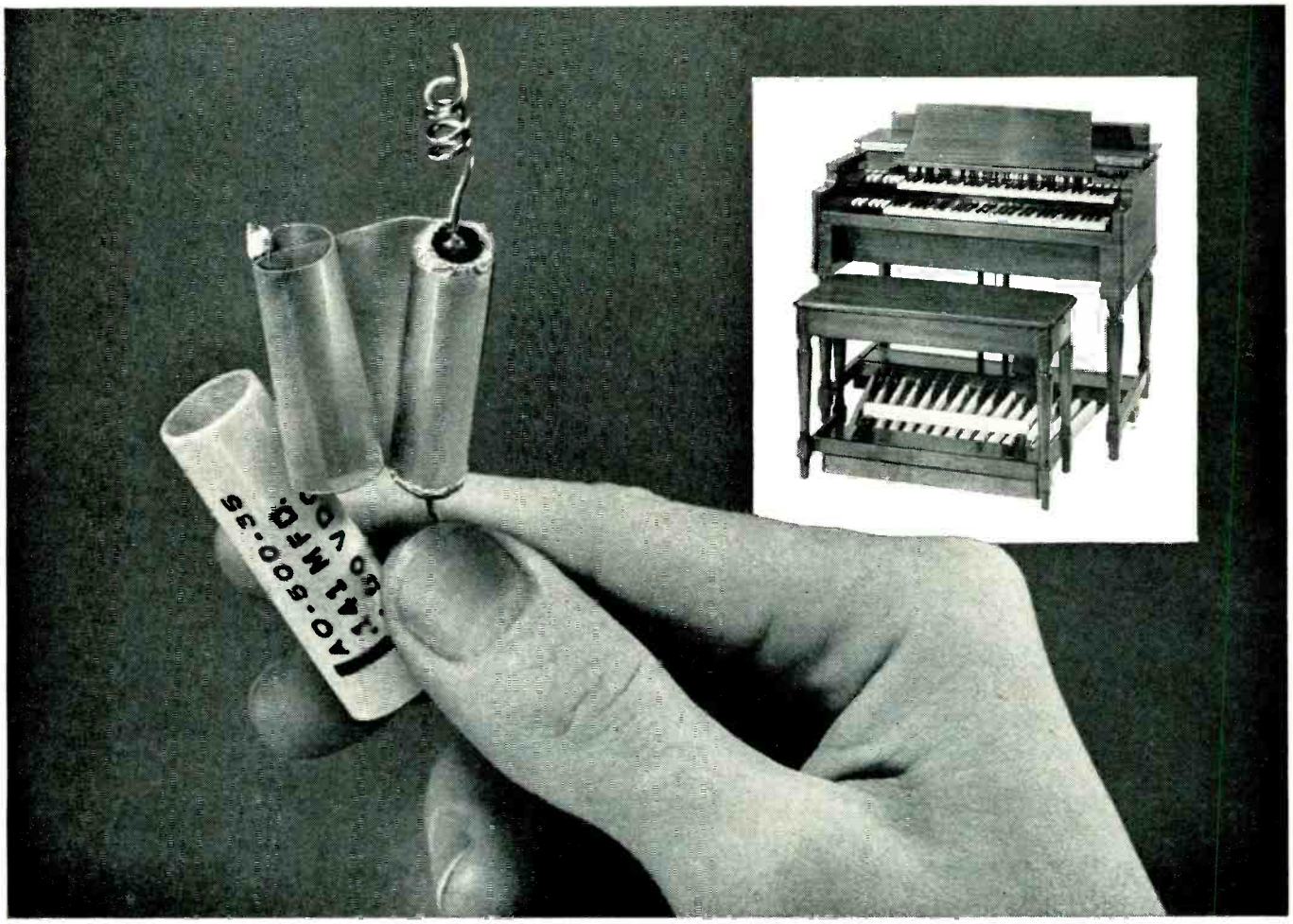
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. A new 2-in., high-performance ball-bearing precision potentiometer provides lower starting and running torque, improved linearity and minimized backlash. Dissipation is 4 w. Dual insulated bushes are independently adjustable to permit adaptation for switch and multifunction potentiometers.

Other functions are available in addition to sine-cosine, to meet special design problems. Ganged assemblies and various combinations of tap arrangements can also be supplied to customer specifications.

TV MICROWAVE LINKS for indoor rack mounting

RAYTHEON MFG. CO., Waltham 54, Mass. Both the KTR-100 and KTR-1000 series (100 mw and 1 w r-f output) tv microwave equipment are now supplied for standard 19-in. rack mounting. In the rack-mounted installation a ferrite isolator is used to eliminate long-line effects with waveguide extensions, thus permitting indoor operation and maintenance of the equipment

SUPERIOR... Du Pont MYLAR* insulation for moisture-resistant capacitors in Hammond organs



CHALLENGING to industry . . . almost unlimited opportunities for practical application of this versatile new film.

"Under humid conditions we find that capacitors made with Du Pont 'Mylar' are superior in both insulation resistance and capacity stability," reports the Hammond Organ Company. "This excellent resistance to moisture is very important to us. We can now use capacitors made with 'Mylar' where previously only capacitors hermetically sealed in metal tubes were satisfactory."

This successful product innovation is only one example of the way an imaginative industry is putting the unique properties of "Mylar" polyester film to profitable use. From metallic yarns to smaller transformers for guided missiles, Du Pont "Mylar" is making possible better products at lower cost in a wide variety of fields. Here's why:

"Mylar" has a tensile strength of 20,000 pounds per square inch. It has greater dielectric strength than most known insulating materials, and an impact strength at least twice that of any known commercial film. What's more, Du Pont "Mylar" is resistant to moisture and solvents, and remains flexible and stable over a temperature range extending from -80°F to 300°F.

How about your product? There may be a way "Mylar" can solve those knotty problems and improve over-all performance. Mail the coupon today for a fact-filled booklet telling you more about this new versatile film—"Mylar."

DU PONT **MYLAR®**

DU PONT POLYESTER FILM

REG. U.S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

*"Mylar" is the registered Du Pont trademark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room E-3, Nemours Bldg.
Wilmington 98, Del.

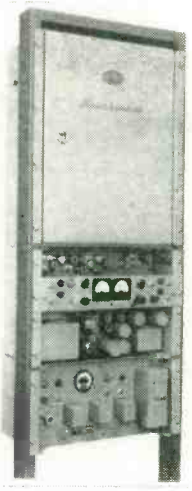
Please send me sample and further information on "Mylar" polyester film.

Name_____

Firm_____

Street address_____

City_____ State_____



while the antenna is located outdoors.

► **Accessory**—A new remote alarm unit, model 3-270, is also available. This provides the following control functions of a remotely located KTR system: (1) primary power can be turned on or off, (2) transmitter carrier can be shut down without turning off primary power, (3) the receiver afc can be disabled.

The alarm is actuated when either the transmitter power or receiver carrier power drops below predetermined levels. Both control and alarm functions can be accomplished over standard telephone wire circuits.

The company is currently delivering tv microwave links for operation at 6,000, 7,000 or 13,000 mc.

DELAY LINES
12.7-mc cutoff frequency

ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J. A unit of type 602 or type 602a step variable delay line consists of 110 sections of L-C m-derived networks and a 22-pole 11-section rotary switch. Both input and out-

Burton Browne / New York

PYRAMID technical bulletin

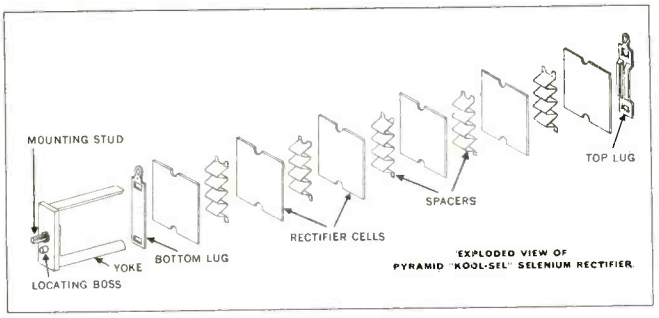
NO.66

SELENIUM RECTIFIERS

General:

The trend toward component miniaturization with attendent increase in equipment compactness has resulted in a steadily rising ambient operating temperature. Selenium rectifiers are particularly critical in this respect because much depends on their ability to maintain à high output voltage over extended periods of time. A major limiting factor in this respect has been the "Center-support" type of construction of conventional rectifiers and the tendency of this construction to concentrate the generated heat within a relatively small area. The Pyramid patented-type construction, known as the "Kool-sel," is a significant break-through of this heat barrier.

An exploded view of a Pyramid rectifier is shown below. Note that the center support has been eliminated completely; instead, the individual selenium rectifier coils are supported at their outer edges. A molded phenolic yoke forms the main supporting member, with a mounting stud and locating boss molded into the yoke. In this way, they become integral parts of that yoke. The lugs of the rectifier are slotted to accommodate the two arms of the yoke and the rectifier cells and spacers are notched to fit snugly on the yoke arms. Clinching lips are provided on the top lug so that when it is pressed on the yoke, all components are locked together to form a rigid assembly. During assembly, the spacers are flexed slightly to insure that the unit remains tight under all normal environmental conditions.



EXPLODED VIEW OF PYRAMID "KOOL-SEL" SELENIUM RECTIFIER

ADVANTAGES OF "Kool-sel" CONSTRUCTION:

Mechanical:

1. Cells and lugs are locked in place and cannot rotate.
2. Locking together of the components is accomplished without the current pickup contacts exerting excessive pressures on the cell counter electrode. Too much pressure may produce three detrimental effects: First, it may decrease the reverse resistance and thereby lower rectifier efficiency. Second, there is a cold flow of the counter electrode from under the pickup contacts. Third, fracture or damage to the counter electrode adjacent to the pickup contacts may occur.
3. The locating boss, being an integral part of the yoke, is always in the correct position.
4. Pulling on the positive lug cannot crack or break the alley (counter electrode) of the adjacent rectifier cell.
5. This particular mechanical construction results in fewer component parts.

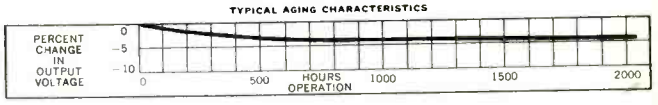
Electrical:

1. There is a high dielectric strength between the "live" components (i.e., cells, spacers, and lugs) and the mounting stud. The normal insulation thickness over the mounting stud is 1/16".
2. There is high resistance to burnouts on current surges.
3. The current pickup points are distributed over the full width of the rectifier cell. This means that heat is dissipated rapidly and the temperature rise of the rectifier cells during the flow of current surges is relatively low.

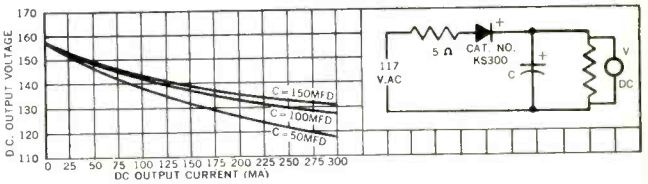
CHARACTERISTICS:

Illustrated below is a typical aging Characteristics Chart, showing percentage change in output voltage vs hours of operation.

CATALOG NUMBER	KS-65	KS-75	KS-100	KS-150	KS-200	KS-250	KS-300	KS-350	KS-400	KS-500
Maximum RMS Input Voltage	130	130	130	130	130	130	130	130	130	130
Maximum Inverse Peak Voltage	380	380	380	380	380	380	380	380	380	380
Maximum Peak Current (MA)	650	750	1000	1500	2000	2500	3000	3500	4000	5000
Maximum RMS Current (MA)	162	187	250	375	500	625	750	875	1000	1250
Maximum DC Current (MA)	65	75	100	150	200	250	300	350	400	500
Approximate Rectifier Voltage Drop	5	5	5	5	5	5	5	5	5	5
Minimum Series Resistance	22	22	22	15	5	5	5	5	5	5
Maximum Operating Plate Temperature	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C



Voltage Regulation: The voltage regulation curves for a 300 ma selenium rectifier in a half-wave circuit with 117-volt rms input shown below. Suitable voltage regulation curves for all Pyramid "Kool-sel" selenium rectifiers are available upon request.



APPLICATIONS:

Radios and Radio-Phonographs: Low-cost, efficient rectifiers for radios and radio-phonograph combinations are "Kool-sel" KS-65, KS-75, and KS-150. The needs of most 5-tube chassis are met by the KS-65, while the KS-75 and KS-150 are used in sets with larger current requirements.

Television Receivers: High-voltage power supplies in television receivers—including color sets—use "Kool-sel" numbers KS-200, KS-250, KS-300, KS-350, KS-400, and KS-500. These rectifiers, used in voltage doubler or voltage tripler circuits provide the proper B-plus voltage, eliminating the size, cost, weight and hum problems of power transformers. "U" shaped brackets are available which permit the rectifiers to be mounted either in vertical or horizontal positions.

Radio Accessories: TV boosters, UHF converters, phonograph oscillators, inter-coms and the like can usually be powered suitably by a "Kool-sel" KS-65 rectifier.

Laboratory Instruments, Power Supplies, Amplifiers: Rectified high voltage through the use of voltage doubler and tripler circuits, for equipment where current requirements run as high as 500 ma, may be provided with "Kool-sel" rectifiers. Types KS-200 through KS-500 will be found useful for laboratory power supplies, DC filament supplies, motion picture projectors, amplifiers, test equipment and other specialized uses.

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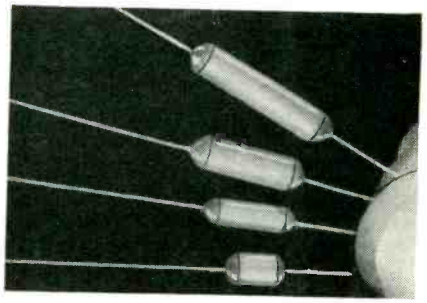
put impedance are equal. Each section of the L-C m-derived network was especially designed to give zero overshoot and minimum rise time. Type 602a has a maximum delay of 2.75 μsec. The rotation of the switch offers 11 positions with equal variation in time delay of 0.25 μsec per step. The unit can be used to match any transmission system with 75 ohms impedance. Maximum input voltage can be as high as 500 v. Rise time of the output pulse is less than 0.03 μsec times the square root of the number of steps in use. Type 602 has identical specifications, except that the characteristic impedance is 200 ohms. Since the cutoff frequency is 12.7 mc, both units are desirable to delay video signals in tv systems.



TANTALUM CAPACITOR is subminiature type

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has developed the subminiature series, type NT, tantalum capacitors to meet the electrical requirements and dimensional limitations of extremely small equipment.

▶ **Ratings and Sizes**—The subminiature capacitors have ratings ranging from 0.5 d-c to 16 v d-c working. Capacitances range from 0.08 to 30 μf, depending on voltage. Case sizes are only $\frac{5}{32}$ in. or $\frac{1}{8}$ in. diameter, and only $\frac{5}{32}$ in. to $\frac{1}{2}$ in. in length.

Type NT's are suited for tight-fitting applications where high stability and other favorable electrical characteristics plus minimum size are essential. These applications include transistor circuits for hearing aids and miniature radio receivers, printed circuit assemblies, subminiature controls and other small, low-voltage devices designed for operation

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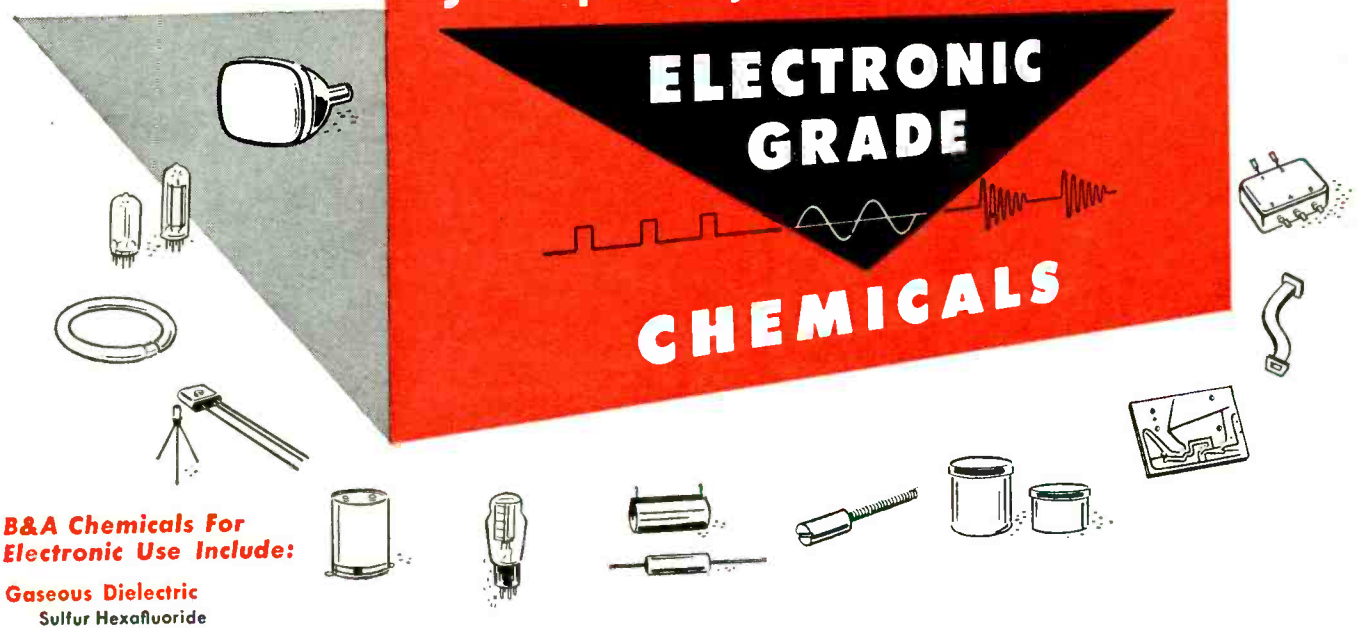

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- Lead-Tin Fluoborate
- Indium Fluoborate
- Nickel Fluoborate

Mineral Acids, Reagent, A.C.S.
- Acetic
- Hydrochloric
- Hydrofluoric
- Nitric
- Phosphoric
- Sulfuric

Solvents, Reagent, A.C.S.
- Acetone
- Isopropanol
- Toluene
- Xylene

Other Electronic Chemicals
- Aluminum Nitrate
- Barium Acetate
- Barium Fluoride
- Barium Nitrate
- Bromine
- Calcium Acetate
- Calcium Carbonate
- Calcium Fluoride
- Calcium Nitrate
- Copper Nitrate
- Hydrogen Peroxide
- Magnesium Oxide
- Manganese Dioxide
- Mercury
- Nickel Oxide
- Potassium Fluoride
- Potassium Hydroxide
- Sodium Carbonate
- Sodium Hydroxide
- Strontium Nitrate
- Thorium Nitrate

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The chemicals listed here range from versatile Sulfur Hexafluoride—used in TV transmitters, radar wave guides, and hermetically sealed transformers—to highly specialized reagent quality chemicals for specific applications. For example, Aluminum Nitrate is offered both as "Electronic Grade, Crystal" for cataphoretic coating of radio tube filaments and as "Electronic Grade, Basic Crystal" for drag and spray methods of filament coating.

For further information, prices and technical assistance, write or phone any B&A sales office listed below.

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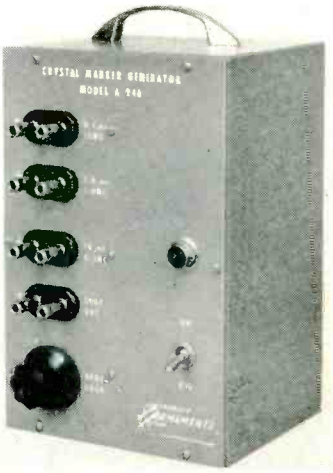
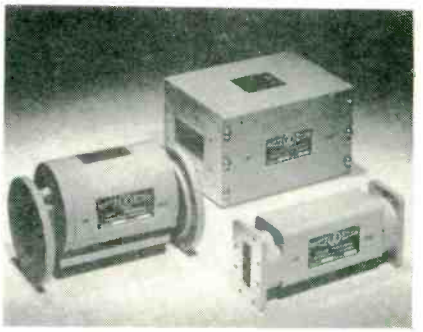


MARKER GENERATOR
crystal controlled pulses

AIRCRAFT ARMAMENTS, INC., Cockeysville, Md. The A246 marker generator provides crystal controlled pulse outputs having repetition frequencies of 100 kc, 1 mc and 10 mc, giving time markers at intervals of 10, 1.0 and 0.1 μsec, respectively. A pulse generating circuit, locked to an integral submultiple of the 100-kc frequency, provides scope trigger of approximately 1-kc repetition frequency.

▶ **Uses**—As a generator of precisely spaced pulses, the A246 is useful for calibrating and marking scope sweeps delay-line calibration, and pulse-width and rise-time determination. As a frequency standard, it provides an abundance of harmonics for receiver, signal generator and wavemeter calibration.



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reduce long-line effects

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new family of C-band load isolators makes it possible to operate magnetrons and klystrons into long lines or high vswr's without long-line effects or other loading problems. They are designed especially for use in airborne weather radar, microwave communication links and certain missile systems.

▶ **Technical Data**—These compact and light isolators provide up to 30 db isolation between source and load with an insertion loss of 1 db or less. A variety of models cover a band of 5,900 to 6,500 mc at average power levels of up to 700 w and peak powers of up to 1 megawatt. The isolators will operate at temperatures up to 100 C without degradation. No special cooling is required up to 300 w average power.

D-C POWER SUPPLIES
high current capability

PRESSMAN ASSOCIATES, 7803 Farnsworth St., Philadelphia 15, Pa., announces two new high-current voltage-regulated d-c power supplies. Model 3552 has two completely independent d-c supplies. One is a 0 to 300-v, 500-ma unit; the other, a 0 to 500-v, 200-ma unit. Each supply is capable of delivering the full rated output current over the entire range of output voltage. Each has 3 mv of output ripple, output impedance of 0.1 ohm at d-c to 3 ohms at 100 kc. The supplies may be stacked in series to give 0 to 800 v at 200 ma. Also included are two independent 6.3-v 10-ampere a-c outputs.

Model 3535 is also a twin supply. The two d-c units are identical and similar to the 0 to 300-v 500-ma supply on the model 3552. They

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If it depends on El-Menco Dur-Mica capacitors, it can run from 12 to 15 years with average use! Not 1,000—but 6,000 or more hours of accelerated testing!

In rigid life tests in which the applied voltage was 1½ times rated voltage and the ambient temperature was 125° centigrade, El-Menco DM-15, DM-20 and DM-30 capacitors out-distanced all normal ratings with each lasting over *6,000 hours* at 125° centigrade. Because of the acceleration of these tests the life of these capacitors may be equivalent to 12 to 15 years or more under normal operating conditions.

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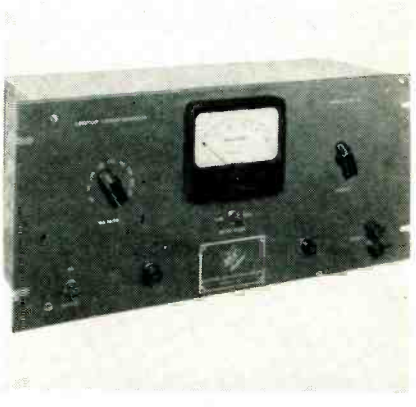
may be stacked in series to give 0 to 600 v at 500 ma maximum. This model also contains two independent 6.3-v 10-ampere a-c outputs.

HYDROGEN THYRATRON
for pulse modulation

PENTA LABORATORIES, INC., Santa Barbara, Calif., has announced the PL-161 hydrogen thyratron for pulse modulator service. By using a compact, rugged 7-pin stem and eliminating the conventional base, the company has reduced the space occupied by the prototype PL-5C22 by 25 percent while retaining full performance characteristics.

▶ **Ratings**—Peak plate voltage is 16 kv; peak plate current, 325 amperes.

Maximum dimensions are: height overall, 6.25 in.; height seated, 5.75 in.; and diameter, 2.56 in.



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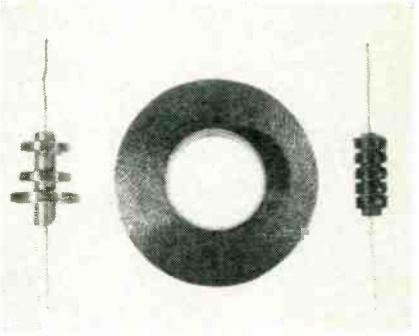
▶ **Specifications**—Output current is continuously adjustable in vernier steps from 5 to 250 ma, and is maintained constant within 2 percent for conditions of short circuit output to a load voltage in excess of 250 v. Ripple is less than 0.05 percent. Price is $325.



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THE FAIRBANKS WIRE CO., INC., 2287 Hollers Ave., New York 69, N. Y., announces a new type of magnet wire designed for the specific needs of the coil winding industry and replacing textile served wire at a substantial savings. The Embee wire provides a high friction surface requiring less critical setups.

▶ **Other Features**—Winding can be done with any reasonable setting. It is made within served wire tolerances and is easily interchange-

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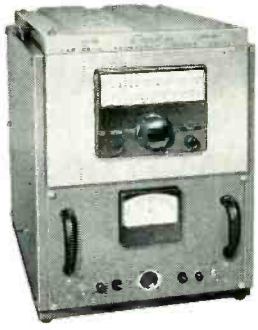

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These are only a few of the many applications of this versatile unit. Portable, it operates on 105 to 130 volts AC single phase and has no rotating parts; it causes no mechanical noise and needs no lubrication. It requires no filtering to prevent interference and provides up to 300VA at 0-130 volts 45 to 2000 cycles. Write for Bulletin VFS-250-E.

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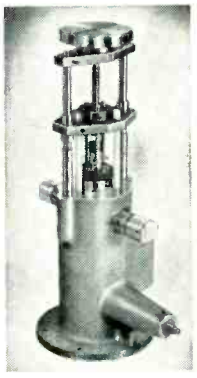

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able. Color coding makes insulation identification easy and accurate. Faster and more thorough impregnation is possible because there is no solid serving material to soak through, thus providing greater protection against moisture absorption.

Embee wire is available for prompt delivery made over standard film insulations in sizes from 36 awg to 39 awg inclusive. Price for a 1 lb sample is $5.

GOLD PLATER
for plating printed circuits

RAMYR MFG. CO., 1624 E. 1st St., Los Angeles 33, Calif. The new gold plater is a complete self-contained unit including d-c power supply and double wall stainless steel tank. The power supply has stepless voltage control, large meters and timer to insure accurate plating.

The double-wall tank unit is heated with sealed contact heaters that are thermostatically controlled. A cathode rod agitator is incorporated for uniform heavy deposits on industrial parts.

This unit was designed to meet the increasing demand for gold plating of printed circuits and other industrial components.

INSERT LINERS
for JAN shields

INTERNATIONAL ELECTRONIC RESEARCH CORP., 177 W. Magnolia Blvd., Burbank, Calif. New heat-dissipating insert liners are available for immediate use with JAN shields in 7 and 9-pin sizes, and are made from 0.003 brass shim stock in black cadmium plated finish. The

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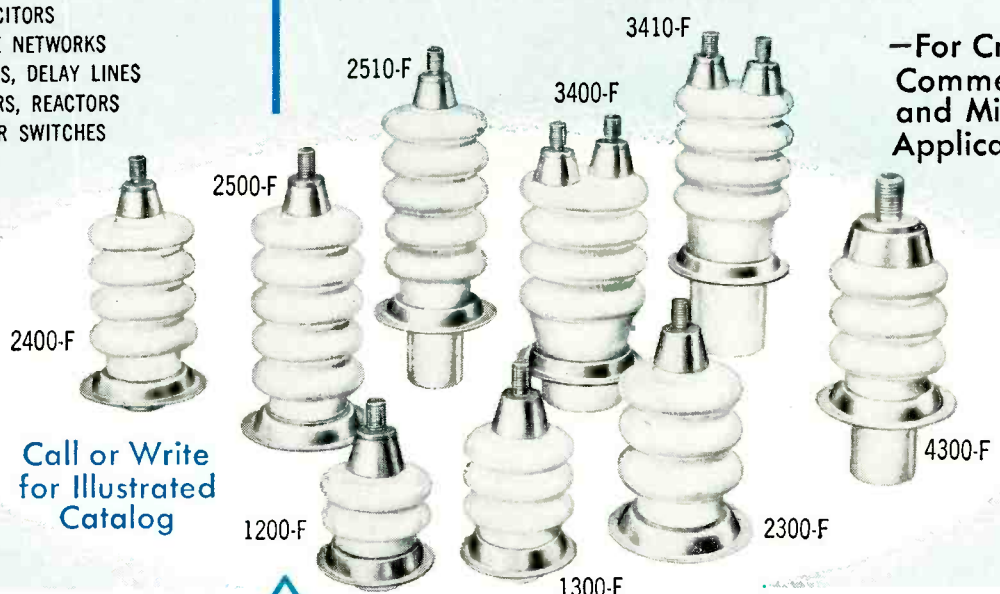
New ADVAC High Voltage Terminals withstand operating temperatures of over 1000°F. They have been service-proven in a wide range of applications where severe environmental conditions, including both mechanical and thermal shock, are encountered. ADVAC super-rugged high voltage terminals are available in nine economical standard types that meet most requirements. For special applications, custom terminals can be produced to your exact specifications.



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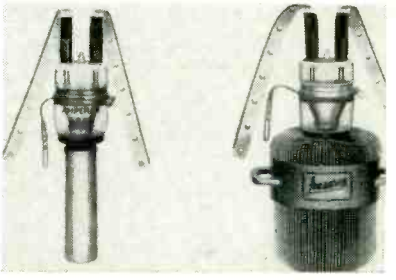
new liners give cooling effects equal to or below bare bulb operating temperatures.

SELF-FOCUSING CRT for monitoring purposes

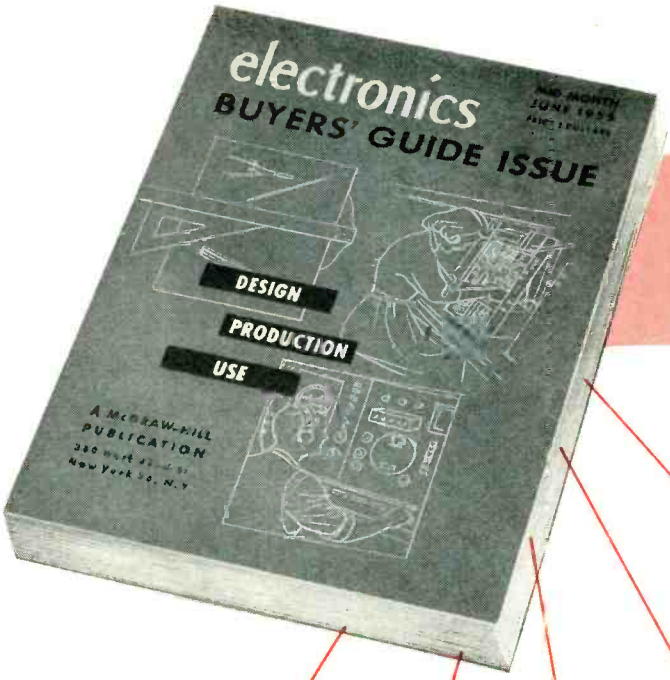
BEAM INSTRUMENTS CORP., 350 Fifth Ave., New York, N. Y., has announced the Cossor 1CP1, a new flat-face 1-in. self-focusing crt, which is ideal for monitoring purposes in a wide variety of electronic circuits.

► **Features**—The new crt features automatic self-focusing at low anode voltage from 500 to 1,500 v and has 250-v heater-cathode insulation. Also featured are newly designed electrodes and structure utilizing precision ceramic tubular spacers exclusively, and new screen material which provides longer life for continuous operation. Screen color is green, short persistence. Base is standard loctal type. Literature and detailed specifications are available.



OSCILLATOR TUBES for industrial service

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N. Y.,



the best way to sell the 6.8-billion dollar electronic market is thru the . . .

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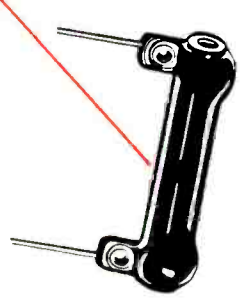

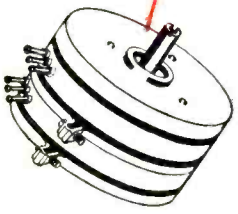

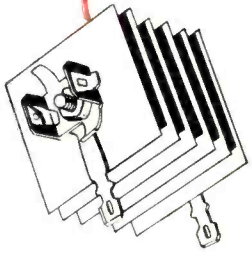

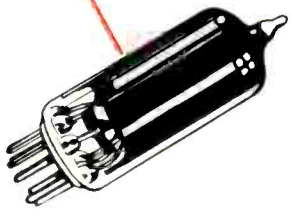

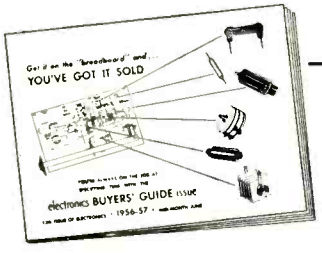

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electronics BUYERS' GUIDE

330 WEST 42ND STREET (ABP) A McGRAW-HILL PUBLICATION (ABC) NEW YORK 36, N. Y.

has announced two new high-power r-f oscillator tubes. Type 6756 is a 3-electrode water-cooled tube with special characteristics as low-impedance r-f industrial oscillator. The filament is thoriated tungsten. The anode is capable of dissipating 20 kw. Type 6757 is the equivalent forced-air-cooled type with 15 kw plate dissipation.

► **Features**—Both tubes feature a low mu, low plate impedance and high transconductance characteristic permitting extremely efficient matching and high output despite varying load conditions. Both types incorporate a heavy-wall copper anode to absorb short-time overloads and also a platinum-clad grid for stable grid-current operation.

POTENTIOMETER
features high accuracies

ANALOGUE CONTROLS, INC., 39 Roselle St., Mineola, N. Y. Model 18-10 potentiometer is a 10-turn device featuring high accuracies and linearities to 0.01 percent. The Teflon shaft seal and high-leakage construction provides leakage resistance consistent with linearity. The linear or functional servo-controlled winding provides high accuracy and low error rate.

► **Application**—The unit is used in a variety of computing control and calibration functions where high accuracy rotation-voltage or rotation-resistance conversion is needed.

POWER TRANSISTOR
grown-junction silicon type

TEXAS INSTRUMENTS INC., 6000 Lemmon Ave., Dallas 9, Texas. Type 970 *npn* grown-junction silicon power transistor is especially designed for use in servo amplifier

now selenium rectifiers designed for printed circuits!

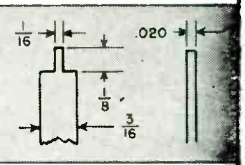
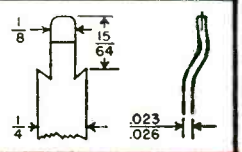
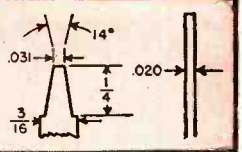
Four output ratings from 65 to 150 milliamps, and a choice of three terminal styles, are now available from Federal to meet your printed circuit requirements.

The new terminal designs cut your assembly and soldering costs . . . permit rapid *automatic* or *manual* insertion into printed circuit boards.

Terminal shoulder stops keep the rectifier plates off the board. Result: rectifier cooling is improved and extra board area is freed for additional printing!

And, as with all Federal selenium rectifiers, *you can count on* their long life, high output voltage, low temperature rise, excellent humidity resistance, and UL acceptance.

TERMINAL TYPES

TYPE	DESCRIPTION	DETAIL DRAWING
a	**Square Tipped**—for light-gauge printed circuit boards up to 1/16" thick.	
b	**Snap-In**—for 1/16" printed circuit boards subject to vibration or inversion. Terminals lock rectifier in place.	
c	**Tapered**—for maximum ease of insertion in heavy-gauge printed circuit boards up to ⅛" thick.	

FEDERAL PRINTED CIRCUIT RECTIFIERS												
FTR No.	1266	1279	1265	1308	1444	1357	1297	1445	1400	1383	1494	1495
DC Output ma (maximum)	65	65	65	65	65	75	75	75	100	100	100	150
AC Input V (rms maximum)	130	130	130	130	130	130	130	130	130	130	130	130
Terminal Type	A	B	A	B	C	A	B	C	A	B	B	B

Federal
A DIVISION OF I T & T

For more information on Federal Printed Circuit Rectifiers phone NUtley 2-3600, or write Dept. F-913

Federal printed circuit rectifiers can be designed for your application in ratings up to 195 volts AC and 600 milliamps DC

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

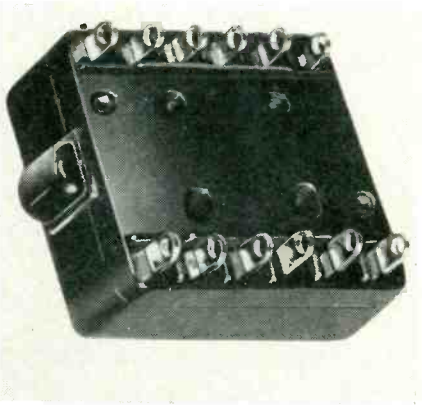
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

output stages. The large energy gap of silicon permits operation at ambient temperatures above 100 C. Each unit is thoroughly temperature cycled. This process consists of 4 cycles from −55 C to + 150 C and 4 cycles at 95 deg relative humidity from −55 C to + 75 C.

The hermetic seal is checked by vacuum testing. Every unit is completely tested for design characteristics and undergoes a rigorous tumble test to check for mechanical reliability.

Ask for bulletin No. DL-S 571.



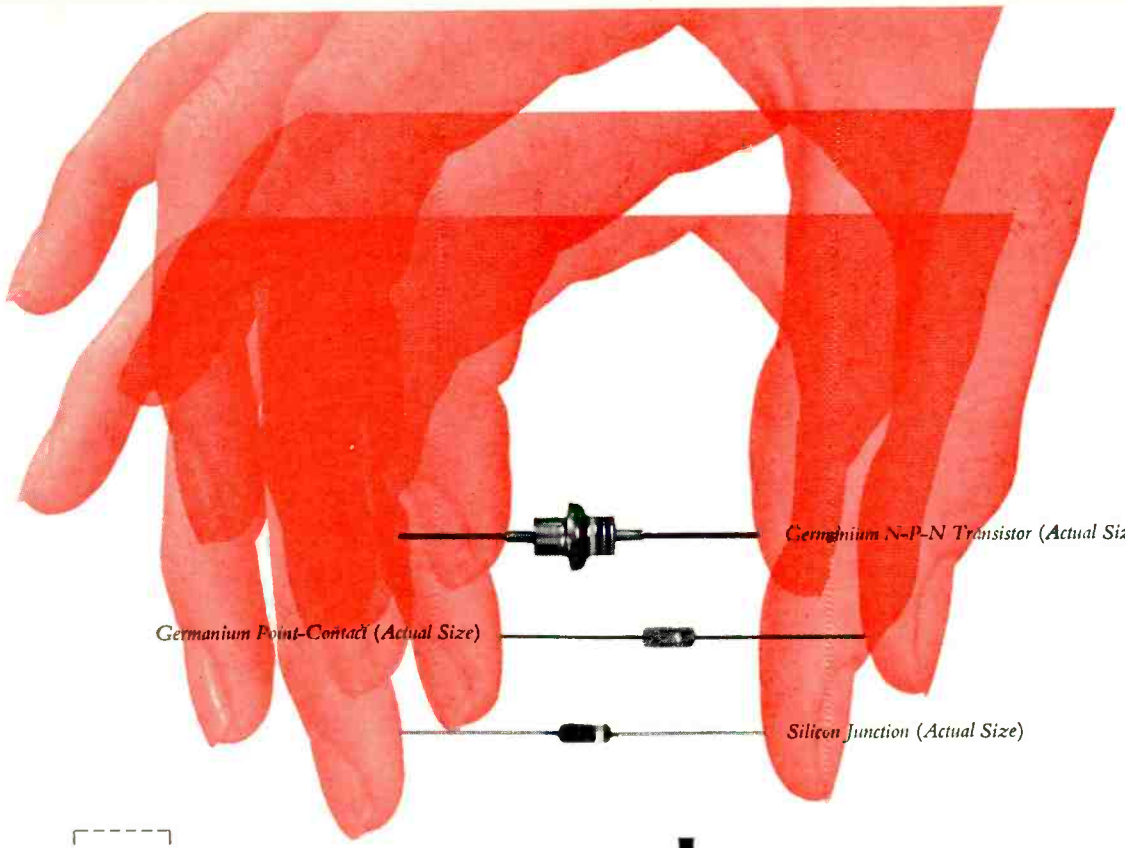
SIX-CIRCUIT CONTROL in small package

ELECTRO-SNAP SWITCH & MFG. CO., 4218 W. Lake St., Chicago 24, Ill., announces a new snap-action switch that gives precision control of 6 circuits simultaneously from a single actuation. Model K3-4 triple-pole switch simultaneously reverses the current flow through two windings of a 3-phase motor up to 1 h-p and also other type of multiswitching installations. The instantaneous snap-action of the 3 poles is totally independent of the speed of actuation making it suitable for installations where even extremely slow moving cams are used.

Electrical rating is 15 amperes at 125/250 v a-c; 15 amperes at 30 v d-c.

COATED RESISTORS can be clip mounted

SAGE ELECTRONICS CORP., Rochester, N. Y., has developed a new line of silicone coated resistors which can be clip mounted. The type S Silicohm resistors feature a silicone



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AT THE IRE SHOW

visit our display in booths 753, 755, 757. Our new N-P-N Fused Junction Transistors will be exhibited in operating demonstrations, together with a representative selection of germanium and silicon diodes from the extensive Hughes line. Meanwhile, for additional information, or descriptive product literature, please write:

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PRODUCTS DIVISION

HUGHES AIRCRAFT COMPANY

International Airport Station, Los Angeles 45, California

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Rugged—Successfully withstand physical shock and vibration.

Stable—Mechanical and electrical characteristics remain stable throughout a long operating life.

All Diodes Tested—For electrical and mechanical characteristics.

Subminiature—Glass envelope: 0.265-inch by 0.105-inch, max.

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A DIVISION OF THE HUGHES AIRCRAFT COMPANY

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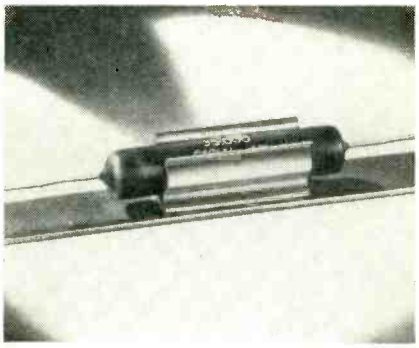


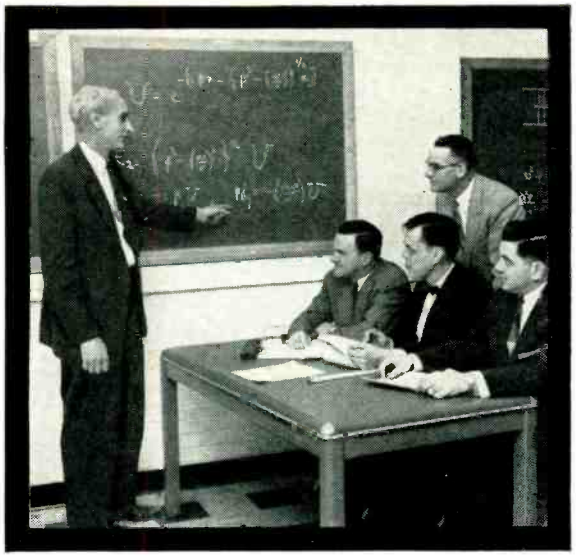
formulated coating which is hard and durable and will not crack, chip or peel when the resistor is pressed into the clip. The quality of the coating is not affected by high ambients—yet it is not brittle and will not craze even when repeatedly cycled in thermal shock as required under MIL-R-26B.

The clip-mounting offers important advantages especially where vibration or high g's are inherent. Because part of the heat is dissipated through the base of the clip into the chassis on which it is mounted, up to 50 percent more power may be gained depending upon mounting location and environment. Thus the resistor may be rated upward allowing more power dissipation for a given size, or the additional rating may be considered as an added factor of safety.

The new line includes 7 dimensions, with ratings from 2 to 10 w and tolerances ranging from 3 percent to 0.05 percent.

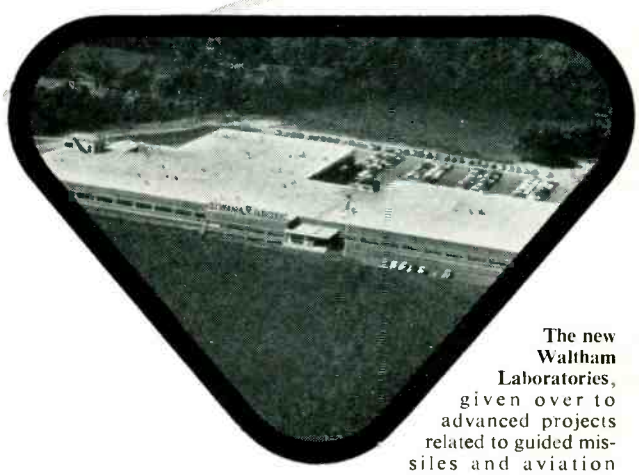
TUBE TESTER DATA on subscription plan

PRECISION APPARATUS CO., INC., 70-31 84th St., Glendale 27, L. I., N. Y., is now making available to all owners of its tube testers an automatic, roll chart and supplementary tube test data service on an annual subscription basis. Under the plan valuable new tube test data are published and forwarded automatically to subscribers who will no longer be burdened with the necessity of writing in for new information whenever new tubes come out. Included in the service is a minimum of 2 new roll charts plus other supplementary test data mailings. Total cost for the completely automatic service is $2.00 for a full year subscription. All in-



Dr. Edwin G. Schneider, Chief Engineer of the Electronic Systems Division, discussing wave-guide theory with top staff members of Waltham Laboratories. From left, *Paul B. Black,* Manager of Avionics Laboratory, *Dr. Sherrerd B. Welles,* Manager of Missile Systems Laboratory, *Dr. Leonard S. Sheingold,* Manager of Applied Research Dept., and (standing) *Dr. Oliver G. Haywood,* Manager of Waltham Laboratories.

Carl Cutler, electronics engineer, testing a traveling wave tube at the Waltham Laboratories.



The new Waltham Laboratories, given over to advanced projects related to guided missiles and aviation electronics. Completely air conditioned, the building contains 120,000 square feet of floor space.

Producing *Producible* Solutions

GIVEN: Problems whose terms extend into tomorrow, whose "unknowns" *must* be solved by electronic systems to assure the military security and industrial progress of the nation.

APPLY: The Systems Approach, modern research, development, and productive capabilities of the Sylvania Electronic Systems Division . . . with installations at Waltham, Mass., Mountain View, Calif., and Buffalo, N. Y., staffed with top-ranking scientists and engineers, and backed by Sylvania's extensive resources in the electronics field.

SOLUTION: *The right electronic systems answers,* capable of being produced in quantity to meet a wide variety of advanced requirements.

Ingenuity, versatility, and *producibility* are the keys to Sylvania's important contributions in the fields of aviation electronics, guided missiles, countermeasures, communications, radar, computers, and control systems. Whether the problem is military or industrial, Sylvania's business is to produce electronic solutions that are *producible.*

SYLVANIA IS LOOKING FOR ENTERPRISING 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 Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Ave., Waltham 54, Mass.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

quiries may be addressed to the company.

PICTURE TUBE
for compact tv receivers

RADIO CORP. OF AMERICA, Harrison, N. J. The 8DP4 is a small, compact, directly-viewed, rectangular, glass picture tube of the l-v electrostatic-focus and magnetic-deflection type. It has a spherical Filterglass faceplate, a screen $7\frac{3}{16}$ in. by $5\frac{3}{8}$ in. with slightly curved sides and rounded corners, and a minimum projected screen area of 35.5 sq in.

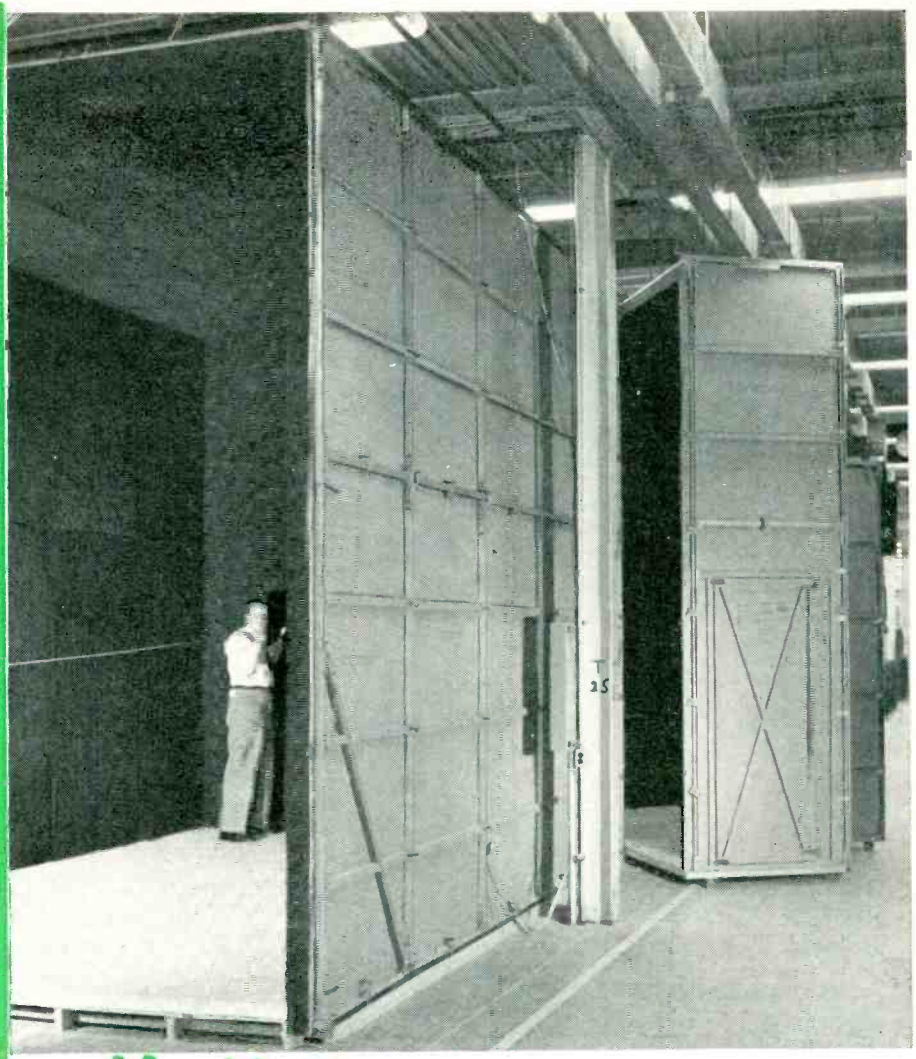
Employing 90-deg deflection, the 8DP4 has a maximum overall length of only $10\frac{3}{4}$ in. and weighs less than 3 lb. Other design features include a specially designed, precision electron gun requiring an external, single-field ion-trap magnet; and an external conductive bulb coating which with the internal conductive coating forms a supplementary filter capacitor.

FLUXLESS SOLDERER
is an ultrasonic unit

AEROPROJECTS INC., 310 E. Rosedale Ave., West Chester, Pa., has added to its line of Sonobond ultrasonic fluxless soldering equipment a large hand model designed

to simulate free space for microwave antenna testing

Westinghouse uses the new



McMillan "free space" room

At Westinghouse Electric Corporation's Air Arm Division in Baltimore, the problem was to produce a large room which would simulate free space conditions for microwave testing to be done in conjunction with environmental testing. The McMillan "free space" unit illustrated above was especially designed in association with Westinghouse to fit this particular need.

McMillan supplied a "modular unit" consisting of the individual structural-steel channels, or ribs, together with the microwave absorber panels. It was a simple job for Westinghouse workmen to form the construction and mount the panels.

In this installation, McMillan Hair Mat, type H-4 was used on the wall and ceiling panels for its light weight, while the floor panels utilized McMillan Plastic Foam Block, type B which can be walked on without affecting its electrical performance. All absorbing materials were backed with copper shielding to prevent R.F. disturbance from outside. Panels were approximately 4' x 8'. The complete front section (right hand section of illustration above) which includes the door, was mounted on roller casters to allow large equipment to be moved in and out.

McMillan can produce any size room on this "modular" principle, with whatever type microwave absorber may be required — for either indoor or outdoor use. Send for catalog.

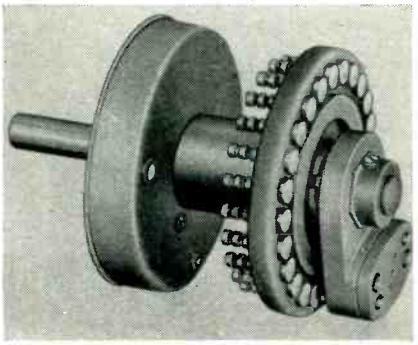
BOOTH #387
IRE SHOW

McMillan INDUSTRIAL CORPORATION
26 BROWNVILLE AVENUE
IPSWICH, MASSACHUSETTS

to solder or coat aluminum, copper, brass, silver or magnesium. The ultrasonic soldering head has a $\frac{5}{8}$-in. diameter soldering tip, readily changeable to other standard or special tips by screw connection.

► **Versatility** — This Sonobond model lends itself to all types of work, ranging from hand work to production operations of many types. It will accommodate a variety of soldering tips, ranging in size from a small pointed tip to $\frac{5}{8}$ in. in diameter.

Sonobond model S-5-H-55-10 includes the ultrasonic soldering head with 70-w tip heater, ultrasonic generator and 1,200-w heating platen.



TURRET-TYPE CONTACT
for step-type switches

THE DAVEN CO., Livingston, N. J., has designed a new turret-type contact for use on all the company's rotary step-type switches. It is a one-piece combination contact and turret lug. It is made of solid silver alloy, which, in turn, is gold plated to provide corrosion resistance and to facilitate soldering.

The new turret lug-contact combination is made with several notches to hold the wire mechanically as well as electrically.

COIL FORM
with threaded ferrite core

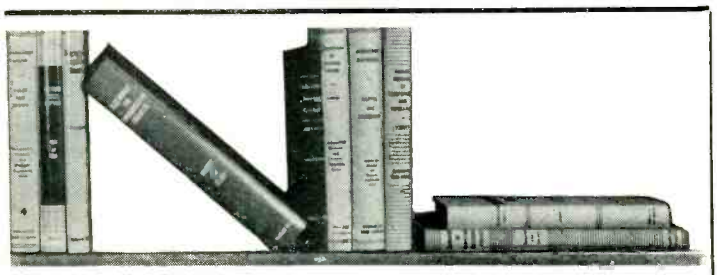
FERROXOCUBE CORP. OF AMERICA, 35 E. Bridge St., Saugerties, N. Y., has available a new low-loss coil form, complete with threaded ferrite core suitable for use in making coils for tuned circuits and filters wherever an easily and repeatedly adjustable inductance value is required.

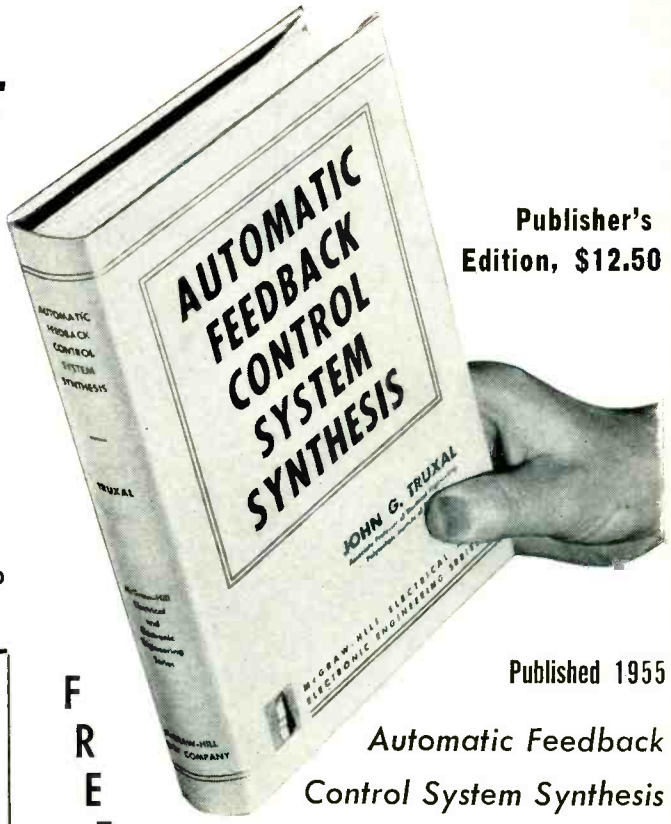
As an example of the range of

FREE

Making possible for you the maximum utilization of available design theory

This book will be given to you with your first selection and charter membership in the McGraw-Hill Electronics and Control Engineers' Book Club





Publisher's Edition, $12.50

Published 1955

F R E E

Automatic Feedback Control System Synthesis

by John G. Truxal

Associate Professor of Electrical Engineering
Polytechnic Institute of Brooklyn

A notably complete and current compilation of methods useful in the design of feedback systems. This graduate-level account of modern feedback theory, with emphasis on the synthesis of feedback control systems, includes an abundance of worked examples and concise summaries which make it invaluable for both advanced students and practicing engineers.

"The book is highly recommended to all engineers."
—*Physics Today*, August, 1955

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Stop here for a moment and check the ten important books listed in the coupon. How many of these books do you own? Have you been denying yourself the stimulus, the positive help that they could give you? They are the contributions of specialists in almost every branch of your field—authorities who offer their practical guidance for your use at any time. Possibly just one idea from one of these books could mean more to you in actual dollars and cents than many times the cost of the book. Add any one of them to your personal library and you are apt soon to number it among the most effective working tools in your possession.

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Send no money—just the coupon. Why not immediately enjoy the stimulus and positive help this new program can afford you? By taking advantage of this special offer, you will receive absolutely free Dr. John G. Truxal's *Automatic Feedback Control System Synthesis*, together with your choice of any one of the ten book shown above as your first selection—at the special Club Price.

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☐ **Fundamentals of Electronic Motion** by W. W. Harman, Associate Professor of Electrical Engineering, Stanford University. Publisher's Edition, $7.00. Club Price, $5.95.

☐ **Engineering Electronics** by G. E. Happell and W. M. Hesselberth, Associate Professors of Electrical Engineering, Purdue University. Publisher's Edition, $8.00. Club Price, $6.95.

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☐ **Handbook of Industrial Electronic Circuits** by John Markus and Vin Zeluff, Associate Editors of *Electronics*. Publisher's Edition, $7.50. Club Price, $6.45.

☐ **Magnetic-amplifier Circuits** by W. A. Geyger, Magnetics Division, U. S. Naval Ordnance Laboratory. Publisher's Edition, $6.00. Club Price, $5.00.

I am to receive FREE with the book checked above a gift copy of *Automatic Feedback Control System Synthesis*. You will bill me for my first selection only at the special club price, plus a few additional cents for postage and handling.

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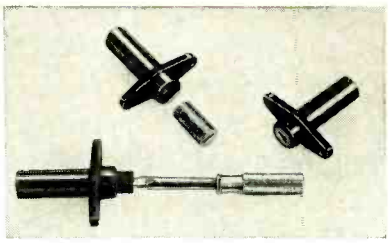
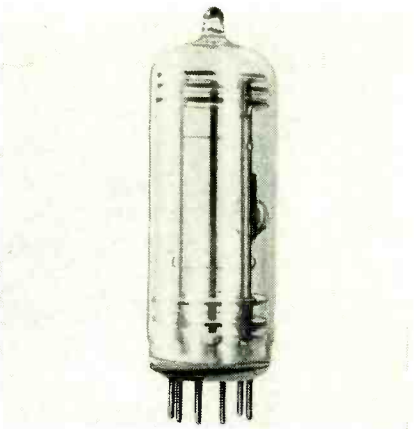


operation, inductances from 300 to 800 μh may be obtained when the form is wound with 250 turns of No. 28 wire and tested at 400 kc.

Complete description and dimensions of the coil form and the threaded core are given in engineering data sheet No. 30.



CRYSTAL UNIT
for use in the l-f range

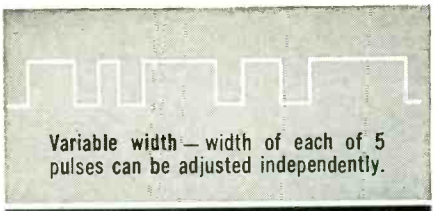
JAMES KNIGHTS CO., Sandwich, Ill., has developed a new 1,000-cycle miniaturized crystal unit for applications in the l-f range requiring both extreme stability and miniaturization. The JK-G7J is specially processed and sealed in a glass-enclosed vacuum.

▶ **Stability**—It has a secular stability of less than 0.002 percent per year. Temperature stability is ± 0.012 percent over a temperature range of −40 to +70. When oven controlled in a JK Thermystal design, it provides temperature stability of ± 0.0001 percent over an ambient range of −55 to +55.

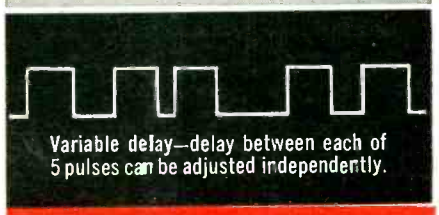
The crystal unit is also available in a MIL type HC13U holder.

POTENTIOMETER
in 50K and 100K units

WATERS MFG., INC., P.O. Box 368, Sudbury, Mass., has expanded its AP-½ line to include 50,000 and 100,000-ohm values. These two new



Variable width—width of each of 5 pulses can be adjusted independently.



Variable delay—delay between each of 5 pulses can be adjusted independently.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

Variable repetition rate—repetition rate of each group of pulses can be varied.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

Model B 950-10,750 mc

Generates multi-pulse modulated carrier for beacons, missiles, radar...provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies ...all in one integrated mobile instrument.

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

A fully integrated self-contained equipment with these features:

Four Interchangeable Microwave Oscillator Units—all stored in the instrument...each with UNI-DIAL control...precision power monitor circuit to maintain 1 mw power output reference level...keying circuit to assure rapid rise time of modulated r-f output... non-contacting chokes.

Five Independently Adjustable Pulse Channels—each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

Precision Oscilloscope with Built-In Wide Band RF Detector for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

Self-Contained Power Supplies—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%
RF Power Output . . . 1 milliwatt maximum (0 DBM)
Attenuator:
- Output Range . . . 0 to —127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . .0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
- Required Ext. Mod. . . . 1 volt rms min.
- Maximum deviation . . . ±0.5 microsecond

Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.

