

**INDEX**

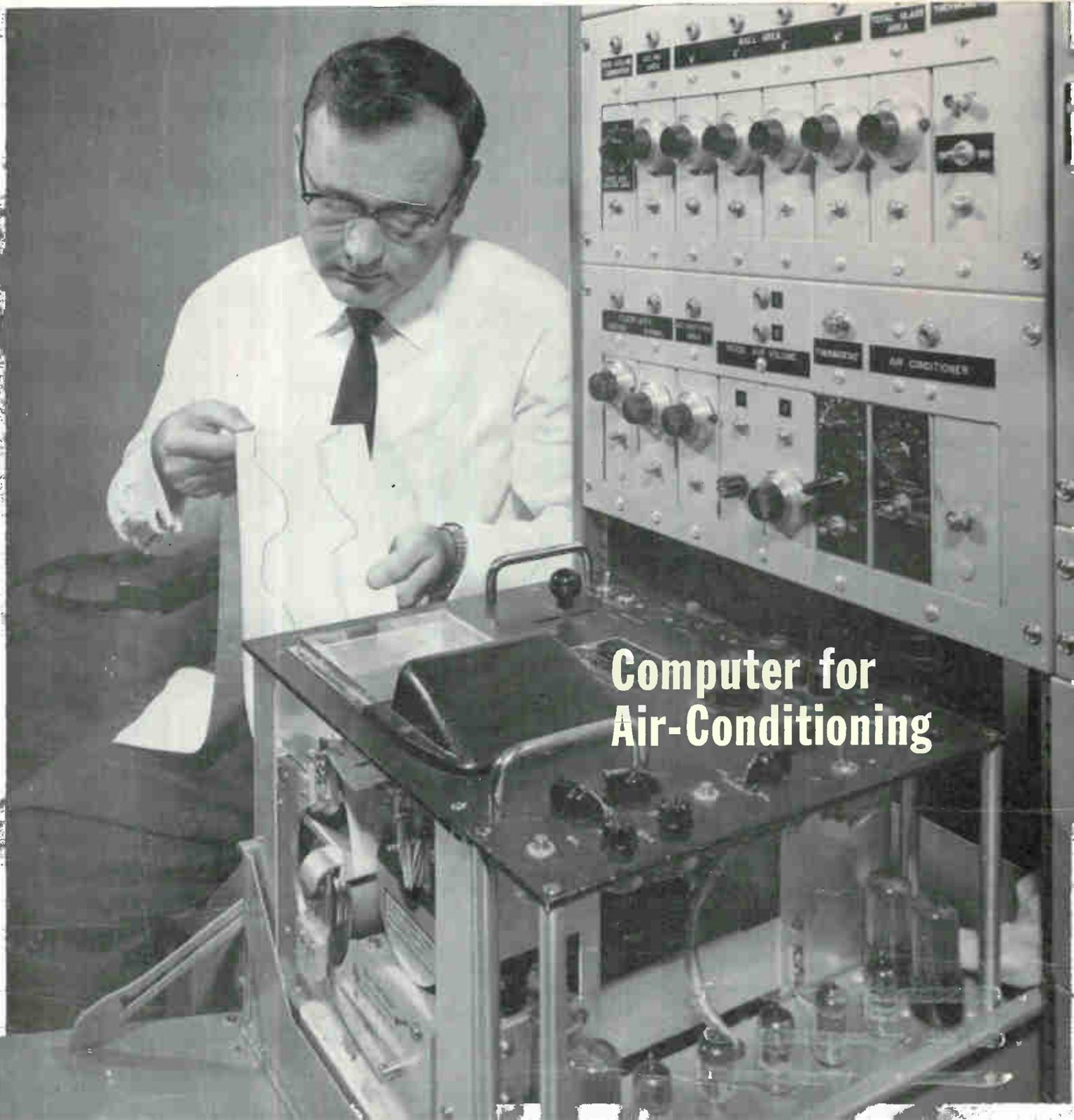
**to Articles for 1959**

# electronics

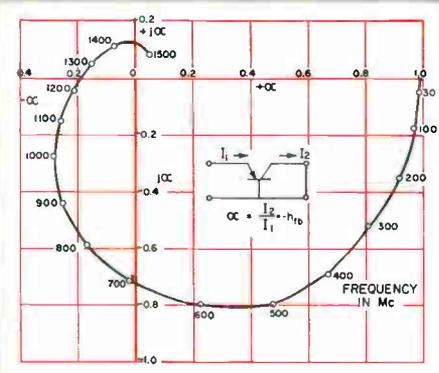
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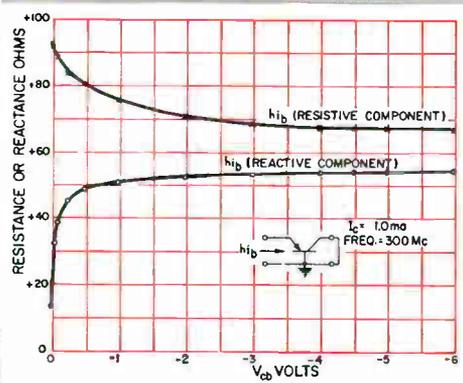
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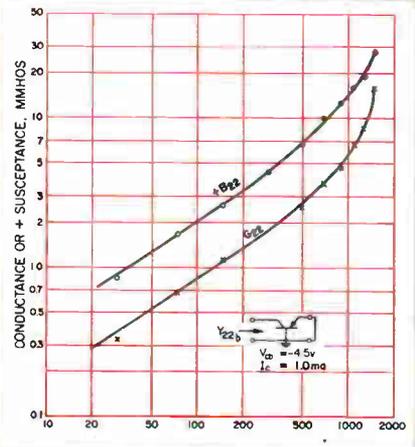
**Computer for  
Air-Conditioning**



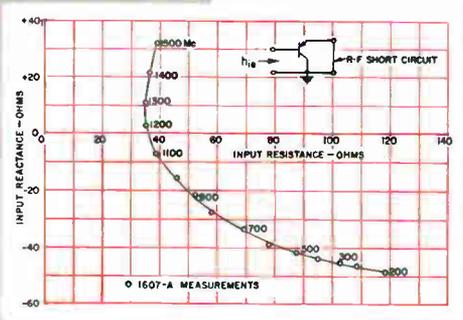
Plot of  $\alpha$ , or  $-h_{fb}$ , versus frequency.



Variation of transistor parameters as a function of collector voltage.

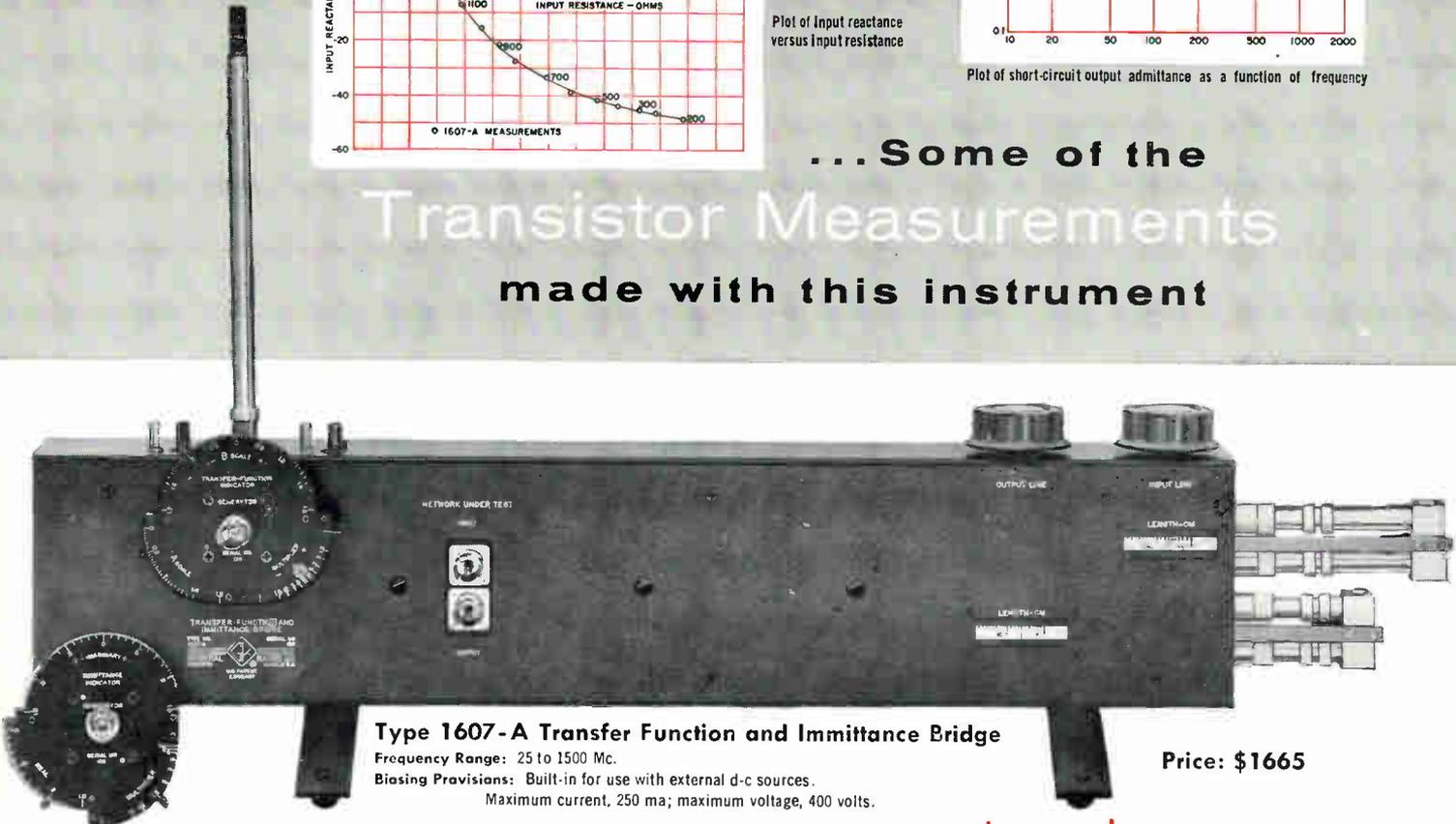


Plot of short-circuit output admittance as a function of frequency



Plot of input reactance versus input resistance

... Some of the  
Transistor Measurements  
made with this instrument



**Type 1607-A Transfer Function and Impedance Bridge**

Frequency Range: 25 to 1500 Mc.  
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Transadmittance ( $Y_{21}$ )	0-600 mmhos	$2.5(1 + \sqrt{\frac{Y_{21}}{20}})\% + 0.5$ mmhos
Impedance ( $Z_{11}$ )	0-1000 ohms	$2.0(1 + \sqrt{\frac{Z_{11}}{50}})\% + 1.0$ ohm
Admittance ( $Y_{11}$ )	0-400 mmhos	$2.0(1 + \sqrt{\frac{Y_{11}}{20}})\% + 0.4$ mmhos

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Vol. 32 No. 52

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## Issue at a Glance

### Business

More Military Business Spanning Canadian Border. New roundup...	18
Electronic Toy Sales Rise. Realism is the key this Christmas.....	20
Libyan Network Expands. To date some \$8 million has been spent..	23
Leasing Market Continues Gain. Our share is \$45-\$50 million.....	24
New Research Grants Made. What's doing in academic circles.....	27
Shoptalk .....	4
Electronics Newsletter.....	7
Washington Outlook.....	8
Financial Roundup.....	11
25 Most Active Stocks.....	11
Market Research.....	14
Current Figures.....	14
Meetings Ahead.....	28

### Engineering

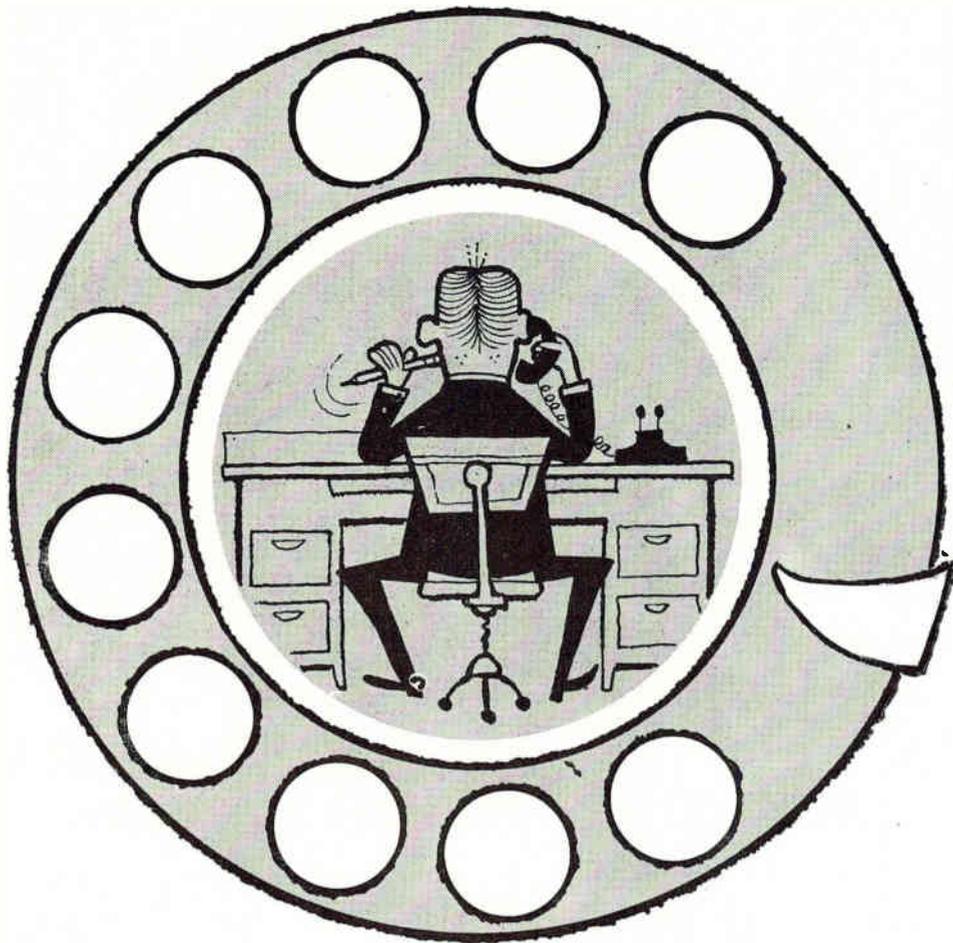
The answer to home air-conditioning is recorded on tape coming from an electronic computer that analyzes over 50 factors affecting the cooling needs of a home. See p 34.....	COVER
Latest Trends in Electron Devices. Improved display elements; low-noise units featured.....	By M. F. Wolff 31
How Analog Networks Solve Air-Conditioning Problems. Computer determines loads.....	By W. L. Wright and C. A. Booker 34
Selecting Transistors for Radiation Environments. Charts give variation of transistor parameters....	By J. R. Bilinski and R. Merrill 38
Recording Manometer. Bridge determines fluid pressure..	By W. E. Gilson and H. Ludwig 41
R-F Cables and Connectors for Military Applications. Cross-index of new and old cable and connector nomenclature..	By M. Pomerantz 42
How Solar Noise Calibrates Radars. Using sun as test equipment....	By J. A. Kueken 44
Curves Find Value of Chopped Waveforms. Obtaining rms value of wave is simplified.....	By J. S. MacDougall 46

1959 Electronics Index. Separate sections list technical articles, business articles, authors..... 65

### Departments

Research and Development. Computers Aid Propagation Studies....	50
Components and Materials. Insulator Without Weight or Volume?..	54
Production Techniques. Epoxy Resin Makes Potting Molds.....	58
On the Market.....	62
Plants and People.....	100
Comment .....	102
Index to Advertisers.....	106

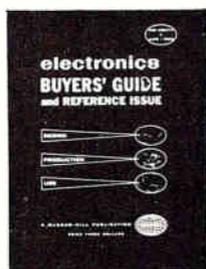
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What's his number?*



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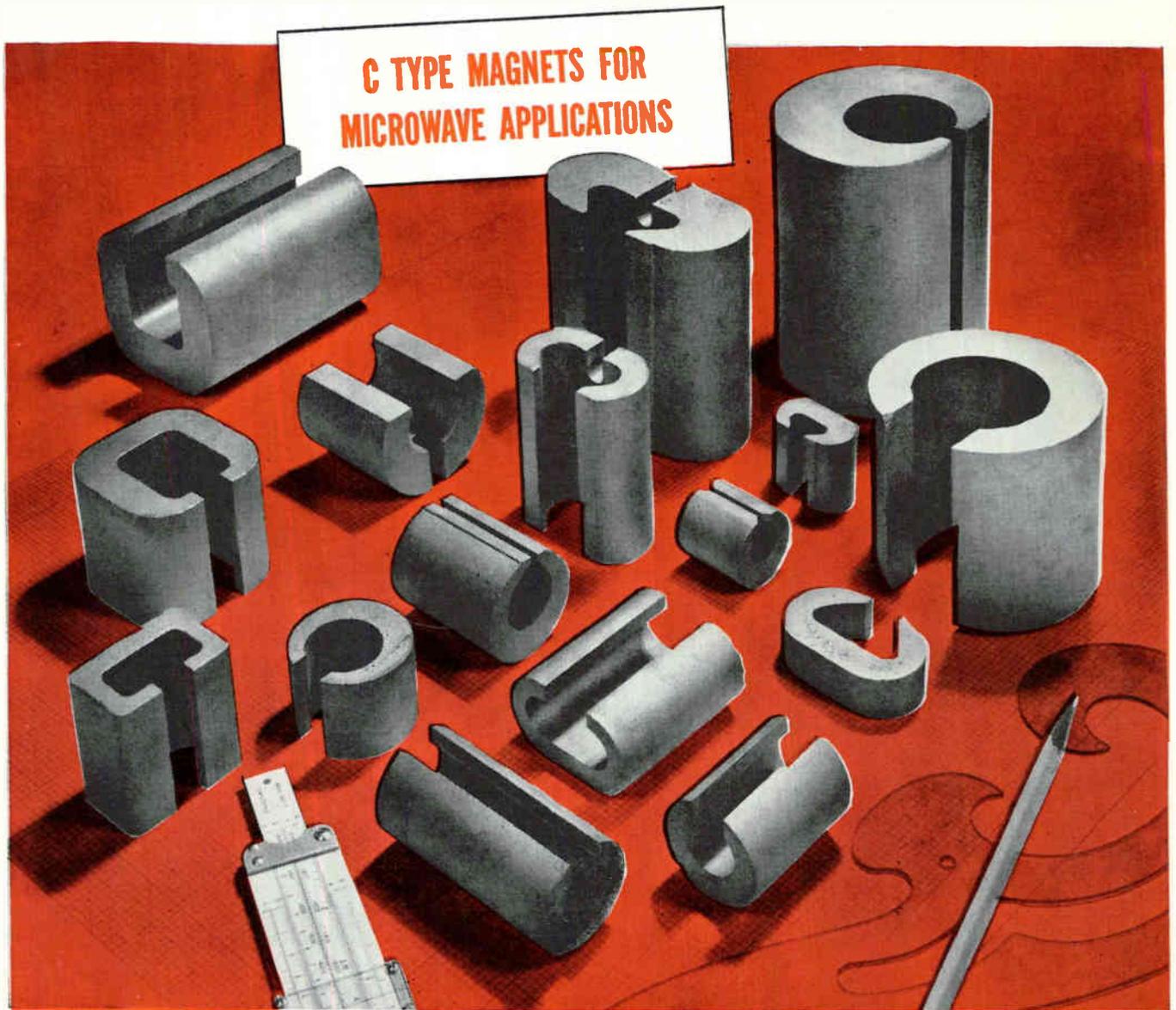
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# SHOPTALK . . . editorial

## electronics

December 25, 1959 Vol. 32, No. 52

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**AND ON EARTH, PEACE.** We have a special report coming up next week which discloses—among many interesting facts—that 58 percent of all electronics business is military. This bangs sharply into our consciousness at the Christmas season.

We live in the computer age, an era that history may say led to the elimination of many onerous mental and physical tasks. The existence of electronic computers can release powerful energies for creative thinking. They represent a bright spot on the horizon, for computers are today employed mostly for peaceful pursuits.

**YET** more than half our industry's business relates to defense, so we are in a sense a munitions industry. The concentration of so much of our energy in this direction keeps us from the enormous potential which electronics possesses for peaceful applications. The whole area of commercial and industrial electronics, for instance, is inadequately explored. Production controls are still largely electromechanical, sometimes out of necessity, but frequently because the concept and design of really sophisticated controls simply hasn't been undertaken.

Further, electronics has many more potential uses in the home, aside from entertainment and communications. These have been discussed before; Sunday supplements have carried features on the subject for years. But the research and engineering have yet to be done.

**MANY** electronics companies continue to fall for the oldest play in the book. They get close to the main chance, smell the big money—and lose integrity. That's why such a large part of our industry is munitions-oriented; it's often easier to pick up a government contract than to develop and engineer an exceptional industrial or consumer product and then merchandise it effectively.

What we need to do is restore the balance. Not by surrendering defense business—that would be bad counsel. But while fulfilling national requirements we should also be opening up more untapped commercial-industrial applications and non-entertainment home uses of electronics. This is ultimately where stability lies; it is in these fields that we should be expending a greater share of our energies and creative imaginations.

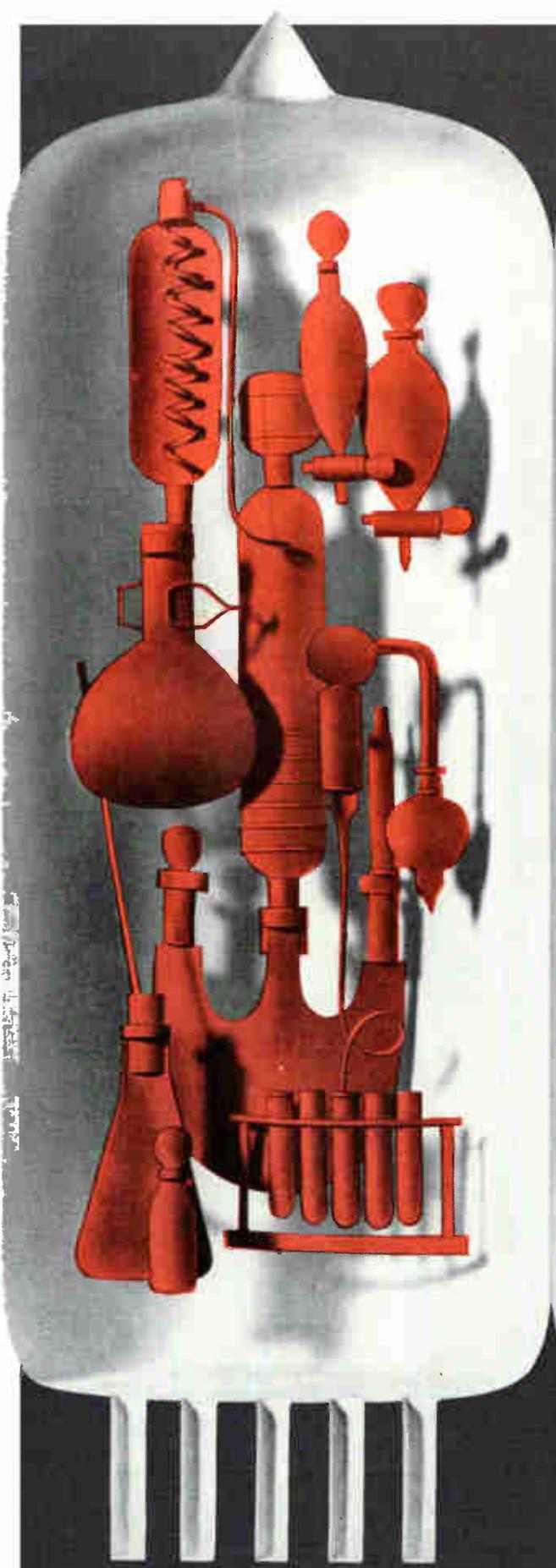
At a season dedicated to peace, we take little comfort in contemplating the fact that more than half our industry is dedicated to war. To redress the balance will require the best efforts of all the fine minds and spirits in the industry.

### Coming In Our January 1 Issue . . .

**OUR MARKET FOR 1960.** Record sales characterized the electronics industry in 1959. Furthermore, sales are headed for a new high in 1960—with all major segments of our industry expected to participate in the growth. That's the forecast made in next week's special report on our market for 1960.

To bring you this year-end statistical summary and forecast, three members of ELECTRONICS' staff have spent months interviewing marketing directors, sales managers, distributors, government and foreign trade experts, as well as studying reams of statistics and trade reports. In this detailed report by Market Research Editor De Jongh and Associate Editors Janis and Emma you'll read about the sales outlook for the military, consumer, industrial, replacement parts and components segments of our industry.

The report also digs into buying and selling in overseas markets. Another section describes new sales and distribution techniques. A section on manpower availability and a six-page foldout with sales charts and tables round out this informative report.



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RCA tubes utilizing N-132 cathode material can add a greater element of reliability to your circuits. Get the complete story from your RCA Field Office.



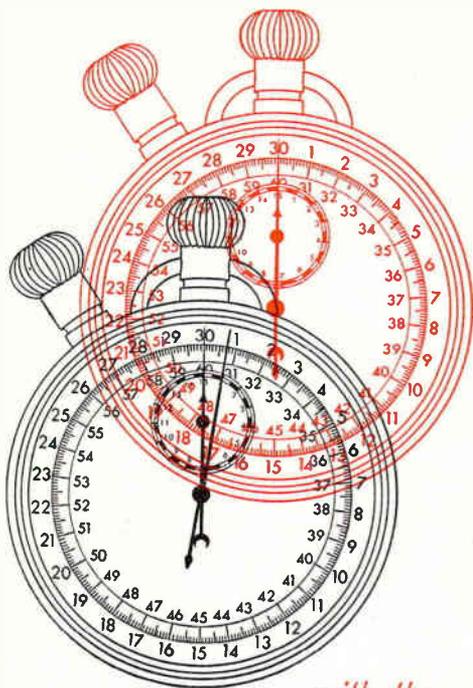
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*Less than 100  $\mu$ v ripple*



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## **ELECTRONICS NEWSLETTER**

**MAGNETIC-CORE MEMORY** providing high-speed linear word selection, with magnetic solid-state switches used for control over word input, is announced by Telemeter Magnetics, Los Angeles. The company expects to offer commercial units to computermakers by next March. Each unit can hold up to 32,000 words of up to 56 bits each in its eight modules of 4,096 cells each. The device, designated type LQ linear memory, will be used in a line of U.S.-made low-cost medium and large computers. Transistor drivers will be used in a special parallel circuit. The firm says there is no limit to the number of units that can be put together, adds that 112-bit double-length words are feasible. Device permits speed of 667,000 additions per second.

*Sales of the electronics industry in 1960 will increase at a rate twice the average for industry as a whole, predicts Paul B. Wishart, president of Minneapolis-Honeywell Regulator Co. Deducting government-sponsored programs, he said, the electrical-electronics industry has spent \$3.8 billion on R&D in 1959, more than the total for all other industries.*

**JAPANESE RADIO EXPORTS** to the U.S. for the month of October amounted to \$10 million, according to figures just announced by the Japan Electronics Industry Association. Breakdown includes 665,309 transistor radios, 195,623 other sets. Total Japanese radio set production in October reached an all-time high of 1,179,859 sets, of which 983,766 were transistor radios. Total number of sets was 120,000 above September output. Record 282,152 tv sets was also produced; none were exported to the U.S.

*Transistorized autopilot developed by Chance Vought is disclosed to be part of the equipment of the Navy's new all-weather F8U-2N jet fighter, for which Chance Vought's aeronautics division just received a \$58-million contract for additional production. Production orders now total about \$100 million for the craft, which is scheduled to make its first flight early in 1960.*

**COMMITTEE ON SPACE RESEARCH (COSPAR)** has been given permanent status with the approval of its new charter by the eight members of the Bureau of the International Council of Scientific Unions (ICSU). Membership is open to national scientific institutions adhering to ICSU that are actively engaged in space research. Following elections and organizational meetings, the First International Space Science Symposium will be held in Nice, France, from January 11 to 15. Participation of U.S. scientists is being coordinated through the Space Science Board of the National Academy of Sciences.

**GLOBAL LOGISTICS** of Army Transportation

Materiel Command, which has a \$780-million inventory and round-the-world supply distribution responsibilities, will be speeded by an IBM 705 III that communicates by wire and radio with installations on five continents. In St. Louis the computer converts requests into shipping orders which are sent to appropriate supply depots, gets orders on the road in under 72 hours compared to previous cycle of 15 days.

*Improved image orthicon tube which eliminates image retention and has a guaranteed operating life of 1,000 hours is reported by Westinghouse. Company says the tube is in production, will sell for "20 percent more than present types which cost about \$1,200."*

**ORBITING SOLAR OBSERVATORY** to be launched by NASA with a Delta vehicle will carry instrumentation provided by Ball Brothers Research Corp. under a \$250,000 contract just announced. The space agency said the contract represents initial funding for the satellite, whose total contract cost may reach \$750,000. NASA also announced initial funding of \$150,000 to Army Ordnance Missile Command for design, construction and integration of a Juno II-launched satellite to study the energy and source of gamma rays. Total of this contract may run to \$800,000. AOMC received initial funding of \$150,000 for another Juno II-launched satellite to sample the ionosphere. Cost of this may reach \$750,000. National Bureau of Standards received a \$130,000 NASA contract for ground experiments with radio signals to determine properties of the ionosphere.

*Vega multi-state rocket vehicle development is being discontinued, the National Aeronautics and Space Administration announces. NASA says the action was taken to reduce the number of vehicles for space programs, explained that other vehicles could accomplish the satellite and space probe projects for which Vega had been planned.*

**MULTIFREQUENCY KEY PULSING** between telephone exchanges over toll and long-distance trunks is possible with new Bell System-compatible equipment developed by General Telephone Laboratories, Northlake, Ill., telephone R & D arm of General Telephone & Electronics. New transistorized gear enables an operator to transmit a pulse by pushing digit buttons. GTL sees special advantages in the pulsing equipment when used in connection with direct distance dialing, which requires a longer numerical address than local telephone calls. Equipment will operate from a regular 48-volt exchange battery, and uses 42 transistors, including 12 power transistors, in its current supply.

You are there — with Cinema...

## Professor CLYDE BEATNIK

(Somewhere way out)



**Q.**—“Hello, Professor, are you working on some new electronic experiment?”

**A.**—“Not me, Daddy, that stuff I don't dig. And I'm no Prof, just call me Clyde.”

**Q.**—“If you're not a Professor, what are you doing with a CINEMA Terminal Board Switch?”

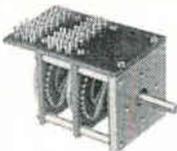
**A.**—“Man, I thought it was one of those crazy small vibraharpes we could use in our jumpin' combo.”

**Q.**—“Oh, are you a musician?”

**A.**—“I'm not Governor Nelson Rockefeller, friend.”

**Q.**—“Do you think everybody should take up music as a hobby?”

**A.**—“Beats me, Dad, but if they do let me know if you hear of a good vibraharp player.”



Maybe it's not a vibraharp, Clyde, but it sure is sweet music to laboratory problems. For

**CINEMA ENGINEERING'S** instrument switches use a time-saving Terminal Board design. Four years of engineering permits the advance planning of modular harness layouts in CINEMA'S CETE and NETE switches. Each terminal is individually identified, thereby saving costly last-minute supervision and eliminating guesswork. They're ideal for moderate and complex switching and wiring applications. Write for our catalog 17S today.

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## WASHINGTON OUTLOOK

**TURMOIL** is boiling up over National Aeronautics & Space Administration's proposed plan for liberalizing its own patent policy.

NASA officials were hoping Congress would allow the agency to adopt a discretionary authority on patents. As the space law stands now, NASA must either take title to any invention developed under its contracts (as the Atomic Energy Commission does) or else waive all rights. It cannot—as the armed services do—take only royalty-free licensing rights and let the title pass.

NASA wants to be able to choose between taking title or limiting itself to licensing rights. Many NASA contractors would prefer making the space agency's policy consistent with the Pentagon's.

Storm center of opposition to the liberalizing movement is Sen. Russell Long (D., La.). In three days of hearings earlier this month, Long's Senate Small Business subcommittee on monopoly practices played up Congressional views for new restrictions on the use of inventions resulting from government contracts. If Long has his way, the Pentagon's policy may be made as restrictive as NASA's or AEC's instead of the other way 'round.

Long's subcommittee will not consider specific legislation. Laws changing NASA policy would originate in the Senate or House Aeronautics & Space Committee, generally regarded as favoring less restrictive policy. But the monopoly practices subcommittee does serve as a loud sounding-board to whip up opposition, and may affect future deliberations of the other committees.

Long's argument—which reflects a sizeable body of Congressional opinion—is that the Pentagon policy “bestows unearned monopolies throughout the country” by allowing contractors to exploit commercially inventions for which the government has paid.

- **The Strategic Industries Association**, a West Coast group of small aircraft and electronics contractors, told the Long subcommittee that restrictions in current federal patent policies, “far from aiding ‘big business’ through their liberality, actually impair our rate of scientific progress . . . through their tight repression on creativity.” Long dismissed SIA's argument, said “they don't speak for my concept of small business.” The Senator also criticized NASA's proposal to liberalize its own policy. He said: “My guess is that the NASA recommendation results from sympathy with the economic interests of its contractors.”

- **Insulation** that will withstand steady temperatures of 1,000 C, and up to 4,000 C for a few seconds, will be required by the military as miniaturization of electronic equipment leads to higher operating temperatures. This was one of the new demanding military requirements discussed at the second annual National Conference on the Application of Electrical Insulation held here recently.

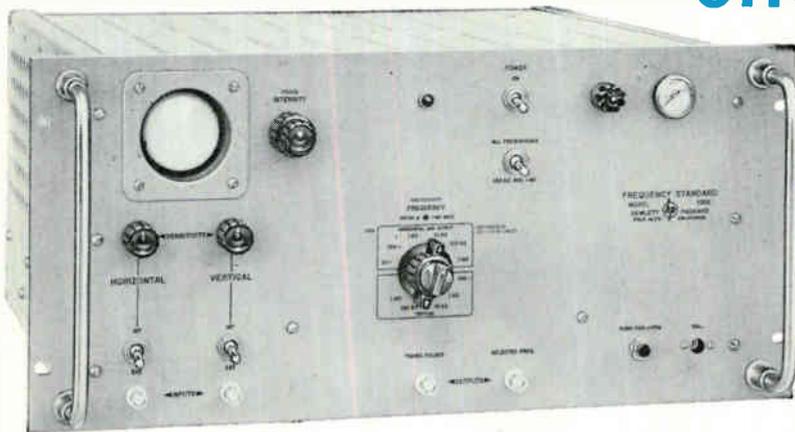
Another requirement involves encapsulation of all electrical equipment used for missiles and rockets—dipping the entire electrical unit in a plastic insulating mixture. When dry, the insulation will absorb shock as well as prevent electrical failure.

Future military requirements will call for: greater insulation resistance to ionizing radiation; greater electrical and mechanical stability of compounds under continued high temperatures; more use of non-flammable plastics; and more ease of application.

- **Here's what was behind Navy's cutback** of ship starts for 1960. Navy officials want to wait for cuts in price and size of shipboard reactors before rushing into nuclear-powered surface vessels. Three atomic surface craft are now on the ways; no new ones are in the 1961 budget.

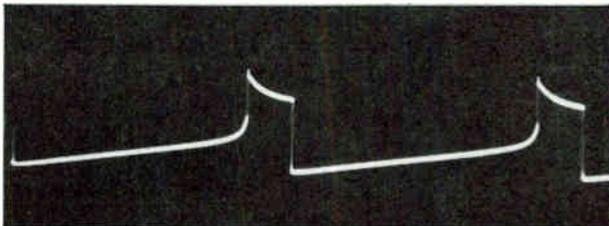
# New, compact PRECISION FREQUENCY STANDARD

offers  $5/10^8$  stability,  
just  $8\frac{3}{4}$ " high

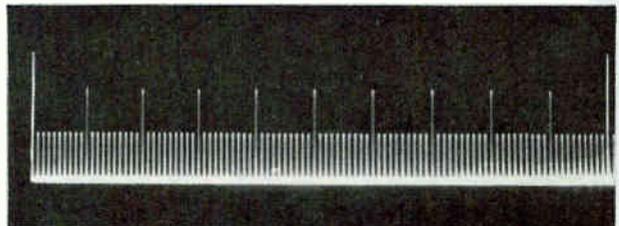


**hp 100ER**

**FREQUENCY STANDARD**



Model 100ER offers six standard sine and four rectangular frequencies in decade steps; available simultaneously and selected on front panel.



Timing comb output pips occur at 100, 1,000 and 10,000 microsecond intervals. Timing comb simplifies "fast" measurements and calibration.

## Specifications

<b>Stability:</b>	$5/10^8$ parts per week, $3/10^8$ short term.
<b>Outputs:</b>	Sinusoidal 10 cps, 100 cps, 1 KC, 10 KC, 100 KC and 1 MC. Rectangular 10 cps, 100 cps, 1 KC and 10 KC.
<b>Output Voltages:</b>	Sinusoidal 5 v rms min.; rectangular approx. 15 v peak. Harmonics to 5 MC obtainable.
<b>Rated Load:</b>	1 MC and 100 KC, 50 ohms nominal; 10 KC, 1 KC, 100 cps, 10 cps, 5000 ohms nominal.
<b>Distortion:</b>	(Sinusoidal) Less than 4%.
<b>Frequency Adjustment:</b>	Screwdriver tune adjusts 1 ppm.
<b>Size:</b>	$8\frac{3}{4}$ " high, 19" wide, 18" deep behind panel. Weight 35 lbs.
<b>Price:</b>	\$900.00.

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

This compact, highly convenient new  $\Phi$  frequency standard not only provides stability equivalent to complex, expensive primary standards, but offers the versatility of a wide variety of outputs. Signals available include six standard sine frequencies and four rectangular signals which may be distributed by 50 ohm cables for use at many different stations on a production line or in the laboratory. A particularly useful feature is a timing comb for calibrating, and for measurement of sweeps and time intervals.

*Stability of 5 parts in one hundred million per week is assured by careful aging and testing of the crystal controlled oscillator and oven.*

Model 100E includes a built-in oscilloscope which may be used as a comparison device to calibrate external equipment such as oscillators through use of Lissajous figures. The scope may also be used to check internal frequency deviation of the instrument.

For complete details and demonstration, see your  $\Phi$  representative or write direct.

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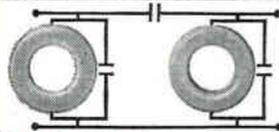
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6039

**hp** now offers 10 different precision oscilloscopes



## ***Smaller filters ease the squeeze!***

Filter designers! First 160-mu moly-permalloy powder cores pack high performance into smaller space

Filter and inductor designers specify our 160-mu moly-permalloy powder cores for low frequency applications. Where space is precious, such as in carrier equipment and telemetering filters, the high permeability of these 160-mu cores eases the squeeze.

In many cases, 160-mu cores offer designers the choice of a smaller core. In others, because inductance is 28 percent higher than that of 125-mu cores, at least 10 percent fewer turns are needed to yield a given inductance.

If Q is the major factor, 160-mu cores permit the use of heavier wire with a resultant decrease in d-c resistance.

Like all of our moly-permalloy powder cores, the 160's come with a *guaranteed* inductance. We can ship eight sizes from stock, with a choice of three finishes—standard enamel, guaranteed 1,000-volt breakdown finish, or high temperature finish. Further information awaits your inquiry. *Magnetics Inc., Dept. E-78, Butler, Pa.*

**MAGNETICS** inc.

# Merger Plans Disclosed

MOTOROLA, INC., plans to acquire the business and assets of the Lear-Cal division of Lear Inc., next month for an undisclosed number of shares of Motorola stock. The stock will be held by Lear for investment purposes.

The division will become a Motorola subsidiary called Motorola Aviation Electronics, Inc. Employing about 400 persons, the division's sales this year were about \$8 million—nine percent of Lear's 1959 volume.

• **Cenco Instruments Corp.**, Chicago, reports a profit increase of 53 percent for the second fiscal quarter ended Oct. 31. Net profits for the period rose to \$436,000 or 42.3 cents a share on 1,013,479 shares outstanding. This compares with \$284,900 or 28.3 cents a share in the same period of 1958. Net sales for 1958's second fiscal quarter were \$4,521,200. This year the figure was \$6,235,800.

• **Ampex Corp.**, Redwood City, Calif., announces record sales and income for the first six months of the current fiscal year. Sales were \$30,002,000, up 86 percent from last year's \$16,147,000 for the same period. Net income rose from \$665,000 to \$1,763,000 for 1958 and 1959 respectively. Earnings per share this year were 80 cents based on shares outstanding (before Ampex merged with Orr Industries). This compares with 36 cents a share for the same period last year. Company backlog is now about \$18 million, up from \$13 million a year ago.

• **Technical Operations, Inc.**, Burlington, Mass., reports sales of \$3,368,000 for the year ended Sept. 30, an increase of 42½ percent over 1958 sales of \$2,363,000. During the year, the company acquired substantially 100 percent control of **Power Sources, Inc.**, and **Chemtrol Corp.** and, in connection with these acquisitions, wrote down its investment in them to underlying book value. The special charges in connection with these transactions

resulted in a small loss for the year.

• **Collins Radio Co.** stock is now on the New York Stock Exchange. Company officials say they are headed for the best year in the Cedar Rapids, Iowa, firm's 26-year history. For the first fiscal quarter ended Oct. 31, sales were more than \$39 million, and earnings topped \$1½ million or 80 cents a share. In all of fiscal 1959, the company earned \$1.95 a share on sales of \$118 million. A backlog of \$210 million is now on the company books.

• **Topp Industries, Phoenix**, and **United Industrial Corp., Detroit**, have approved merger plans. The final papers will be signed next week. New entity will be named after UIC.

## 25 MOST ACTIVE STOCKS

	WEEK ENDING DECEMBER 11			
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	3,052	16½	14¾	16½
Elec & Mus Ind	2,597	12¾	11¾	12¼
Sperry Rand	2,552	27½	25½	25¾
Reeves Sndcrt	1,202	13½	12	12¾
Philco Corp	912	37½	29¼	30¾
Collins Radio	876	56¾	47½	55½
Lear Inc	843	22¾	19¾	20½
Gen Electric	798	97¾	91½	93½
Univ Control	782	20¼	18½	19½
Int'l Resistance	683	20¾	17¾	18½
RCA	679	72¼	70¼	71¼
Muntz TV	664	4¾	3¾	4½
Amer Bosch Arma	635	31½	27½	30½
Gen Tel & Elec	623	81¾	77½	81
Standard Coil	622	18¾	16½	16½
Int'l Tel & Tel	609	41¾	39½	40
Clevite	586	53¾	44¾	53½
Gen Transistor	506	32¾	29½	31½
Varian Assoc	445	48	44	45½
Raytheon	418	57¾	53½	53½
Gen Dynamics	415	50¾	47¾	47½
Burroughs	389	37½	35½	35¾
Emerson	353	19¾	17½	19
Westghse Elec	351	110	105	107½
Siegler Corp	317	36¾	33¾	33¾

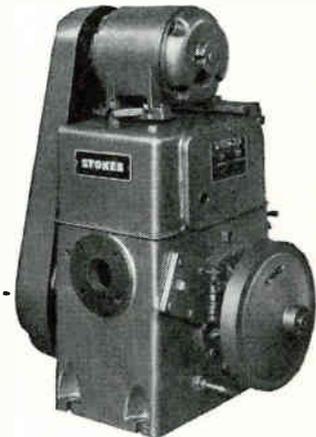
The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

## NEW ISSUES PLANNED

	No. of Shares	Price per Share
Fairchild Camera	39,802	\$ 0
Lafayette Radio	275,000	5.00
N. Atlntc Indstrs	70,625	4.00
Teleprompter	125,000	1.00

\*to be announced

# need high vacuum components?



Stokes Series H Microvacs were designed by vacuum specialists . . . are industry engineered to meet your needs . . . give you more pumping capacity per dollar. The integral construction includes dynamic balancing, valves, motor, belt guard, and automatic lubrication—there are no extras to buy. A complete line of Microvacs include capacities from 17 to 500 cfm. For fast, efficient pump-down—you can depend on Stokes Microvac Series H Pumps.

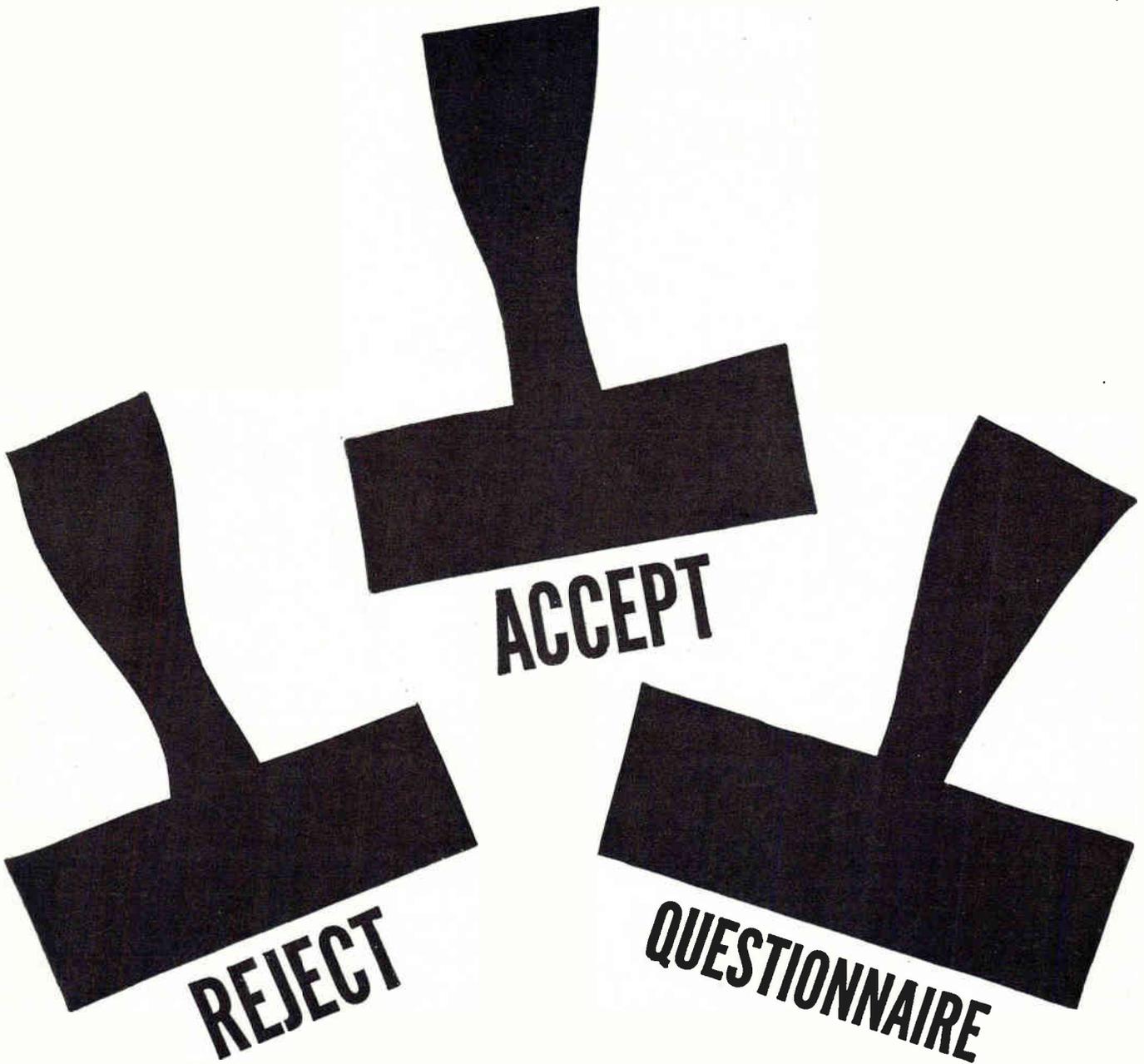
STOKES makes a complete line of vacuum components . . . advance-designed and engineered to help make your vacuum systems more productive. Each unit reflects Stokes' unparalleled experience, pioneering leadership and wealth of basic vacuum technology.

The product list includes: Diffusion Pumps, Vapor Booster Pumps, Mechanical Pumps, Mechanical Booster Pumps, Vacuum Gages, and Valves.

Send for technical data on any or all . . . without obligation.

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**REJECTED** — whenever the order indicates that the in-

dividual is NOT within the editorial field of the publication.

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# New "METALLIZED" MYLAR Subminiatures

## PROBLEM-SOLVING CAPACITORS for High density packaging



**SPACE SAVING.** Significant size reduction over film-foil and paper-foil designs can save vital space. The net volume saved increases with capacity value.

**WEIGHT SAVING.** The quantity of metal required for plates in these metallized Mylar\* designs is less than 5% of that for an equivalent foil design. Weight saving increases rapidly as capacity value increases.

**"EDGE MOUNTING"** Because its cross-section is rectangular, Type X663F permits mounting with either the side or edge in contact with the chassis. Type X663FR is designed for edge mounting only.

**SUPERIOR IR** Insulation resistance of these rugged Mylar dielectric types far exceeds the IR obtainable from paper designs (See curve below for actual performance.) \* DuPont's trademark for polyester film.



**X663F**  
AXIAL LEADS



**X663FR**  
RADIAL LEADS

- ① TOUGH MYLAR CASE
- ② EPOXY END SEAL

**INSULATION RESISTANCE.** Greater than 30,000 megohm-microfarads at 25°C, but need not exceed 30,000 megohms.

**DISSIPATION FACTOR.** Less than 1% when measured at or referred to 1000 CPS — temperature of 25°C.

**VOLTAGE RANGE.** Available in 100, 200, 400 and 600 VDC

**ACCELERATED LIFE TEST.** 250 hours at +100°C and 125% of rated voltage

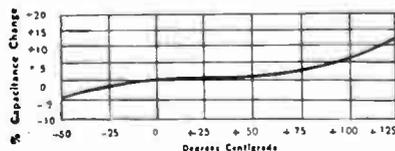
**CAPACITANCE TOLERANCES.** Standard tolerance ±20%; also available in ±10%, and ±5%

**TEMPERATURE RANGE.** Full rated voltage from -55°C to +100°C, to +125°C with 50% derating

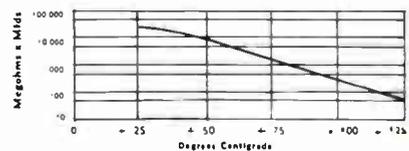
### TYPICAL SIZES-SHOWING THICKNESS • WIDTH • LENGTH

CAP IN MFDS	100 VOLTS			200 VOLTS			CAP IN MFDS	100 VOLTS			200 VOLTS		
	T	W	L	T	W	L		T	W	L	T	W	L
.01	156	203	3/16	125	187	3/16	1.00	421	593	1 1/2	453	687	1 1/2
.1	250	359	3/8	250	359	3/8	2.00	406	718	1 3/4	453	734	1 3/4
.33	296	484	3/8	328	500	3/8	3.00	453	765	1 3/4	546	903	1 3/4
.47	359	546	3/8	343	625	3/8	4.00	500	890	1 1/2	656	1015	1 3/4
.68	343	515	3/8	421	750	3/8	5.00	484	843	1 3/4	625	1250	1 3/4

Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



Write for literature on these NEW, "space-saving" types



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A LEADING MANUFACTURER OF TUBULAR, CERAMIC DISC AND ELECTROLYTIC CAPACITORS

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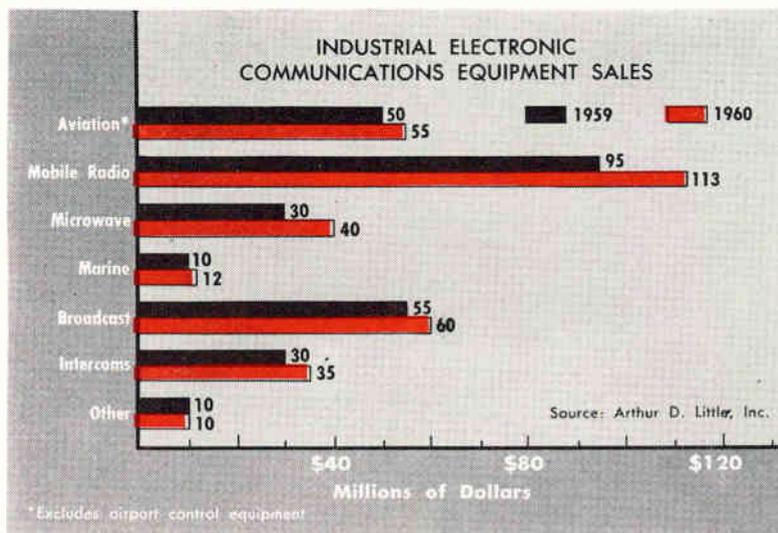
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One of a series of advertisements prepared by the ASSOCIATED BUSINESS PUBLICATIONS

## MARKET RESEARCH



## Communications Sales to Rise

COMMUNICATIONS EQUIPMENT is one of the most promising areas of industrial and commercial electronics, claims John Thompson, industrial specialist with Arthur D. Little, management and engineering consultants.

Thompson estimates total sales for seven communications-equipment product groups shown in the chart at \$280 million for 1959 and forecasts a 16 percent sales gain will bring the total to \$325 million for 1960.

### Phenomenal Growth

The consistent gains in communications equipment sales are exemplified by the phenomenal growth of mobile radio service, Thompson points out. In 1947, there were only 36,000 mobile radio transmitters authorized by FCC. By the end of 1958, there were about 700,000 authorized. Mobile radios serve in many fields of commerce, industry and government activity.

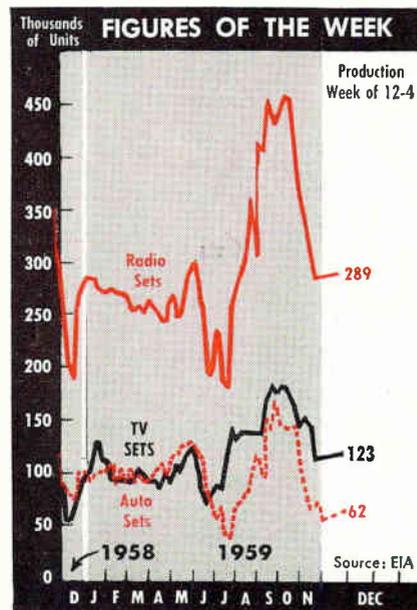
Commercial and private aircraft communications equipment sales are expected to increase in the next five years.

The expected liberalization by the FCC of point-to-point microwave authorizations for industry is expected to result in a wave of installations by industry to serve the pent-up demand for data handling and communications facilities between banks and their branches, between warehouses and branch

stores, and other industrial and commercial facilities, Thompson says.

More extensive employment of intercommunication systems in offices and factories for rapid communications supports expectations of a 17-percent increase in sales of intercoms between 1959 and 1960.

• **Motorola** sees rising market for f-m car radios over the next two years. Firm is currently making marketing plans for its new f-m car radio. It estimates that between 50,000 and 100,000 f-m radios, mostly European, are now installed in U. S. autos.

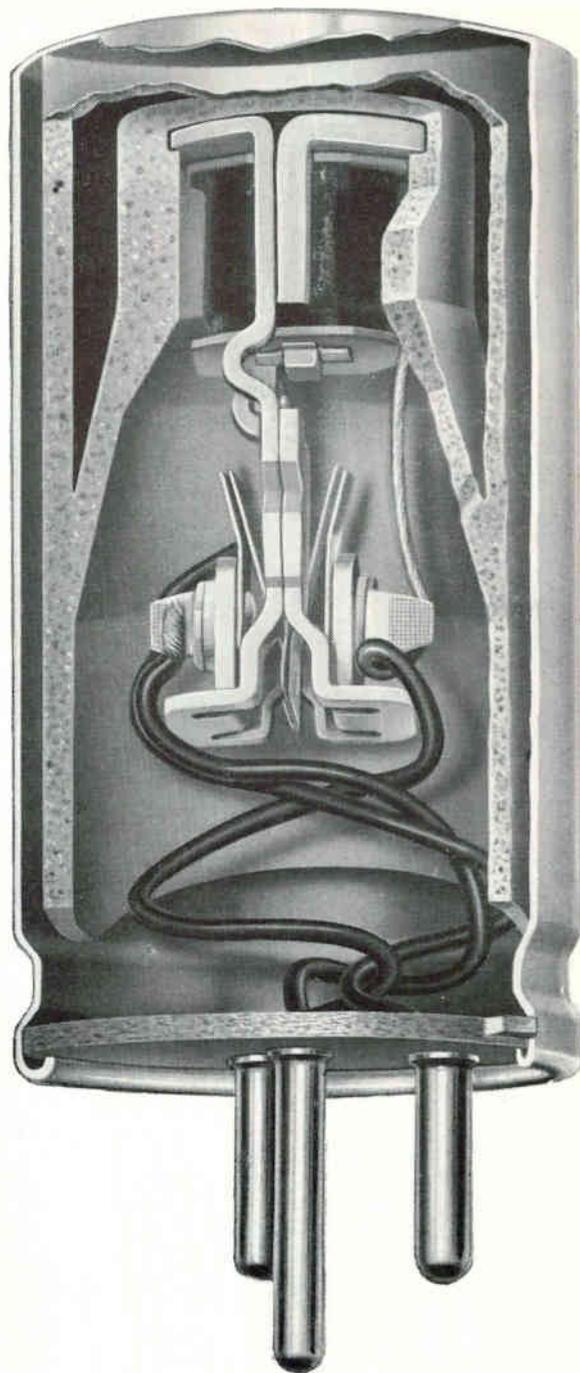


**Build extra value  
into  
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with Mallory vibrators**

Mobile, two-way Citizens Band radios bring new simplicity and convenience to communication for thousands, and open brand new markets for you.

If you're now building Citizens Band radios or planning to, Mallory vibrators deserve a place in your power supply design. Their exceptionally long life, quiet operation and constant output are the result of more than 25 years of Mallory pioneering in vibrator design. More Mallory vibrators have been used in mobile radios than all other makes combined. Mallory engineers have helped develop efficient, economical power supply circuits for many set manufacturers.

Make use of this experience. Let Mallory help you choose and apply the vibrator model that best fits your needs, as well as assist in the design of your power supply circuitry. Write today for a get-together with a Mallory vibrator specialist.



*Series 1600 Vibrator*

Contact buttons have been eliminated for far greater contact area . . . lower rate of erosion . . . steadier voltage . . . and an end to contact sticking. Light mechanical mass of vibrating reed assures quiet operation.

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An 18-page Special Report on Electronic Markets will appear in the January 1st issue. An important feature of this report will be an 11 x 23 inch full-

color fold-out chart of the market statistics for the electronic industry. The report will also include the latest figures on electronics manpower, exports and imports of electronics equipment and components, and channels of distribution for electronics products.

To cover actual reprinting cost, handling charges, postage, etc. for this Special Report the following prices will be charged: 75 cents for single reprint copies; 60 cents each for quantities of 10; 50 cents each for 25 or more.



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## WHAT'S NEW IN COMPONENTS?

What *useable* discoveries are being made on the frontiers of electronic knowledge? Here are a few selected at random: directive long-range sonar transducer . . . high-speed ferrite memory and logic element . . . space-probe telemetry system . . . master preamplifier for X-band radar. You can never tell when one is going *your* way. This is just ONE of the reasons why you should subscribe to **electronics** (or renew your subscription).

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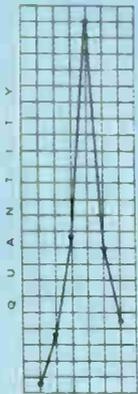
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## by *cppc*



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The SG-17- and ST-17- type pancake synchros (SG-18- and ST-18- with housings) are our most standard line for gyro pick-off applications.