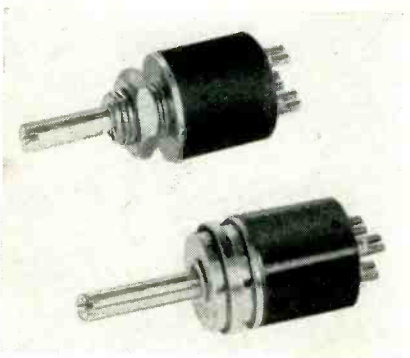
AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

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

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Chicago • Dayton • Englewood • Fort Worth • Los Angeles • New York Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto—Export: Rocke International Corporation

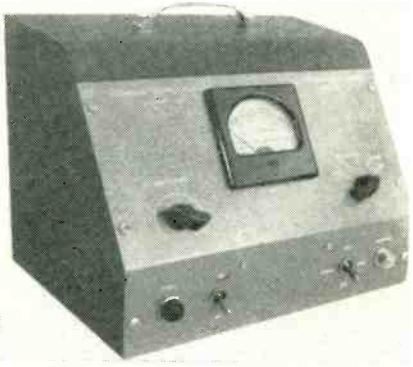
NEW PRODUCTS (continued)



pots embody the basic design features of the earlier AP-½—2-w rating at 80 C, all connections spot-welded or soldered, goldplated fork-type terminals, servo or bushing mount, anodized aluminum body, and centerless-ground stainless-steel-alloy shaft.

▶ **Ganging**—They can be furnished with radial or axial terminals or with wire leads and can be ganged for operation of up to 4 units from a single shaft.

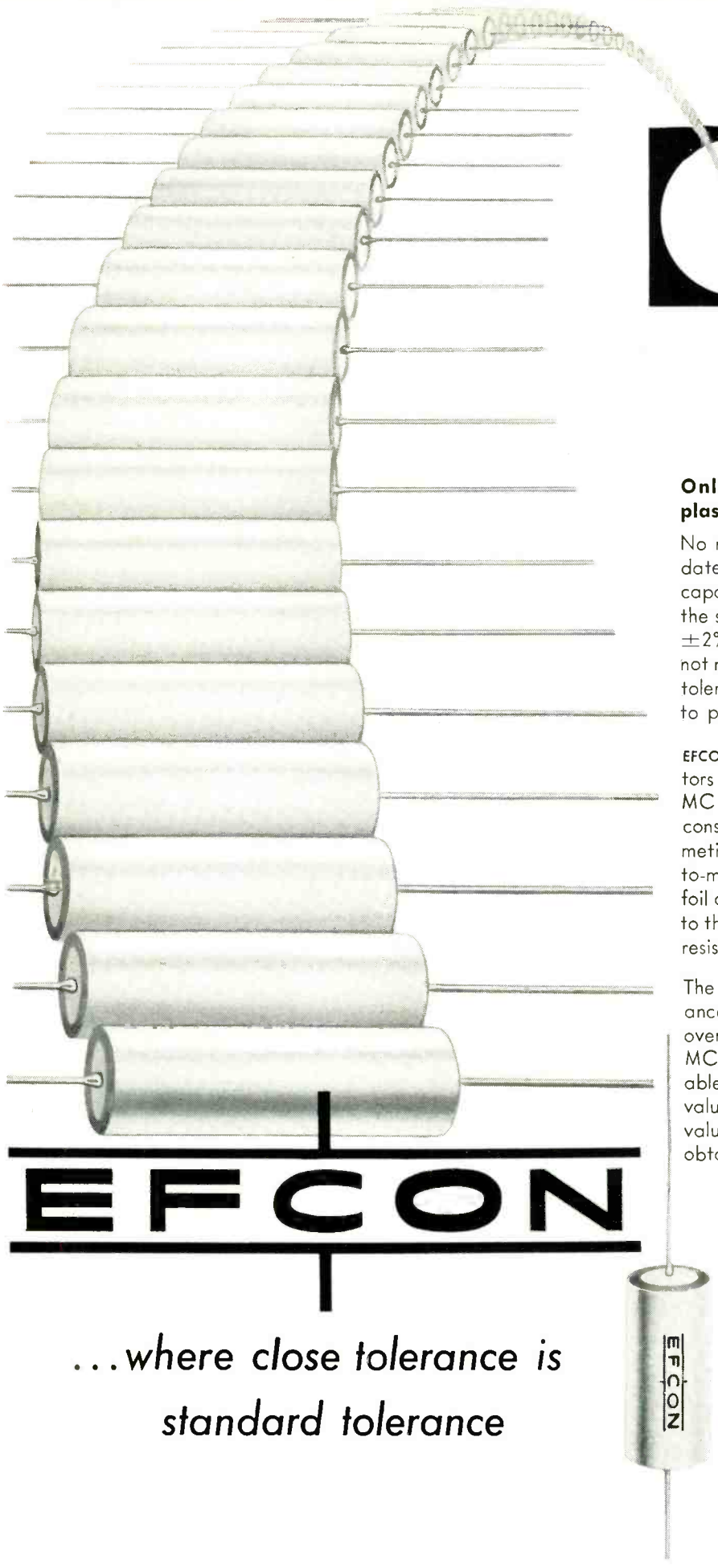
Two-percent linearity is standard with the 50,000 and 100,000-ohm units; 5 percent is standard for the lower values. Catalog sheets are available.



CRT REACTIVATOR
extends picture tube life

SCHEEL INTERNATIONAL, INC., 4237 No. Lincoln Ave., Chicago 18, Ill., has announced the model D-60 crt tester and reactivator. Restoration of cathode emission is made possible by boiling away the gas which surrounds the cathode and chokes off the normal emission capabilities of the picture tube. The model D-60 will not harm the picture tube in any way.

The equipment provides a systematic and complete means for testing the crt and detects internal



DON'T DERATE DELIVERY DATES FOR CLOSE TOLERANCE CAPACITORS

Only EFCON mass-produces miniature plastic film capacitors to close tolerances.

No need to delay your equipment delivery dates while awaiting delivery of precision capacitors. At Electronic Fabricators, Inc., the standard production runs are for ±1%, ±2%, and ±5% tolerance capacitors. It is not necessary to pick and choose from wider tolerance production runs nor is it necessary to pay premium prices for close tolerance.

EFCON Mylar* and Polystyrene Film Capacitors are each available in two styles: Types MC and PC have a rigid cardboard tube construction; Types MH and PH are hermetically sealed in a metal case with glass-to-metal, solder-sealed terminals. Extended foil construction with leads directly soldered to the foil minimizes inductance and contact resistance for all types.

The plastic film ensures high insulation resistance, low dielectric absorption and stability over extended temperatures and life. Types MC, PC, MH and PH capacitors are available in a range of standard capacitance values from 0.001 to 2 mfd. Non-standard values and tolerances closer than ±1% are obtainable to your specifications.

Other EFCON CAPACITORS . . .

Type TH Teflon* Film Capacitors . . . for high-temperature and high humidity application.

Type S Molded Silver Mica Capacitors

...where close tolerance is standard tolerance

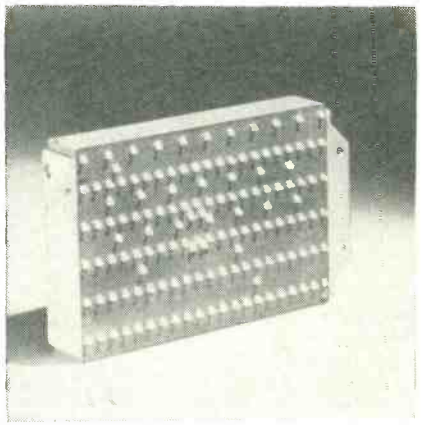
ELECTRONIC FABRICATORS, INCORPORATED

682 Broadway, New York 12, N. Y.

Write Dept. K for technical data

*DuPont Trademark

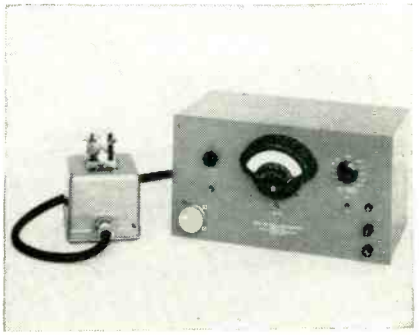
shorts or troublesome heater to cathode leakage currents.



DELAY LINE
of lumped-constant type

LITTON INDUSTRIES, 336 North Foothill Road, Beverly Hills, Calif. Model SIP4 delay line provides especially long multitapped time delays required for pulse coding and decoding circuits. It is of the lumped-constant type, tapped every two microseconds.

► **Specifications**—Total delay time is 200 μsec. By use of new techniques for coil winding and equalization, rise time is held to 4 μsec. Attenuation is held to less than 12 db with a pulse of 8 μsec. Impedance is 400 ohms and temperature coefficient is less than 40 ppm per deg C.



ELECTROMETER
wide flexibility of range

APPLIED PHYSICS CORP., 362 W. Colorado St., Pasadena, Calif. Model 31 vibrating reed electrometer has standard ranges of 1, 3, 10, 30, 100, 300, 1,000 mv and 3, 10 and 30 v.

► **Capabilities**—It can detect a current as small as 1.0×10^{-17} amperes

Use GENERAL PLATE Composite Contacts to cut costs,

Brighten Your Product's Future

increase production, and provide reliable performance

General Plate's "know how" in the production of Composite Contact Materials can indeed brighten your products' future. By having General Plate fabricate your complete contact assemblies, you will save money, time, and trouble . . . eliminate needless equipment cost and problems of scrap disposal . . . and have at your disposal contacts and contact assemblies made to exact specifications shipped to you ready for installation when you want them.

Or, you may prefer to fabricate your own assemblies. General Plate Composite Contact Materials — available in overlay, edgelay, top-lay and inlay strips — make it possible for you to produce complete contact assemblies to close tolerances by simple blanking and forming operations.

In either case, comparison of the final costs of properly designed Composite Contact Assemblies fabricated from General Plate Composite Contact Materials against costs of similar assemblies produced by older methods of brazing, welding, staking, or spinning will reveal the resultant economies and fabricating ease available to you.

Write for complete information and catalog PR700 which describes General Plate Composite Contacts and other General Plate Composite Metals.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
313 FOREST STREET, ATTLEBORO, MASS.

GENERAL PLATE ELECTRICAL CONTACT KITS FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are composite-metal strips for fabrication of contact posts. These kits are available at nominal cost.

You can profit by using General Plate Composite Metals!

Want more information? Use post card on last page.

originating in a high impedance source. Charges are as small as 5×10^{-16} and voltages as small as 0.02 mv can de detected.

Radioactivity measurements, pH determination, mass spectrometry and measurement of electrical properties are a few of the applications for which this instrument can be used.

▶ **How It Works**—It operates by d-c input signal to a-c through the use of mechanical energy to move the impressed charge through an electrostatic field. The a-c signal thus produced, which is a measure of the impressed charge, is amplified in a stable a-c amplifier and then rectified and used to drive the indicating meter. A portion of the rectified a-c is applied as a negative feedback to give high stability.

DATA-VISION SYSTEM
for distant picture scanning

DAGE TELEVISION DIVISION, Thompson Products, Inc., West 10th St., Michigan City, Ind. The Data-Vision system consists of a slow-sweep vidicon data camera, a data control monitor which establishes the electrical operating characteristics of the system, and a data receiver remotely connected, by radio or a telephone line, to the output terminals of the data-control monitor.

▶ **Function**—The system permits immediate inspection and distant reproduction of still pictures, maps or records in situations heretofore impossible because of the complexity or expense of coaxial cable connections or broad radio bandwidths.

A complete picture is scanned

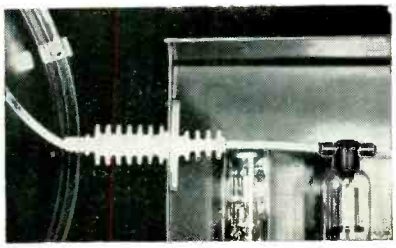
ADVERTISEMENT

IRE SHOW PRE-VIEWS

Mechanical packaging components from the computer field now providing means to mount, house, fasten, connect and monitor electronic circuitry of all types as easily accessible, simple to service plug-in units

NEW TRENDS

Greater Reliability in Multiwire Connector Cabling With Simpler Construction Seen at Show



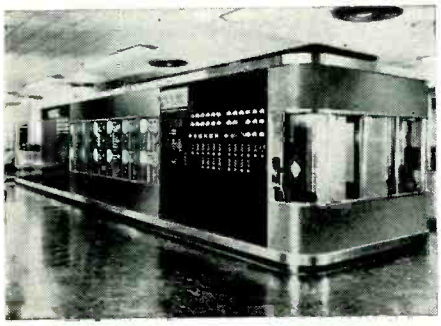
30 KV connector cable for Color TV uses Alden connector technique to provide connector cable with large safety factor at low cost and in volume.

A whole new series of single lead and multi-wire connectors having the connector insulation molded directly to the wire insulation will be shown at the New York IRE Show. This integral molded connector technique encapsulates contacts, completely seals all wire junctions and provides strain relief for all leads in a single one piece molding. Multi-wire unit connector cables using this technique have a tremendous increase in reliability. Simplifies equipment servicing. Enhances equipment appearance.

First used in television to solve the problems of corona suppression and high voltage arc-over where the bonding of the connector and wire insulation eliminated the need of long arc-over paths on the back of connectors—the technique now is expanded to multi-wire connectors. Up to now it has been necessary to pot the leads of assembled connectors to get these features in multi-wire connectors. The Alden molded connectors eliminate this costly and slow operation. They provide this sealing feature by molding the contact and leads as inserts into such materials as polyethylene, nylon, polyvinyl chloride, (PVC) and fluorothenes (Kel-F) in one operation. The designer can now pick Alden connector layouts, choose the insulating material best suited for his requirements and have the connectors and cable molded as a unit to his cabling layout.

Single lead high-voltage disconnects, miniature 2 to 5 lead and rugged 7 to 11 lead connectors will be shown along with tube cap connectors using the same technique.

Discuss your molded connector cable applications with Alden engineers at the IRE Show, or write for the new Alden Handbook Section on Connectors.



This and other large scale computers use a new series of Alden mechanical components as simple, direct means of getting reliability of operation, new ease of servicing and simple maintenance of electronic equipment.

Front panel "Tell-tales" designed to save space operate at greater efficiency.

A new trend in front panel indicator lights, fuseholders, test point jacks and patch boards that provide the operator efficient means of monitoring equipment operations can be seen at the Alden Booth No. 185-7 at the N. Y. IRE Show. New design concepts make these front panel "Tell-tale" components smaller, easier to use, simpler to lay out.

TINY INDICATOR LIGHT

By building a light bulb about one quarter the conventional size and molding it right into the front of panel lens diffuser. Alden "Pan-i-Lite" provides an indicator light of brilliant quality that is visible from any angle, fits tiny hole (1/4" dia.). offers large voltage selection (6V, 12V, 28V, 110V). gives the designer new freedom in making front panel indicator lights work for him.

INDICATING FUSEHOLDERS

Indicator fusing of voltages from 6, 28. 110 to 220V with the Alden Fuselite now enables the engineer to monitor all circuits to reduce and isolate troubles caused by complexity. Tiny "Fuse-lites" give warning flash of fuse trouble and permit instantaneous refusing by simple twist of wrist from front of panel.

MINI-TEST POINT JACKS

For solving the problem of getting front panel circuit outputs and check points in small space, a complete series of tiny insulated test point jacks in choice of molding compounds for all environments and voltages, are being shown. Matching molded Patch Cards and Test Points color coded to match jacks make it simple for engineers to design compact, efficient patch boards.

A basic assortment of Alden packaging components developed from computer packaging techniques now being used by design engineers to package many other types of electronic circuitry for plug-in unit construction.

Computer packaging components yielding tremendous advantages in other types of circuitry

Computer-born packaging components that permit division of circuitry into plug-in functions: mount it compactly in vertical planes: package his self-contained planes of circuitry in standard chassis that plug into racks or housings; provide each plug-in chassis with "Tell-tales" that monitor operation and spot trouble instantly; give him central, accessible point of check for all chassis interconnects—will be shown at Alden Products Co. Booth No. 185-7, IRE Show.

IN TEST GEAR

Eastman Kodak Engineers found these Alden packaging components a natural for building up test gear for the Navy.

IN AUTOMATIC ELECTRONIC CONTROLS

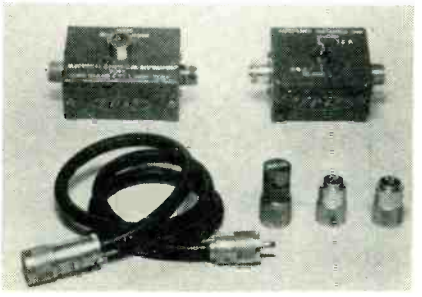
Automatic electronic controls for city's lighting system, for automatized milling machine, by large automobile manufacturer for automatized production-line machine, are showing it can be a simple matter to package your automatic electronic control circuitry to insure uninterrupted operation.

IN OFFICE EQUIPMENT

Recognizing the problem of soaring costs of servicing electronic office equipment, a manufacturer of high speed facsimile transmission systems meets the problem head on using the Alden packaging components to get plug-in unit design. He now has equipment that can go anywhere in the world with reliable operation assured.

If not attending the Show write for details to Alden Products Co., 9127 N. Main St., Brockton, 64, Mass.

and traced on a distant radar-type receiver tube in from 2 to 7 sec. Records of moderate complexity can be transmitted for 15 miles over lines that are equalized to 8 kc or used to modulate a standard radio transmitter. A complete specification leaflet is available.

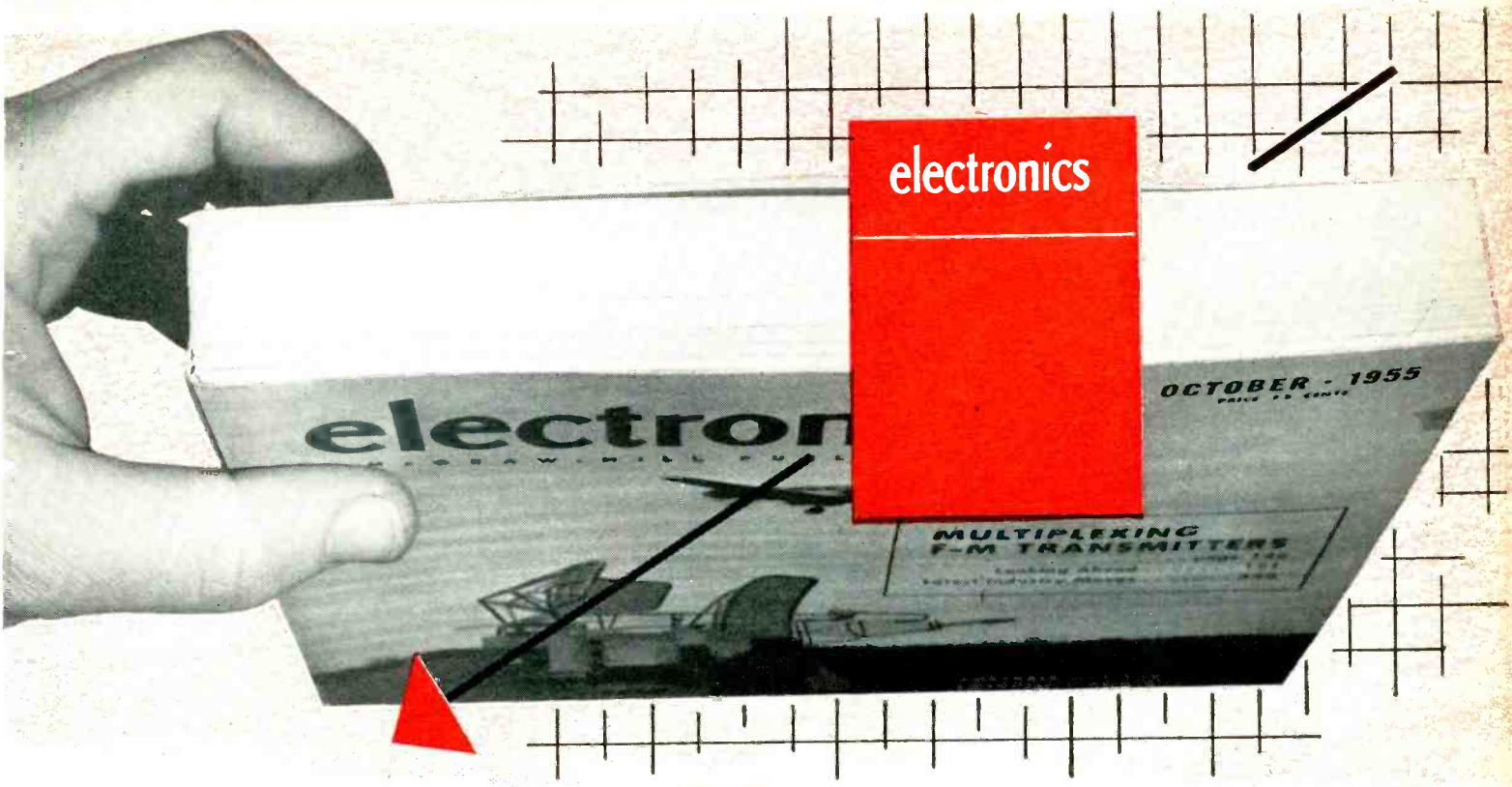


P-T EQUIPMENT for wide-band problems

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long Island City 1, N. Y. A new line offers most equipment needed for wide-band pulse transmission problems from d-c to 1 millimicrosecond rise time pulses (0 to 350 mc) standard coaxial cables prefabricated to any desired length with any desired standard connectors; coaxial line terminations for any impedance from 50 to 200 ohms; impedance matching boxes for joining different impedance lines; and pulse splitters-mixers, and pulse attenuators, and variable pulse delay boxes are included.

VIBRATION TESTER a handy little device

KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y. The V scope No. 100 is a displacement sensing device which will determine with ease and economy the amplitude of vibration. The V scope or optical wedge is attached to the vibrating table in such a manner that the heavy vertical lines are on the same plane in which the table is vibrating. As the unit vibrates, a portion of the wedge becomes hazy. Thus an illusion is obtained in which the tip of the wedge recedes to a new point, depending upon the amplitude of vibration. For example, if the wedge



IN ELECTRONICS THERE'S NEED FOR A BIG MAGAZINE...

THICK WITH IDEAS!

How big is big?

The electronic industry has answered that question in the case of magazines.

The fact is that the bigger ***electronics*** has grown, the more time our readers spend with it. They have proven this . . . in *several* ways.

In 1951, ***electronics*** ran an average of 87 pages of editorial matter per issue. In 1954, the average was 133 pages per issue or an increase of 34.6 percent. At the same time, the advertising pages also increased from 297 to 335, up 16.7 percent.

Did readers object to this increase in size?

Not if you judge by the way they renewed their subscriptions! For his $6 per year, the reader now gets more information in the editorial pages and more product knowledge in the advertising pages. If he didn't *want* this more-for-your-money increase, he could say so, quickly and unmistakably. For he could simply refuse to renew his subscription. *The contrary has happened.* From 62.2 percent in 1952, renewals rose to 70.76 percent in 1955—because the book is *thick with ideas!*

This 12.7 percent increase in the renewal rate lends no support whatever to the theory that people won't read a magazine that is thick with extra pages.

Another research study also proves that theory wrong. (And more directly.)

In 1951, surveys showed that the average reading time devoted to ***electronics*** magazine was 2 hours, 17 minutes. Today, with its contents increased by 21.8 percent, readers spend 3 hours, 22 minutes reading it. That increase of 32 percent in voluntary reading disproves the argument that a big book lessens intensity of reading.

Aside from theories and surveys, one fact is obvious to anyone . . . anyone, that is, familiar with the bewildering growth of the electronic industry. The electronic engineer of today and tomorrow *must keep pace by reading or else risk lagging behind.* He cannot miss the new developments, new technics, new products that are coming into being each month. Read he must or lose his touch.

That is why he turns first to ***electronics*** . . . because this magazine gives him most complete information. That is why he reads *most* in ***electronics*** . . . because its advertisers are the leading manufacturers and sources—and *it's thick with ideas!*

ABC **electronics** ABP

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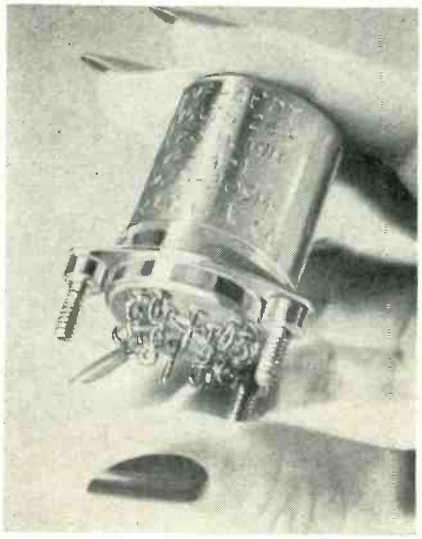
recedes to the fifth vertical line, the total displacement of the table and equipment is 0.062.

Price of the V scope is $5 per 100.



SUBMINIATURE RELAY
weighs only 0.225 lb maximum

U. S. RELAY Co., 1744 Albion St., Los Angeles, Calif. The S-309M subminiature relay features electronic measurement of all contact pressures during relay operation; hermetic sealing with nongaseous silicone materials throughout, plus mechanical securement; and methods to make final adjustments after the relay is sealed.

▶ **Characteristics**—The relay is 1⅝ in. high by 1¾ in. in diameter; contact rating is 2 amperes, noninductive at 26.5 v d-c or 115 v a-c (also available for dry circuit applications and printed circuits); and operational shock, 50 g.

Both 85 and 125 C ambient temperature operation are featured. Operational altitude of the 4 pdt relay is 80,000 ft.

VOLTAGE DIVIDER
suited for panel mounting

COAST COIL Co., 5352 W. Washington Blvd., Los Angeles 16, Calif. Model 2000 precision a-c voltage divider fills the need for a small, compact variable ratio transformer of high accuracy which is suitable for panel mounting in equipments of all types. Front panel space require-

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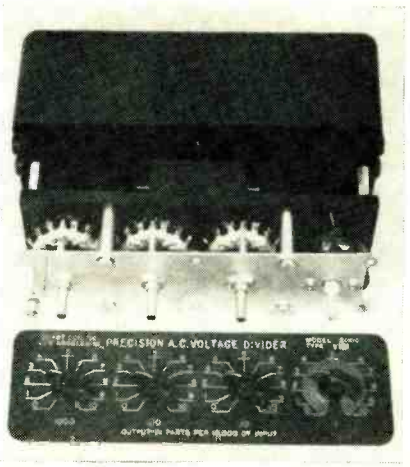
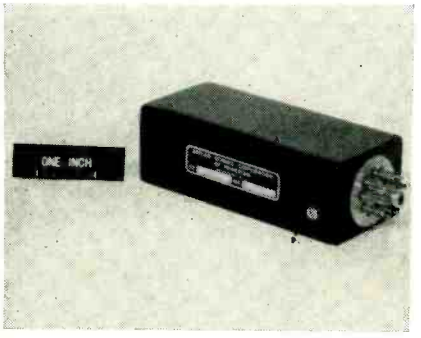


ment is 3 by 9 in. while the rear panel space requirement is 3 by 9 in. by 3½ in. deep.

Available accessory items for use with the voltage divider are bridging and scaling transformers which may be mounted in spaces provided within the unit.

► **Types**—Differing types of the model 2000 are available which give a selection as to the voltages and frequencies of operation. All types have resolution better than 0.0005 percent and accuracy better than 0.004 percent.

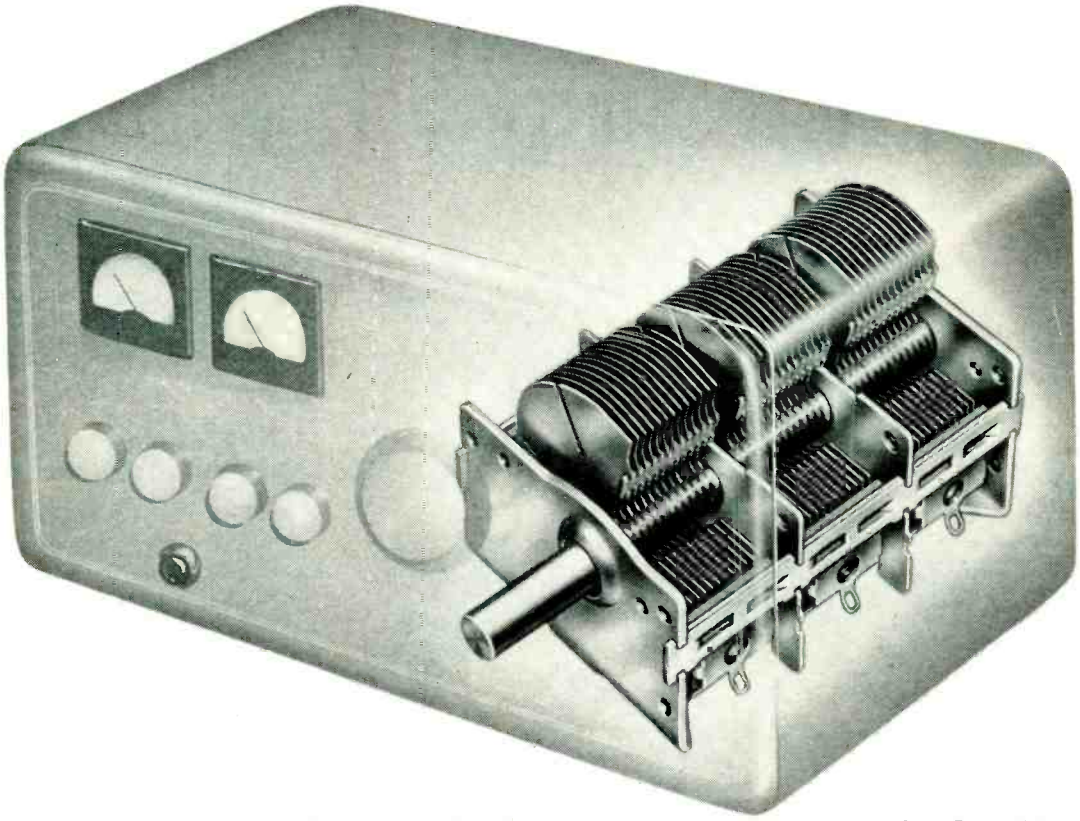


OSCILLATOR
a keyer-subcarrier unit

APPLIED SCIENCE CORP. OF PRINCETON, Box 44, Princeton, N. J. Type DKO keyer-subcarrier oscillator permits pulse-width multichannel coding on a single channel in a standard f-m/f-m telemetering system.

When used with a suitable p-w commutator, the unit permits p-w multiplexing and coding of a large number of data channels on a single 40-kc or 70-kc subcarrier channel. This unit requires 25.2 v, 0.3 ampere and 150 v d-c 10-ma power

variable capacitors for electronic Instruments



save time, trouble, and expense, when made by R/C

Whether you manufacture frequency meters, grid dip meters, or "Q" meters—sweep generators or communications kits—if it includes a variable capacitor, chances are Radio Condenser can help you.

As a major supplier of tuning devices for thirty-four years, R/C has long manufactured a complete line of standard, special, and custom variable capacitors especially for instrument use. Characterized by quality consistent with the particular end product, these variable capacitors are well suited to rapid, low-cost, quantity production.

Let us know what your requirements are and we'll be happy to send you complete information on the variable capacitors you need. Or, a call to the Radio Condenser Engineering office nearest you will bring a variable capacitor specialist right to your desk.

RC

RADIO CONDENSER CO.

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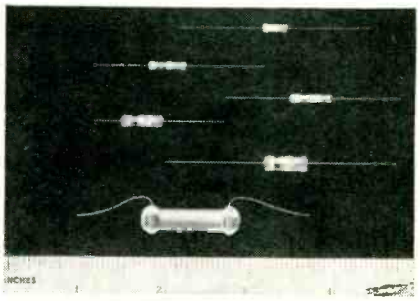
Middle West: 4335 West Armitage Ave., Chicago 39, Ill., SPaulding 2-4411.
West Coast: 1102 Southwestern Avenue, Los Angeles 6, Calif., REpublic 2-8103
Export: International Div., 15 Moore St., N.Y. 4, N.Y., CABLE: MINTHORNE
Canada: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

See US AT THE I.R.E. SHOW—780 Airborne Ave.

and accepts 0 to +5 v signals sampled a total of 900 times a sec.

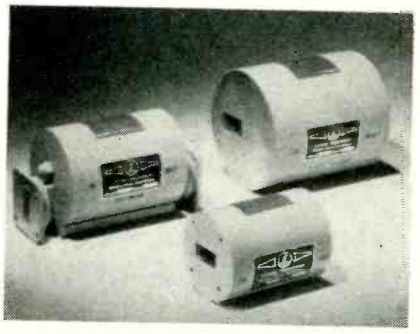
The model DKO-10 is approximately 4¼ in. long by 1 7/16 in. high by 1⅞ in. deep, and weighs 8 oz.



RESISTORS
deposited carbon type

ELECTROSEAL PRODUCTS, INC., 22 E. 40th St., New York 16, N. Y., has announced a new line of deposited carbon resistors for use in electronic and avionic applications. They are available in a wide range of standard RETMA ohmage values and are produced in 1/20, 1/10, ¼, 1/3, ½, 1 and 2-w sizes. Standard tolerances are 2, 5 and 10 percent.

▶ **Construction**—Type B axial-lead resistors are manufactured by depositing carbon on extruded tubular ceramic forms. Metal end-caps into which double-tinned copper leads have been swaged and soldered, are press-fitted over the ceramic body to assure a constant 360-deg contact with the carbon coat. Type A radial resistors are similarly constructed except that tightly wound tinned copper leads are used in place of the metal end-caps.

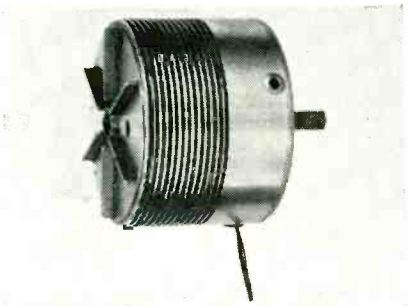


LOAD ISOLATORS
reduce long-line effects

LITTON INDUSTRIES, 336 North Foothill Road, Beverly Hills, Calif. The new family of X-band load isolators

makes it possible to operate magnetrons and klystrons into long line or high vswr's without long-line effects or other loading problems.

▶ **Features**—The compact and light isolators provide 10 to 18 db isolation between source and load with an insertion loss of 0.5 to 1 db. A wide band of 8,600 to 9,600 mc is covered at average power levels of 20 to 300 w and peak power of 100 kw to 300 kw. The isolators are designed with minimum package sizes for applications where space and weight are at a premium. They will operate at temperatures up to 100 C without degradation. No special cooling is required.



SYNCHRONOUS MOTOR
with reversible speeds

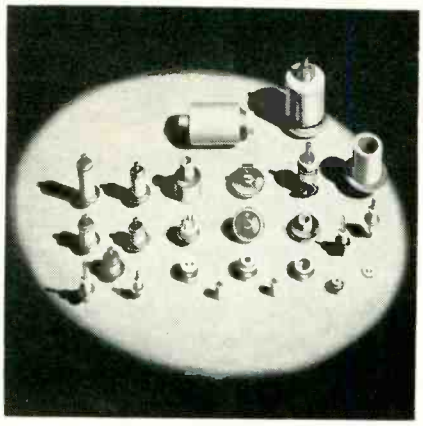
TECHNICAL DEVELOPMENT CORP., 4060 Ince Blvd., Culver City, Calif. Measuring $3\frac{7}{32}$ in. in diameter by $2\frac{39}{32}$ in. long, excluding shaft, these small hysteresis synchronous motors deliver 5 to 6 in. oz of torque at constant speed. Three models currently available have reversible synchronous speeds of 600 rpm, 1,200 rpm and 1,800 rpm.

All motors are self-cooled and may be supplied with single or double-ended shafts. Nominal shaft diameter is $\frac{1}{4}$ in.; however, the 600 rpm model may be supplied with a precision-ground capstan shaft and a weighted flywheel-rotor for directly driving magnetic tape at $7\frac{1}{2}$ ips.

HERMETIC TERMINALS
of Alumina ceramic

AMERICAN LAVA CORP., Cherokee Blvd. & Mfrs. Road, Chattanooga 5, Tenn. New high-strength, high-temperature metallized hermetic

For additional information on all items on this page, use post card on last page.



terminals of Alumina ceramic may be installed by silver soldering at temperatures up to 750 C. Copper-brazed terminals are available for still higher temperature applications.

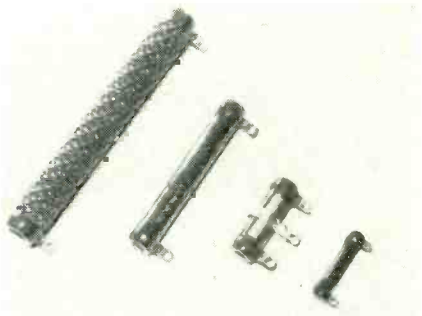
▶ **Other Advantages** — AlSi Mag 576 and AlSiMag 614 offer ultra low loss ceramic with an improved glaze of superior surface resistivity, permanent leak-tight bonding; higher tensile and impact strengths; greater resistance to spalling and breakage; and exceed MIL-T-27A torque requirements.

CHOPPERS
are of instrument quality

JAMES VIBRAPOWR CO., 4050 N. Rockwell St., Chicago 18, Ill., announces a new line of instrument quality choppers. The 1200 series, with reliability and long life necessary for continuous instrumentation, are intended for application in analog computers, continuous recorders, d-c amplifiers and servo systems.

▶ **Features**—The new chopper component has extremely low resid-

ual noise in the switching circuit. The lift-off contact mechanism reduces to a minimum contact bounce and chatter, as well as extending closure stability over life. All of the new models operate with the same high degree of precision, when subjected to extremes of temperature, vibration and shock.



WIRE-WOUND RESISTORS
range from 2 w to 2,000 w

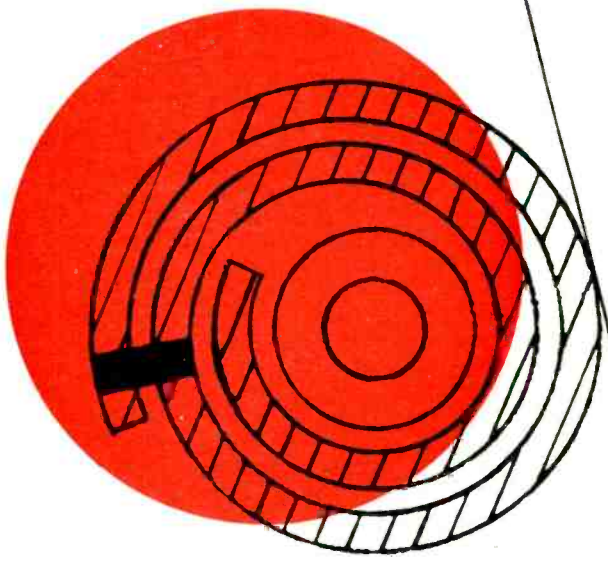
L. A. RESISTOR CO., INC., 14742 Arminta St., Van Nuys, Calif., is manufacturing a complete line of vitreous enameled wire-wound resistors, ranging from 2 w to 2,000 w inclusive. In addition to the standard lines of fixed or adjustable resistors, there are oval, rib-wound and ferrule types available.

▶ **Winding**—The resistors are wound with a high grade resistance wire on special designed steatite cores and are then covered with two coats of vitreous enamel. All electrical connections are silver soldered to insure a perfect connection.

A tolerance of ±10 percent is considered standard; however, a closer tolerance can be maintained. All resistors are individually tested and inspected before shipment. Special resistors and assemblies can be engineered at no extra charge.

PCM TRANSMITTER
for 152 to 174-mc range

WEST COAST ELECTRONICS CO., 5873 W. Jefferson Blvd., Los Angeles 16, Calif. Model 1 pcm transmitter was designed for use with the model 2 pcm timing receiver to provide a wide-band radio link for communication of pulsed data. The effective system bandwidth of the link is one-



Burroughs BIMAG tape wound Magnetic Cores

set new standards for uniformity!

- **Burroughs is experienced** in both the manufacture and application of cores.
- **Burroughs has specialized** on a specific range of core materials, sizes, and performance characteristics.
- **Burroughs has developed** improved core manufacturing and testing techniques.

Available in quantity or in sample lots. For information write to Dept. M.

Burroughs

Burroughs Corporation

ELECTRONIC
INSTRUMENTS
DIVISION
1209 Vine Street, Philadelphia 7, Pa.

half mc. High transmitter power (1 kw peak) and low receiver noise figure (7 db) make possible reliable digital communication over long distances.

▶ **Specifications**—The unit is crystal-frequency-controlled to a frequency stability of 0.001 percent, and is capable of transmitting pulses as short as 2 μsec and as long as 15 μsec. It is designed to operate under ambient conditions of 0 to 45 C and relative humidity between 35 and 95 percent.

Mounting in a standard 19 in. relay rack, the unit is 19 in. wide, 15 in. deep and 52½ in. high and weighs 295 lb. Price is $6,475 and shipment can be made 75 days after receipt of order.

TIME DELAY RELAY
for use at 125 C

BRANSON CORP., Boonton, N. J., announces its new type TRH thermal time delay relay capable of dependable and repeatable performance in ambient temperatures of 125 C.

▶ **Features**—Type TRH is a temperature compensated thermal unit operating on voltages up to 125 v with time delays available between 1 second and 1 minute. It is hermetically sealed and will withstand the environmental requirements of high-speed military aircraft, including vibration up to 500 cps.

TRANSISTOR TESTER
a direct-reading unit

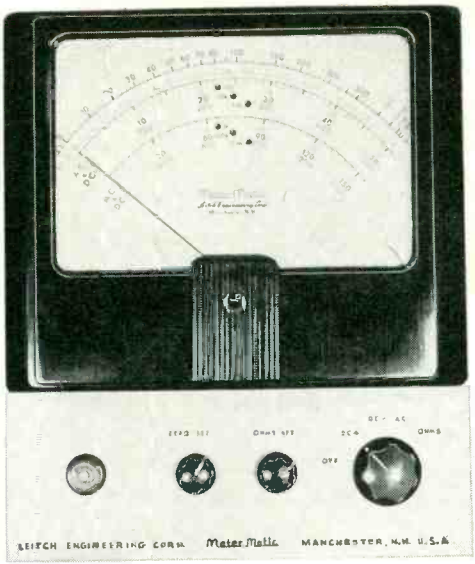
SCIENTIFIC SPECIALTIES CORP., Snow & Union Sts., Boston 35, Mass. Both high and low-power transistors, either point-contact or junction types with collector dissipation as high as 50 w can be tested in either

THE *NEW* LEITCH

meter-matic

AUTOMATIC VACUUM TUBE VOLT-OHM METER

COMPLETELY AUTOMATIC RANGE-SWITCHING



COMPLETE BURN-OUT PROTECTION

"Compact"
Model 21-56

Price
$149.50

NOW . . . USERS REPORT METER-MATIC CUTS CHECKING TIME 46%

Here's Why

- Completely automatic range selection. No manual switches.
- One second range search time. Unit automatically finds value of unknown voltages, ohms.
- One second reset time.
- Large, easy-to-read, 8½" dial, with recessed lights to indicate correct scale.
- Direct reading, without zero multipliers.
- One set of probes for all functions.

PLUS COMPLETE BURN-OUT PROTECTION

for Meter-Matic and unit being tested. Instrument tests up to 1500 volts, with burn-out protection up to 2000 volts.

INQUIRIES INVITED. WRITE FOR BULLETIN #21-56

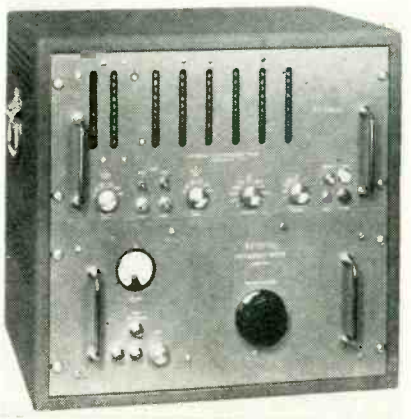
Leitch ENGINEERING CORPORATION

326 Lincoln Street
Manchester, New Hampshire
Man. 3-4773

common-emitter or the common-base connection. Model T-62 features the direct reading of small signal parameters (h_{11}, h_{12}, h_{22}, alpha and beta) as well as of the static characteristics I_{co}, V_b, V_e, V_c, I_b, I_e and I_c. All ranges of practical interest are provided at low test-signal levels.

▶ **Measuring Circuit** — The self-contained oscillator and locked-in phase-sensitive voltmeter, whose amplifier is highly degenerative at frequencies other than the oscillator frequency, results in a selective measuring circuit capable of a high degree of accuracy and reproductibility.

Five current-bias ranges from 50-ma to 500-ma full scale, and two collector voltage-bias ranges of from 0 to 10 v and from 0 to 100 v are provided.



FREQUENCY METER
no plug-in attachments

BERKELEY DIVISION OF BECKMAN INSTRUMENTS, INC., 2200 Wright Ave., Richmond 3, Calif. Combining the job of 6 instruments, model 5571 frequency meter functions as a frequency ratio meter, an 0-1 mc period meter, 1 μsec to 10 million sec time interval meter, 0 to 2 mc events-per-unit-time meter, and a high speed straightforward counter.

Accuracy is ±1 count ± crystal stability. Input sensitivity is 0.1 v rms, with positive or negative trigger slope. WWV connection is provided for time-base standardization.

▶ **Applications** — Model 5571 can be used for filter and crystal testing, oscillator calibration and testing, design and testing of telemetering,

transmitter and receiver equipment, transmitter monitoring and precision phase measurements.

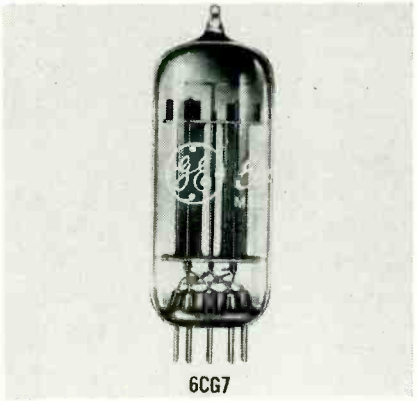
STABILIZING AMPLIFIER
for analog computing uses

GEORGE A. PHILBRICK RESEARCHES, INC., 230 Congress St., Boston 10, Mass. Model K2-P stabilizing amplifier was designed especially for stabilizing operational amplifiers in electronic analog computing applications. As a stabilizer for the K2-W and K2-X, it requires no additional components, only wiring connections.

The high input impedance (2.0 megohms) causes small shunting effects while its gain of 1,000 times at d-c allows extremely accurate solutions in an analog assemblage. The K2-P needs only 6.3 v a-c (50-60 cps) at 0.4 ampere and + 300 v d-c at 2.4 ma.

▶ **Other Data**—It is 4½ in. high overall; weighs 3 oz, and uses a single 12AX7 and an Airpax A175 chopper. A 400-cycle version, model K2-P4, and a servo application version without input filter, model K2-P1, are available.

Price of the model K2-P is $55.



6CG7

TWIN TRIODE
for general-purpose uses

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The 6CG7 is a miniature 9-pin twin triode. Within its maximum ratings it is designed for use in a wide variety of general-purpose applications, particularly as vertical and horizontal oscillators in tv receivers. The tube may also be used as a blocking oscillator, phase inverter, multivibrator or any multi-

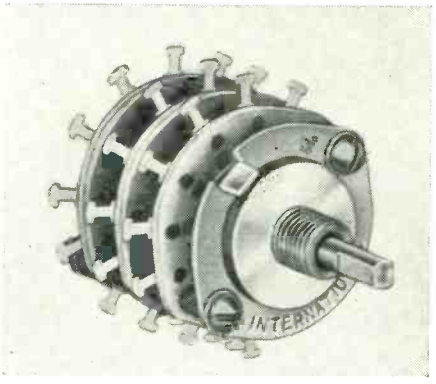
For additional information on all items on this page, use post card on last page.

tude of applications requiring a medium-mu twin triode. It has a controlled heater warmup characteristic of 11 sec.

► **Ratings**—Maximum plate voltage rating is 300 v; and plate dissipation of each plate is 3.5 w. In typical operation as a class A1 amplifier with 250 plate volts and −8 grid volts, each section has an amplification factor of 20, plate resistance of 7,700 ohms and transconductance of 2,600 μmhos.

FILTERS
for communications uses

H. O. BOEHME, INC., 915 Broadway, New York 10, N. Y., is offering a complete line of communications filters. The line is available in a wide variety of types, frequency characteristics and impedance matches to clarify all types of keyed audio signals. They are especially designed for minimum ringing or tailing and for optimum results under dynamic conditions.

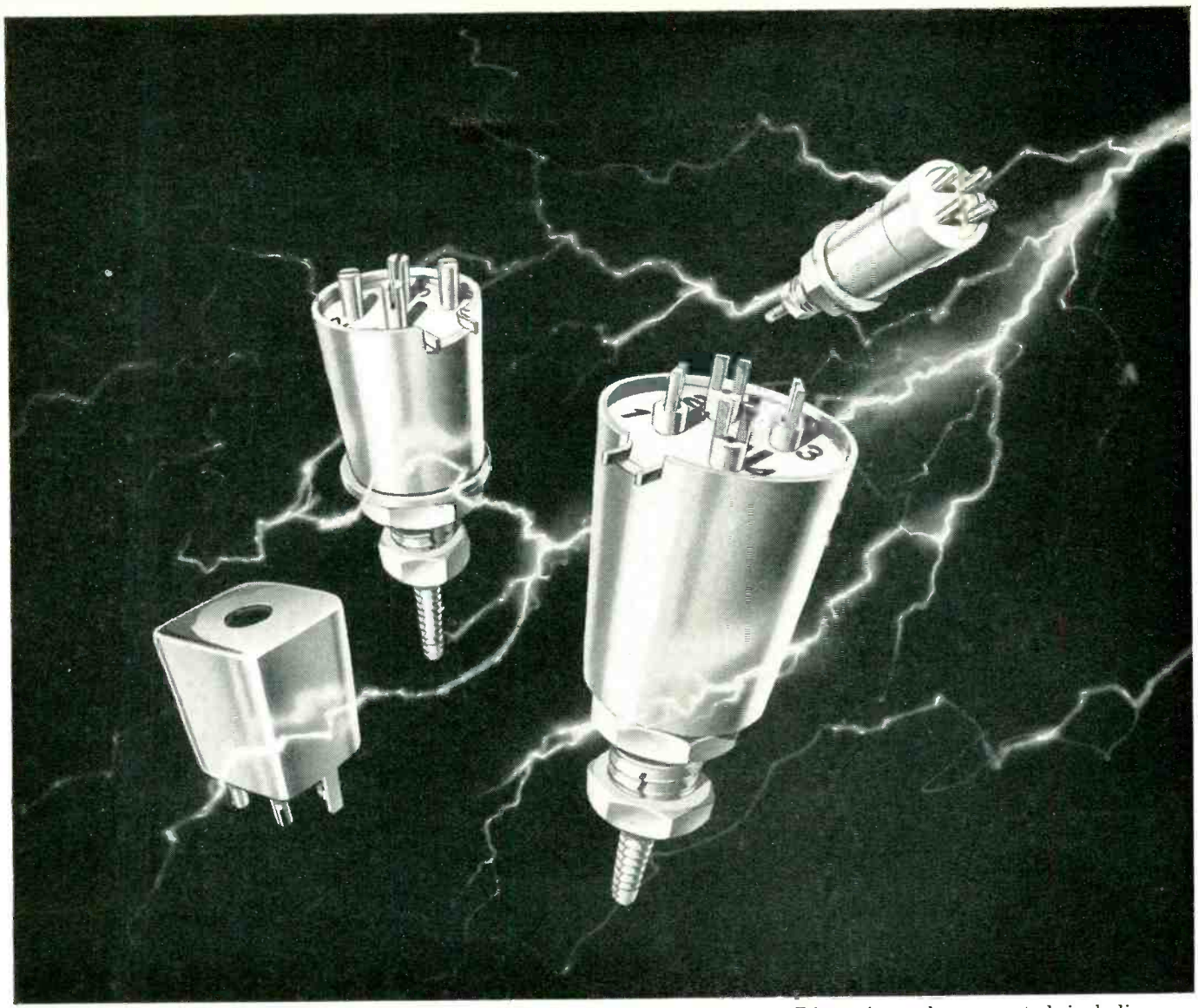


ROTARY SWITCH
is a 12-position unit

INTERNATIONAL INSTRUMENTS INC., New Haven, Conn. A new line of low-current, subminiature rotary switches only 1.160 in. in diameter including contacts, offers 12 stator positions per deck exclusive of poles.

Designated the series 7000, the switches are designed for use on electronic testing equipment, miniaturized and transistorized devices, and many other applications where saving space is important.

► **Construction**—An outstanding feature is the wafer of a specially impregnated glass melamine which



Four sizes of shielded coil forms cover a wide range of design requirements. Dimensions when mounted, including terminals, are: LS-12 (square type for printed circuits), ½" x ½" x ½"; LS-9, 7/16" diameter x ½" high; LS-10, 5/8" x 15/16"; LS-11, 15/16" x 17/32". Each form mounts by a single stud. Windings may be universal or wound to your specifications.

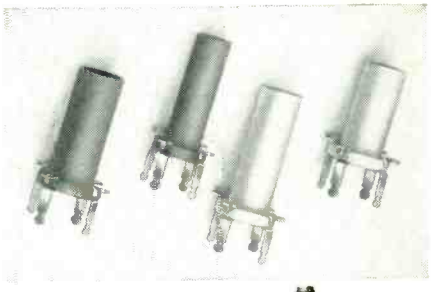
Where shock treatment doesn't work

CTC miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil windings, they bring all the ruggedness and dependable performance you require for your "tight spot" applications — IF strips, RF coils, oscillator coils, etc.

CTC combines *quality control* with *quantity production* to supply exactly the components you need, in any amount. CTC *quality control* includes material certification, checking each step of production, and each finished product. And CTC *quantity production* means CTC can fill your orders for any volume, from smallest to largest.

For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, Cal.

TYPE SPC phenolic and ceramic printed circuit coil forms can be soldered after mounting. Phenolic forms: ¾" high when mounted, in diameters of .219" and .285". Ceramic forms: ¼" diameter, in mounted heights of 5/8" and 13/16", with 10/32" powdered iron core, and collars of silicone fibreglas. Forms come with threaded slug and terminal collar. Units mount through two to four holes, as required. Available as forms alone or wound as specified.



CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

SEE THE CTC COMPONENTS ON DISPLAY AT BOOTH 502, IRE SHOW, KINGSBRIDGE ARMORY, NEW YORK, MARCH 19-22

has high humidity resistance, and is tough but not brittle. Wafer contacts are silver plated and double wiping for low contact resistance and self-cleaning for long life. Solder type lugs on the wafer's connection ends make for ease in wiring.

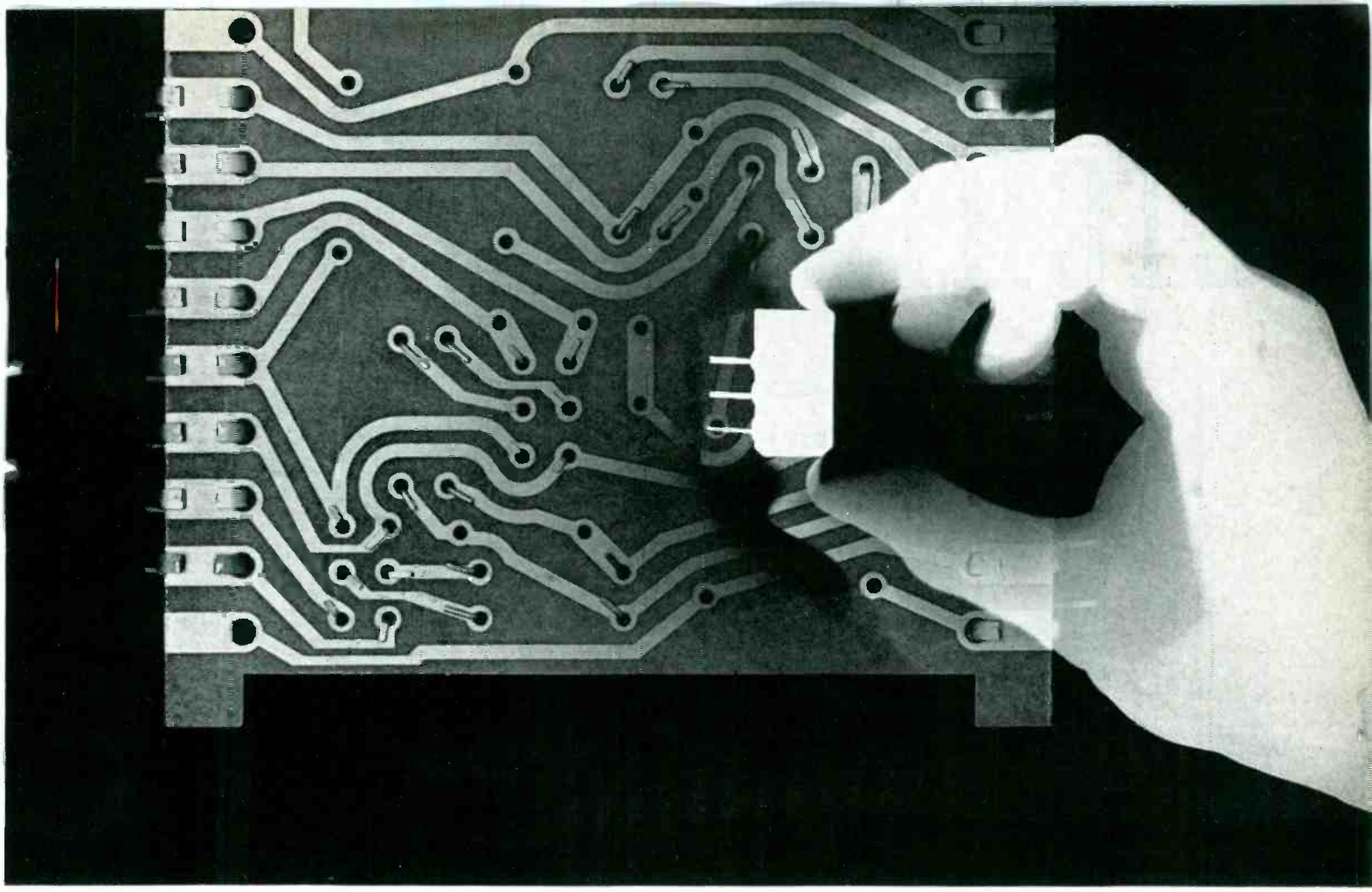
▶ **Specifications**—Contact resistance is 0.015 ohm; dielectric strength, 1,000 v rms minimum; insulation resistance, 100 megohms minimum; current carrying capacity, 1 ampere at 50 v d-c; and current breaking capacity, 250 ma at 50 v d-c or noninductive a-c load.

MINIATURE TUBES
for tv applications

RADIO CORP. OF AMERICA, Harrison, N. J., has introduced two general-purpose, multiunit tubes of the 9-pin miniature type (6BH8 and 6AU8) which may be used in a wide variety of applications in black-and-white and color tv receivers. Each tube embodies a medium-mu triode and a sharp-cutoff pentode in one envelope. Both types are designed with a 600-ma heater having a controlled warmup time to insure dependable performance in tv receivers employing a series-heater string arrangement.

▶ **Pentode Features**—The pentode units feature individually a high transconductance value of 7,000 μmhos, and are intended for use as video amplifier tubes. They may also be used as video i-f amplifier tubes, sound i-f amplifier tubes, or as age amplifier tubes.

▶ **Triode Features**—The triode unit of the 6BH8 has an amplification factor of 17, and is particularly



Westinghouse miniature rectifiers plug in for printed circuits

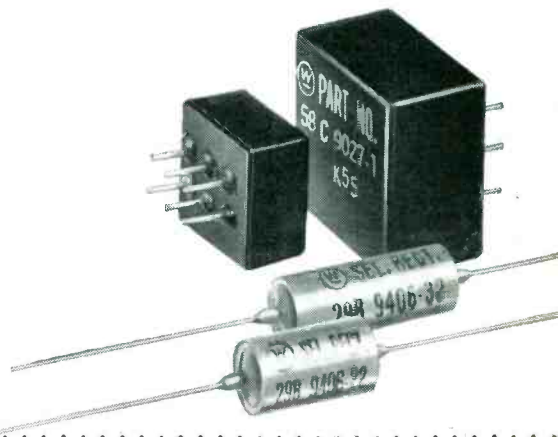
Reliable, low-cost, d-c power supply for your military or commercial electronic and electric equipment calls for Westinghouse selenium rectifiers. A new-design enclosure featuring plug-in terminals makes them particularly well suited for printed circuits. Optimum circuit versatility is obtained through multiple terminal headers.

Westinghouse selenium rectifiers are compact, lightweight; save precious space; contribute to easy accessibility. They have low forward drop and low reverse leakage, are also available as a unit with magnetic amplifiers. Packaged in resin-sealed Moldarta* boxes for use in potted assemblies, or hermetically-sealed nickel silver boxes for open mounting.

A wide range of Westinghouse selenium rectifiers in stack, boxed and cartridge form is ready to serve your design engineering needs. More information? Send coupon below. J-01001

*Trade-Mark

Input 0 - 33 VAC per cell
Current 0.03 - 0.2 amp
Bridge units available to 150 VAC
Size: ¼- and ½-inch cell diameter
Operation up to 75°C ambient temperature.



YOU CAN BE SURE...IF IT'S

Westinghouse

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I'm interested in more information about:
☐ Selenium rectifiers ☐ Cypak* control
☐ Magamp* magnetic amplifiers.

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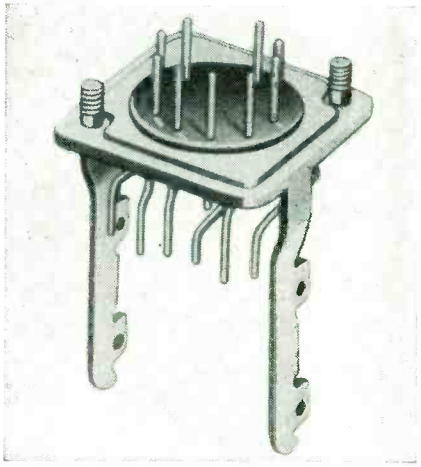
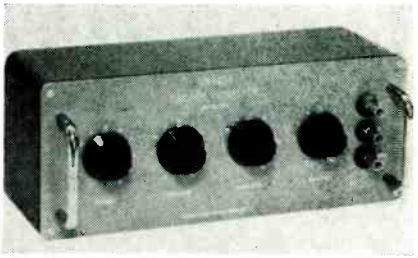
suited for use in l-f oscillator circuits. Triode section of the 6AU8 has an amplification factor of 40, and is intended for use in sync-separator, sync-amplifier, syn-clipper and phase-inverter circuits.