These units have been manufactured in large quantity and are readily available for prototype breadboarding. The high accuracies shown on the left are obtainable in standard 26v or 115v units.

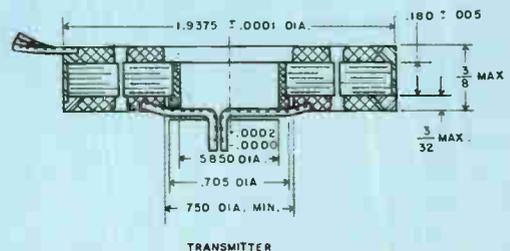
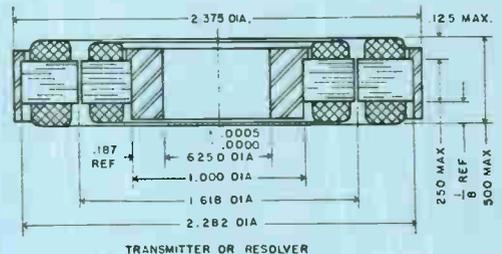
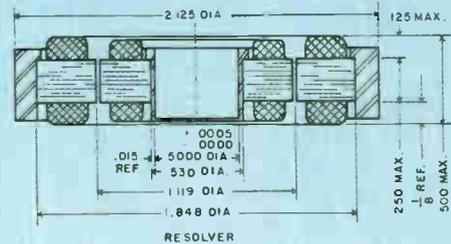


### Custom Designed Pancakes

CPPC has developed a number of special pancakes (drawings below) with relatively large bores and narrow stack heights.

Means have been devised to minimize error due to clamping pressures on these thin units.

Special accuracies have been maintained where required. Let us know your needs.



### Pancake Resolver for Gimbal Mounting

Clifton Precision produces special pancake resolvers for direct gimbal mounting. They were developed for use in cascaded amplifier-less resolver systems and have been trimmed for 10K input impedance, 0° phase shift and a constant transformation ratio, with temperature, at 900cy. Accuracies of 4', perpendicularities of 3' and nulls of 1mv/v of output or less can be held.



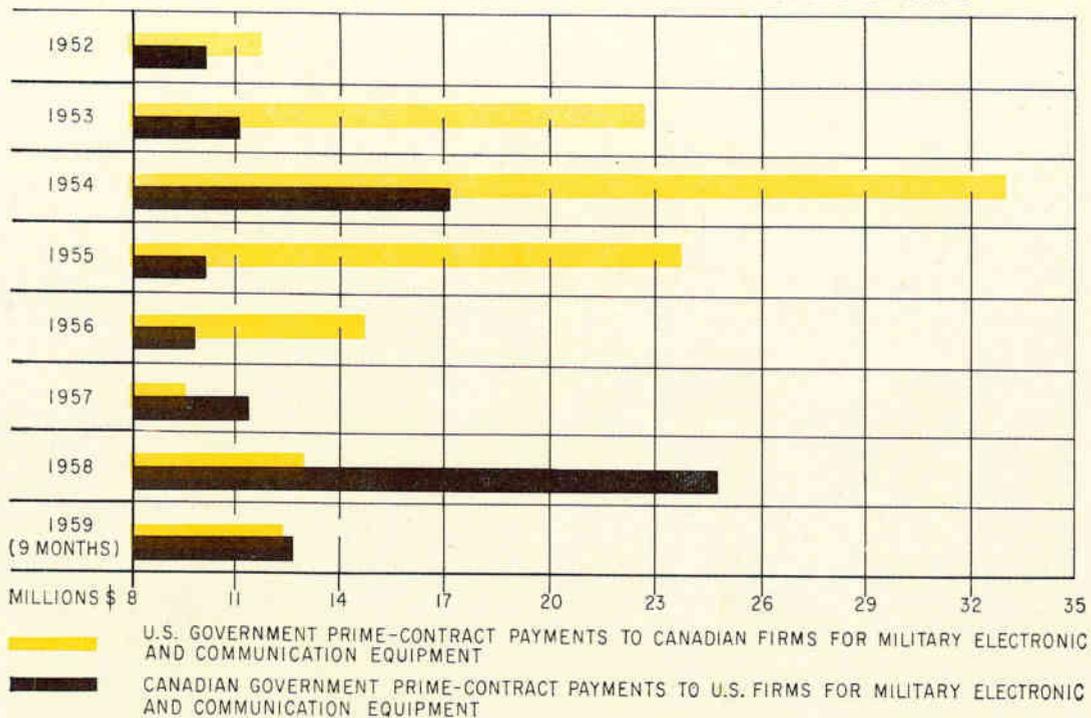
Special techniques maintain concentricity between rotor and stator — thus reducing difficulties commonly encountered in gimbal mountings.

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COMPARISON OF U.S.-CANADIAN MILITARY ELECTRONICS IMPORTS



# More Military Business Spanning Canadian Border

Now many U.S. and Canadian electronics firms participate equally in each government's military buying. Here's an exclusive roundup

By **JOHN F. MASON**, Associate Editor

LAST WEEK a top executive in a U. S. electronics firm scanned a bidders' list his purchasing department had just prepared. The executive was looking for subcontractors to help with a large military prime contract. He was surprised to find the list included several Canadian companies.

Finding Canadian electronics companies on the list would not have happened a year ago. They started appearing after the Production Sharing Program discussions held by the two countries in late 1958.

Since then, American prime contractors active in defense work have subcontracted close to \$20 million to Canadian electronics firms. And 60 of Canada's electronics companies are registered with seven U. S. government agencies.

In subcontracting, Canadian imports from the U. S. amounted to several times the \$20 million the U. S. spent there. Next year, subcontracting both ways across the border is expected to increase even more.

Both governments, and much of the electronics industry on either side of the border, foresee mutual advantages now and in the future from closer development and production cooperation. More activity should create more markets and more widespread technical interchange.

A Department of Defense production official says Canada was not in a position to develop alone the complex equipment necessary for her own defense. Another factor that demanded closer cooperation was the decision by both countries

to create a single air defense system for North America.

U. S. defense procurement in Canada was formalized by the Hyde Park Agreement in 1941. This agreement was intended to ease the imbalance of payments between the two countries that developed as a result of Canada's large purchases of military equipment in the U. S. during the early years of World War II. The agreement also gave Canadian industry consideration under the U. S. priorities system. The 1941 agreement was never formally cancelled, but it was not active after war's end in 1945.

## Agree On Principles

The increased military production programs of Canada and the U. S. following the invasion of Korea led to the Statement of Prin-

ciples for Economic Cooperation, which was approved in 1950.

It was agreed the two countries "shall cooperate in all respects practical, and to the extent of their respective executive powers, to the end that the economic efforts of the two countries be coordinated for the common defense and that the production and resources of both countries be used for the best combined results."

In 1956, Canadian firms were permitted to bid on supplies to be used in the U.S. as well as abroad. Late in 1958, the Production Sharing Program opened the door for subcontracting in Canada by American firms. For all practical purposes, Canada is now almost completely exempt from the Buy American Act. All tariffs and price differentials have been eliminated.

### Looking Into Facilities

The Department of Defense is at present looking to Canada's production facilities for weapons systems coordination. But on a long-term program, Canada's ability to participate in the coordinated development programs of mutual interest, leading, in time, to production contracts, DOD says. Canadian firms are interested in this aspect of the new cooperative effort.

Developmental work for Canada might come by way of DOD's increased use of the Association Contractors' approach. U.S. joint venturers responsible for design and development of a large weapon system might include a Canadian firm with particular experience in one element of the system as part of the team.

The principle joint U.S.-Canadian defense projects are the Sage-Bomarc system and the Pinetree early warning line. DEW-line was completely financed by the U.S. and the mid-Canada line by Canada.

Chart shows the yearly total of U.S. Defense Department prime contracts awarded to Canadian firms for electronic and communications equipment from 1952 through the first nine months of 1959, and Canadian National Defense contracts to American companies for the same equipment.

The program definition of these figures includes electronic communications equipment of all types, such as radar, radio, telegraph, tele-

phone, underwater sound and fire-control equipment. Development, maintenance, management and transportation services associated with the procurement and installation of electronic and communication equipment are also included.

From 1952 through 1956, the U.S. government was spending for military prime contracts for this equipment in Canada at least twice the amount that Canada was spending for the same purpose in the U.S. (Canada's subcontract imports, however, were more than making up for this imbalance.)

The peaks in 1953, 1954, and 1955 (\$22.9 million, \$33.1 million, and \$23.9 million) were mainly due to work contracted by the U.S. for the Pinetree early-warning radar defense line. Canada's top spending in the U.S. in 1958 (\$24.8 million) was also for Pinetree, much of which went for microwave communications and troposcatter equipment. Area communications gear was also bought that year for another Canadian military project.

Canadian firms have received contracts, other than for construction, valued at about \$130 million in connection with the U.S.-financed portion of Pinetree. A large part of this was for electronic systems and components.

The major items, says the Canadian Defense Dept., included: AN/TPS-502 radars and spares from RCA Victor Co. Ltd.; AN/FPS-502 radars and spares from Canadian Arsenals Ltd.; AN/CPS-6B radars and spares from Canadian General Electric Co. Ltd.; AN/FPS-3 radars and spares from Northern Electric Co. Ltd.; DDR-2 tele-

printer receivers from Canadian Aviation Electronics Ltd.; and AN/CNH-501 recording systems from Sonograph Ltd.

### Business to Come

Canada's biggest buying from the U.S. is yet to come. Purchasing for the Sage-Bomarc complex has barely started. Some equipment that will be needed includes computers, communications and radar gear, and the hundreds of thousands of components needed for this equipment. Canada expects to spend close to \$200 million for the equipment in the U.S.

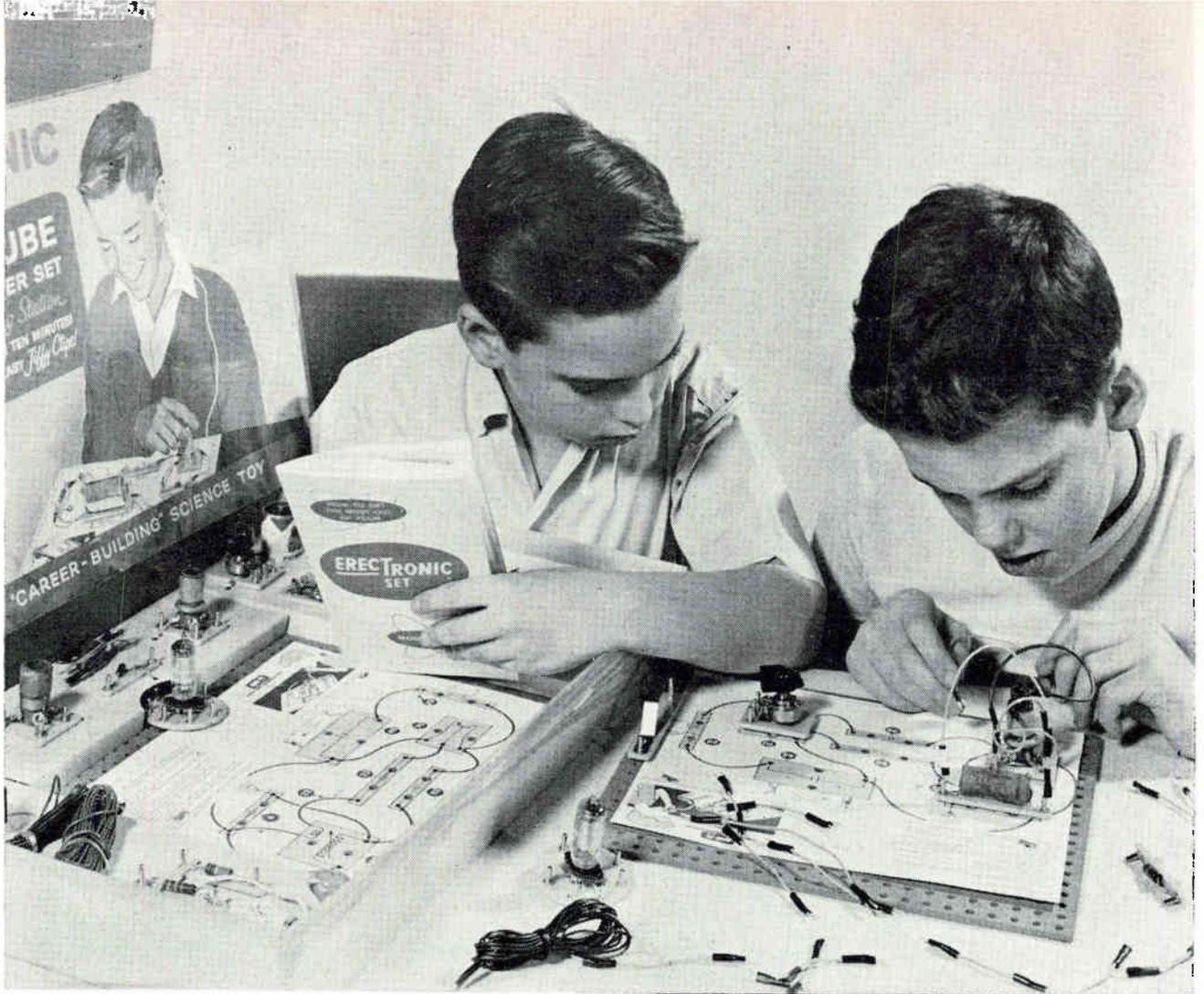
According to the Buy American Act, any contract with a supplier or contractor situated in Canada may be made by the U.S. government with, and administered through, the Canadian Commercial Corp.—owned and controlled by the Canadian government—at 2450 Massachusetts Ave. NW, Washington, D. C., or at 56 Lyon St., Ottawa, Canada.

Direct communication with the Canadian supplier or contractor is authorized only in connection with problems of inspection and technical matters. If such a problem affects the contract price, approval from the Canadian Commercial Corp. must be obtained. All payments are made to the Corporation in Washington.

U.S. firms looking for Canadian subcontractors do not need to go through the Canadian Commercial Corporation. Suppliers are contacted directly or through the Electronics Branch of the Department of Defense Production in Ottawa, or its liaison offices in the U.S.



Canada expects to buy from the U. S. \$200 million in Sage-Bomarc gear like computer maintenance consoles (IBM model is shown), computers, radar, data-processing equipment



Layout boards guide youngsters in making their own radio receivers

# Electronic Toy Sales Up

This Christmas more toys than ever are related to our industry. It's no accident. Example: one toymaker keeps a staff of research engineers

Thousands of toy displays this Christmas show that today's youngsters are looking to electronic toys as reflections of the grown-up world around them.

Toymakers feel that half-way imitations of the real thing may grow increasingly scarce as children demand more and more reality.

A spokesman for Toy Manufacturers of the USA, Inc., points out a child today is exposed to the latest developments in technology through television, magazines and the conversations of older people.

One idea of the lengths manufacturers are going to in their search for realism may be seen in

model kits made by one major toy company.

A spokesman for the firm tells **ELECTRONICS** that his company maintains a large staff of research engineers. Part of their job is to monitor technical and trade publications to keep watch for newly declassified items. When such an item is found, the company applies to the government for plans, data.

An example of how this affects toy manufacturing activity is seen in one of the latest model kits, the *USS George Washington*, Polaris-firing submarine.

Washington released hull plans and structural details of the vessel,

but withheld information on equipment in some of the sub's compartments. Company engineers deduced the appearance of the missing sections and had a model kit in production about three months before the actual launching of the boat itself.

In addition to models on virtually every missile system now in existence, there are models of space stations of the future—designed by special consultants from industry.

Radio equipment at the basic level is becoming increasingly popular, say toy industry spokesmen. One example is a series of layout boards and assorted components.

With such a set, a child can make

his own receiver or voice transmitter. (Low power input from flashlight batteries prevents violations of FCC broadcast rules.) Several makers include a transistor or two to keep up with new designs.

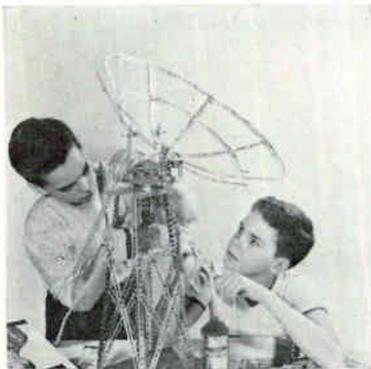
### Toy Radios, Too

A good sales record was expected this year for toy transistor radios made to sell for under \$10. Salesmen say a number of these may disappear from the playroom when Dad discovers how well they work.

Manufacturers of older lines of conventional toys have been quick to adapt their products to reflect today's emphasis on science.

The familiar dowel-and-spool construction toys that many of today's adults grew up with now contain full instructions for making "radar towers" and "tv antennas". One firm provides plans for a rotatable mechanism resembling a radio astronomy telescope installation.

Model railroad equipment also shows the trend to scientific toys. Missile carrying gondola cars, as well as so-called electronic launching systems, are becoming a nec-

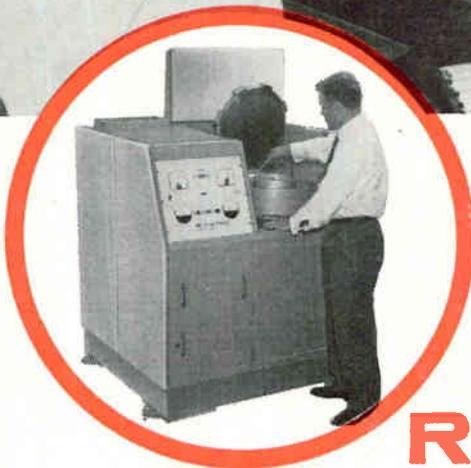


Rotating "satellite tracker" is featured in mechanical toy line

cessity for every well-equipped marshalling yard in toyland.

Although toymakers will sell more than \$1½ million worth of merchandise this year, a number of firms are not pleased with the seasonal aspect of their operations. (Biggest volume of sales is between Thanksgiving and Christmas.)

Two electric train makers are turning to other areas to supplement their off-season activities. One firm will start producing automotive switches, while the other plans to begin producing remote tuners for tv sets.



*fastest, most sensitive,  
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DETECT "LEAKERS"  
in hermetically  
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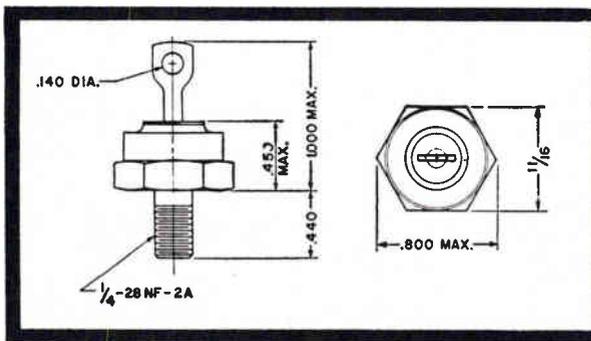
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1N1192A	22A	100V	150°C	1.2V at 60 amps.		5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.		5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.		5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.		5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.		5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.		5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.		5.0 MA



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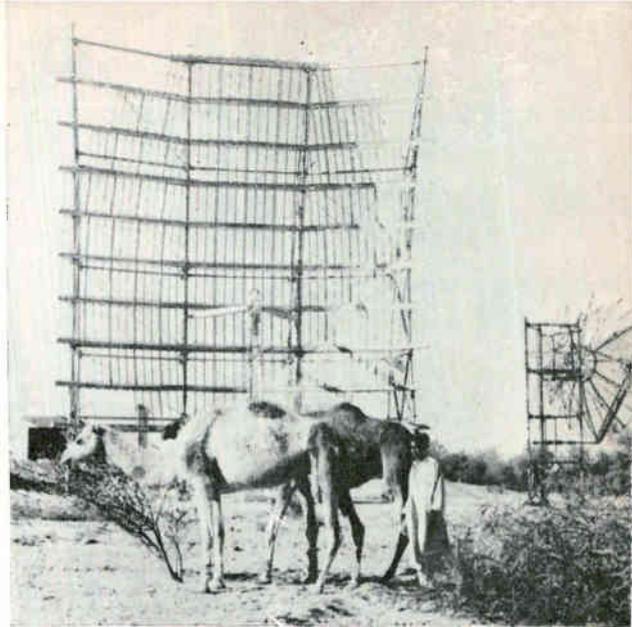
Santa Monica, California  
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Division of General Motors • Kokomo, Indiana



# Libya Network Expands Fast

Dedication ceremony marks latest equipment addition as growing system spreads radio and telephone facilities in kingdom



Modern antenna structures rise above camel trails in terrain unchanged since biblical days

THE CHRISTMAS SEASON in Libya this year is being marked by plans for the dedication of new studio facilities in the year-old broadcasting system of this North African kingdom.

To date, some \$8 million has been spent for electronic equipment and associated structures. About \$1½ million remains to be spent from the original funds.

## Serving Cities

December 24, significant to most of the Western world, is important to Libyans as their Independence Day. Because of this, proposed dedication ceremonies may find the royal family participating.

The Libyan system is being expanded under a contract signed in 1957 with the International Cooperation Administration. In two years the network has grown to provide facilities for both telephone and radio broadcasting for most of the coastal cities and some inland locations.

A number of communication channels are reserved for the Tripoli radio station which uses them to send programs to other cities for rebroadcast, and to receive program signals from other locations.

The other channels are used for telephone communications. These are carried by direct wire within the towns and cities and are also relayed by radio for intercity traffic.

The system is being worked on by Page Communications Engineers, Inc., a subsidiary of Northrop Corp., in a joint venture with

Hermes Electronics Co. (formerly Hycon Eastern), Cambridge, Mass.

The Libyan network uses cable, wire and line-of-sight microwave, as well as troposcatter stations, to link the cities between Benghazi and Tripoli. Now under construction are similar facilities for interconnecting circuits with El Garin and El Beda.

System designers say the network is notable in that it uses tandem troposcatter links with reflectors back to back as in conventional radio-relay systems. These tropo facilities join the ends of the line-of-sight microwave links. Over-water tropo links join Misurata to Sirte (a distance of 120 miles) and Sirte to Benghazi (a distance of 220 miles).

The kingdom of Libya, which became independent only eight years ago, inherited a communications system that was ravaged by war.

## Broadcast Facilities

Now—under direction of the Ministry of Communications of Libya—the ICA and the two American firms working in the area have furnished operational facilities for telephone service linking the coastal towns with Tripoli and Benghazi.

This equipment, which includes buildings and towers, has been functioning since May, 1959.

There are now 21 telephone channels between Tripoli and Misurata and 12 voice channels from Misurata to Benghazi. Three broadcast channels are reserved for a wide-band link between the broadcast

studios at Tripoli and Benghazi.

In addition, a 24-voice channel microwave system linking Idria airport with Tripoli has also been completed.

The system will eventually extend throughout Libya from the Tunisian border to the United Arab Republic. To insure adequate personnel, on-the-job training is being given to Libyans. Provisions have also been made to furnish test and maintenance programs.

Funds have been provided by ICA through the United States Mission to Libya for training, expansion and all other aspects of system operation.

Plans for the coming year are to double the present 3,500 telephone lines now in use and to install an additional 3,500 central office lines. Rehabilitation of the outside plant facilities in Tripoli is also scheduled.

A future demand of 15,000 lines for this city is foreseen.

The Ministry also plans to expand small local exchanges in a number of towns. Appropriations from the Libyan government are being added to ICA funds. It's expected that work will carry through January, 1961.

Engineers are finding frequent reminders of the region's historical past. In one city, Cussabat, is a cistern built by the Romans when they first fortified the area.

Today it is serving the peaceful purpose of supplying water for personnel and equipment of the Cussabat relay station.

# NEW SPRAGUE MODEL 500 INTERFERENCE LOCATOR

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UNIT PINPOINTS SOURCE  
OF INTERFERENCE



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## Leasing Market Continues

U. S. companies are now renting \$45-\$50 million of electronic gear. Big reason: cut capital outlay

CHRISTMAS PARCELS moving through the St. Paul, Minn., Union Depot this year were processed by a \$1-million electronic system requiring no capital outlay by depot owners.

This saving in capital expenditure was made possible by the growing practice of leasing equipment. Nationwide Leasing Co., Chicago, which negotiated leasing of the Stewart-Warner sorting system to the depot, estimates \$45-\$50 million of electronic equipment is now on lease in the U. S.

The electronics industry itself now rents about 8 percent of leased equipment being used in the country. In dollars this percentage comes to about \$24 million and includes such items as office furniture, air-conditioners, etc.

A prime factor in the rising interest in leasing is that it allows equipment to be had without expenditure of capital funds.

- A company wanting equipment contacts a leasing firm and describes the item and supplier. (The applicant, incidentally, must give evidence of financial soundness.)

- The leasing agreement is drawn up, and the leasing firm obtains the equipment, plant, land or whatever else is required.

### Usually Long-Term

Leasing of this type is usually long-term. Periods range from three to 10 years. Most leases fall in the three-to-five year category with renewal options available. Cost of the equipment lease is based on the price of the item plus leasing charges.

Lessees may buy the equipment they are leasing, but usually don't. Exercise of a purchase option can be construed by the Internal Revenue department as converting a leasing agreement into a conditional sales contract. In such case,

## Mobile Computer 'Flies' B-58



Computer on wheels (lower right) makes 750 tests of the B-58's control system in 90 minutes. Without the "go" or "no go" equipment, spot testing takes two days. Unit, built by Eclipse-Pioneer div. of Bendix, simulates all command signals to the Hustler autopilot from the air data computer, accelerometers, gyros, radio navigation gear and other air-environmental and direction references

# Gains

leasing charges cannot be deducted from taxes.

A true lease is deductible as an operating expense. Hence equipment leased for a given period may be written off for tax purposes during that time.

As a sales tool, electronics manufacturers are finding the leasing agreement advantageous from several points of view. Lease plans broaden the number of customers for such specialized items as instruments and computers. Companies which feel they can't afford to buy will often lease without hesitation.

The defense nature of much of today's electronics activity is another factor in favor of leasing. A company in defense work can use equipment for a contract without risking capital in case of cancellation. Interest on equipment purchased in connection with a military contract may not be charged to the contract. Equipment rental costs, however, may be.

## Brisk Business

Major leasing companies expect to do business totaling about \$100-million this year. Nationwide Leasing reports a brisk trade in computer systems leased to industrial processors.

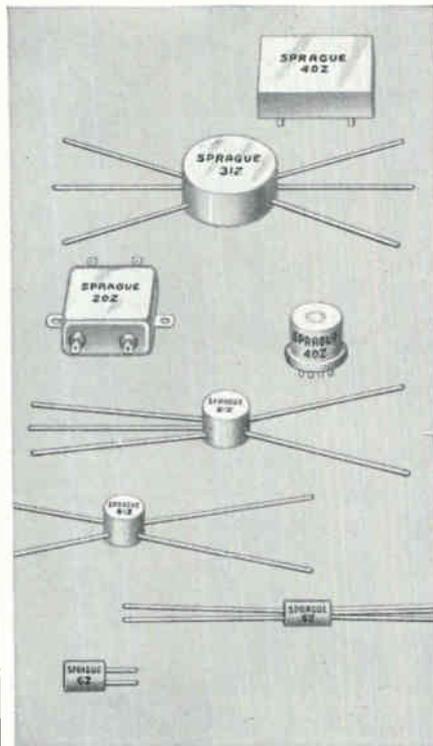
One example is a major oil producer which leases one of the largest analog computer facilities operated by a private company.

United States Leasing Corp., San Francisco, says electronics manufacturers are leasing more than 25 percent of the equipment now on its books. This firm currently handles about \$10 million worth of equipment on lease to our industry.

The largest single leaser, according to C. B. Stone, USLC board chairman, is Thompson Ramo Wooldridge with more than \$3-million worth of leased gear in use.

President P. D. Booth, Jr., of the Booth Leasing Corp., San Francisco, estimates that about 15 percent (\$3 to \$4 million) of his company's volume is conducted with electronics companies. Booth reports a brisk business in oscilloscopes, instruments and other electronic equipment.

## Miniature Pulse Transformers

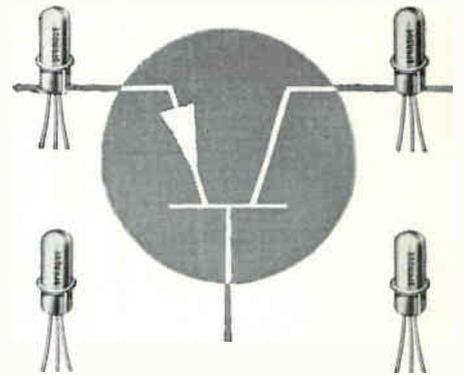


Sprague miniature pulse transformers are ideally suited for application in low-power, high-speed computer circuitry where pulse signals may range up from 20 millimicroseconds and wider in duration, at repetition rates as high as 10 megacycles, with pulse levels ranging from fractions of a volt to several hundred volts.

Typical circuits utilizing Sprague Pulse Transformers include *pulse amplifiers* (for current or voltage step-up, impedance matching, decoupling, pulse inversion and push-pull operation); *pulse shaping and differentiating*; *blocking oscillators* (in regenerative circuits of the triggered and self-triggered type); *general transistor circuits*.

Choose from Sprague's wide variety of mounting styles, shapes and encasements... for conventional or printed wiring board assembly.

Write for the complete series of engineering bulletins to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.



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Made by electrochemical manufacturing techniques, Sprague Micro-Alloy Transistors are uniformly reliable and very reasonably priced.

For complete engineering data sheets on the types in which you are interested, write to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts. \*Sprague Micro-Alloy Transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are fully interchangeable.



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## BANANA PINS

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# New Research Grants Made

RESEARCH IN ELECTRONICS at the academic level seems likely to maintain the same brisk 1959 pace during the coming year. Here are some signs:

- **New York University** College of Engineering reports total research expenditures during the past academic year rose from \$2,990,000 in 1958 to a new high of \$3,300,000. This research was carried out by 477 faculty members, full-time research engineers and scientists as well as graduate students. Among sponsors of research programs are the National Academy of Science, the National Science Foundation, Sperry Gyroscope, military agencies of the federal government and municipal agencies.

- **University of Arizona's** Numerical Analysis Laboratory announces development of a three-ton "computercade". This mobile unit is now ready to take to the road to visit schools throughout the state to stimulate interest in mathematics and science. The exhibit makes it possible for students to observe the inner workings of modern electronic computers.

- **Case Institute's** Dr. Frederick Reines proposed a new type of scintillation counter at last month's fall meeting of the American Physical Society at the Institute. His approach attempts to distinguish between the normal gamma radiations present in the earth's environment and the many fewer beta radiations involved in studies of very small amounts of radioactivity. Such a detection scheme may make possible further studies of the free neutrino.

Feasibility of the new counter is now being investigated. The system will take advantage of the fact that gamma rays lose energy in collisions occurring over relatively wide spaces, while beta radiations do this in a limited region. It is believed that using two different

liquids in the counter will produce two colors when collisions take place. Appropriate filtering would then allow the two sources to be detected and counted.

- **Stanford University** reports a new \$200,000 grant from the Ford Foundation to finance increased emphasis on educating engineering teachers with Ph.D.'s. Aim of the program will be to get as many highly qualified people as possible into engineering faculties in the next five years, according to J. H. Pettit, dean of the School of Engineering. Half the funds will be used for predoctoral fellowships and tuition loans.

- **Iowa State University**, in a joint announcement with the Association of Maximum Service Telecasters, says the university Engineering Experiment Station will begin a one-year study of uhf wave propagation. The project will also make a study of the extent and severity of adjacent channel interference in tv broadcasting. Both projects will be supervised by Dr. W. L. Hughes.

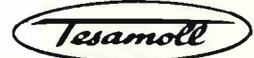
- **University of California** researchers at the U. Cal. Electronics Research Laboratory are working on a novel method for focusing a low-density plasma column by having the fields of an axisymmetric traveling wave propagating along the axis of the column. The U. C. team says others have made similar experiments, but the use of slow wave circuits has not been reported on by any other research groups.

- **Rutgers University** reports that during fiscal 1958-59 its Bureau of Engineering conducted 36 projects representing an investment by government and industry of more than \$300,000. The figure does not include administrative costs or thesis work. A highlight in the bureau's year was the opening of a microwave electronics laboratory.

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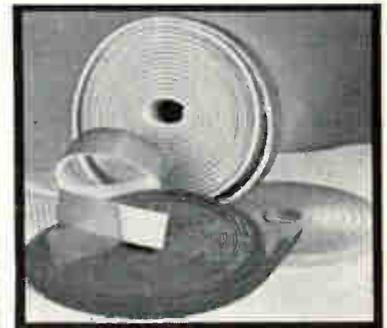
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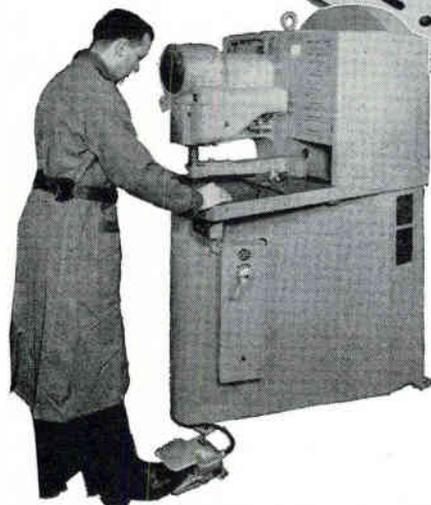
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**SETUP TIME**—9.3 minutes

**PRODUCTION RUN**—5 pieces

**PRODUCTION TIME PER PIECE**—2.8 minutes

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## MEETINGS AHEAD

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 1-4: Instrument-Automation Conf. and Exhibit, ISA, Sam Houston Coliseum, Houston, Texas.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Texas.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Apr. 4-7: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland, O.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., New York City.

Apr. 20-22: Southwestern IRE Conf. & Electronics Show, PGME of IRE, Shamrock Hilton Hotel, Houston, Texas.

May 3-5: Western Joint Computer Conf., Jack Tar Hotel, San Francisco.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 62.

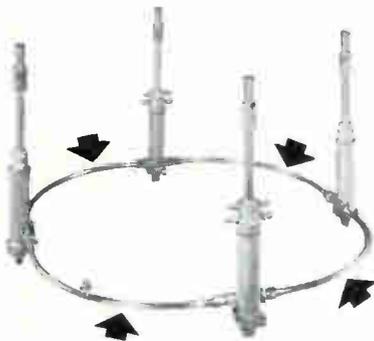
# S.S. White

## DRIVE AND CONTROL IDEAS FOR ENGINEERS

*Tips on better designing with flexible shafts*

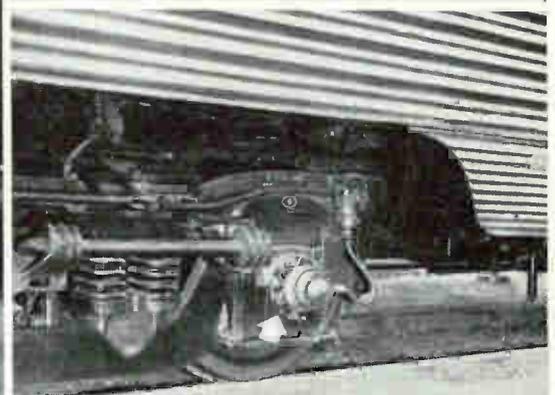
### REMOTE CONTROL

Reliable synchronization at high temperature is made possible by S. S. White flexible shafts on this actuator system for jet afterburner nozzles. The job assigned the shafts was to synchronize the system to permit multipoint installation and smooth, even application of power . . . at ambient temperatures up to 650F! To see how flexible shafts simplify design, picture doing this with solid shafts, gearing, universals, and other paraphernalia, around a 360° bend . . . and then imagine installing it!



### POWER DRIVE

Running cool at 45,000 rpm! The S. S. White flexible shaft on this grinder-miller permits the use of carbide and diamond tools at speeds that were previously unknown to hand tools. The flexible shaft drives the handpiece from a 1/4-hp motor suspended over the table at speeds up to 45,000 rpm, without overheating and without vibration. A good point for designers to note is that in many cases, the higher the speed of a flexible shaft, the better the performance.



### COUPLING

Alignment and vibration problems are solved by an S. S. White flexible shaft on this railroad brake controller. The device detects wheel slippage during braking, by means of rotary switches on each axle that detect changes in relative movement between pairs of wheels on the truck. If damaging slip occurs, the device releases brake pressure until slippage stops. A flexible shaft is fitted to the axle and drives the rotor in the switch, eliminating alignment problems and preventing excessive axle vibration from reaching the sensitive device.

# S.S. White

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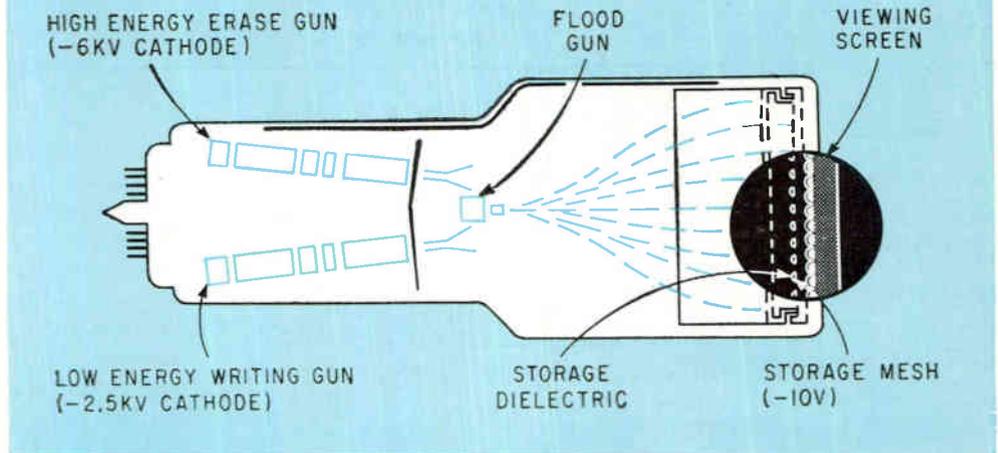


FIG. 1—Five-inch bombardment induced conductivity tube uses dual effects target for selective erasure

# Latest Trends in Electron Devices

Improved storage and display devices, code translation with photoconductive-electroluminescent elements, low-noise and solid-state devices rate high interest at 1959 Electron Devices Meeting

By MICHAEL F. WOLFF, Assistant Editor

**ELECTRON DEVICE TECHNOLOGY** keeps advancing both in new devices and in improvements to existing ones. Researchers have developed more versatile storage and display devices, and smaller cathode-ray tubes. New design techniques are leading to improved performance from traveling wave tubes, parametric amplifiers and secondary emission multiplier tubes.

**SELECTIVE ERASURE TUBE**—A direct-view, halftone storage tube capable of selective erasure and nonstorage writing has been developed at Hughes Research Laboratories'. Operation of the new tube, shown in Fig. 1, is based on a storage target that exhibits dual charging phenomena.

Selection of the charging effect, and therefore the charging direction, is determined by incident beam energy. At lower beam energies the secondary emission effect prevails and the storage surface is charged positively, allowing the tube to write. At higher

beam energies, the bombardment induced conductivity effect predominates and the storage surface is charged toward the backplate negative potential. In this mode the tube is capable of selective erasure; that is, it can rapidly erase one or more of the smallest written elements rather than having to erase the entire storage target.

At an intermediate beam energy the two effects cancel. When this happens the cathode-ray information can be presented on the viewing screen without disturbing the written or erased area of the storage target.

**ELECTROLUMINESCENCE** — Electroluminescent (EL) panels continue to receive attention for their usefulness as storage and display devices (ELECTRONICS, p 44, July 10, 1959). Several electronic systems have been devised at Sylvania Research Laboratories for gaining access to crossed-grid EL

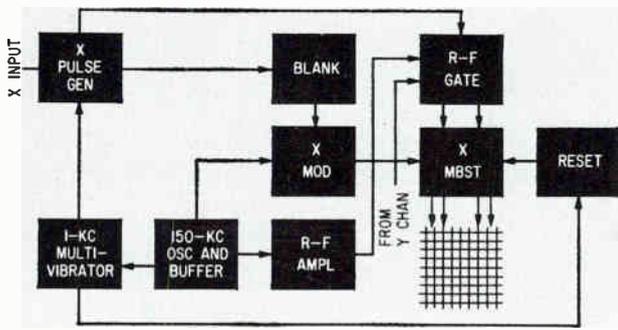


FIG. 2—Preferential access to EL panels is obtained with magnetron beam switching tubes (MBST)

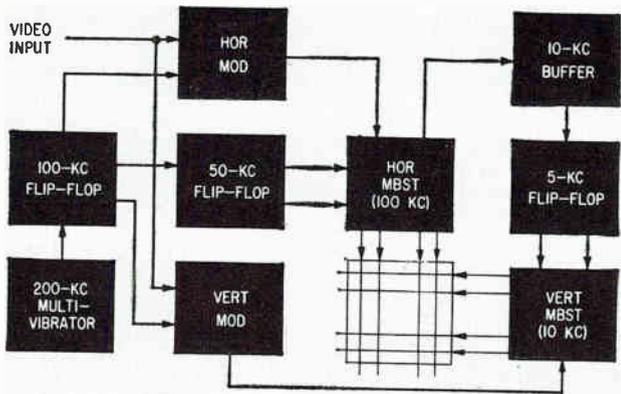


FIG. 3—Sequential scan system uses beam switching tubes to scan a 5 sq in., 100 × 100 panel at 20 frames a second

panels<sup>2</sup>. Crossed-grid panels have a continuous layer of glass-embedded EL phosphor overlaid with an impedance-matched nonlinear resistive layer. This layer reduces the cross-light effect which results from half-voltage excitation on the coordinate lines. Contrast ratios of 10,000 to 1 have been obtained with these panels.

Both preferential access and sequential scanning have been obtained using magnetron beam switching tubes as the basic switching and modulating elements. Figure 2 shows the X channel of a system for gaining direct access to any desired element in a 10 × 10 panel. The Y channel is identical. The multivibrator triggers the pulse generators which sample the varying d-c inputs and convert them to r-f bursts. The r-f gates then drive the beam switching tubes, setting them to the desired position. After the screen position is selected, it is kept excited with an a-c drive signal so that the selected element will glow.

Figure 3 shows a fast, sequential, single-pulse system with an excitation rate of 10 microseconds an element.

**LOGIC ELEMENTS**—Photoconductive-electroluminescent (PC-EL) elements are being used at Sylvania for code translation in display systems with segmented EL panels<sup>3</sup>. Although diodes and mechanical switches have been used for translating digital data to the segment-display code, size and cost advantages are claimed for PC-EL logic elements. A

simple, compact panel array consisting of these elements in polycrystalline layers has been constructed in approximately the area of the displayed character.

A digital-to-display code translator consists of a 10 parallel strip EL array which lies across a seven parallel strip array of PC cells. Translator logic is obtained by light-masking the PC strips from the EL strips at the appropriate cross points. The same device can be used to translate other codes by increasing the number of strips.

One drawback to this technique is the relatively slow switching speed of a logic element—10's of milliseconds to go from ON to OFF. However, because logic is processed in parallel, element switching time is the total memory access time.

**REFLECTED-BEAM KINESCOPE**—In both cathode-ray storage and conventional tubes the trend toward reducing size and weight is continuing. For some tubes this is being accomplished by replacing as much of the magnetic focus and deflection equipment as possible with electrostatic components. An example of a new approach is provided by RCA's reflected-beam kinescope<sup>4</sup>.

The reflected-beam kinescope displays its images on a screen 21 inches in diameter with a tube structure 10 inches long. An effective deflection angle of nearly 180 degrees is obtained with deflection power equivalent to that used in conventional 90-degree kinescopes.

The reflected-beam tube is axially symmetric. Its spherically-curved face is in tandem with a similarly-curved phosphor screen. The screen has an array of fine holes through which the electron beam passes after leaving the gun. The beam is reflected back to this convex surface by a transparent conductive coating on the concave side of the tube face.

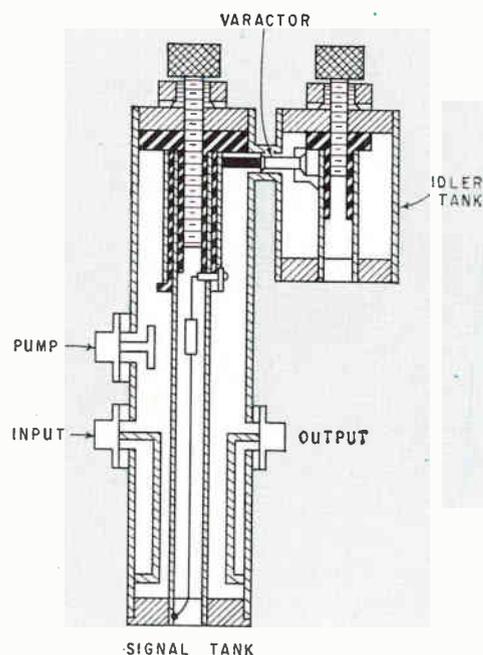


FIG. 4—Low pump power, 220-mc parametric amplifier does not require circulator or isolator

Although the tube has the advantages of low deflection power, shortness and good detail contrast, its brightness is one-fourth that of present black-and-white tv display tubes. Also, its resolution is somewhat lower.

**PARAMETRIC AMPLIFIER**—A 220-mc parametric amplifier requiring only 0.05 milliwatt of pump power has been developed at Motorola under an Air Force contract.<sup>5</sup> Because of its low pump power requirements, the amplifier can be used with a transistorized pump, permitting the design of an all solid-state uhf receiver.

The amplifier consists of two resonant coaxial lines interconnected at the high impedance ends by a varactor diode, as shown in Fig. 4. Variable capacitors at these ends provide the tuning. One cavity is resonant at both the 220-mc signal frequency and the 700-mc pump frequency while the other cavity is resonant at the 480-mc difference frequency. Dual resonance in one cavity permits impedance matching at the pump frequency—an important factor in minimizing the pump power. The amplifier has a single-channel noise figure of approximately 2 db, a gain of 13 db and a 400-kc bandwidth.

**TRAVELING-WAVE PARAMPS**—Gains of 20 to 30 db have been obtained at Hughes with the S-band traveling wave parametric amplifier shown in Fig. 5.<sup>6</sup> The rectangular cavities are inductively coupled through irises which may be exchanged to vary pass-band size and characteristics. The pump originates in a C-band klystron and is supported by a second circuit capacitively coupled to each signal cavity.

Gains of greater than 20 db have been obtained by using nonreciprocal-loss ferrite elements in the irises between the cavities. Gains of 10 db have been achieved over 10 percent bandwidth. The amplifier has a theoretical double-channel noise temperature of 80 K due to insertion loss in the diodes.

**MULTIPLIER TUBE**—A grid-controlled secondary-emission electron multiplier tube capable of raising a 20-30 milliamper input to a 5-ampere output pulse has been constructed at the Naval Research Laboratory.<sup>7</sup> The output can be delivered into a load impedance of 100 ohms. Rise and transit time are less than 10 and 20 millimicroseconds, respectively. The tube can provide a positive output pulse with a positive grid input.

As shown in Fig. 6, the tube consists of a series of concentric cylinders. The controlled emitter source is the grid and cathode of a 6AG7 pentode. There are four louvered dynodes outside the last grid, with the first dynode serving as the missing pentode plate. A relatively large number of louvers keeps current density low and reduces space charge effects.

The positive output pulse is taken from dynode 5 while a negative output can be taken from the screen-mesh collector. A high current output is obtained because while the concentric design allows the emission area to increase with radius, the current density remains the same.

**LOW-NOISE DEVICES**—An example of the low-noise devices currently under development is a C-band traveling-wave tube with a 20-db gain and a noise figure in the 4.5-db range.<sup>8</sup> The Bell Laboratories device tracks in gain to  $\pm 0.2$  db over 10-percent bandwidth and tracks in phase to  $\pm 2$  degrees over the same bandwidth.

The tube has a hollow electron beam and uses permanent magnet focusing in which a peaked magnetic field is produced at the cathode.

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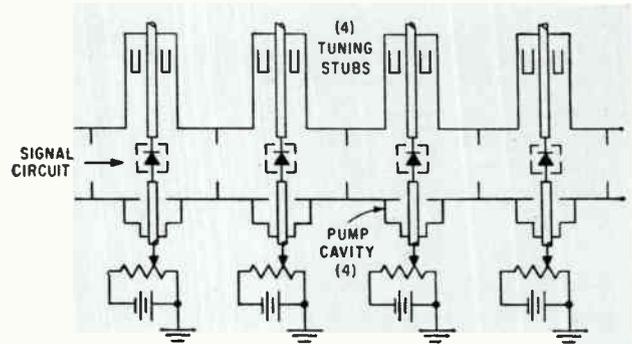


FIG. 5—Signal-idler circuit of traveling wave paramp has four rectangular cavities centrally loaded by variable capacitance diodes

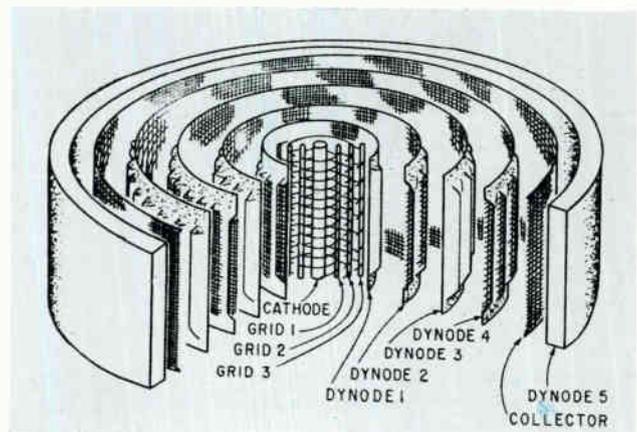


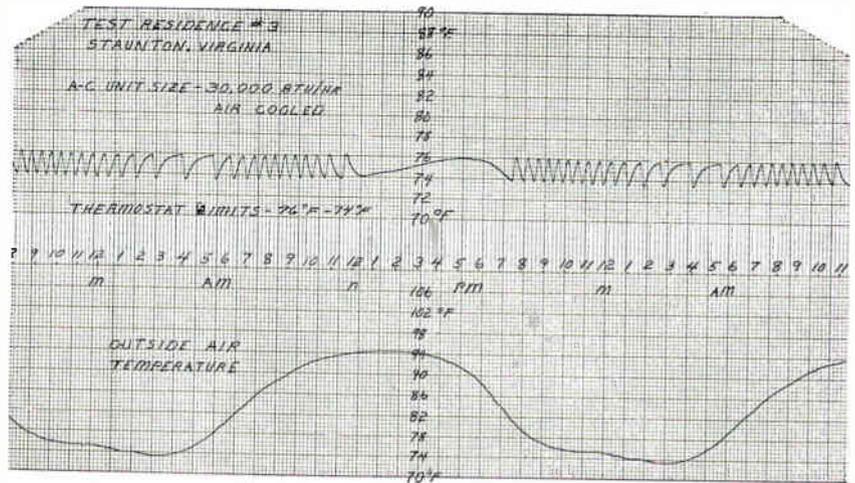
FIG. 6—Secondary emission multiplier tube has transconductance of 600,000  $\mu$ mhos. Tube is suited to coaxial input and output

# How Analog Networks Solve

Specially designed analog computer offers an effective means of predicting thermal behavior and cooling load of dwellings. Concept is based on thermal circuits that represent unit areas of the physical structure

**R**ESIDENTIAL structures are complex thermal systems whose dynamic behavior is difficult to predict accurately. An analog computer offers an effective means of predicting their thermal behavior, consequently the cooling loads of dwelling structures. Previous use of analog computers to analyze the thermal behavior of dwellings has been limited to studies of special enclosures<sup>1-4</sup> and to the use of a general purpose analog computer as a tool in predicting residential cooling loads<sup>5</sup>. The Westinghouse Analog Recording Air Conditioning Computer, known as the WARAC, is the first computer known to have been developed specifically for the determination of residential air conditioning loads.

The computers' theory of operation is based on the use of the thermal circuit technique, the well-known analog between electrical and thermal systems, and the unit-area method of analog representation. A thermal circuit is a simple



A typical record obtained from the computer. Chart shows the daily variation of indoor and outdoor temperatures under the particular conditions of the tests. Any of the test conditions may be altered and the new results obtained in less than a minute

picture of the thermal system.

Previously, analog networks were used to represent the entire structural element (wall, roof, etc.). The values of the network components were determined by the area and construction of the element. This, in many instances, resulted in large impractical component values.

The unit area method of analog representation along with the scale system used (see editorial box) offers the advantages over other methods of analog representation of flexibility and practical component values. The unit area method uses analog networks which represent a section of unit area of the structural element.

## Currents and Heat Units

The computer behaves electrically as the thermal behavior of the house under study. As shown in Fig. 2, a varying d-c voltage,  $T_{o,a}$ , is generated within the function generator and fed through an amplifier,  $O$ , to the outdoor air bus. The amplifier serves as a low impedance source in simulating the outdoor air as a heat source or sink.

Solar radiation signals,  $I_{TV}$  and  $I_{TH}$ , are derived from the function generator and fed to radiation am-

plifiers. These amplifiers convert 60-cps signals into currents which are directly proportional to the net solar radiation in Btu/hr/ft<sup>2</sup> striking each of the walls and roof of a house. These currents flow into the outside surface terminals of the wall and roof analog networks.

At this point the currents divide, the largest percentage of each current returning to the outdoor air bus through an outdoor air film resistor,  $R_o$ . The value of  $R_o$  is equal to the effective resistance of heat transmitted by conduction, convection and radiation from the exposed surface to the outdoor air and surroundings. The voltage drop across  $R_o$  represents the rise in surface temperature above the outdoor air temperature.

Voltage difference, analogous to the temperature differences created across the exposed walls and roof by warm outdoor air and solar radiation, causes currents to flow through the analog networks. Each current has a magnitude equal to the rate of heat flow through each structural element. The current varies as a function of temperature differences and construction.

Current in each analog network flows through an equivalent inside



**THE FRONT COVER**—Overall view of the analog computer. The left hand cabinet contains the power supplies, the output recorder and two rows of amplifiers. The center cabinet has the plug board for the analog networks, the meters for reading temperatures and heat flow, and storage space for spare networks. The right-hand cabinet contains two rows of amplifiers and the radiation function generator

# Air-Conditioning Problems

By W. L. WRIGHT and C. A. BOOKER,

New Products Engineering Dept., Westinghouse Electric Corporation, Cheswick, Pennsylvania

air film resistor,  $R_i$ , into an area amplifier,  $A$ , where it is multiplied by the area of the represented element. Resultant currents represent the total heat gains through the structural elements of the dwelling.

## Amplifier Outputs

Windows are considered as walls in simulating heat transfer by conduction. Transmitted solar radiation signals are derived from the function generator and fed into the glass radiation amplifier,  $C$ . The amplifier outputs are equal to the net solar radiation transmitted per sq ft of glass. These currents are fed directly into the glass area amplifiers where they are multiplied by the glass areas within the walls of the house.

The four total transmitted radiation currents are added and flow into an inverse area amplifier where the sum is divided by a factor equal to the area of the represented floor. Amplifier output is fed into the top surface terminal of the floor analog. Most of this current flows through the floor-inside-air resistor into the floor area amplifier where it is multiplied by a factor equal to the area of the floor. The resultant current represents the net floor heat gain. The remaining current flows into and through the floor analog network.

Heat from transmission gains, transmitted solar radiation, ventilation and internal loads is stored in the walls, internal partitions and air mass within the house. This is represented in the computer by the storage of charge on the capacitors of the structural element analog networks and the inside air thermal storage amplifier.

Storage of heat results in rising internal temperatures as indicated by the rising voltages appearing at the inside terminals of the analog networks. When the temperature of the inside air,  $T_{IA}$ , as repre-

## DETERMINING THERMAL BEHAVIOR OF DWELLINGS

An analog computer, developed specifically for determining residential air conditioning loads is based on the use of a thermal circuit. This representation of a typical wall construction, Fig. 1A, is illustrated in Fig. 1B. This analogy between a thermal and an electrical system uses analog networks which represent a section of unit area of the structural elements. Current flow through the analog network is equivalent to the average unit area heat flow through the structural element. The voltages appearing at the terminals

of the network are equivalent to the average temperatures,  $T_{so}$  and  $T_{si}$ , of the structural element surfaces.

The current flow through each structural element analog network is multiplied by a factor numerically equal to the area of the element of an area amplifier. The resultant current represents the total transmission heat gain or heat flow through the structural element.

Use of the unit area method, made possible by the development of the area amplifier, has in turn made it possible to use a simple building block technique in constructing an electrical analog of a house. This building block technique is discussed in this article.

The heat sources and sinks simulated within the computer are the sun, outdoor air, the earth, appliances and people. Outdoor air temperature and solar radiation falling on the four walls and roof of the house are simulated by a special function generator. Simulation of earth or ground temperatures and internal loads such as appliances and people is accomplished within the computer by potentiometer networks.

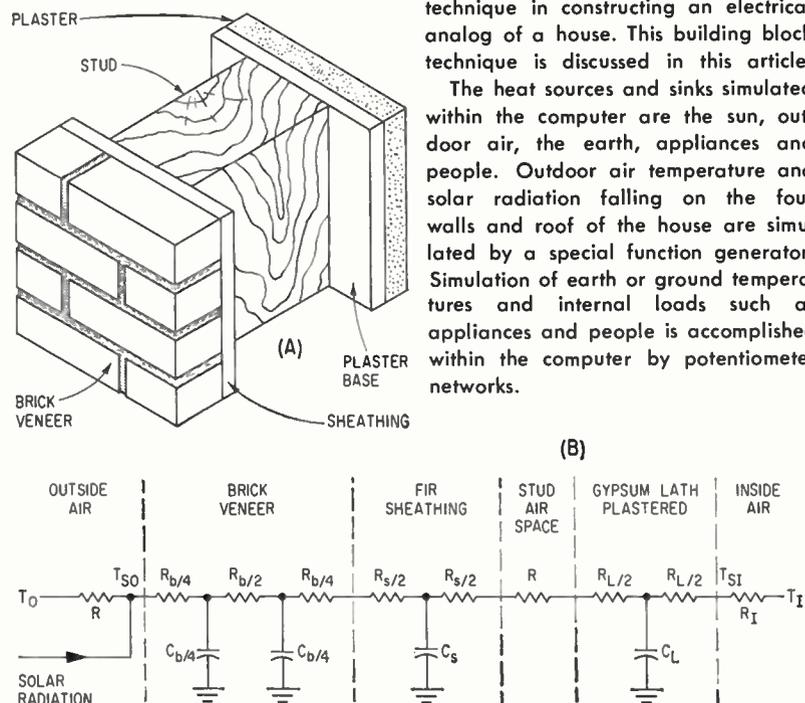


FIG. 1—Typical wall unit (A) and its thermal circuit representation (B)

## ANALOG AND THERMAL QUANTITIES

The unit area method used to analyze thermal behavior of dwelling uses a scale system which numerically equates the dimensions of each system.