RELAY HEADER ASSEMBLY
cuts production costs

HERMETIC SEAL PRODUCTS CO., 29-37 South Sixth St., Newark 7, N. J. The newly developed relay header assembly eliminates these costly steps: buying or producing square cover plates with studs attached; stamping the hole in the cover plate for the hermetically sealed header; attaching and shaping pigtails; soldering or brazing the mounting bracket to the cover plate; and mounting the seal in the cover plate.

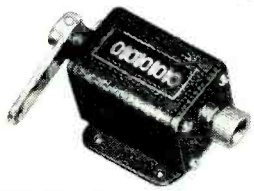
Complete data, drawings and prices are available from the company.



DECADE INDUCTOR
with high value of Q

SHASTA DIVISION, Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif. Model 1210 decade inductor is a general-purpose

Here's THE basic V-R "COUNTER-PACKAGE" for INDUSTRY...

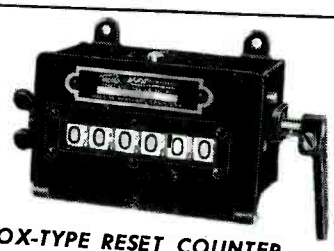


SMALL RESET COUNTER

A compact, rugged reset counter for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

Dimensions: 1¾" long, 1 19/64" high, 1 1/16" wide

Speed: Up to 1000 counts per minute.



BOX-TYPE RESET COUNTER

For punch press installations, conveyors, metal-working equipment, die casting, plastic-molding, rivet, spring and wire machining, or any installation requiring a heavy duty counter.

Dimensions: 4¼" long, 2 5/32" high, 3⅜" wide.
Speed: 500 counts per minute.

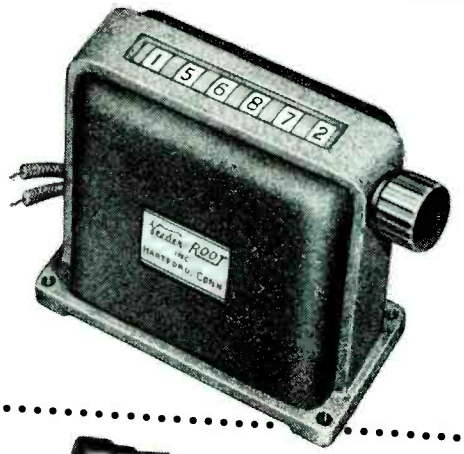
RESET MAGNETIC COUNTER

For remote indication of machine operation from plant to office.

Dimensions: 3 15/16" long, 2½" high, 1⅝" wide.

Speed: Up to 1000 counts per minute.

Coils: 110V-AC are standard. Other voltages are available. Panel mounting feature also available.

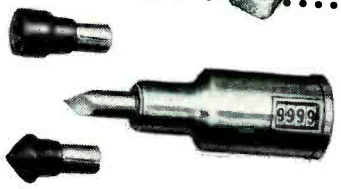


HAND TALLY

For quick spot-checks of production or performance.

Dimensions: 1 17/64" long (to end of reset knob), 1¾" deep, 2" high.

Counts one for each depression of the thumb lever, and resets to zero by a turn of the knob.



CLUTCH SPEED COUNTER

For checking to make sure that the machine is operating at the required R.P.M.

Dimensions: 3¼" long, ⅞" max. diameter. Non-Reset.

Internal clutch operates counter only when rubber tip is pressed against the shaft.

Here are 5 of the most widely used Veeder-Root Counters in industry . . . and they're immediately available from stock at leading Industrial Supply Distributors. There are Veeder-Root mechanical, electrical and manual counters for use in production recording and control, wage payment, time study work, quality control. In fact, you can profitably apply Veeder-Root Counters to every machine, operation, process or system in your plant. Ask your own Industrial Supply Distributor. Or write Veeder-Root Inc., Hartford 2, Conn.

Everyone can count on

VEEDER-ROOT

"The Name that Counts"

Insist on Standard

VEEDER-ROOT COUNTERS

from your

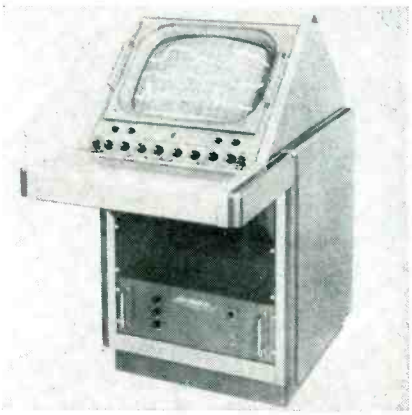
Industrial Supply Distributor

or write us on special problems

laboratory instrument designed to provide inductance values in the range from 0.001 henrys to 11.11 henrys in 0.001-henry steps to an accuracy of ±1 percent. It is designed for use in wave filters, tuned circuits, and equalizers for audio and supersonic frequencies. The stability, accuracy, and high value of Q makes it valuable for simulation of network problems and tuned circuit performances.

► **Other Features**—Toroidal construction practically eliminates the effects of external magnetic fields and makes possible close stacking of the coils without errors from mutual inductance. Electrostatic shielding and mechanical protection are furnished by the aluminum frame and covers. A high-temperature wax coating is provided on the toroids to keep moisture from the windings.

Weight is 8½ lb. Price is $240.



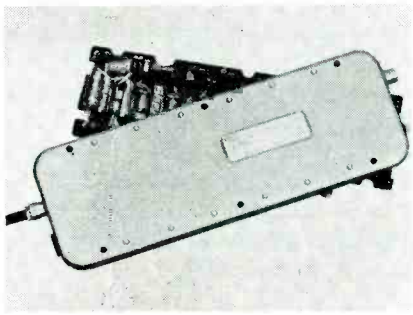
MEDICAL SCOPES
for demonstration uses

ELECTROMEC, INC., Los Angeles 39, Calif., announces new large screen oscilloscopes for medical teaching, demonstration and monitoring. The 17 or 21-in. crt's employed permit detailed observation of complex waveforms to a high degree of resolution and long range visibility.

► **Research**—For research applications, pilot experiments may be readily accomplished in minimum time without having to set up complete recording systems.

Vital data which can be demonstrated or monitored include: nerve and muscle action potentials, ballistocardiograms, pressure curves and phonocardiograms. Besides

providing an excellent monitor for the operator, the Electromec large screen oscilloscope serves as an ideal teaching aid for students interested in these and similar procedures.

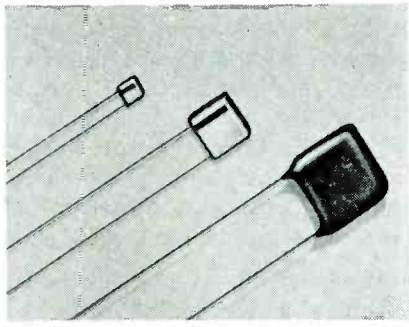


A-F CONTROL STRIPS
in drawn aluminum cases

RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif., has available subminiature afc units for use in conjunction with its subminiature i-f amplifiers.

The afc units are available in drawn aluminum cases, utilize highly reliable printed circuit techniques, and can operate under temperatures of −65 C to +125 C, vibration of 15 g (from 10 to 2,000 cps), shocks of 60 g. Input circuitry is available for use with balanced or single mixers at any frequency and bandwidth.

The units also contain i-f amplification, discriminators, diode search-stopper-phantastron afc circuitry, and cathode follower output. Available to military specifications, a typical unit is 9 in. long by 3 in. wide by 25/32 in. thick, and weighs only 1 lb.



WAFER THERMISTORS
temperature compensating

THERMISTOR CORP. OF AMERICA, Metuchen, N. J., has available a

complete series of wafer-type thermistors suited for temperature compensation of transistors and other temperature dependent devices.

► **Varieties**—The new elements are stocked in a complete range of resistance from ohms to megohms, and are available with extremely high temperature coefficients (up to 7 percent per deg C at room temperature in high resistance values). When furnished with stranded leads, these thermistor wafers—even in sizes as small as 1/10 in. square—possess the same power handling ability as older types up to ½ in. in diameter.

TRANSISTORS
useful in computer circuits

GENERAL TRANSISTOR CORP., 95-18 Sutphin Blvd., Jamaica 35, N. Y., is now producing new diffused *pnp* junction transistors capable of operating at collector voltages of 100 v.

Known as GT 34-100, they are recommended for use in switching a neon light in computer circuits. Each is doubly sealed—encapsulated in plastic and hermetically sealed in a can.

EPOXY GLASS
noncrazing, punching grade

MICA CORP., 4031 Elenda St., Culver City, Calif., has developed a cold, noncrazing punching grade of epoxy-glass. It is expected to speed up production, eliminate waste and lower tooling costs wherever it is used.

► **Materials and Properties**—Micaply epoxy-glass is a laminated material made from thermosetting epoxy resin reinforced with woven glass fabric. Its properties combine high strength, low moisture absorption, excellent electrical properties and a resistance to attack by inorganic acids and organic solvents.

► **Applications** — When laminated with various weights of copper, one or both sides, the material can be etched to form printed circuits. Copper-clad epoxy-glass is also used as a base for commutators, binary code disks plus numerous other

FREE 3-D BROCHURE

shows how you get superior brass parts with

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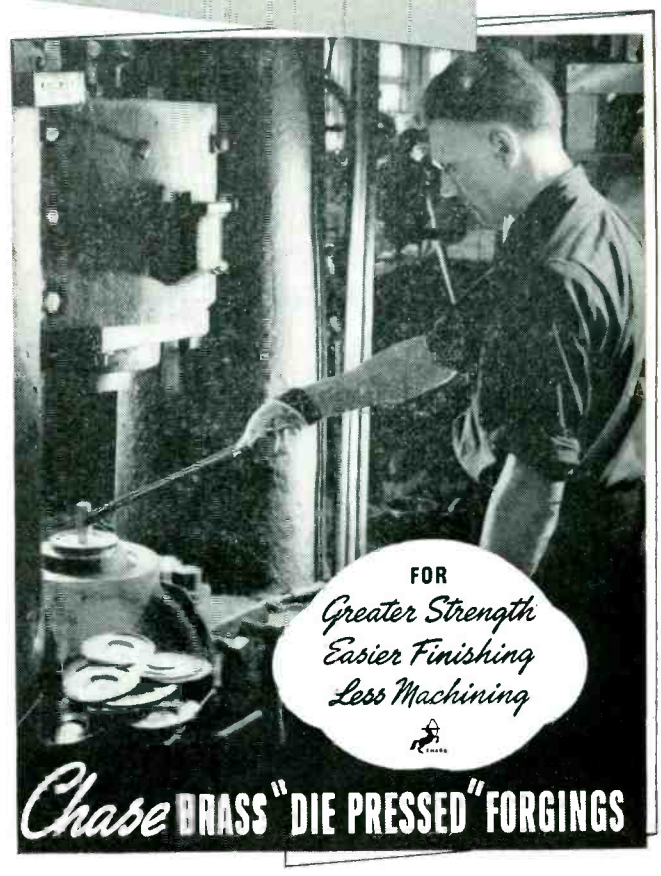
If you need metal trim, intricate metal decorations, builder's hardware or strong interchangeable parts for mechanical assemblies, this 3-D brochure is for you! It can show you the way to *reduce production costs* while you improve product performance and appearance. Send coupon below, today, for your FREE copy!



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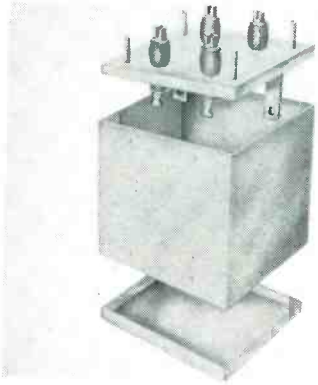
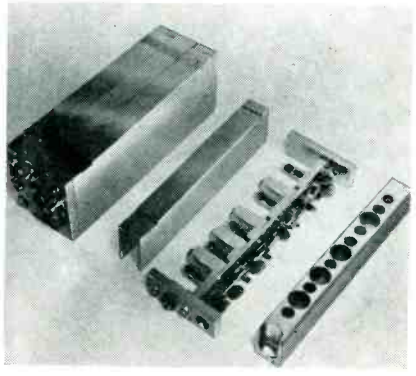
electronic applications. Unclad material is widely used for mock-up boards, gaskets and various insulation purposes.



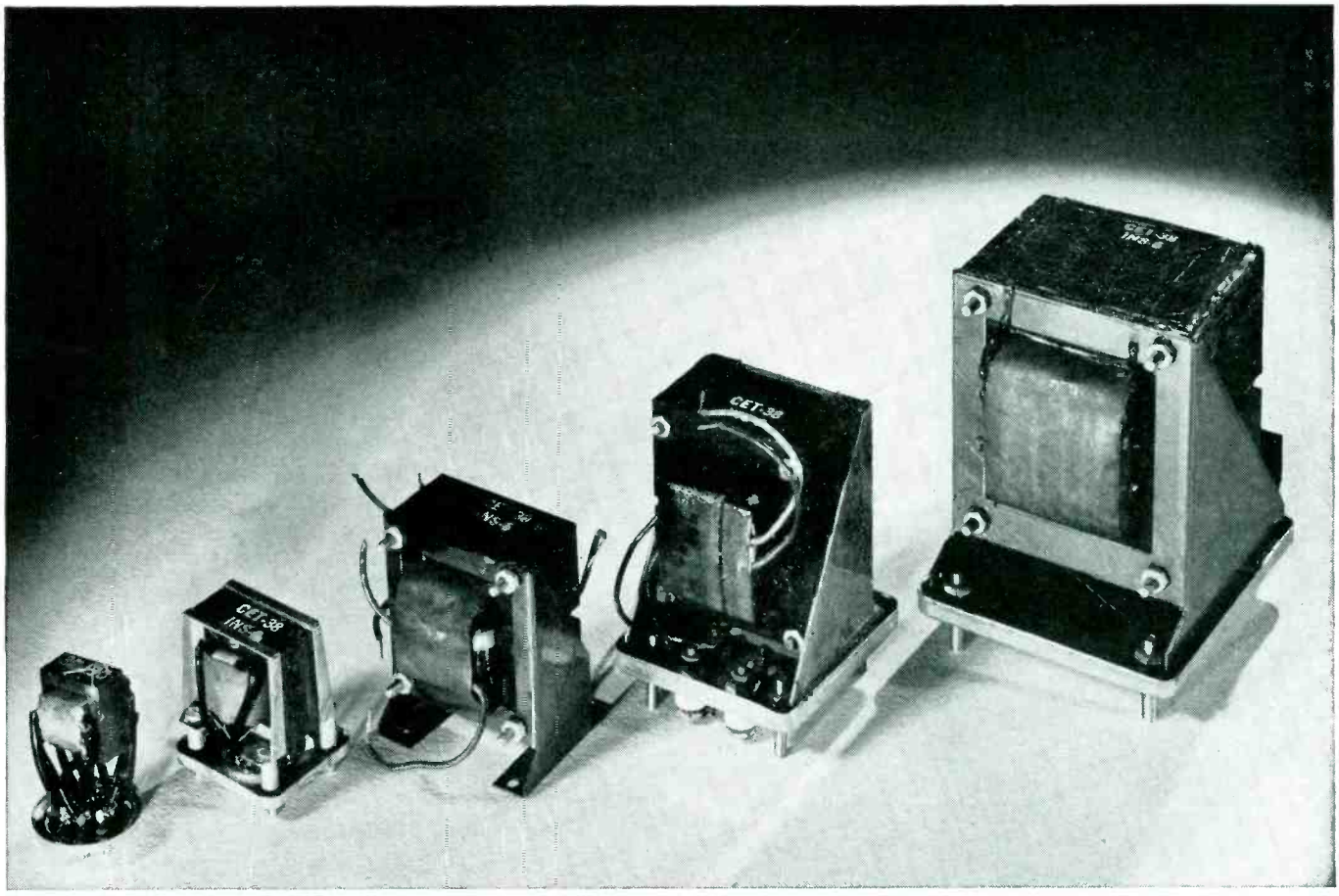
SEALED ENCLOSURES
fabricated to specification

SILICONE SEALS, INC., 3125 Milwaukee Ave., Chicago 18, Ill., has announced fabrication service of hermetically sealed enclosures for the electronic industry. The containers are custom-fabricated to customer specifications. Brackets, mounting studs and complete units are plated in accordance with specific requirements. The sealed closure assemblies are made in accordance with military standards for such units.



VHF RECEIVERS
and power supplies

LAND-AIR, INC., Oakland International Airport, Oakland, Calif., announces production of subminiature a-m and f-m receivers individually constructed as three compact modules: an r-f assembly, i-f assembly and power supply, each module weighing approximately 2 lb with dimensions of 1 in. by 3 in. by 9 in. The three modules can be mounted as an entity or as



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The operation of a transformer is no better than the magnetic core around which it is built. With Allegheny magnetic materials in the core, you get the *best*—uniformly and consistently.

Sure there are reasons why! For one thing, there's the long experience of a pioneer in development and quality control of electrical alloys. But most important, the A-L line offers complete coverage of any requirement you may have, any service specification. 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 special high-permeability alloys such as Allegheny 4750, Mumetal, etc.

In addition, our service on magnetic materials includes complete lamination fabrication and heat treatment facilities. What's more, this extensive experience in our own lamination stamping department is a bonus value for all users of A-L electrical sheets or strip. ● Let us supply *your* needs. *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

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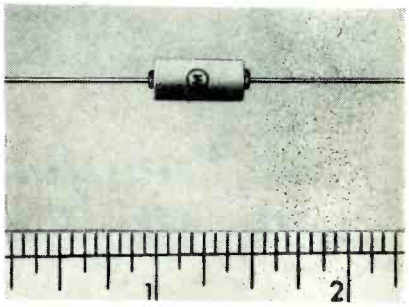
separate units to utilize restricted or normally unusable spaces in guided missiles, aircraft and vehicular installations.

► **Uses**—These receivers accomplish frequency monitoring of transmitted intelligence — timing, control, voice, special instrumentation. Available in several frequency ranges from 40 to 235 mc, the receivers feature crystal frequency control, wide-band frequency response, excellent sensitivity, quieting and noise rejection.

The subminiature power supply operates independently or in conjunction with the receiver. Providing B+ and filament voltages to varied equipments, its extreme light weight and sturdy, compact form minimize accommodation problems in critically balanced airborne devices.



CERAMIC CAPACITORS
lower capacitance values

MUCON CORP., 9 St. Francis St., Newark 5, N. J., has announced a new series of voltage sensitive ceramic capacitors with lowered capacitance values that range from 300 $\mu\mu$f down to 100 $\mu\mu$f for those applications where type VSR and VSE are not low enough in capacitance. Known as types LVSR and LVSE, the capacitance of these units may be decreased as much as 60 percent by the application of d-c potential up to 200 v. The former has maximum sensitivity at room temperature and the latter has voltage sensitivity at approximately 70 C.

Both types are housed in a steatite tube approximately 3/32 in. in diameter and approximately 1/2 in. long and have No. 26 gage leads.

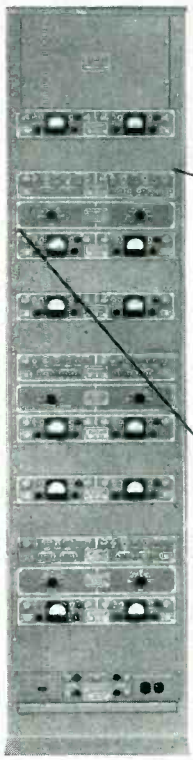
► **Uses**—Applications are unlimited especially in the fields of tuning

Never before . . . Duplexing and Break-In Without Relays

NEW! **Northern Radio**

DUPLEX TELEGRAPH SYSTEM

For Multi-Channel Tone Equipment



NEW! Simple 4 position switch selects from 12 possible duplex combinations.

NEW! Duplex operation between stations connected via carrier telegraph channels.

NEW! *All-electronic*, without relays or moving parts to wear.

NEW! Polar or neutral for either half duplex or full duplex.

NEW! Break-in now also possible for all *half*-duplex circuits.

NEW! Provided with positive feature to prevent space signal lock-out.

NEW! Includes individual line battery for each channel.

The Northern Radio Duplex Telegraph System consists of one each Dual Frequency Shift Tone Keyer, Type 153 Model 3; Dual Duplex Selector Panel, Type 200 Model 1; Dual Loop Switch Panel, Type 200A Model 1; and Dual Frequency Shift Tone Converter, Type 152 Model 3. The Frequency Shift Tone Keyer and Converter are our latest improved Model 3's, specifically designed for use with this system.

The Dual Duplex Selector Panel and Dual Loop Switch Panel make possible complete duplexing and break-in operation of a Northern Radio or similar multi-channel Frequency Shift tone telegraph system. Such a system meets the requirements of any standard telegraph line or terminal apparatus for either full duplex or half-duplex operation. Because this system is all-electronic, it meets all speed requirements and yet has the flexibility and isolation heretofore possible only with relays.

The Dual Loop Switch Panel rapidly selects half-duplex and/or full duplex mode of operation for any of the 4 standard loop options by front panel switching available from the 12 loop options in the Dual Duplex Selector Panel.

The Dual Duplex Selector Panel provides 12 loop options, patching facilities for monitoring purposes and channel routing, including the possibility of patching-in another teleprinter loop circuit (T-junction). Any of the 12 loop options are available and may be selected for the Dual Loop Switch Panel by simple strapping arrangement. It has an individual line battery for each channel for greatest circuit flexibility. Battery and line fuses are also provided for maximum protection.

The Dual Duplex Selector Panel is provided with positive non-lockout features. An accidental "spacing" of the line, even over prolonged periods of time, such as caused by patching errors, will not lock the system into a permanent space (no loop current) condition. The system will instantly be ready to operate as soon as the fault is removed. This is due to a novel arrangement of the internal batteries which at all times can provide power to the telegraph loops.

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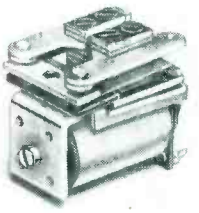
and frequency control, frequency modulation, harmonic generation, dielectric amplifiers and the like.



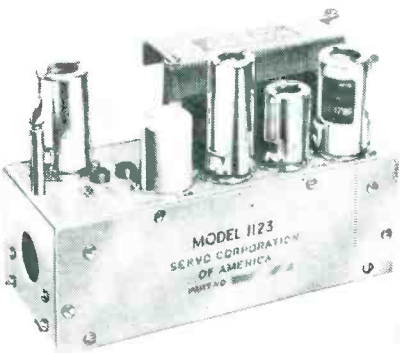
SMALL RELAY
switches heavy current

MAGNECRAFT ELECTRIC CO., W. Grand Ave., Chicago 51, Ill. Switching of heavy current in small space is achieved by a new class 11D miniature relay.

The specially designed spst normally open, double-break contacts reliably switch up to 20 amperes, noninductive load.

▶ **Dimensions and Operations**—Overall dimensions are 1 5/8 in. length, 15/16 in. width, and 1 7/16 in. height. Minimum coil operating power is ½ w.

The new relay is available for d-c operation up to 150 v. Other relays with similar heavy-duty contacts are available for operation from a-c.



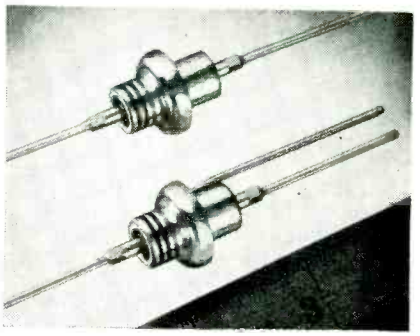
AMPLIFIERS
meet MIL-E-5400 requirements

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Models 1123 and 1124 Servoflex amplifiers are designed to meet the light-weight, small-space and quality performance of opera-

tion in high-altitude servo systems. Both are light, compact plug-in units featuring built-in preamplifier and built-in power supply.

With instantaneous response the 1123 accepts 400-cycle phase-reversible input. The 1124 accepts a single d-c input or takes the difference between two such inputs and a built-in 400 cycle synchronous chopper modulates the d-c signal to an a-c signal. Both models will drive any 115-v, 400-cycle servo motor rated at 8 w or less.

For each model, a 3-leg transformer acts as a combined power supply and output transformer in the unique reluctance amplifier circuit. An internal negative-feedback loop in the 1123 incorporates a log network, providing error rate damping useful in stabilizing position servo systems.



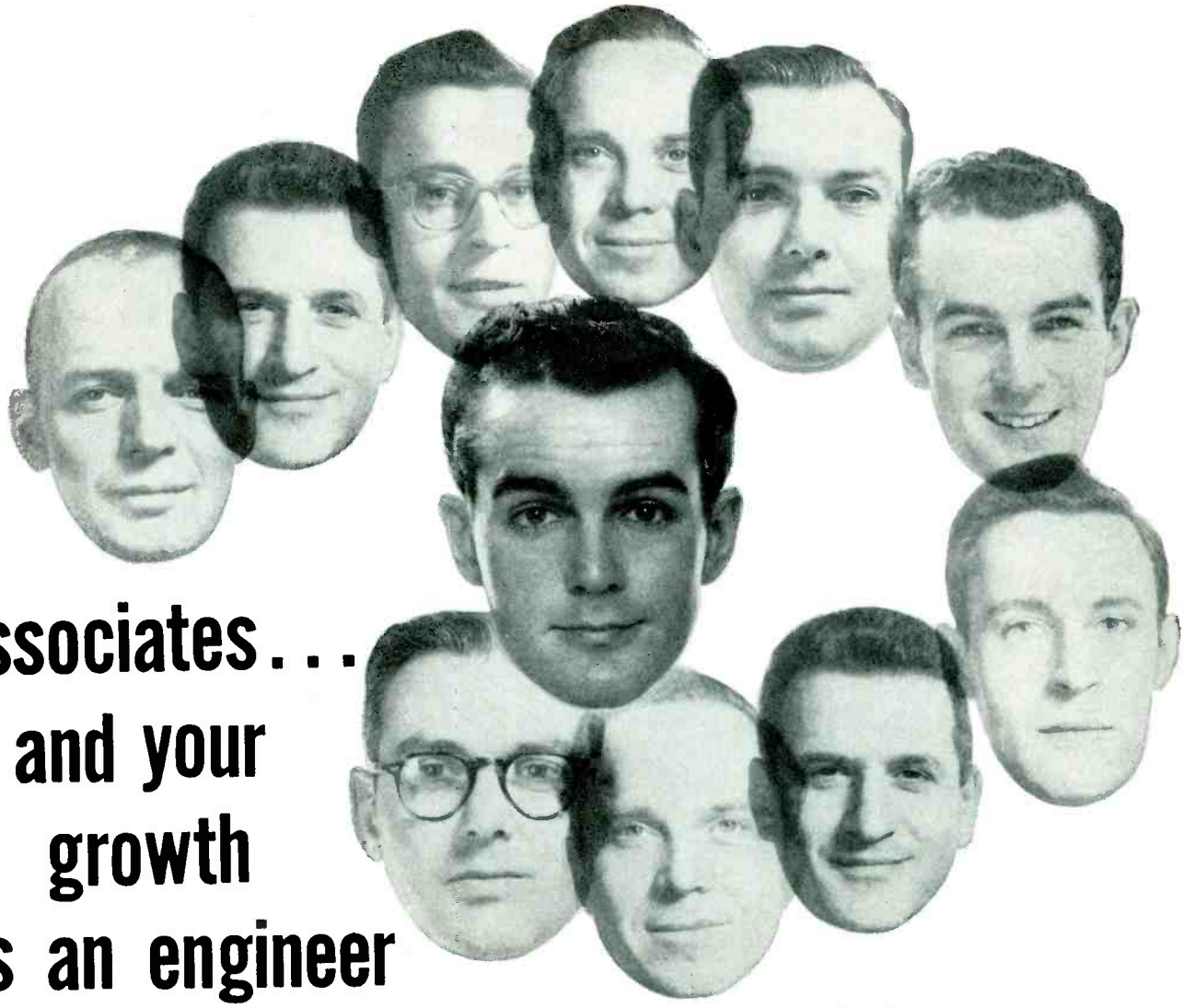
NPN TRANSISTORS fused junction germanium

HUGHES AIRCRAFT CO., Culver City, Calif. Type HA5001, HA5002 and HA5003 *npn* fused junction germanium transistors are characterized by high gain and low noise figures. They exhibit a negligible alpha-crowding effect at high currents.

▶ **Applications**—The low alpha-crowding effect makes the devices particularly applicable to high-current medium-power amplifiers. They are also suitable for such applications as: computers, switching, audio-amplifiers, i-f amplifiers, r-f amplifiers, and oscillators.

▶ **Ratings**—All three types have a maximum collector current of 100 ma, and a collector dissipation of 500 mw. When used with clips, or with suitable heat sinks, these ratings can be increased.

For HA5001, HA5002, and HA-



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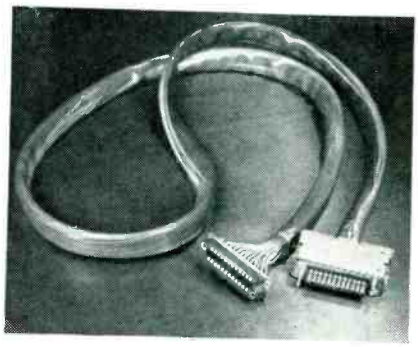
5003 respectively, maximum current amplification (alpha) is 1.0, 0.965, and 0.99; maximum collector-to-base voltage is 30 v, 15 v and 20 v; collector cutoff current is 5 μa, 12 μa and 10 μa. Overall length (including leads) is 1.937 in. The transistor body is 0.344 in. in diameter and 0.414 in. long.



VINYL TUBING
for wide temperature range

RESIN INDUSTRIES, INC., P. O. Box 1589, Santa Barbara, Calif. Resinite EP-69A is a vinyl insulation sleeving that conforms to the requirements of specification MIL-I-631B, type F, form U, grades a and b, class I and II, category 1 and 2. It provides a working temperature range from −48 C to +90 C and a dielectric strength of 750 v per mil. It performs beyond specifications for corrosion, fungus, oil and flame resistance.

► **Sizes**—The tubing is available in all standard sizes from No. 20 Awg through 2½ in. i-d with standard wall thicknesses. Nonstandard tize tubing is available on special order.

Colors are transparent, black, white, red and blue.

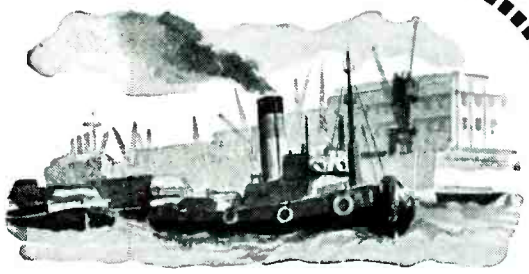
POWER SUPPLIES
are transistorized

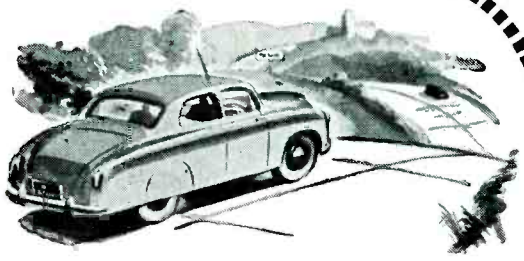
UNIVERSAL ATOMICS CORP., 19 E. 48th St., New York 17, N. Y., has available a new line of completely transistorized d-c to d-c power supplies that can produce up to 16,000 v from 1½ v of input. They weigh about 6 oz and occupy only about 4 cu in.

► **Uses**—The units can be used in all c-r and infrared applications

For additional information on all items on this page, use post card on last page.

REPORTER





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LOW BATTERY DRAIN
MOBILE RADIO TELEPHONE

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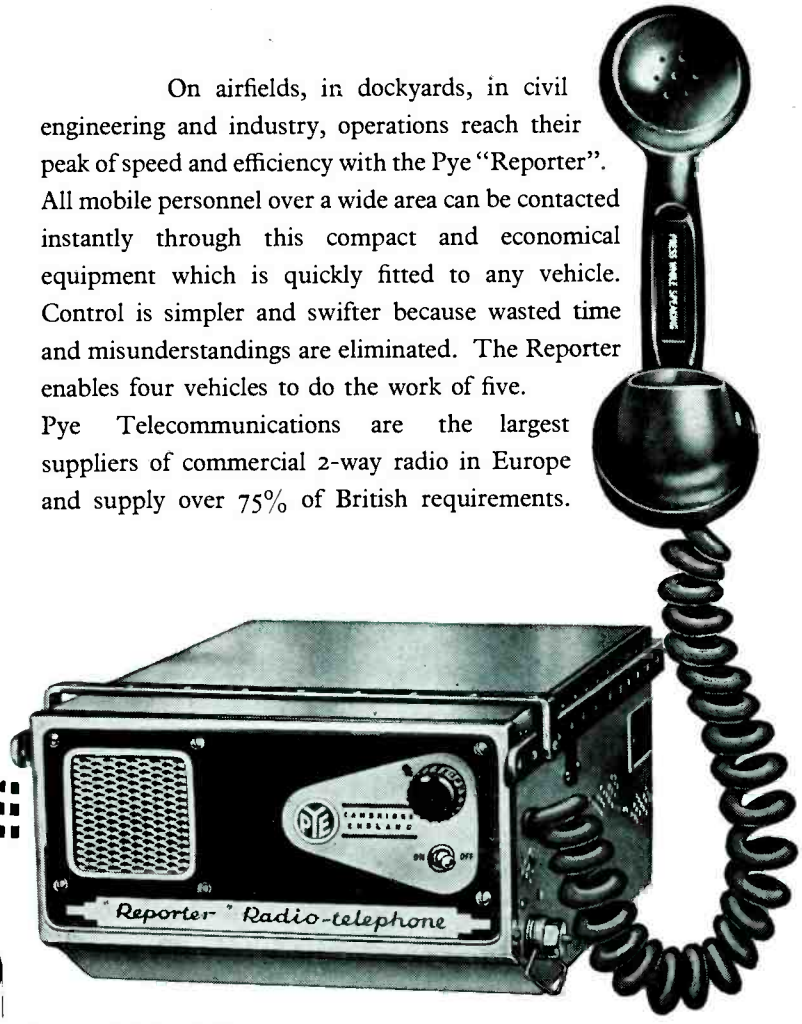
Pye Telecommunications are the largest suppliers of commercial 2-way radio in Europe and supply over 75% of British requirements.



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such as portable oscilloscopes, portable tv sets, radar h-v applications, infrared scanners, drones, rockets, guided missiles and radiation detection equipment of all kinds.

They are rugged to withstand 20,000 g or more, recover instantaneously from shorting, and have an ambient temperature cycle of −25 C to 100 C. They come in rectangular or cylindrical shape, and can be custom-made to fit any specifications.

DECADE COUNTER TUBE provides 15-v output

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6802 cold cathode-bidirectional decade counter tube was designed to expand the flexibility of counter tubes for application in direct-reading counters, computers, automation devices, military fire control and many types of monitors.

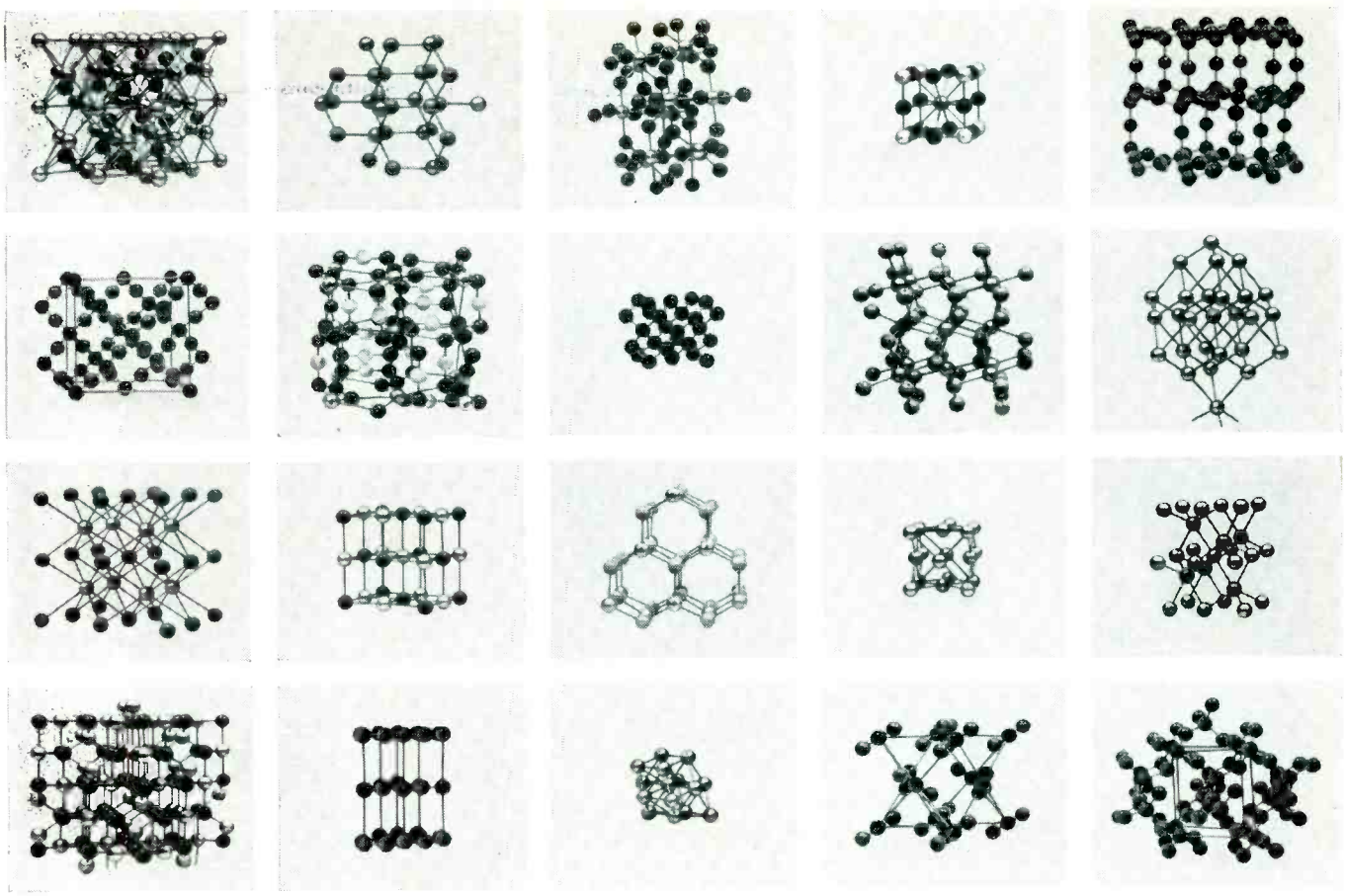
▶ **Technical Data**—With output connections to 4 of the 10 cathodes (numbers 0, 5, 8 and 9), an output of at least 15 v is provided by the new decade counter tube. The standard circuit frequency range is 0 to 4,000 pps—up to 10 kc with special circuitry.

In conjunction with one driver, type 6802 fulfills the function of several conventional tubes, making possible reduced power requirements, smaller package and increased circuit reliability.

Literature

Industrial Electron Tubes. Radio Corp. of America, Harrison, N. J. The 16-page booklet—RCA Interchangeability Directory of Industrial-Type Electron Tubes (Form No. ID-1020A)—lists 2,000 type designations of 26 different manufacturers arranged in alphabetical-numerical sequence.

The directory covers vacuum power tubes, vacuum and gas rectifiers, thyratrons, ignitrons, mag-



Crystal structure models. Top row, left to right: cuprite, zincblende, rutile, perovskite, tridymite. Second row: cristobalite, potassium dihydrogen phosphate, diamond, pyrites, arsenic. Third row: caesium chloride, sodium chloride, wurtzite, copper, niccolite. Fourth row: spinel, graphite, beryllium, carbon dioxide, alpha-quartz.

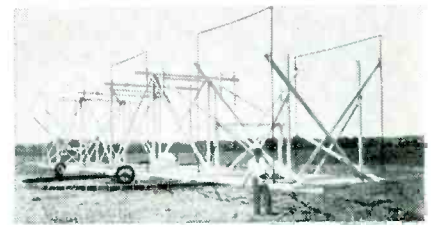
FROM ATOMS TO STARS

Research at Bell Telephone Laboratories ranges from the ultimate structure of solids to the radio signals from outer space. Radio interference research created the new science of radio astronomy; research in solids produced the transistor and the Bell Solar Battery.

Between atoms and stars lie great areas of effort and achievement in physics, electronics, metallurgy, chemistry and biology. Mechanical engineers visualize and design new devices. Mathematicians foreshadow new communications techniques.

Despite the diversity of their talents, Bell Laboratories scientists and engineers have much in common. A habit of teamwork channels these talents into great communications advances. These men have developed the world's finest telephone system. In doing so, many have become leaders in their fields. Opportunities for achievement await properly qualified scientists and engineers at Bell Telephone Laboratories.

Models of the atomic patterns in solids help Bell Laboratories scientists visualize their electrical behavior.



Directional antenna used by Karl G. Jansky in discovery of stellar radio signals at Bell Telephone Laboratories in 1932.

BELL TELEPHONE LABORATORIES

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netrons, cold-cathode tubes, phototubes, oscillograph tubes, camera tubes, and receiving-type tubes for industry and communications. The booklet is priced at $0.20 per copy.

Impedance Stabilization Networks. Filtron Co., Inc., Flushing, L. I., N. Y. A 2-page catalog sheet describes the series FSR-700 line impedance networks for 50-100-200-500 ampere circuits. The units discussed are useful in connection with the measurement of r-f interference in accordance with Air Force Specification MIL-I-6181B and Navy Specification MIL-I-16910A.

Data supplied includes: maximum voltage ratings available, complete ratings for all units in the line, termination and connector types, dimensions and part numbers. Each rating is furnished in two designations, one for each of the above specifications, and are not interchangeable due to specified electrical characteristics.

The networks are illustrated by means of line drawings and photograph. Write for catalog sheet FSR-700, issue A.

Computing and Analysis Facilities. Cook Research Laboratories, Division of Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., has established within the laboratory a new, separate service group —a computing and data reduction facility. The facilities and scope of this service group are illustrated and described in bulletin R-16.

Voltage-Digital Translators. Epsco, Inc., 588 Commonwealth Ave., Boston, Mass. A recently presented article on high-speed voltage-to-digital translators outlines theory and applications of these versatile units. The article gives considerable insight into the application of these new devices into the field of data reduction and offers a theoretical discussion of the requirements of systems used in data reduction.

Color TV Test Equipment. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill. Bulletin A-103 is a completely descriptive 3-color double sided flyer featuring the

J. B. Rustic, General Superintendent, Operating Department, American District Telegraph Company, tells how:

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"Stone walls, iron bars, squads of guards — nothing protects money and property like our burglar alarm service — in co-operation with the police, of course.

"Every year, ADT Protection Service saves subscribers hundreds of thousands of dollars by automatically detecting burglaries, fires, and other dangerous conditions.

"Our systems have to work — all the time. And they do, thanks to constant supervision, proper maintenance — and to Air Express!

"For if new parts are needed, Air Express delivers for us anywhere in the country in a matter of hours!

"Yet, we actually save money with Air Express. A typical 20-pound shipment goes from New York to St. Louis for $7.48. That's $3.17 less than any other complete air service!"

AIR EXPRESS **Air Express**

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY

model 458 7-in. Colorscope and 434 Varidot white dot generator. It contains pictures of the instruments along with specifications, prices and information concerning proper usage of these testers.

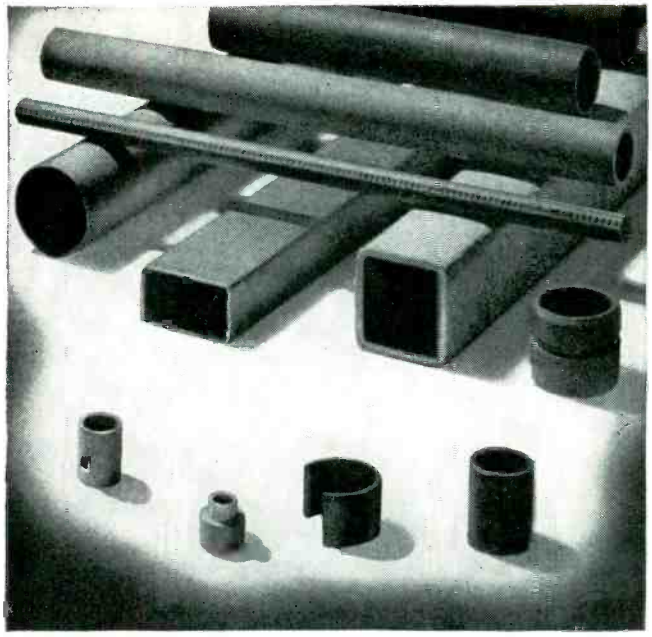
Timers and Switches. General Control Co., 1201 Soldiers Field Road, Boston 34, Mass., is offering a 4-page condensed catalog of special interest to design engineers concerned with timers and electromechanical switches. It shows pictures, diagrams and general specifications of the company's various switches, as well as its electronic and synchronous-motor timers and custom control panels.

Instrumentation Bulletin. Beckman Division, Beckman Instruments, Inc., Fullerton, Calif. An electronic hot-rod that accelerates ions 1,000 miles per sec in a millionth of a sec, automatic spectrophotometers which speed laboratory analysis and a new pH electrode are all described in bulletin No. 17. The bulletin also contains many other illustrated articles on how Beckman instrumentation is aiding laboratory and industrial users.

Picture Tubes. Radio Corp. of America, Harrison, N. J. A 16-page booklet (Form No. KB-106) contains ratings, characteristics, and base-connection diagrams for all RCA picture tubes including color tubes, and features a replacement directory giving information on recommended RCA replacements for more than 150 industry types.

The booklet also keys all RCA Silverama aluminized picture tubes for quick and easy reference. The booklet is priced at $0.20 per copy.

Vibrating Reed Electrometer. Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif., has announced a bulletin covering the new Model 31 Cary vibrating reed electrometer. It describes the wider flexibility of ranges now standard, including 1, 3, 10, 30, 100, 300, 1,000 mv and 3, 10, 30 v. The bulletin also describes performance and outlines several applications. Another section of the bulletin describes operation of



C-D-F SPIRAL TUBING offers many advantages to the cost-conscious design engineer and purchasing agent. It is low-cost, moisture-resistant, high-strength, and easy to fabricate. It has sufficiently low dielectric loss properties and good dielectric strength for many applications.

New C-D-F Plastic Spiral Tubing reduces unit costs, improves products

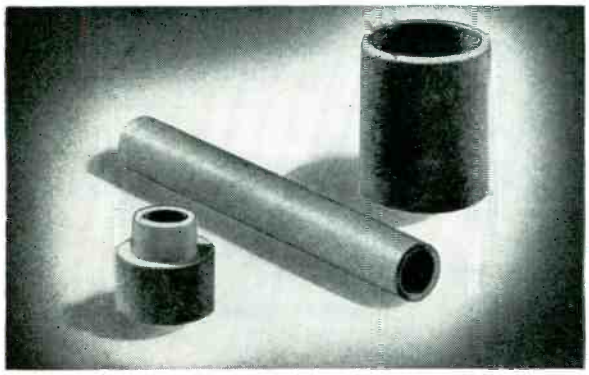
Using C-D-F's new Spiral Tubing is a way of saving money in buying electronic insulation . . . without lowering the electrical and mechanical characteristics of the part required. This special tubing is a high-strength plastic made from paper or vulcanized fibre that is spirally wound. It is available in two basic forms in various grades: (1) as plain untreated tubing. (2) as impregnated tubing containing various types of thermosetting insulating varnishes.

BUY ONLY THE PROPERTIES YOU NEED

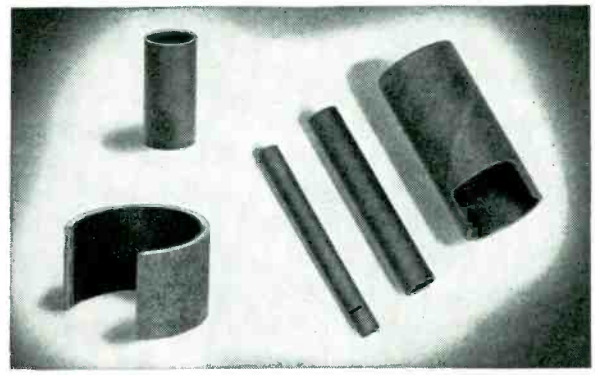
Spiral Tubing can be used to replace rolled or molded laminated phenolic tubing in many cases. As the degree of moisture resistance and mechanical strength is established during the manufacturing process, you specify . . . and buy . . . only those properties required for the application. C-D-F also offers complete designing, machining and assembly. You can get finished components, or random length tubing, with fast deliveries. Write for Technical Folder ST-53 and samples, after checking our catalog in Sweet's Design File. Call the C-D-F sales engineer listed there—he can save you time and money immediately with C-D-F Spiral Tubing!

CONTINENTAL DIAMOND FIBRE

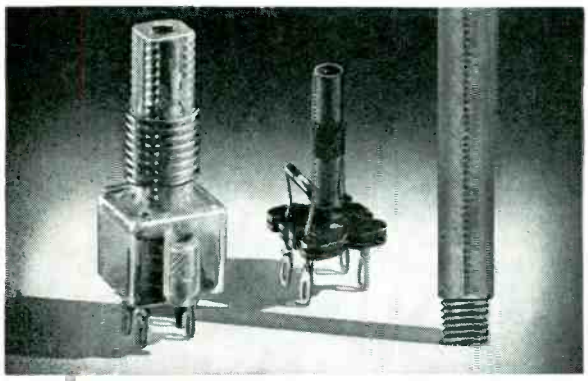
CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 16, DELAWARE



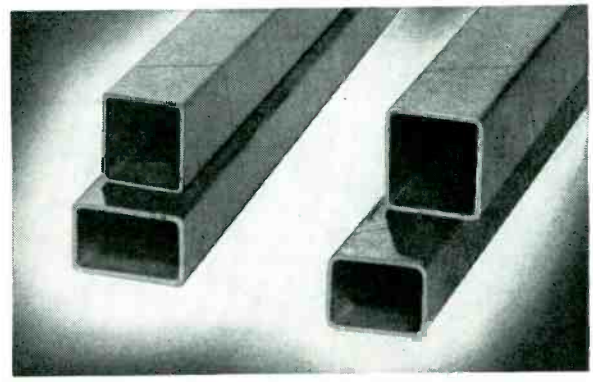
A VERY HARD TUBE is supplied in C-D-F Grade 6A. The parts shown have maximum mechanical strength, lowest water absorption rate under immersion conditions and most stable dielectric loss properties. Fine for bushings and cores.



THIN-WALL SPIRAL TUBING has good concentricity and is tough. Note thin wall construction, cleanness of machining, variety of shapes. C-D-F Spiral Tubing is easily machined, formed, punched. Made in many grades for special applications.



NEW CONSTANT TORQUE TUBING, for permeability tuning with iron cores, features exact internal threading with three point suspension of the core to prevent binding . . . *no* external embossing to lower dielectric strength. Write for samples.



HARD OR SOFT, square or rectangular coil-form tubing is made for solenoid and transformer applications. Sides are straight with minimum gap in paper winding. Supplied in soft, varnished kraft, or hard, rigid tubing.

the model 31, provides dimension and construction information and presents information on several modifications and accessories which are available.

Sleeving and Tubing. Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y. Complete comprehensive technical data on a line of sleeving and tubing are given in catalog No. 55-T. Included is a cross reference chart and price list. The line described is designed for the rigid performance requirements of the aircraft, electrical and electronic industries.

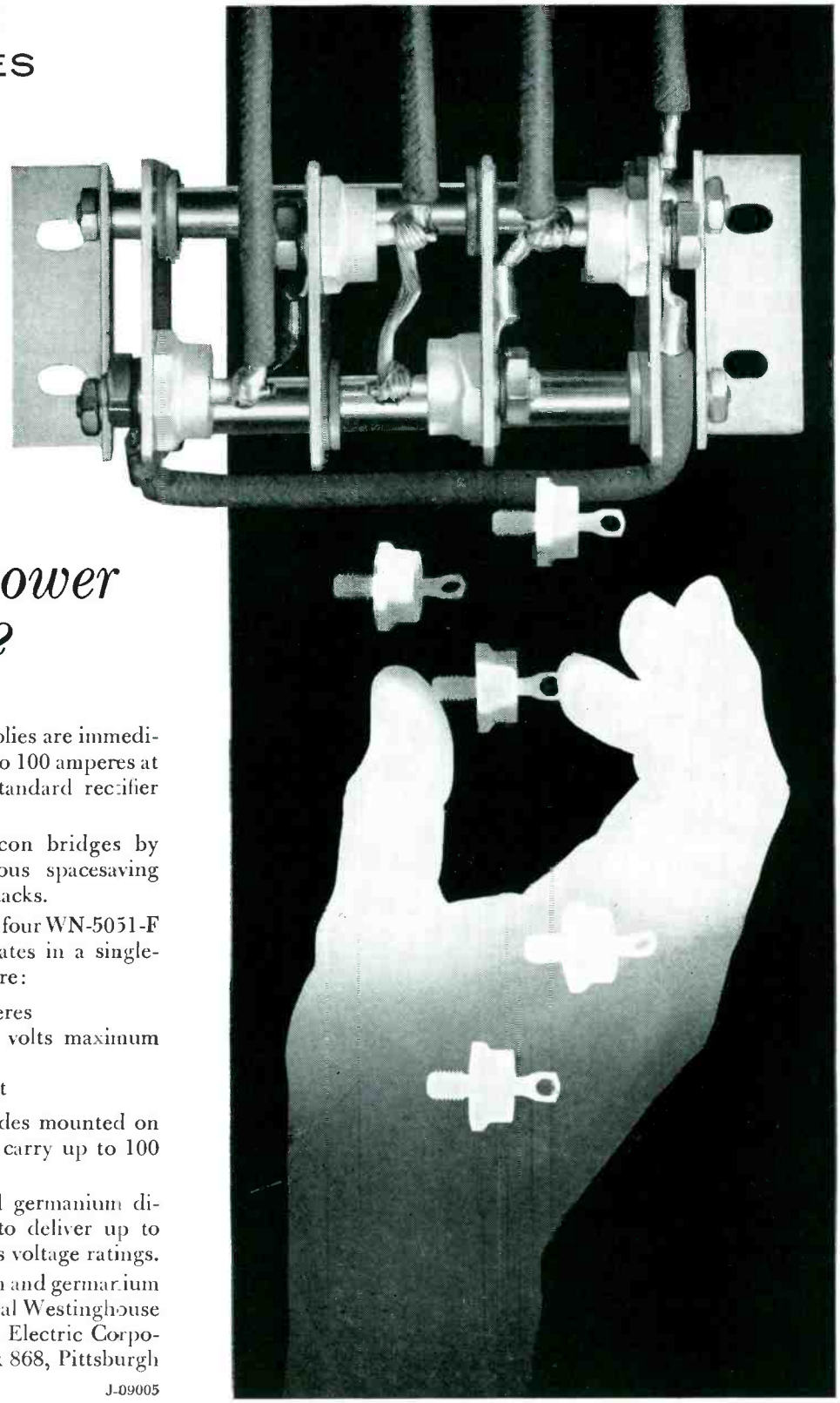
Progressive Speaker Expansion. University Loudspeakers, Inc., 80 South Kensico Ave., White Plains, N. Y., has available a new guide to progressive speaker expansion. The PSE Guide, only 3 in. wide when closed, opens to 26 in. when fully expanded from its accordion fold. Complete in every detail, it contains information for expansion of speaker systems to the fullest potential—illustrating step-by-step expansion with simple color-coded charts. The guide includes data on the use of adjustable networks, dual impedance woofers, adjustable response woofers, midrange speakers and tweeters. The complete line of University speaker and network components is illustrated with all important specifications included.

Power Pentodes. CBS-Hytron, a Division of Columbia Broadcasting System, Inc., Danvers, Mass. Bulletin E-262 covers two new tube types, 6CS5 and 12CS5, for use in low-voltage audio applications. The tubes described are miniaturized beam pentodes with the same power handling capability and electrical characteristics as the type 6W6GT.

The tubes discussed in the bulletin were designed to fulfill the demand for high audio-power output with low supply voltages and may be used in printed circuit radio and tv receivers. They are of miniature 9-pin construction yet perform as well as tubes having larger envelopes.

Ceramic Materials. Stupakoff Division of The Carborundum Co., Latrobe, Pa. New technical data on

WESTINGHOUSE SILICON BRIDGES



How much power do you need?

Westinghouse silicon bridge assemblies are immediately available with outputs from 5 to 100 amperes at 50 to 300 volts peak inverse in standard rectifier circuits.

These new pre-assembled silicon bridges by Westinghouse permit a tremendous spacesaving compared to equivalent selenium stacks.

Typical performance figures using four WN-5051-F diodes on 2″ x 2″ aluminum plates in a single-phase bridge, shown at the right, are:

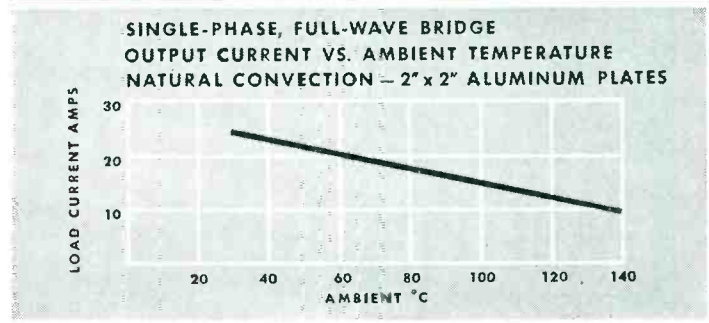
- continuous-load current 25 amperes
- leakage current <20 ma @ 300 volts maximum peak inverse
- natural convection 30° C ambient

A similar assembly with the diodes mounted on 5″ x 5″ plates with forced air can carry up to 100 amperes continuous.

Other Westinghouse silicon and germanium diodes can be mounted in bridges to deliver up to 600 amperes load current at various voltage ratings.

For detailed information on silicon and germanium bridges and diodes, contact your local Westinghouse sales office or write: Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-09005



YOU CAN BE SURE...IF IT'S

Westinghouse

11 of the company's ceramic materials is the subject of a new 6-page bulletin. Featured is a chart which gives physical and electrical characteristics for all of the materials, including authoritative data on alumina, Stupalith, Cordierite, Forsterite and other ceramic materials. General characteristics and typical applications are given for all classes of products. Also included is a section devoted to design considerations for the guidance of engineers, in which such subjects as tolerances, flatness, walls and surfaces are discussed.

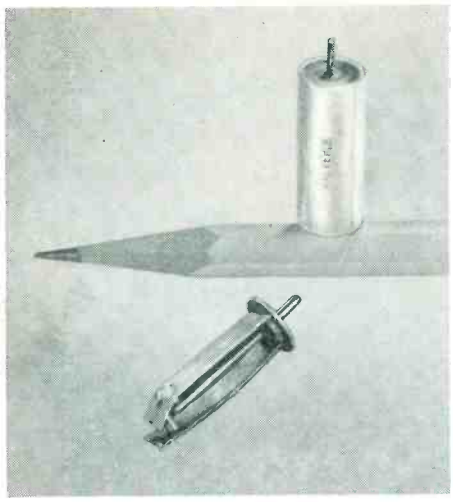
Germanium Rectifiers. Bart-Messing Corp., 229 Main St., Belleville, N. J. Standard models of Sel-Rex germanium rectifiers, from 50 to 50,000 amperes capacity, in either forced air or completely sealed water-cooled design, are illustrated and described in a new 4-page folder. Featured in the rectifiers discussed are high efficiency, unlimited life and voltage regulation.

Photosensitive Devices and CRT's. Radio Corp of America, Harrison, N. J. A 24-page catalog (No. CRPD-105) contains technical data on 45 types of phototubes, 6 types of tv camera tubes, and 56 types of crt's. Each tube is covered by a text description, tabular data, and a socket-connection diagram. Representative tube types are illustrated throughout the catalog. The new catalog is priced at $0.20 per copy.

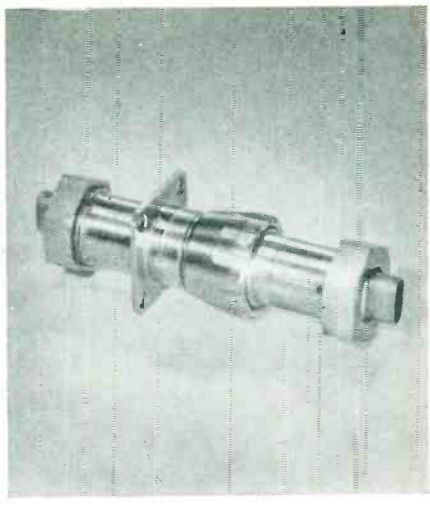
Filmpot Applications. Fairchild Controls Corp., Park Ave., Hicksville, L. I., N. Y. A 4-page folder contains an illustrated article on Filmpots and their recent applications. The metallic film potentiometer described is ideally suited for service as the correcting element in servo loop systems where the high resolving power permits higher system accuracy as a result of the elimination of hunting, which may occur under certain conditions with balancing potentiometers of lower resolving power. Other applications of the unit discussed are listed.

Instrument Catalog. Waters Mfg., Inc., P. O. Box 368, South Sudbury, Mass. A new catalog includes the wide-range inductance bridge for

Variable-resistor trouble caused by failure of spring to resist corrosion and heat. Or by failure to permit sound weld on collar. SOLVED WITH INCONEL* NICKEL-CHROMIUM ALLOY. *Resistor shown is used in power field, also in welding equipment. Sliding Inconel spring clip, silver contact rivet, assure corrosion resistance, weldability, and constant pressure. Despite 570°F temperatures at times, Inconel spring takes overloads. Replaced plated-steel springs. Used last 5 years by International Resistance Co., Philadelphia, Pa.*



Sticking, fouling, commutation trouble on conductive actuating contact springs. Encountered in miniature thermostats. SOLVED WITH DURA-NICKEL* AGE-HARDENABLE NICKEL STRIP. *Constant elasticity gives true snap action. In 3/8" x 15/16" unit shown, temperature control is held to within 2°F up to 350°F. No drift, no sticking, no fouling in this "Val 90" miniature thermostat. Resists fatigue and relaxation. Made by Valverde Laboratories, 252 Lafayette St., New York 12, N. Y.*



Vibration and heat trouble often pose problems to designers of electrical connectors used, for example, continuously at 800°F in aircraft. SOLVED WITH "R"* MONEL FREE-MACHINING NICKEL-COPPER ALLOY . . . OR CAST MONEL. *Units fabricated from these nickel-copper alloys never rust or freeze together. Show no carbide precipitation at 800°F. Permit quick make-break connection of watertight, gas-tight joint such as above "Hot Zone" Electrical Connector that defies vibration. Produced by American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill.*

Electrical-resistance trouble from oxide on terminal lug of rheostat. A problem when contact brush is moved from resistance wire to terminal lug very infrequently. SOLVED WITH MONEL* NICKEL-COPPER ALLOY. *Monel lug allows excellent electrical contact. Used on rheostats for 22 years by Ohmite Manufacturing Co., 3601 Howard St., Skokie, Illinois.*

Liquid-corrosion trouble due to attacks by chemicals, brine and the like. On sheathing of strip heaters, for example. SOLVED WITH MONEL* NICKEL-COPPER ALLOY. *This Monel sheath resists deterioration from heat as well as corrosives, yet permits delivery of heat up to 750°F. Unit shown is product of Waage Electric, Inc., Kenilworth, N. J.*

Trouble-spots . . .

removed by designers using Inco Nickel Alloys

Take no chances. Use components that will back up your designs.

Those illustrated give trouble-free performance, thanks to vital parts made from Inco Nickel Alloys.

Component manufacturers use Inco Nickel Alloys where parts require combinations of properties. High mechanical properties, specific electrical properties, corrosion resistance, resistance to high or low temperatures, good workability and machinability.

Inco's research staff can recommend the right alloy for your trouble. So whenever you have a component problem, check with us.

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67 Wall Street — New York 5, N. Y.

INCO
TRADE MARK

measuring inductance of iron-core inductors, filter chokes, transformers and plate reactors; the cathode interface impedance bridge for measuring the impedance that develops in vacuum tubes used in computers and tv receivers; the crystal diode curve tracer for testing diode characteristics; and the Waters torque-watch gage for measuring low torque in servomechanisms, small motors and potentiometers.

The catalog describes the instruments, gives uses, methods of operation, theory, and specifications regarding models, ranges of measurement and power requirements.

Test Instruments. Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, L. I., N. Y. Catalog No. 23 illustrates and describes in detail the entire line of the company's test instruments for industrial and radio-tv-communications service and other electrical and laboratory applications.

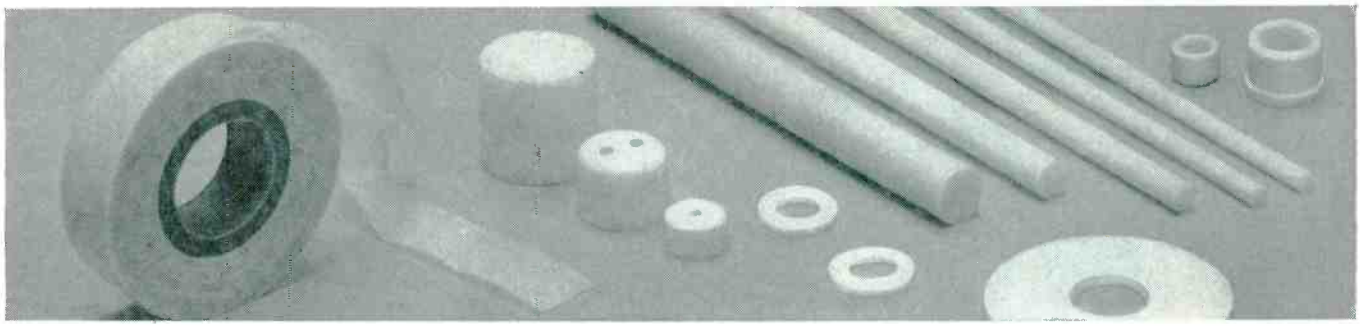
Screen-Booth Filters. Tobe Deutschmann Corp., Norwood, Mass. The 2-page engineering bulletin No. F-108 describes screen-booth filters for use in power supply lines to shielded test rooms where tests are performed to military specifications. These filters are built to specification MIL-S-4957 and provide over 1,100 db attenuation from 100 kc to 1,000 mc; in some units the range is extended down to 14 kc and up to 15,000 mc. Industrial types are also available.

Television Lens. The Perkin-Elmer Corp., Norwalk, Conn., has published a brochure describing the Auto-Zoom model 16 tv lens for use with 16-mm tv cameras and the vidicon tube.

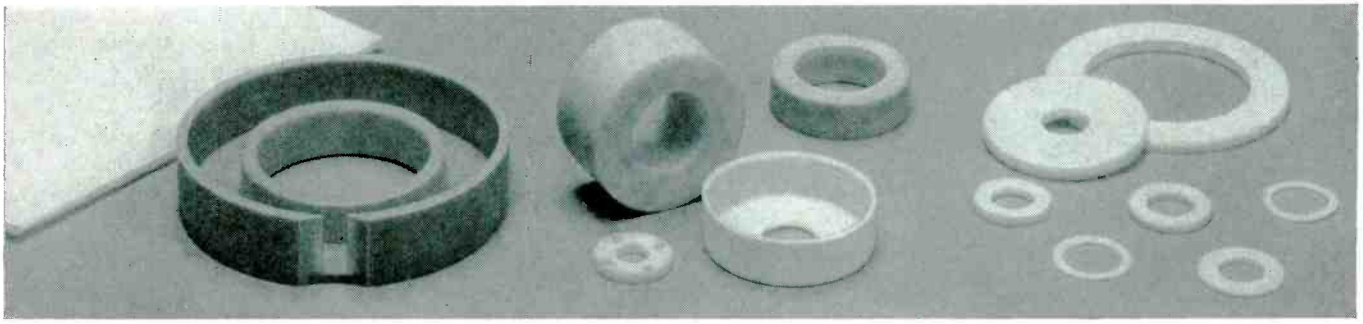
The lens features a 5-to-1 variable focal range and motor-driven zoom, focus and iris which permit its control at any distance from the camera. It covers the full vidicon format with no vignetting at the corners. It can focus on any object from 6 ft to infinity.

The 4-page, 2-color brochure describes the features, specifications and uses of the new lens.

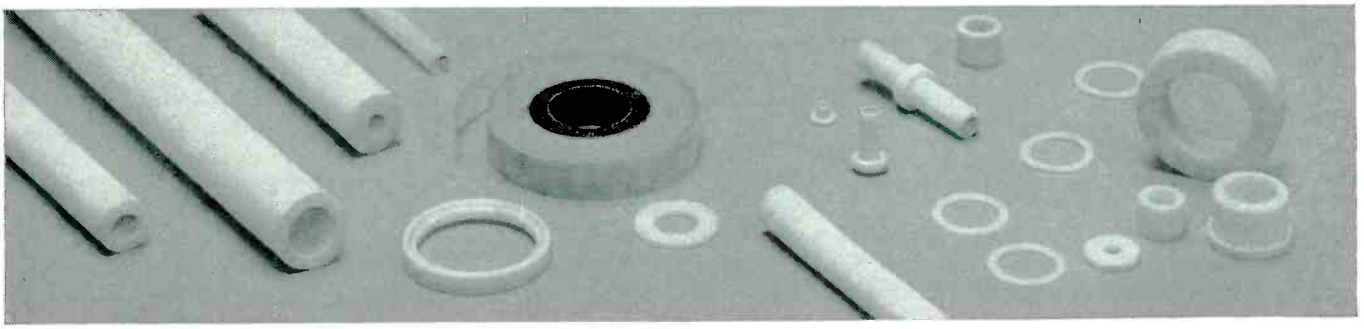
Nobrush Notations. Georator Corp., Manassas, Va., announces publication of *Nobrush Notations*, to be issued regularly. Each issue



DON'T GIVE UP WITHOUT TRYING



AN R/M Teflon* PRODUCT



What are you striving for—product improvement?—better equipment performance?—a more economical process? A product made of "Teflon" by R/M could well be the missing link you're seeking. For R/M has been working with this wonder plastic ever since it was produced and, with it, has solved some of the very toughest problems encountered in recent years by electrical and electronics engineers.

It is quite conceivable that R/M has already faced your particular problem and come up with a solution to it. So take advantage of the skill, experience and unmatched help that R/M can offer you. The many different products pictured indicate R/M's versatility in "Teflon" manufacture. We can fabricate to your own specifications or supply you with "Teflon" in the form of rods, sheets, tubes or tape in 13 colors conforming to military standard color code. 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 the discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi. *Du Pont trademark

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, Manheim, Pa.

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RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Packings • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose Rubber Covered Equipment • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

contains engineering specifications of a new type of Nobrush electric generator or frequency converter. There is also a brief discussion of the engineering features of the machine and the best mode of use in electrical and electronic work. The first issue has photograph and engineering specifications of a new 60 to 400-cycle converter, 0.5 kva output.

Readers are invited to have their names placed on the mailing list.

Broadcast Equipment. Langevin Mfg. Corp., 47-37 Austell Place, Long Island City 1, N. Y. An 8-page folder illustrates and describes transformers, reactors, amplifiers, power supplies and special equipment custom-built by the company.

Data Reduction. Benson-Lehner Corp., 11930 Olympic Blvd., Los Angeles, Calif. A 4-page 2-color folder shows and describes the complete line of data reduction equipment and components being manufactured by the company. Included are 3 different models of OSCARS (oscillograph analyzer and recorders), 3 BOSCARS (ballistics film analyzers and recorders), and 3 plotters. Described and illustrated also are the company's projectors, LINIPOT (rectilinear potentiometer) and KEYPAK (digital keyboard).

Induction Heating Control Station. Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill. A new bulletin fully describes control stations used in conjunction with remote station and motor generator induction heating equipment of either 960, 3,000 or 9,600 cycles and ranging in power output from 30 kw.

Technical data for use of equipment in applications such as tempering, annealing, selective hardening, surface hardening, normalizing, shrink fitting, stress relieving, hot forming, forging, and for brazing and soldering are listed.

Shock and Vibration Service. Shock and Vibration Research Inc., 820 Hammond Bldg., Detroit 26, Mich., announces publication of a new 2-color booklet explaining how their new service offers important engineering assistance in such fields

New!

LAMBDA MODEL 71 PORTABLE POWER SUPPLY

WIDE RANGE! 0-500 VDC @ 0-200 MA
LIGHT! Weighs only 49 lbs.
COMPACT! 13" high, 8¾" wide, 14½" deep

A de luxe unit that combines every good engineering feature with maximum compactness and portability.

A VERSATILE, HEAVY-DUTY PORTABLE WITH BROAD FIELD AND LABORATORY APPLICATIONS

Cannot be damaged by external overloads! No down time! Circuit breakers provide complete protection!

$289.50 *F. O. B. Factory, College Point, N. Y.*

SPECIAL FEATURES

- Overload Circuit Breakers. AC and DC Circuit Protection
- No "Down Time" due to External Overloads
- Stable 5651 Reference Tube
- Vernier High Voltage Control
- Hermetically-Sealed, Oil Filled Condensers
- Time Delay Tube Protection
- All-Aluminum Construction
- Made by America's Leading Power Supply Specialists

SPECIFICATIONS FOR LAMBDA MODEL 71 PORTABLE

INPUT.....105-125 VAC, 50-60 CPS, 475 W (max)

DC OUTPUT NO. 1 (regulated for line and load)
Voltage.....0-500 VDC (continuously variable)
Current.....0-200 MA (over entire voltage range)
Regulation (line)....0.15% or 0.3 volt (whichever is greater)
Regulation (load)....0.15% or 0.3 volt (whichever is greater)
Internal Impedance.....Less than 4 ohms
Ripple and Noise.....Less than 5 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) 5,500 ohms
(b) 0-200 VDC (no load) 25,000 ohms
Current range:
Any value of external load impedance may be used including continuous low impedance or short-circuit. Insignificant inter-action on Output No. 1 Short Circuit Current: 9 MA (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 12.6V (nominal) at 5A, or in parallel for 6.3V (nominal) at 10A.

AMBIENT TEMPERATURE AND DUTY CYCLE:
Continuous duty at full load up to 40°C (104°F) ambient.

OVERLOAD PROTECTION:
External overload protection.....AC and DC magnetic circuit breakers. Trip-Free. Instant manual reset. Front panel.
Internal failure protection.....Fuses, access through rear of cabinet.

INPUT AND OUTPUT CONNECTIONS:
Input.....8 foot heavy duty rubber covered line cord with integral molded plug, rear of cabinet.
Output.....Sturdy insulated "5-way" binding posts, front panel.

METERS:
Output voltage.....Multi-range 3½" rectangular voltmeter calibrated 0-50 VDC, 0-200 VDC, 0-500 VDC.
Output current.....3½" rectangular milliameter calibrated 0-200 MA.

VOLTAGE REFERENCE TUBE:
A stable 5651 reference tube is used to obtain superior long-time voltage stability.

TIME-DELAY RELAY CIRCUIT:
A 30 second time delay circuit is provided to allow tube heaters to come to proper operating temperature before high voltage can be applied.

SIZE AND WEIGHT AND FINISH:
Size.....13" H x 8¾" W x 14½" D
Weight.....49 lbs.
Finish.....Two-tone gray

LAMBDA Electronics Corp.

THE FIRST NAME IN POWER SUPPLIES

11-11 131 STREET • COLLEGE POINT 56, NEW YORK • INDEPENDENCE 1-8500

Want more information? Use post card on last page.

as: radio countermeasures, instruments for detection, telemetering, electromechanical controls, missile guidance systems, computers, servomechanisms, simulators and acoustics.

Precision Potentiometers. Fairchild Controls Corp., Park Ave., Hicksville, L. I., N. Y. "General Aspects of Precision Potentiometers" is the title of an article contained in a recent 6-page bulletin. It shows how the state of the art of manufacturing precision potentiometers has advanced by leaps and bounds in the past 5 years. The booklet is well illustrated.

Magnetic Starters. Essex Wire Corp., Logansport, Ind., offers a new 8-page bulletin on their complete line of reversing and nonreversing line-voltage a-c magnetic starters. Construction, application and engineering specifications, pertaining to the various types of starters is included. Also listed are thermal overload relays which are used in conjunction with the starters.

Bulletin 1020 gives service instructions and a parts list.

Wide-Band D-C Amplifier. Doelcam, A Div. of Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass. Technical bulletin WBA describes a new wide-band d-c amplifier for data-handling systems, plug-in type, model C23125. Applications, features, performance characteristics and other data are described.

Thermal Relay. OK Electronics Corp., 7 Hunt Place, Nutley, N. J. A 4-page brochure illustrates and describes the model 200 thermal time-delay relay, a hermetically sealed temperature-compensated mechanism suitable for delay periods from two seconds to five minutes. It is useful in all types of military, commercial and communications equipment. The bulletin gives mechanical and electrical data and general applications.

Potentiometer Catalog. Waters Mfg., Inc., 4 Gordon St., Waltham, Mass. Precision wire-wound potentiometers with bushing-, or servo-mounts, ranging from ½ in. to 1⅛ in. in diameter, with resistances

"If You've Used High Vacuum

You'll Really Appreciate These New NRC High Vacuum Components"

"They'll make your life easier . . . your vacuum system more productive.

"Take this new **NRC Model 520 Alphatron® Ionization Vacuum Gauge.** Its six scales cover the range from 1000 millimeters to 0.1 micron with accuracy better than ±2%. It's especially suitable for use with recorders because drift is negligible despite wide line voltage variation. It's rugged. Jolt the head, subject it to vibration, you still get accurate readings, and it's less subject to contamination than any other high vacuum gauge.

"This new **A-2-P Air-cooled Purifying Diffusion Pump** has speed, blankoff, and forepressure tolerance ranking with the best two-inch diffusion pumps without the complications of a water-cooled system. What's more, you can air release it while it's still hot.

"The **NRC Rotary Gas Ballast Pump** equals any mechanical pump under *ideal* conditions but *continues* to do the same job even when pumping 100% water vapor or many other condensable vapors.

"We've found the importance of components like these through years of building and operating high vacuum systems and equipment. Why not take advantage of our experience?"

See these at work, Booth 224, I.R.E. Convention, March 19-22, 1956.

NRC

NRC EQUIPMENT DIVISION

NRC EQUIPMENT DIVISION
NATIONAL RESEARCH CORPORATION
Dept. 43, Charlemont St., Newton Highlands 61, Massachusetts

Send me Data Sheet on Vacuum Gauges ☐ Diffusion Pumps ☐ Rotary Gas Ballast Pumps ☐
Have your representative call ☐

Name..... Title.....
Company.....
Address.....
City..... Zone..... State.....

Want more information? Use post card on last page.

ranging from 10 to 100,000 ohms, and including a low-torque series, are described in the new Aerohm catalog. Mechanical and electrical specifications are listed in chart form, as are resistance ranges, linearity for both bushing-, and servo-type mounting, electrical rotation with or without stops, functional rotation with or without stops, dissipation rating with temperatures, torque rating per cup, weights, and capacity for ganging of unit on a single shaft.

Improved Soldering. Anchor Metal Co., Inc., 244 Boerum St., Bklyn 6, N. Y. "Solder and Its Proper Application" is a compact guide to improved industrial use of solders and fluxes.

Packed with informative soldering hints and tips, the folder discusses the varied types of soft and hard solders used in metal joining; nine different methods of applying heat to solder and joint; preparation of work prior to soldering; determination of heat requirements for production soldering of small pieces, and for large surfaces; procedures to follow for strong soldered connections; and a description of fluxes and how to select them. A special section is devoted to problems common to aluminum soldering and their solution.

High-Readability VTVM. The Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 4 of the *Journal* illustrates and describes the enhanced accuracy vtvm which measures a-c voltages to an accuracy of within ±1 percent over the frequency range from 50 cps to 500 kc and over the voltage range from 1 mv full scale to 300 v full scale in 12 ranges. Complete specifications of model 400 H vtvm are listed. Also described is the use of the notch wattmeter with the company's signal generators.

Precision Delay Lines. Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. Engineering data sheet ADL-6 covers the new 5,000-μsec delay lines which are specifically designed for use in precision analog computing, autocorrelation, and subsonic and sonic applications. The delay lines discussed feature

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extremely long delay, low attenuation and excellent phase linearity over a wide range of frequencies.

The design described is based on M-derived techniques employing high Q toroidal inductance assemblies and ultrastable polystyrene capacitors. The 125 taps are brought out on the front panel by heavy double-turret lugs for easy accessibility. The units have found application in the study of speech waveforms, wow and flutter of tape mechanisms, sonar returns, sonar ranging and servo analysis.

This data sheet includes complete specifications.

Digital Computing and Control Circuits. Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass. A 20-page brochure covers logical design of digital computing and control circuits with 3C-PAC's. In the report, examples of the application of 3C-PAC's in the design of digital computing and control circuits are given. A full table of contents and 21 line drawings are included.

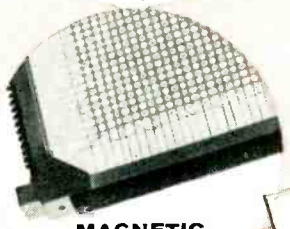
Industrial Products. General Findings and Supply Co., Attleboro, Mass. An 8-page booklet discusses the company's line of precious and nonprecious laminated metals, as well as fabricated precision parts and assemblies for the electronic, aircraft and allied industries.

UHF Attenuators. Stoddart Aircraft Radio, Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif., has available an 8-page brochure entitled "UHF Attenuators." The company's full line of coaxial attenuators and coaxial line terminations is illustrated with full description and complete specifications. Especially detailed description is given of the small turret attenuator which affords selection of any of six steps of attenuation with a simple pull-turn-push positioning sequence, and which is available in any combination of attenuations between 0.1 db and 60 db, including fractional db values.

Capacitors. Micamold Electronics Mfg. Corp., 1087 Flushing Ave., Brooklyn 37, N. Y. A file folder includes the first of a series of

FERRAMIC CORES

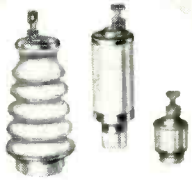
FERRAMIC MAGNETIC CORES



MAGNETIC MEMORY PLANES

"ADVAC" HIGH TEMPERATURE SEALS

STEATITES



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General Ceramics design and production facilities are geared to today's electronic and electrical requirements. In many cases, standardized designs and production methods can reduce costs and facilitate delivery. When specifications call for new designs and engineering, General Ceramics' half century of ceramic manufacturing experience is available to help solve your problem quickly, and economically!

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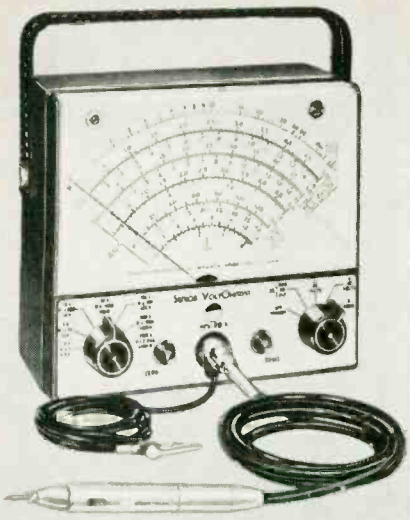
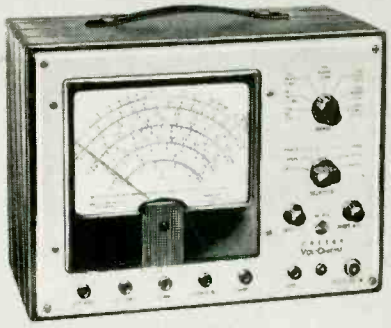


RCA-WV-98A . . . ALL-NEW SENIOR VOLTOHMYST . . . incorporates all the important time-proved performance features of earlier VoltOhmysts including direct peak-to-peak readings of complex waveforms. The new Senior VoltOhmyst includes an improved circuit providing greater accuracy, and a BIG full-vision meter face with the easiest-to-read scales ever designed into a VTVM! Complete with WG-299A DC/AC-Ohms probe and cable, instruction booklet. **$75.00***

RCA-WV-77-B . . . ALL-NEW JUNIOR VOLTOHMYST . . . one of the greatest values in vacuum-tube volt-ohmmeters. Embodies several new design features in addition to operational characteristics which have made earlier versions of the instrument the choice of thousands in radio and TV servicing, industry, electronics, communications, broadcasting, and in the armed forces. Complete with WG-299A DC/AC-Ohms probe and cable, instruction booklet. **$55.00***



RCA-WV-87A . . . MASTER VOLTOHMYST . . . features a 27 sq. in. meter. Its easy-to-read peak-to-peak scales are particularly useful for TV, radar, and other types of pulse work. Has accuracy and stability necessary for many laboratory applications. Complete with probes and cables, including: WG-218 direct probe and cable, WG-222 DC/Direct probe, ohms probe and cable, current leads, negative current lead, ground lead and instruction booklet. **$112.50***

*User Price (optional)

Accurate • Stable • Reliable • Portable • Easy-to-set-up • Easy-to-read

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superior quality test instruments FOR LABORATORY . . . PRODUCTION TESTING

Modern engineering, testing, and production techniques demand test instruments with *practical* operating features. RCA VoltOhmysts are "packed" with practical features which make them especially suited for operation over extended periods under rigorous production-line conditions. Features include: electronically protected meters; accuracy unaffected by normal line voltage fluctuations; easy-to-read expanded scales; one zero setting holds for all voltage and resistance ranges; accessory probes extend dc ranges to 50 KV, and extend frequency response to 250 Mc.

Factory-built, factory-tested, and calibrated to *laboratory* standards, RCA VoltOhmysts are the finest VTVM's for the money. For the VoltOhmyst to fit your needs, see the chart at the right.

CHOOSE THE VOLTOHMYST THAT SUITS YOUR NEEDS

Features	Master VoltOhmyst WV-87A	Senior VoltOhmyst WV-98A	Junior VoltOhmyst WV-77B
Measurements:			
DC Voltage	0.02-1500v	0.02-1500v	0.05-1200v
AC (rms) Voltage	0.1-1500v	0.1-1500v	0.1-1200v
AC (peak-to-peak) Voltage	0.2-4200v	0.2-4200v	—
Resistance	0.2-1000 meg.	0.2-1000 meg.	0.2-1000 meg.
Current	10 uamp.-15 amp.	—	—
Accuracy:**			
DC current	±3%	—	—
DC voltage	±3%	±3%	±3%
AC voltage	±5%	±3%	±5%

**At full-scale points
+For positive voltages, ±5% for negative voltages

RCA TEST EQUIPMENT
RADIO CORPORATION OF AMERICA

For technical details, call your RCA Distributor, or write RCA, Commercial Engineering, Section C19W, Harrison, N. J.

RCA Ultra-Sensitive DC Microammeter, WV-84A, For Reading Extremely "Feeble" Currents.

WV-84A measures minute currents from 0.002 to 1000 ua—in six ranges! It can be used as a very high-resistance voltmeter—up to 1005 megohms on 100-volt range. And, the WV-84A can be used as a megohmmeter for measuring resistance up to 90,000 megohms. $100.00* less batteries.

Well-suited for applications in such fields as biology, nucleonics, chemistry, and electro-mechanics—as well as electronics—the WV-84A is completely portable, with a self-contained battery power supply.

bulletins that will, when all of them are published, cover the complete lines of products the company manufactures. Also available is a brochure which briefly outlines the principal series of capacitors manufactured for military equipments. Included are most of the capacitors covered by MIL specifications JAN-C-5, JAN-C-25, JAN-C-62 and JAN-C-91.

Square Wave Generator. Hewlett-Packard Co., 331 Page Mill Road, Palo Alto, Calif., has available a single page reprint illustrating and describing the model 211A square-wave generator with 0.02-μsec rise time. Included are chief features and technical specifications. Price of the unit discussed is $265.

Contact Modulators. Airpax Products Co., Middle River, Baltimore 20, Md. Bulletin No. 103, revised edition, describes theory and application of the contact modulator, popularly called the chopper. It includes detailed descriptions of chopper characteristics including definitions of all terms, a review of procedures for measuring chopper characteristics, a summary of chopper applications, a nonmathematical discussion of chopper theory and a report of studies into noise sources.

The bulletin concludes with a summary of characteristics of popular commercially available choppers with a convenient reference table of mounting dimensions and principal characteristics. An extensive bibliography enables readers to locate pertinent reference articles in this growing field.

Ohmmeters. Industrial Instruments, Inc., Cedar Grove, N. J. The LRO bulletin provides technical information and specifications on both the LRO and LRO-1 low-resistance ohmmeters. Both meters feature extremely low current through the test piece for readings on components or circuits.

Regulated Power Supply. Deltron, Inc., 2905 N. Leithgow St., Philadelphia, Pa., has available a bulletin describing two new power supplies of the electronically regulated type with the output voltage variable from 0 to 500 v and currents of 500 ma at any voltage within its

range. Complete technical and operational specifications are listed. The units described feature high performance and low cost.

Thermocouple Refractory Insulators. Stupakoff Division of The Carborundum Co., Latrobe, Pa. Stupakoff thermocouple refractory insulators are detailed in a new 6-page bulletin. The bulletin also contains dimensional charts for hundreds of sizes and types of tubing and beads. Also included is information on how to order Stupakoff thermocouple insulating tubing.

TV Picture Tube Chart. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y., has released a new version of its handy tv picture tube comparison chart.

Over 170 different picture tube types are listed on the chart. Added informational features include ion trap listings, focus, deflection, and base diagrams. Face, body, basings and length-in-inches on all tubes are included.

Linear Accelerometers. Doelcam, a division of Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass. A technical bulletin describing a new line of linear accelerometers, model GG22 series, recently added to the Doelcam line of aircraft and missile components has just been released. Bulletin LA presents features, specifications, outline drawing and installation data.

Electronic Components. Mandex Mfg. Co., Inc., 2608 W. 16th St., Chicago 8, Ill., has published a 60-page illustrated catalog of its electronic components. The brochure gives designers and engineers full information, drawings and specifications on molded and laminated tube sockets, terminal strips, lugs, plugs and the like.

D-C Power Supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has announced a new bulletin describing model MR532-15A, 2 to 36 v at 15-ampere magnetic amplifier tubeless regulated d-c power supply. Advantages of the use of tubeless power supply units are outlined.

The unit discussed has a range of 2 to 36 v at 15 amperes (con-

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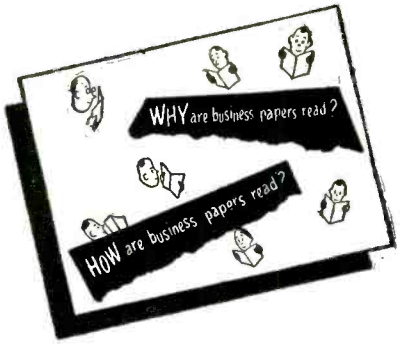

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One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

tinuous) with a ± ½-percent regulation over the range of 5 to 32 v and a ± 2-percent regulation over the 2 to 5-v and 32 to 36-v range with a ripple of 1 percent rms, and a response time of 0.1 to 0.2 sec maximum.

Theory of operation, typical features and improvements are described and illustrated. Complete characteristics are included.

Beryllium Copper Strip. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa. The new 12-page bulletin 6 offers suggestions for ordering beryllium copper strip. It includes a discussion of available alloys, tempers, sizes and tolerances with tubular data on properties. It presents data on Penntemp mill-hardened beryllium copper strip that requires no heat treatment.

Electronic Aircraft Components. Hufford Machine Works Inc., 2201 Carmelina Ave., Los Angeles 64, Calif. A 4-page folder illustrates and describes autopilot amplifiers and components, airborne power supplies, a transistorized static inverter, magnetic amplifier relay, voltage regulator, magnetic amplifier regulated power supplies and a frequency changer.

Rectifiers and Power Supplies. Technical Apparatus Builders, 109 Liberty St., New York 6, N. Y., has released catalog PR156, which lists the complete specifications, ratings and prices for its new line of d-c power components, Tabtron selenium rectifiers, d-c power supplies, Tabtron chokes and transformers.

Featured in PR156 are Tabtron d-c power supplies for automation, aviation, radio, relays, tv and others which meet Government JAN specifications.

Test Units. Davenport Mfg. Co., 1713 N. Ashland Ave., Chicago 22, Ill. Units for over potential testing and power supply use, along with standard meters, h-v voltmeters, shunts, transformers, phase sequence indicators, and other equipment comprise the line announced in a new 20-page catalog.

Detailed product descriptions and illustrations are attended by schematics, performance charts and output tables to make the catalog a

helpful, data-packed handbook for proper unit selection. The range of engineering services available and the scope of the company's experience are indicated in a back-page listing of the special equipment offered by the company. A price list is included.

Steatite Ceramic. Star Porcelain Co., 158 Muirhead Ave., Trenton 9, N. J., has available three revised catalog sheets on standard parts in Lavolain, a steatite ceramic for high-temperature insulation with high dielectric and mechanical strength.

Catalog sheets 400, 600 and 700 contain specifications on center shoulder bushings, insulating washers and bushings, and insulating shoulder bushings.

Picture Book of Springs. Associated Spring Corp., Bristol, Conn. An 80-page book has been prepared to show spring users the various kinds of workmanship done by the corporation. Products covered vary so much in their uses, types, shapes, sizes and materials that they are best described by pictures. An index is included.

Power Tubes for Broadcasting and Industry. General Electric Co., Schenectady 5, N. Y., has available a new edition of its booklet on the interchangeability of power tubes used in broadcasting and industry. Designated ETI-719B, it is a time-saver in selecting interchangeable tube types. A new feature of the publication is a listing of the 282 tube types in alphabetical and numerical order instead of by manufacturer. The list includes all types of power tubes for which GE has a direct replacement.

Reliable Tube Specification Sheet. American Radio Co., 445 Park Ave., New York 22, N. Y., has announced a new specification sheet for a line of 14 Miniatrons, long-life preferred reliability miniature electron tubes. Included among the tubes described are the 6J4WA, 6101/6J6W, 5654/6AK5W, 5749/6BA6W, 5750/6BE6W, 6005/6AQ5W, 6073/OA2WA, and 2D21. Maximum ratings and typical operation are shown.

Plants and People

Edited by WILLIAM G. ARNOLD

Institute of Radio Engineers readies plans for 1956 national convention, appoints new officers for the year. Manufacturers form new companies, expand plants and facilities. Engineers move to new positions in the industry

1956 IRE National Convention Draws Electronics Industry

Kingsbridge Armory will again be the IRE showplace for electronics exhibits as it was in 1955

MORE than six acres of space will be used for the 714 exhibits at this year's IRE convention in New York City, March 19-22. The technical program will comprise 55 sessions at which a total of over 270 papers will be presented. A highlight of the technical program will be the symposium on the U. S. Earth Satellite Program, Tuesday evening, March 20th. Dr. W. R. G. Baker will preside at the symposium which recognizes the planned International Geophysical Year.

The annual IRE Banquet will be held at 6:45 pm, Wednesday, March 21 in the grand ballroom of the Waldorf-Astoria Hotel. John V. L. Hogan will accept the Institute's Medal of Honor and C. Guy Suits of GE will speak for new IRE Fellows. Arthur V. Loughren, the 1956 IRE president, will present IRE awards. John D. Ryder, the retiring 1955 IRE president, will be toastmaster.

The radio engineering show will be held in Kingsbridge Armory and Kingsbridge Palace in the Bronx, N. Y. Show hours are 10 am to 10 pm except Wednesday when they are 10 am to 5 pm.

The annual meeting of the IRE will be held at 10:30 am, Monday, March 19 in the grand ballroom of the Waldorf. John T. Henderson, IRE regional director of Canada, will speak on Borderline Engineers. Herre Rinia, director of research of the Philips Research Labs, Eindhoven, Holland, and new 1956 IRE vice-president, will also speak.

Technical sessions will be held at the Waldorf, Kingsbridge Armory and the Belmont Plaza Hotel beginning at 2:30 pm on Monday, March 19. Sessions will be held each morning and afternoon thereafter through 5 pm, Thursday, March 22. A schedule of the sessions and individual papers begins on page 468 of this issue.

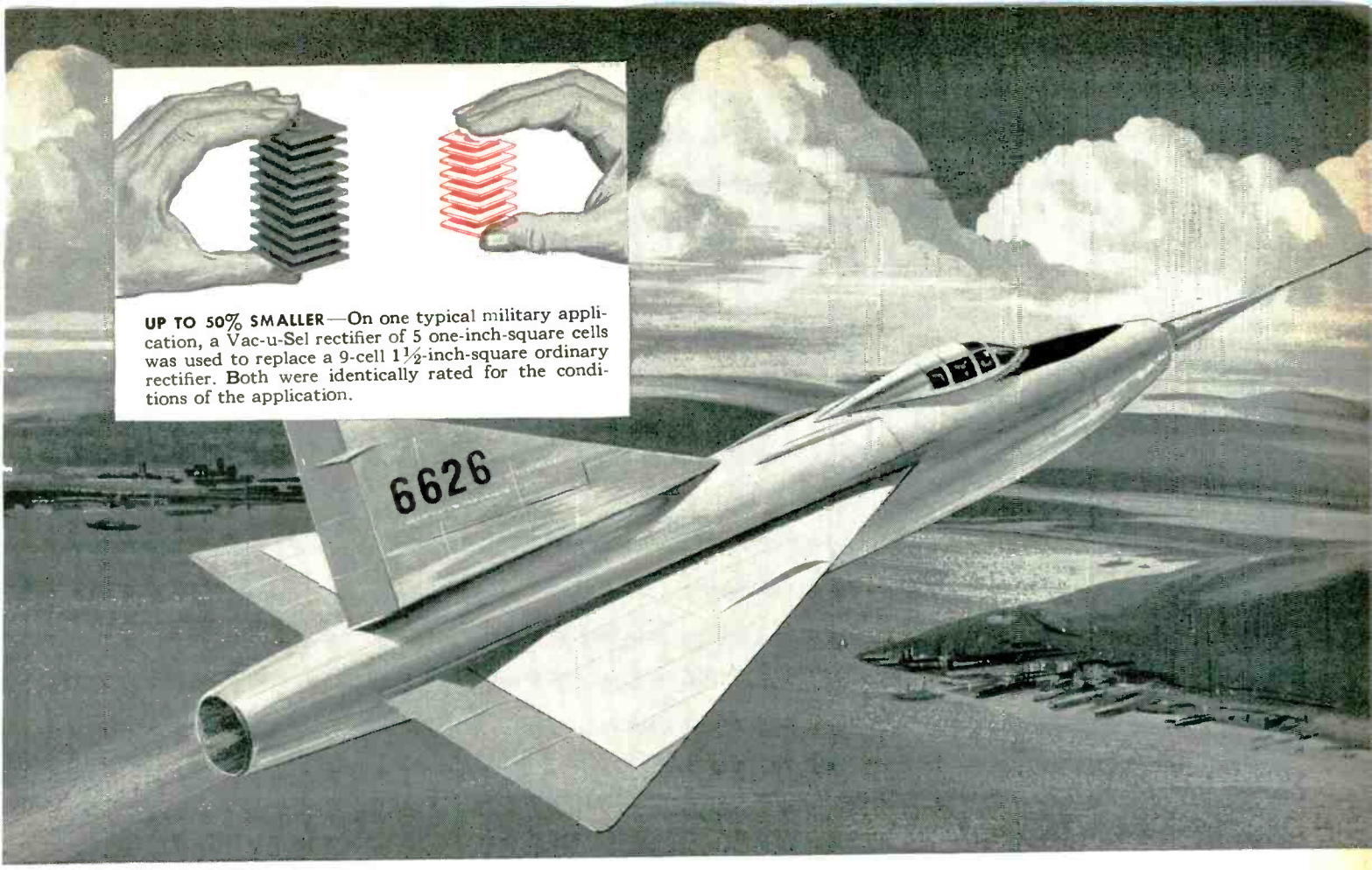
Free bus service between Kingsbridge Armory and the Waldorf-Astoria Hotel will be provided for registrants.

Registration can be made either at the Waldorf-Astoria any day of the convention from 9 am to closing or at Kingsbridge Armory any time during show hours.

1956 Officers Appointed by IRE

SIX members were appointed to the IRE board of directors for 1956.

W. R. G. Baker, vice-president of electronics for GE was reappointed treasurer. Haraden Pratt was appointed to his fourteenth term as IRE secretary. Donald G. Fink,



UP TO 50% SMALLER—On one typical military application, a Vac-u-Sel rectifier of 5 one-inch-square cells was used to replace a 9-cell 1½-inch-square ordinary rectifier. Both were identically rated for the conditions of the application.

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G-E Vac-u-Sel* Rectifier Reduces Design Space 50% and Costs Less Too

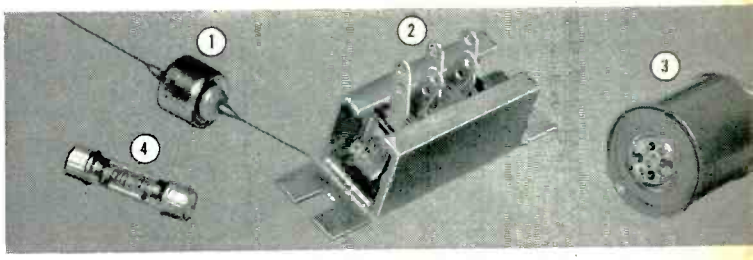
You can save design space and initial cost by taking advantage of the unique characteristics of General Electric Vac-u-Sel rectifiers . . . and still satisfy the requirements of your toughest military applications.

SMALL SIZE: Vac-u-Sel rectifiers can be made up to 50% smaller than ordinary selenium stacks for many specific applications. This is possible, because of the individual cell's ability to carry much greater than normal currents, and be operated at full-rated voltage at elevated ambients. You can often specify a G-E Vac-u-Sel rectifier that is smaller and lighter, but still fully within MIL specifications. These smaller stacks cost from 30 to 50% less than ordinary selenium.

WIDE TEMPERATURE RANGE: The 45-volt Vac-u-Sel rectifier stack (63 volts peak inverse) is capable of full-voltage and full-current operation from −65 C to 110 C without derating.

A full line of Vac-u-Sel rectifiers is available. Contact your G-E Apparatus Sales Office, or write for bulletin GEA-5935 to: Section 461–40, General Electric Co., Schenectady 5, N. Y.

*Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process. Vac-u-Sel rectifiers are produced by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium, and copper-oxide component rectifiers.



DESIGNED TO MEET MIL SPECIFICATIONS, Vac-u-Sel rectifier stacks are available in (1) metal-clad, (2) potted, (3) oil-immersed, and (4) glass-melamine housings, and in special finishes. Wide range of ratings is available.

Progress Is Our Most Important Product

GENERAL ELECTRIC

director of research of the Philco Corp. and former editor of ELECTRONICS, was appointed editor of the IRE to succeed John R. Pierce, director of electronics research of Bell Telephone Laboratories.

Appointed as directors were Alfred N. Goldsmith, consulting engineer and editor emeritus of the IRE; T. A. Hunter, president of the Hunter Manufacturing Co. and editor of the IRE Student Quarterly and J. W. McRae, president of the Sandia Corp. and past president of IRE.

Royal McBee And General Precision Form Computer Firm

ROYAL MCBEE CORP. and General Precision Equipment Corp. are forming a new jointly-owned subsidiary company with equal interests, under the name of Royal Precision Corp.

The new company will develop, produce and market electronic data processing and computation machines and accessory input and output mechanisms, storage devices, and code conversion equipment, for complete data processing centers.

The new enterprise will utilize facilities of both parent companies.

Under the agreement, the initial arrangements contemplate that Librascope, a GPE subsidiary, will develop and produce computers and data processing equipment. The technical resources and facilities of the other companies of the GPE group, will furthermore be available to Royal Precision Corp.

Royal McBee will develop and produce accessory input and output mechanisms as well as code conversion equipment and other supplementary devices for the computers. It will also act as the marketing outlet for all equipment produced for Royal Precision Corp.

Last year Royal-McBee acquired a majority interest in the Robotyper Corp. of Hendersonville, N. C., makers of automatic typewriting equipment and auxiliary attachments. It also owns a controlling interest in Instrument Development Laboratories, whose activities are in the electronic and instrumentation field.

For the fiscal year ended July 31, 1955, Royal-McBee's sales were $84,000,000.

Raytheon Operates New Television Cabinet Plant

RAYTHEON has started production in its new 204,000 sq ft plant in Chicago.

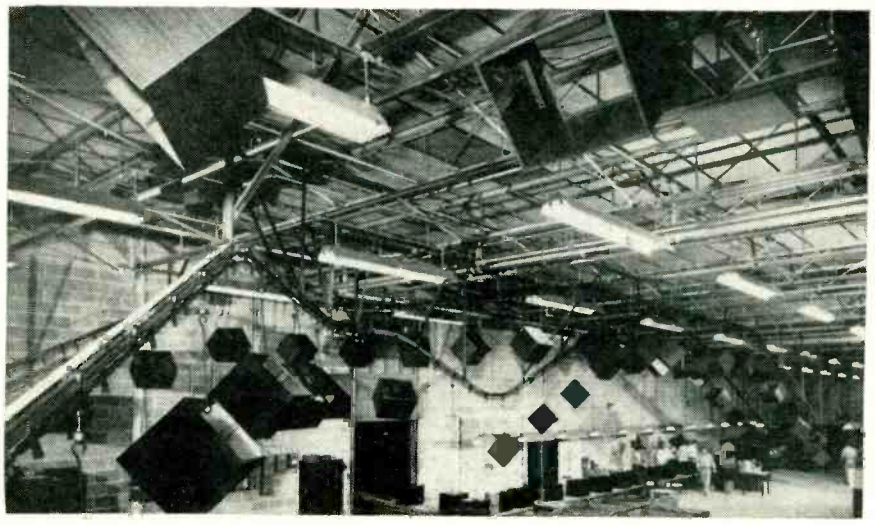
The building houses metal TV cabinet fabricating and painting operations as well as warehousing facilities.

All of the firms 21 inch and 17 inch table model, console and lowboy steel cabinets are now being made in the new plant where some 45,000 sq ft are devoted to this operation.

Of 105,000 sq ft of warehouse space, 80,000 currently will be used for direct storage, with the remainder assigned to the factory service and the export departments.

The opening of the new building has provided an over-all efficiency increase of 75 per cent in the production of the steel cabinets, according to the firm.

About 250 cabinet units an hour, from stamping of the blanks to the drying of the finished painted cabinet, can be handled on the major production line.



Steel tv cabinets ride overhead conveyors at new Raytheon plant

On a second line, in which a graining process is added to provide a mahogany, blonde or maple finish, about 180 units an hour can be produced.

Nearly 1,500 feet of a newly-designed "caterpillar drive" overhead conveyor system serves the two production lines.

IBM Establishes New Research Unit, Plans California Expansion

TO DEVELOP the business machines of the future, International Business Machines Corp. has established a new independent research organization. The new group will remain within the company's research & engineering department, but will operate independently of its parent. It will be headed by Ralph L. Palmer, formerly IBM director of engineering.

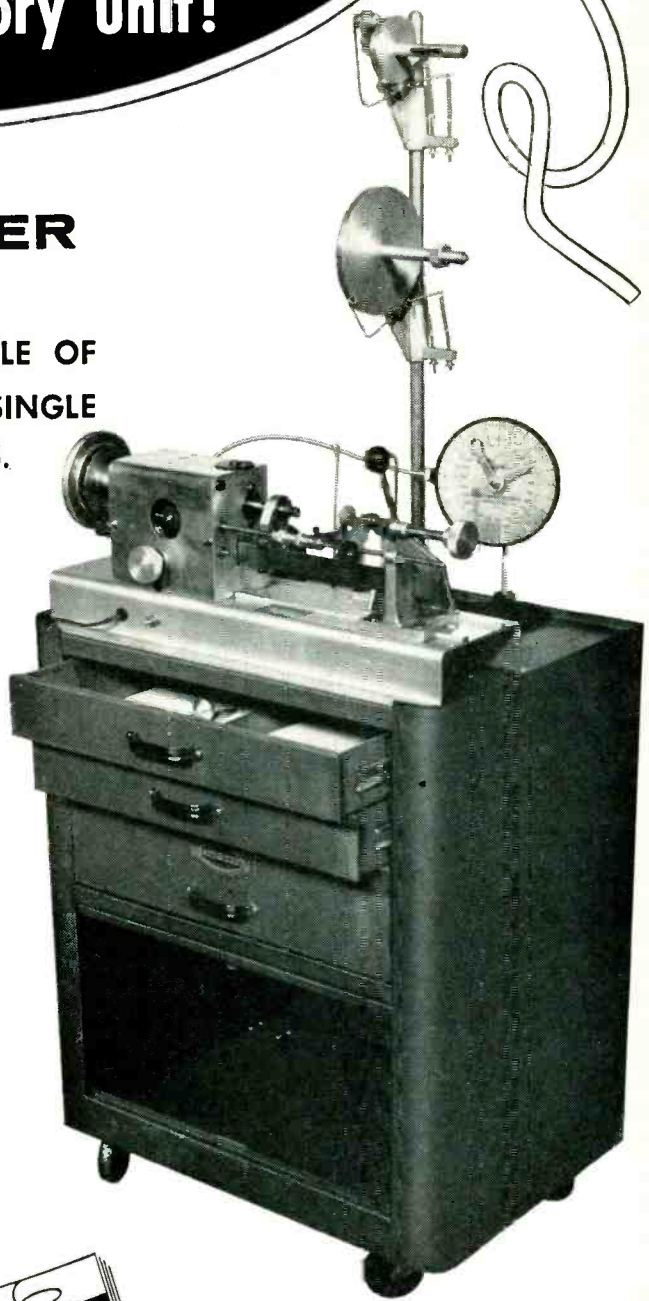
A portion of the company's present engineering operations at Poughkeepsie, N. Y., will be reorganized into a product development laboratory. The new laboratory will be directed by Horace S. Beattie, formerly manager of the Poughkeepsie engineering laboratory.

In his new position, Palmer will

NOW... the world's most Versatile Coil Winder available as a complete laboratory unit!

MODEL W COIL WINDER

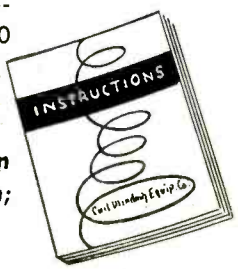
THE ONLY COMMERCIAL MACHINE CAPABLE OF WINDING LATTICE—BOBBIN—INTERLEAVED—SINGLE LAYER—BANK WOUND—INTERWOVEN COILS.



Now the world's most versatile coil winder made up in one mobile compact unit complete with all necessary equipment e.g. lubricants, wrenches, instruction book, etc. The model W is capable of winding every type of coil required in the electronic or industrial laboratory except toroids.

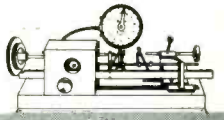
SPECIFICATIONS

⅛ HP motor and speed control—Gears from 25-100 teeth—Wire Guide for universal or lattice winding—Wire Guide for bobbins or layer winding—Wire Guide for single or multiple layer coils to 6" in length—3:1 reverse idler for bank winding and long multiple layer coils—Cams for continuous traverse adjustment, 0"-1½"—Large yoke for larger bobbins and transformers—Available with clock counter calibrated in ¼ turns or with drum type predetermining counter—Universal type arbor for coils with hollow cores—Pi spacing attachment with 1/32 index plate—Adjustable bank winding cam—Feeds for wire as fine as .001"—Rack feed range .00083" to .150" per turn (7-1200 TPI). Maximum distance from head to tailstock 8"—Layer wound coils using cam traverse 2 to 600 TPL. Net weight 140 lbs.



Model W with cabinet comes with 50 page instruction book complete with charts for universal computation; work sheets and nomographs.

Cabinet made of auto body steel with reinforced corners and ends; heavy duty ball bearing rubber tired caster with 2 foot brakes; size 17"x25½"x32" high; one cylinder lock secures all compartments.



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be responsible for all basic research on new techniques and devices for use in IBM's future products. The existing research departments of the present Poughkeepsie laboratory will form the nucleus of the new research organization at Poughkeepsie and the program will be coordinated by Palmer with similar activities at IBM's other laboratories. Beattie will be responsible for all commercial product development and product engineering at Poughkeepsie.

IBM also announced plans to construct manufacturing, engineering, and educational facilities on a portion of its recently acquired 190-acre site in San Jose, California.

Approximately 400,000 sq ft will be built on the site in a "campus-style" arrangement where separate buildings will house manufacturing facilities, a product design laboratory, an advanced development laboratory, and educational facilities. Eventually, about 1,500 employees will occupy the buildings.

One of the principal products to be manufactured at the new plant will be electronic data processing machines incorporating IBM's new "random access" memory device.

The operations at IBM's existing facilities in San Jose will be moved to the new areas in the fall of 1956.

General Transistor Moves To Larger Plant

GENERAL TRANSISTOR CORP., manufacturers of transistors and germanium diodes, has moved and now occupies a renovated building in Richmond Hill, N. Y.

The firm now has over 200 per cent more manufacturing area than in the former Jamaica plant. The company plans to produce over two million transistors this year.

Nuclear Technology Conference Set

NUCLEONICS magazine will cosponsor an Industrial Nuclear Technology Conference with the Armour Research Foundation in Chicago. The meeting will be aimed at an industrial audience and will cover uses of radioactive materials in

many industries and in chemistry and biology. Radiation sources and nuclear instrumentation will also be covered. The meeting will be held on May 15 and 16 at the Museum of Science and Industry in Chicago, Ill.

Gardner To Speak At IRE Meeting

TREVOR GARDNER, formerly assistant secretary, Air Force, research and development, will speak on "Maintaining Technological Superiority" during the national IRE convention in New York, March 20, at a luncheon sponsored by IRE's Professional Group on Aeronautical & Navigational Electronics. The PGANE luncheon will be held at the Ambassador Hotel. Gardner recently resigned from the government post.

Du Mont Elects Patten, Expands For Missiles

Stanley F. Patten

STANLEY F. PATTEN has been elected treasurer of Allen B. Du Mont Laboratories in addition to his duties as vice-president and a director. He succeeds Paul Raibourn, who will continue as a director of the corporation.

Patten, who joined Du Mont as assistant to the president after his retirement from the Navy as a rear admiral in 1947, was elected vice-president in 1951 and a director in 1952.

Du Mont also announced formation of a new missiles engineering department which will be responsible for all company design and de-

velopment work in the missle field. Du Mont engineering groups engaged in missile electronic work over the past few years will become associated with the new department.

The company plans to expand the new department. Installation of additional facilities at Du Mont's new West Coast headquarters in Los Angeles, Calif. has begun.

Donald M. Christie has been promoted to the position of manufacturing manager of the government manufacturing division of the firm.

Prior to his new appointment, he was coordinator of manufacturing and engineering for the mobile department of the communication products division. More recently, he had been inspection department manager of the technical products division.

GE Forms Antenna Group, Names Engineers

GE HAS formed a separate radar antenna engineering organization within its Naval Ordnance department.

The new group will have complete responsibility for development, design and engineering consultation services for both marine and land-based radar antennas.

Frank X. Schnabl will direct the new group with the title of manager-antenna engineering.

Theodor Buchhold, German rocket expert who chose to continue his work in the United States rather than in Russia, has joined GE as a consulting engineer.

The 55-year-old engineer, who helped develop the control and guidance systems for several of the world's most powerful missiles, including the German V-2, will serve in the company's general engineering laboratory.

In his new post, he will continue his work in the guided missile field.

Dr. Buchhold came to the United States in 1946 to work on a U. S. government missile project.

After developing the basic concept of a new inertial guidance system for Redstone missile, Dr. Buchhold joined the Ford Instrument Company, Long Island City, N. Y., as consultant to the vice-

president of engineering.

GE also announced the appointment of Charles R. Buchwald as manager of manufacturing engineering of its cathode ray tube plant in Syracuse, N. Y.

Buchwald joined the G-E Electronics Laboratory in 1951 and in 1953 was named supervisor of facilities development in the cathode-ray tube sub-department. In June, 1955, he was appointed superintendent of the cathode-ray tube plant at Syracuse. He held this position until his recent appointment.

Packard-Bell Appoints Three

SAM F. ARN has been appointed to the position of chief engineer and Hugh L. Vick, aviation equipment procurement specialist, has been named chief, sales and contract administration of Packard-Bell's technical products division. Both Arn and Vick will report to Richard B. Leng, vice-president in charge of the technical products division.

Arn has 16 years of professional engineering experience. He joined Packard-Bell as engineering sales manager and was later appointed sales manager of the division.

Before joining Packard-Bell he engaged in research and development in the fields of telemetering, missile beacons, IFF, radar and communications systems.

Hugh L. Vick, who has had 16 years of professional administrative experience, has been handling the contract administration phase of the technical products division's sales and contract administration for sometime and now assumes sales responsibilities, as well.

Thomas I. Humphreys joined the company as assistant chief engineer of research of the technical products division.

Humphreys has had twenty years of professional experience in electronic research and development and was previously associated with the U. S. Naval Research and Ordnance Laboratories and the National Bureau of Standards where he was engaged in extensive research on IFF and guided missile

Thomas I. Humphreys

systems and development.

Packard-Bell also announced that the assets of Technical Reproductions, a California firm in the printed circuit field, have been purchased by the Packard-Bell Co.

It will be operated as a department of the firm's technical products division, under the direction of Richard B. Leng, vice-president in charge of the division.

The firm said that printed circuits were used in approximately five per cent of all television and radio sets manufactured in this country in 1954 and in nearly twenty per cent of all sets manufactured last year. It predicted that by 1960, printed circuits will be utilized in fifty per cent of all sets manufactured in the country.

Former employees of Technical Reproductions, Inc., including former president Arnold O. Babbe, will be absorbed into the new department of the technical products division. Sales will be handled by Anthony J. Arman and will be under the direction of Hugh Vick, manager of sales and contracts administration of the division.

Varian Names Dodds and Wagener

WELLESLEY DODDS, formerly of RCA, and Winfield Wagener, formerly of Eitel-McCullough, have joined the staff of Varian Associates in Palo Alto, Calif.

Dodds heads the company's newly established traveling wave tube and backward wave oscillator development department. He served thirteen years as research engineer and

manager of microwave tube advanced development of the RCA tube division.

Wagener had been with Eitel-McCullough for ten years as sales engineering manager before joining Varian Associates. He entered the vacuum tube business in 1929 as a development engineer with Federal Telegraph Co., and has had research and development experience with RCA, Heintz & Kaufman Ltd. and Litton Engineering Laboratories.

Long associated with the electronics industry on the west coast, Wagener will serve as 1956 chairman of the San Francisco Council of the West Coast Electronics Manufacturing Association.

IT&T Promotes Top Engineers

ANDRE G. CLAVIER, Brig. Gen. Peter C. Sandretto (U. S. Air Force Reserve), and Dudley M. Day have been elected vice-presidents of IT&T's Federal Telecommunication Laboratories.

Both Clavier and Sandretto, former assistant vice-presidents, will continue to serve as technical directors in charge of commercial and military development programs, respectively.

D. M. Day, who has been secretary, treasurer and counsel for the Laboratories for the past several years, will continue to serve in these capacities.

IT&T also announced that Rear Admiral Frederick R. Furth, U.S.N. (Retired), who has served

Andre G. Clavier

Peter C. Sandretto

for the past two years as chief of naval research, joined the firm as assistant to Harvard L. Hull, president of Farnsworth Electronics Co. He will be active in new product development for the IT&T division.

As chief of naval research in 1954 and 1955, Admiral Furth directed the expansion and use of new techniques in the Navy's continuing support of upper atmosphere research, a program that has permitted the Navy to move ahead rapidly with the technical portion of the earth-satellite program.

North American Expands Autonetics

NORTH AMERICAN AVIATION plans to construct a $3,300,000 headquarters building for its Autonetics division on an 18-acre site in Downey, Calif.

Construction is scheduled for completion next fall.

Autonetics is engaged principally in the development, engineering and manufacture of automatic navigation and control equipment for military aircraft and missiles. It also has a number of devices under development for various non-military applications.

The building will provide some 300,000 sq ft of floor space for administrative offices, general research, development and application engineering and manufacturing of computers and aircraft fire control system.

A radar field laboratory will be installed on the roof.

When the building is completed,

Autonetics' 8,000 employees will occupy facilities totalling about 900,000 sq ft, some 500,000 sq ft of which are now either in construction or design stages. Another two-story 200,000 square foot facility at the Downey plant, scheduled for occupancy in March, will house the division's development, engineering and manufacture of automatic navigation systems.

David G. Soergel has been appointed manager of the newly created applications department of Autonetics.

He is concerned with customer relations, market analysis and the promotion of applications for autonetics products.

He joined North American in 1949 and served as staff representative in electro-mechanical engineering, as an assistant to the vice-president in charge of the missile and control equipment organization, and, in 1954, as manager of the electro-mechanical products department recently integrated into Autonetics.

Robert Vogeler Joins Rollins

ROBERT A. VOGELER has been appointed executive vice-president and Admiral Robert H. Gibbs as assistant vice-president in charge of administration of the Rollins Electronics Corp. of Lewes, Delaware, manufacturers and engineers of electronics components and assemblies.

Vogeler was formerly vice-president of IT&T and has been associated with the electronics industry for the past 25 years.

Admiral Gibbs, a graduate of Annapolis in 1925, retired from the U. S Navy in 1955 after a career of command at several Naval laboratories and installations.

Dalmo Victor Selects Dunbar

ALLEN S. DUNBAR has been appointed to the newly-created position of manager of advanced technical planning department for

Dalmo Victor Co. of San Carlos, Calif.

His new duties will include a survey of both airframe and missile operational trends and problems, and will require his attendance at all technical meetings and symposia concerned with advanced systems planning. This data will assist the company in formulating a future program for guiding its engineering development and sales effort.

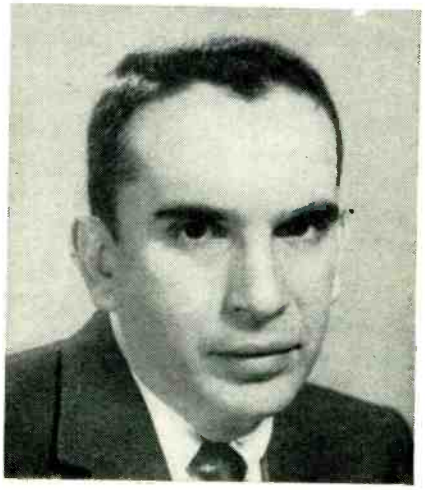
He joined the firm in 1953, as associate director of research, and most recently was assistant to the chief engineer.

His prior experience was as senior research engineer in charge of microwave research and development at Stanford Research Institute; electronics scientist on research and development of microwave optics at the Naval research laboratory and as a staff member of the radiation laboratory of MIT.

Bendix TV Names Two Executives

JOHN M. MILLER JR. has been appointed works manager and Stanley R. Scheiner as director of engineering of the television and broadcast receiver division of Bendix Aviation Corp.

Miller succeeds C. M. Granger, who has been made manager of automotive radio operation for the radio communications division of the firm. Miller has been director of engineering for Bendix Television for the past 10 months and previously was chief engineer. He



Stanley R. Scheiner

joined Bendix in 1947 after serving with the radio engineering staffs of Atwater Kent, Philco Corp. and RCA.

Scheiner, assistant director of engineering since April, has been one of the principal engineers for Bendix television for the past six years. He came to the company eight years ago from Philco, where he was radio receiver engineer.

Bendix also announced the appointment of Howard K. Morgan to the new engineering position of director of commercial aviation systems.

He will coordinate engineering activities of all Bendix divisions on commercial aircraft components, including electronic flight systems.

Morgan, formerly director of engineering of Bendix' Kansas City division operated for the Atomic Energy Commission, will direct advanced planning on communications and navigation units such as autopilots, the Polar Path compass, airborne weather radar and an integrated navigational flight system.

Prior to joining the Bendix staff in 1945 as assistant director of engineering for the radio division he was on the staff of TWA as director of engineering.

National Aircraft Acquires Mag-Electric

MAG-ELECTRIC PRODUCTS of Hawthorne, Calif. has been acquired by National Aircraft Corp. of Burbank, and will be operated at its present location as a wholly owned subsidiary.

Purchase of Mag-Electric marks the further expansion of National Aircraft in the electronic component field and supplements the company's transistor activities in Burbank. The new subsidiary manufactures magnetic amplifiers, power supplies, delay lines, electronic test equipment and transformers.

More than 70 engineers, technicians and workers currently employed will be retained under the new management. Present plant facilities comprise 11,000 sq ft

R. C. Stunkel, president of National, assumes the presidency of

the new NAC subsidiary and Robert O. Vaughan, NAC vice-president and general manager of the Marvelco electronics division, has been named as vice-president of Mag-Electric.

Hans Hollmann, director of research at Marvelco, will head up the research program at the Hawthorne plant.

ACF Appoints Division President

Richard B. Hubbard

RICHARD B. HUBBARD has been appointed president of the ERCO division of ACF Industries. He comes to the ERCO division, which specializes in the manufacture of flight simulators and electronic devices of various kinds, from Specialties, Inc. of Syosset, L. I., where he was vice-president and chief engineer. He also served with the Fairchild Engine and Airplane Corp., North American Aviation, and the Allison division of General Motors in various engineering capacities.

Sylvania Expands Three Plants, Picks Engineers

SYLVANIA Electric Products announced plans for a new 48,000 sq ft engineering and pilot production building in Towanda, Pa. for the company's tungsten and chemical division.

Construction will begin late this year and will be completed in the summer of 1957.