Quantity	Thermal Unit	Electrical Unit
Time	1 hour	1 second
Capacitance	btu/deg F	1 microfarad
Resistance	1F/btu/hr	1 megohm
Potential	Deg F	volt
Energy Transfer Rate	1 btu/hr	1 microamp

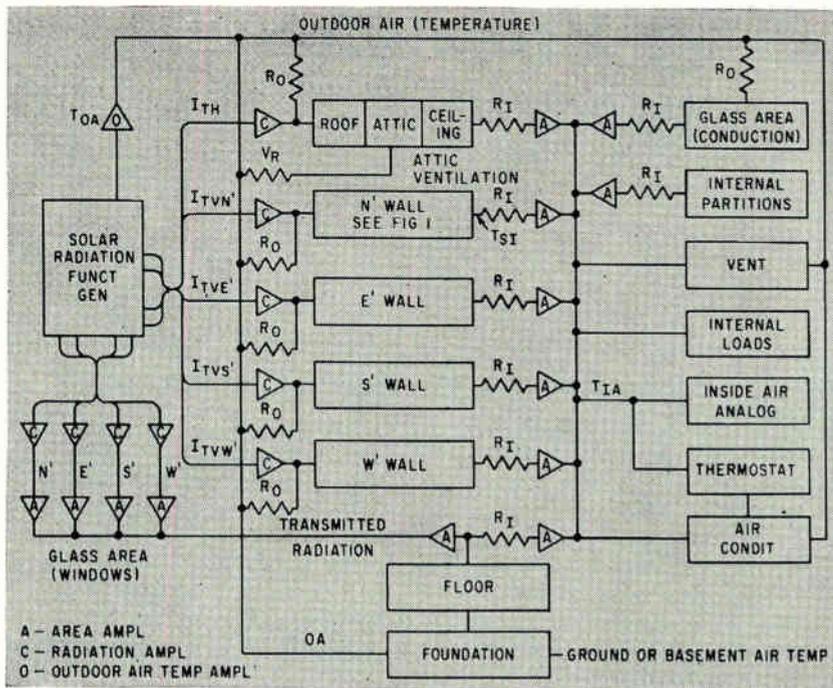


FIG. 2—Block diagram of computer used to determine air-conditioning capacity

sented by the voltage appearing at the terminal of the inside air analog, reaches the ON temperature setting of the thermostat, the air conditioner is turned on.

The inside air temperature analog voltage begins to drop as the air conditioner analog removes heat from the capacitors of the house analog system. Current flow through the air conditioner analog represents the instantaneous rate of heat removal or capacity of the air conditioner. The air conditioner analog continues to remove heat from the analog system until the inside air temperature analog voltage has dropped to the OFF setting of the thermostat and the unit is turned off. An analog temperature cycle of the inside air is completed when the inside air temperature analog voltage again reaches the ON setting of the thermostat analog.

#### Radiation and Area Amplifiers

The radiation amplifier, Fig. 3A, is a two-stage, push-pull circuit with negative current feedback followed by diodes for d-c output. These amplifiers supply 500  $\mu$  d-c into a voltage up to 100 v d-c. Full output is obtained with a 5 v rms input.

A dummy load with a polarity opposite to the active load balances the secondary load on the transformer output and obtains satisfactory feedback.

The area amplifier used depends upon the individual application. Figure 3B is a schematic of the circuit used for the walls. This circuit maintains the two grids of  $V_1$  at the same voltage and keeps the voltage drop across  $a R_1$  and  $R_2$  the same. The voltage drop across  $a R_1$  is  $I_{in} a R_1$ ; therefore, the current through  $R_2$  will be  $I_2 = a (I_{in} R_1/R_2)$  and the output current will be  $I_{out} = I_{in} + I_2 = I_{in} [1 + a R_1/R_2]$ .

The circuit produces an output current which is a multiple of the input current dependent only upon the value of  $R_1$ ,  $R_2$ , and the setting  $a$ . Furthermore the magnitude of the multiplier is linearly dependent upon  $a$ .

Stage  $V_1$  amplifies the difference in potential between its two grids. The amplified difference is fed to  $V_2$  by resistive coupling where it is amplified. A balance potentiometer in the coupling network between  $V_1$  and  $V_2$  adjusts the circuit for zero output current at zero input current. Right plate of  $V_2$  is driven by left plate of  $V_2$  through the triode section of  $V_3$ , used as a cathode follower. This results in an increase in gain of  $V_2$  when feeding a single-ended output. The pentode section of  $V_3$  is connected in a circuit similar to a cathode follower except that the screen grid is driven by the triode section to increase effective gain. The control grid is con-

nected through a resistive divider to the screen grid. The multiplier can be adjusted to any value from 1 to 1,000 and may be read directly from the dial of ten-turn potentiometer  $R_1$ . The voltage at the output terminal may have any value between 0 and +50 v d-c. For any given multiplier, the output current will remain within  $\pm 0.25$  percent  $\pm 5 \mu$ a over the range of voltages and for output currents between -1 to +10 ma.

Several versions of this circuit used in the computer provide multipliers up to 3,000 and voltages up to 100. A 6CL6 as the output stage provides nominal currents up to 30 ma.

Outputs of the area amplifiers are fed to an inside air bus which is connected to circuits that represent the thermal storage of the air, the air conditioner and thermostat. Internal heat gains are also fed to the same point. For the circuit representing air thermal storage, a capacitance continuously variable up to about 1,000  $\mu$ f is required.

#### Air Thermal Storage

To avoid the voltage drop in the current measuring resistor two circuits similar to the area amplifiers are used, Fig. 4. One circuit provides the current, and the other establishes the voltage.

Tubes  $V_{11}$  and  $V_{12}$  invert the voltage drop across  $R_1$  with respect to the input voltage. Since  $R_1$  and  $R_2$  have the same voltage drop across them, the grids of  $V_1$ , being at the same potential, the currents will be inversely proportional to the resistances:

$$\frac{I_c}{I_1} = \frac{R_1}{R_2}$$

The voltage at terminal B is the same as at terminal A and the currents are related. The circuit appears at its input like a capacitor which has a value

$$C = C_1 \alpha \frac{R_2}{R_1} + C_2$$

With the values shown, the apparent capacitance may be varied from 12 to 1,000  $\mu$ f.

The balance of the circuit is similar to the area amplifiers except that equal and rather large current capabilities are provided for both polarities of current. Tubes  $V_1$  and  $V_2$  are the usual two-stage ampli-

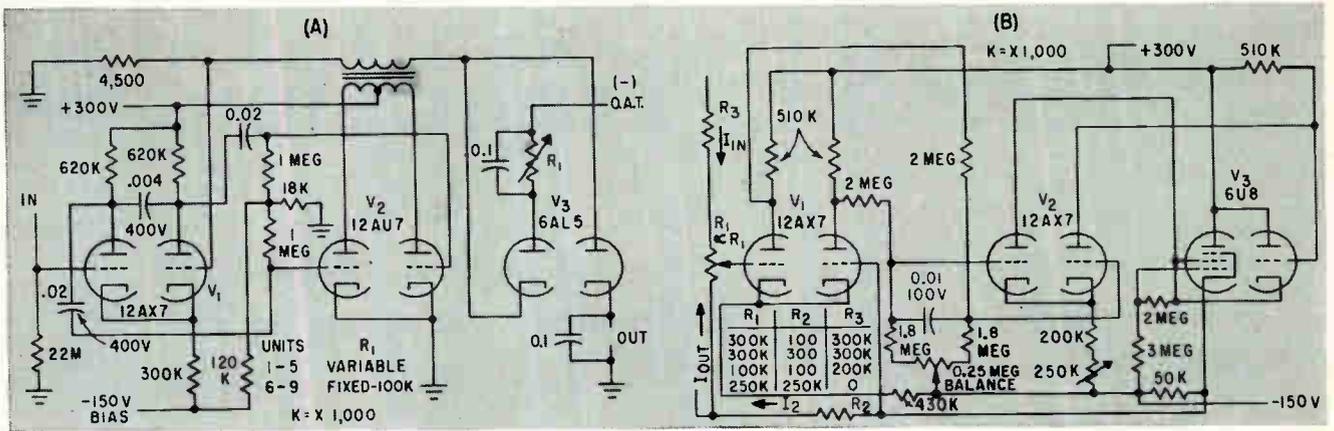


FIG. 3—Solar radiation amplifier (A) and area amplifier (B) used in the WARAC computer

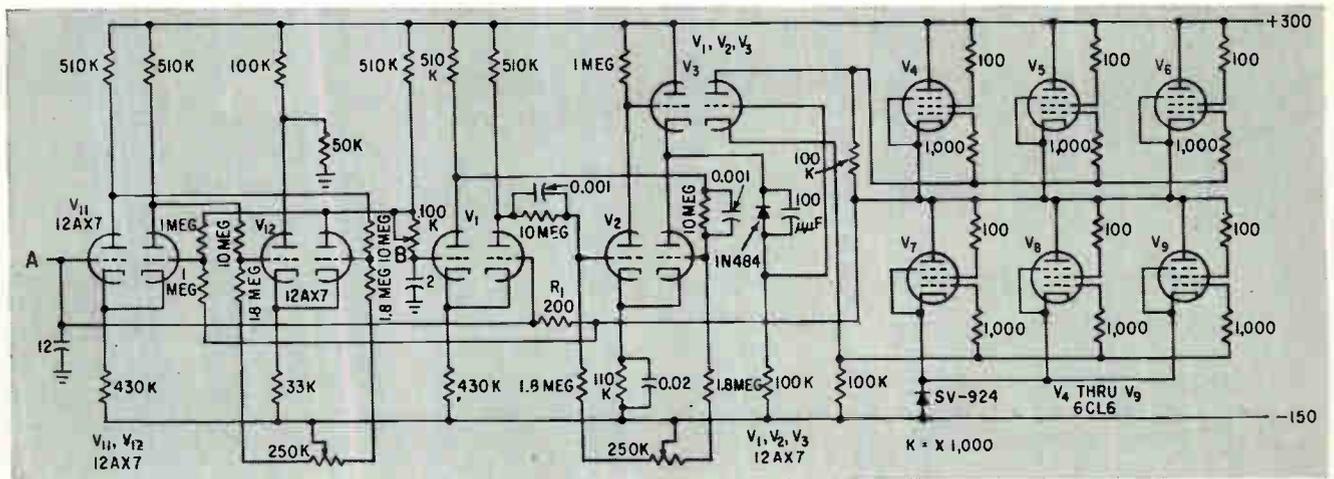


FIG. 4—Thermal air storage circuit uses configuration similar to the area amplifiers

fier with  $V_3$  providing the bootstrap and also phase inversion. The output stage uses three 6CL6's in each phase of a single-ended, push-pull arrangement. This gives a circuit with a 90-ma nominal current capability in either direction.

The 6CL6 has a plate dissipation rating that permits 30 ma per tube output. High gain and transconductance make the grid swing relatively small and ease bias and drive problems.

#### Air Conditioner

The air conditioner circuit, Fig. 5, simulates either air or water-cooled air conditioners with capacities of up to 90,000 btu/hr. The output stage uses three 6CL6's in parallel to obtain the required output current, and the feedback circuit from the area amplifier is a bridge.

A thermostat circuit controls the air conditioner in accordance with the indoor temperature. Front panel controls are provided for the turn-on temperature and the temperature differential. The circuit is

turned on and off by a flip-flop through a resistor-diode network.

It takes the computer 24 seconds to analyze over 50 factors that will affect cooling needs.

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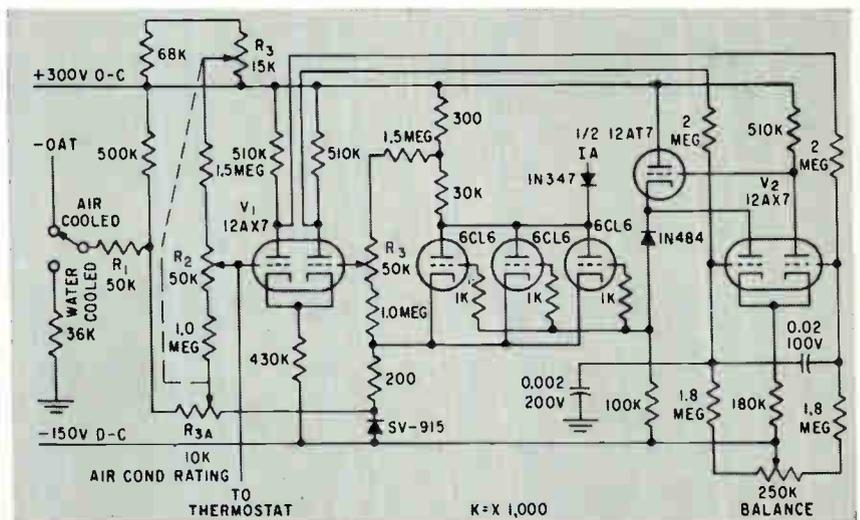


FIG. 5—Air-conditioner circuit simulates either air or water cooled air units with capacities up to 90,000 btu/hr.

# Selecting Transistors for

How to predict the change in transistor current gain with nuclear radiation. Nomographs also permit finding lifetime and tolerable neutron dosage for different transistor types

By JOHN R. BILINSKI and RICHARD MERRILL, Light Military Electronics Dept., General Electric Co., Ithaca, N. Y.

**N**UCLEAR RADIATION effects are becoming important in design of transistorized airborne equipment for the military. Obtaining electronic equipment that can survive a nearby nuclear burst is now being considered. With future prospects of nuclear aircraft, equipment must also be able to operate for a long time near reactor radiation.

## Radiation Damage

Of the semiconductor properties affected by radiation, changes in minority carrier lifetime are the predominant cause of permanent damage in a semiconductor device (ELECTRONICS, p 55, Nov. 27, 1959). Lifetime is relatively sensitive to radiation, decreasing with increasing dose because of the introduction of recombination centers.

Assuming there is no interaction between the original recombination centers and those introduced by the radiation, and that surface recombination velocity does not vary appreciably during irradiation, then the minority carrier lifetime during irradiation may be expressed as

$$\frac{1}{\tau_P} = \frac{1}{\tau_i} + \frac{\phi}{K}$$

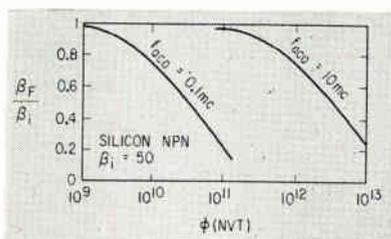


FIG. 2—Graph shows radiation resistance improving as  $f_{aco}$  increases

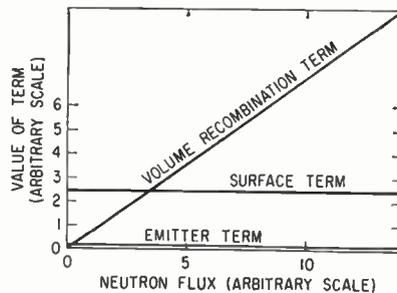


FIG. 1—Change in terms of Eq. 1 with neutron flux for typical transistor

This equation will hold for neutron, electron, proton, alpha and gamma radiation. The lifetime damage constant,  $K$ , can be expressed in other parameters, but can be considered an empirical constant determined experimentally for a particular type of radiation. Values of  $K$  for a fission environment are presented in Table II. These values are determined primarily by high energy neutrons.

## Effects on Transistors

Radiation produces a permanent decrease in current gain,  $\beta$ , along with a transient change in the leakage current,  $I_{co}$ . From first-order theory, the grounded-emitter current gain for a  $pn$ p transistor can be written as

$$\frac{1}{\beta} = \frac{SWA_s}{D_p A_e} + \frac{\sigma_b W}{\sigma_e L_{ne}} + \frac{1}{2} \left( \frac{W}{L_{pb}} \right)^2 \quad (1)$$

A similar relationship can be obtained for an  $n$ pn transistor by changing subscripts  $p$  to  $n$  and  $n$  to  $p$  throughout Eq. 1.

The first term on the right-hand side of Eq. 1 is the surface recombination term, the second is the emitter efficiency term and the third is the volume recombination term. Changes in these terms for a typical transistor are shown in Fig. 1. During irradiation, changes in the volume recombination term are of greatest importance. It can be assumed that a transistor will fail as a result of changes in this term before the changes in the other terms become significant.

The effect of radiation on the volume recombination term can be attributed to permanent changes in the minority carrier lifetime. Making use of the relations

$$L_{pb}^2 = D_p \tau_p \quad \text{and} \quad f_{aco} = \left( \frac{1.22}{\pi} \right) \left( \frac{D_p}{W^2} \right)$$

the volume recombination term can be written as

$$\frac{1}{2} \left( \frac{W}{L_b} \right)^2 = \left( \frac{1.22}{2\pi} \right) \left( \frac{1}{f_{aco}} \right) \left( \frac{1}{\tau_p} \right) \quad (2)$$

Equation 1 can be written as

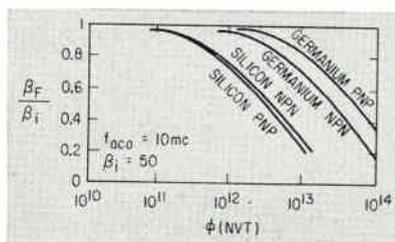


FIG. 3—Graph shows change in  $\beta$  as a function of neutron dosage

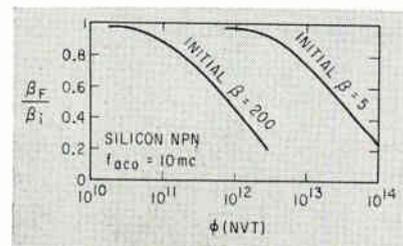


FIG. 4—Graph shows variation in initial  $\beta$  with radiation resistance

# Radiation Environments

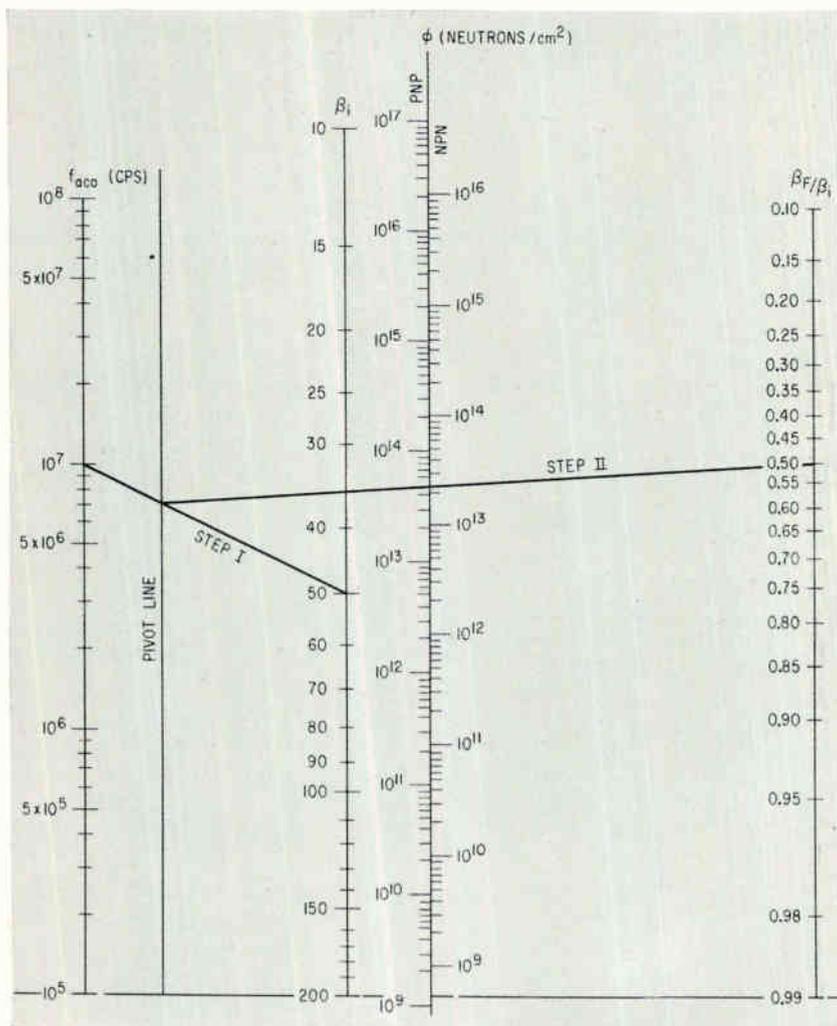


FIG. 5—Nomograph for obtaining variation in grounded emitter current gain of germanium npn and pnp transistors with neutron flux

$$\frac{1}{\beta} = \frac{SWA_s}{D_p A_e} + \frac{\sigma_b W}{\sigma_e L_{ne}} + \left( \frac{1.22}{2\pi} \right) \left( \frac{1}{f_{\alpha 0}} \right) \left( \frac{1}{\tau_p} \right) \quad (2a)$$

Under radiation

$$\frac{1}{\beta_i} = \left( \frac{1}{\tau_{pi}} + \frac{\phi}{K} \right)$$

Substituting this expression in Eq. 2a gives

$$\frac{1}{\beta_F} = \frac{SWA_s}{D_p A_e} + \frac{\sigma_b W}{\sigma_e L_{ne}} + \left( \frac{1.22}{2\pi} \right) \left( \frac{1}{f_{\alpha 0}} \right) \left( \frac{1}{\tau_{pi}} + \frac{\phi}{K} \right)$$

This leads to

$$\frac{1}{\beta_F} = \frac{1}{\beta_i} + \left( \frac{1.22}{2\pi} \right) \left( \frac{\phi}{K f_{\alpha 0}} \right) \quad (3)$$

Normalizing

$$\frac{\beta_F}{\beta_i} = \frac{1}{1 + \left( \frac{1.22}{2\pi} \right) \left( \frac{\phi \beta_i}{K f_{\alpha 0}} \right)} \quad (4)$$

Although Eqs. (3) and (4) were developed for a *pnp* transistor, they apply equally well to an *nnp* transistor if the proper *K* is used.

No completely satisfactory method of predicting the effect of radiation on the leakage current of a transistor is known. An increase in  $I_{c0}$  is observed during irradiation. This increase is transient, and when the transistor is removed from the radiation, the  $I_{c0}$  may decay to its original value or to an intermediate permanent damage value. In a fission environment,  $I_{c0}$  begins to increase at approximately

Table 1—Symbols

$\beta$	grounded emitter current gain
$\beta_F$	$\beta$ after irradiation
$\beta_i$	$\beta$ before irradiation
$\sigma_b$	base conductivity
$\sigma_e$	emitter conductivity
$\tau$	minority carrier lifetime
$\tau_F$	$\tau$ after irradiation
$\tau_i$	$\tau$ before irradiation
$\phi$	integrated neutron flux (nvt)
$A_e$	area of emitter junction
$A_s$	effective surface recombination area around emitter
$D_p$	diffusion constant for holes
$f_{\alpha 0}$	alpha cutoff frequency
$I_{c0}$	leakage current
$I_e$	emitter current
$K$	lifetime damage constant
$L_{ne}$	diffusion length for electrons in the emitter
$L_{ph}$	diffusion length for holes in the base
$S$	surface recombination velocity
$W$	base width

the same radiation dose at which  $\beta$  begins to decrease. The product  $\beta I_{c0}$  can be considered as remaining constant, with  $I_{c0}$  increasing as  $\beta$  decreases.

The change in  $I_{c0}$  is attributed to ionization produced by gamma radiation. Recombination of holes and electrons can result in a photovoltage across a junction and a net increase in leakage current. The encapsulating material surrounding a junction may have some influence on the magnitude of the surface effects.

Leakage current may also be changed because of bulk damage by neutrons. Thus for radiation consisting of both fast neutrons and gamma radiation, permanent damage is generally observed in  $I_{c0}$ , even though the transient damage predominates.

## Radiation Resistance

Equation 4 shows the change in transistor current gain as a function of neutron flux,  $\phi$ , in a radiation environment. This equation is useful since it is given in known transistor parameters. Equation 4 can be rewritten as

$$\phi = \frac{f_{\alpha 0} K}{0.194 \beta_i} \left( \frac{1}{\beta_F / \beta_i} - 1 \right)$$

which shows that the maximum neutron flux a transistor can tolerate, for a given allowable change in  $\beta$ , is a direct function of  $f_{aco}$  and the constant,  $K$ , of the recombination process. The  $f_{aco}$  is dependent on the base width: the narrower the base width, the less recombination that can take place per unit time, and the transistor is that much more radiation resistant. therefore, a higher  $f_{aco}$  transistor will be more radiation resistant. As shown in Fig. 2, an increase in  $f_{aco}$  by a factor of 100 increases  $\phi$  by

the same factor.

The lifetime damage constant,  $K$ , depends upon the type of material, as shown by Table II. The change in  $\beta$  as a function of neutron dose is illustrated in Fig. 3 for various types of transistor. An appreciable gain in radiation tolerance can be achieved by using germanium transistors rather than silicon transistors. Germanium *pnp* transistors are better than germanium *npn* ones. The difference between silicon *npn* and *pnp* transistors is slight.

Table II—Lifetime Damage Constant for Fast Neutrons

Material	Transistor Type	$K$ (nvt-sec)
<i>n</i> -type Ge	<i>pnp</i> Ge	$5.0 \pm 2.0 \times 10^7$
<i>p</i> -type Ge	<i>nnp</i> Ge	$2.4 \pm 0.4 \times 10^7$
<i>n</i> -type Si	<i>pnp</i> Si	$2.8 \pm 0.8 \times 10^6$
<i>p</i> -type Si	<i>nnp</i> Si	$3.2 \pm 1.1 \times 10^6$

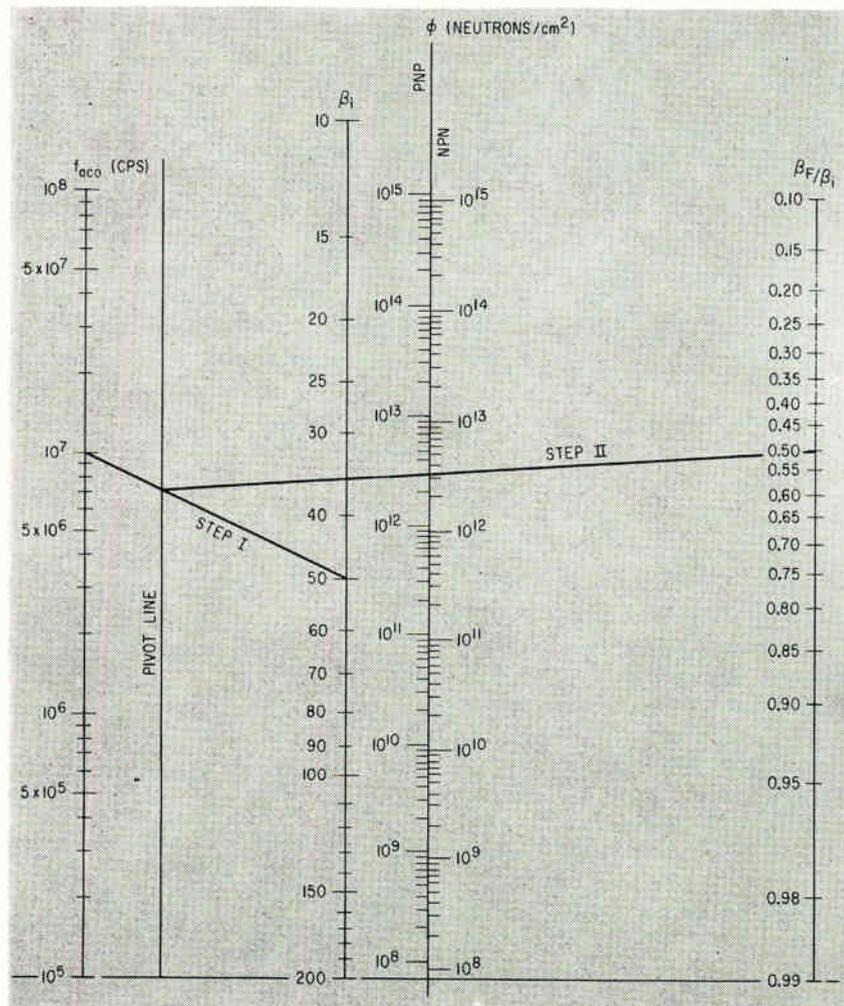


FIG. 6—Nomograph for obtaining variation in grounded emitter current gain of silicon *nnp* and *pnp* transistors with neutron flux

Fig. 4 shows the variation of initial  $\beta$  with radiation resistance. The smaller the  $\beta_i$ , the larger the neutron flux that the transistor can tolerate. The most radiation-resistant transistors are germanium *pnp* transistors having a high  $f_{aco}$  and low  $\beta_i$ .

### Nomographs

The nomographs in Fig. 5 and 6 can be used to determine the percentage change in transistor grounded emitter current gain because of a certain amount of neutron flux. These nomographs are based on Eq. 4.

To use the nomograph: First, place a straight edge connecting the value of  $f_{aco}$  and  $\beta_i$  of the transistor, noting the intersection with the pivot line. Next, take the straight edge and make a connection with the pivot line intersection point and the  $\beta_f/\beta_i$  value found tolerable. Read on the  $\phi$  scale (*nnp* or *pnp* depending on type transistor) the neutron dose that will cause the reduction in  $\beta$ .

As an example, if the manufacturer of a silicon *nnp* transistor specifies an  $f_{aco} = 10$  mc and  $\beta_i = 50$ , and if the design tolerance is  $\beta_f/\beta_i = 50$  percent, then from Fig. 6,  $\phi = 3.3 \times 10^{12}$  neutrons/cm<sup>2</sup>.

If the neutron flux rate and the tolerable change in current gain are known, then Fig. 5 and 6 can be used to compute the time the transistor will operate in the nuclear environment. This is done by finding  $\phi$ , as described, and dividing this value by the neutron flux.

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# Recording Manometer

Pressure of the body's vital liquids are measured and recorded by photoelectric system. Mercury or other opaque fluids may also be measured

By W. E. GILSON and H. LUDWIG, Medical Center of the University of Wisconsin, Madison, Wis.

**B**IOLICAL PRESSURES in the blood, bile or spinal fluid (those readily measured with a water or mercury manometer) are important in medical research, diagnosis and treatment. Such pressures must frequently be observed and recorded over long periods of time. The instrument to be described, an improved version of one previously reported by one of the authors<sup>1</sup>, has the advantage that there is no zero drift and the pen deflection is directly in millimeters of water. The instrument was developed for a study of the effect of drugs on spinal fluid pressures<sup>2</sup>.

Pressures are measured by a liquid-filled glass-tube manometer connected by surgical tubing to the preparation. A movable aluminum carriage fits over the manometer tube and holds a photocell. The photocell receives light through the tube from a fluorescent lamp on the opposite side. The photocell is made to follow the meniscus of the liquid by a servomechanism which also drives the pen as shown in Fig. 1.

## Servo Loop

The resistance of cadmium-sulfide photocell  $D_1$  decreases with incident light. The light transmitted to the cell is greater when the manometer liquid level is above the cell than when the level is below it. This happens because the transparent liquid in the tube forms a cylindrical lens which focuses light along a line 2 mm behind the tube. The photocell is positioned 2 mm behind the tube. Here it is most responsive to the change in light intensity occurring when light crosses the meniscus of the liquid.