It will be devoted entirely to development laboratories and pilot production facilities for the fields

of semiconductors, phosphors, chemicals, and metallurgical products.

Sylvania also will double the size of its television picture tube division plant in Fullerton, Calif.

Construction of a 50,000 sq ft addition to the Fullerton plant has started and is scheduled for completion this May.

With the Fullerton expansion, the picture tube division will have well over 800,000 sq ft of floor space.

Sylvania also formed Semsa Electronics, S.A. as a manufacturing subsidiary. The new company is building a 40,000 sq ft plant in Monterrey, Mexico where television sets and television picture tubes will be produced.

Semsa is scheduled to begin the manufacture of aluminized black-and-white picture tubes in early March, and by mid-year is expected to be in production of television sets. E. J. Parker will serve as general manager of Semsa.

Irwin Goldman has been appointed manager of technical planning for the research laboratories of Sylvania Electric Products.

Prior to his new appointment, Goldman was head of technical services of Sylvania's physics laboratory.

Henry M. O'Bryan was appointed manager of scientific liaison of Sylvania Electric.

Dr. O'Bryan joined Sylvania in 1951 as manager of the physics laboratory at the company's research center in Bayside, N. Y., after having served for four years on the Research and Development Board of the National Military Establishment.

Sylvania also announced that Frank M. Thomas has been appointed manager of equipment development for the electronics division.

Keystone Establishes Acme Screw

KEYSTONE BOLT & NUT CORP. has established the Acme Screw & Fastenings Corp. in Bristol, Conn., as a manufacturing division for machine screws, cap screws, stove

bolts, rivets and special headed parts. Keystone has a new building in New York City and 86,000 sq ft of warehouse space in Brooklyn, N. Y.

American Lava Promotes Deaderick

JAMES W. DEADERICK has been promoted to technical director of research of American Lava Corp. of Chattanooga, Tenn. He has been with the firm for 21 years.

Infra Names Production Chiefs

P. G. Yeannakis

P. G. YEANNAKIS has been named to take charge of all electronic production facilities for Infra Electronics in Roseland, N. J.

He has had over 16 years of experience in the field of aircraft instrumentation work at Bendix Aviation, where he most recently was senior engineer, supervising resolvers and synchros.

Clint Honeywell was appointed to reorganize and supervise production methods.

He has had over 15 years experience in the aircraft accessories and small motor field as a development and production engineer. He was formerly with Servo-Tek.

Samuel C. Lepidge was appointed head of the synchro development group of the firm.

He has had over 20 years experi-

ence in design and development work. After 3 years as radar officer in the Navy he joined Bendix Aviation as an engineer on the design and testing of guided missiles.

During the past 10 years Lapidge has been engaged in design and development work on synchros of all types and systems using synchros.

Armour Research Plans Expansion

A $5,000,000 BUILDING program has been announced by Armour Research Foundation of Illinois Institute of Technology.

The expansion program calls for the construction of three buildings and substantial additions to two buildings over the next 10 years.

ARF expects to have a 50 per cent increase in research volume and personnel within five years.

The building plans are based on the assumption that the Foundation will have a research volume of $16,000,000 and a staff of 1,600 by 1961.

Among the new buildings planned is the $1,250,000 physics and electrical engineering research building now under construction to be completed in 1956.

Brownlee To Head Canadian Admiral

STUART D. BROWNLEE has resigned from his position of general manager of the Radio-Electronics-Television Manufacturers Association of Canada and president of Canadian Radio Patents Limited to become executive vice-president of Canadian Admiral Corp. Limited, in charge of Admiral's operations in Canada.

Brownlee has been general manager and secretary of RETMA of Canada since September 1, 1945, and previously was with the appliance engineering and law departments of the Canadian General Electric Company in Toronto.

He was appointed general manager of Canadian Radio Patents Limited in 1945 at the same time as he joined RETMA of Canada. He was elected a director of Cana-

dian Radio Patents Limited in 1952, becoming president of that company in 1954. For the past ten years he has also been secretary-treasurer of the Canadian Radio Technical Planning Board.

Baird Associates Elevates Billings

BRUCE H. BILLINGS, director of research at Baird Associates, of Cambridge, Mass., has been named general manager.

Dr. Billings, who was also elected to the company's board of directors, will continue to direct all technical programs at the firm's main plant in Cambridge and at the Baird transistorized products activity in Waltham, Mass. He assumes additional corporate and administrative responsibilities.

With the company since 1947, he came from Polaroid Corp., where he was chief physicist specializing in infra-red work.

Consolidated Appoints Gilman and Hatchl

SAMUEL GILMAN has been appointed technical assistant to the director of the systems division of Consolidated Electrodynamics Corp.

Gilman, for the past year chief project engineer, industrial controls, at Curtiss-Wright Corp., will be a special consultant on electronic data-processing systems.

He worked 11 years in research and development for Westinghouse. He has also been assistant to the

Samuel Gilman

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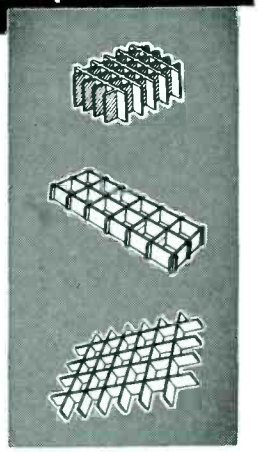

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chief engineer of American Machine and Foundry Co.; chief engineer of Boonton Radio Corp. and project engineer on radar navigation systems at General Precision Laboratories.

Sidney Hatchl, who for the past two years has been head of the electronic circuit and systems section of the Electro-Technical Laboratories in Houston, Texas, was named a project chief of the division. He will specialize in high-speed data processing and tape recording systems.

Crosley Selects Two Engineers

DONALD B. NASON, who joined Crosley in 1941 as chief receiver engineer, becomes vice-president and director of Crosley's government products engineering. W. R. Lawrence, Jr., who became manager of Crosley's Nashville, Tennessee plant in 1944, becomes vice-president and general manager of the Nashville operations.

During World War II, Nason was responsible for design, development and product engineering of many equipments for the Army, Air Force, Navy and Signal Corps.

During the World War II, Lawrence was successively division manager for the Consolidated-Vultee Aircraft Corporation at Tuscon, Arizona, and for the same corporation's plant at Nashville, which now is part of the Crosley division.

Republic Subsidiary Names Manager

WILLIAM K. HOOPER has been appointed manager of Republic Etched Products.

During World War II he supervised construction and operation of radar installations as a Captain in the Army Signal Corps. In 1946 Hooper joined the Sperry Products Co. He resigned his position of assistant general manager to assume his new duties.

Republic Etched Products, a subsidiary of Republic Foil and Metal Mills, was incorporated last year to manufacture etched aluminum

foil for use in electrolytic types of capacitors.

The pilot plant is in operation in Danbury, Conn. and commercial production is now proceeding on a limited scale. The company anticipates substantial expansion of output during the coming year.

Patton Joins Airpax Products

Henry W. Patton

HENRY W. PATTON has joined Airpax Products Co. of Middle River, Baltimore, Md. as project leader in the engineering department. In his new position he will lead the development of special electromagnetic devices.

From 1951 to 1952 he was senior electronic engineer with Baldwin Piano Co. where he developed wideband video amplifiers for military equipment. Prior to joining Airpax, Patton had been with Collins Radio Co. in the research and development division where he was in charge of special component development and quality control for magnetic amplifiers.

Indian Electronics Plant In Operation

THE Indian Defence Ministry's $20 million project—Bharat Electronics—has gone into production.

When the factory reaches maximum output in 1960, its annual volume in the form of various electronics equipment, is expected to be in the region of $10 million. In the first year, 1956-57, the factory proposes to manufacture a

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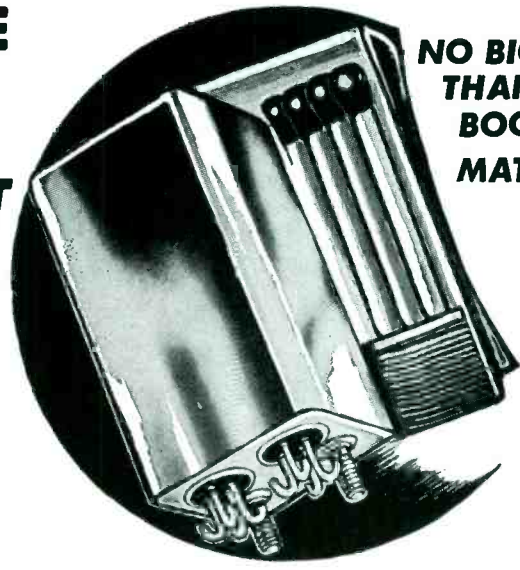

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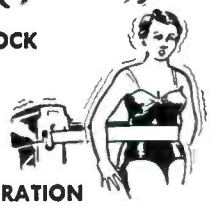

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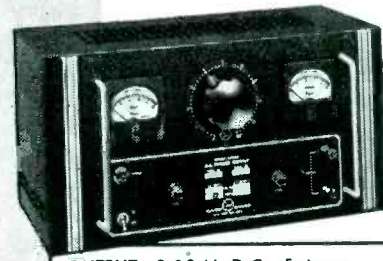

OUTPUT: 0-30 V. D.C., 5 Amps.
RIPPLE: ½ % at Maximum Load
REGULATION: 1/10 Load, 34.5 V.
Full Load, 30.0 V.
RACK MODEL **KM75**
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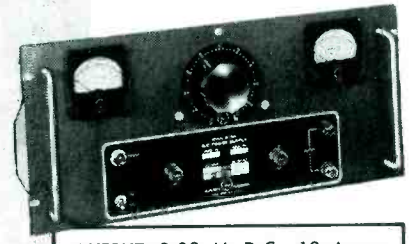

OUTPUT: 0-30 V. D.C., 10 Amps.
RIPPLE: 1% at Maximum Load.
REGULATION: 1/10 Load, 35 V.
Full Load, 30 V.
RACK MODEL (Illus.) **KM81**
BENCH MODEL **KM81B**
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OUTPUT: 0-28 V. D.C., 20 Amps.
RIPPLE: 1% at Maximum Load.
REGULATION: 1/10 Load, 33 V.
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In 1952, the French Compagnie Generale de Telegraphie was appointed as the Government of India's technical consultant over a ten-year period. About six miles from Bangalore, Bharat Electronics covers an area of 700 acres. By the end of 1957, it is expected to absorb a labor task force of 5,000.

Sarkes Tarzian Acquires Silicon

The facilities of the Silicon Corporation of America have been acquired by Sarkes Tarzian and will operate as part of the rectifier division.

Orders for silicon rectifiers placed on the Silicon Corporation or on Sarkes Tarzian will be filled from Bloomington, Indiana. Production facilities are being moved to Bloomington and will be expanded as required.

All the key personnel who have been operating Silicon have joined Sarkes Tarzian.

Liberty Appoints Research Head

MOGENS W. BANG has joined Liberty Manufacturing Corp., in Youngstown, Ohio as director of its research and development laboratory. He has held engineering positions with various Danish radio manufacturers and Allen B. DuMont Labs. He served as president of Mogens Bang & Co., Copenhagen, Denmark, representing several American manufacturers in the electronics field.

NBC Takes Over Westinghouse TV Station

NBC BEGAN operation of television station WPTZ and radio station KYW in Philadelphia and announced these major plans for the Philadelphia stations:

A change of call letters to WRCV and WRCV-TV.

Installation as soon as possible of facilities for originating local television programs in color.

Appointment of Lloyd E. Yoder,

 Want more information? Use post card on last page.

veteran NBC station manager, as general manager.

Astron Elects New President

JOSEPH FRANK was elected president of Astron Corp.

One of the company's original founders, he had served as vice-president in charge of sales up until his recent election. He previously was associated with the Solar Corp.

Wind Turbine Names Assistant Chief Engineer

EDWARD H. SHIVELY has been appointed assistant chief engineer of the Wind Turbine Co., manufacturers of antenna towers and antenna systems.

He will concentrate on communications antenna development under th supervision of chief engineer, Albert C. Veldhuis.

Before joining Wind Turbine, Shively was transmitter supervisor for Crosley tv Station WLW-D in Dayton, and, more recently, a project engineer for RCA in Camden where he participated in the development of uhf television antennas.

Norden-Ketay To Acquire Gyromechanisms

NORDEN-KETAY has contracted to acquire all the assets, business, name and good will of Gyromechanisms of Halesite, Long Island, N. Y.

Gyromechanisms, which has ap-

Stokley Webster

proximately 65 employees will continue its operations at its plant in Long Island.

When the acquisition of Gyromechanisms is completed, Stokley Webster, president, will become general manager of Norden-Ketay's gyromechanisms division.

Jeffers Selects Program Head

ROBERT L. BUTTLE has been appointed ceramics engineer in charge of an experimental program in electronics products by the Jeffers electronics division of the Speer Carbon Co.

He formerly was associated with the Lenox China and Coors Chemical and Scientific Porcelain. He will be located with the research and development department of Jeffers electronic division in Du Bois, Pa.

Magnavox Plans New Cabinet Plant

THE MAGNAVOX CO. plans to build a new factory at Jefferson City, Tenn. The plant is initially scheduled to build cabinets for radio and television sets produced at the firm's Greeneville, Tenn. plant. The building will have about 75,000 sq ft of productive floor space and will employ from 300 to 400 people. It is scheduled to begin operation about June 1.

Gray Appoints Plant Head

J. PHILIP WORTH has been appointed plant manager of Gray Research & Development Co.

He was most recently an executive in the manufacturing department of Electrolux of Old Greenwich. Previously, he was associated with P. R. Mallory & Co. and Warren Telechron.

Canoga Elevates Three Engineers

CANOGA CORPORATION at Van Nuys, Calif. has appointed Edward J. Farley to the special engineering projects group. He will evaluate

specifications and represent the firm in its technical customer relations.

He was assistant to the director of engineering liaison at Reeves Instrument.

J. G. McCann, formerly chief microwave and antenna engineer, has been named chief engineer. Robert J. Stegen, formerly senior microwave and antenna project engineer, has assumed the position of chief microwave and antenna engineer. McCann, in his new duties, will supervise and correlate all electronic, microwave and mechanical engineering.

Electronic Engineering Promotes Three

L. S. PRESTON has been appointed engineering manager in the Los Angeles division of the Electronic Engineering Company of California.

As head of the newly formed engineering group, he is responsible

L. S. Preston

for all of the company's engineering and allied activities which include special support facilities including the drafting department and technical editing department.

Prior to his new appointment, Preston served as head of the company's engineering department. His previous experience includes work as division manager of the Florida division.

Preston joined the company in May 1949 as an electronic engineer and was named to head the

Florida division in October, 1950.

Donald R. Proctor has been named assistant engineering manager in the division. He joined the firm in 1951 as an electronic engineer and as a project engineer has been responsible for the design and construction of complex timing, firing and ground instrumentation equipment for missile ranges as well as other electronic developments.

Charles A. Atherton was appointed manufacturing manager in the division.

He formerly was the head of the company's assembly shop.

Clarostat Names George Immen

GEORGE H. IMMEN has been appointed applications engineer of Clarostat Mfg. Co. During the past 25 years he has held positions in engineering and sales with such organizations as General Instrument Corp., Lear, Hazeltine Electronics and Sperry Gyroscope.

Radio Receptor Appoints Engineer

ARTHUR HERTZBERG has been appointed resident field engineer for California by the engineering products division of the Radio Receptor Co. Hertzberg had been senior project engineer for radio receptor in Brooklyn.

He has been with the firm for 15 years.

Daystrom Expands, Selects Executive V-P

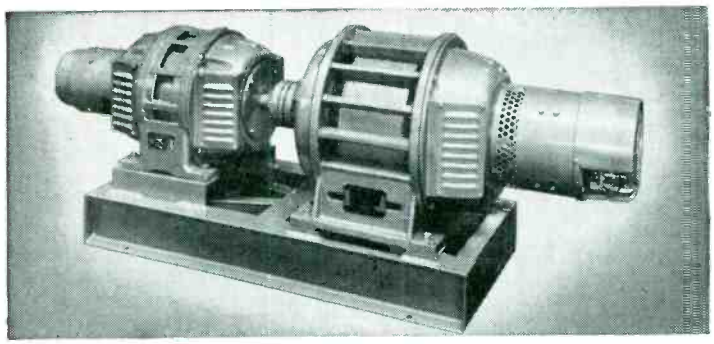
DAYSTROM has purchase approximately 20 acres of land in Berkeley Heights, N. J. as a site for a new executive office building for the corporation's headquarters staff.

Construction of the new offices, which will contain 16,000 sq ft, will begin shortly.

The firm also has tentative plans to construct an electronics research laboratory on the property at some future date for its top level research and development engineers.

Daystrom also announced the ap-

400 cycle High Frequency Power Supplies



This typical 400 cycle High Frequency Generator is available from 1 KVA to 100 KVA. Variable frequency power supplies can be designed with outputs as low as 3 cycles and as high as 2000 cycles.

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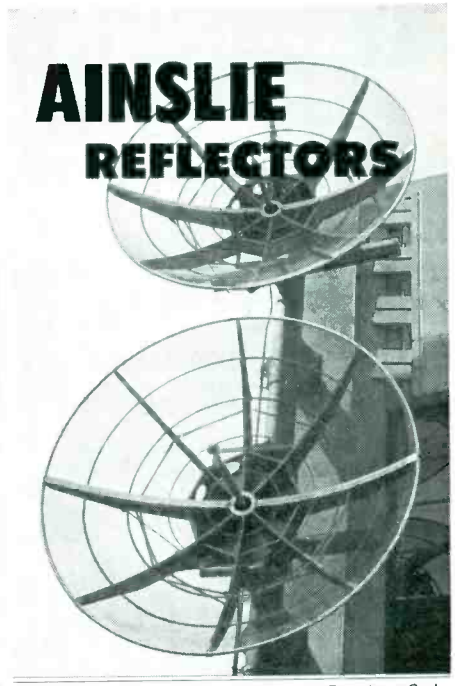

(Photo courtesy of the New England Bell Telephone Co.)

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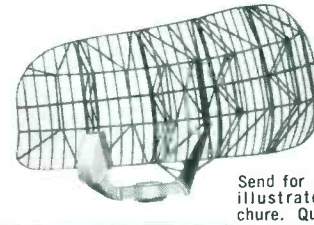

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Ainslie CORPORATION

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pointment of Dause L. Bibby as executive vice-president. He was formerly vice-president of International Business Machines.

Bibby joined IBM in 1934 starting as a sales trainee.

Sperry Elevates Tube Head

Joseph C. Brenner

JOSEPH C. BRENNER has been appointed vice-president and works manager of the Sperry electronic tube division at Gainesville, Florida.

The division is comprised of scientists and production specialists who provide electronic power tubes, klystrons, traveling wave tubes and backward wave oscillators developed for long-range weapons systems.

Brenner is a Sperry veteran of 18 years. His management experience includes manufacturing, engineering, research, production control and mobilization planning supervision. He was appointed manufacturing engineering manager in 1949 and director of tube manufacturing in 1953.

North Atlantic Opens New Plant

NORTH ATLANTIC INDUSTRIES opened its new facility at Westbury, New York. The company is engaged in the development and manufacture of electronic control systems with emphasis on the automation of production processes and machinery. Currently active in

the management are Malcolmn D. Widenor, president; Walter Lipkin, vice-president and Frank Mullen, secretary.

Ace Moves To Larger Plant

ACE ELECTRONIC ASSOCIATION, manufacturers of sub-miniature potentiometers and trimmers, moved to new and larger quarters in Somerville, Mass.

The move increases floor space by 12,000 sq ft.

Air Force Needs Engineers

THE engineering review and standards division of the Rome Air Force Depot, Rome, N. Y. is seriously hampered in accomplishing its mission due to the lack of engineers in the following fields:

Telephone Central Office, Telephone Outside Plant, Ground Radar (search, height, enroute traffic control, etc.), Fixed-Plant Radio (ground-air, microwave radio relay, hf point-to-point, etc.) and Computers.

Annual salaries for present vacancies range from $5,440. to $7,570.

Engineers interested in the above positions should contact the Depot.

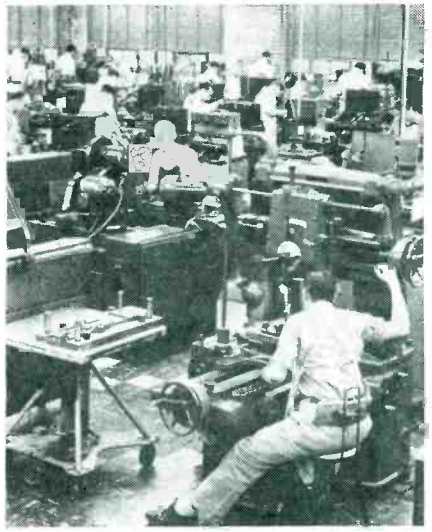
Kimble Glass Promotes Two

G. PRYOR MOLLOY has been promoted to new products manager for the electronic products division of Kimble Glass Co., subsidiary of Owens-Illinois.

Molly, who joined Kimble in 1950, has been director of field engineering at the company's Columbus, O., plant. He was succeeded in that position by Leonard C. Pierzchala, engineer in the new products division.

Volkert Completes Third Expansion

A 12,000 SQ FT plant expansion has been completed by Volkert Stampings, Queens Village, N. Y., manufacturer of precision metal parts



New Volkert toolroom

for the electronics industry. The extension increases production capacity by 25 per cent and is the firm's third major expansion since it moved to Queens Village in 1949. Plant area now totals approximately 42,000 sq ft.

Volkert's toolroom and engineering department are relocated in the new plant addition, allowing for increases in the personnel of both sections. The production facilities are also being rearranged for better accessibility and for the addition of new equipment.

Rese Engineering Selects Endres

RESE ENGINEERING, Philadelphia manufacturers of digital computer and magnetic memory core test equipment, appointed Richard O. Endres as director of engineering development.

He was formerly with RCA's engineering products division. He will assume direction of development of the firm's line of equipment.

Jensen Promotes Two Engineers

ROBERT J. LARSEN has been named senior development engineer and James F. Novak was promoted to senior design engineer of Jensen Mfg. Co. of Chicago.

In his new position, Larson will concentrate on horn and driver

Want more information? Use post card on last page.

unit development projects.

Novak will work in the fields of direct radiator speakers and speaker systems and enclosures.

IRE Sets Technical Papers For 1956 Convention

The following is the complete list of technical papers and program events to be presented at the 1956 IRE National Convention in New York City on March 19-22:

Monday Afternoon, March 19, 1956 (2:30-5:00 P.M.)

INSTRUMENTATION I

Moderne Room, Belmont-Plaza

A Transadmittance Meter For VHF-UHF Measurements by William R. Thurston of General Radio Co.

Measurement Of Electron Tube Admittance Matrix Parameter At UHF by Mack M. Zimet and Seymour Friedman of New York Naval Shipyard.

Transistor Measurements At High Power Levels by S. I. Kramer and R. F. Wheeler of Fairchild Guided Missiles Division.

A Transistorized Events-Per-Unit Time Meter by H. Chisholm of Beckman Instruments.

The Application Of Magnetic Techniques To A Reliable 40 KC EPUT Meter Design by D. A. Weinstein of Beckman Instruments.

MEDICAL ELECTRONICS I

Starlight Roof, Waldorf-Astoria

The Perception Of Direction As A Function of Binaural Temporal And Amplitude Disparity by R. J. Christman of Rome Air Development Center.

An Apparatus For Brain Tumor Localization Using Positron Emitting Radioactive Isotopes by S. Aronow and G. L. Brownell of Massachusetts General Hospital.

The Application Of Automatic, High-Speed Measurement Techniques To Cytology by W. E. Tolles, R. C. Bostrom and H. S. Sawyer of Airborne Instruments Laboratory.

An Intercommunication System For The Surgical Operating Room by M. M. Davis, Jr. and Maitland Baldwin of National Institutes of Health.

The Physiograph—A New Instrument For The Teaching Of Physiology by L. A. Geddes, of Baylor University.

VEHICULAR COMMUNICATIONS: "NEW HORIZONS FOR VEHICULAR COMMUNICATIONS"

Astor Gallery, Waldorf-Astoria

Miniaturization Techniques Utilized In A Multi-Channel Crystal Controlled VHF Oscillator by E. M. Stryker, Jr. of Collins Radio Co.

A New Concept For Communication Vibrator Design by A. B. Tollefsen, Jr. of P. R. Mallory & Co.

More Words Per Minute Per Kilocycle by Curtis B. Plummer of FCC.

A Vehicular User Looks At The Future by Delbert E. York of United Fuel Gas Corp.

Is 960 MC. Suitable For Mobile Operation– by C. J. Schultz of Motorola.

GENERAL COMMUNICATIONS SYSTEMS

Jade Room, Waldorf-Astoria

The Place Of Communications In Integrated Data Processing by A. O. Mann of SKF Industries.

A New Means For Analysis Of Communication Equipment And System Performance Using Log-Log Selectivity Curves by Emerick Toth of Naval Research Laboratory.

Sixteen Channel Time Division Multiplex System Employing Transistors And Magnetic Core Memory Circuits by J. C. Myrick of Rixon Electronics and W. E. Morrow of MIT Lincoln Labs.

Transmitting Tubes For Linear Amplifier Service by R. L. Norton of Penta Laboratories.

Methods Of Reducing Frequency Variations In Crystals Over A Wide Temperature Range by L. F. Koerner of Bell Labs.

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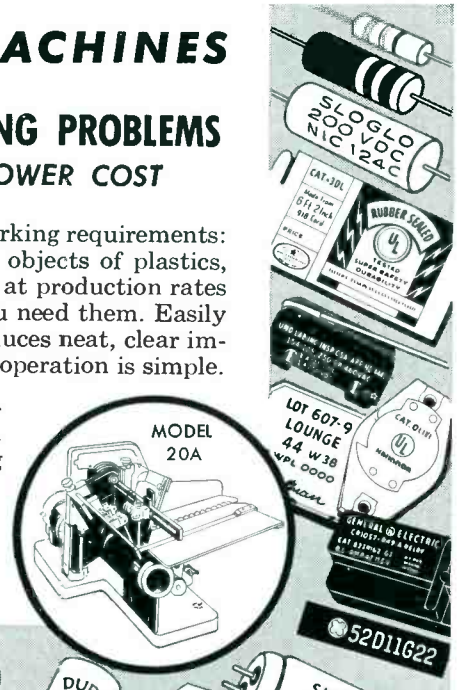

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ANTENNAS AND PROPAGATION—PROPAGATION

Sert Room, Waldorf-Astoria

Wave Propagation Over A 350-Mile Path At 960 MC. by I. H. Gerks and A. J. Svien of Collins Radio Co.

Ionospheric Cross Modulation From A 1000 KW Long Wave Broadcast Transmitter by E. T. Martin and George Jacobs of U. S. Information Agency.

Atmospheric Refraction Of 8.7 MM Radiation by G. R. Marner and R. M. Ringoen of Collins Radio Co.

Recent Developments In The Theory Of Sea Clutter by Martin Katzin of Washington, D. C.

Radar-Type Propagation Survey Experiments For Communication Systems by R. E. Lacy and C. E. Sharp of Signal Corps Engineering Labs.

ASSURING OUR ENGINEERING FUTURE

Grand Ballroom, Waldorf-Astoria

Industrial Research Of The Future by E. Duer Reeves of Esso Research and Engineering Co.

Human Relations Responsibilities of Engineers by Paul E. Hemke of Rensselaer Polytechnic Institute.

The Challenge Of Engineering Management by C. H. Linder of General Electric.

Education For Engineering Management by Eli Shapiro of MIT.

INFORMATION THEORY I

Kingsbridge Armory, Marconi Hall

Information Theory And Quality Control by Jerome Rothstein of Signal Corps Engineering Laboratories.

Coherent Detection Of Sinusoidal Signals In Gaussian Noise by K. S. Miller of New York University and R. I. Bernstein of Columbia University.

Piecewise Quadratic Detectors by Ralph Deutsch of Hughes Research Laboratories.

A Theory For The Experimental Determination Of Optimum Nonlinear Systems by Amar G. Bose of MIT.

Evaluation Of Complex Statistical Functions By An Analog Computer by R. R. Favreau of Electronic Associates and H. Low, I. Pfeffer of The Ramo-Wooldridge Corp.

THE EFFECTS OF ENVIRONMENTAL AND OPERATING CONDITIONS ON THE RELIABILITY OF "RELIABLE" ELECTRON TUBES

Faraday Hall, Kingsbridge Armory

A Basic Study Of The Effects Of Operating and Environmental Factors On Electron Tubes by W. S. Bowie of GE.

The Effects of Shock And Vibration by Frank Warnock, Jr. of GE.

The Effects of Heater Voltage and Heater Cycling by W. S. Bowie of GE.

The Effects of Ambient Temperature by Paul F. Barnett of GE.

The Effects of Plate Voltage, Plate Current and Plate Dissipation by D. E. Lammers of GE.

The Effects of Pulse Operation by Wray U. Shipley of GE.

Tuesday Morning, March 20
(10:00-12:30 A.M.)

ULTRASONICS

Belmont-Plaza, Moderne Room

Ultrasonic Stroboscope by Egon A. Hiedemann of Michigan State University.

Surface Resonances of Bubbles and Biological Cells by Eugene Ackermann of Pennsylvania State Univ. and Thomas F. Proctor of Corning Glass Works.

Electronic Design Considerations In The Application of Piezoelectric Transducers by Wilson Bradley, Jr. of Endevco Corp.

Propagation of Elastic Pulses Near The Stressed End Of A Cylindrical Bar by Allen H. Meitzler of Bell Telephone Laboratories.

Transient And Steady-State Response Of Ultrasonic Piezoelectric Transducers by Edward G. Cook of Schlumberger Well Surveying Corp.

Some Resonator Properties Of Synthetic And Doped Synthetic Quartz by Andrew R. Chi of Signal Corps Engineering Laboratories.

AUTOMATIC CONTROL

Starlight Roof—Waldorf-Astoria

Feedback-Controlled Length-Modulated Pulse Generator by James E. Shea and Philip Ordung of Yale University.

A Non Linear Noise Suppression Network For Feedback Control Systems by Robert L. Gordon of Sperry Gyroscope Co.

Measurement And Stabilization Of Nonlinear Feedback Systems by G. Casserly

and J. G. Truxal of Polytechnic Institute of Brooklyn.

Optimum Switching Criteria For Discontinuous Automatic Controls by Nicholas J. Rose of Stevens Institute of Technology.

The Reasonableness Check In Automation by Charles H. Doersam, Jr. of Doerco-Consultants.

AIR TRAFFIC CONTROL
Astor Gallery

Symbolic Display System For Air Traffic Control by Lee T. Harris of Rome Air Development Center.

A New Look At Requirements For Electronic Systems In Air Traffic Control by R. S. Grubmeyer of Franklin Institute.

Traffic Control Electronics Research Goes Modern by Ernest N. Storrs, Joseph L. Ryerson of Rome Air Development Center.

An Analysis For Human Flight Control by L. J. Fogel of Stavid Engineering.

Enhancement Of Aircraft Radar Return By Use Of Airborne Reflectors And Circular Polarization by Joseph J. Panasiewicz of Rome Air Development Center.

A Three-Dimensional Aircraft Visibility Diagram by Albert Feiner and Fred Diamond of Rome Air Development Center.

TRENDS IN TV EQUIPMENT
Waldorf-Astoria, Jade Room

High Stability Television Synchronization Generator by F. T. Thompson of Westinghouse Electric Corp.

A Pedestal Processing Amplifier For Television by Ralph C. Kennedy of NBC.

A New Electronic Masker For Color Television by Jesse H. Haines of A. B. DuMont Labs.

Reworking The Network Or Remote Video Signal by Ray R. Embree of KING-TV.

A New Color Camera For Closed-Circuit Applications by L. E. Anderson of RCA.

AUDIO TECHNIQUES
Sert Room, Waldorf-Astoria

A Simplified Procedure For The Design Of Transistor Audio Amplifiers by W. W. Wells and A. E. Hayes, Jr. of North American Aviation.

An Audio Flutter Weighting Network by Frank A. Comerci of Nutley, N. J.

A Flutter Meter Incorporating Subjective Weightings by Mitchell A. Cotter of Consumers Union of the U. S.

Performance Measurements Of Magnetic Tape Recorders by J. Byrne Hull of Ampex Corp.

A 3000 Watt Audio Power Amplifier by Alexander B. Bereskin of University of Cincinnati.

ANTENNAS AND PROPAGATION
Grand Ballroom, Waldorf-Astoria

A Theory Of Scattering By Non-Isotropic Irregularities With Application To Radar Reflections From The Aurora by H. J. Booker, Cornell University.

Correlation Of Radar Sea Clutter On Vertical And Horizontal Polarization With Wave Height And Slope by F. C. MacDonald of Naval Research Laboratory.

Precipitation Particle Impact Noise In Aircraft Antennas by R. L. Tanner of Stanford Research Institute.

Analysis Of Conical Scan Antennas For Tracking by John B. Damonte and Don J. Stoddard of Dalmo Victor Co.

Correction To Current Distribution On Curved Reflectors by Robert Plonsey of University of California.

SYMPOSIUM ON AIR FORCE COMMUNICATIONS AND ELECTRONICS PROBLEMS AND PHILOSOPHIES
Marconi Hall, Kingsbridge Armory

CHAIRMAN: Gordon A. Blake of Headquarters USAF.

MODERATOR: John E. Keto of Wright Air Development Center.

SPEAKERS: Gordon Gould of Air Research and Development Center. Harry Davis of Rome Air Development Center. L. M. Hollingsworth of USAF Cambridge Research Center.

MICROWAVE TUBES
Kingsbridge Armory, Faraday Hall

An Investigation Of A Traveling Wave Tube With An External Slow Wave Structure Using Lumped Circuit Elements by A. R. Matthews, C. T. Sah, K. R. Spangenberg of Stanford University.

Behavior Of Hollow Beams In Radial Electrostatic Fields by L. A. Harris of GE.

Microwave Transmitter Tuning by

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Rapid-Interchange, Fixed-Frequency Klystrons by R. A. La Plante of Philips Laboratories.

Design And Performance Of Low Noise Guns For Traveling Wave Tubes by R. C. Knechtli and W. R. Beam of RCA.

Backward Wave Oscillators by W. Menke of Sperry Gyroscope Co.

Backward Wave Oscillators For Low Voltage Operation by W. L. Beaver of Varian Associates.

Tuesday Afternoon, March 20 (2:30-5:00 P.M.)

QUALITY CONTROL AND RELIABILITY STUDIES OF ELECTRONIC EQUIPMENTS

Belmont Plaza, Moderne Room

Achieving And Analyzing Operational Reliability With Equipment Of Imperfect Intrinsic Reliability by W. F. Luebbert of Stanford University.

Some Reliability Aspects Of Systems Design by Fred Moskowitz and John B. McLean of Rome Air Development Center.

Training For Quality Control by C. J. Quirk of Allen B. DuMont Laboratories.

A Bombing System Reliability Program by R. L. Wendt and M. H. Smith of Sperry Gyroscope Co.

A Reliability Department Operation For Production Missiles by E. F. Dertinger of Bendix Products Division.

NUCLEAR INSTRUMENTATION

Starlight Roof, Waldorf-Astoria

Some Transistor Circuits Used In A Magnetic Core Type Kicksorter by F. S. Goulding, Atomic Energy of Canada.

Punch Card Recording Of Multiple Counting Data by H. D. LeVine and Henry Sadowski of U. S. Atomic Energy Commission.

Instrument Opportunities In Nuclear Systems by Victor Parsegian of Rensselaer Polytech. Institute.

Control Aspects Of Boiling Water Power Plant by W. C. Lapinski of Argonne National Laboratory.

Geneva Reactor Control Systems by S. H. Hanauer and E. P. Epler of Oak Ridge National Laboratory.

NAVIGATION

Astor Gallery, Waldorf-Astoria

A Radiometric Inertial Reference System by Victor W. Bolie of Collins Radio Co.

Analytical Prediction Of Missile Guidance Accuracy by W. E. Mathews of Hughes Aircraft Co.

Considerations Affecting The Choice Of A Long Range Navigation System by Sidney Rosenberg of Rome Air Development Center.

Doppler Type High Frequency Radio Direction Finder by Joseph A. Fantoni and Richard C. Benoit, Jr. of Rome Air Development Center.

USAF UHF Direction Finding Facility by Richard C. Benoit, Jr. and Joseph A. Fantoni of Rome Air Development Center.

Colocation Of Tacan VOR-DME Systems by P. E. Ricketts of Rome Air Development Center.

TV TRANSMITTING EQUIPMENT AND TECHNIQUES

Waldorf-Astoria Jade Room

High-Gain Antenna Arrays for Television Broadcast Transmission Using a Slotted Ring Antenna by Andrew Alford and Harold H. Leach of Alford Manufacturing Co.

Self-Diplexing Antenna for TV Transmitters by C. B. Mayer and Paul M. Pan of GE.

Television Field Intensity Measurements —A Tool in Transmitting Antenna Planning by Raymond E. Rohrer and Oscar Reed, Jr. of Jansky & Bailey.

A New Monitor for Television Transmitters by C. A. Cady of General Radio Co.

A Pack Type Television System by William B. Harris of RCA.

HIGH QUALITY SOUND REPRODUCTION

Waldorf-Astoria, Sert Room

Equalization Considerations in the Design of High Quality Tape Recorders by R. H. Snyder of Ampex Corp.

Design of a High Fidelity 10-Watt Transistor Audio Amplifier by R. P. Crow and R. D. Mohler of Motorola.

Performance Of The "Distributed Port" Loudspeaker Enclosure by Adelore F. Petrie of GE.

A Phonograph System For The Automobile by Peter C. Goldmark of CBS Labora-

tories.

The Recent History Of High Quality Magnetic Phonograph Pickups by Norman C. Pickering of Pickering and Company.

TELEMETERING COMPONENTS
Kingsbridge-Marconi Hall

Calibration Errors In Wire Strain Gage Transducer Systems by William Harrison of Allegeny Instrument Co.

Precision Subcarrier Discriminator For F-M Telemetering by William H. Duerig of Electro-Mechanical Research.

Automatic Tracking Antenna Array For The 217 mc/s Telemetering Band (Apota) by H. G. Oltman, Jr. and B. J. Bittner of Sandia Corp.

Subminiature Telemetering Transmitter by L. R. Hendershot of ACF Electronics.

A Bi-Directional Pulse Totalizer For Control And Telemetry by H. D. Wright of Anatran Engineering Corp.

ELECTRON TUBES
Kingsbridge Armory, Faraday Hall

Image Orthicon For Pickup At Low Light Levels by A. A. Rotow of RCA.

Heat-Flow Considerations In The Design of High-Dissipation Receiving Tubes by O. H. Schade, Jr. of RCA.

The Hy-Tramp, A Grid Controlled High Transconductance Electron Multiplier by W. E. Hostetler of National Union Electric Corp.

A Long-Life Cathode For High-Power UHF Transmitting Tubes by M. J. Slivka and R. E. Manfredi of GE.

A Method Of Measuring Cathode Interface Impedance by W. U. Shipley of GE.

Tuesday Night, March 20
(8:00-10:30 P.M.)

SYMPOSIUM: THE U. S. EARTH SATELLITE PROGRAM—VANGUARD OF OUTER SPACE
Starlight Roof, Waldorf-Astoria

The IGY Program by Joseph Kaplan of National Academy of Sciences.

The Exploration Of Outer Space With An Earth Satellite by John P. Hagen of Naval Research Lab.

Placing The Earth Satellite In Its Orbit by Milton W. Rosen of Naval Research Lab.

Telemetering And Propagation Problems Of Placing The Earth Satellite In Its Orbit by Daniel G. Mazur of Naval Research Lab.

Tracking The Earth Satellite And Data Transmission By Radio by John T. Mengel of Naval Research Lab.

Optical Instrumentation Of The Earth Satellite by Fred L. Whipple of Harvard University.

The Scientific Value Of The Earth Satellite Program by J. A. Van Allen of State University of Iowa.

COLOR TELEVISION TAPE RECORDING
Marconi Hall, Kingsbridge Armory

A Magnetic Tape System For Recording And Reproducing Standard FCC Color Television Signals—General Considerations by Harry F. Olson of RCA.

Electronic System by W. D. Houghton of RCA.

The Magnetic Head by J. A. Zenel of RCA.

The Tape Transport Mechanism by A. R. Morgan and M. Artzt of RCA.

Audio Systems by J. G. Woodward of RCA.

Wednesday Morning, March 21
(10:00-12:30 A.M.)
MICROWAVES I—GENERAL
Moderne Room, Belmont Plaza

Leakage Radiation From A Braided Co-Axial Cable by E. R. Schatz, M. E. Taylor, R. F. Robl, and K. L. Konnerth of Carnegie Institute of Technology.

A Trimode Turnstile Wave Guide Junction by R. S. Potter of Naval Research Laboratory.

The H-Guide, A Waveguide For Microwaves by F. J. Tischer of Huntsville, Alabama.

Microwave Spectrum Synthesis Using The Traveling Wave Tube by P. D. Lacy of Hewlett-Packard Co.

An Orthogonal Mode Transducer by R. L. Fogel of Hughes Research Laboratories.

ENGINEERING MANAGEMENT TECHNIQUES
Starlight Roof, Waldorf-Astoria

Words Needn't Fail by P. Beall of Annapolis, Maryland.

How Teamwork Brainstorming Solves

Problems by W. A. Pleuthner of Batten, Barton, Durstine & Osborn.

Strengthening The Recognition Of Engineering by G. W. Griffin, Jr. of Sylvania Electric Products.

The Motivation Of Technical People by Lyle Spencer of Science Research Associates.

FLIGHT DATA REDUCTION SYSTEMS

Astor Gallery, Waldorf-Astoria

An Improved System For Collecting And Processing Flight Test Data by H. W. Royce of Instrumentation Section, Glenn L. Martin Co.

Airborne Data Acquisition System by William H. Foster of Electronic Engineering Co.

Requirements Of A High Speed, High Quantity, All-Electronic Data Processing System by Frank K. Williams of Rocketdyne.

Techniques For A High Speed, High Quantity, All-Electronic Data Processing System, Idiot II by Martin L. Klein of Rocketdyne.

BROADCAST AND TELEVISION RECEIVERS

Waldorf—Jade Room

Application Of Transistors To Battery-Powered Portable Receivers by John W. Englund of RCA.

Stability Considerations In Transistor IF Amplifiers by D. D. Holmes and T. O. Stanley of RCA.

Analysis Of Double Tuned Transformers For Transistor Amplifiers by J. Hellstrom of Westinghouse Electric Corp.

Transient Response Versus Chrominance Bandwidth In Simultaneous Color Television Receivers by Charles W. Baugh, Jr., and Harold E. Sweeney of Westinghouse Electric Corp.

A Deflection And Convergence System For Use With The Color Picture by R. B. Gethmann of GE.

CIRCUITS I—SYMPOSIUM ON APPLICATIONS OF RECENT NETWORK IDEAS TO FEEDBACK SYSTEM PROBLEMS

Sert Room, Waldorf-Astoria

Network Theory In The Practical Design Of Control Systems by J. G. Truxal of Polytechnic Institute of Brooklyn.

The Stability Concept by J. L. Bower of North American Aviation.

Root Locus In Feedback System Synthesis by J. A. Aseltine of Systems Research Corp.

Modulated Control Systems by R. E. Graham of Bell Telephone Laboratories.

NUCLEAR EFFECTS ON ELECTRONIC SYSTEMS

Grand Ballroom, Waldorf-Astoria

Effects Of Nuclear Radiation On Electronic Components by Thomas Baldwin of Evans Signal Lab.

Nuclear Effects On Communication Systems by Jack Eggert of Signal Corps Engineering Labs.

Dose Rate Dependence of Dosimeters At Dose Rates Up To Two Million Roentgen Per Hour by Marvin Stein of Evans Signal Lab.

Techniques Of Measurement At High Radiation Rates by Peter Brown of Signal Corps Engineering Labs.

Radiological Instrumentation by Jerrold Carp of Signal Corps Engineering Labs.

ELECTRONIC COMPUTERS I

Marconi Hall, Kingsbridge Armory

A Multiple Input Analog Multiplier by D. D. Porter and A. S. Robinson of Columbia University.

Analogue Multiplying Circuits Using Switching Transistors by Kan Chen and R. O. Decker of Westinghouse Electric Corp.

Logic Design Of The RCA Bizmac Computer by A. D. Beard, L. S. Bensky, D. L. Nettleton and G. E. Poorte of RCA.

Input And Output Devices In The RCA Bizmac System by J. A. Brustman, K. L. Chien, C. T. Cole and D. Flechtner of RCA.

The Burroughs Series G High-Speed Printer by Edmund M. DiGiulio of Control Instrument Co.

ANTENNAS AND PROPAGATION—ANTENNAS

Faraday Hall, Kingsbridge Armory

Cross Polarization Effects On Antenna Radiation Patterns by Nathan Marchand of Marchand Electronic Laboratories and W. G. Scott of Melpar.

A Vertical Antenna Made Of Trans-

posed Sections Of Coaxial Cable by Harold A. Wheeler of Wheeler Laboratories.

Electrically Small Ferrite Loaded Loop Antennas by V. H. Rumsey and W. L. Weeks of University of Illinois.

A Wide Band Coaxial Hybrid by Andrew Alford and C. B. Watts, Jr., of Andrew Alford, Consulting Engineers.

Dielectric Bifocal Lenses by Russell M. Brown of Naval Research Laboratory.

Wednesday Afternoon, March 21
(2:30-5:00 P.M.)

MICROWAVES II—FERRITES

Belmont Plaza Moderne Room

The Design Of Non-Reciprocal Phase Shift Sections by H. N. Chait and N. G. Sakiotis of Naval Research Laboratory.

Tensor Permeabilities Of Ferrites Below Magnetic Saturation by E. G. Spencer and R. C. Le Craw of The Diamond Ordnance Fuze Laboratories.

A Miniaturized High Temperature Isolator by R. F. Sullivan and R. C. Le Craw of The Diamond Ordnance Fuze Laboratories.

Broadbanding Ferrite Microwave Isolators by P. H. Vartanian, J. L. Melchor and W. P. Ayres of Sylvania Electric Products.

Ferrite Microwave Phaseshifters by R. F. Soohoo of Cascade Research Corp.

A Balanced Stripline Isolator by O. W. Fix of Holloman Air Force Base.

DESIGN APPROACHES WITH PRINTED WIRING

Starlight Roof, Waldorf Astoria

Engineering of Printed Circuits to Facilitate Production by Robert C. Calcut and Charles A. Artz of Admiral Corp.

Principles Of Circuit Design For Automation by H. S. Dordick of RCA.

Modular Construction—Its Implications To The Design Engineer by Robert E. Bauer of ACF Electronics.

A New Automation Technique For Soldering Components To Foil-Wire Boards by A. A. Lawson, P. E. Ritt, Jr. and H. K. Hazel of Melpar, Inc.

Printed Circuits Via Xerography by F. A. Schwertz and E. M. Van Wagner of The Haloid Co.

Cupric Oxidized Copper Foil For Printed Circuit Laminates by L. W. McGinnis, J. S. Tatnall and G. H. Mains of National Vulcanized Fibre Co.

OVER-THE-HORIZON SYSTEMS

Astor Gallery, Waldorf-Astoria

VHF Transhorizon Communication System Design by R. M. Ringoen of Collins Radio Co.

Over-The-Horizon Radio Transmission Tests Between Florida And Cuba by K. P. Stiles of A T & T.

A Broadband Over-The-Horizon Link—Florida To Cuba by R. T. Adams, H. Havstad, L. Pollack and W. Sichak of Federal Telecommunication Laboratories.

An Over The-Horizon Radio Link Between Puerto Rico And The Dominican Republic by R. E. Gray and R. A. Felsenheld of Federal Telecommunication Laboratories.

Relative Interference Produced By UHF Scatter And Line-Of-Sight Systems by R. M. Ringoen of Collins Radio Co.

COLOR TELEVISION RECEIVERS

Waldorf-Astoria Jade Room

The "Chromatron" As The Basis for Low-Cost Television Receivers by R. D'Amato, R. Dressler, A. Jacobs of Chromatic Television Laboratories and J. R. Popkin-Clurman and S. M. Decker of Telechrome Manufacturing Corp.

The Optimum Relative Phosphor Efficiencies by S. K. Altes of GE.

A New Color Television Display—The Apple System by J. S. Bryan, R. G. Clapp, E. M. Creamer, S. W. Moulton and M. E. Partin of Philco Corp

A Beam-Indexing Color Picture Tube—The Apple Tube by G. F. Barnett, F. J. Bingley, S. L. Parsons, G. W. Pratt and M. Sadowsky of Philco Corp.

Current Status Of Apple Receiver Circuits And Components by R. A. Bloomsburgh, W. P. Boothroyd, G. A. Fedde and R. C. Moore of Philco Corp.

TELEMETERING SYSTEMS

Sert Room, Waldorf-Astoria

Automatic Remote Control And Telemetering By Telephone by Charles H. Doersam, Jr. of Doerco—Consultants.

Noise And Crosstalk In Multiplexed F-M Systems by Raymond A. Runyan of Electro-Mechanical Research.

High Capacity Pulse Code Telemeter

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- AUXILIARY FILAMENT POWER FOR OTHER CIRCUIT REQUIREMENTS
- REGULATOR CIRCUIT PLATE POWER
- APPLICATION BULLETIN WITH EACH UNIT

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ST2010

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Secondaries:

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5.0V	3	A
6.3V	3	A
6.3V	1.2	A
6.3VCT	6	A

*Note 40 ma provided

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And Data Reduction System by George S. Shaw of Radiation, Inc.

The Development Of A High Speed Electronic Multiplexer And Coder For Use With A PCM Telemeter by Robert P. Bishop and Robert E. Marquand of Radiation, Inc.

ELECTRONIC COMPUTERS II
Kingsbridge Armory, Marconi Hall

A Magnetic Drum Sorting System by Bonnar Cox and Jacob Goldberg of Stanford Research Institute.

A Magnetic Drum Extension To The Gamma 3 Computer by P. L. Dreyfus, H. G. Feissel and B. M. Leclerc of Compagnie Des Machines Bull.

The Univac Magnetic Computer Part II. Logical Design And Specifications by A. J. Gehring, L. W. Stowe and L. D. Wilson of Sperry Rand Corp.

The Univac Magnetic Computer Par II. Megacycle Magnetic Modules by Bruce K. Smith of Sperry Rand Corp.

The Univac Magnetic Computer Part III. Drum Memory by V. J. Porter, S. E. Smith and M. Naiman of Sperry Rand Corp.

ANTENNAS AND PROPAGATION—MICROWAVE ANTENNAS
Kingsbridge Armory, Faraday Hall

High Efficiency Metallized Fiberglas Microwave Lens by R. L. Smedes of Sperry Gyroscope Co.

Ferrod Radiator Systems by F. Reggia, E. G. Spencer, R. D. Hatcher and J. E. Tompkins of The Diamond Ordnance Fuze Laboratories.

Design Method For Very Long Linear Arrays by Maurice G. Chernin and Robert W. Bickmore of Hughes Aircraft Co.

Some New Antenna Designs Based On The Trough Waveguide by Walter Rotman and Nicholas Karas of Air Force Cambridge Research Center.

Future Trends In Radomes For Ground Electronic Equipment by Milton V. Ratynski of Rome Air Development Center.

A Toroidal Microwave Reflector by G. D. M. Peeler and D. H. Archer of Naval Research Laboratory.

Thursday Morning, March 22
(10:00-12:30 A.M.)

CIRCUITS II—DESIGN AND APPLICATION OF ACTIVE NETWORKS
Belmont Plaza, Moderne Room

On The Driving-Point Impedance Functions Of Active Networks by N. DeClaris of MIT.

Active Network Synthesis by I. Horowitz of Microwave Research Institute.

Some Considerations On The Stability Of Active Two-Point Elements And Applications by Arthur P. Stern of GE.

Two Invariants Of Noisy Linear Amplifiers by H. A. Haus and R. B. Adler of MIT.

Graphical Analysis Of Transistor Circuits By Separation Of Variables by D. L. Finn and B. J. Dasher of Georgia Institute of Technology.

ELECTRONIC COMPUTERS III—SYMPOSIUM ON THE IMPACT OF COMPUTERS ON SCIENCE AND SOCIETY
Starlight Roof, Waldorf-Astoria

Allen V. Astin of National Bureau of Standards; R. E. Meagher of University of Illinois; David Sayre of International Business Machines Corp. and Jay W. Forrester of MIT.

COLOR TELEVISION
Waldorf-Astoria, Astor Gallery

Recent Improvements In The 21AXP22 Color Kinescope by R. B. Janes, L. B. Headrick, J. Evans of RCA.

G. E. Post Acceleration Color Tube by C. G. Lob of GE.

Correct Prints Of Color Tube Screens by H. Heil of GE.

The Unipotential Mask-Focusing Colortron by N. Fyler, C. Cain, P. Hambleton of CBS-Hytron.

Focusing Mask Color Kinescopes by E. G. Ramberg, H. B. Law, H. S. Allwine, D. C. Darling, C. W. Henderson and H. Rosenthal of RCA.

COMPONENT PARTS I
Jade Room—Waldorf-Astoria

The Power Supply In Military Equipment by Sol Perlman of Rome Air Development Center.

The Silver-Zinc Rechargeable Battery by Paul Howard of Yardney Electric Corp.

The Wafer Coil Pulse Transformer by Alfred Babcock & Albert Zack of Sylvania

Electric Products.

Developments In Magnetic Component Packaging by A. Lucic of North American Aviation.

INDUSTRIAL ELECTRONICS
Waldorf-Astoria—Sert Room

High Frequency Shields by Raymond E. Lafferty of NBC.

Field-Intensity Measurements On Induction-Heating Equipment by T. E. Nash of RCA.

Basic Considerations In The Design Of Electronic Power Supplies For Electrodynamic Shakers by Donald J. Fritch of The Calidyne Co.

Magnetic Amplifier Industrial Control Techniques For Improved Accurary And Reliability by Henry W. Patton of Airpax Products Co.

INFORMATION THEORY II
Grand Ballroom, Waldorf-Astoria

Certain Aspects Of Coherence, Modulation and Selectivity In Information Transmission Systems by Stanford Goldman of Syracuse University.

Some Results In Coding Theory by Claude Shannon of Bell Telephone Labs.

Session Commentary by Peter Elias of MIT.

Factors Determining The Channel Capacities And Design Constraints In Groups Of Nerve Fibers by P. D. Wall, J. Y. Lettvin, W. S. McCulloch and W. H. Pitts of MIT.

MICROWAVES III—FILTERS
Marconi Hall, Kingsbridge Armory

Directional Channel-Separation Filters by S. B. Cohn and F. S. Coale of Stanford Research Institute.

A Resonant Cavity Frequency Duplexer by E. O. Bowers and C. W. Curtis of Hughes Research Laboratories.

Synthesis Of Wide-Band Microwave Filters To Have Prescribed Insertion Loss by E. M. T. Jones of Stanford Research Institute.

Crossed-Mode Tunable Selector For Microwaves by N. A. Spencer of Wheeler Laboratories.

The Susceptance Of A Circular Iris To The Dominant TE_{11} Mode In Circular Waveguide by M. Handelsman of Rome Air Development Center.

INSTRUMENTATION II
Faraday Hall—Kingsbridge Armory

A Method For Repetitive Examination Of Transient Phenomena by J. W. Dorsett, Jr. of Ampex Corp.

A Magnetic Head For The Megacycle Range by Otto Kornei of Clevite Research Center.

Extending The Versatility Of A Laboratory Magnetic Tape Data-Storage Device by A. V. Gangnes of Ampex Corp.

A Time Bridge by M. B. Kline and C. E. Webb of Allen B. DuMont Laboratories.

A Versatile Quadrature Time Base Comparator For Automatic Frequency Measurement by I. J. Weber of Sperry Gyroscope Co.

Thursday Afternoon, March 22
(2:30-5:00 P.M.)

CIRCUITS III—NETWORK SYNTHESIS TECHNIQUES
Moderne Room, Belmont-Plaza

Simple And Double Alternation In Network Synthesis by F. Reza of Syracuse University.

Synthesis Of Tchebycheff RC Band Pass Filters by D. Helman of RCA.

Pulsed RC Networks For Sampled Data Systems by J. Sklansky of RCA Laboratories.

An Operational Calculus For Numerical Analysis by Samuel Thaler and Rubin Boxer of Rome Air Development Center.

Linear Complementary Smoothing Compensated For Sampled Data Lags by Joseph L. Ryerson of Rome Air Development Center.

SOLID STATE DEVICES
Empire Room, Waldorf-Astoria

Electrets by Eric G. Linden of Signal Corps Engineering Laboratories.

High Frequency Germanium NPN Tetrode by D. W. Baker of GE.

Power Transistor Design Limitations by Mason Clark of Bell Telephone Laboratories.

Investigation Of Power Gain And Transistor Parameters As Functions Of Both Temperature And Frequency by A. B. Glenn and I. Joffe of RCA.

High Frequency Silicon Tetrode by R. F. Stewart and W. A. Adcock of Texas

Instrument Co.

Semiconductor Capacitance Amplifier by F. Dill, Jr. and L. Depian of Carnegie Institute of Technology.

WHERE IS MEDICAL ELECTRONICS GOING? A SYMPOSIUM IN PREDICTION

Astor Gallery, Waldorf-Astoria

Four speakers with experience in widely varied parts of the biophysical, medical, electronic and engineering sciences will compare notes on the present state of the art and will attempt to predict the major directions in which biophysical medical electronics will make future advances.

V. K. Zworykin of RCA Research Laboratories; Craig L. Taylor of University of California; Alan C. Burton of University of Western Ontario and Otto H. Schmitt of University of Minnesota.

COMPONENT PARTS II

Jade Room, Waldorf-Astoria

Preparation Of Standards & Test Procedures For Printed Circuits by E. R. Gamson and A. Henesian of Stanford Research Institute.

New Ceramic Feedthrough Capacitors With Tremendous Increase In Effective "Capacitance" by H. M. Schlicke of Allen-Bradley Co.

Performance Of Continuous And Discontinuous Tube Feedthrough Capacitors At VHF And Higher Frequencies by E. M. Williams of Carnegie Institute of Technology, and J. H. Foster of Erie Resistor Corp.

Piezoelectric Ceramic I-F Band Pass Filters by Oskar E. Mattiat of Clevite Research Center.

Tantalum Solid Electrolytic Capacitors by D. A. McLean and F. S. Power of Bell Telephone Laboratories.

INFORMATION THEORY III

Waldorf-Astoria, Sert Room

A Prediction Theory Approach To Information Rates by Kerns H. Powers of MIT.

Reduced-Alphabet Representation Of Television Signals by E. H. Kretzmer of Bell Telephone Laboratories.

A Bit-Squeezing Technique Applied To Speech Signals by E. E. David, Jr. and H. S. McDonald of Bell Telephone Laboratories.

Communication Through Noisy, Random-Multipath Channels by George L. Turin of MIT.

Multipath Distortion Of TV Signals And The Design Of A Corrective Filter by A. V. Balakrishnan of RCA.

MICROWAVE INSTRUMENTATION

Marconi Hall, Kingsbridge Armory

An Amplitude Regulator For Microwave Signal Sources by P. Fire and P. H. Vartanian of Sylvania Electric Products.

Measurement Of The Complex Dielectric Constant Of Materials From 100 To 1200 MCS Over A Wide Range Of Temperature by I. Bady of Signal Corps Engineering Labs.

The Z Scope—An Automatic Impedance Plotter For Microwaves by J. P. Vinding of Cascade Research Corp.

A Swept, Broadband, Microwave, Double Detection System With Automatic Synchronization by D. L. Favin of Bell Telephone Labs.

Coaxial Components Employing Gaseous Discharges At Microwave Frequencies by R. H. Geiger and P. E. Dorney of Roger White Electron Devices.

High Power Breakdown Of Microwave Structures by F. R. Stevenson of Sperry Gyroscope Co.

BROADCAST TRANSMISSION SYSTEMS —NEW HORIZONS

Faraday Hall, Kingsbridge Armory

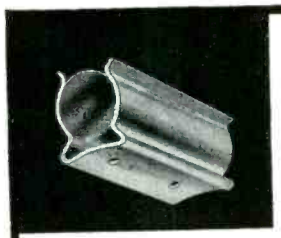
The Technical Boundary Conditions Of Subscription Television by Alexander Ellett and Robert Adler of Zenith Radio Corp.

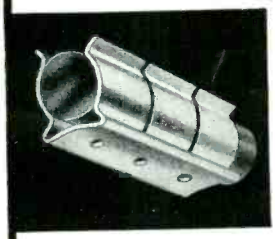
An Integrated System Of Coded Picture Transmission by E. M. Roschke, W. S. Druz, Carl Eilers, and Jan Pulles of Zenith Radio Corp.

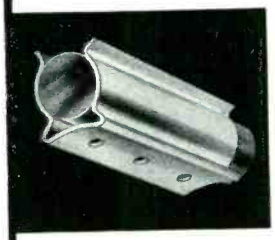
Chromaticity Coordinate—Plotter Photometer by Wilbur H. Highleyman of MIT, M. J. Cantella of USN and V. A. Babits of Rensselaer Polytechnic Institute.

Recent Improvements In Black-And-White Film Recording For Color Television Use by William L. Hughes of Iowa State College.

Design Considerations For A High Quality Transistorized Program Amplifier For Remote Broadcast Use by John K. Birch of Gates Radio Co.







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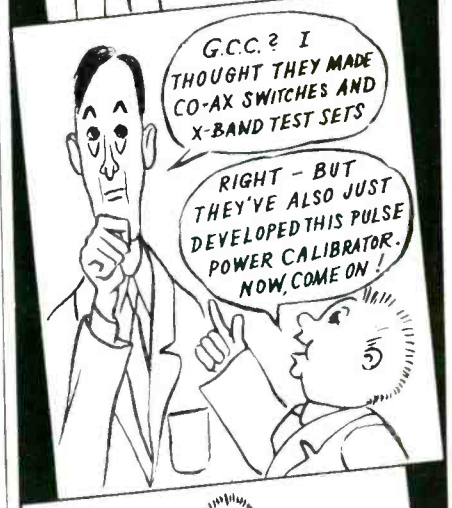

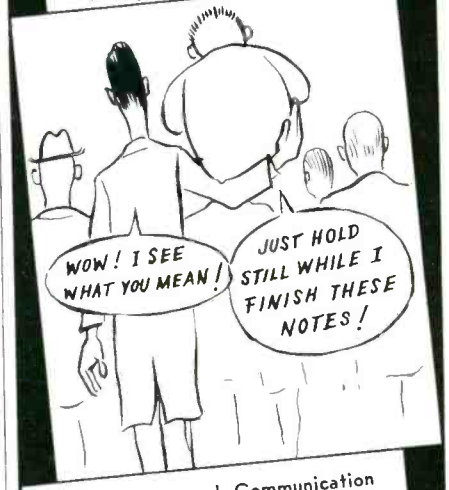

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New Books

Fundamentals of Television Engineering

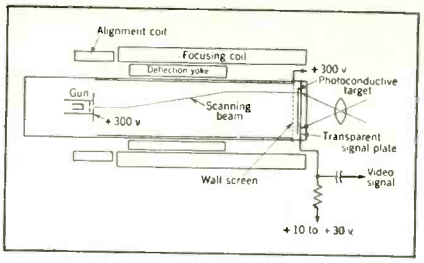
By Glenn M. Glasford
McGraw-Hill Book Company, Inc., New York, 1955, 642 p, $12.75

The author of "Fundamentals of TV Engineering" has two basic aims: first, to describe in concise form the underlying principles of television engineering in all of its optical electronic and electrical ramifications; second, to present the material in such a way and with such selected references that the text offers an easy guide to further research and detailed study of the basic fundamentals. In accomplishing his aims Professor Glasford has carefully presented the material with an optimum balance between textual explanation and mathematical derivations so that the average electronic engineer should not be confused by lengthy equations nor be left in the dark about specific functioning or practical aspects.

▶ **Textbook** — As a textbook, for electronic students, the framework of fundamentals is complete—even including considerable material on color television. The level of certain sections would, however, necessitate the guidance of the students by a careful and experienced teacher, a qualification which Professor Glasford obviously fills. On the other hand, the well grounded electronic engineer will find the material soundly organized and adequately complete with a minimum of redundant material.

Overall organization of the seventeen chapters divides the subject into five parts, three of which concern the basic operation of a tv system and two of which are concerned with circuit functioning and relevant equipment.

Of the first three sections, three chapters are on the building blocks of tv, namely light, optics and scanning, two on camera and picture tubes, covering the generation and reproduction of visual information, and three chapters on the processing of the picture information signals, namely video and transport signal amplifiers.



Operation of the vidicon

▶ **Engineering** — The five-chapter section covering the principles of electronic and pulse engineering apply them to the specific transport frequency, scanning and synchronizing circuits. The material on circuits applies to all of the types of equipment used in television transmission and reception.

The four final chapters crystallize the principles and circuit techniques established in the rest of the book. They include the circuit and operating details of generating equipment such as sync generators, cameras and video transmitters and then conclude with a final chapter on television receivers.

If there be any criticism of the book it should be leveled at the rather short chapter on television receivers for it is in this area that the electronics field is rapidly advancing, what with such devices as transistors, miniaturized components, printed circuitry and color processing techniques.

On the whole "Fundamentals of Television Engineering" is well written and presented; although not a classic it compares well with competitors at its particular level. —Harry E. Thomas, *Senior Project Engineer Federal Telecommunication Laboratories, Nutley, New Jersey*

Electronic Transformers and Circuits

By Reuben Lee
John Wiley & Sons, Inc., New York, 1955, 360 p, $7.50.

Purpose of this book is to present data to aid designers of transformers for electronic equipment and the designers of electronic equipment who will make use of transformers. Only transformers and reactors useful in electronics are discussed making it unnecessary for the electronic engineer to wade

through pages of material on power-station units to find the material he needs.

► **Content**—The book includes material on transformers for rectifiers, amplifiers, pulse and video circuits. Also high-frequency transformers, control transformers and magnetic amplifiers. New material not covered in the first edition published eight years ago covers magnetic amplifiers, pulse circuits, toroids, wide-band transformers, r-f power supplies and charging chokes.

Chapter 2 deals with transformer construction. Information is given on characteristics of various core materials and ratings of insulators.

► **Design Charts**—The book is particularly valuable to the design engineer because of the great number of time-saving reference charts included. There are design charts for 60-cps transformers, linear reactors, filters, amplifier and pulse circuits.

Useful also to the engineer will be the many practical problems worked out in detail throughout the book.—J.M.C.

Introduction to Electric Analog Computers

BY C. A. A. WASS
McGraw-Hill Book Co., New York, 1955, 237 *p.* $6.50.

IN fields which are advancing as rapidly as are analog computation and simulation, the appearance of a new book is always welcome. If the book happens to come to us from another country, it assumes even greater importance, since it can be expected that different techniques will have been developed and described.

In this case we have both of the conditions satisfied and, in addition, it is a well thought out and well written text. Despite differences in terminology and symbolism, Mr. Wass' book will satisfy the requirements of first-year graduate students and other engineers with no prior training in analog techniques.

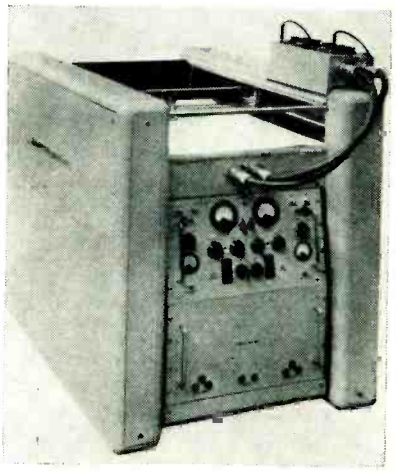
► **Differential Analyzers**—The book

covers the subject matter from a basic discussion of linear differential analyzers and simulators through nonlinear techniques to a basic consideration of the hardware involved. Included is material for those interested in either operation or construction. As might be expected, the book describes the art as it was about two years ago, without much mention of such recent advances as, for example, problem checking equipment and systems.

The first chapter is entitled Electronic Calculating Machines and describes not only differential analyzers and analog simulators, but also describes briefly both digital machines and nonelectronic analog machines. The next two chapters discuss linear analog computation, from both the analyzer and simulator points of view.

► **Nonlinear Systems**—A chapter of nonlinear simulators follows, based on problems in ballistics, electronics and mechanics. Three chapters then are concerned with design of summing amplifiers, integrators and multipliers. A short chapter on operation of simulators is followed by a chapter covering auxiliary equipment such as signal generators and recorders. The final chapter describes modern British machines.

Chapter 7, on nonlinear equipment, contains much material which has not been available in a single source. The description of working machines given in the last chapter is also of unusual interest, since in it are illustrated principles and


X-Y plotting board

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April 29–May 8, 1956

Information and catalogues from:

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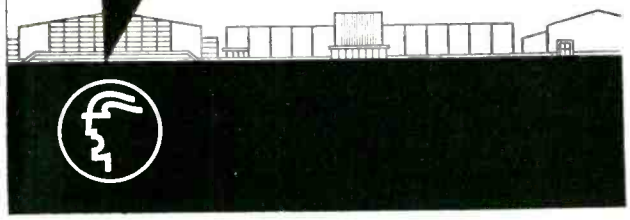

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techniques (example, a servo-controlled balancing device for amplifiers) which have not been used to a large extent in our country. Although the book will not be of much help to the experienced analog engineer, it contains all the material required to provide a good working familiarity with the subject.—HOWARD HAMER, *Senior Engineer, Electronic Associates, Inc., Long Branch, N. J.*

Servomechanisms and Regulating System Design, Volume II

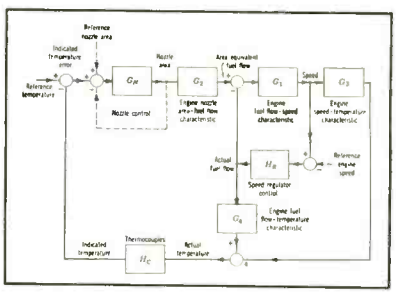
BY HAROLD CHESTNUT and ROBERT W. MAYER

John Wiley and Sons, Inc., New York, 1955, 384 p, $8.50.

THE SECOND volume of this work was published early in 1955, about four years after the publication of the first volume. Much of the delay was caused by the necessity of including new developments in this young and rapidly growing field.

Volume I, slanted toward the engineering student or engineer with little servo experience, concentrated on developing mathematical tools and techniques needed for servo analysis. To achieve that goal, such topics as the use of complex numbers, the Laplace transform and other methods of solution of linear differential equations, steady-state analysis by the attenuation-phase approach, stability criteria (Nyquist, Routh etc), the use of the complex plane in stabilization, multiple-loop systems and steady-state to transient correlation of system performance, were treated.

The present volume, on the other hand, is written primarily as a text for the use of the more advanced graduate student, and as a



Jet-Engine Control

reference for the servo design engineer. Thus its emphasis is on synthesis.

▶ **Nonlinearities** — The concluding chapter deals with the deliberate rather than the unavoidable use of nonlinearities. They can be employed for improving system synchronization, accomplishing changes in system performance and meeting a wide range of performance requirements.

Throughout the volume, the use of computers and/or simulators is advocated, either where parameters of the linear servo are difficult to determine, or where nonlinearities make it difficult to treat the system analytically. This is an instance of the authors' emphasis on achieving good engineering solutions to servo problems.

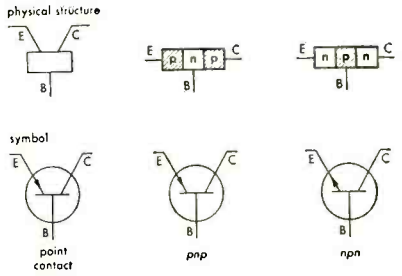
A bibliography of 117 items, covering mostly the years 1946 to 1952, is included. There is an adequate index. Some practical examples are worked out in the text, but there are no problems for solution by the student.

The major contribution of this book lies in its extensive treatment of the nonlinear servo. In this respect it is somewhat unusual in the literature, where often the analysis embraces only methods applicable to linear systems. The material, overall, is well organized, and presented in an easily comprehensible manner. The treatment is not excessively mathematical. This book represents, in the authors' words, "a report on some phases of the present state of the feedback control system art."—JOSEPH L. BALL, *Project Manager, W. L. Maxson Corp., New York, New York.* HENRY B. WEISBECKER, *Project Engineer, Simmonds Aerocessories, Inc., Tarrytown, New York.*

Radio Operating Question and Answers

BY J. L. HORNUNG and A. A. MCKENZIE
McGraw-Hill Book Co., New York, 1955, 571 *p,* $4.50.

THE purpose of this book is to furnish concise, quick answers to questions that appear in the most recent



Structure and schematic of transistor types

revision of the booklet "Study Guide and Reference Material for Commercial Radio Operator Examinations" published by the Federal Communications Commission.

The 12th edition of this well known text opens with a section entitled "How To Use This Book," which includes a study chart indicating page location of questions and answers about subjects upon which the various commercial license examinations are based. The questions have been grouped according to subjects to enable the reader to concentrate upon one aspect of the examination at a time.

The authors have been liberal with examples, diagrams, and illustrations to help the reader understand the answers.

▶ **More Data**—The appendix is unusually complete, including Q-codes, especially the new ones for special purposes, time-signal information, phonetic word lists and resistor and capacitor color codes.

An up-to-date list of last-minute questions and answers on such subjects as transistors, magnetrons, klystrons and color television has been included in the addendum.

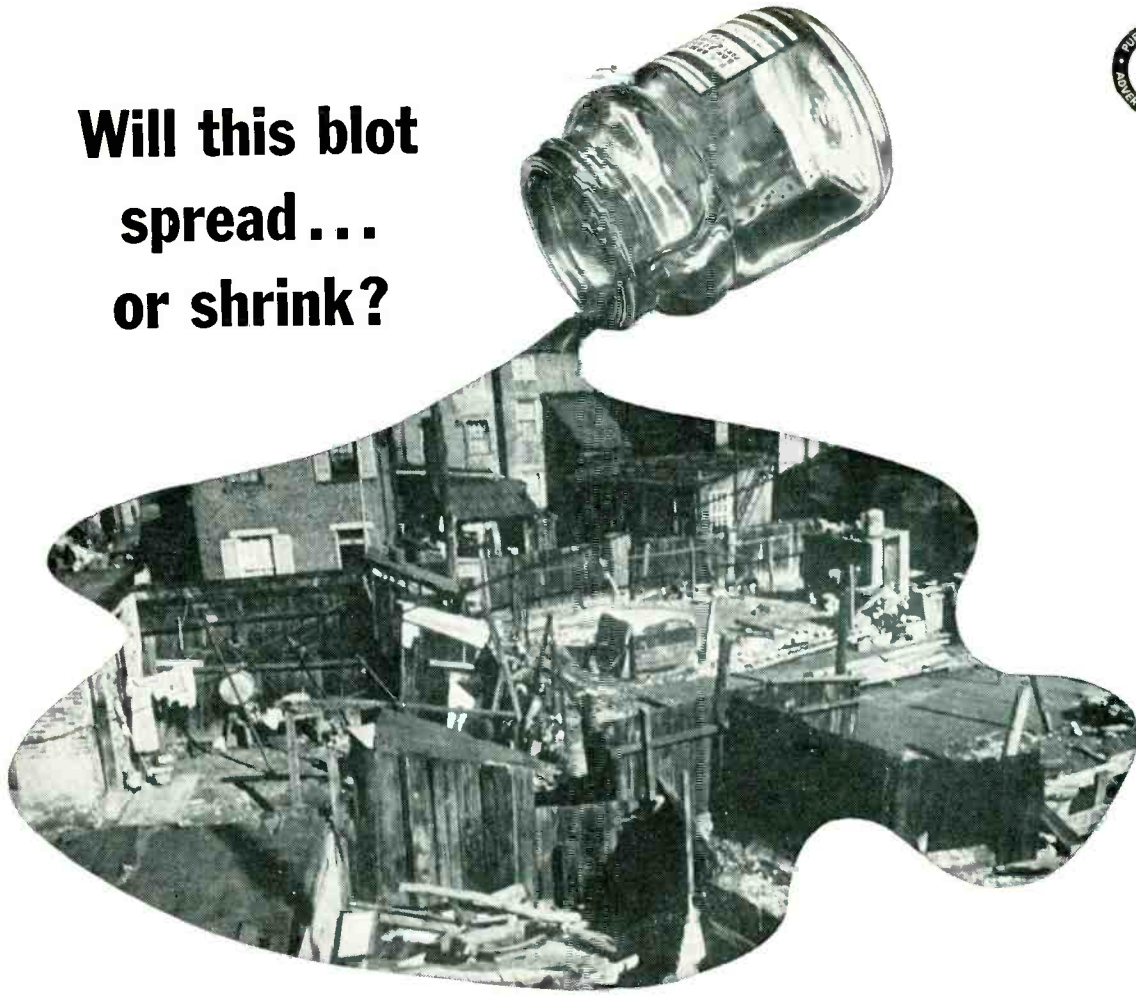
This book should be considered a valuable addition to the engineering library, both for study and for reference.—G. B. RILEY, *Supervisor of Television WOR-TV, New York, New York*

Geometrical Mechanics and de Broglie Waves

By J. L. SYNGE
Cambridge University Press, New York, 1954, 167 *p*, $4.75.

PROFESSOR Synge has written a formal but interesting book about an area of physics that has

Will this blot spread... or shrink?



NOTHING STRIKES so brutally at human lives as a slum.

Yet of America's many millions of homes, the blot that is a slum covers more than 1 out of every 10 . . . and nearly one-half of all our homes are urgently in need of repair and basic improvements.

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Your *firm* pays when the community where you do business goes downhill. Slums automatically mean lower purchasing power and less effective labor.

Good citizenship is good business

It's good citizenship and good business both for your firm to join efforts to check housing decay . . . to stop slums before they start. In fact, it's the *responsibility* of every business, as it is of every other good citizen, to support community improvement efforts.

Some slums are beyond repair. They should be torn down and a fresh start made. Others can be remodeled, made to conform to better living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Adding your support to the efforts of the millions already attacking the problem, your firm can help stop slums cold and put America's housing standards at a new height.

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Send for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It also lists booklets, research reports, check-lists, and other material which can help you protect the housing health of your community. Address P. O. Box 500, Radio City Station, New York 20, N. Y.

ACTION

American Council To Improve Our Neighborhoods

not, to this writer's knowledge, been previously explored. It is an effort to organize, for the solution of relativistic quantum mechanical problems, a body of theory which is exactly analogous to that of physical optics.

It is generally known that in optics there exist two major methods of treating problems. The method based on Maxwell's equations and those of geometrical optics.

Between these two self-contained formalisms, there lies a semicoherent body of theory, called physical optics, with which one almost always works in the design of optical instruments.

▶ **Approach**—It is the function of this book to provide just such a middle ground for relativistic quantum mechanics. As before, there exists a wave method, based on Schrödinger's equation (relativistically, of course, the Dirac or Klein-Gordon equations). This is rigorous, but hard to apply to many problems. When the wavelengths are short compared to all relevant lengths, the classical limit appears. Here one has a geometrical mechanics that can be based on the variational principle of de Maupertuis. What Professor Synge does is to append the concept of de Broglie waves to this geometrical mechanics.

The results are closely related to the results of the old quantum theory, in which classical mechanics had superimposed on it the quantization of action.

The book is not one to be picked up and browsed through by the reader who is not formally inclined, but should appeal to the mathematical physicist and to the mathematician who is interested in relativistic mechanics. The sections about the latter are entirely selfcontained.

H. W. LEWIS, *Bell Telephone Laboratories, Inc., Murray Hill, N. J.*

Eine Anlage Fur Impuls-Code-Modulation

By CAMILLO MARGNA
Verlag Leemann, Zurich, 1955, 83 *p.*

ALTHOUGH the principles of pulse-code-modulation (pcm) were known over two decades, it was only

during WW II that the first practical systems were demonstrated.

Chapters 1 and 2 are concise and straight forward—with one exception; as is the case with most pcm-literature, the transmission link is assumed to make only a negligible number of errors in the pulse-no pulse decision, the main bulk of distortion being supplied by the quantizing noise. This assumption does make pcm superior but it is not usually prevalent in practice. If the pulse error rate grows comparatively high, a method of transmission which does not attribute different weights to the transmitted pulses give better results.

▶ **Coding**—Chapter 3 describes a number of coding and quantizing methods. The method chosen by the author for the construction of the experimental transmitter and therefore, described in most detail is the classic counter-chain code.

Byproduct of this is, however, that the description of the counter-chain transmitter will give the newcomer to the field a rather complete overall view over the art of pulse circuitry.

The chapter on decoding devices is short but complete and sufficiently detailed.

An intensive bibliography at the end of the book lists pertinent articles and books written from 1947 to 1954.

As a whole the book is useful as an introduction to the pulse-modulating techniques.

E. KEONJIAN and H. N. PUTSCHI, *General Electric Company, Syracuse, N. Y.*

Dictionary of Television, Radar and Antennas

Compiled by W. E. CLASON. *Elsevier Press Inc., Houston, Texas,* 1955, 760 *p*, $21.50.

DEFINES 2,450 technical terms clearly in English and gives equivalent terms in five other languages, with British versions where different.

The book is made up in tabular form, with each spread or pair of pages having 10 columns, as follows: (1) No. of term; (2) English

term, often in several different equivalent British and U.S. versions; (3) Subject—whether rdr, ant or tv; (4) Definition in English; (5) French equivalent terms; (6) Spanish equivalents; (7) Italian equivalents; (8) Dutch equivalents; (9) German equivalents; (10) No. of term.

Five separate alphabetical indexes in the five foreign languages give the number of the term in the English-alphabetized listing. The English listing itself is liberally cross-indexed, so that terms in any of the six languages can be quickly found.

For the topics covered, as listed in the title, this book is highly recommended. It is in no sense a complete electronics dictionary, however; not even the word electronics is defined. A complete coverage of all terms should require about four more books of this size, because the 1945 6,000-term language of electronics has just about doubled in a decade.—J.M.

The Technical Report

By W. H. WEIS
Reinhold Publishing Corp., New York, 1954, 485 *p.* $12.00.

EXTENDING beyond the usual range of organization and writing, this book presents chapters on distributing, filing and using reports. So comprehensive an approach is obtained by compiling the papers of some two dozen scientists and librarians who have specialized in handling technical reports.

Ten papers were presented in Sept. 1953 before the division of chemical literature of the American Chemical Society in its symposium on the research report. Other chapters were deliberately written to augment the material covered by these ten papers. Other chapters are taken from theses to complete the topical coverage.

▶ **Organization** — Two chapters deal with the functions of technical reports in industry and government. The following nine chapters, occupying somewhat less than half the book, present material on preparation and processing of reports including: writing progress reports, writing formal reports, com-

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Whatever the emergency is, everybody's going to want help at the same time. It may be hours before outside help reaches you. The best chance of survival for you and your workers—and the fastest way to get back into production—is to know what to do and be ready to do it. Disaster may happen TOMORROW. Take these simple precautions TODAY:

☐ **Call your local** Civil Defense Director. He'll help you set up a plan for your offices and plant—a plan that's safer, because it's integrated with community Civil Defense action.

☐ **Check contents** and locations of first-aid kits. Be sure they're adequate and up to date. Here, again, your CD Director can help. He'll advise you on supplies needed for injuries due to blast, radiation, etc.

☐ **Encourage personnel** to attend Red Cross First-Aid Training Courses. They may save your life.

☐ **Encourage your staff** and your community to have their homes prepared. Run ads in your plant paper, in local newspapers, over TV and radio, on bulletin boards. Your CD Director can show you ads and official CD films or literature that you can sponsor locally. Set the standard of preparedness in your plant city. There's no better way of building prestige and good community relations—and no greater way of helping America.

Act now . . . check off these four simple points . . . before it's too late.

mon faults and recommended practices in writing reports, literature summaries, preparation and presentation of oral reports, editing reports, style manuals, illustrating, duplicating and binding reports, and finally a chapter on graphs and tables.

The two following chapters describe methods for distributing company and government reports including such aspects as security. The next eight chapters, about a quarter of the book, deal with filing. In addition to general considerations of filing reports, subject classification, and indexing, chapters present material on: indexing by hand-sorting punched cards, the uniterm coordinate indexing of reports (the first significant inovation in report indexing for many years), cataloging government reports, procedures for security-classified reports, storing and housing unpublished reports, and a chapter on abstracting reports. The concluding three chapters discuss the use of reports. One chapter in particular summarizes much useful information on how to locate and obtain government reports.

Also included in the book are two appendixes; one a reproduction of the report manual of Georgia Tech Engineering Experiment Station, the other a reprint of Executive Order 10501 (Nov. 1953) which deals with security handling of government reports. Author and subject indexes make the book useful for reference purposes.

▶ **Content**—As is to be expected in a compilation of this nature, there is a wide variation in the quality of the chapters. The opinions of the authors will certainly be of interest to editors and librarians directly concerned with the preparation, handling, and using of technical reports. However, it is doubtful that the scientist or engineer who is called upon to write and read technical reports will care to read about reports at such length. They will still find the small pamphlet "Aids to Technical Writing" by R. C. Jordan and M. J. Edwards (Bulletin No. 21, Engineering Experiment Station, University of Minnesota, Minneapolis, 1944) more helpful per page. For those

who care to read at greater length about how to write well, this reviewer recommends "Fundamentals of Good Writing" by Cleanth Brooks and R. P. Warren (Harcourt, Brace and Co., New York, 1949) or "Technical Writing" by T. A. Richard.

Practically all of the authors mention somewhere in their chapters the extreme importance of technical literature in today's rapidly advancing science and industry. The tremendous bulk of such literature is staggering. The burden placed on the practicing scientist of reading even that portion of the literature which bears directly on his field of inquiry is out of hand. Although much can be done by proper indexing and abstracting to facilitate the location of reports, the time consumed in reading them is longer then the time to reproduce the results.

▶ Style—This book is an example of verbose writing. In fact if the literary style here is indicative of what is being fostered on our technical literature, it is time to become alarmed at the confusion being created by scientists turned editors. This reviewer considers it especially significant that none of the authors who have contributed to this book have formal training in journalism or experience in writing for publications that are read because they are readable. The sections on illustrating are especially disappointing. Nothing is presented about mathematics. FRANK H. ROCKETT, *Airpax Products Company, Baltimore, Maryland*

Thumbnail Reviews

Nuclear Radiation Detectors. J. Sharpe. John Wiley & Sons, Inc., New York, 1955, 179 p, $2.50. Discusses basic processes for detecting nuclear particles, including such detection media as phosphors and ionization chambers. Compares efficiency of various detectors and discusses such specific detectors as scintillation counters, ionization chambers, gas multiplication and proportional counters and Geiger counters.

Technical Publications. C. Baker. John Wiley & Sons, Inc., New York, 1955, 302 p, $6.00. Book first published in England discusses preparation of text books, technical articles and papers,

advertising and brochures. Particularly strong on effective presentation of technical illustrations. Not aimed primarily at electronics field.

Abstracts of the Literature on Semiconducting and Luminescent Materials. Battelle Memorial Institute. John Wiley & Sons, Inc., New York, 1955, 200 p, $5 (paper). Volume contains over 750 abstracted articles covering one year's literature in the field. Over 220 articles deal with germanium and silicon and their applications. Other semiconductors include selenium, tellurium, intermetallics, oxides, sulfides and other compounds.

Molecular Beams. N. F. Smith. John Wiley & Sons, Inc., New York, 1955, 133 p, $2. Considers the nature and behavior of molecular beams. Also their magnetic and electrostatic deflection, atomic and molecular beam radio-frequency spectroscopy.

Scattering and Diffraction of Radio Waves. J. R. Mentzer. Pergamon Press Ltd., London, 1955, 134 p, 1/10. Theoretical treatment of problems of diffraction and scattering of radio-frequency waves by various obstacles. Of interest to workers in radar and other microwave systems.

Vector Analysis. Homer E. Newell, Jr., McGraw-Hill Book Co., Inc., New York, 1955, 216 p, $5.50. Developes algebraic and calculus operations with vectors for the engineer and physicist. Applications are given in the fields of kinematics, mechanics and especially electromagnetic theory.

Advances in Research and Applications, Vol. I, Solid State Physics. Frederick Seitz and David Turnbull. Academic Press Inc., New York, 1955, 469 p, $10.00. Chapter on Valance Semiconductors, Germanium and Silicon provides theoretical basis for development of transistor action.

Improving the Work Skills of the Nation. National Manpower Council. Columbia University Press, New York, 1955, 203 p, $3.50. Proceedings of conference held in Spring 1955. Concerns training and selection in industry. Some application to electronics industry.

The BEAMA Catalogue. British Electrical & Allied Manufacturers' Association. Iliffe & Sons Ltd., London, 1955-56, 1,034 p. Contains information on power plant equipment, industry, transport and communications equipment and domestic appliances. Glossary in five languages.

Color Television Receiver Practices. Hazeltine Electronics Labs staff. John F. Rider Publisher, Inc., New York, 1955, 200 p, $4.50 (paper), $6.00 (cloth). Theory and practice of color television receiver design. Covers tubes, decoders, sync circuits, i-f and video amplification and laboratory apparatus.

Backtalk

Equipment Rental

DEAR SIRS:
THIS is written with reference to your comments "Lend-Lease" under *Cross-Talk* in the October, 1955, ELECTRONICS.

Our larger systems of vibration test equipment, consisting of vibration exciters powered by either rotary or electronic power supplies (in either case with fairly complex servo control systems), may be leased.

We hope that this information might be passed on to anyone seeking to rent vibration test equipment.

WAYNE TUSTIN
Sales Engineer
MB Manufacturing Company
New Haven, Connecticut

EDITOR'S NOTE: Thanks for so advising us. We'd like to hear from others who have electronic equipment available on a lease basis.

Patents Challenge

DEAR SIRS:
THE letter from Mr. Sharpe ("Patent Examiners Needed", *Backtalk*, Dec. '55) points out a very important need. It may be appropriate to supplement this information from a less official source, with some remarks on the nature of the examiner's work.

While the requirements for eligibility to appointment as an examiner call for a scientific or engineering background, the actual work is perhaps half legal in nature. In the course of experience, an examiner must acquire a substantial knowledge of patent law and practice in the field of prosecution of applications for patents.

Court work is, of course, another matter. In any case, the knowledge required of an experienced examiner is comparable to that needed by the attorney. Except for the fact that it is all on paper, the work of an examiner is anything but routine. Each case is different, and many are difficult and challenging. The logic involved in a legal problem can be just as complex as that in an engineering problem.

Experience as an examiner is very valuable in the patent law profession. Patent Office experience is a recognized route of entry into that field. It is practicable to attend law school at any of several universities in the Washington area during one's employment as an examiner, and this is quite generally done.

The requirements for admission to practice as an attorney before the Patent Office may be fulfilled by admission to the bar plus three or more years' experience in the examining corps.

Patent attorney positions with companies generally command higher salaries than engineering posts with similar time of experience.

Another facet of work as an examiner that is usually overlooked is the opportunity to become familiar with technical literature, and to get practice in searching it. The Patent Office library has perhaps the most complete collection of technical periodicals in the world. Searchers embrace publications as well as patents. Patent examining offers the best experience there is, in developing skill and speed at scanning technical literature, and in becoming familiar with the publications and the art.

Students and recent graduates who feel attracted to the subject of law and technical literature as well as to engineering or physical science would be well advised to consider entering the examining corps. A good first step would be to talk with a patent attorney or agent, to get a more specific view of the nature of the work.

LAWRENCE FLEMING
Falls Church, Va.

Gravity and Inertial Mass

DEAR SIRS:
YOUR *Looking Ahead* (ELECTRONICS, p 121, Jan. 1956) wild conjecture on the possible nature of gravity is an open invitation to all curbstone physicists to voice their theories. Here is one I frequently laugh off, but sooner or later return to, with a certain fascination:

> The inexplicable phenomenon of gravity is a simple manifestation of inertial mass if the entire universe is expanding at a constantly accelerating rate.

This means not only the expanding universe of astronomy, but

Want more information? Use post card on last page.

the subatomic expansion of every particle and void.

Here is food for thought. Readers are cautioned not to write it off too quickly; the most obvious objections succumb to serious analysis.

CHARLES C. LITTELL, JR.
Engineering Associates
Dayton, Ohio

Editor's Note: Perhaps other curbstoners would like to join the discussion.

Novel Transmission Line

DEAR SIRS:
REVIEWING my 12-year stack of ELECTRONICS, the article "Surface Wave Transmission Lines" by Georg Goubau, in the Buyers' Guide, June 1955, interested me.

Reference was made to a line with a loss of only 6 db per mile at 250 mc. The dimensions of the experimental line and launchers were not indicated.

Could the line be about No. 4 AWG and the launcher about one meter in diameter? Any further information would be appreciated for experimental purposes.

CLIFFORD A. THOREN
N. Hollywood, California

Editor's Note: The article appeared originally in ELECTRONICS, p 180, April, 1954. The following reply has been received from Mr. Goubau.

DEAR SIRS:
THE transmission line quoted in the article "Designing Surface Wave Transmission Lines" in ELECTRONICS, p 180, April 1954, has been described in the "Transactions," No. 3 August 1952, of the "Professional Group on Antennas and Propagation" of the IRE.

The cable used was a standard HH cable (manufactured by General Cable) of 1.42 cm thickness, covered with a layer of brown polyethylene of 0.34 cm thickness. The HH cable is made of 6 interlocking segments forming a flexible tubing.

The theoretical loss of this line at 250 mc was about 3 db per mile and the measured loss 6 db per mile. The large discrepancy between the calculated and the measured losses was caused by two factors.

The seams between the segments of the conductor form spirals. Therefore the current of the wave must overcome the resistance of the

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joints, thus causing an increased average conductivity loss.

Since the line had several curves, and the sag was quite large, a thicker dielectric coat should have been used. According to recent investigations the ratio between the total diameter of the line (d_o) and the diameter of the bare conductor (d_i) should be greater than 2 (about 2.3 to 2.5) for all lines which require supports. Antenna feed lines may have a smaller ratio (particularly in the microwave range).

A line of No. 4 AWG wire with $d_o/d_i = 2.3$ assuming brown polyethylene with a power factor of 0.0005 has a theoretical loss of 7.8 db per mile at 250 mc. The actual loss will be about 9 db per mile, if the line is substantially straight and the sag minimized. Copperweld wire is preferable to copper wire because the sag can be reduced.

A horn of 1-m diameter would have a launching efficiency of about 90 percent and therefore would be appropriate in size.

GEORG GOUBAU
Signal Corps Engineering Labs.
Fort Monmouth, N. J.

Editor's Note: Not recognizing the HH cable as one of the common r-f types, we checked with the manufacturer. To our surprise, it turns out to be one designed for heavy current at 220,000 volts that was widely used at Boulder Dam. Hollow and segmented, it comes uncoated and 1.100 in. in diameter. The segments are assembled by machine and locked together in a sort of zipper or tongue and groove assembly.

D-C Path

DEAR SIRS:
AFTER reading over my article "Basic Control Circuits Are Packaged", p 122, December 1955 issue, I noticed a few mistakes that evidently occurred in the printing.

In Fig. 1, the correct symbol for an operational amplifier should be a triangle rather than a square. In Fig. 6, the one-megolum resistors should be connected from grid to cathode.

Unless the grids are connected in this manner there would be no d-c grid return for the demodulator.

LARRY S. KLIVANS
Radioplane Company
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EDITOR'S NOTE: In block diagrams, our draftsmen use blocks, squares or rectangles.

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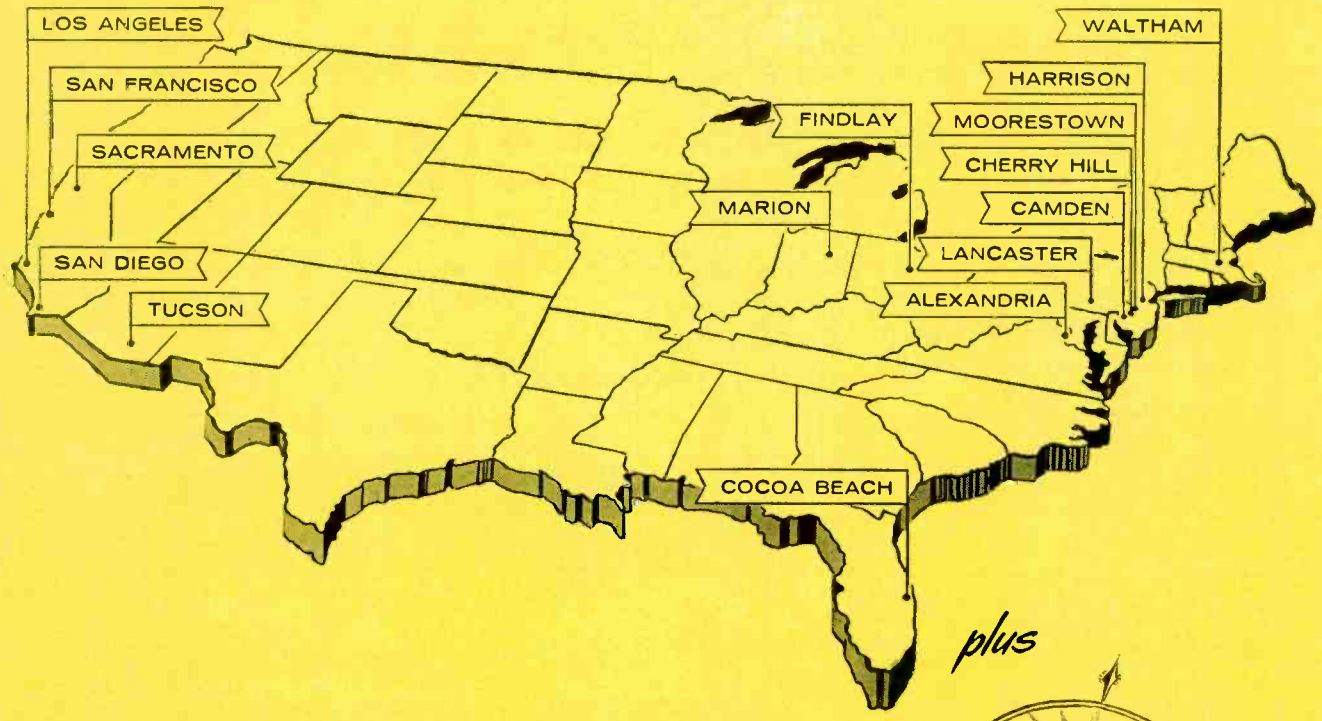

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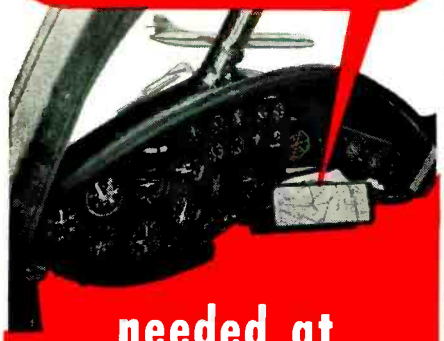

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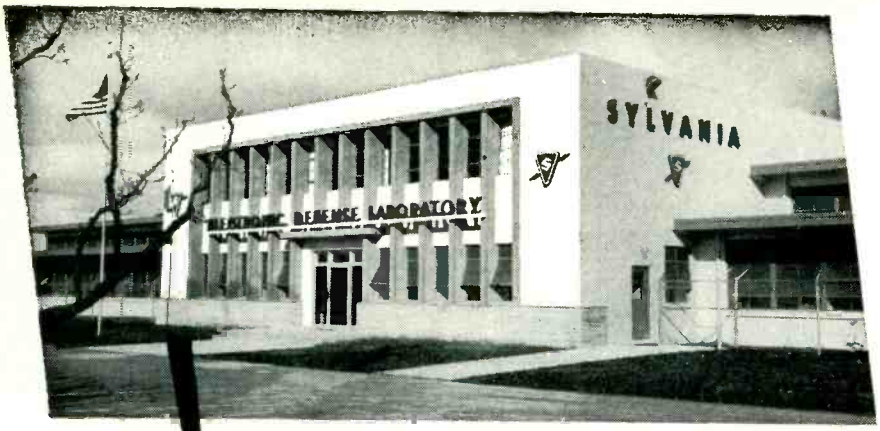

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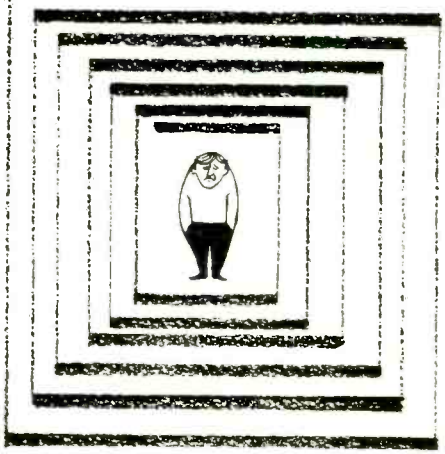

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TRAVELING WAVE TUBE DEVELOPMENT—A comparative newcomer to us but we'll soon be tops. We need additional engineers to help us accomplish this.

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Electronics engineers

do you see...
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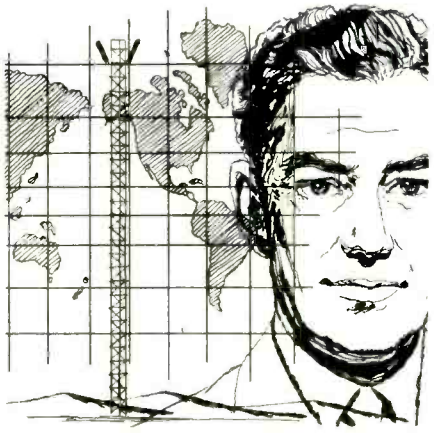
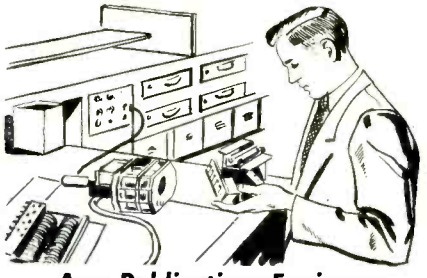


or just the details?



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ANTENNA DESIGN Duties involve developing requirements for communication navigation and radar antenna systems and participating in design of the systems. Most of the development work in this field is performed at Lockheed Laboratories.	**COUNTERMEASURES** Duties involve developing requirements and monitoring programs for advanced electronic countermeasure systems, including receivers, analyzers and jammers.	**COMMUNICATIONS** Duties involve developing long-range communication and data link systems, studying meteorological and atmospheric features and guiding antenna design.

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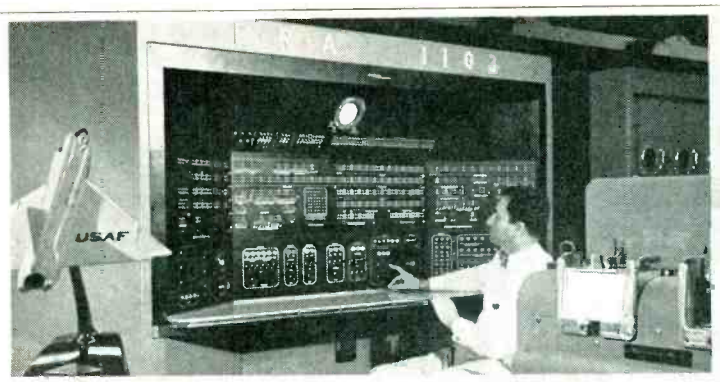

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ENGINEERS

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PART 2 *is a cooperative effort. It is completely optional. But if an engineer wishes to increase his retirement fund, by making a small monthly payment, Republic will* MORE THAN MATCH *his contribution.*

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Engineers

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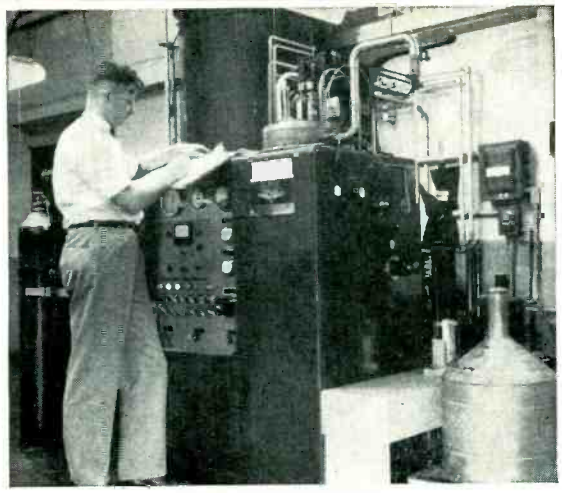

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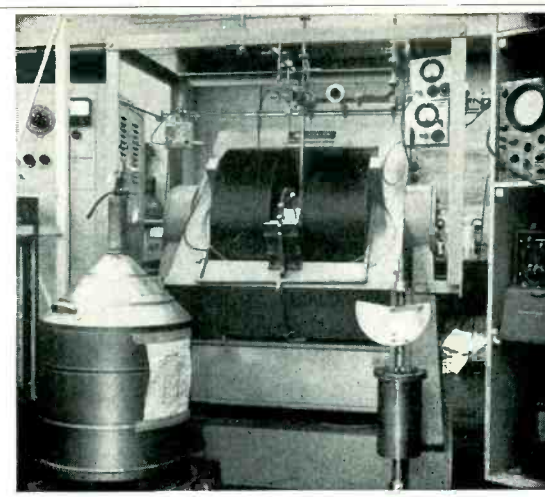

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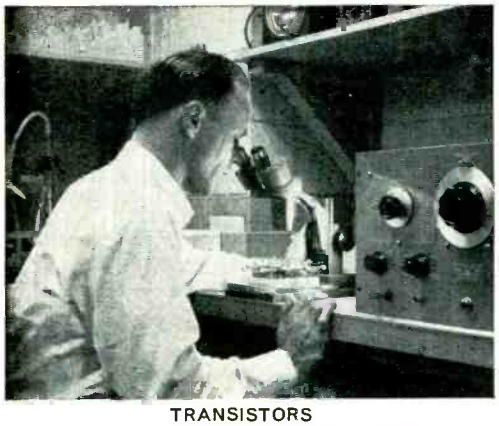
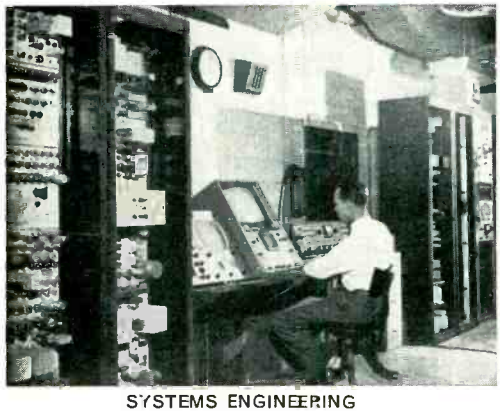
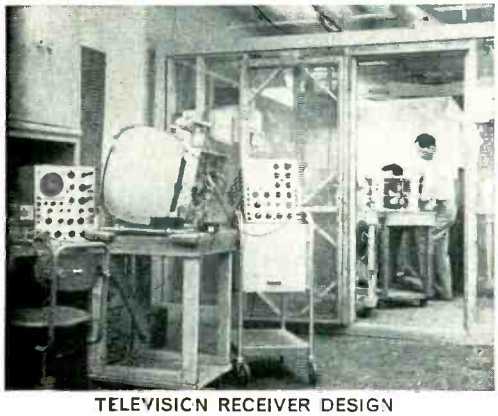
ENGINEERS, PHYSICISTS, CHEMISTS



TRANSISTORS



SYSTEMS ENGINEERING



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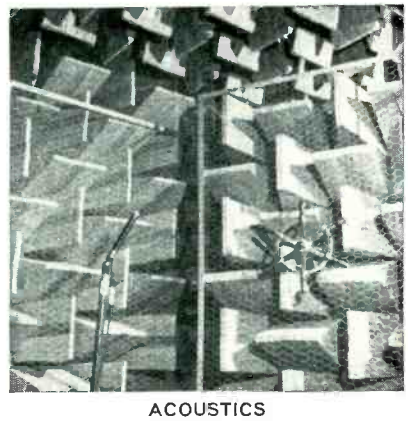

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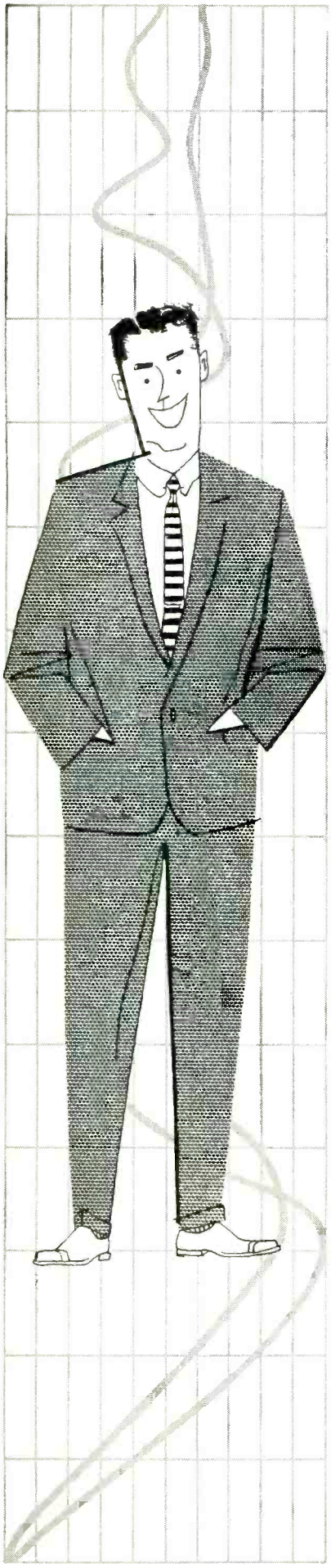

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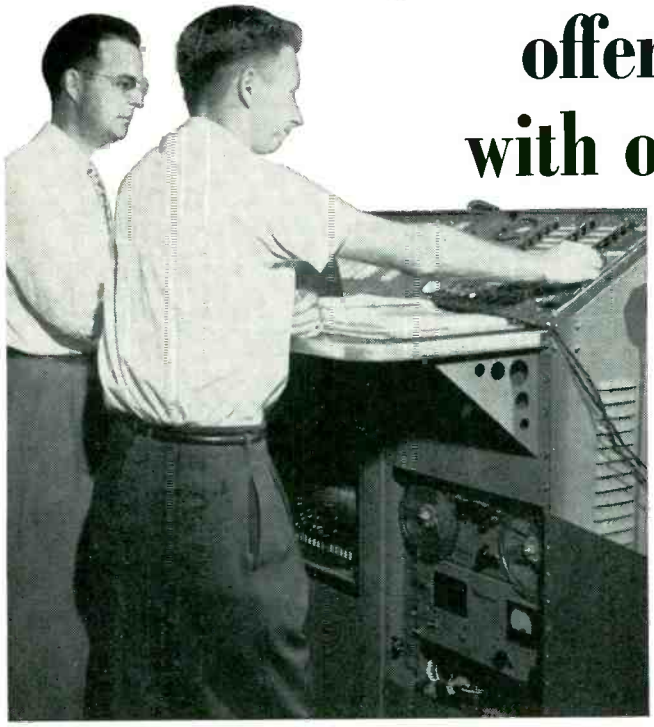

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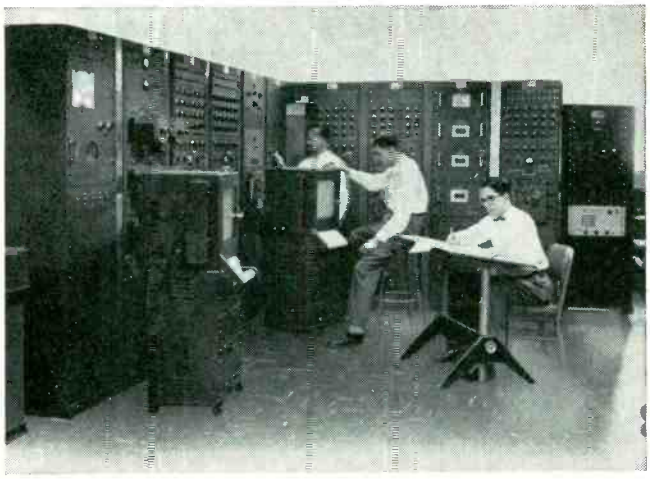

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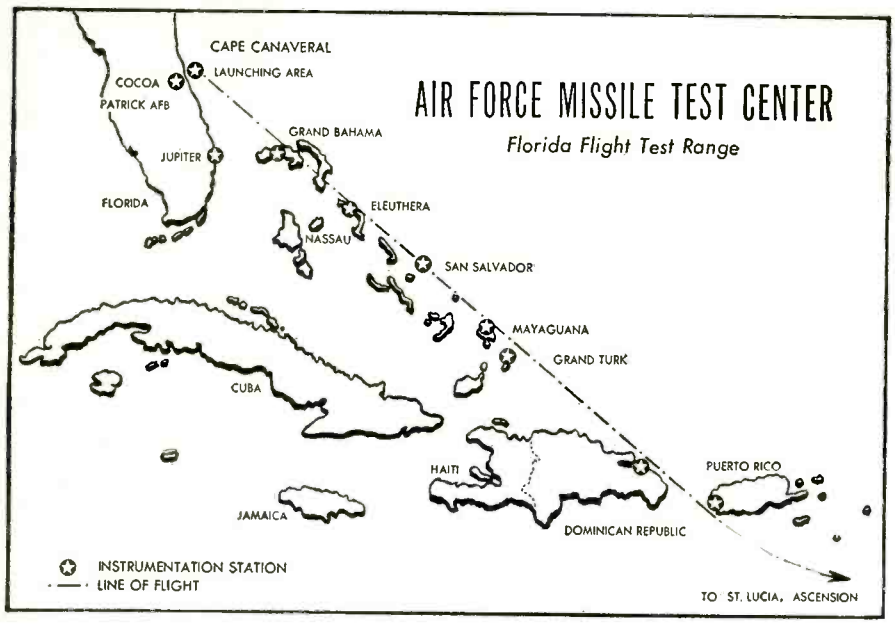

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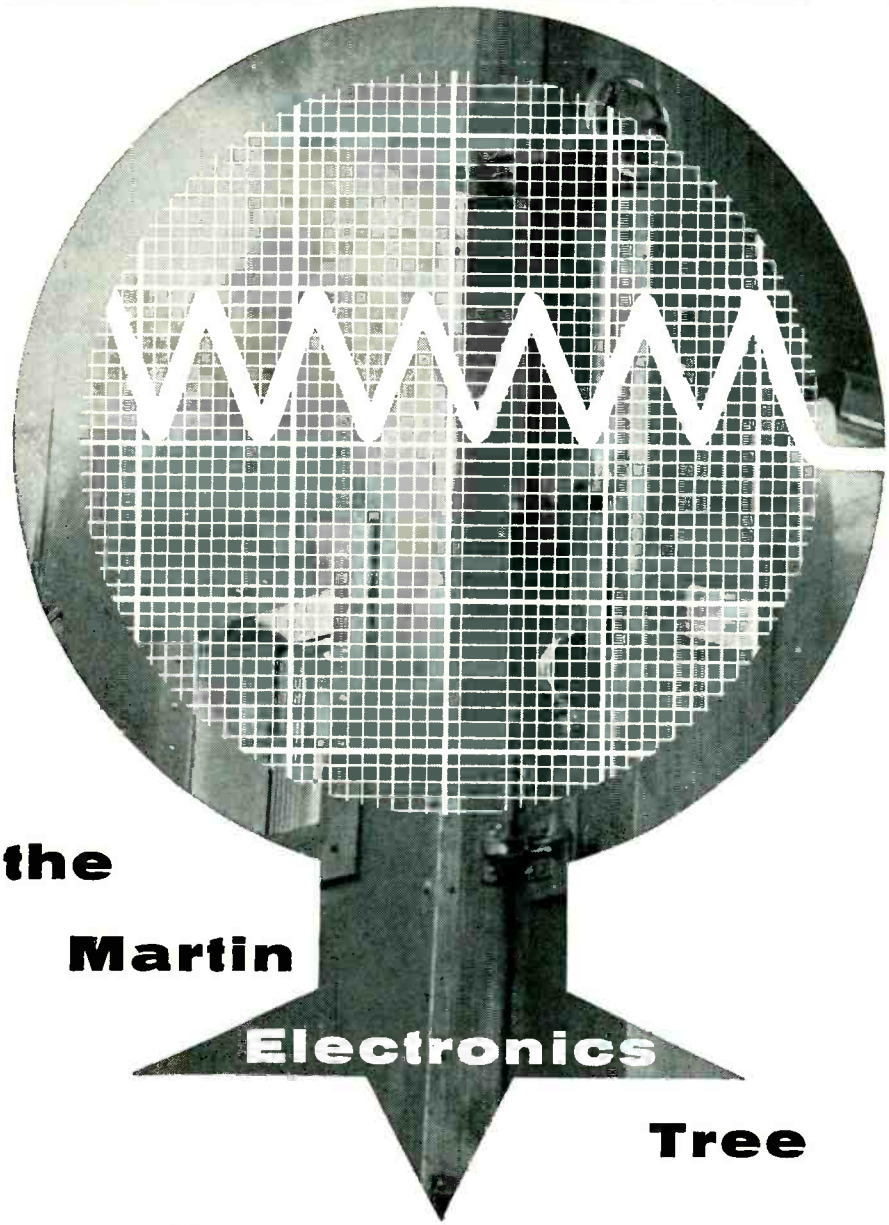
Inquire for further information by sending resume to:

W. Murphy, Personnel Director, Tung-Sol Electric Inc., 545 N. Arlington Ave., East Orange, N. J.



the Martin Electronics Tree

Today, its roots are feeding research and development activities on more than a dozen top-rated projects, including 6 guided missile programs, 4 aircraft, a major air defense system, an earth satellite launching vehicle and a variety of highly specialized weapons systems.

Main branches of the Martin electronics tree include:

SYSTEMS DESIGN for radar, guidance, communication, navigation and reconnaissance systems.

CIRCUIT DESIGN for tuners, receivers, digital computers, memory devices, advanced data processing equipment, and a wide range of special weapons systems components.

THEORETICAL STUDIES for microwave components, antennas, radomes for missiles and high-speed aircraft, and many advanced design applications.

Electronics engineering at Martin is second to none in the industry today, and our advanced programs are creating many important new opportunities. Contact J. M. Hollyday, Dept. E-3, The Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE

Contact Martin Representative
Hotel Waldorf Astoria
throughout
IRE Convention Week

Dear Joe:
This is a quick note on the wire I just sent telling you to get that resume to Farnsworth - fast!
Now I know why the majority of engineers who come here for an interview never leave. The enthusiasm here - for the work - the people and the town - is really amazing. Maybe it's because of the close association with top-notch scientists and engineers who have contributed a lot of "firsts" in the field of electronics. Like our Phil Farnsworth, the inventor of electronic television and a real inspiration to all of us here. (I sound like an old timer, don't I?)
Fact is, Joe, that's the way they make you feel - like you belong. Here you will be heard - not just one of the herd.
The whole set-up is so good, Joe, I wish you would tell all the other fellows about the opportunities here at Farnsworth for good men in R & D guidance and control, radar, microwaves, antennas, systems test equipment, countermeasures, transistor applications, closed circuit television etc.
Tell them to write to:
Don Dionne
Farnsworth Electronics Co. Fort Wayne, Ind.
(a division of International Telephone & Telegraph Corp.)
You'll be doing them and Farnsworth a big favor.

Sincerely
Jack

We have been able to tell you about *these* radars—

but are forbidden by security regulations to publicize the many other advanced radar and weapons systems we are developing. Raytheon's reputation for "Excellence in Electronics" has been greatly enhanced by the contributions it has made to the radar equipment field.

The recent expansion of our engineering facilities makes it possible to offer unusual opportunities to experienced creative engineers for the design and development of these radar and weapons systems. Your inquiries will be welcomed and a postcard is supplied below for your convenience.

RAYTHEON MANUFACTURING COMPANY
Radar Department
WAYLAND LABORATORY
WAYLAND, MASSACHUSETTS

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
WAYLAND LABORATORY
WAYLAND, MASS.

Please send me a copy of your new brochure describing the Wayland Laboratory. I understand you will also send a brief resume form which I will be able to complete in a few minutes.

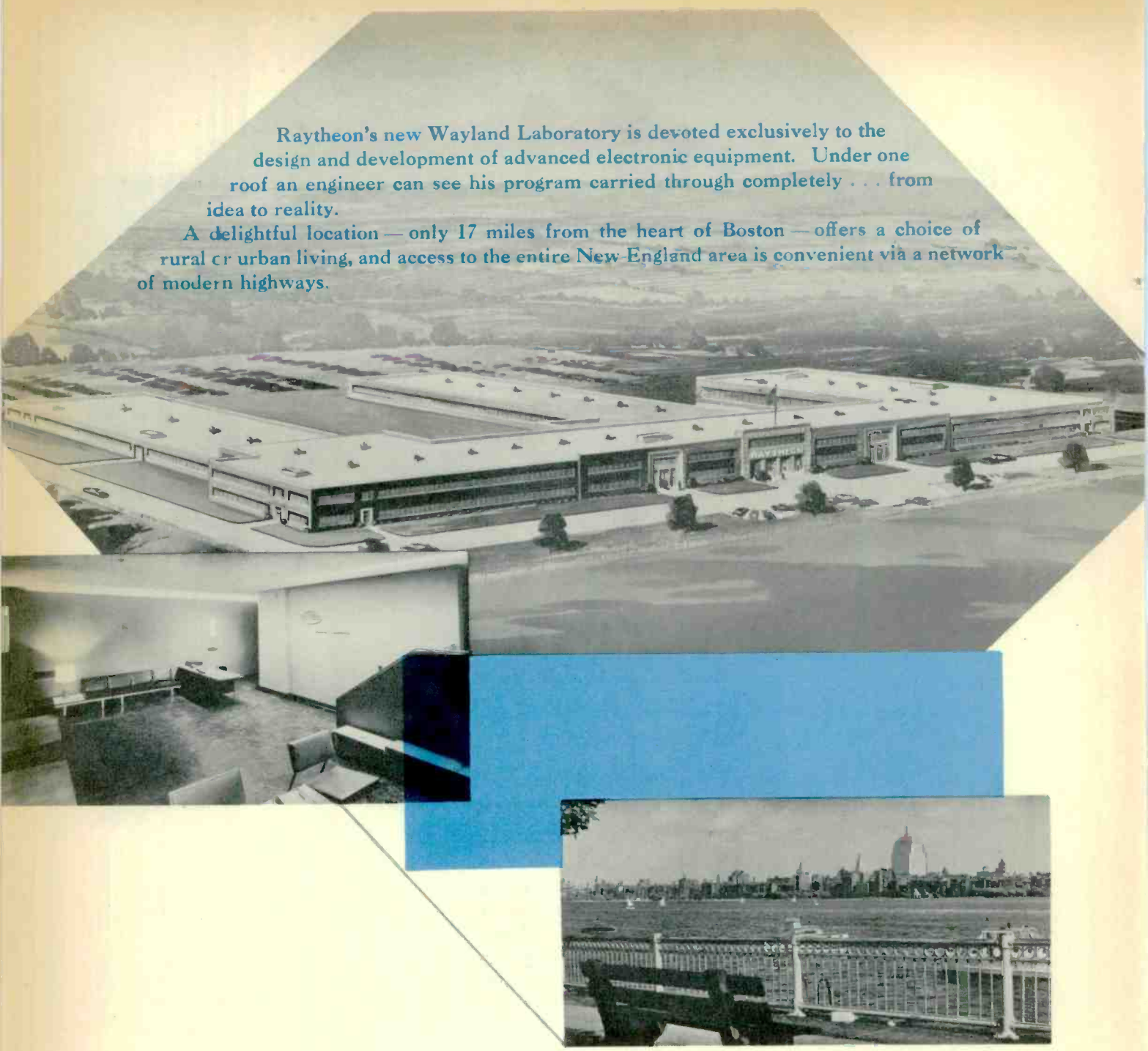
Name_____

Address_____

City_____ Zone____ State_____

Raytheon's new Wayland Laboratory is devoted exclusively to the design and development of advanced electronic equipment. Under one roof an engineer can see his program carried through completely . . . from idea to reality.

A delightful location — only 17 miles from the heart of Boston — offers a choice of rural or urban living, and access to the entire New England area is convenient via a network of modern highways.



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RAYTHEON

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RAYTHEON MANUFACTURING COMPANY
Wayland Laboratory
Wayland, Mass.

Atten: R. E. Doherty, Radar Dept.

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WAYLAND LABORATORY
WAYLAND, MASSACHUSETTS

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for immediate placement

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MECHANICAL ENGINEERS
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COMPUTER ENGINEERS
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Engineering at NCR:

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3. A RECREATIONAL PROGRAM for year-round enjoyment of the entire family, including a new NCR Country Club with 36 holes of golf, and a 166-acre employees' park for outings with swimming, boating, and supervised play for the children.