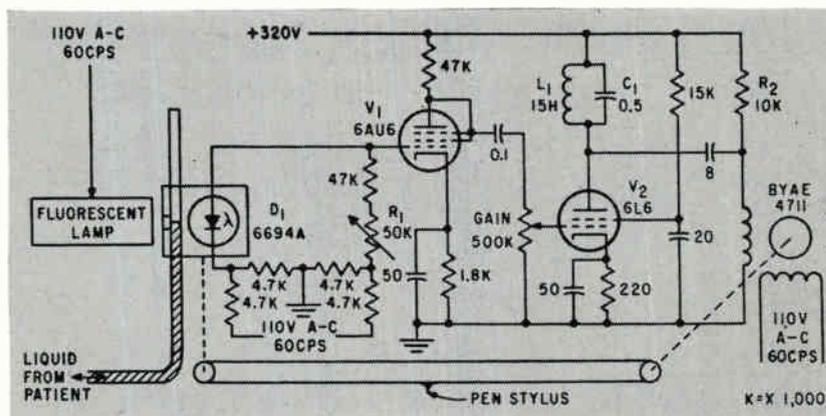


FIG. 1—Servo loop maintains photocell at meniscus level of liquid. Mechanical linkage also drives recording pen stylus

The light source, manometer, and photocell are enclosed in a box to shield them from outside light.

The photocell resistance forms one leg of a resistive bridge. Bridge balancing potentiometer  $R_1$  is adjusted to balance the bridge when the photocell is opposite the meniscus. A rise in manometer fluid unbalances the bridge and presents a 60-cps error signal to the amplifier. A fall in pressure unbalances the bridge in an opposite sense, thus reversing the phase of the grid signal. Parallel resonant circuit ( $L_1$  and  $C_1$ ) in series with the plate of  $V_2$  attenuates 60-cps harmonics. Resistor  $R_2$  supplies direct current to the control winding to increase dynamic damping of the motor and minimize hunting. The motor is coupled through a gear train, pulleys and bead chain to the photocell carriage. The fluorescent lamp extends beyond the length of the manometer. The upper end of the lamp is covered with a light shield and the lower end is reinforced with

a reflector. At the extremes of photocell-carriage travel, this arrangement automatically unbalances the bridge in the proper direction to keep the carriage from hitting the stops. The manometer tube bore is fine enough to permit spinal pressure measurements without excessive drain on spinal fluid. The tube is readily removed from the photocell carriage for cleaning and sterilization.

Instead of a transparent fluid, an opaque one such as blood or mercury may be used if the connections to the main winding of the servo motor are reversed, so that less light drives the photocell carriage up instead of down.

The authors wish to acknowledge the assistance of F. J. Schadauer and A. Breitzke in the construction of the instrument.

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# R-F Cables and Connectors

Table I—Cross-Index and Application Data for Old (Group I) and New (Group II) R-F Cables

MIL-C-17B Cables	Char Imped- ance (ohm)	Diameters (inches)				Max Oper Volts RMS	Attenuation (db/100 ft)		Remarks
		Inner Cond (nom)	Over Dielectric (nom)	Outer Cond (max)	Over- all (nom)		400 mc	3 kmc	
(I) RG-5B/U	50	0.051	0.181	0.260	0.328	3,000	6.5	ND <sup>a</sup>	
(II) RG-212/U	50	0.0556	0.185	0.265	0.332	3,000	6.5	24	
(I, II) RG-6A/U	75	0.0285	0.185	0.264	0.332	2,700	6.5	23	
(I) RG-8A/U	52	0.0855	0.285	0.34	0.405	5,000	6	21.7	
(II) RG-213/U	50	0.089	0.285	0.34	0.405	5,000	5.5	19	
(I) RG-9B/U	50	0.0855	0.28	0.355	0.42	5,000	6.1	21.8	improved attenuation and corona stability above 3,000 mc.
(II) RG-214/U	50	0.089	0.285	0.36	0.425	5,000	5.5	19	
(I) RG-10A/U	52	0.0855	0.285	0.34	0.475 <sup>c</sup>	5,000	6	ND <sup>a</sup>	armored version of RG-8A/U armored version of RG-213/U
(II) RG-215/U	50	0.089	0.285	0.34	0.475 <sup>c</sup>	5,000	5.5	19	
(I, II) RG-12A/U	75	0.0477	0.285	0.34	0.475 <sup>c</sup>	5,000	5.2	18.5	
(I) RG-13A/U	74	0.0477	0.28	0.355	0.42	5,000	5.7	ND <sup>a</sup>	
(II) RG-216/U	75	0.0477	0.285	0.36	0.425	5,000	5.2	18.5	
(I) RG-14A/U	52	0.102	0.37	0.463	0.545	7,000	4.3	14	
(II) RG-217/U	50	0.106	0.37	0.463	0.545	7,000	4.3	14	
(I) RG-17A/U	52	0.188	0.68	0.76	0.87	11,000	2.8	11	
(II) RG-218/U	50	0.195	0.68	0.76	0.87	11,000	2.5	11	
(I) RG-18A/U	52	0.188	0.68	0.76	0.945 <sup>c</sup>	11,000	2.8	11	armored version of RG-17A/U armored version of RG-218/U
(II) RG-219/U	50	0.195	0.68	0.76	0.945 <sup>c</sup>	11,000	2.5	11	
(I) RG-19A/U	52	0.25	0.91	0.99	1.12	14,000	2.3	7.5	
(II) RG-220/U	50	0.26	0.91	0.99	1.12	14,000	2.3	7.5	
(I) RG-20A/U	52	0.25	0.91	0.99	1.12	14,000	2.3	7.5	armored version of RG-19A/U armored version of RG-221/U
(II) RG-221/U	50	0.26	0.91	0.99	1.12	14,000	2.3	7.5	
(I) RG-21A/U	53	0.0508	0.185	0.264	0.332	7,000	33	33	high attenuation cable
(II) RG-222/U	50	0.0556	0.185	0.264	0.332	7,000	90	90	
(I, II) RG-22B/U	95	0.0456 <sup>b</sup>	0.285	0.355	0.42		10.5	25	5% max capacitance unbalance 10% max transmission unbalance
(I) RG-55B/U	53.5	0.032	0.116	0.176	0.206 <sup>c</sup>	1,900	11.7	40	
(II) RG-223/U	50	0.035	0.116	0.176	0.216 <sup>c</sup>	1,900	11.7	40	
(I, II) RG-58C/U	50	0.0375 <sup>c</sup>	0.116	0.15	0.195	1,900	14	50	
(I, II) RG-59B/U	75	0.023	0.146	0.191	0.242	2,300	9	30	
(I, II) RG-62A/U	93	0.0253	0.146	0.191	0.242		8	16	less than 1.5% capac stability
(I) RG-74A/U	52	0.102	0.37	0.463	0.545	7,000	4.3	14	armored version of RG-14A/U armored version of RG-217/U
(II) RG-224/U	50	0.106	0.37	0.463	0.545	7,000	4.3	14	
(I, II) RG-81/U	50	0.0625	0.321	0.375 <sup>d</sup>	0.375	3,000	5.5	20	for extreme high temp applications
(I, II) RG-85A/U	75	0.1045	0.68	0.76	1.565 <sup>c</sup>	10,000	2.8	9	for burial applications
(I) RG-87A/U	50	0.096	0.28	0.355	0.425	5,000	5	14	high power (Teflon) version of RG-9B/U high power (Teflon) version of RG-214/U
(II) RG-225/U	50	0.0936	0.285	0.36	0.43	5,000	5	14	
(I) RG-94/U	50	0.1125	0.292	0.38	0.445	7,000	3.8	13	high power (Teflon) version of RG-14A/U high power (Teflon) version of RG-217/U
(II) RG-226/U	50	0.127	0.37	0.44	0.5	7,000	3.8	14	
(I) RG-117/U	50	0.188	0.62	0.67	0.73	7,000	2.3	ND <sup>a</sup>	high power cable
(II) RG-211/U	50	0.19	0.62	0.67	0.73	7,000	2.3	10	
(I) RG-118/U	50	0.188	0.62	0.67	0.78	7,000	2.3	ND <sup>a</sup>	armored version of RG-117/U armored version of RG-211/U
(II) RG-228/U	50	0.19	0.62	0.67	0.78	7,000	2.3	10	
(I) RG-143/U	50	0.057	0.185	0.25	0.325	3,000	6	18	high power (Teflon) version of RG-5B/U high power (Teflon) version of RG-212/U
(II) RG-143A/U	50	0.059	0.185	0.25	0.325	3,000	6	18	
(II) RG-187/U	75	0.012	0.06	0.084	0.11 <sup>c</sup>	1,200	21	ND <sup>a</sup>	miniature Teflon cable miniature Teflon cable miniature Teflon cable miniature Teflon cable
(II) RG-188/U	50	0.02	0.06	0.081	0.11 <sup>c</sup>	1,200	20	ND <sup>a</sup>	
(II) RG-195/U	95	0.012	0.102	0.124	0.155 <sup>c</sup>	1,500	17	ND <sup>a</sup>	
(II) RG-196/U	50	0.012	0.034	0.054	0.08 <sup>c</sup>	1,000	29	ND <sup>a</sup>	

(a) No data available (b) Each strand of two-strand conductor (c) Maximum (d) Nominal

# for Military Applications

By **MORTON POMERANTZ,**

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NEW NOMENCLATURES have recently been given many r-f cables with military applications. These new cables and their original counterparts are incorporated in the latest supplement (Supplement 1C) to MIL-C-17B.

The changes result from previous action, changing the characteristic impedance of JAN-C-17A cables from 52 ohms to 50 ohms. Connectors associated with these cables were already rated at 50 ohms. However, the inner conductors of the cables were enlarged and in many cases this necessitated modifications in the connectors to make them electrically and physically compatible with the 50-ohm cables.

These modifications are now completed. Except for series C and N connectors for RG-217/U cable, applicable military drawings have been revised. The two exceptions have been modified at USASRD and are expected to be coordinated by the other military services soon. Before the modifications were made, however, the 52-ohm cables were reinstated in MIL-C-17B so that cables would be available for the unmodified connectors. The new nomenclature was assigned the 50-ohm cables to distinguish them from 52-ohm cables.

The tabulations presented here are intended to guide systems engineers in selecting cable and fittings and by providing a cross-index resolve any confusion which may have resulted from the changes noted.

The tables do not include semirigid, partial-air-dielectric cables, presently being considered for adoption in coordinated military specifications. These are generally used when long distances between parts of a system would result in prohibitive attenuation if solid dielectric cables were used. Connectors for these cables are commercially available.

Table I compares the JAN-C-17A cables reinstated in MIL-C-17B (Group I) with the new 50-ohm cables (Group II). For cables of other impedances, only one nomenclature change was made (RG-13A/U to RG-216/U), because of minor dimensional changes.

Table II lists fittings and connectors for the Group II cables. Suffix letters in the connector nomenclature have been modified. These connectors accommodate 50-ohm cable, but may not accommodate 52-ohm cable.

The miniature Teflon cables are not included as there are no military standard connectors for them. Military needs are being filled by commercial miniature connectors.

The author acknowledges the helpful suggestions of J. P. Agrios, who also coordinated much of the

data contained in Table I.

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Table II—Connectors for Group II Cables

MIL-C-17B Cables	Fittings*	C Series	N Series	BNC Series	Other
RG-212/U	—				
RG-6A/U <sup>b</sup>	PS	UG-626B/U	UG-18D/U		
RG-143A/U	JS	UG-633A/U	UG-20D/U		
RG-222/U	JSB	UG-630A/U	UG-159C/U		
RG-213/U	PS	UG-573B/U	UG-21E/U		
RG-214/U	JS	UG-572A/U	UG-23E/U		
RG-216/U <sup>b</sup>	JSB	UG-570A/U	UG-160D/U		
RG-225/U	PRA	UG-710B/U			
RG-215/U	PS	UG-943B/U	UG-941B/U		
RG-12A/U <sup>b</sup>	JS	UG-944A/U	UG-940B/U		
	JSB	UG-937A/U	UG-936B/U		
	PRA	UG-945B/U			
RG-217/U	PS	UG-707(U) <sup>c</sup>	UG-204(U) <sup>c</sup>		
RG-218/U	PS	UG-708B/U	UG-167E/U		UG-1258/U <sup>d</sup>
	RS				UG-352B/U <sup>d</sup>
RG-219/U	PS		UG-982/U		UG-154A/U <sup>d</sup>
	RS				UG-352B/U <sup>d</sup>
RG-220/U	PS				UG-156A/U <sup>d</sup>
RG-221/U	ASFF				UG-157B/U <sup>d</sup>
RG-22B/U <sup>b</sup>	PS				UG-421A/U <sup>e</sup>
	JPSF				UG-423A/U <sup>e</sup>
RG-223/U	PS	UG-709B/U	UG-536B/U	UG-88D/U	UG-699/U
RG-58C/U	JS	UG-704A/U	UG-556B/U	UG-89C/U	
	JSB		UG-160D/U	UG-909A/U	UG-700/U <sup>f</sup>
	PRA			UG-913A/U	
RG-59B/U <sup>b</sup>	PS	UG-627B/U	UG-603A/U	UG-260C/U	UG-692/U <sup>f</sup>
RG-62A/U <sup>b</sup>	JSB	UG-631A/U		UG-261C/U	UG-923/U <sup>f</sup>
RG-224/U	PS		UG-1006(U) <sup>c</sup>		
RG-81/U	PS		UG-486/U		
	JS		UG-483/U		
RG-85A/U <sup>b</sup>	PS				UG-1179/U <sup>d</sup>
RG-226/U	PS			none available	
RG-211/U	PS				UG-532A/U <sup>e</sup>
	ASFF	UG-711B/U			UG-533B/U <sup>e</sup>
RG-228/U	PS				UG-532A/U <sup>e</sup>
	ASFF				UG-533B/U <sup>e</sup>

(a) Key: PS—plug, straight; PRA—plug, right angle; JS—jack, straight; JSB—jack, straight, bulkhead; JPSF—jack, panel, square flange; ASFF—adapter, straight, female-to-female; RS—receptacle, straight (b) Other than 50-ohm or 52-ohm cable (c) Recent modification, not coordinated (d) LC series (e) Twin series (f) SM series (g) LT series

# How Solar Noise

Optical sighting of sun combined with simultaneous measurement of solar noise checks congruence between boresight telescope and antenna pattern axes

By J. A. KUECKEN,

Project Engineer, Antenna Development, Avco Corp., Cincinnati, Ohio



Radar set AN/MPS-16, a C-band height finder, was used in solar-noise calibration experiments.

**S**UPERSONIC AIRCRAFT intercept using automatic data handling systems and intercept plotters has placed increasingly stringent requirements upon the accuracy of early warning and height finder radar data.

In the usual radar system, it is possible to check the calibration of all circuits with internal or portable test gear. However, the antenna and its servo system bear the entire burden of angular bearing accuracy. The only information most radar systems have regarding the bearing and elevation angles of a target is usually obtained from the physical position (or aiming angles) of the antenna in the ON TARGET position. This relationship between the physical position of the antenna structure and the bearing angle of the antenna beam is usually calibrated at the factory; however, throughout the life of the system it is not usually checked. This calibration, or antenna boresight, is often suspect and the method to be described provides a simple and effective means of checking the calibration of the antenna as installed.

Pattern and gain measurements and boresight and level calibrations of radar antennas are usually per-

formed on a specialized antenna range. A remote transmitter provides a reference signal and the antenna is held in a fixture. The site terrain is of particular importance in that local reflections must be minimized. These conditions do not usually prevail at field radar sites and the necessary equipment is not available.

## Solar Noise

The sun is a powerful emitter of radio waves throughout the r-f spectrum<sup>1</sup>. Intensity of the radiation is approximately proportional to the wavelength. This makes possible the use of the sun as a remote test source for the measurement of antenna patterns. A further advantage is that the position of the sun relative to any fixed position on the earth may be readily calculated with ephemeris or almanac, knowing only the exact time and geographical location. Information regarding antenna boresight, patterns<sup>2</sup>, and atmospheric refraction<sup>3</sup>, may be obtained if the radar system is sensitive enough to detect this solar noise. This technique is lim-

ited by the finite extent of the radio-solar disk and the nature of the noise signals received. Other radio sources such as Cygnus A are well known and of much smaller extent. These sources would tend to yield a more accurate pattern, but their measured strength is much smaller.

The factory boresight setting may become suspect in a radar set after rough handling and field assembly and disassembly. Structural members of the antenna have occasionally been broken in transportation accidents and other mishaps. Mechanical repairs are then likely to leave the boresight open to question.

Since many ground radars come equipped with a boresight telescope, it was decided that the simplest procedure would be to check the congruence of the boresight telescope axis with the antenna pattern axis. Once the relationship between these two axes is known, the normal boresight procedure can be followed with allowance for known error.

It is necessary in the field that the received average-noise signal prove relatively steady and constant in magnitude throughout the test. Otherwise it would be necessary to repeat the test many times. Secondly, it is important to discover whether the received noise signal is sufficiently strong to permit ready recognition and to preclude need for an auxiliary radiometer or other equipment.

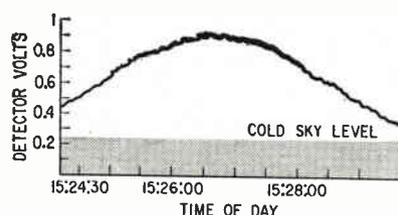


FIG. 1—Receiver second-detector voltage varies as sun drifts past antenna beam

# Calibrates Radars

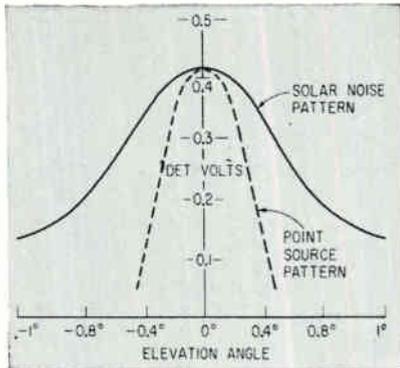


FIG. 2—Solar noise pattern compared with point source pattern, as a function of elevation angle

Figure 1 illustrates a drift pattern of the sun taken with a slightly reduced manual gain setting. This pattern was taken by placing the antenna beam in the path of the sun and recording second detector voltage as a function of time as the sun passed through the antenna beam. The transmitter was inoperative for this test. Two things about this pattern are noteworthy. First is the strength of the received signal which carries the second detector voltage well above the normal receiver noise with the antenna looking at the cold sky. Second is the steadiness of the pattern. The recorder used had a 2-sec response time and neither the recorder nor the second detector voltmeter showed any appreciable fluctuation on any of the series of measurements. This pattern is representative of the signal steadiness obtained during the entire measurement program.

Figure 2 illustrates the average solar elevation pattern of the antenna obtained with two different radar systems and a series of measurements compared with an average elevation pattern taken with a point source on the antenna range. The distortion of the solar pattern due to the finite width of the source (0.5 degree for the sun) is noticeable. The ordinate is second detector output voltage.

Attempts were made to measure accurately the received signal power by comparison with a calibrated signal generator; however, it was

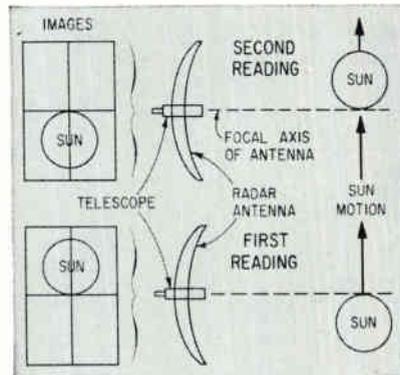


FIG. 3—With antenna stationary in path of sun, second detector voltage is measured at sun upper and lower limbs

found that a c-w signal tended to saturate the receiver before the equivalent second detector voltage was attained. Signal strength measurements made by the tangent noise method using a 10  $\mu$ sec pulse revealed a maximum signal-to-noise ratio of 15 db.

## Calibration

The antenna is cranked around to face the sun and the second detector voltage is read and recorded when the optical disk of the sun is tangent above and tangent below (upper and lower limb readings) the horizontal crosshair of the telescope (as shown in Fig. 3), swinging slightly in azimuth to keep the vertical crosshair centered. These readings are then applied to the chart of Fig. 4 to obtain the angular error of the boresight telescope. This error may then be applied as a correction in the system boresighting procedure normally used with the radar.

In a series of 21 measurements covering two different radar systems, the maximum difference in the readings on a single system was about 0.03 degree or approximately 1/20 of a beamwidth. This precision of measurement is more than adequate for boresight checking of search or height finder radar.

The second detector voltage readings throughout the series of experiments (covering a period of several months) were sufficiently repeatable and constant to be usable as an overall index of antenna

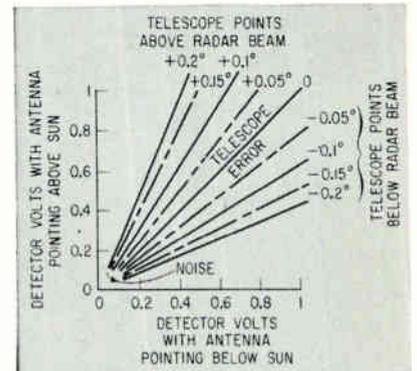


FIG. 4—Boresight correction chart determines degree of misalignment between boresight telescope and radar beam

gain and receiver condition. Thus they provided the operating crew with a confidence factor concerning the accuracy of the radar system operation.

A similar technique is applicable to nearly any modern radar system possessing a sufficiently large antenna and sufficiently sensitive receiver. Above X-band it is not likely that most radars would be capable of detecting solar radiation. However, below S-band, the radio temperature of the sun is so large that nearly all radars should be capable of detecting solar radiation and making use of this technique. Radars installed within a radome or radars not equipped with a boresight telescope would have to be supplied with external information regarding the position of the sun at the two times of measurement. This information could be either measured or calculated from an ephemeris, knowing time and geographical location. A second possibility would be use of collimated and interchangeable infrared and optical telescopes or use of an infrared telescope and an appropriate beacon.

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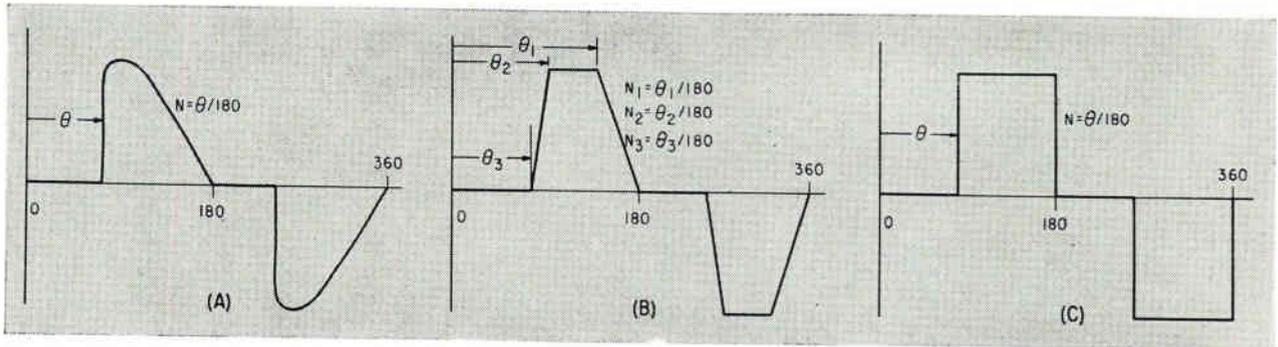


FIG. 1—Waveforms of chopped sine wave (A), asymmetrical chopped trapezoidal wave (B) and chopped square wave (C) show angle measurements required

# Curves Find Value of Chopped Waveforms

Finding the rms value of a chopped current or voltage wave is simplified with these curves and ordinary test equipment including average-reading meter and an oscilloscope

By J. S. MACDOUGALL, Application Engineer, Raytheon Co., Needham Heights, Mass.

**F**REQUENTLY, IN WORK involving magnetic amplifiers and switching devices, it is necessary to find the rms value of a chopped sine or square wave. Since commonly used laboratory meters read average values, a correction factor is necessary to obtain the true rms value. The following equations and curves enable the engineer to find quickly the meter multiplication factor for the chopped sine wave and square wave (or its more general form, the trapezoidal wave) when using a meter that reads average values.

Although voltages are used as the measured quantity throughout the analysis, the results apply equally well to currents. A

glossary of terms is given in Table 1.

### Sine Wave

The waveform given in Fig. 1A could be the output from a magnetic amplifier at some firing angle  $\theta$ . If  $N = \theta/180$ , then the outputs are given by

$$E_{rms} = E_m \sqrt{\frac{1-N}{2} - \frac{\sin 2(180-\theta)}{4\pi}}$$

and

$$E_{d-c} = \frac{E_m}{\pi} [1 - \cos(180 - \theta)]$$

The meter is calibrated to read root mean square of the average sine wave value. Therefore:  $E_{d-c} = M_r/1.11$  where  $M_r$  is the actual a-c meter reading. Since

Table 1—Glossary of Terms

- $\theta$ —Firing angle in electrical deg
- $N$ —Fraction of total possible firing angle =  $\theta/180$  (for ease of measurement on oscilloscope)
- $M_r$ —Actual Meter Reading in rms volts (amps)
- $E_{rms}$ —Actual rms voltage
- $E_m$ —Zero to peak voltage
- $E_{d-c}$ —Actual d-c value of voltage
- $F$ —Meter correction factor (true rms =  $F \times M_r$ )

$E_{rms} = F \times M_r$ , the meter correction factor  $F = E_{rms}/E_{d-c} \cdot 1.11 =$

$$\frac{1}{1.11} \times \frac{\sqrt{2\pi^2(1-N) - \pi \sin 2(180-\theta)}}{2[1 - \cos(180-\theta)]} \quad (1)$$

Equation (1) is plotted in Fig.

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2 as a function of  $N$  and  $\theta$  and is labeled SINE.

**Square Wave**

For the trapezoidal wave shown in Fig. 1B the d-c and rms value are given by:

$$E_{d-c} = \frac{E_m}{2} [1 - (N_3 + N_2 - N_1)]$$

$$E_{rms} = \frac{E_m}{\sqrt{3}} \sqrt{1 - (N_3 + 2N_2 - 2N_1)}$$

Hence meter correction factor

$$F = \frac{E_{rms}}{E_{d-c}} \times \frac{1}{1.11} \tag{2}$$

$$= \frac{1}{1.11} \frac{2}{\sqrt{3}} \frac{\sqrt{1 - (N_3 + 2N_2 - 2N_1)}}{[1 - (N_3 + N_2 - N_1)]}$$

For a symmetrical wave  $N_2 = 1 - N_1 + N_3$

$$\therefore F = \frac{1}{1.11} \frac{1}{\sqrt{3}} \frac{\sqrt{4N_1 - 2N_3 - 1}}{(N_1 - N_3)} \tag{3}$$

For the square wave of Fig. 1C,  $N_1 = N_3$

$$\therefore F = \frac{1}{1.11} \frac{1}{\sqrt{1-N}} \tag{4}$$

Equation 4 is plotted in Fig. 2 as the SQUARE curve.

**Examples**

**Example 1:** An inverter has power control obtained by chopping its square wave output. Average reading type meters show an output of 110 v rms and 2 amp rms. An oscilloscope trace shows a firing angle of 90 deg. Find the true power output.

Enter the graph (Fig. 2) at  $\theta = 90$  deg and find the meter

correction factor of 1.27 on the square wave line.

Therefore:

$$E_{rms} = 1.27 \times 110 = 140 \text{ v}$$

$$I_{rms} = 1.27 \times 2 = 2.54 \text{ amp}$$

And the true power output is  $P_o = 140 \times 2.54 = 356 \text{ w}$ . Without the correction factor the indicated power output would have been  $2 \times 110 = 220 \text{ w}$ .

**Example 2:** If the inverter of example 1 is non-ideal because of stray circuit reactances its output wave form will more closely approximate a trapezoidal shape (Fig. 1B). Suppose that measurements made on an oscilloscope showed that  $\theta_3 = 90$  deg,  $\theta_1 = 170$  deg and  $\theta_2 = 95$  deg. Because of the many shapes possible in a trapezoidal waveform it is not feasible to provide a general graphical solution so a formula must be employed directly. Since  $N = \theta/180$ ,  $N_3 = 0.500$ ,  $N_2 = 0.527$ ,  $N_1 = 0.945$ . Using Eq. 2 the correction factor becomes:

$$F = \frac{1}{1.11} \frac{2}{\sqrt{3}} \frac{\sqrt{1 - (-0.336)}}{[1 - (0.082)]}$$

$$= \frac{(1.04)(1.16)}{0.918}$$

$$= 1.31$$

Therefore:

$$E_{rms} = 1.31 \times 110 = 144 \text{ v}$$

$$I_{rms} = 1.31 \times 2 = 2.6 \text{ amp}$$

Thus, the actual power output for these conditions would be  $144 \times 2.6$  or  $375 \text{ w}$ .

**Sine Wave**

**Example 3:** The specification on a magnetic amplifier calls for a current output of at least 15 amp rms when the firing angle is 120 deg. In the laboratory an output of only 9 amp is read on an average type meter and it appears that the amplifier will fail the test.

However, reference to the sine curve in Fig. 2, shows that the meter reading should be multiplied by 1.77 to obtain a true rms current of 15.9 amp. The table is entered for  $\theta = 120$  deg or for  $N = 120/180 = 0.67$ .

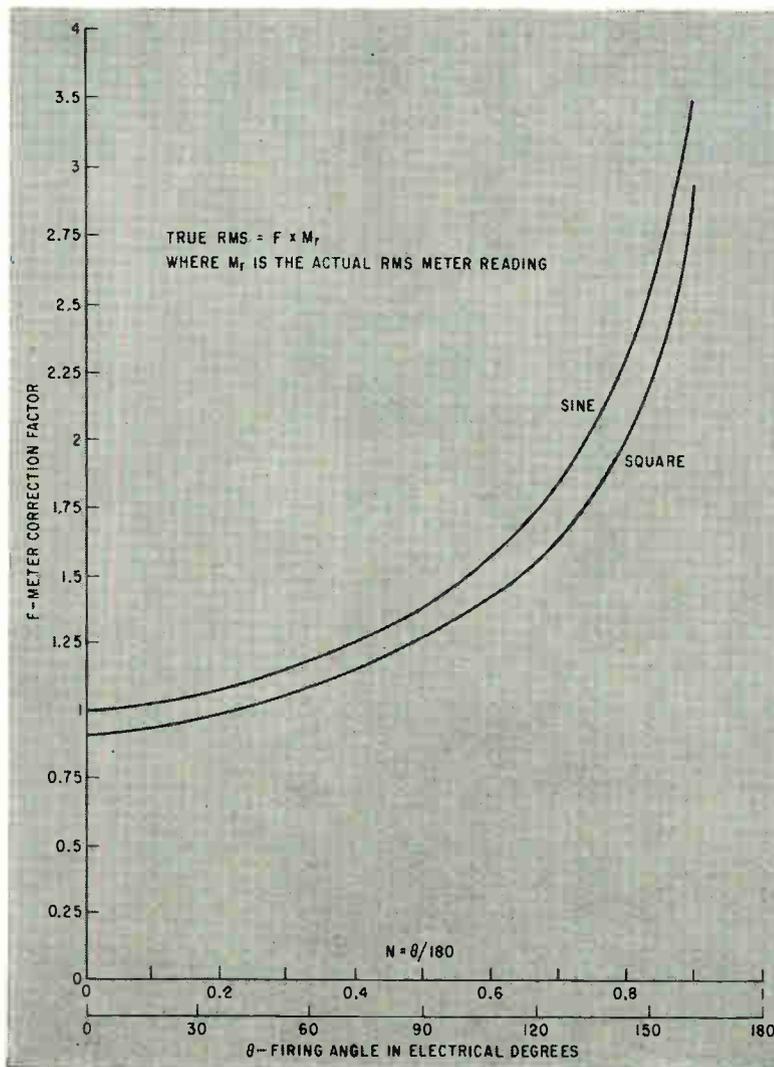
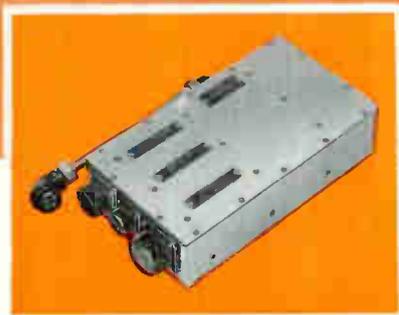


FIG. 2—Relationship of firing angle to correction factor is indicated



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LFE designed a Magnetic Control Amplifier that maintains constant

power supply frequency despite radical variations in load and temperature extremes. Acting as a servo-controller this compact solid state device controls flow of hydrogen peroxide to the turbine and constantly corrects frequency error and load unbalance. The degree of control achieved ( $\pm 0.5\%$ ) represents the ultimate in the present state of the art.

The reliability of the basic design has been proven in production, by LFE, of several thousand Magnetic Amplifier Controllers for the B-52. From proposal — to prototype — to production, the performance of the servo-controller dramatically exemplifies LFE's capability for meeting new problems with new concepts.



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# Computers Aid Propagation Studies

IMPROVED computation techniques are making digital computers more useful in scientific research requiring data reduction, data analysis and data-to-theory comparisons. For example, the National Bureau of Standards is using commercial digital computers in its radio propagation studies at Boulder Laboratories.

Fundamental studies being done include analysis of specular reflection from ionized meteor trails, world-wide prediction of transmission loss over ionospheric and tropospheric propagation paths and preparation of maps of ionospheric and tropospheric characteristics.

## Collection and Preparation

Techniques that will eliminate intermediate handling of data before processing are being investigated. Unfortunately, present limitations preclude recording in form suitable for direct input to the computer.

Reducing filmed records produced by ionospheric vertical sounding equipment is presently done by reading and scaling by an operator. Values are hand-punched on cards that are used as input. An integrated procedure using standard format, a system of machine cards and routine manipulation of data

have increased speed of this type data reduction.

Data taken in the field are now recorded in several ways besides strip-chart form. These methods include punched cards or punched paper tape for digitalized data and 12-channel magnetic tape for analog recordings. The analog data are either fed directly into special analog computers or later converted into digital form. Recording data from strip charts to punched cards can be accelerated by using a machine on which the operator aligns cross hairs and pushes a button. The machine records the data in card form for computer use.

One Bureau service is prediction, several months in advance, of ionospheric characteristics to permit selection of appropriate transmission frequencies for long-distance propagation. The computer performs many calculations involved in the theoretical models, allows testing of the models against observed data on a scale that would not otherwise be possible.

Present ionospheric prediction services are in the form of printed graphs. In the future, MUF (maximum useable frequency) predictions will also be issued on magnetic tape or on punched cards for those

having computers. Computer users will feed these data into their computer with coordinates of the paths to be used. Their computer will develop predictions for these paths.

## Ionospheric Maps

The Bureau has developed a computer program that produces contour maps of the ionosphere. It is expected that similar maps can be prepared from other ionospheric characteristics, meteorological data or other geophysical quantities.

To produce numerical ionospheric maps, data are analyzed by progressively fitting series of orthogonal functions in three coordinates: time, latitude and longitude. The process requires smoothing for clustering of points and noise interference. When completed, the time and geographical variations of optimum frequency are represented by a table of coefficients for a quite complicated function of three variables, equivalent to a mathematical map.

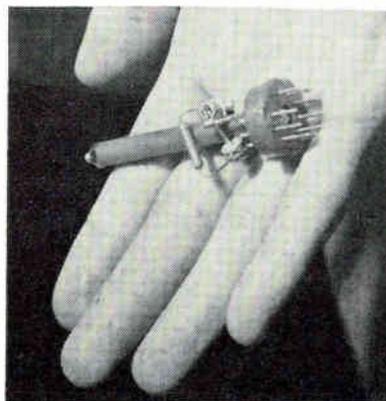
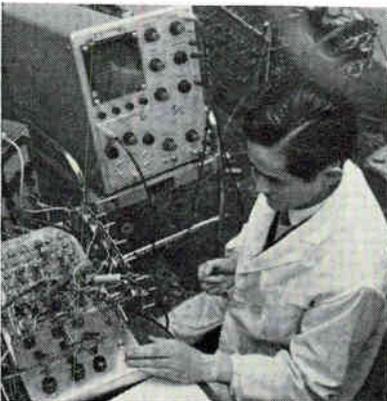
This project is not a mechanization of the Bureau's present prediction program. It is instead an attempt to make the most effective use of high-speed computers.

Most data in radio propagation experiments are continuously recorded over a period of time, mostly in analog form. Where a large amount of data must be reduced to not more than between 1 and 5 percent accuracy, special purpose analog computers have been constructed. One is a special application of an automatic wave analyzer. Compatible with the 12-channel magnetic tape used to record the data, this computer plays back the tape and produces a spectrum analysis of the wave function. Other analog computers have been developed or modified to analyze amplitude distribution, fade rate and fade-rate duration. High-speed digital voltmeters convert this analog information to digital form.

## Data Analysis

Analysis of data by computer for some propagation studies permits

## Tunnel Diode Computer

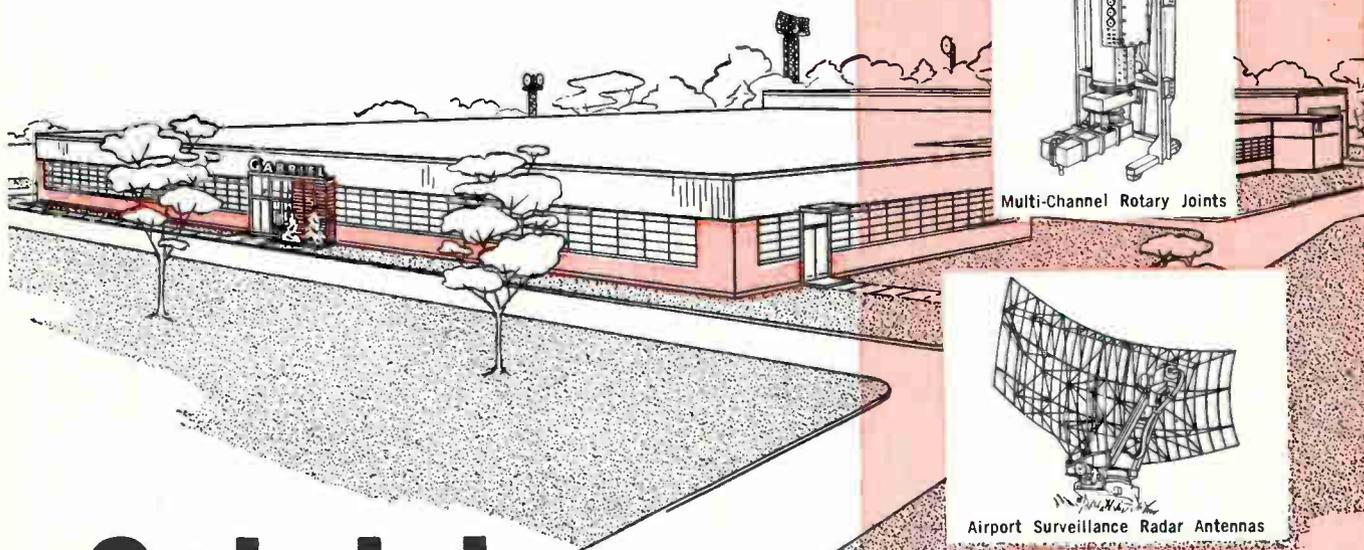


Characteristics of the tunnel diode are being exploited in Japanese computer. Tunnel diode in module at right is used by Eiichi Goto, left, assistant professor at Tokyo University, in computer mockup

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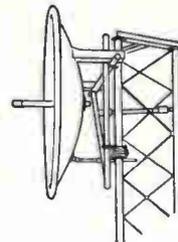
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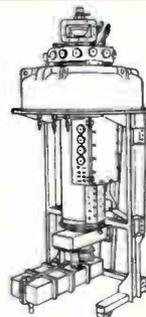
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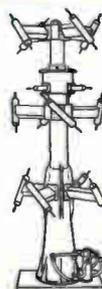
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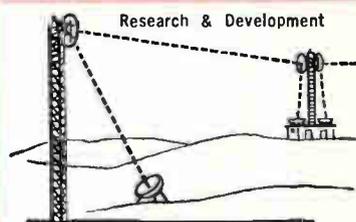
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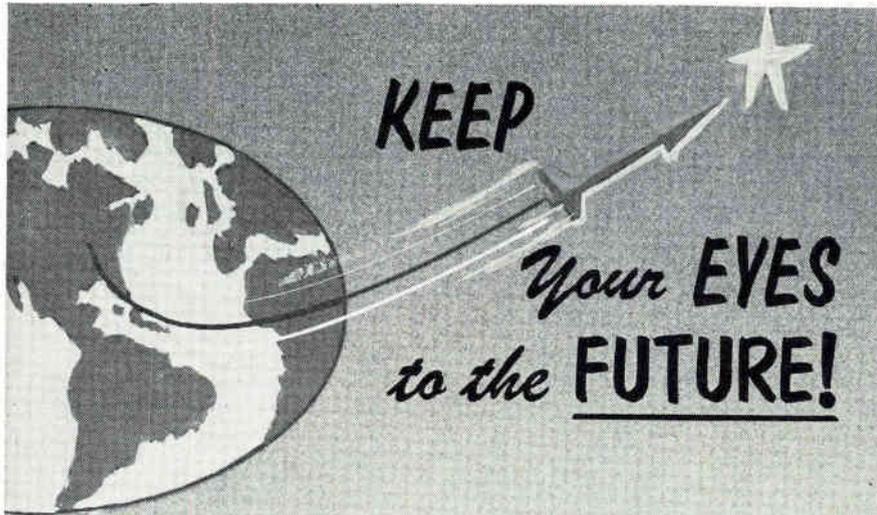
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meaningful summaries of large amounts of statistical data. An example is the development of the NBS standard refractivity index. A quantitative understanding of the bending of radio waves is important to successful use of radar height-finding methods, tropospheric forward-scatter predictions and radio guidance systems.

Similarly, analysis and comparison of data by computer are assisting in studies of meteor trail communications systems.

In sferics studies (naturally occurring atmospheric radio signals), signals are analyzed into individual frequency components. This analysis proved valuable in studies of attenuation of sferics and low-frequency radio waves traveling through the atmosphere.

Substantial changes in the scope and accuracy of predictions for other types and ranges of propagation are also in process. Those concerned with development of vhf and uhf equipment will soon have tables of hourly median levels of transmission over predetermined paths. The computer made possible consideration of models involving many more parameters. Provision within the model can now be made for air turbulence and other weather conditions. The data are based on a 5-year observation program over 300 main paths in the U. S.

Many theoretical calculations have been extended far beyond the limits of previous work by computers. Extended theoretical calculations and machine-plotting of graphs were used in a pilot study of the practical value of an atlas of diffraction curves, based on the Van Der Pol-Bremmer theory of surface-wave diffraction. These curves can be used to give field strength that can be expected from transmissions at frequencies from 10 kc to 10 kmc using the diffraction method of propagation.

### Hall-Effect Is Used In Playback Heads

TAPE-RECORDER playback heads have been developed which use the Hall effect. F. Kuhrt of Ulm, W. Germany, developed the new heads to

overcome a limitation of conventional inductive heads.

Advantage of the Hall-effect heads is that they are said to provide an output the amplitude of which is independent of rate-of-change of flux and therefore of frequency. Output of inductive heads is frequency dependent.

The Hall-effect playback head consists of a wafer of indium-antimonide sandwiched between two blocks of ferrite. The ferrite blocks come together at the bottom to form the working gap in contact with the magnetic tape. The magnetic flux is thus made to traverse the thickness of the wafer.

A polarizing current is passed along the length of the wafer and the output voltage, which may be as high as 500  $\mu$ V, appears at right angles to this current.

## Scanner Lightens Roll Of Gee-Gee Followers

ELECTRONIC currency-identification device issues parimutuel wager tickets automatically. The system was demonstrated recently by American Totalisator division of Universal Controls to officials of the state of New York and to track management.

The machine, called Amteller, accepts five-dollar bills of varying crispness and age. It performs the same service for the customer as does the human ticket seller. Originally designed for five-dollar bets, each machine can be adjusted for a wide variety of bets. However, one machine can be used for only one denomination and for either win, place or show bets.

In operation, the customer inserts a five-dollar bill, face up, in the money drawer. The drawer is closed and one of twelve buttons is pressed to indicate choice of entry in the race. An electric scanner identifies the bill and within one second activates a standard ticket-issuing machine.

Winning tickets are paid off in the normal manner. When the machines at the regular windows are locked at the push of the starter's button, Amteller is also automatically locked.

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# Insulator Without Weight or Volume?

"WE WOULD LIKE our insulation to occupy no volume, to be weightless, but still perform its function as a dielectric barrier impervious to contaminants and with perfect heat transfer characteristics".<sup>1</sup> This would be the ideal electrical insulation, according to J. S. David of General Electric.

The ideal is always difficult to attain. But David's remarks, recently heard at the Electrical Insulation Conference in Washington, D. C., are not as far fetched as they may seem (for one approach, review what Flaschen and Garn of Bell Labs did by exposing metal to oxidizing carriers of fluorine: *ELECTRONICS*, p 80, June 12).

Electrical insulation problems were well aired in Washington, D. C. this month. And nearly 2,000 engineers gathered to hear more than 80 technical papers that presented their own solutions to many insulation problems.

Engineers also took a look at insulation practices in Europe. The Second National Conference on the Application of Electrical Insulation held on Dec. 8 to 10th was cosponsored by the American Institute of Electrical Engineers (AIEE) and the National Electrical Manufacturers Association (NEMA). The European Insulation Technology Luncheon was organized by the AIEE Electrical Insulation Committee under the chairmanship of K. N. Mathes of General Electric. Principal speakers invited were W. J. K. Oburger, deputy director, Austrian Productivity Center and J. H. Mason of the Electrical Research Association, Surrey, England.

## High-Temperature Ceramics

Ceramics for high temperature electrical applications were described by J. D. Walton and J. N. Harris of Georgia Institute of

Technology". Their paper described a project undertaken with the Air Force to develop wire insulation to function from 85 F to 1,500 F. An anodized aluminum coated copper wire provided the desired electrical insulation. However the porous coating required to provide the desired degree of flexibility presented a sealing problem which was approached using three systems: ceramic, organic coating; colloidal silica; and silicone resins.

Slip cast fused silica is being considered for radomes to operate above the temperature limits of reinforced plastics. Since slip cast fused silica has excellent thermal shock resistance as well as the desired electrical properties and is easily and inexpensively fabricated, it appears to be a very promising candidate material.

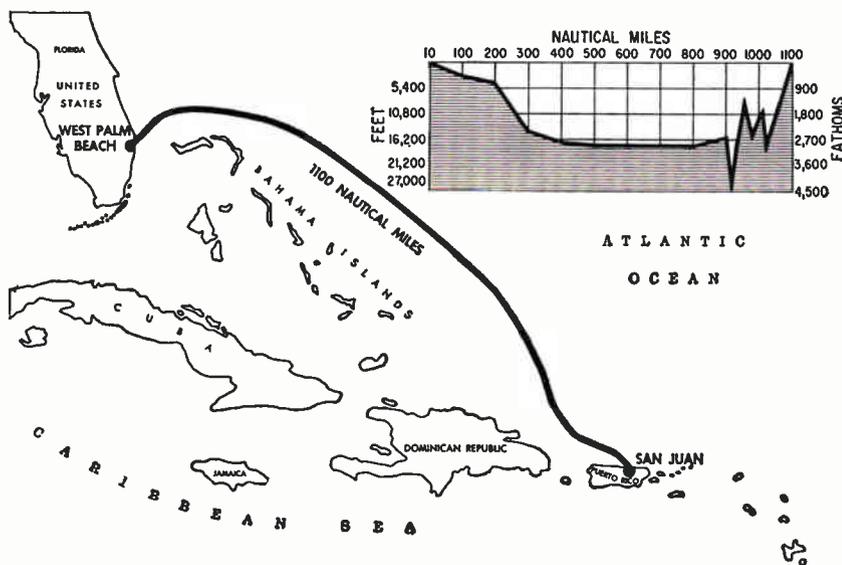
## Stable Polymers

The properties of a new class of very heat stable organic polymers were presented by R. V. Einstman of E. I. duPont De Nemours & Co., Inc.<sup>2</sup> Data presented related to MK polymer coated by special techniques on woven glass fabrics. These polymers offer Class H or better thermal stability, excellent radiation resistance, good fabricating and maintenance characteristics and the possibility of being available in such varied form as coated fabrics, wire enamel varnish and fiber, thereby making possible a complete, chemically-homogeneous insulation system. Einstman pointed out that the MK polymer and coated glass fabrics are still in an experimental stage though quantities for thorough testing are available.

## Materials & Methods

The session on new materials and methods in electronics included a paper on alumina powder as a potting material for electronic transformers (*ELECTRONICS*, p 92, Dec. 18). Other subjects discussed were: an improved diallyl phthalate material, DAPON for dimensional and electrical stability in electronic

## Speech Cable Link to Puerto Rico



Black line stretching between West Palm Beach and San Juan plots path of twin telephone cables that are now dropping into the deepest parts of the Atlantic. Copper conductor, running through the center of each cable, is wrapped with three copper tapes and insulated with polyethylene. Covering these are copper tapes that serve as return conductor for electric current, and an overlapping copper tape to prevent boring by marine life. These elements are in turn protected by layers of fabric tape, jute, steel armor wire and two more layers of jute. The \$17 million project is a joint undertaking of the Long Lines Department of American Telephone & Telegraph Co. and Radio Corporation of Puerto Rico, a subsidiary of International Telephone & Telegraph Corp. Cable circuits, ready in February, will provide voice paths free of atmospheric disturbances

## Research and Development in ADVANCED ELECTRONICS

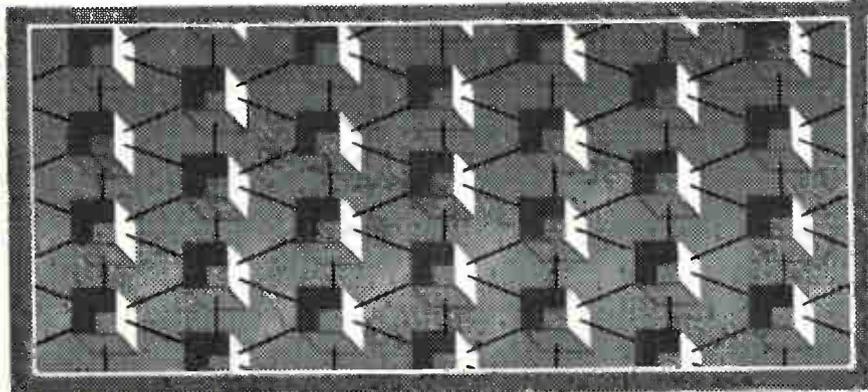
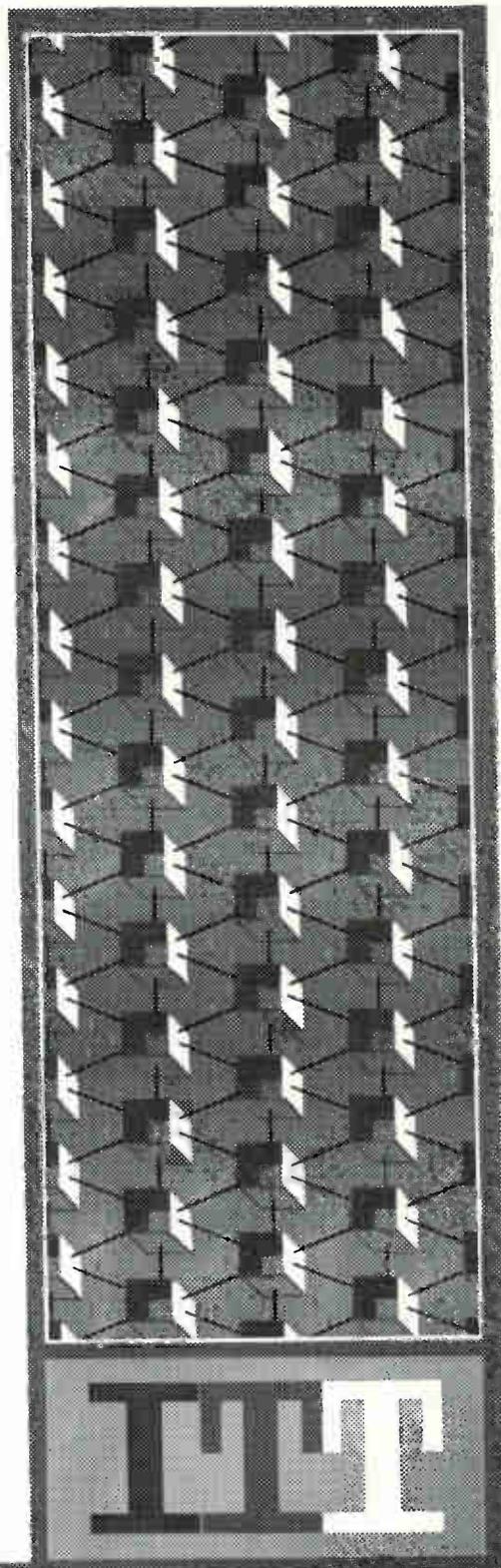
Today at ITT Laboratories significant progress is being made in such areas as broadband communications systems, low-noise parametric amplifiers, atomic clocks, inertial navigation systems, high density storage tubes, and space guidance, navigation and flight control. Major achievements are resulting in stored program digital computers and digital communications.

Communications is an area of unlimited challenge which constantly occupies our efforts. To find more room within the radio spectrum for electronic communications — from direct current to the cosmic rays — is a major goal. Revolutionary ways to extend communications is another. One direction in which we are making headway is the use of single satellite systems of the delayed transponder type. In a few years ITT's "Earth Net" communications system may be a reality, providing global communications via three satellites in orbit.

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applications<sup>4</sup>; a paper on various types of encapsulation accomplished through the use of PLASKON alkyd molding compounds developed at Allied Chemical<sup>5</sup>; and a new silicone potting compound, a dielectric gel, developed at Dow Chemical<sup>6</sup>.

Another session on new elevated temperature wire insulations presented a paper on a high-temperature flexible cable developed at Hughes<sup>7</sup>; the development of a high-temperature flat harness for an electrical rotary joint<sup>8</sup>; high-temperature performance of wire and cable insulated with Teflon TFE and FEP resins<sup>9</sup>; and the use of one-component epoxy system in high reliability transformers<sup>10</sup>.

The session on dielectric strength testing included papers on test equipment<sup>11</sup>; conditioning for dielectric strength tests<sup>12</sup>; procedures for measurements<sup>13</sup>; and interpretation of test results<sup>14</sup>.

The session on elevated temperature printed circuits included a paper on reliable printed circuits<sup>15</sup>; a study of high temperature resistance of copper clad laminates<sup>16</sup>; a paper that outlined high temperature peel strength vs conductor lifting on printed circuit laminates<sup>17</sup>; a glass microfiber-reinforced Teflon insulation made by a paper type process<sup>18</sup>; and printed wiring on ceramic bases<sup>19</sup>. This last paper mentioned the need of an industry-wide program to set up standard specifications covering wiring on ceramic bases.

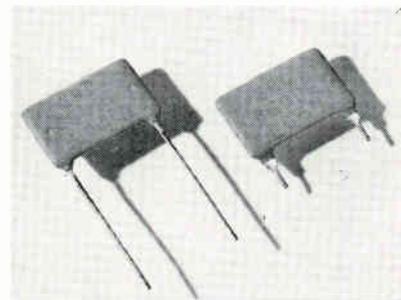
A progress report on silicone insulation was read by J. S. Hurley, Jr. of General Electric and the design engineer was given a picture of the newest available materials: silicone fluids, silicone resins and silicone elastomers as well as modifications of these products which fit into the electrical applications. This paper contained much factual information on the physical and electrical properties of silicones for insulation and looked into the future of these materials to see where progress leads.<sup>20</sup>

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## Wafer-Thin Capacitors



Silvered mica capacitors of very thin construction could have applications where the thicker types would not be suitable. These new cement insulated capacitors have an average thickness under  $\frac{1}{8}$  in. and are available in 7 sizes with overlapping capacitance ranges.

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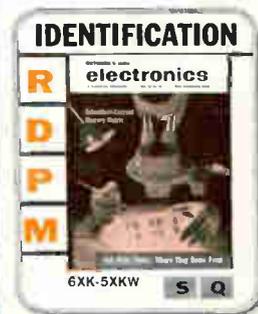
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and in the electronics BUYERS' GUIDE



# Epoxy Resin Makes Potting Molds

By JOHN DELMONTE, General Manager, Furane Plastics, Inc., Los Angeles, Calif.

EPOXY RESINS, used as flexible molds, are finding growing acceptance among electrical and electronic manufacturers for fulfilling functions useful to the assembly and potting of electrical components. Low in cost and easy to prepare, they are valuable for limited production. In numerous instances, epoxy potting resins are cured in molds of the same material. With appropriate release agents, multiple castings may be produced.

## Model Preparation

An accurate model or pattern is essential, since the mold will capture all surface details. Molds may be split in order to facilitate withdrawal of the cured castings or potted component. In this event, a parting plane is established and one half of the mold poured at a time. The model, the parting plane, and the enclosing box or container are coated with release agents before the mold material is poured.

## Mold Preparation

If a motor armature is selected for split mold preparation, the following steps are followed:

Model is examined for undercuts and filled in clay or caulking compounds where the potting material will ultimately occupy. Whatever space is occupied by the clay or caulking compound during the mold preparation will be occupied by the potting material.

Establish the mold parting line (Fig. 1) in the area of the plane intersecting the widest dimensions of the model. In this example, it would cut through the center of the motor shaft, splitting the motor in half. A plane may be physically es-

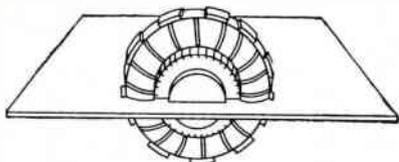


FIG. 1—Establishing mold parting line

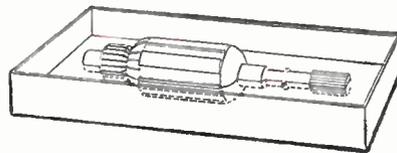


FIG. 2—Armature is placed in frame to pour mold half

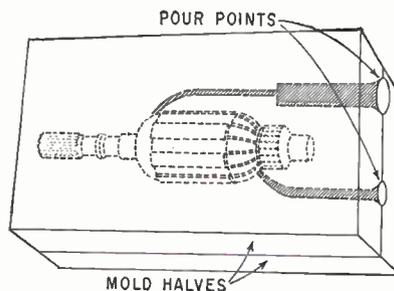


FIG. 3—Phantom view of closed mold

Pair of mold halves for potting motor armature. Molds are approximately 3.5 × 2 × 0.5 inches in size

tablished with the aid of plaster or a piece of masonite profiled to the contour of the motor.

## Pour Points

Plan appropriate pour points, preferably so that as the mold material is poured it will enter at the bottom of the mold and rise upward to a reservoir containing the excess. All high points should have "bleeder" outlets to permit entrapped air to escape.

Encase the entire unit within a box or frame (Fig. 2) and apply release agent to all surfaces. Buttons for alignment of the second half of mold should be introduced.

Mix, pour, and cure molding compound. Estimate volume and mass required on the basis of 0.06 pounds per cubic inch.

Remove model and clean up mold half. Reinsert the motor model and repeat the same steps in pouring the second half of mold. Details are summarized in Fig. 3.

There are a few notes and precautions to be observed: If a flexible mold (Shore D of 40 to 50) is required, glass cloth reinforcing



strips should be introduced before mold half is poured, at those areas subject to greatest flexing. Use special silicone release agents in the epoxy mold each time, to minimize sticking of potting compound.

## Curing

Cure temperatures under 170°F are preferred for the potting material used, as the molds will not take high temperatures. Undertake initial experiments upon simple models until you become familiar with the mold making materials, their advantages and limitations.