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EMPLOYMENT DEPARTMENT, TECHNICAL PROCUREMENT SECTION 4

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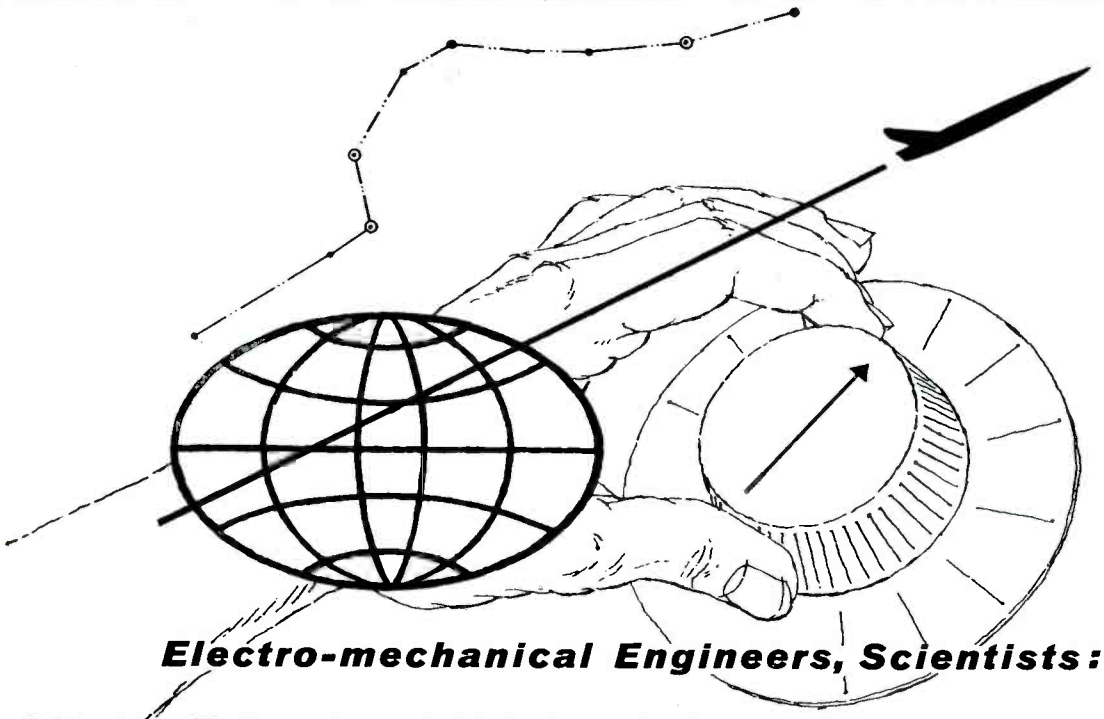

Electro-mechanical Engineers, Scientists:

IN TODAY'S ELECTRONIC ACHIEVEMENTS LIE TOMORROW'S CAREERS

Your work in advanced guidance and control systems and components at AUTONETICS today is excellent assurance of *long-range* opportunity. Problems like heat resistance, weight reduction and sub-miniaturization in electro-mechanical devices for missiles and manned aircraft have a direct application to non-military industry.

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In developing and designing precision electro-mechanical equipment, you will use the finest digital and analog computers and other advanced research and test facilities at AUTONETICS.

In addition to all the physical advantages at AUTONETICS, you will welcome the professional attitude of your colleagues here. You can expect to be informed about your personal progress, have your ideas listened to.

If you are interested, AUTONETICS welcomes your inquiry. All replies will be held in the strictest confidence.

Choice openings for:

Computer Specialists Electro-Mechanical Designers Environmental Test Engineers Electronic Component Evaluators Instrumentation Engineers Fire Control Systems Engineers Flight Control Systems Engineers Electronics Research Specialists Computer Programmers Computer Application Engineers Automatic Controls Engineers Electronic Engineering Writers Inertial Instrument Development Engineers Preliminary Analysis and Design Engineers

Also Openings for Draftsmen and Technicians

Contact: **Mr. D. S. Grant, Engineering Personnel Office**
Autonetics, Dept. 991-20E, 12214 Lakewood Blvd., Downey, Calif.

You are cordially invited to visit our booth number 59 at the I. R. E. Convention, and North American's I. R. E. Convention Headquarters at the Waldorf-Astoria Hotel for a showing of technical films on the remarkable growth and development of the Company's Missile and Control Equipment Operations.

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

ELECTRICAL NAVIGATION COMMUNICATION FIRE CONTROL RADAR INSTRUMENT SYSTEMS INSTRUMENTATION SYSTEM ANALYSIS SYSTEM INTEGRATION ANTENNAS

electrical design

With 16 years leadership in the vital field of missile research and development, Northrop Aircraft offers unusual opportunities for advancement in the categories listed below. Here you can apply your skill and ability on the pilotless Snark SM-62 A-bomb carrier; on Northrop's new long-range interceptor project; and on numerous other weapon system assignments. Where better could you be, and grow, than with a pioneer? There's an interesting position for you in one of the following groups:

Electrical Group, which is responsible for the design of such things as power generation and distribution systems, rectifiers and power converters, and auxiliary systems as applied to manned aircraft, guided missiles and ground support equipment.

Communications and Navigation Group, which is responsible for the design of C/N systems in manned aircraft and installation of guidance systems in missiles. Considerable research effort is devoted to air-borne antennas and the elimination of radio interference in C/N systems.

Fire Control Radar Group, which is responsible for the installation and application of the most advanced type of fire control systems in fighter-interceptor aircraft. The work covers the installation of the equipment and associated wiring; continuing liaison with equipment manufacturers; preparation of system analysis and reports; and follow-up of system performance in the field as aircraft become operational.

Instrument Group, which is responsible for the design of instrument systems for manned aircraft and the installation of flight test instrumentation for guided missiles. Typical systems for which the group is responsible include: Flight Instruments; Engine Instruments; Instrument Panel Design; Automatic Pilots and Augmenters; Fuel Flow and Quantity Systems; and Integrated Electronic Instrument Systems.

All four basic groups originate their basic design and layouts, prepare production design releases and originate all types of tests to support flight, design and production requirements.

There are now a number of openings available for engineers in each of these groups at all experience levels. Too, there are opportunities for draftsmen with either electrical or mechanical experience.

If you qualify for any of these challenging opportunities, we invite you to contact Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., Hawthorne, California, or call ORegon 8-9111, Extension 1893.

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FIELD ENGINEERS

Pacific Division, Bendix Aviation Corporation needs electronic field engineers to form a new Field Engineering Group offering excellent opportunities for growth. The job requires missile system analysis, flight analysis and actual flight tests.

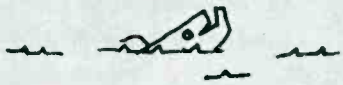
Positions are open at several levels and inquiries are also invited from recent graduates. Salaries based on ability, experience and education.

Address inquiries to W. C. Walker, Engineering Employment Manager, Pacific Division, Bendix Aviation Corporation, North Hollywood, California.

ENGINEERS

Live and work in Florida

RADIATION, Inc. has many outstanding opportunities for qualified electronic, mechanical, nuclear and aeronautical engineers in the fields of electronics, avionics, and instrumentation. Here is your chance to join a dynamic, expanding organization which offers excellent working and living conditions, professional recognition, and extensive employee benefits.



RADIATION, Inc. is a research and development corporation with a leading part in many of today's outstanding advances in electronics . . .

- Aircraft Positioning Development
- Special Weapons Instrumentation
- Solid-State Circuit Development
- Analog-to-Digital Conversion
- Missile Checkout Equipment
- Special Radar Developments
- Aircraft Instrumentation
- Digital Data Recording
- Pulse Code Telemetry
- Low-Level Switching
- FM-FM Telemetry
- Aircraft Guidance

Address your inquiry to:

Ralph L. Bickford
Director of Personnel
Radiation, Inc.
Melbourne, Fla.

Work of the engineering department is accomplished by small flexible groups, each assigned to a specific phase of a project. These groups generally include engineers with both highly specialized and comprehensive backgrounds. Such a system provides freedom, professional growth and recognition for the individual, and encourages initiative. Unusual opportunities are here for the competent engineer to continue his professional career with maximum advantage. Openings presently exist ranging from junior engineer to section head. Salaries and assignments are equably based on experience and background. You are invited to submit your qualifications with the assurance of prompt and careful consideration.

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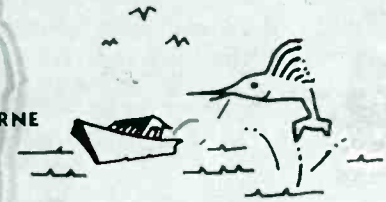


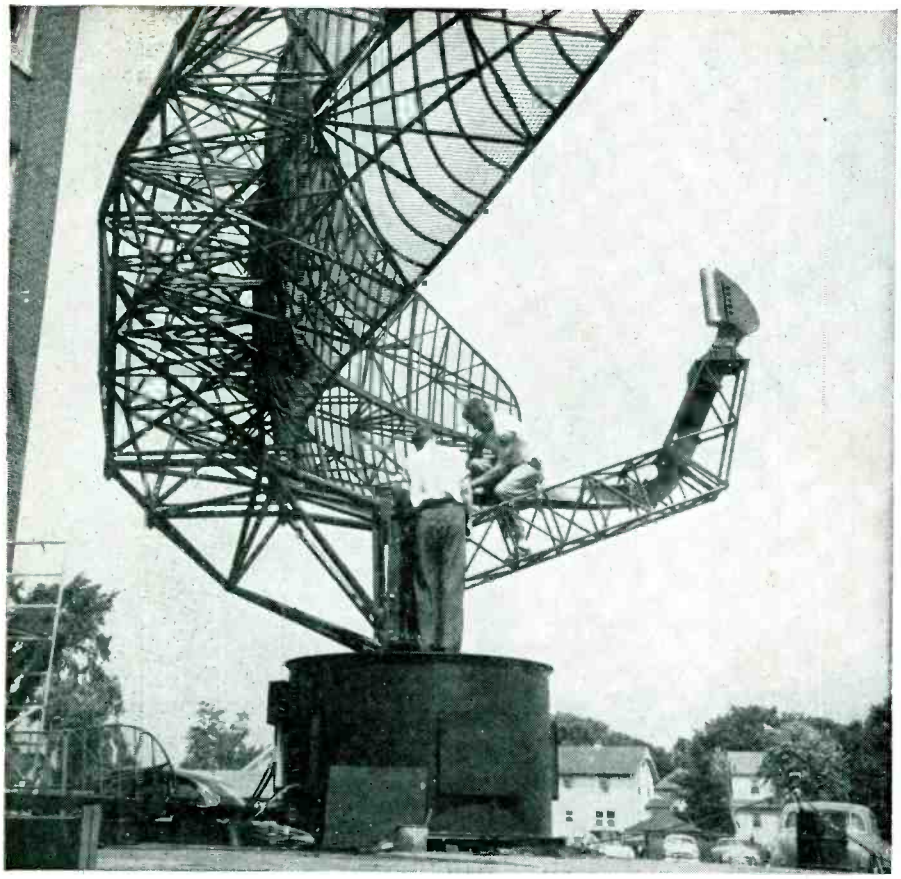
NOTE TO MRS. ENGINEER

Florida has much to offer you and the children: freedom from snow and cold and all the inconveniences that go with it . . . good schools and housing . . . year-round outdoor recreation including lake and ocean beaches, boating, fishing, and picnicking. In short, Florida is a wonderful place to live and you can enjoy it with the additional satisfaction of knowing your husband has a place to work where his ability is recognized and he has unlimited opportunity for growth and advancement. We would be happy to talk it over with you when your husband is interviewed.

RADIATION Inc. Melbourne, Fla. Orlando, Fla.

Electronics • Avionics • Instrumentation

See our representative at the IRE Show Booth 10, Kingsbridge Palace.



FIELD ENGINEERING
WITH A FUTURE—at Raytheon

PLAN YOUR CAREER HERE — Raytheon needs men like you who are qualified for field engineering and have the ability to build a future in electronics. Experience in the field has enabled many of our engineers to become executives at Raytheon. Unlimited opportunity is open to you now in the following programs:

MISSILES	**Air-to-Air – Ground-to-Air**
RADAR	**Search – Fire Control** **Bombing – Countermeasures**
Other Equipment	**Ship and Airborne Sonar – Multiplexers – Microwave Relay Links – Communications**

Raytheon has designed and built complicated electronic equipment for the past 30 years. One of its present equipment projects is the world's most publicized radar—the DEW LINE radar.

If you have a college degree, you'll rate preference. However, if you have an extensive electronic background, send in your application. Special training will be provided by our Training Facility to prepare you for your assignments.

Attractive salaries, benefits, and allowances. Domestic and overseas assignments.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
100 River St., Waltham 54, Mass.

DO YOU NEED ENGINEERS WITH EXPERIENCE IN:

- Research
- Development
- Design
- Instrumentation
- Servomechanisms
- Missiles
- Audio Systems
- Control Systems
- Radar
- Computers
- Transistors

Place an "ENGINEERS WANTED" advertisement in this SEARCHLIGHT SECTION of ELECTRONICS. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the electronics industry. The selective circulation of ELECTRONICS offers you an opportunity to choose the best qualified men available throughout the industry.

For Rates and Information Write:

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with background in design of complex electronic systems, for a key position supervising a small group engaged in design and development of nucleonic instruments and systems.

Must be able to assume responsibility and contribute ideas.

If you fulfill these basic requirements, we would be pleased to have you consider the possibility of joining our team . . . the most successful team in the nuclear field.

Please write in confidence to . . .

Tracerlab
130 HIGH STREET, BOSTON 10, MASS.

It's great to be a Westinghouse Engineer

AT THE ELECTRONIC TUBE DIVISION IN ELMIRA, NEW YORK.

It's great ot be associated with this history-making division of our world-famous organization . . . where you, as an individual, are given every encouragement to grow, professionally and financially. It's great, too, living in Elmira . . . only minutes away from your job, and from the best fishing, hunting, boating, etc., you've ever had. (Plus fine schools, good homes, and nice neighbors.)

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Meet some of our team and find out more about the fine opportunities listed below

We'll be in New York a day earlier, SUNDAY, Mar. 18, thru Thurs., Mar. 22

Phone for app't, Mr. R. M. Jarrett
Waldorf-Astoria Hotel, ELdorado 5-3000
All day and evening

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MICROWAVE TUBES: Magnetrons, traveling wave tubes, klystrons, reference cavities, and other devices.

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for each of the aforementioned fields.

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Micromave, image orthicon receiving or color TV tubes.

— • —

If unable to see us at the Convention, Send resume to R. M. Jarrett

Interviews in your area, or travel expenses paid for Elmira interviews.

WESTINGHOUSE ELECTRIC CORP.
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BEECHCRAFT

NEW ADVERTISEMENTS

received by March 2nd will appear in the April issue, subject to space limitations.

Address copy to the Classified Advertising Division

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Industrial Personnel Consultant

ELECTRICAL ENGINEERS

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SORENSEN & COMPANY, INC.
375 Fairfield Avenue **Stamford, Conn.**

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Stromberg-Carlson offered me and my family so much more than a good salary, plus bonus and a flock of fringe benefits, that I couldn't say anything but "*When do I start?*"

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There's Rochester, and its surroundings. Right in the heart of the Finger Lakes; only four hours from the Adirondacks. Home of the Eastman School of Music and Eastman Theatre; of world-famous parks; of no less than thirteen golf courses; of schools and shopping centers unrivalled in the East; of scientific industries whose engineers turn up as your next-door neighbors.

Above all there's *opportunity*. As the chap who hired me put it, "This is the spot for men who are either stymied in a little company, or buried in a giant." More than twenty fields of employment are open—as shown by the list to the right.

I started with a detailed letter of inquiry to Howard L. Foote, at the address below. Why don't you do the same?

- Audio Amplifiers
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- Data Processing
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- Magnetic Tape Recorders
- Microwave, communication
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- Transistor Engineering
- Voice communication
- Writers—Bid Proposal
- Writers—Technical

P.S. Look us up at the March I.R.E. show in New York City

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

104 Carlson Road, Rochester 3, N. Y.

S-C STROMBERG-CARLSON

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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.

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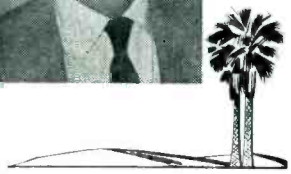
Want to get off the treadmill?

Then, you may be interested in knowing why I'm with MOTOROLA IN PHOENIX



THIS IS A NEW FRONTIER insofar as the electronics industry is concerned. But it's big . . . and it's growing.

Motorola came to Phoenix just six years ago, looking for room to grow in a climatic environment ideal for electronic research. Already the Phoenix Motorola Research Laboratory has grown to a skilled staff of 1200, filling to capacity facilities which were supposed to be large enough for many years' growth. A second research and production plant designed for an additional staff of 1,000 is now being built in nearby Scottsdale. The new Motorola Transistor Plant went into production last month. Here is an unparalleled opportunity to get in on the ground floor and grow with the world's newest electronics center.

Vitally important programs now underway and others ready to start in guided missile electronics, radar and communications provide exceptional opportunities to men with experience in circuit design and development, mechanical engineering and drafting (including design for severe environment), physics, microwaves and systems engineering.

This integrated expansion in Phoenix by the world's largest exclusive electronics manufacturer has already attracted an unusual group of men with the highest technical competence. The working atmosphere is actually campus-like in its informality and its encouragement of original research and creative ideas. There is always an interesting challenge. We specialize in difficult engineering problems at Motorola in Phoenix. An outstanding profit-sharing plan increases the monetary rewards that are important to all of us.

We live well. You can buy or build more house for less money here in Phoenix than almost anywhere else in the country. There's plenty of room to move around. And, for most of us, the drive from home to work takes only a few minutes.

We feel wonderful. It's already Springtime in Arizona! By actual U.S. Weather Bureau figures for the last 57 years, Phoenix is the sunniest, warmest, driest city in the United States. No snow to shovel! It's great for the kids to be able to play outdoors all year. For weekend drives and vacations, we have our choice of the most colorful mountains, canyons and Indian country in the world . . . more National parks and monuments within half a day's drive than anywhere else in the country.

We've found an unbeatable combination here in Phoenix. We work where it's *fun to live* . . . there's room to grow and *opportunity unlimited.*

If you're an electrical or mechanical engineer with experience in electronic applications, write me today. I'll be glad to tell you what Motorola in Phoenix has to offer a man with your particular qualifications.

Bob Samuelson

Dr. R. E. Samuelson, Chief Engineer
Motorola Research Laboratory
3102 North 56th Street, Phoenix, Arizona

MOTOROLA, INC.

See us at the I.R.E. Convention.
We'll be there, at the Waldorf, March 19-22.

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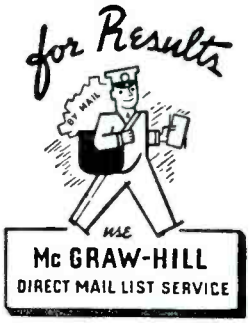
For complete, detailed information about our service, fill in the caupon or write for your copy of our free Business and Industrial Direct Mail catalogue.



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Stromberg-Carlson, a Division of General Dynamics Corporation, is located in the Finger Lakes region of upstate New York. In addition to providing a wide variety of challenging engineering opportunities, excellent salaries are offered with the finest working conditions in a modern electronics laboratory. Unusual recreational and educational facilities are available in this medium-sized progressive city, and fine residential areas are located within a mile of the plant. Because of the variety of its product line, which is approximately equally divided between military and civilian, Stromberg-Carlson offers a degree of stability and an opportunity for advancement unequalled in the industry. Openings:

Radio Communication Systems **Data Systems** **Digital Techniques**
Microwave Circuits **Mechanical Design Engineering** **Infrared**
Automatic Test Systems **Countermeasures** **Navigational Systems**
Military Transistor Applications **Radar** **Missile Guidance Systems**

Write or call collect:

C. W. Finnigan, Chief Electronics Engineer

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

104 CARLSON ROAD, ROCHESTER 3, N. Y.

P. S. Look us up at the March I.R.E. show in New York City.

ELECTRONIC ENGINEERS

Experienced in design of electronic circuits, radio frequency, DC and video amplifiers, pulsers and IF amplifiers, electronic control circuits for gating and limiting, magnetic relays.

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Industrial or laboratory experience. Knowledge of wave motion in solids, sonar techniques, seismology, acoustics or ultrasonics.

ULTRASONICS . . . . . Key to your future success

Here is an industry which has just crossed a threshold of unlimited possibilities. Together with electronics, it is America's fastest growing industry, and Sperry Products, Inc. is a recognized leader in the field. To keep pace with expanding markets, Sperry has openings for engineers and physicists in its continuing development program.

Here are creative opportunities to develop new ultrasonic products and new applications for existing products with this long established company.

These are permanent positions with an organization that has always emphasized long term non-defense objectives. With Sperry Products, Inc. you gain outstanding company benefits, a high salary commensurate with your abilities, and relocation expenses to the charming Connecticut county of Fairfield. Please send complete resumes in confidence to P. J. Olivo. Convenient interviews will be arranged.

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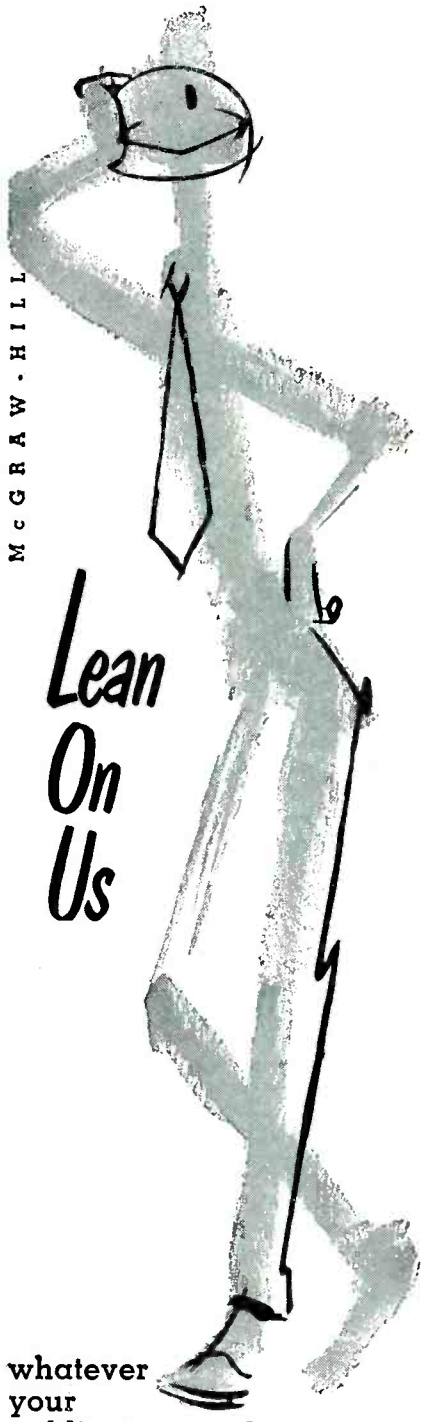

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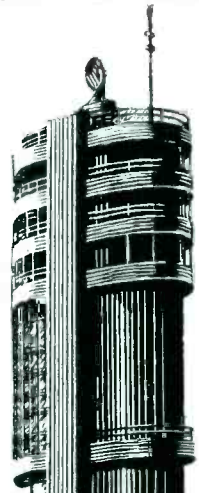

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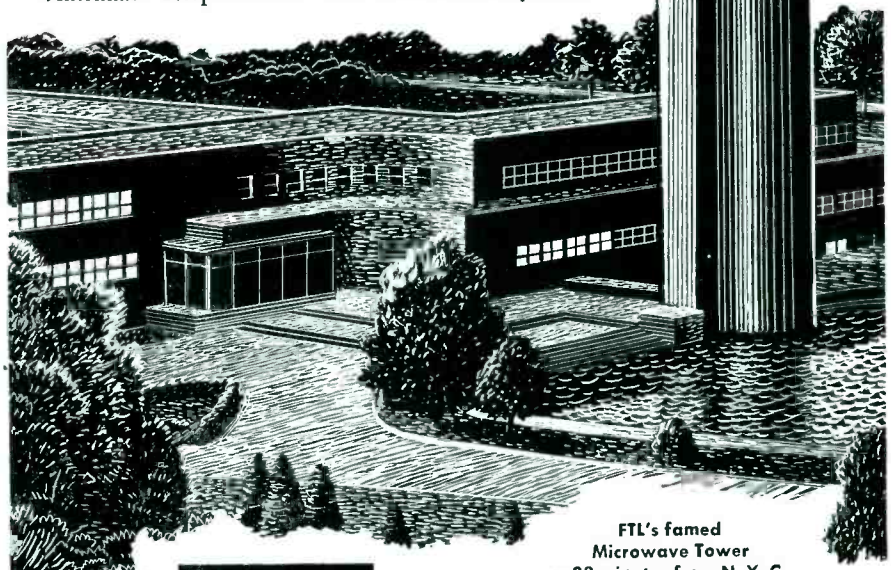

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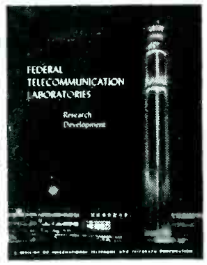

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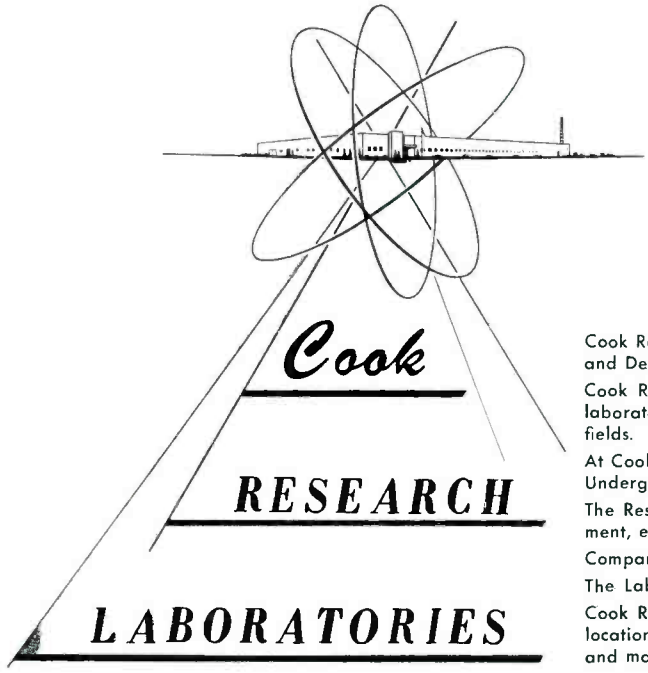

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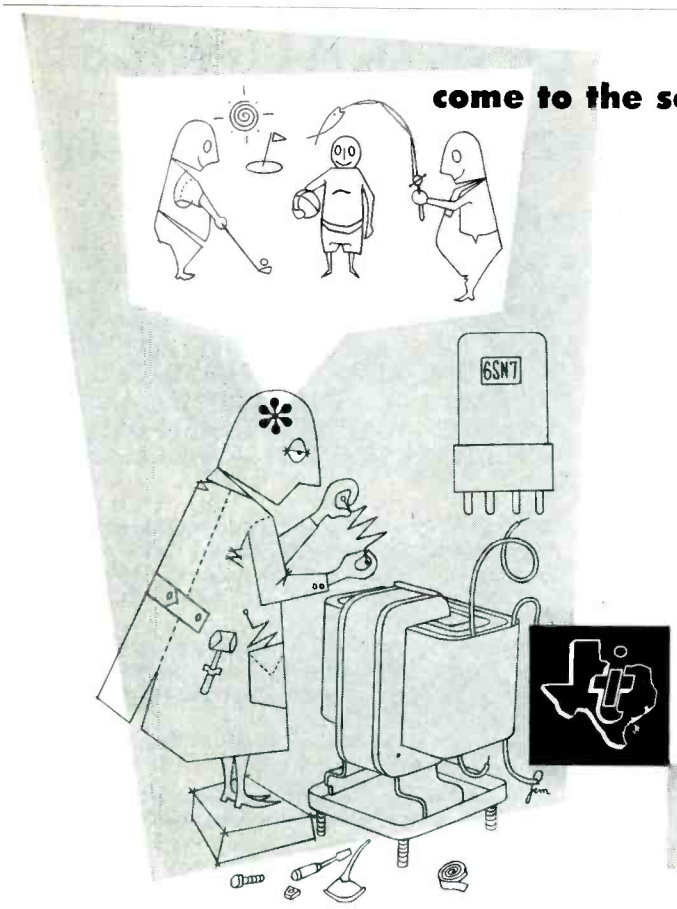

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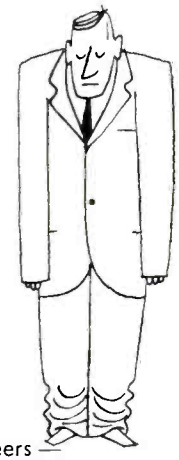

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ENGINEERS: production, mechanical, design, methods, research, plant, tool. Designers, Draftsmen, Master Mechanics.

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ENGINEERS: aeronautical, combustion, electrical, mechanical, metallurgical, servo, structural, production, design, electronic, flight test, heat transfer, instrumentation, research, Physicists, Stress Analysts, Designers, Draftsmen, Aero and Thermodynamacists, Mathematicians, Pilots.

BUSINESS WEEK . . . management men in all phases of American business and industry.
ENGINEERS:—various titles in management levels.

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CHEMICAL WEEK . . . business news magazine of Chemical Process Industries.
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COAL AGE . . . coal mining industry.
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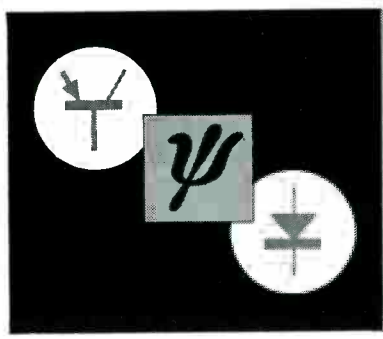

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2E35	1.95	4-65A(Surp)	16.50	RK61	2.75	304TL Surp.	10.50			872A	1.25	5686	.65	5906	15.00

807W/5933 **$2.85**

						396A/2C51	3.00								
						403B/5591	2.75								
						404A/5847	10.00								
						410R/3K30	99.50								
						412A	3.90								
						416A	36.70								
						416B	50.00								
						417A									
						Klystron	3.50								
						417Aw/wv.									
						guide	2.75								
						417A/5842	10.00								
						418A	16.00								

AND MANY OTHERS! OVER 1000 TYPES IN STOCK . . . . WRITE!

SPECIAL PURCHASE!
LIMITED QUANTITY!

KOTRON SELENIUM RECTIFIERS

ALL BRAND NEW • GUARANTEED
FIRST QUALITY

Volts AC/DC	Max. DC Amperes	Circuit	Special Sale Price
10-0-10/8	1.2	Center Tap	$1.60
" "	6.4	"	2.80
" "	16	"	4.80
" "	36	"	8.00
" "	48	"	9.60
" "	48	"	9.60
" "	64	"	12.00
" "	80	"	15.60
" "	84	"	16.80
" "	96	"	18.80
" "	128	"	23.20
36/28	7	Full Wave Bridge	$7.55
" "	14	"	15.80
18/14.5	1.3	Full Wave Bridge	$2.84
" "	2.4	"	3.80
" "	17.5	"	10.36
" "	26	"	15.96
18/14.5	39	"	23.60
" "	52	"	27.60
" "	52	"	27.60
" "	70	"	34.00
" "	70	"	34.00
40/34		Full Wave Bridge	
" "	0.6	"	3.56
40/36	1.2	"	4.40
40/34	2.4	"	5.20
" "	3.2	"	6.04
" "	6	"	9.96
" "	12	"	19.60
" "	18	"	23.60
" "	34	"	39.60
" "	36	"	47.20
120/100	0.6	Full Wave Bridge	$8.76
" "	3.2	"	15.96
" "	9	"	34.00
" "	25	"	68.00

Terms: F O B—N Y C—25% Deposit with order—or send full remittance to save C O D charges—D & B Rated Firms (F2½ or Better) Net 10 days. CABLE: BARRYLECT, N. Y. TELEGRAPH: BARRY ELECTRONICS, FAX, N.Y.C.

NEW RECTIFIER TRANSFORMERS

Continuous Ratings Prf: 115V, 60 cycles input SEC: 9, 12, 18, 24, and 36 volts.		
	1 Amp.	$5.75
	2 Amps.	6.75
	4 Amps.	8.75
	12 Amps.	15.95
	24 Amps.	35.65
	50 Amps.	59.00
	100 Amps.	108.00

NEW RECTIFIER CHOKES

Continuous Ratings			
1 Amp	.1 Hy	1.5 ohm	$4.95
2 Amps	.04 Hy	.9 ohm	5.95
4 Amps	.07 Hy	.6 ohm	7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohm	29.95
50 Amps	.005 Hy	.01 ohm	54.00

FILTER CAPACITORS

Capacity	W. Voltage	Each
400 MFD	25 V.	$1.00
500 MFD	200 V.	1.95
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
1000 MFD	35 V.	1.50
2000 MFD	50 V.	2.25
6000 MFD	15 V.	2.50

DIRECTRON SELENIUM RECTIFIERS

FULL-WAVE BRIDGE TYPE

Max. AMPS.	18VAC 14VDC	35VAC 28VDC	54VAC 42VDC	72VAC 56VDC	120VAC 100VDC
1	$1.35	$2.35	$3.75	$4.50	$7.45
2	2.00	2.75	5.35	5.90	9.15
2½-3	2.95	4.15	5.85	7.85	12.75
4	3.50	6.45	11.35	14.35	21.75
6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.05	25.05	37.25	48.75	78.50
24	14.25	28.75	44.50	57.65	81.00
30	17.95	34.35	56.50	71.00	109.00
36	22.45	42.35	65.00	86.95	134.00
50	29.50	54.35	105.45	115.75	174.00
100	59.50	119.00			

We build either Selenium Rectifiers, Transformers, and Chokes to your specifications. Call or write.

TUBE CARTONS • STACKERS

FOR FREE SAMPLES—WRITE ON YOUR LETTERHEAD

Super gloss red & black, or plain glossy white. Both types with new safety partition that meet U. S. government specifications! Specify white or colored when ordering.

SIZE	FOR TUBE TYPE	Quantity per case	PRICES Per case	Per 100
Miniature red & black 1" x 1" x 3"	6AU6, 6AL5, etc.	3000	$27.00	$1.00
Miniature glossy white	" "	3000	27.00	1.00
GT red & black 1¼" x 1¼" x 3⅜"	6SN7GT, 6W4GT, etc.	2000	22.50	1.25
GT glossy white	" "	2000	22.50	1.25
Large GT red & black 1½" x 1½"x4½"	1B3, 6BQ6GT, etc.	1500	20.25	1.50
Large GT white	" "	1500	20.25	1.50
G red & black 2"x2"x6"	5U4G, 6BG6G, etc.	1000	18.00	2.00
G white	" "	1000	18.00	2.00
Small Jumbo, white 3"x3"x7 ½"	809, 866A, etc.	550	41.25	7.50
Large Jumbo, white 4"x4"x10"	813, 872A, etc.	300	27.00	10.00
Ministackers, white (holds 10 minitubes)		1000	13.50	1.50
GT stackers, white (holds 10 GT tubes)		1000	18.00	2.00
Lead sheaths for crystal diodes		144	12.90	10.00

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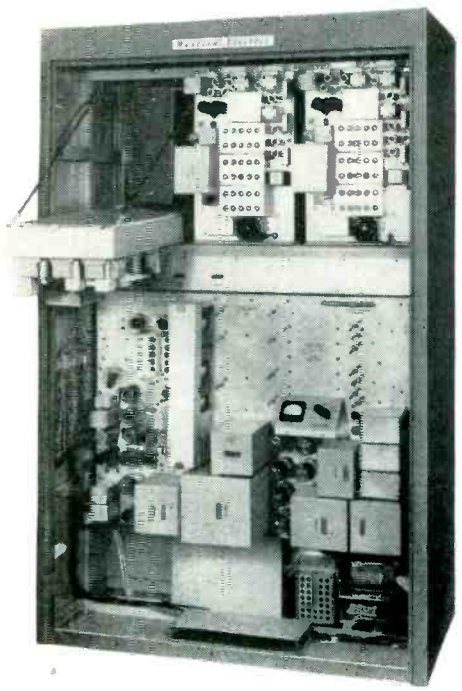
IRE SHOW VISITORS — VISIT OUR WAREHOUSE FOR

WESTERN ELECTRIC 250/350 W. RADIOTELEPHONES



Recent Design and Construction, with following exceptional features: *30 Channels Transmit & Receive, all Crystal-controlled. * Frequency Range 2-20 MC. * Motor Driven Channel Switching Controlled by Channel Selector. * Voice Operated Carrier Control (VODAS) or Push-to-Talk, as desired. * Monitors 3 Separate Channels Simultaneously. * Full Remote Control Operation. * Highest Degree of Design, Construction and Components. This Model 248A Radiotelephone Equipment was developed at Bell Telephone Laboratories to furnish powerful, dependable radiotelephone communication, especially on the high seas. It is ideal for ship installation, airport installation and other fixed-radio installation, since its design and construction are of the highest possible degree.

Each 248A Equipment consists of: 1-48A Radiotelephone Transmitter; 1-48A Radio Receiver (cabinet has provision for a total of 3 receivers, the 48A Receiver provides 10 channels in the 2-6 MC range; a 48B Receiver provides 10 channels in the 4 to 20 MC range, available at additional cost. The 2nd and 3rd receiver may be either a 48A or 48B, available at extra cost); 1-43A Control Unit (may be installed remotely); and, 1-104A Antenna Tuning Unit (medium frequency). A 104B Antenna Unit with whip antenna for the higher frequency, is available at additional cost.

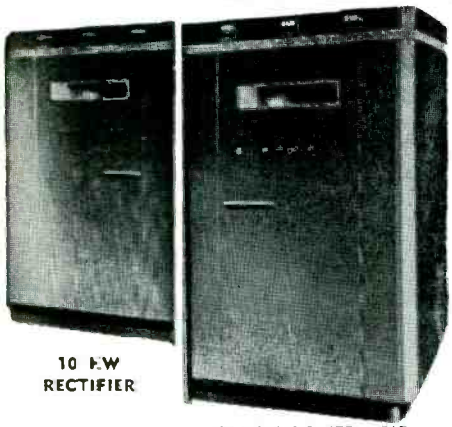
The 48A Radiotelephone Transmitter provides 30 channels of transmission, all crystal controlled, and is rated at 250 watts output. However, a Western Electric Modification Kit is supplied with each, which will increase the power to 300/350 watts. Features of this transmitter include automatic variable-gain audio amplifier; sidetone (hearing of one's own voice in the telephone receiver); interlock safety relays; provision for Selective Ringer installation within cabinet (up to 3 units, 1 for each receiver) for automatic selective calling; motor driven switches for channel selection, controlled by the 43A Remote Control Unit which incorporates a telephone handset, monitoring loudspeaker; ventilating fan for cooling and providing filtered air within cabinet; hinged transmitter and individual receivers for easy access to parts, etc.

Operation of this equipment is from 115 V., 50/60 cycles AC.

This equipment is NOT GOVERNMENT SURPLUS, and is NEW—UNUSED. Additional accessories and full spares also available. Priced far below original selling price!!

WRITE FOR DESCRIPTIVE LITERATURE AND PRICES

GE 10 KW FM POWER AMPLIFIER and RECTIFIERS



10 KW RECTIFIER

10 KW POWER AMP.

BRAND NEW, not war surplus, 10 KW FM Power Amplifiers with associated separate Power Rectifiers, designed for boosting low power FM broadcasting stations. Can be used for increasing power of television stations (sound portion), or by changing L and C can be converted to power amplifier on other frequencies. Present range 88-108 MC. Rectifier Power Supply delivers approximately 5,000 V. at 18.4 KVA. Operates from 220 V., 50/60 Cycles, 3 phase AC. Power Amplifier uses 2 GL5518 (not supplied) forced-air cooled GE high efficiency tubes. Includes internal blower system, reflectometer amplifier (with tubes) and GL-8008 rectifier tubes. Beautifully constructed, new equipment at terrific price savings!

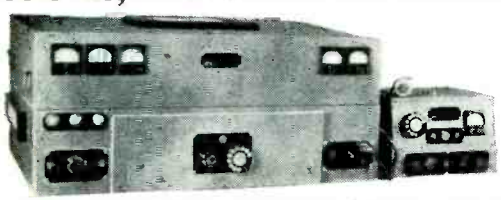
PRICE, Type BF-3-A 10 KW RF FM Amplifier and Separate Rectifier, less RF Final Tubes **$4,000.00**

RECTIFIER ONLY, if desired. **WRITE FOR PRICE.**

50 W. 6—CHANNEL RADIOTELEPHONES

Transmitting and Receiving Eqpt., type SCR-543. Ideal for medium-range communications, for **Marine, Forestry, small Airports, Lighthouse** installation and Military applications. Frequency range 1650 to 4500 KC, with six crystal-controlled channels in Transmitting and Receiving—plus complete manual tuning of receiver as well. Has built-in loudspeaker which can be turned "off" for complete handset use, noise squelch circuit, built-in loading coil for short antenna applications, and many other features. The radiotelephone, BC-669 A.B. or C., is for phone communications only. The BC-669 D or E includes provision for CW transmission and reception (BFO in receiver). Both types available. The Power Supply—PE-110 is designed for 110 V. AC (50/60 cycles) operation. Power Supplies for 12 or 24 V. DC operation can be supplied upon order, which power supplies permit the transmitter to deliver up to 60 W. of power output. Available NEW-UNUSED, or USED-EXCELLENT, complete with Remote Control, Handset, Instruction Book, Antenna material, etc. WRITE FOR PRICES & DESCRIPTIVE LITERATURE, specifying operating voltage.

RC-263 TRANSMITTING EQPT. 50/75 W. OUTPUT, 1.5-10.0 MC, 4-CHANNELS CRYSTAL OR VFO CONTROL, AUTOMATIC DIAL CONTROLS ALL OPERATIONS, FULL REMOTE CONTROL, ETC.



Radio Transmitting Equipment RC-263 consists of Radio Transmitter BC-1100-A, Remote Control Unit RM-40-A, and Microphone T-27-C. Radio Transmitter BC-1100-A is a four-channel crystal—or master-oscillator controlled, 75-watt radio telegraph or 50-watt radio telephone transmitter (conservative ratings). It operates in the frequency range from 1,500 kc to 10,000 kc and is suitable for remote control over two pairs of telephone lines. The radiated radio telephone signals are amplitude modulated. Remote Control Unit RM-40-A consists of a microphone amplifier, line level indicating meter, microphone supply rectifier and switching circuits, and pulse dial to control relays in Radio Transmitter BC-1100-A. This unit is designed to operate in conjunction with Radio Transmitter BC-1100-A and performs all necessary functions, such as channel selection, Power-on or off, cw or phone, etc.

The frequency range covered by each of the four individual channels is from 1,500 to 10,000 kc. This frequency spectrum is covered by means of several overlapping bands. Any one of the four channels can be tuned to any frequency within these limits. For example, channel A might be set on 1,580 kc, channel B on 1,600 kc, channel C on 1,620 kc, channel D on 1,640 kc. On the other hand, channel A might be on 1,580 kc, channel B on 3,300 kc, channel C on 7,200 kc and channel D on 9,800 kc.

Radio Transmitting Equipment RC-263 is designed to operate on 100 to 260 volts alternating current, 25 to 60 cycles, single phase. Transmitter dimensions are: 18" H. x 40½" W. x 30¼" D. The Remote Control Unit measures: 10" H. x 14" W. x 13½" D. ALL EQPT. IS NEW-UNUSED and in original export packing. Available Complete with tubes, microphone, Instruction Book, and case of full spares which includes meters, relays, tubes, resistors, capacitors, additional microphone, etc. **WRITE FOR PRICE & DESCRIPTIVE LITERATURE.**

600 W. A.F. POWER AMPLIFIER

Designed by Bell Telephone Laboratories, ruggedly constructed 600 Watt Audio Power Amplifier. Ideal for use in airports, shipyards, or wherever high intensity sound may be required. Excellent for conversion to Modulator Unit for modulating 1 KW transmitters. Comprises push-pull audio power stage utilizing 4—805 power triodes in push-pull parallel, with built-in-motor blower for cooling. High voltage power supply uses selenium rectifiers, no tubes. Requires 40-60 watt pre-amplifier to drive to full capacity. Input impedance 250/500 ohms, output impedance 13/6.5 ohms (to speakers). Operates from 115 to 230 Volts, 3 phase 50/60 cycles AC. Dimensions of wooden chest 24⅝" x 28⅞" x 21½". Supplied with tubes, connecting cable, schematic diagram, etc. Shipping weight 290 lbs.

PRICE EACH, SLASHED TO $169.50

ALL MATERIAL SUBJECT TO PRIOR SALE!

CABLE ADDRESS: TELEMARINE, N. Y.

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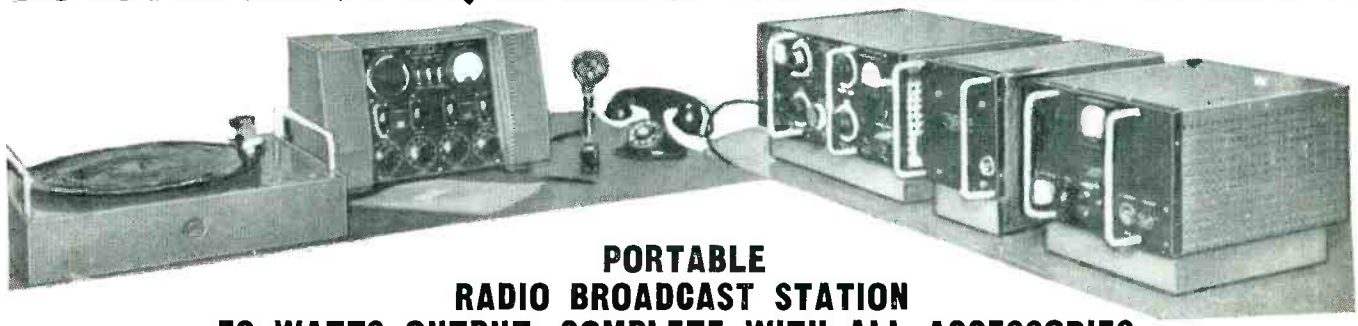
COMMUNICATIONS CO.

3040 W. 21st Street, Brooklyn 24, N. Y.

Phone: ES 2-4300

OUTSTANDING EQUIPMENT AT REAL LOW PRICES!!



PORTABLE
RADIO BROADCAST STATION
50 WATTS OUTPUT, COMPLETE WITH ALL ACCESSORIES

NEW, UNUSED **equipment, designed for Psychological Warfare (Propaganda) and Armed Forces Radio—Troop entertainment, this equipment will meet FCC specs for carrier stability (crystal-controlled) and fidelity.** ***Freq. Range*** **is 1,100 to 1,500 KC, and design provides either crystal control or VFO.** ***Modulation*** **is 100% using a special hi-efficiency circuit.** ***Operation*** **is from 90 to 240 Volts, 50/60 cycles AC, and total drain at full modulation —725 watts.** ***Audio Response*** **is within 1 db from 100 to 5,000 cps, and distortion less than 5% rms at 100% modulation. Design provides for use with quarter-wave antenna against ground, with loading coil of sufficient inductance included within transmitter to permit use of smaller antenna where conditions do not allow proper size. THE EQUIPMENT SUPPLIED FORMS A COMPLETE MOBILE OR PORTABLE BROADCAST STATION. The following are the various units supplied: 1—Broadcast Transmitter, 1—Power Supply (operates from 110v. 60c. AC), 1—Pressure Cooling and Voltage Selector unit, 1—Control Console Mixer, 1—Phonograph 2-Speed (78 & 33⅓ RPM) Turntable, 1—Dynamic Microphone, 1—Set of Operating Tubes, 9 Connecting Cables, Spare Parts Kit, Construction Manual, and 5 sturdy Trunk for housing & transporting this material.**
WRITE FOR PRICES.

LARGE QUANTITY SPECIALS!

GN-58 HAND GENERATORS.
Used with SCR-694 and GRC-9 Field Radio Equipments to power both Transmitter and Receiver units. Complete with seat pedestals, hand-cranks, and legs, in UNUSED condition. 300 units available.

PE-104 POWER SUPPLIES.
Used in SCR-284 Field Radio Equipment to power Receiver section. Operates from 6 or 12 V. DC source, and delivers filament, plate, & bias voltages necessary. Each power supply is complete with vibrator, plus spare vibrator, all NEW—UNUSED in original export packing. Approx. 1500 units available.

DM-35 DYNAMOTORS.
Used with SCR-508/528/608/628 in Transmitter to supply plate power. Operates from 12 V. DC and delivers 625 V. DC at 225 ma. **NEW units,** complete with mtg. plate, plug connector and spare brushes, in original export packing. Approx. 450 units available.

SELECTIVE RINGER FOR MOBILE OR MARINE RADIOTELEPHONES.
Western Electric Model 107A, for use with Bell Telephone System for selective calling of marine or mobile radiotelephones. Alternate 600 and 1500 cycle tones, at a rate of 8 to 11 frequency shifts, actuate a selector mechanism to close a ringing or light circuit (not supplied), Dimensions of unit are: 14-1/16" long, 8¾" high, and 6-27/32" wide, DC operating voltage of from 90 to 250 V. is obtained from receiver. **NEW—UNUSED units** with Instruction Book. **EACH**.....**$85.00**

BRITISH-TYPE INFRA-RED IMAGE (SNOOPERSCOPE) TUBES.
Used in British "Tabby" for seeing in the dark for "snooper" or "sniperscopes". Will detect objects at night illuminated by "dark" infra-red rays. Requires power supply of 3000 to 4000 volts at a few microamperes. Screen size is 1⅜" dia. All tubes checked before shipment.
Price.....**3 for $10.00**

FRONT END LENS ASSEMBLY.
For above. Speed F1.9, f.L 91.44 mm Outside dia. at one end 60 mm. Length of mount 64 mm. **Each**.....**$7.00**

STEP-UP OR DOWN 120/240/460. 3KVA. TRANSFORMER.
Heavy-duty transformer, single phase, 50/60 cycles, mounted in oil immersion type can approx. 22" high x 14" dia. can be removed from can and operated air-cooled with negligible drop in KVA rating, due to rugged overdesign. **NEW—UNUSED units,** less oil, shpg. wt. 300 lbs.
EACH.....**$44.50**

ALL MATERIAL SUBJECT TO PRIOR SALE!
CABLE ADDRESS: TELEMARINE, N. Y.

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Phone: ES 2-4300

COMPLETE EQPT'S IN QUANTITY

SCR-300 FM WALKY-TALKY
18-Tube, low power, dry battery operated FM Transmitter and Receiver for portable use for range of 3 to 5 miles. Freq. range 40.0 to 48.0 mc. Supplied complete consisting of BC-1000 Transmitter-Receiver with battery case, Handset TS-15, Belt ST-55, Harness ST-54, Strap ST-50, and Antenna AN-130 or AN-131. Reconditioned to **LIKE-NEW**, tested and guaranteed.

SCR-536 BC-611 HANDY TALKIES
Famous World War II Handy-Talky weighing only 3.85 lbs. complete. Consists of 5 tube, low power, dry battery operated radio receiver and transmitter measuring 15¾" x 3⅝" x 5⅜". Freq. Range 3.5 to 6.0 mc, with crystal control of any one frequency in this range of both transmitter and receiver. Range approx. 1 to 3 miles, with extremely simplified operation. All are LIKE-NEW, with NEW chassis installed, tested.

TCS-5 to 14 RADIOTELEPHONES
Popular and Efficient Navy Transmitting and Receiving Eqpt., ideal for boat, mobile or military applications. Freq. range 1.5 to 12.0 mc; power output 25 watts A1, 15 watts A3. Transmitter provides 4 crystal control channels—1 MO control channel; Receiver provides 4 crystal control channels, or continuous manual tuning. Available reconditioned to LIKE-NEW, complete, consisting of: Transmitter, Receiver, Remote Control, Antenna Loading Coil unit, set of 3-cables, 12 V. DC, or 24 V. DC, or 110/220 V. AC Power Supply, microphone, and telegraph key. All tested and guaranteed.

SCR-508/528 FM EQPTS.
FM transmitting and receiving equipt., designed for vehicular installation. Freq. range 20.0 to 27.9 mc. Power output of transmitter 30 watts. Transmitter provides 10 crystal controlled channels, receiver is continuously tunable over entire range employing calibrated tuning dial. Available complete, consisting of: 1—BC-604 Transmitter, 1 BC-603 Receiver (SCR-528, SCR-508 uses 2 BC-603's), FT-237 mtg. plate, MS-49 to 53 Mast Sections, Mast Base Insulator MP-37, all tubes, necessary dynamotors, etc. All LIKE-NEW, reconditioned material, tested and guaranteed.

SCR-522 VHF EQUIPMENT
For aircraft or airport installation, Amp. modulation Transmitting-Receiving Eqpt, operating in the freq. range of 100-156 mc. Provides 4 crystal-controlled channels in both Transmit & receive units. Supplied complete, NEW, export packed cases, as follows: Transmitter-Receiver in Case CS-80, PE-94 Dynamotor (for 24 V. DC), Control Box BC-602, Jack Boxes BC-629 & BC-631, complete set of plug connectors, and Instruction Book. Antenna AN-104 is optional and additional. Also available, Power Supply RA-62 to permit 110 V. AC, 50/60 cycle, operation.

SCR-619 FM RADIOTELEPHONES
For Pack or Vehicular installation, FM Trans-Receive eqpt. provides 2 pre-set channels in the 27.0 to 38.9 mc band, delivers 1.5 watts to the antenna, and operates from a total of 6 volts (storage batteries). Batteries are rechargeable from any 6, 12 or 24 V. DC source with Battery Charger PE-210. This eqpt. is NEW, complete consisting of BC-1335 Transmitter-Receiver with all tubes and crystals, PE-210 Battery Charger, Battery (Storage) Box CH-291, Microphone T-17 or T-45, cables, etc.

SCR-610 FM VEHICULAR EQPT.
This popular FM Transmitter-Receiving Eqpt. provides 2 channels in the 27 to 38.9 mc range. Transmitter output is rated at 2 watts, and crystal control of both channels is included. Available in Reconditioned to LIKE-NEW, and consisting of: Transmitter-Receiver BC-659, Power Supply PE-117 or PE-120 for 6, 12 or 24 V. DC operation, Handset TS-13, Mast Sections MS-50 to 53, and Mast Base MP-48.

SCR-506 TANK EQPT.
Medium Power AM Transmitting-Receiving Eqpt. designed for tanks, armored vehicles, etc. Provides CW or Voice communications over the frequency range of 2.0 to 4.5 mc. Receiver includes 2 bands of coverage, 2 to 3.5 mc and 3.5 to 6.0 mc. Provides 4 pre-set channels, with crystal-calibrator circuit for maintaining frequency accuracy. Power Output is 50-90 W on C.W. and 10 to 25 W. on voice—depending upon frequency. Equipment is available complete, in NEW-UNUSED condition, for 12 V. DC operation, and consists of: 1—Radio Transmitter BC-653, 1 Radio Receiver BC-652, 1 Mounting Plate FT-253, Antenna Mast Sections MS-49 to 53, Mast Base Insulator, T-17 Microphone, HS-30 Headphones, plus other extras.

LIMITED QUANTITY ITEMS

MODEL LSR-420F: RADIO BEACON OR SHIP RADIO TRANSMITTER. Freq. Range 275-510 KC. Power Output 100 Watts CW, 150 Watts MCW. Operates from 115 V. AC, 60 C. New Eqpt.
LSR-520-C RADIO BEACON POWER AMPLIFIER. Class B Linear Amplifier used with above LSR-420 to increase power output to 600 Watts CW or 800 Watts MCW. Operates from 115 Volts 60 C. AC.
BC-797 VHF 10-126 MC. 50W. AM Output for 110 V. 50/60 C. AC.
BC-460 Collins Autotune Transmitter, 250 W. A1 200 W. A3 or A2, 10-Channels 2-16 mc.
BC-447, 300 W. A1, 4-13.4 mc. 2-channels.
SCR-510/610. FM Trans-Receiver, 20 to 28 and 28 to 37 mc respectively. With PE-117 or 120 Vibrator Power Supply and other accessories.
SCR-619. FM Trans-Receiver 27 to 38.9 mc. complete with all accessories. NEW units.
TBK HF 500W 2-20 Mc Transmitter with MG. Starter and Spares.
TAJ 500 W. Output, 175-550 Kc. with M.G. for AC or DC operation.
TAQ. Same as TAJ above but 1,000/1,500 W. output with MG.
TBL 350 W. Output, A1, A3, IF. & H.F. for AC or DC operation.
WILCOX 3KW AM TRANSMITTER, 2-20 MC. Consists of 96C RF Unit, 50A Modulator, and 36A Rectifier Power Supply. Crystal-controlled. Excellent. Like-New Condition.
LINK-1498, VHF Trans-Rcvg. Eqpt. 70-100 MC, 50 Watts output FM. Available in 14 VDC & 110 V AC operation.
150-AY Mackay IF Ship X'mttrs.
8707 RMCA Ship Radio Compass.
SB-14GY Console Switchboard.
SB-23/GTA Power Supply for above.
BC-224 Receivers.

BEACHMASTER 250W. AUDIO AMPLIFIER. Super-Power Audio Amplifier, designed by Bell Tel. Labs., all self-contained waterproof case. Ideal for outdoor applications, airports, carnivals. Operates from 110 V. 50/60 cycles AC. Complete with 14 tubes, including 8—805's for push-pull power stage. Dim: 26½" x 16¾" x 10". Shpg. wt. 190 lbs. Used—Excellent condition. **EACH** (with connecting plugs).....**$169.50**
PAE-2 ELECTRIC MEGAPHONE. Mfd. by Remler for U. S. Navy to give concentrated directional sound over a long distance. Consists of a Horn Assembly which includes Microphone, Reproducer, trigger Switch, and Connecting Cable; and a Portable Amplifier with self-contained Power Supply and 6-Volt Storage Battery. Will beam voice over 500 yards or more outdoors. Charger and Storage Rack for 110 Volts AC or DC operation, (charging) available separately. Portable Megaphone Dim: 20" H. x 13½" W. Portable Amplifier Dim: 13¾" H. x 12¾" W. x 3¾" D. Complete with tubes, connecting cables, Inst. Book. UNUSED cond. Shpg. wt. 85 lbs.
PER SET.....**$79.50**
STOWAGE & CHARGING RACK, for above. Operates from 110 V. AC or DC to charge storage battery at tapering rate. Dim: 15½" H. x 18" W. x 11¾" D. Unused condition. Shpg. wt. 55 lbs. **EACH**.....**$19.50**
BC-224—RECEIVER FOR MARINE OR MOBILE. Operates from 12V. DC (internal dynamotor), tunes from 1.5 to 18.0 mc. Similar to BC-312 and 348 in appearance. Includes BFO for CW reception, Crystal Filter Circuit, Standby Switch, and many other features. Used—Excellent Condition. Shpg. wt. 35 lbs.
EACH.....**$79.50**
48 V. DC to 110 V. AC, 3-PHASE, 2KW. ROTARY INVERTER, like-New units. Ideal for marine, train, or farm installations to obtain AC power for operating AC devices. Compact. Shpg. wt. 275 lbs.
EACH.....**$95.00**
RECTIFIER RA-20. 110 V. AC to 250 V., 100 MA DC. Compact Transformer-type all-shielded Power Supply for all receivers or test equipt. Completely filtered output, with fuse and on-off switch. Excellent for converting dynamotor operated receivers to AC operation. Supplies 12.6 V. AC for heaters. Used—Excellent Condition. Dim: 6⅝" x 3⅛" x 5⅜". Shpg. wt. 20 lbs.
EACH.....**$15.95**
RCA IP25 INFRA-RED IMAGE CONVERTER TUBE, used in American Snooperscopes and Sniperscopes. All NEW, UNUSED Condition. Shpg. wt. 8 lbs. **$49.50**

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JUNCTION BOXES

CBY-62018
CW-22081
CBY-62008A
CBY-23049

RELAYS

5059R
5058
5055
5053SM
5053
Price Bros. Relay #10
A-18259
Antenna Switching Relay Box
BG-AN-198
BC-408

TUBES

35T Eimac
53A
VT-127A
WL-530
100TH
250TH
450TL
750TH
15E

TRANSFORMERS

D 163248	D 165964	KS 9608	KS 8984
RET. D 163250	KS 9273	KS 9602	KS 9153
D 163254	KS 9012	KS 9605	KS 8983
D 162899	KS 9536	KS 9117	X 330005
D 183254	KS 9336	KS 9607	A 14987

AIRCRAFT SPARK PLUGS

RB-19R	RP-43-S	RB-312 S2
RB-485S2	63-S*	RC-9R
590 S2	64-S	RS-14-1R
613 S2	LE-44	RZ-14-R
RB 5/2	LE-45	R-214
RB 5/3	LS-48	RB 27-R
RB 5/4	AC-181	RB 23
RB 5/5	AC-281	RS 19-2R
RB 23-R	RB-212 S2	RN-5/3

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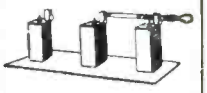
VOLTS	MFD	Price	VOLTS	MFD	Price
25KV	1.0	★49.95	1000	28.0	5.50
25KV	0.5	★39.95	1000	2.0	.69
25KV	0.1	14.95	1000	0.5	.19
7.5KV	0.5	4.25	600	10	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	★.69
3KV	0.1	★1.19	600	2	★.39
2.5KV	2.0	★2.95	600	1	★.19
2KV	5.0	2.95	660AC	5	2.95
2KV	.25	.89	330AC	5	1.29

SPECIAL SWITCHES

SW 141 ( ) DPST normally open with or without lock-in position on push button, part of CD-318 cord set suitable for 115 V. AC SPECIAL ★.19¢



SW 224 SPDT Antenna change switch Square D Cat. No. 9320-962 SC #3ZK-9503 - 20 Bakelite Base 2x8x¼ ★.49¢

SENSITIVE MU-SWITCH 15A. 125 V. AC 15/32-32 threaded bushing. SPDT—69¢

MULTIPLE SECTION OIL CAPACITORS

10 Mfd 400 Volts ★59¢
Dual 5 mfd 3 term. bottom mount. Meets specs for 600 V operation at 40°C. 3¾x3⅜x2

9½ Mfd 600 volts ★59¢
8 Section 2-2-2-1-1-.5-.5-.5 Rated by Western Electric at —50 to +85C will pass 1000 V. test at 40° 4¾x4¾x1½

Molded, Upright and Ceramic-Cased Mica Capacitors

01	4LS	600WV	CM45B103J	.32
02	4LST	600WV	CM50B203G	★.45
001	A2L	2500WV	Thickness 7/16"	.49
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0068	F2	3000WV		★.99
00015	Type 59	10,000WV	3Amp @ 1MC	★5.95
0002	Type 56	10,000WV	1.6Amp @ 1MC	5.95

PULSE NETWORK SPECIAL ★$2.95
Sprague 15-1-400-50 15 Kv
1.0 usec 400 P.P.S. 50 Ohm Z

VARIABLE TRANSMITTING CAPACITORS

19 to 116mmfd 27 plates, .085' air gap. O/a dim. 4¾Lx3½x2¼ SC# 3D 9019V-1 P/o Tuning Units TU-7A a TU-79.....★98¢

3 PHASE INDUCTION VOLTAGE REGULATOR

General Electric Type IRT. 1.64 Kva. Filled with 9 gal. oil. Primary 208 volts. Brand New, Limited Quantity. Special.....$90.00

OCTAL SOCKETS ★$5.00 C

Johnson 122-128 steatite sockets; Amphenol 49-558, steatite ring mounting; Amphenol ceramic and mica filled 1-5/16 and 1½ mounting centers.

RELAYS

Amperite 6NO-110 time delay relay, octal tube base 6V Heater, normally open. Contacts rated 3A.....★.99¢
Allied BO 13D35 SPST Double break normally open 24V DC. Coil Silver contacts each rated 15 Amp @ 24V DC or 115V AC.....★.98¢
Autelco Jr Type 16 115V AC coil DPDT Snap Action contacts rated 15 Amp 115V, 5 Amp 230V.....2.95
Cook #773 Standard Telephone Relay 900 ohm DC coil double arm 14 contacts 11A-1B-1C-1D 4"Lx1½Wx 2½H .....★1.09

COAXIAL CABLE & CONNECTORS

RG 9 B/U.....★15.00 C FT
PL 259 Plug.....★29¢
Amphenol 83-183-Angle Adaptor ★23¢

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Potentiometer JLU 2000 Ohm 2w with lock nut .....★.44¢

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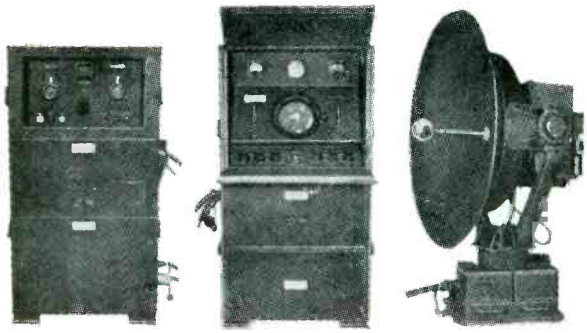

Figure 1. Radar equipment SCR-682-A.

VG-1, 2, 3—24" P.P.I. REPEATER INDICATOR

The remote P.P.I. is a projection radar repeater using a skiatron tube to project a radar image to the top of the console, which is a transparent 24" screen used as a plotting table. This set will operate very well with the SCR-682 at an airport or weather observing station. Five ranges are provided, 4, 10, 20, 80, and 200 miles. Range marks are provided. This set operates with any radar set with a P.R.F. rate of 60-1000 CPS. Power input 110v 60 cyc. A very bright image allows use in a well lit room. Complete spares for this equipment in stock. Other repeaters in stock include: VC, VD, VE, VF, VK. WRITE.

SCR-616—BC-1269

F.M. & A.M. 145-600mc communications receiver. The BC-1269 is a UHF version of the BC-312-342 series and looks very similar. The receiver is a superhet covering the 145 600mc in 2 bands. The dial is calibrated in megacycles. F.M., C.W., or A.M. reception is offered. Power input is 110v 60 cyc using a RA-61 power supply or 12.6v AC and 250v DC 100 MA. This set is one of the nicest receivers designed. Write.

AN/GRC-3 thru 8

The GRC series are the new field and mobile military communications sets. These sets cover 20-58.4 mc depending on the transceiver used. These sets replace the SCR-508, 608 etc as the standard high freq. communication sets. The transmitter output is 15 watts. The transceiver are tuneable or fixed tuned. Input powers are 12 or 24v DC. Components are miniaturized and hermetically sealed. Complete installations are avail. Write.

AN/PRC-8, 9, 10

The PRC series of radio sets are the new F.M. high freq. back pack walkie-talkies superceding the SCR-300. These sets are completely miniaturized and weigh app. 18 lbs. complete, with battery. The PRC-8 covers 20-27.9 mc. PRC-9 covers 27 to 38.9 mc. PRC-10 covers 38-54.9 mc. The set has 16 tubes. The receiver is A.F.C. controlled and has a sensitivity of .5 microvolts. The transmitter power output is app. 1 watt F.M. A crystal calibrator is provided to check and calibrate the set. The receiver is equipped with a squelch control. This set can be used with the AN-GRA-6 to provide remote operation and automatic relay. We can supply spare parts for these sets. Write.

OTHER EQUIPMENT AVAILABLE

AN/URC-4 145 and 250 mc. Air. sea rescue transceivers. All subminiaturized.
AN/ARC-12 and up
AN/APG-15 and up
36/APS-15 and up
AN/APR-4 and up
AN/TRC-7 100-156mc walkie-talkie
AN/ART-18, 23, 24 Radar relay sets
AN/APN-19 beacon
AN/APN-12 transponder
AN/CPN-6, 8, 17 radar beacons
AN/UPN-1, 2, 3, 4 S and X-band radar beacons

115 V. 60 CYCLE BLOWERS:

At Left: 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; 3-⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅜" 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 8-¾" 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**

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #ROD-200 ..... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106 ..... **$6.95**

Same as above, but with 12- Curved Director. No. CDBL-2106 ..... **$7.95**

OTHER BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER—100 CFM—3" intake; 2" outlet. Shunt Motor 4" x 2" 3000 RPM @ 24 VDC $5.95

6 VDC SINGLE—100 CFM—No. 6100—USED: $4.95

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: 3-½" 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

INVERTERS & GENERATORS:

GENERATOR—115 V. 400 Cycle, 1400 Watt. Single Phase. 28.5 VDC 400 Watt. ..... USED: $89.50

GENERATOR: Motor 3 HP. 115/230 60 cycle single phase; Generator 115 Volt 400 cycle single Phase 1400 Watt & 28.5 VDC 400 Watt. Belt Drive. Reconditioned $195.00

AC-DC GENERATOR—Output 115 VAC 800; cycle 10.5 A. & 28.5 VDC; 60 A at 2400 RPM. ⅞" spline shaft. Bendix Eclipse No. NEA-3. ... NEW: $18.95

TYPE 800-1-D—Input 28 Volt 62A; output 115 Volt 7 Amp. 1 Phase 800 cycle. ..... NEW: $24.95

MOTORS:

24 VDC REVERSIBLE MOTOR—3.7 RPM, 40 lb. Torque. Motor size: 5-⅜" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco. No. 441-1008 ..... $5.95

27.5 VDC—6000 RPM. 1.5 oz. in Shaft Size: 1⅛" x ¼". Motor size: 2½" x 1½" No. 5069-267 .... $4.95

26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛" $1.95

110 VDC 1/70 HP., 1550 RPM. Motor size: 4" x 2½". Shaft size: 1" x 3/16". Redmond #157 ..... $4.95

12 VDC 1/30 HP., 4500 RPM. Motor size: 3" x 2½". Shaft size: 1" x 3/16". Delco #5047520 ..... $4.95

27 VDC 1/10 HP., 3500 RPM. Shaft size: ⅝" x ¼". Motor size: 4"x3-½". Air Assoc. No. EE-763. .$6.95

80 VDC 1/50 HP., 3000 RPM. Shaft size: ⅜" x ½". Motor size: 5" x 3". G.E. #5-PN38HA10. . . $8.95

28.5 VDC 1/35 HP., 2200 RPM. Shaft size: 1½" x ¼". Motor size: 4½" x 3¾". Electrolux #16876. . .$5.95

27 VDC GEAR HEAD MOTOR—960 RPM; 1/75 HP; 1.75 A. Size: 5" x 3". Shaft ¼" x ⅝". Air Assoc. #EE120M1 ..... Price: $7.95

27.5 VDC GEAR HEAD MOTOR—324-1 Ratio; 4050 RPM; Right Angle Drive Motor. Size 5" x 3-½". Shaft: 5/16"x¾". Bodine Type #V10R. Price: $7.95

24 V. GENEVA LOC ACTUATOR MOTOR ASS'Y.—1/25 HP; 15000 RPM. w/Gear Head & Limit Switches. Motor Size: 5-½" x 3-½"; Angle Drive Shaft: ¾" x ½". Bendix #LM-106524. Price: $7.95

24 VDC GEARED HEAD MOTOR—Heavy Duty. 8 Amp 2-½ lb. Torque, 100/200 RPM. Shaft Size: 5/16" x 1". Right Angle Drive. $8.95

27 VDC MOTOR—1.5 A.; 1/50 HP.; 3000 RPM Shunt Motor; Motor Size: 3" x 2-¼". Shaft: 5/16" x ¾". Oster #D8-1 or WEVS-5876. ..... Price: $2.95

27.5 VDC MOTOR—1/100 HP.; 7000 RPM; Motor Size: 3" x 1-¾"; Shaft: ¼" x ¾" L. Oster #C2BP-1A—Price $2.95

PM MOTORS AVAILABLE: Delco 5069625, Delco 5068571, Delco 5069370—Write for Prices.

115 Volt 60 cycle GEARED HEAD MOTOR—24 RPM. 1/100 HP. Right Angle Drive—Size: 7-½" x 4" x 4". Shaft Size: 3/16" x ¾" ..... NEW: $9.95

115 VAC 60 Cycle INDUCTION MOTOR—1.9 RPM. 75 Torque oz. in.; 9 Watts—Holtzer Cabot Motor Type RWC-2505 ..... $9.95

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Stock up while they last! Extremely high (100) inverse volts. So only 8 are needed to make a full-wave 115 V. bridge (2 in series in each leg, with high safety factor, instead of the usual 3 per leg.) 30 ma average. Also, greatly reduced reverse current: only 300 uA at —50 V! Normally, a very high priced unit, so this is a terrific buy! Next price break is: 1,000 for $325.00

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OA4G 1.00	3P1 2.00	6AR6 1.25	HK-154 5.00	WE-394A 3.00	834 7.50	2183 5.00
OA5 4.00	3AP11A 5.00	6AS6 1.25	FG-166 14.00	394A 1.85	835 3.50	2252 14.00
OB2 .60	3B21 5.00	6AS6W 1.50	FG-172 35.00	WE-396A 2.90	836 1.50	ZB-3200 72.50
OB3 .75	WE-3B24 .95	6A S7G 2.35	QK-181 15.00	WE-404A 10.00	837 .95	R-4100 6.75
OC3 .70	3B24W 4.75	6BM6 20.00	FG-190 7.50	410R 100.00	GL-838 2.00	R-4330 7.50
OD3 .65	3B25 3.00	6C21 17.50	HF-200 9.50	GL-415 25.00	838 .75	5528 5.00
EL-C1B 1.50	3B26 2.85	6J4 2.00	CE-201 2.25	WE-417A 10.00	842 1.85	5550 25.00
XFG1 2.00	3B27 3.00	6J4WA 3.30	CE-203 3.50	WL-417A 2.50	843 .35	5551 40.00
1AF4 2.50	3B28 4.85	6J6W 1.50	203A 2.50	WE-418A 15.00	845 4.00	5553 100.00
1AG5 2.00	3BP1 2.00	6L6WGB 3.00	203Z 5.00	WE-420A 5.00	845W 7.50	5556 6.75
1B22 1.50	EL-3C 5.00	6SC7GTY 1.50	204A 25.00	WE-421A 7.00	849 18.50	5557 3.75
1B23 2.50	EL-3CJ 8.50	6SN7WGT 1.50	WE-205B 1.75	GL-434A 10.00	851 9.00	5558 6.00
1B24 5.00	3C22 55.00	6SU7GTY 2.00	207 35.00	446A .40	852 5.00	5560 17.50
1B27 10.00	3C23 3.50	7BP7 3.50	211 .45	446B 1.50	860 2.75	5610 1.00
1B32 1.00	3C24 2.50	7CP1 10.00	WE-211C 10.00	GL-451 5.00	861 15.00	5632 8.50
1B35 4.50	3C31 1.50	7EP4 10.00	WE-211D 8.00	WL-460 8.50	865 1.00	5634 6.50
1B36 3.75	3C33 7.50	9GP7 5.00	WE-212E 25.00	464A 2.15	866A 1.15	5637 3.75
1B38 25.00	3C37 10.00	9LP7 5.00	217A 1.00	WL-468 10.00	866 JR 1.00	5638 6.50
1B40 2.00	3C45 5.85	9MP7 5.00	217C 2.00	RH-507 20.00	868 2.00	5640 8.50
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1B47 7.50	3D22 9.75	12A6 .40	CE-220 .50	CK-529AX 2.00	CE-872A 1.50	5644 6.50
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1C21 2.00	3DP1A 7.50	12DP7 17.50	221A 2.00	WL-531 7.50	872A 1.25	5650 85.00
1P21 25.00	3E29 8.50	12DP7A 35.00	CE224 5.00	WL-532A 1.00	874 .50	5651 1.50
1P24 .50	3EP1 2.00	12GP7 17.50	WE-231D 2.00	GL-546 2.00	876 .75	5654 1.20
1P28 7.50	3FP7 2.00	12J5WGT 1.50	232CH 100.00	559 .45	878 .45	5656 6.50
1P29 1.50	3FP7A 3.35	12K8Y .50	RX-233A .70	GL-575A 10.00	879 .35	5670 1.45
1P30 1.50	3GP1 2.00	12L8GT .75	CE-235A 5.00	575A 7.50	884 .95	5676 1.25
1P32 1.00	3HP7 3.00	LM-15 (I.O.) 50.00	WE-242A 5.00	WL-579B 10.00	885 .95	5678 1.00
1P34 1.75	3J21 50.00	NE-16 .30	WE-242C 7.00	631-P1 6.75	889RA 75.00	5687 2.00
1P36 2.35	3J31 25.00	FG-17 3.75	WE-244A 7.50	WL-632A 17.50	902P1 2.00	5691 4.25
1P37 2.25	3K27 125.00	RK-19 .85	WE-245A 7.50	KX-642 7.50	905 2.00	5692 4.25
CE-2C 1.50	3KP1 5.00	RK-20A 7.50	WE-249B 2.50	WL-655/	913 20.00	5693 3.50
2A4G 1.15	3RP1 7.25	TZ-20 1.50	WE-249C 2.50	658 100.00	SD-917A 3.75	5696 1.00
2AP1 3.90	3X2500A3 85.00	RK-21 .85	250R 4.75	WL-670A 8.00	917 2.25	5703 1.00
2AP1A 5.50	4-400A 40.00	RK-23 2.50	250TH 17.50	WL-681/686 25.00	918 1.50	5720 15.00
2AS15 4.75	4B22 6.50	HK-24 3.00	250TL 14.50	WE-701A 2.50	920 2.00	5725 1.50
2B26 1.25	4B23 5.00	HK-24G 2.00	WE-251A 45.00	702A .35	922 1.00	5726 .55
2B36 .50	4B24 5.00	CE-25A/B 1.00	WE-252A 9.50	702B .75	923 1.40	5727 1.35
2C21 .40	4B25 8.00	RK-25 2.25	WE-253A 2.50	703A 1.25	925 2.00	5728 9.00
2C26A .35	4B26 3.00	25E6WG 4.00	WE-254A 4.75	WE-704A .70	927 .95	5734 9.00
2C33 .70	4B27 2.25	25T 3.00	HK-257B 8.50	WE-705A .70	931A 2.50	5740 35.00
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WE-2C51 2.90	4J34 30.00	35T 3.00	WE-268A 7.50	WE-714AY 20.00	958A .35	5819 30.00
2C53 10.00	4J52 50.00	35TG 3.00	FG-271 40.00	715A 2.00	959 1.45	5820 400.00
2D21 .60	4X100A 15.00	RK-39 1.25	WE-274A 3.00	715B 3.50	SN-974B 8.50	5826 350.00
2D21W 1.35	EL-C5B 1.00	VX-41 5.00	WE-274B .90	715C 11.50	SN-976D 8.50	5827 5.00
2E22 2.50	EL-5BHD 5.00	CE-48 1.75	274R .35	WE-717A 1.00	991 .30	5829 1.00
2E24 1.95	EL-5B2.5 6.50	RK-49 2.85	WF-275A 5.00	717A .35	1000T 100.00	5842 10.00
2E25 1.35	5AP1 2.50	HY-51B .50	WE-276A 7.50	WE-719A 9.50	CK-1005 .30	5847 10.00
2E26 3.00	5B21 1.00	FP-54 35.00	276A 2.50	720AY-EY 35.00	CK-1006 2.50	5915 1.00
2E29 1.00	5BP1 2.00	HK-54 2.00	WE-282A 5.50	WE-721A 2.50	SN-1006 6.50	5932 3.00
2E36 1.25	5BP1A 5.00	T-55 3.50	WE-283A 3.50	721A .50	CK-1007 .60	5933 2.00
2E41 2.00	5BP2A 4.75	RK-58 .90	WE-285A 5.00	721B 7.00	SN-1007A 6.50	5948/1754 200.00
2J21A 2.75	5BP4 2.00	QK-59 25.00	WE-286A 6.00	723A/B 8.50	SN-1007B 8.50	5962/BS-101 6.50
2J26 4.00	5C22 25.00	QK-60 25.00	287A 2.50	WE-724A .75	CK-1009 3.00	5963 1.40
2J27 4.00	5C30 1.00	RK-60 1.35	WE-295A 5.00	WE-724B 1.00	SC-1016C 6.50	5979/BS-1 15.00
2J29 15.00	5CP1 2.00	QK-61 25.00	WE-296A 25.00	WE-726A 5.00	SC-1017C 6.50	5980/BS-2 10.00
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2J53 25.00	5JP4 6.25	75TL 7.50	WE-311A 5.00	807W 2.00	1619 .30	8005 4.00
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2J55 50.00	5JP11 9.00	FG-81A 5.00	316A .50	809 2.25	1624 .95	8011 1.00
2J56 75.00	5LP1 7.50	VR-90 .75	WE-323A 7.50	810 10.00	1625 .30	8012 1.00
2J61 15.00	5LP1A 20.00	FG-95 17.50	323B 4.00	811 2.65	1630 .40	8012A 3.50
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2K28 28.00	5X3 3.00	100TH 6.00	WE-339A 7.50	814 1.35	1642 .40	8020 1.25
2K30 100.00	5X3P1 75.00	VR-105 .70	WF-347A 3.00	815 1.00	1649 1.00	8021 .75
2K33A 50.00	5Z2P7 50.00	HY-114B .75	WF-349A 6.00	816 1.00	1654 3.50	8025 1.25
2K34 85.00	5Z4P11 100.00	WE-121A 3.50	WF-350A 2.65	822 10.00	1656 6.50	8025A 2.00
2K41 85.00	EL-C6A 6.00	WE-122A 1.50	WF-350B 2.65	826 .50	1661 6.00	8026 5.00
2K45 40.00	EL-C6J 6.25	F-123A 2.00	WE-352A 15.00	SD-828A 6.50	1846 50.00	PD-8365 50.00
2K47 110.00	EL-C6L 5.00	WE-123A 5.00	F-353A 2.00	SD-828E 6.50	1850A 100.00	9001 .85
2K54 7.50	EL-6C 8.00	WE-124A 3.75	WF-353A 3.50	828 9.50	1851 1.75	9002 .60
2K55 5.00	6AC7W .75	VT-127A 2.00	WF-355A 12.00	829 5.50	1904 9.00	9003 1.25
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C3J	6.35	VR-105	.79	2J61	16.40	4AP10	4.99	6J6W	1.29	707B	4.45	708A	2.99	830B	2.99	1625	.29
C6J	7.99	VR-150	.79	2J62	4.60	4B22	6.49	6K4	3.99	282A	6.49	709A	1.69	832A	7.49	1626	.29
CRP/RK-72	.49	OA2	.74	2K22	14.50	4B25	7.55	6X4W	1.49	286A	7.50	713A	.96	833A	31.50	1630	.79
EC1	1.99	OB2	.89	2K23	16.50	4B36	4.69	12A6	.39	287A	6.61	714AY	24.95	836	1.99	1632	.59
EF-50	.89	1B22	1.69	2K25	15.00	4C27	8.95	12AT7	.85	304TH	10.00	715A	2.65	837	1.99	1641	1.88
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EM-3GA	39.50	1P30	1.99	2K33A	59.95	4C35	12.95	15E	1.25	307A	1.85	715C	14.50	841	.59	1644	.48
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FG-105	12.99	2APIA	6.44	2K55	9.50	5BP1	2.49	26C6	1.19	327A	3.35	EY/DY	14.65	851	16.50	2050W	2.40
FG-154	14.99	2BP1	5.99	2V3/G	1.39	5BP1A	8.99	28D7	.89	329A	4.69	719A	1.49	860	3.49	2051	.76
HF-100	7.49	2BP11	7.99	2X2	.34	5BP4	2.99	7BP7	6.25	347A	3.88	721A	8.45	861	19.00	5651	1.39
HK-24	3.69	2C21	.49	2X2A	.89	5C22	25.00	9LP7	5.00	350B	2.99	721B	1.99	864	.69	5654	1.40
HK-54	3.99	2C22	.39	3A5	.49	5CP1	3.99	10Y	.39	356B	7.45	722	1.19	865	.49	5656	8.25
HY-114B	.69	2C26	.39	3AP1	3.99	5CP1A	12.49	12X3	1.59	371B	1.29	723A/B	8.99	866A	1.19	5670	2.20
		2C26A	.49	3B22	1.49	5CP7	9.99	18C	.29	388A	1.49	724A	1.15	869B	30.00	5686	1.79
		2C33	.79	3B24	2.99	5CP11A	14.99	24R	1.89	393A	4.35	724B	1.45	GL-872A	2.49	5687	2.69
		2C39	4.99			5D21	6.99	35T	4.99	394A	2.99			872A	1.29	5702	1.49
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REL-21	1.00	2C42	9.75	3B27	3.49	5JP1	16.99	100TH	3.99	WL-460	8.99	726B	25.00	885	1.10	5751	2.10
RK-34	.39	2C43	10.97	3B28	4.69	5JP4	14.99	203A	5.99	WL-464A	4.25	726C	24.50	9-3	.69	5763	1.25
RK-59	1.88	2C44	1.35	3BP1	1.88	5J33	7.99	205B	1.99	CK-508AX	1.10	730A	7.95	902P1	2.99	5814	1.35
RK-60	1.99	2C46	7.49	3BP1A	5.15	5LP1	19.99	205D	3.99	CK-521AX	1.10	800	1.29	918	1.99	5879	1.10
RK-61	3.50	2C53	9.90	3C21	1.29	5NP1	6.99	207	49.50	527	14.50	801A	.42	927	1.45	5933	2.95
RK-65/5D23	14.99	2D21	.69	3C22	64.95	6C21	19.95	211	.72	WL-530	19.50	802	2.89	931A	2.99	5963	1.19
RK-73	.69	2D21W	1.39	3C23	5.99	6AC7	.64	215A	3.49	WL-531	6.25	803	2.69	954	.19	5964	.74
RX-233A	.79	2E22	2.25	3C24	1.50	6AC7W	1.50	217A	2.99	532A	.99	804	9.99	955	.29	5977	3.89
VT5/215A	.69	2G22	2.29	3C33	8.99	6AG7	.79	217C	4.99	700A/B/C/D/E	10.99	805	4.90	956	.25	6080	2.99
VT25/10	.49	2J21	2.99	3C45	6.25	6AJ5	1.19	221A	3.99	701A	4.99	807	1.25	957	.33	6080W	3.90
VT25A/10Y	.39	2J22	4.99	3CP1	2.25	6AK5	.54	233A	1.19	702A	2.25	807W	3.25	958A	.39	8002R	18.50
VT67/30 Spec	.26	2J27	5.99	3D23	4.99	6AK5W	1.19	242C	8.00	703A	1.90	808	1.79	959	1.40	8005	4.50
VT-158	17.50	2J30	14.50	3DP1	1.88	6AN5	2.12	249B	2.99	704A	1.59	809	3.15	991	.39	8012	1.85
VU-111	.19	2J31	14.50	3E29	10.25	6AR6	1.49	249C	3.99	705A	1.25	810	9.95	CK1005	.46	8013	2.50
1B32/532A	.99	2J32	13.50	3EP1	1.88	6AS6	1.19	250TH	24.95	706A	8.75	811	3.19	CK1006	1.97	8013A	3.49
QK-59	29.50	2J33	13.50	3GP1	1.88	6AS7/G	2.49	250R	4.99	706B	16.50	813	11.49	1500T	94.50	8020	1.39
QK-61	32.00	2J34	13.50	3J21	49.95	6BM6	39.50	258B	4.49	706C	19.50	814	2.69	1608	2.99	8025	1.99
QK-185	99.00	2J38	14.00	4-65A	19.00	6C4W	2.99	259A	5.99			815	1.95	1613	.95	9001	.79
VR-78	.89	2J39	11.00	4-125A	26.50	6D4	2.99	264C	3.90			816	1.05	1614	1.49	9002	.69
						6F4	2.99	271A	12.99			826	.75	1616	.59	9003	1.10
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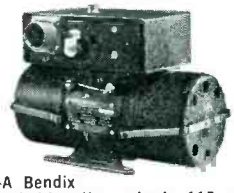

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R210-1A Kearfott Trans. 26/11 8V 400 cy.	15.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 32V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
CK5 Bendix Mtr. 2 phase 26V 400 cy.	17.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
1377-0410 Kollsman 26V 400 cy.	10.00
1515B-0410 Kollsman 26V 400 cy.	20.00
10047-2-A Bendix 26V 400 cy.	12.50
2900 Transicoil 115V 400 cy.	15.00

ESTERLINE-ANGUS RECORDER

Model AW 0-1 MA

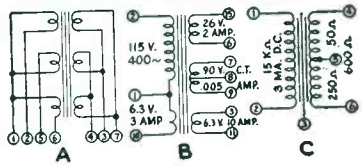
DC Milliameter permanent magnet moving coil type. Spring clock duel speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument.
Portable case **$200.00**

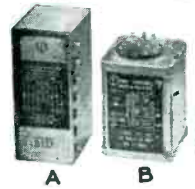
RATE GYRO TYPE T-2004-3C-A MFG. KEARFOTT CO.

Gyro motor excitation 115V, 400 cy. 3 ph. Take off output: 26 VAC 400 cy. single phase. Rating 20°/sec. Approximate Diameter 3¾", Height 2⅜". Weight 1¾ lbs. Hermetically sealed. Equipped with 28 VDC heater. Operates efficiently in range of —54°C to +71°C. Sensitivity .2250 volts/degree at 10K load.
This is the famous Gyro used in many military units. Government cost over $1700.00. New condition.
Limited quantity @..... **$150.00 ea.**

HIGH CYCLE TRANSFORMERS

Primary each 115V—400 cy—3 phase





A. $3.50

B. $3.00

C. $2.00

SMALL DC MOTORS

(approx) size overall 3¾" x 1¼" dia.:)	
5069600 Delco PM 27.5 VDC 250 rpm	$12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
MM A-11 Globe PM 24 VDC	7.50
5BA10AJ18 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1¼" in dia. 2" long overall	4.00

G. E. RECTIFIER

Model 6RC89F16. Input 115v., 60 cy., 1 ph. Output 115v. dc. @ 10 amps. Consists of a metal cabinet 41 x 21 x 21 inches containing a transformer, copper-oxide rectifier, secondary reactor, ventilating fan, control circuits and aux. equipment. Transformer and reactor tapped to vary output. A 0-15 amp. DC meter on front of cabinet. A useful piece of equipment for testing in lab or shop where 115 vdc. at 10 amps is needed.

Also will charge a 54 cell emergency storage battery. Unused surplus. Only a few of these available. Special....$97.50
Shpg. Wt. approx. 300 lbs.

HIGH POT TRANSFORMER

Westinghouse. PRI: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price...$29.50

RADAR ANTENNAS

SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New $279.50

SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases.....$149.50

SO-13 (10 CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New $89.50

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in this ad. New less tubes.....$29.50

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

HIGH-VOLT OIL CAPACITORS

Mfd.	KV	Price
.001	50	$22.95
.02	20	9.75
.025	50	17.95
.025/.025	50	24.50
.1/.1	4.5	3.50
.135	7.5	6.95
.2	50	39.50
.25	15	9.95

SPECIAL
1 MFD. 7500 Volt Pyranol Filled
$6.95

Mfd.	KV	Price
.25	20	$15.95
.25	50	54.50
.5	25	39.50
1.	7.5	6.95
1.	15	29.50
1.	20	42.50
1.	25	49.50
2.	5.5	9.50

BARGAINS IN TEST EQUIPMENT

FLUXMETER. Measures field strength of magnets from 500 to 4000 gauss. Indicates polarity. Probe gap 1¼". British handicraft in fine hardwood case with hinged cover. Operating instructions on underside of cover. Size 12-¾ x 9 x 6 in. A lab instrument. Also ideal for classroom magnetics instruction. A real buy at only **$14.95**

FREQUENCY METER 375 to 725 Mcs. Model TS-127/U. Compact. Self-contained, precision (± 1 Mc). Sturdily constructed Hi-"Q" resonator has average "Q" of 3000. Uses 957, 1S6 and 3S4 tubes. Requires standard 1½V "A" and 45V "B" battery, not supplied. Brand new with instruction book, probe and spare kit of tubes..... **$27.50**

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. For operation on 115V 60 Cy. Price..... **$98.50**

SPECIAL OFER! 80 page Tech. Manual for Panoramic Adapter AN/APA-10. Full of circuitry, descriptive data, theory, etc. Postpaid in U. S. A. Only..... **$2.75**

TEST OSCILLATOR TS-47/APR, 40-2000+ Mc. Fundamental 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. New with handbook of Maintenance Instructions..... **$149.50**

AN/APR-1 RECEIVER. For use with tuning units TN-1, and N-2, and N-3. Range 38-1000 megacycles. Price with tubes less tuning units..... **$95.00**

158-210 Mc RECEIVER BC-1068A. Has 2 tuned RF stages, tuned converter and oscillator, 5 IF stages, diode detector, tuning eye, and 2 stages of audio. Tuning coils may be altered for lowering or increasing coverage. Operates from 115V, 60 Cy. Gov't. cost estimated at $700.00. Our special price including 14 tubes. Shipping Weight, Approx. 60 Lbs. Only..... **$29.50**

300-1600 Mc TRANSMITTER T85/APT5. Nominal output 10 to 30 watts. Tunable cavity provides range from 300-1600 Mc. Filament transformer operates from 115 V 60 Cy. Uses 8 tubes: 1—931A, 2—6AC7, 2—6AG7, 1—6L6G, 2—829B, 1—3C22 (oscillator). New. Price with 400 cy power supply, plugs, ant., etc. **$169.50**

AMPLIDYNES

5 AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New $34.10

5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New $23.50

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New.....$4.50

Armor. Synchro Differential Generator. Type 6DG. New.....$29.50

INVERTERS

Leland Elec. Co., PE206A. Input: 28DC at 38 Amps. Output, 80V, 800 cy, 1 Ph., 485V. New $22.50

G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New..$32.50

G.E. 5AS13155I1A. Model 218J. Input: 28 DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New.....$89.50

G.E. 5D21NJ3A. Input 27 V. D.C. Output 110V., 400 Cy. 1 Ph., 485 VA. New $29.50

Type PU-7/AP. 2500 VA. Input 28 V. D.C. Output 115 V., 400 Cy., 1 Ph. New $79.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps. or 13 VDC at 40 amps. Radio filtered and complete with line switch. New $89.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60 VDC at 8.3 Amps. Field 27.5 VDC at 2.3A RPM 4000. H.P. 0.5 New.....$27.50

9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels.
Price $.10 ft. Sample 100 ft. Coil..$10.00

TERMS: Rated Concerns Net 30 FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: DEERFIELD 7-0044

ELECTRONICRAFT INC.

Cable Address: Electraft, N.Y.

27 MILBURN ST. BRONXVILLE 8, N. Y.

Rx FOR ALL P.A.'S: Do You Suffer From A, W, Y, WA, WGA, WGB, WGT, WGTA, WGTB, Headaches?

For quick and permanent relief from ruggedizationitis, call—wire—write us today. We stock for immediate delivery, all current and most comprehensive inventories of new, first quality, fully guaranteed commercial JAN—MIL—E1B, reliable and ruggedized tubes.
Of course, we stock klystrons, magnetrons, thyratrons and all other special purpose tubes.
Export orders promptly handled

OA2WA	$2.40	6J4WA	3.45	5517	1.75	5727	1.75	5993	5.50
OB2WA	2.40	6J6W	.85	5635	4.95	5744	.95	6005	1.50
OC3W	3.00	6L6WGB	2.25	5636	3.95	5751	2.25	6021	4.95
OD3W	3.00	6SJ7WGT	2.90	5638	8.00	5755	8.50	6021A	4.95
1B24A	15.00	6SK7W	1.90	5640	7.50	5763	1.25	6030	Q.O.R.
1B35A	5.00	6SL7WGT	1.75	5643	6.00	5783	4.50	6034	Q.O.R.
2C39	5.00	6SN7WGT	1.50	5647	4.75	5787	4.50	6035	29.50
2C39A	9.00	6X4W	.95	5654	1.30	5814	.80	6038	5.00
2C39B	26.00	6X4WA	2.50	5656	7.00	5814A	1.50	6073	2.40
2D21W	1.35	12AT7WA	2.75	5663	1.25	5819	35.00	6082	3.25
2K28A	37.50	12AU7WA	2.25	5670	1.50	5820	400.00	6095	1.25
3B24W	5.00	304TH	8.75	5672	1.20	5829	1.35	6096	1.50
3B24WA	8.50	304TL	10.50	5686	1.95	5840	4.50	6097	1.25
3D21A	4.50	400A	2.95	5687	2.75	5879	1.15	6098CT	6.50
4PR60A	50.00	409A	2.00	5691	4.75	5881	2.25	6099	1.40
4X150A	19.50	412A	3.75	5692	5.00	5894	16.00	6100	2.25
6AC7W	.85	416B	50.00	5693	4.75	5899	4.00	6101	1.85
6AK5W	1.25	420A	8.50	5696	1.25	5899A	5.00	6111	6.75
6AL5W	.85	723AB	9.00	5702	1.75	5904	10.00	6113	1.25
6AN5WA	6.25	807W	3.50	5718	2.75	5905	15.00	6130	13.50
6AQ5W	1.50	829B	9.50	5721	150.00	5906	15.00	6136	1.55
6AS6W	2.25	832A	7.50	5722	5.50	5932	4.00	6186	3.75
6AU6WA	1.55	872A	2.75	5725	2.25	5933	3.50	6189	2.25
6C4W	4.50	931A	3.95	5726	.85	5964	.75	6201	2.75

SPECIAL LOW PRICES TO QUANTITY BUYERS—ABOVE PRICES DURING MARCH ONLY

RCA, TUNSOL SYLVANIA, Etc.

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NO SECONDS

74 CORTLANDT ST., N. Y. 7, N. Y. **BARCLAY 7-5839** **Dept. E.**

Terms: Rated firms, send P.O. All shipments F.O.B. New York. COD shipments, enclose 25% with order.

A BARGAIN FOR SOMEONE!

Three-phase
60/400 cy. Motor-generator Set

OUTPUT

GE 9 KW 400 cycle generator with 4 wire connection for 120 volts single phase, or 208 volts 3 phase. Equipped wih voltage regulator and blower. Power factor is .9.

INPUT

15 hp 3 phase 60 cycle motor rated for 220 or 440 volts. Magnetic controller included.

This equipment is unused, still in original crate, $2000.00 value for only $790, fob our plant. Contact Mr. Henry.

SERVO-TEK PRODUCTS CO.

1086 Goffle Road **Hawthorne, N. Jer.**
Phone: **HA 7-3100** ***Cable:*** **"Servo-Tek"**

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391 Riverside Ave.
Yonkers 5, N. Y.

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

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. Mtg. 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

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284.....$2.75

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

K-Band, X-Band Eqpt. Available.....Send for List

X BAND—1" x ½" Waveguide

PARABALOID DISH, 18" diam. Spun Aluimnum, 8" Focus. For AN/APS-6.....$4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long.....$5.00

FLEXIBLE SECTION 9 in. long, Cover-to-Cover. $5.50

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler. 20 DB., with "N" Takeoff.....$22.50

3CM. DIPOLE FEED, 15" L. for APS-15.....$14.50

MITRED ELBOW, Cast aluminum. 1¼" x ⅝" W.G. W.E. Flanges. "E" Plane.....$3.50

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 160 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/UG 40 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

90 degree elbows, "E" or "H" Plane 2½" radius.$8.50

ADAPTER, waveguide to type "N", UG 51-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.

COAXIAL R.F. FILTERS

F-29/SPR-2. Hi-Pass., with 1000 mc. Cut-off. Type "N" input and output. 50 Ohms Z.....$9.50

F-41/SPR-1. Hi-Pass. with 300 mc cut-off. Type "N" input and output. 50 Ohms Z.....$10.50

AUDIO TRANSFORMERS

LVM-11. Multimatch Line Autoformer. Rated 30 watts. Will match up to 10 separate 500-ohm lines. Impedances: 500/250/167/125/100/83/71/62/50 ohms..$3.40

G-5604 Plate-to-Line 20,000 ω (with 32 MA. DC) to 600 ohms. Resp. 250/3500 cps. ± 2db, 15 mw. Level..55¢

W-15-21: Hybrid: Input Trans #1: 300 w/300 ohm. Trans. #2: 600 ohm/250,000 ohms.....$1.19

W-15-41: Hybrid Output. Trans. #1: 300/30 ohm. Trans. #2: 300/13,000 ohm (Plate).....$1.15

● **SPECIAL:** Set of 2 Transformers: Input Trans. W-15-41 and Output Trans. W-15-21. (Above)..$1.97

KS-9496: Output, 9000 ohms P-P. to 9 ohm V.C. 250 watts, 100 to 10,000 cps ± 1db.....$8.95

KS-9449: Driver Trans. P-P 6V6 (8000 ohms) to PP Grids CL. "B" (805's). 10 watts 1000-10,000 cps ± 1db.....$2.45

● **SPECIAL:** Matched Transformers KS 9449 and KS 9496 (Above).....$9.95

AT 017: Interstage: 10,000 ohm pp plates to 80,000 up grids. For BC 614 Speech Amplifier.....$1.35

AT 199: Output: 6000 ohm plate to line (200/600 ohms) Response: 200-12 kc. For CFIA and CF 3A....$2.45

AT 037: Mike to grid: 75 ohms to 125,000 ohms...$.65

J-871: Output: Pri: 20,000/16,000 ohms P-P. Or 5,000 /4,000 ohms. Sec: 500/16/7.5/5/3.75/1.25 ohms, Silcor, hi-fi.....$2.75

AT SUB Subouncer, Multimatch, 200 ohms to 15 K ohm C. T. and 100 K ohm Grids.....$.69

AT501 HI-FI Special: PRI: 3000 ohms P-P/Sec: 4/16/ 12/50/200 ohms 60-10,000 CY.—1 db 50W.....$3.49

AT152 HI-Fi Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db.....$1.40

AT602 Output to H. S. or line PRI: 14,200 ohms SEC: 8000/600 ohms.....$1.10

AT666 Intercon Input: Spkr (-4-8 ohms) to grid ($250,- 000 ohms).....$0.69

AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY.....$1.95

AT858 Plate (10,000 ohms C.T.) to line (125 ohms) (125130 ohms) Hi-Fi—50 W.....$6.95

AT-694 Hi-Fi Output: 3 Watts. 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db.....$1.49

BARGAIN SPECIALS

APT-4 Jamming transmitter. Uses 5J30 or 5J31 magnetron. Power output: 130 watts, 350-760 mc. New complete with tubes.....$95.00

MD 30/APT-4. Modulator. For noise modulating of APT-4. Operates from 115 v, 400 cy. New.....$35.00

L & N RATIO BOX, #1553. Basic unit for capacitance, impedance, and conductance bridge. New, complete with instruction book.....$225.00

FILTER, Artificial Line: WECO D163169. 650 ohms imp. insertion loss: 5 db.....$32.50

Barry shock mounts: nos. 2045, C-2060, C-2070, C-2090.....45¢ ea.

Trihedral radar reflector, MK-1, aluminum.....$3.50

SPLICER, for 11/16 perforator tape. WEco # X-61859 list 20 SCS #4TW 61859-20. Complete set, with number tape dispenser.....$8.50

MN 28Y Control box, unit of MN 26 compass. New.$3.75

Noise filters. Mallory NF1-1, 100 amp/35 vdc.....$1.00

Power supply unit, navy type—EL-2, Input: 115 vac, 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear.....$9.50

Coaxial switch, 12-position, with type "N" fittings. Type SA-14/SPR-1.....$17.50

Amplifier, Altec A-127. 18 Watts output with response from 20-20,000 cps. Operates from 115 v. 60 cps. Std. rack panel mtg. Used, excellent.....$103

Pulse analyzer, type APA-6. With 3 in. scope....$235

BC 602 Control box for SCR 522 (pushbutton)....$3.75

24-volt Transformer. Input 115v/60 cy. Output 24v/3A.....$1.79

Phase-shifter. Helmholtz type: 0-360 deg.....$2.50

Capacitor, oil-filled, 0.25 mfd./25,000 volts dc.....$15

Hydrophone, MODEL MI-2. A lattice of 3 crystals in a disk-like structure: 17-37 Kc.....$27.50

AN/CRW-2A Remote control receiver, for operating target planes, etc. New, with soundproof mounting 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-wide 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

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

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.....$32.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR83	14	..	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	2.60	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 60†	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

‡ Less Filter. * Replacement for PE 94.

† Used, Excellent.

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: 13.75 V; 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

PLATE—115V/60~INPUT

PT- 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	1.15
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	2500V12 MA H'SLD	4.95
PT-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60~INPUT

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 18 Ohms	5.75
CG-044	8.5H/350 MA, 3.5 KV Test 50 Ohms	6.35
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
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-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-266	20H/300 MA	6.95
CH-999	15HY/15 MA—400 ohms DCR	1.95
CH-445	0.5HY/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

VHF TEST SET

The signal generator is designed to serve as an aid in aligning 152-162 megacycle FM receivers. It consists primarily of a temperature controlled crystal oscillator, the plate circuit of which is tuned to the 48th harmonic of the crystal frequency. The generator provides an extremely stable output which can be varied continuously from zero to well over a hundred microvolts. Provision has been made for two-frequency output provided that a dual crystal is utilized.

New, Less Crystal.....$32.50

PULSE TRANSFORMERS

4P37: Primary, 50 Ohms 750V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance Bifilar 12.6V/2.5A.....$32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN".....$22.50

WECO: D-163247 For Modulator of SCR 720....$22.50

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW.
Bifilar: 1.5 amps (as shown).....$62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well.....$24.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well.....$32.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well.....$29.50

54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR.....$3.50

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR.....$5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg.....$5.00

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise.....$8.95

PULSE NETWORKS

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp..$27.50

H-615 10KV. 0.85 usec., 750 PPS, 50 ohms imp..$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32 40H @ .08A. 21 KV Test.....$37.50

G.E. 25E5-1-350-50 P2T, "E", CKT, 1 Microsec. Pulse @ 350 PPS. 50 Ohms Impedance.....$69.50

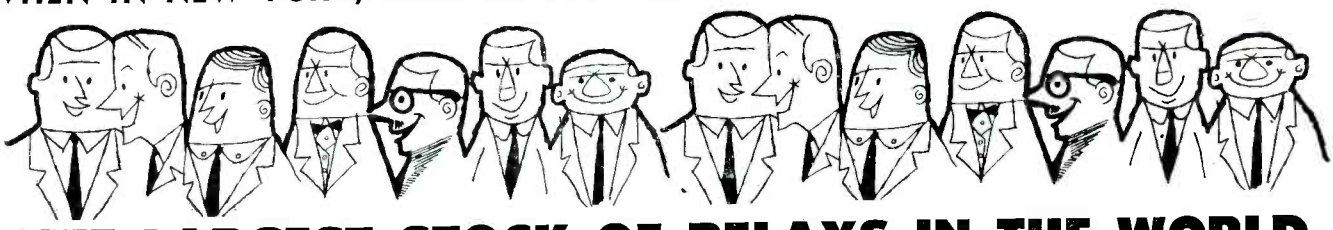
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac Test.....$14.95

H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance, 5 sections.....$62.50

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

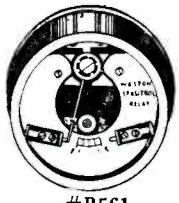
343 Canal St., New York 13, N.Y. Dept. E-3 Chas. Rosen Phone: CAnal 6-4882

WHEN IN NEW YORK, DROP IN AND SEE . . .



THE LARGEST STOCK OF RELAYS IN THE WORLD

WESTON Type 705 SENSITROL



#R561

Stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact which draws movable contact and holds it firmly. Contacts remain closed until reset. Will operate directly from a photocell or a group of thermocouples. Net weight 14 oz.

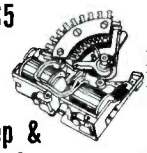
Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #R560 .....**18.75; 10 for 170.00**

Same as #R560 but with glass face; Weston Model 705 Type 6 #R561.....**19.75**
10 for 180.00

Single contact (Normally Open), Solenoid Reset; Sensitivity: 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact: "Twintact", capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R523 .....**17.75 10 for 160.00**

Same as #R523 with Brass Cover Weston Model 705 Type 4 #R523N.....**16.75**
10 for 150.00

SS5 STEPPING SWITCHES

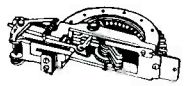


Step & Reset

Mfd. by Western Electric Minor Switch 10 steps and off Contacts: #'s R960, 975, 976 **Gold** plated brass; Bridging Wiper; Net Wt. 1 lb.

		Lots Each	of 10
#R960; Single Level;	6 to 12 VDC.	**9.50**	**8.00**
#R975; Single Level;	24 to 36 VDC.	**10.50**	**9.00**
#R976; Single Level;	48 to 60 VDC.	**11.50**	**10.00**
#R977; Two Level;	6 to 12 VDC.	**11.50**	**10.00**
#R978; Two Level;	24 to 36 VDC.	**12.50**	**11.00**
#R979; Two Level;	48 to 60 VDC.	**13.50**	**12.00**

SS6 Mfd. by Western Electric Co.; 22 step; 5 levels; Bridging Wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz.



"Homing" Type; 180° Wipers; Step in One Direction

		Lots
	Each	of 10
#R926; 6 to 12 VDC	**13.75**	**11.50**
#R980; 24 to 36 VDC	**14.75**	**12.50**
#R981; 48 to 60 VDC	**15.75**	**13.50**

SS7 Mfd. by Western Electric Co.; 44 step; 2 Levels; Bridging Wipers; Contacts: Gold plated brass; Interrupter Switch; 1 Break-Make; Net Weight 1 lb. 14 oz.

"Homing" Type; 360° Wipers; Step in One Direction

		Lots
	Each	of 10
#R927; 6 to 12 VDC	**13.75**	**11.50**
#R982; 24 to 36 VDC	**14.75**	**12.50**
#R983; 48 to 60 VDC	**15.75**	**13.50**

AUTOMATIC ELECTRIC TYPE 13 "Homing" type; Step in one direction; 25 position; 180° wipers, one bridging and remainder non-bridging; Interrupter switch: 1 break.

Our #	Nom	DCV Max	Levels	Auto Elec #	Price Ea.
886	6	12	3	RG26	16.75
900	24	36	3	RA92	16.75
887	48	56	3	RA95	16.75
888	6	12	6	RB31	18.75
889	24	36	6	RB36	18.75
890	48	56	6	RB38	18.75

CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break. #R891; 24-36VDC; 3 levels; Clare #SD19. .**12.95 each**

IMMEDIATE DELIVERY

WESTERN ELECTRIC MERCURY CONTACT

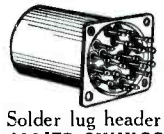
Pressure Sealed; Octal Plug Base D171584; (Equivalent to 275B); SPDT; 1 coil of 4500 ohms plus 24V Heater. Operating current: 8.0 ma, release current: 5.2 ma. Overall length: 3¼", overall diameter: 1-3/16" #R1021 .....**6.95 ea.**
10 for 65.00 100 for 625.00

SIGMA SENSITIVE

SIGMA 4F8000S; 1 ma; SPDT (1C); 8000 ohm; #R425 .....**3.95 ea.**
3 for 10.00 10 for 30.00

SIGMA 5F16000S; 0.5 ma; SPDT (1C); 16000 ohm; #R627.....**5.95 ea.**
10 for 50.00 100 for 450.00

Production Quantities



HERMETICALLY SEALED

ALLIED SMHX-1; 24-VDC; 6PDT(6C); 10 **Amp contacts**; 230 ohm; Solder lug header; #271 .....**6.50 ea.**
ALLIED SKHXCC; 24 VDC; DPDT(2C) 425 ohm; Solder lug header; #R85...**4.95 ea.**
ALLIED SKHXCCCC; 24 VDC; 4PDT(4C); 425 ohm; Solder lug header; #R86 **5.50ea.**

A-C RELAYS

GUARDIAN SNAP-ACTION: SPST; 30 Amp contacts; 115V, 50-60 cyc; #R1023 **1.95**

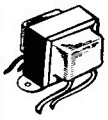
ALLIED BOGA115: 115V, 50-60 cyc; DPDT (2C); 12 Amp Contacts; #R692.....**3.00 ea**
LEACH 1127BF: 115V, 50-60 cyc; DPDT (2C); 8 Amp Contacts; #R141.....**2.75**
10 for 25.00 100 for 225.00

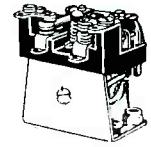
MERCURY TIME DELAY

ADAMS & WESTLAKE 1040-8-9; 115V, 50-60 cyc; 0.75-1.25 sec. delay make, 0.3 break; SPST (1A), 35 Amp. #**R151**.....**9.50**
10 for 90.00 100 for 825.00

ALLIED PO12A115: 115V 50-60 cyc; 4PDT; 10 Amp contacts; #R1025.....**4.50 ea.**
10 for 40.00 100 for 350.00
GUARDIAN 150: 115V, 50-60 cyc; SPDT, 3 Amp contacts; #R1029 **1.50**
10 for 12.50 100 for 110.00

24 VOLT TRANSFORMER; 1.5 Amp; Pri; 115V; 50-60 cyc; Double shielded; Net wt: 1½ lb; #T120.....**1.50 ea.**
10 for 13.00 100 for 100.00



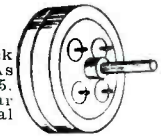


ALLIED D-C RELAYS

Type	D-C Volts	Ohms	Contacts Type†	Amps	Stock No.	Price Each
AN13D33...	24	175	1A	75	R436	2.95
BN18D33...	24	175	6C	15	R868	4.75
BO9D35...	24	230	3C	12	R522	3.00
PO9D34...	24	230	3C	15	R873	3.00
PO11D34...	24	230	3C, 1A	15	R631	4.00
BJ6D36...	24	255	2C	5	R120	1.50
F6D.....	14	100	2A, 1C	1	R870	2.00
BO13D35...	24	230	1C(H)	20	R238	2.25
BO6D35...	24	230	2C	12	R491	2.25
BO15D33...	14	230	1C(H)	20	R480	2.25
BO13D32...	12	70	1A(H)	20	R06	2.00
STKCCCC	24	300	4C	1	R876	2.50
SKC.....	24	300	1C	1	R877	1.00
SKCC.....	24	300	2C	1	R874	1.25
SKA.....	24	300	1A	1	R635	1.00

†A=SPST, normally open; B=SPST, normally closed; C=SPDT; H=double make.

PHASE SHIFT CAPACITORS



W.E. #D150734 S.C. Stock No. 2C6996-1053A/C2. As used in BC1053A, SCR-545, Mark 34 and other Radar equipment. New, in original boxes.
$25.00 each 10 for 225.00

LATEST SUBMINIATURE TYPES

ALLIED 50G MH-12; MIL-R-5757A; 24-29 VDC; 4PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 2.9 oz; Operate time 8 millisec; 1-1/16" dia. × 1-5/16" H; #R1138.....**5.50 ea.**
STRUTHERS DUNN 220XFX100; Same as Allied above but 6PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 3 oz; 1-3/16" dia. × 1-11/16" H; #R1145.....**6.00 ea.**

Write or phone WAlker 5-9642 for your relay requirements. Ask for Mr. Greenberg or Mr. Herzog. We have a large variety of standard types of relays and solenoids for a multiplicity of uses which are not listed for a variety of reasons.

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT.

SEND FOR LATEST CIRCULAR. TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days; All Others Remittance with Order. Orders Under $10.00 Remittance with Order, Plus Approximate Shipping Charges (Overage Will Be Returned).
Cable address: UNIGENCOR, N. Y.

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

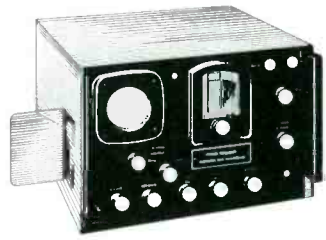
Universal general corp.

MICROWAVE TEST EQUIPMENT

NEW TUBES

Standard brands. First grade only.
No pull outs. No rejects.
No rebrands. At lowest prices.

Type	Price	Type	Price	Type	Price
OA2	$1.00	4J33	150.00	714AY	36.00
OA3	1.10	4J34	100.00	715A	4.50
OB2	.99	4J35	150.00	715B	9.00
OB3	1.10	4J36	150.00	715C	15.00
OC3	.96	4J37	150.00	717A	1.50
OD3	.89	4J38	150.00	719A	15.00
C1B	2.95	4J39	150.00	720AY/GY	50.00
1B22	1.50	4J40	150.00	721A	1.50
1B23	6.95	4J41	150.00	721B	7.50
1B24	9.00	4J42	190.00	723A/B	18.00
1B26	1.75	4J51	190.00	724A	1.95
1B27	15.00	4J52	225.00	724B	2.25
1B38	35.00	4J53	225.00	725A	18.00
1B50	23.00	5BP1	3.95	726A	10.00
1B51	7.50	5BP2A	12.00	726B	45.00
1B56	35.00	5BP4	3.95	726C	45.00
1B60	35.00	5CP1	7.50	730A	22.50
1N21	.55	5CP7	9.95	750TL	45.00
1N21A	.95	5CP7A	18.00	801A	.90
1N21B	1.50	5CP12	15.00	802	3.95
1N21C	12.50	5D21	10.00	803	5.95
1N22	.66	5JP1	27.50	805	6.95
1N23	.90	5JP2	19.50	807	1.25
1N23A	.90	5JP4	27.50	808	1.95
1N23B	1.50	5J23	25.00	809	2.95
1N23C	7.50	5LP11A	25.00	810	10.50
1N25	4.50	5SP7	96.00	811A	3.75
1N26	6.75	C6A	11.00	812A	3.95
1N27	3.50	C6J	7.50	813	13.75
1N34A	.79	7BP7	5.00	814	3.75
1N38	1.00	7DP4	9.00	815	3.25
1N43	2.25	12AP4	50.00	816	1.45
1P25	75.00	12DP7A	45.00	829	11.00
2C39A	13.50	LM15	200.00	829A	12.00
2C40	12.00	15E	1.75	829B	12.50
2C43	14.50	15R	.75	830B	2.00
2C44	.60	NE16	.59	832A	9.95
2C46	7.50	20A	.75	833A	40.00
2D29	.99	KY21A	8.25	834	7.50
2IA	12.00	RK21	2.50	836	3.95
2J22	9.00	RX21	8.00	837	2.75
2J26	15.00	KH24G	1.95	838	5.95
2J27	15.00	25T	2.95	849	35.00
2J31	24.00	35T	4.95	857B	150.00
2J32	29.00	35TG	5.95	860	3.50
2J33	32.00	RK39	2.75	861	25.00
2T34	36.00	HF5	1.75	866A	1.50
2J36	90.00	HK54	4.50	869B	67.50
2J38	8.95	RK72	1.00	869BX	50.00
2J39	8.59	RK73	1.00	872A	3.50
2J40	29.00	FG95	19.95	874	2.25
2J42	135.00	100TH	7.95	878	1.50
2J49	60.00	FG105	20.00	879	.50
2J50	55.00	122A	1.75	884	1.50
2J55	150.00	203A	7.50	885	1.50
2J56	110.00	211	.95	902P1	6.75
2J61	20.00	217C	12.00	931A	5.00
2J61A	25.00	242C	10.90	954	.35
2J62	15.00	244C	9.50	955	.50
2K22	29.00	249C	4.25	956	.75
2K23	15.00	250TH	19.95	957	.25
2K25	19.50	250TL	19.95	958A	.60
2K26	68.00	252A	3.00	959	2.25
2K28	35.00	275B	1.00	E1148	.25
2K29	35.00	304TH	10.00	1280	.95
2K33A	75.00	304TL	12.50	1500T	135.00
2K39	140.00	307A	2.50	HK1554	75.00
2K41	135.00	310A	4.50	1603	5.00
2K42	180.00	310B	6.75	1612	1.50
2K43	199.00	311A	6.50	1613	1.25
2K44	195.00	312A	3.50	1616	1.25
2K45	80.00	323A	15.00	1619	.45
2K48	95.00	327A	3.75	1622	1.50
2K50	295.00	325A	6.75	1624	1.75
2K54	35.00	350A	4.50	1625	.35
2K55	25.00	350B	5.95	1626	.25
2K56	72.00	HK354C	15.00	1654	2.75
3AP1A	10.00	357A	15.00	1851	1.80
3BP1	7.20	368AS	4.95	2000T	150.00
3B24	5.50	371B	1.50	2050	1.80
3B25	5.50	385A	4.50	2051	1.00
3B26	5.00	388A	1.80	VARIOUS 5000 AND 6000 SERIES OF NEW PRODUCTION	
3B28	8.00	393A	7.50		
EL3C	5.50	394A	3.95		
3C22	75.00	MX408U	.50		
3C24	1.75	417A	15.00		
3C31	2.95	434A	15.00		
3DP1	7.50	446A	1.95	5820	475.00
3DP1A	10.00	446B	3.95	5826	450.00
3DP1A-52	10.00	450TL	45.00	8012	2.00
3EP1	5.00	450TH	52.50	8012A	2.50
3E29	15.50	464A	7.50	8013	3.00
3GP1	5.00	471A	1.25	8013A	3.50
3J21	75.00	527	24.00	8019	1.75
4B26	5.40	WL530	23.00	8020	1.85
4C27	10.00	WL531	22.50	8025	3.97
4C28	35.00	WL533	15.00	PD8365	96.00
4E27	16.00	HK654	35.00	9001	1.52
4J25	50.00	700A/D	10.00	9002	.90
4J26	50.00	701A	4.50	9003	1.25
4J27	50.00	703A	3.95	9004	.35
4J28	50.00	704A	1.95	9005	2.75
4J29	50.00	705A	2.75	9006	.25
4J30	30.00	706AY/FY	25.00	THOUSANDS OF OTHER TUBES	
4J31	150.00	707A	5.57		
4J32	150.00	707B	6.57		



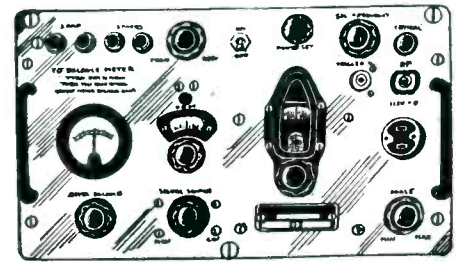
NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

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.

NEW UNUSED SURPLUS TS 259 K BAND
23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW
TS-147 B/UP TEST SET
TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR
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.

SPECIAL! 5,000 V. POWER SUPPLY
For IP25 Infrared Image Convertor from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube **$990**

Other test equipment
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TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western Electric Synchroscope
T35/AP X Band Signal Generator
TS36 AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS174/AP Signal Generator
TS175/AP Signal Generator
TS182
TS226 Power Meter
TS239A-TS239C Synchroscope
TS251 TS258 TS418
TS270 S Band Echo Box
TS323 Frequency Meter
TF890/1 X Band Spectrum Analyzer
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APS 3 and APS 4 Radar
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APR5A Microwave Receiver
APT2-APT5 Radar Jamming Transmitter

Special! TS45 X BAND GENERATOR—$99.00

MINIMUM ORDER 25 Dollars

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Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
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Quartz Crystal Comparators.
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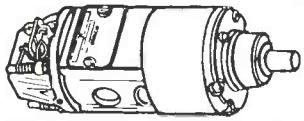

#5071895 ¼ SHAFT or 11/16 GEAR.... $17.50
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Two Types of Clamps to hold motor: $1.50 ea.

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FILAMENT TRANSFORMER 6v—1½ amps Weighs—1 lb. 97¢

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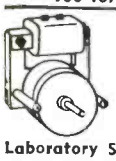

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4 RPM on 50cy or 4¾ RPM on 60 cy. $2.85	3.6 RPM. 3.15
2 RPM ..$2.90	1 RPM .. 3.95
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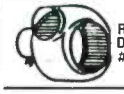
	1 R.P.12Hr3.25
	60 RPM.. 4.85

Laboratory Special 1 of Each Motor $25.

BLOWERS 115 Volts A.C. 60 cy.



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6 Watt Most POWERFUL TELECHRON MOTOR 110V 60 CY
1 RPM 6.50
6 RPM (Revers.) 10.00

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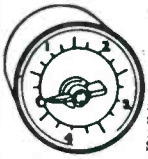

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Also available in 15 min., or 30 min. or 1 hr. at....$6.50

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110v 60 cycle 30 RPM		$2.60
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MIT type TS155 Signal Gen. 2C40 lighthouse cavity 2700-2900mc. wg below cutoff atten., thermistor bridge, 115vac reg. pwr. supply, $325.00.
2400 MC plumbing. All types. WRITE.
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OBU-3 NEAR NEW **24.95**

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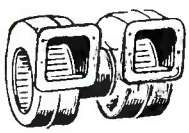

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AN/URM-64
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OS-8/U

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SG-25/U
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TFX-13GA
TPS-51PB/10
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TS-47/APR
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TS-51/APG-4
TS-53/AP
TS-56/AP
TS-59/APN
TS-61/AP
TS-62/AP
TS-69/AP
TS-74/UPM

TS-76/APM-3
TS-89/AP
TS-90/AP
TS-91/TPS-1
TS-92/AP
TS-96/TPS
TS-98/AP
TS-100/AP
TS-101/AP
TS-102/AP
TS-103/TPM
TS-108/AP
TS-110/AP
TS-111/CP
TS-114/APS
TS-117/AP
TS-120/UP
TS-125/AP
TS-126/AP
TS-127/UP
TS-131/AP
TS-143/CPM
TS-146/AP
TS-147/AP
TS-148/UP
TS-153/AP
TS-155C/UP
TS-159/TPX
TS-164/AR
TS-165/TPM
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TS-173/UR
TS-174/U
TS-175C/U
TS-182/UP
TS-184/AP

TS-186/UP
TS-189/AP
TS-203/AP
TS-211/UPM
TS-222/MPM
TS-226/AP
TS-238/GP
TS-239C/U
TS-250/U
TS-251/UP
TS-268/U
TS-270B/UP
TS-278/AP
TS-285/GP
TS-294/U
TS-297/U
TS-305/AP
TS-306/U
TS-309/AP
TS-328A/U
TS-329/UP
TS-330/TSM
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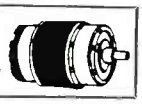

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