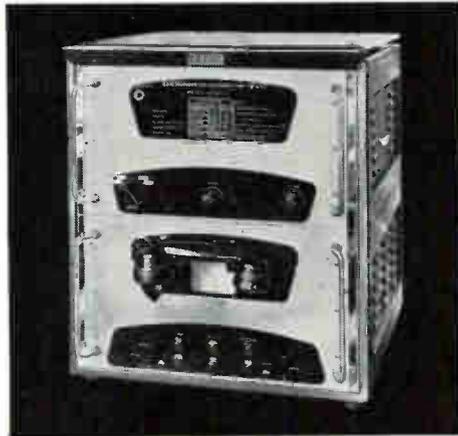
Basically, techniques of mixing, pouring and curing of simple models are sound and much lower in cost than precision machining of molds. Epoxy molds prepared in this manner offer substantial savings to electrical and electronic manufacturers.

A recommended mold material is Epocast 11-B (Furane). It is room temperature setting, resulting in negligible thermal shrinkage during cure although there is slight polymerization shrinkage. This leads to accurate mold dimensions. Flexibility is adjustable, according to pro-



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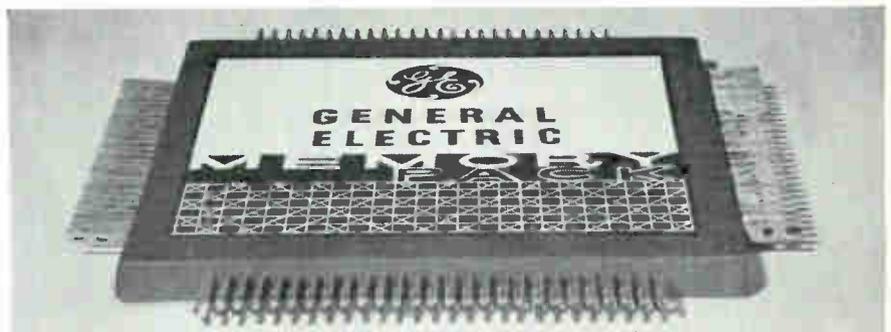
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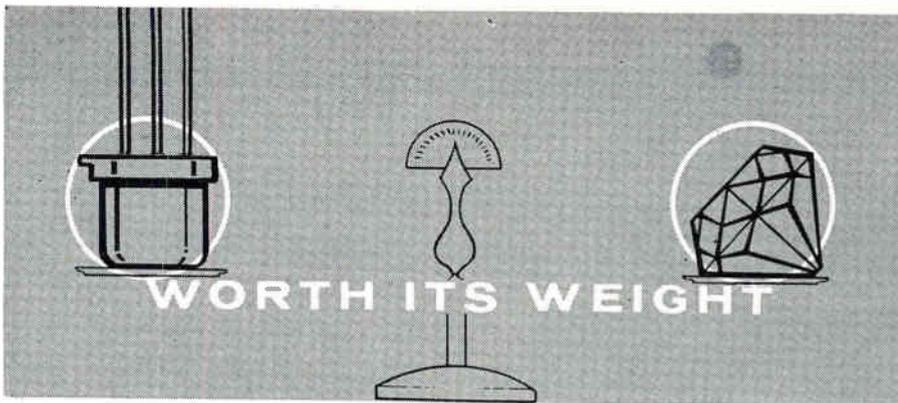
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portion of hardener used. Gravity pour provides a smooth surface, entrained air being displaced by fillers.

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Relays are packaged in groups of 30. The plastic sheet in which the blisters are formed and the backing card are preperforated at the blister flanges so that individual packages can be removed from the card, without destroying the seal.

The sheet of blisters is placed in a loading tray with the open sides of the blisters up (Fig. 1). After the relays are placed in the blisters, a plastic coated card is laid on top. The tray is positioned on a blister package sealer, made by Tronomatic Machine Mfg. Corp., New York.

The flanges of the blisters are sealed to the card by a contoured hot plate which is pressed onto the card by a ram. A temperature of 350 F, pressure of 85 psi and a seal-

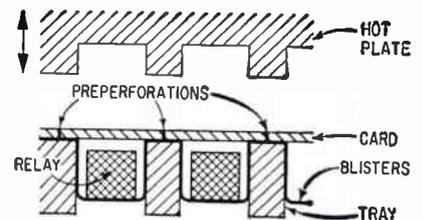


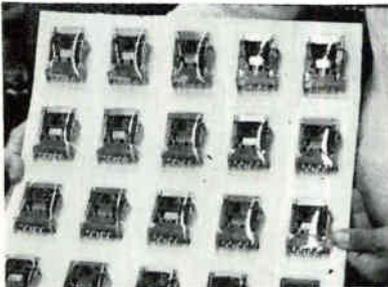
FIG. 1—Hot plate seals blister flanges to card



Relays are loaded in tray of blisters. Blister sheet is seen at left



Tray is placed in machine and covered with coated card



Finished package. Identifying numbers on relays are visible through blister

ing cycle of 4 to 6 seconds are normally used.

The loading tray is aluminum. The card coating and blisters illustrated are acetate. The sealing machine can be modified to provide an inert gas or other filling in the blisters. The cards are stacked in cartons for shipment or storage.

### String Returns Jeweler's Lathe Tool Traverse

JEWELERS' LATHES are frequently used for fine machining on electronic components. If the traverse crank which moves the cutting tool parallel to the workpiece is turned by hand, the work can be made less tedious by supplying the machinist with a piece of string. The string is tied to the crank and wound on the crank shaft as the traverse is made. To return the tool to starting position, the string is pulled. Or, a weight can be hung on the end of the string and the string hung free through a hole in the workbench, so the string winds and unwinds itself. This is used by Electro Tec Corp., S. Hackensack, N. J.

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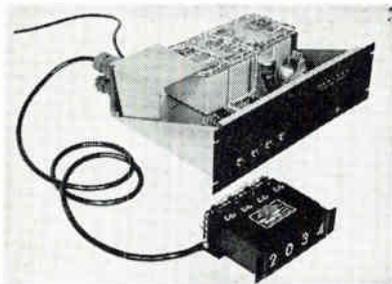
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## Transformers impedance matching

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Pa. Model ATMS-2002 impedance matching transformers are available for use with the ATMS-2001 power amplifier permitting an out-



put impedance selection 4, 16, 64, 600 or 2,400 ohms. Frequency response of the matching transformers is 30 cps to 150 kc  $\pm$  2 db at extreme impedance values. The transformers can handle up to 20 w of power with distortion at less than 1.5 percent.

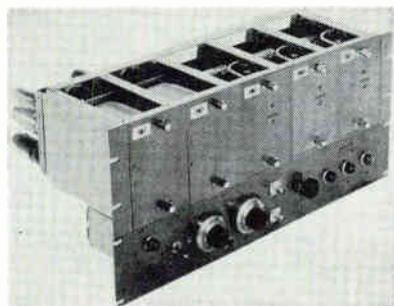
**CIRCLE 302 ON READER SERVICE CARD**

## Contact Switch mercury-wetted

C. P. CLARE & Co., 3101 Pratt Blvd., Chicago 45, Ill. Type HGX-1003 mercury-wetted contact switch is designed for use as a limit switch, float switch, stepping switch, pulse generator, time base, or in other applications where it may be actu-

ated by a permanent magnet. The switch capsule is sealed in glass and pressurized with hydrogen. The capsule is potted in an impregnated paper tube to make it safe and practical to use with permanent magnets. The HGX-1003 will handle a contact load of 5 amperes maximum, 500 v maximum, 250 va.

**CIRCLE 303 ON READER SERVICE CARD**



## Voltage Comparator precision unit

ELECTRO PRECISION CORP., P. O. Box 669, Arkadelphia, Ark. The DLI-205 comparator, designed for rapid, accurate GO, NO-GO indication of d-c voltage levels, is particularly valuable in automatic component testing, system checkout, or process

monitoring. It features a self-contained Zener diode reference, true differential input giving 60 db common mode rejection, and 0.1 percent absolute accuracy. The two limit settings are established by 1,000 division locking potentiometer dials. Common mode rejection is 60 db at 60 cps. Price is \$1,100.

**CIRCLE 304 ON READER SERVICE CARD**

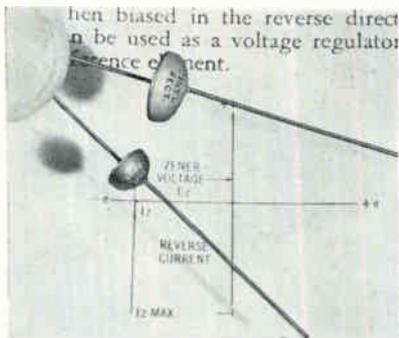
## D-C Power Supply extended range

OPAD ELECTRIC CO., 43 Walker St., New York 13, N. Y. The d-c output voltage range of model KM88 aircraft battery substitute has been extended to cover 0-30 v d-c at the full load rating of 20 amperes.



Maximum rms ripple has also been reduced to be within  $\frac{1}{2}$  of one percent of the average d-c output. Input to the supply is 115 v a-c 60 cycles single phase. Marginal checking, overvoltage testnig as well as normal operation of 28 v airborne equipment are possible.

**CIRCLE 305 ON READER SERVICE CARD**



## Silicon Zener Diodes 500 mw and 1 w rated

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. An economy line of silicon Zener diodes, designed specifically for commercial equipment applications, demonstrate low Zener impedance values and very sharp Zener "knees". They are available

in standard RETMA 10 percent voltage steps from 5.6 to 27 v. All types embody a technical advancement in the sealing of Zener diode junctions, termed "Tri-Sealed"—a three-layer seal assuring high resistance to humidity, shock, vibration, temperature extremes and other adverse environmental conditions.

**CIRCLE 306 ON READER SERVICE CARD**

## Subminiature Triode high vacuum

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, N. Y. The 6977 subminiature triode with fluorescent anode is used in solid-state computers and missile systems.

It is especially suitable for use with transistors because of its low power consumption (30 mw anode power only when lighted and 30 mw of heater continually); and because its high input impedance has no loading effect upon the transistor circuit. The tube structure

consists of a single strand direct heated filament with long life properties and requiring 1 v and 30 ma, a-c or d-c. Around the cathode is a cylindrical control grid. The anode is a grid-like structure coated with a P-15 phosphor.

**CIRCLE 307 ON READER SERVICE CARD**

## Time Base and d-c amplifier

HOUSTON INSTRUMENT CORP., 1717 Clay Ave., Houston 3, Texas. HRT-1 time base provides seven rates of sweep voltage for use with X-Y plotters. Rates available from 0.5 mv per sec to 50 mv per sec with 2 percent accuracy, which corresponds to 2 sec to 200 sec for 100



mv. By resetting the recorder attenuator sweep rates may be re-

duced to 1,000 sec with some loss in linearity. Starting and resetting may be accomplished by a panel switch or a single remote contact. A "halt" switch is provided to stop and later resume the sweep at any time. By rotating the panel switch to "DC Amp" the unit becomes a multipurpose chopper stabilized d-c amplifier.

**CIRCLE 308 ON READER SERVICE CARD**

## Phasemeter precision unit

THE W. L. MAXSON CORP., 475 Tenth Ave., New York 18, N. Y. Model 901 precision phasemeter measures phase angle difference between two sinusoidal voltages within a frequency range of 30 to 20,000 cps over a range of 0 to 360 deg to an absolute accuracy of 0.1 deg and

an incremental accuracy of 0.01 deg. Unit is capable of self-calibration and provides sense information to remove 180 deg ambiguity. Input impedance is 10 megohms shunted by 25  $\mu$ f. Input signal level can vary from 0.5 to 10 v rms. An output signal jack is available for continuous monitoring of phase changes with chart recorders.

**CIRCLE 309 ON READER SERVICE CARD**



## PNPN Rectifier diffused silicon

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas. Type 130 diffused silicon *pnpn* controlled rectifier is a four-layer device expected

to be used widely in regulated power supplies, reversing drives, light dimming devices, surge voltage suppression, latching relays and many other applications. They feature 50 to 400 v in both piv and breakover voltage with an average

rectified forward current of 3 amperes at 50 C, 1 ampere at 125 C. The devices will operate to 150 C, stud temperature, and a maximum one time surge current of 30 amperes can be tolerated.

**CIRCLE 310 ON READER SERVICE CARD**

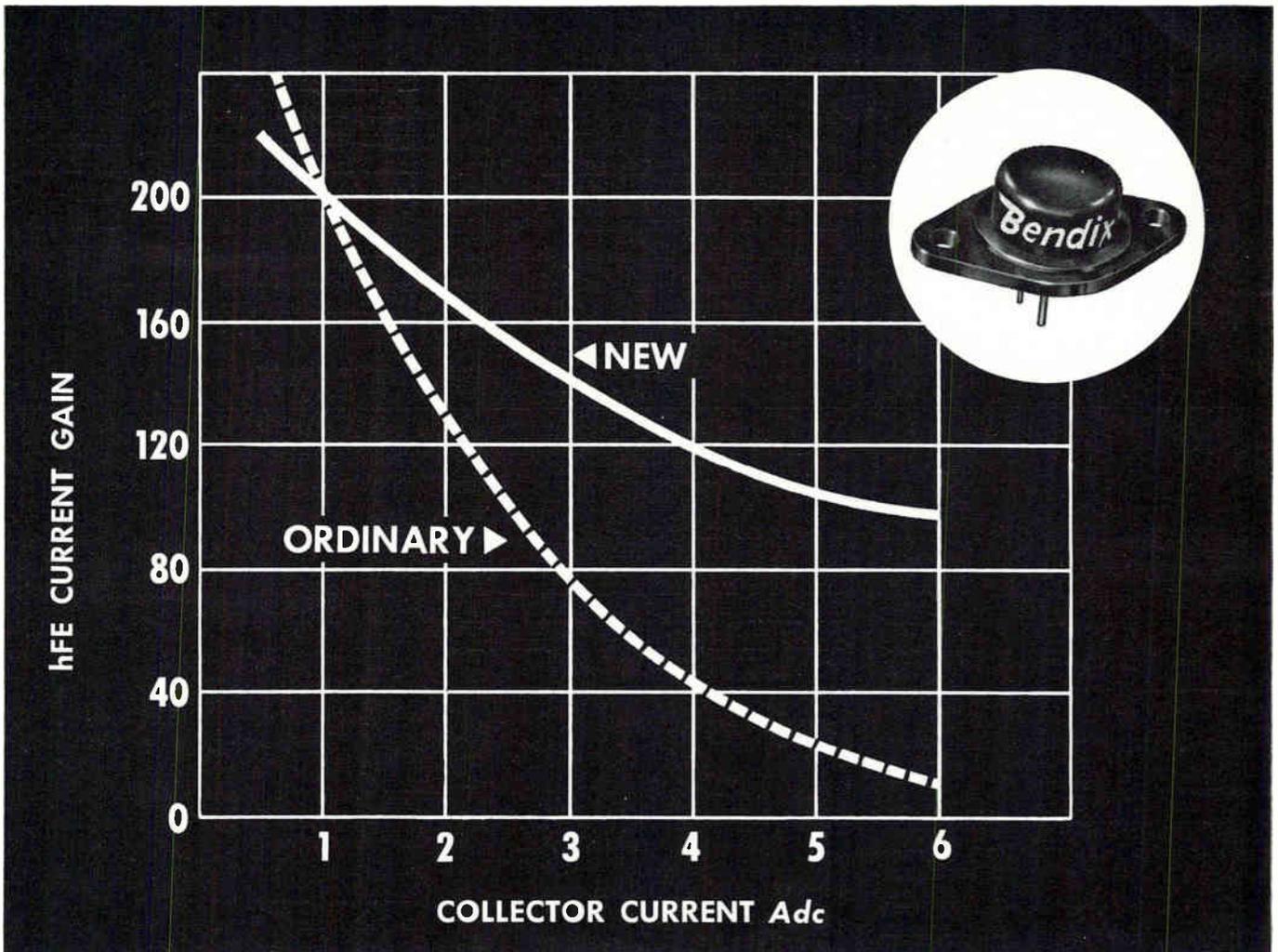
## A-F Voltmeter 20 cps-400 kc

WAYNE KERR CORP., 1633 Race St.,

Philadelphia, Pa. Type M-121 a-f voltmeter, accurate to  $\frac{1}{2}$  of 1 percent, measures audio- and low radio-frequency signals and has

full-scale ranges from 1 mv to 100 v rms. Frequency range is from 20 cps to 400 kc.

**CIRCLE 311 ON READER SERVICE CARD**



Solid line indicates the low beta fall-off of one of the new Bendix transistors as compared to that of an ordinary transistor.

## NEW BENDIX HIGH GAIN INDUSTRIAL POWER TRANSISTORS OFFER FLATTEST BETA CURVE

Now available—a new series of power transistors with the flattest beta curve in the industry, made possible by an exclusive Bendix process. This new series has very high current gains—up to 200 at 3 Adc—and a 10-ampere peak current rating.

Featuring ten-amp performance at a five-amp price, the 2N1136, A, B; 2N1137, A, B; and 2N1138, A, B series provide:

- LOW BETA FALL-OFF → LESS DRIVE AND LESS DISTORTION
- LOW SATURATION RESISTANCE → GREATER CIRCUIT EFFICIENCY
- VOLTAGE BREAKDOWN RATINGS → ELIMINATION OF BURN-OUT
- CURRENT GAIN MATCHING → OPTIMUM CIRCUIT PERFORMANCE

Ideally suited for use in static converters and regulators, these power transistors also have numerous applications in relay replacements and drivers for relays, magnetic clutches, solenoids and other loads requiring high current. In addition, their extremely high current gain and excellent hFE linearity make them practical and efficient television vertical output amplifiers and hi-fi amplifiers.

Current Gain hFE at Ic = 3 Adc	Maximum Voltage Rating		
	Vcb 60 Vce 40	Vcb 90 Vce 70	Vcb 100 Vce 80
50-100	2N1136	2N1136A	2N1136B
75-150	2N1137	2N1137A	2N1137B
100-200	2N1138	2N1138A	2N1138B

For complete information, contact SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office.

West Coast Sales Office: 117 E. Providencia Avenue, Burbank, California

Midwest Sales Office: 4104 N. Harlem Avenue, Chicago 34, Illinois

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Export Sales Office:

Bendix International Division, 205 E. 42nd Street, New York 17, New York

Canadian Affiliate:

Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario, Canada

SEMICONDUCTOR PRODUCTS

**Red Bank** Division

LONG BRANCH, N. J.



## TECHNICAL INDEX

### A

Accelerator, low-cost, produces electron beams for bombarding materials .....RD72 Aug 14

Accelerator, multiparticle variable energy, being designed for flexibility .....RD104 Nov 20

Accelerator, T-tube, for low-thrust propulsion of space vehicles.....SR65 Apr 24

Accelerator, two-mile long traveling-wave, being built at Stanford .....103 Aug 7

Accelerometers, piezoelectric, plastic block used for mounting.....RD70 Jan 16

Accelerometers effect vertical gyro cutout .....RD64 July 10

Adapter, tunable f-m multiplex, for stereo .....66 Apr 10

Adder drives ultrasonic delay line of realistic radar clutter simulator .....78 Sept 25

Adder, half, made using integrated circuit concept .....SR53 July 31

Adhesive for dip-soldering printed circuit boards .....CM83 Mar 27

Adhesive, synthetic rubber-resin .....CM157 Mar 13

Adhesives, environmental limits of materials used for.....SR81 Dec 4

Air conditioning problems solved by analog computer .....34 Dec 25

**Aircraft**

Aircraft landing guidance, miniature X-band radar with high resolution for .....48 Jan 30

Aircraft landing made safer with transistorized marker beacon receiver .....76 Nov 13

Analog tester speeds missile, aircraft checks .....RD77 Feb 20

High intensity strobe lights on wing tips make flying safer .....CM70 Sept 4

Slot-antenna array for missiles and aircraft .....56 Feb 27

Air surveying techniques.....113 Oct 23

**Air Traffic Control**

Air traffic control (LOTRACS) developed .....RD100 Nov 20

Airport dual-channel radar has high resolution for ground traffic control .....RD64 Apr 3

Automatic voice data link for air traffic control .....47 Jan 9

Scan conversion equipment for air traffic control.....CM135 Oct 23

Storage tube improvements aid air traffic control .....CM66 July 10

System for removing radar information over narrow-bandwidth air traffic control relay circuits .....48 Apr 17

**Alarm Circuits**

Digital data system monitors meteorological environment of intrusion alarms .....RD120 Dec 4

Nuclear bomb alarm systems.....53 May 8

Transistorized alarm circuit warns of faults in digital systems.....48 July 3

Tube-transistor hybrid used as memory and alarm circuit.....63 June 5

Vhf intrusion alarm is self-adjusting .....RD62 Aug 28

Alphanumeric characters formed by analog techniques .....116 Oct 23

Altitude measurement, miniature X-band radar with high resolution for .....48 Jan 30

Alumina powder, silicone treated, becomes potting compound that pours .....CM92 Dec 18

Aluminum-clad circuits ready for applications .....CM132 Oct 23

Aluminum-clad copper wire of many sizes available for high-temperature magnetic wire.....CM73 Oct 30

Aluminum extrusion houses module units .....PT77 Oct 30

Aluminum finishes for use in electronic applications .....58 Feb 20

Aluminum finishes used in electronics, production methods and applications data for.....58 Feb 20

**Amplifiers**

200-Kw amplifier for testing Polaris missile parts .....RD65 May 1

Advantages of using thermistors in transistor amplifiers .....SR53 July 31

Age amplifier for speech intelligibility measuring system.....88 May 29

Amplifier design for highly sensitive, wide-bandwidth electrometer .....71 Oct 9

Items for which the page reference is marked "RD", "CM" and "PT" are editorial material published in Research and Development, Components and Materials, and Production Techniques departments, respectively. Designation "ERS" indicates item is an Electronics Reference Sheet. Designations RF, EN and MR in Business Index stand for Business Feature, Electronics Newsletter and Market Research, respectively. Designation F in Authors' Index stands for Technical Feature.

Amplifier-detector for electronic pupillograph used to accurately measure eye pupil movement .....67 Sept 25

Amplifiers, transistorized, for memory drum track recorder .....74 Oct 9

Analog system using single operational amplifier simulates second-order differential equations .....RD64 Mar 6

Area amplifiers for analog computer used to predict cooling load and thermal behavior of dwellings .....34 Dec 25

Audio amplifier design cuts plate dissipation .....72 Apr 10

Audio amplifier using tunnel diodes .....60 Nov 27

Audio transistor amplifier, for hearing aid gives more output using vibrating armature speaker .....RD72 Jan 9

Automatic video processing amplifier holds video level while switching studios .....96 May 29

Bandpass transistor amplifier design method .....RD74 Feb 20

Behavior of solid-state amplifier under neutron radiation.....55 Nov 27

Blanking amplifier, transistorized, for radar and television sweep circuits .....46 June 26

Cascaded differential amplifiers reduce error caused by power supply variations .....54 July 17

Characteristics of magnetic amplifier core materials.....55 Feb 6

Chopper-stabilized, d-c amplifier, error detector for high-speed analog-to-digital encoder...101 Dec 4

Commercially available push-pull magnetic amplifiers for servo systems .....134 Mar 13

Common mode rejection amplifiers for strain gages and thermocouples .....43 July 24

Compensation network for reducing distortion in class-B amplifiers .....54 May 22

Computer-servo amplifier for joystick controlled telescope positioner .....87 Apr 24

Conversion feedback amplifier for core displacement measuring system .....52 July 10

Curves for finding rms value of chopped current or voltage wave in magnetic amplifiers.....ERS46 Dec 25

Design and performance of sub-audio tunable amplifier.....RD72 Nov 6

Designing high-quality audio-frequency transistor amplifiers.....60 June 12

Direct-coupled transistor amplifiers, techniques for limiting load and power dissipation of.....58 Jan 9

Distributed amplifiers for wide-band applications .....64 June 19

Drift-free, magnetic d-c amplifier for instrument applications .....RD62 Apr 17

Electronic micrometer amplifier.....44 Jan 2

Encoder video preamplifier for removing radar information over narrow-bandwidth circuits.....48 Apr 17

Feasibility of using a maser amplifier in an active radar system demonstrated .....43 Oct 30

Feedback design for transistor amplifier .....52 Aug 14

High-gain d-c operational amplifiers for function generation.....66 Nov 6

How to design pulsed distributed amplifiers for radars or high-level pulse amplification.....56 Mar 20

1-f amplifiers, 30-mc, using tunnel diodes.....43 Oct 30

Integral pressure transducer amplifier for working with a strain gage signal in millivolt range .....125 Mar 13

Integrator amplifier, transistor, for manned space flight guidance system .....49 Aug 14

Limiting amplifier for precision variable time-interval generator .....58 Apr 3

Linear pulse amplifier for micro-second sampling switch.....36 Jan 23

Logarithmic and period transistor amplifiers for nuclear reactor control .....52 May 22

Low-distortion high-fidelity transistor monitor amplifier for broadcast duty .....118 Sept 11

Low-noise parametric amplifier in production in San Francisco.....103 Aug 7

Magnetic amplifier for machine tool static switching circuit.....57 June 12

Magnetic amplifier for zero, d-c or very low-frequency current applications .....84 Nov 13

Magnetic amplifiers and transistor circuits regulate frequency of klystrons .....68 Feb 13

Magnetic amplifiers for control switching in industrial control .....51 June 26

Magnetic amplifiers operate fail-safe circuits for conveyor systems .....60 July 10

Magnetic amplifiers replace voltage-sensitive relays in d-c bus voltage regulator .....101 Dec 4

Magnetic amplifiers, used in four-quadrant multiplying device.....58 Jan 9

Maser sensitivity curves for determining receiver sensitivity and noise figure relationships .....ERS70 Feb 20

Negative-resistance amplifier Hall effect device, diagram for.....63 Jan 16

New microwave systems using parametric amplifiers .....27 Aug 21

Nomograms for designing complete resistance-coupled amplifiers .....ERS102 Apr 24

Ohmic heating and totem pole amplifiers for maintaining plasmas at 100 million C.....57 Oct 9

Operation of tunnel diode in an amplifier discussed using equivalent circuit .....54 Nov 6

Operational amplifier for analog computer used to diagnosis heart ailments .....56 Oct 2

Parametric amplifier, 220-mc, requires only 0.05 milliwatt of pump power .....31 Dec 25

Parametric amplifier and antenna combination receive signals from Pioneer IV.....RD80 June 5

Parametric amplifier made from thin films .....RD92 Nov 13

Phase-stabilized uhf amplifier for controlling directivity of antenna pattern .....50 Jan 2

Plasma study may open way to development of amplifier between microwave and infrared ranges .....RD60 July 3

Power amplifier drives ultrasonic delay line of realistic radar clutter simulator .....78 Sept 25

Receiving preamplifier for underwater sonic telemeter for trawl fishing determines depth of net .....66 Mar 27

Recording amplifier for pulse-duration tape recording system .....56 Feb 6

Reducing r-f intermodulation by power amplifier design techniques .....71 Nov 27

Reference amplifier for magnetic modulator playback system.....58 Mar 6

Regulating high voltage with magnetic amplifiers .....64 July 17

Rugged i-f amplifier for miniature X-band radar with high resolution .....48 Jan 30

Self-sustained emission tube improves amplification of preamplifier .....CM66 Feb 6

Selective amplifier for radio direction finder with automatic readout .....52 Apr 17

Servo preamplifiers using direct-coupled transistors .....74 May 15

Single-ended transistor amplifiers for class-B, high-fidelity operation .....86 May 29

Single-transistor output circuit approximates push-pull class-B audio output .....74 June 12

Solar radiation amplifier for analog computer used to predict cooling load and thermal behavior of dwellings.....34 Dec 25



Helicopter lays special cable at 100 mph	CM109	May 29	Chemical power sources for space-age electronics	43	Mar 20	Frequency translation systems improve multipath pulse communications	66	June 19
R-f cables and connectors for military applications (see Jan. 1st issue for 2nd part of this article)	42	Dec 25	Chokes, dynamic test of filter choke inductance at rated average current	RD54	Jan 23	Influence of parametric amplifiers and solid-state maser on communications	39	Apr 17
Silicon rubber compounds for thinner-walled cable insulation	CM94	July 31	Chopped current or voltage wave, finding rms value with ordinary test equipment and curves	ER846	Dec 25	Instrumentation system for intelligibility evaluation of voice communications	88	May 29
Specially engineered cables for data processing and transmission equipment	CM75	Oct 2	Chopper, highly sensitive electronic, reduces field-switching transient duration	RD66	Oct 2	Interplanetary communications using space probes and satellites	43	Oct 30
Speech cable links U.S. and Puerto Rico	CM54	Dec 25	Chopper transistor for voltage comparator using high-speed power switch	56	Jan 30	Military communications improved using dynamic trap to capture weak f-m signals	64	Jan 9
Tamper-proof tap-proof cable for tv, telephone and wire photo service	CM81	Dec 11	Chopper, transistorized, for d-c operational amplifier used in analog computers	94	Apr 24	Modern communications methods	SR93	Oct 23
Caliper, electronic, checks printed circuits	44	Jan 2	Chromate coatings, production methods and application data for	58	Feb 20	Paramps and twt's for low-noise reception of extremely weak signals	105	Dec 4
<b>Cameras</b>			Chronotron, vernier, times nuclear particle flight	44	Mar 6	Propagation studies, analyzer statistically evaluates noise-signal amplitudes for	48	July 24
Fast electronic camera shows metal fatigue	RD60	July 3	Circuit board assembly for mechanization of electronics firms	49	Nov 6	Significant developments in microwave, telegraph and telephone systems improve transmission quality	72	Dec 18
Photoemissive television camera tubes, tabulation of commercially available types	92	Apr 24	Circuit board of quick-connect for training technicians	CM109	Nov 20	Soviets give data on sun satellite	RD66	Jan 30
Remote tv film camera, transistorized sound amplifier for	58	Jan 16	Circuit board printed in full color	CM130	Aug 7	Speech cable links U.S. and Puerto Rico	CM54	Dec 25
Transistorized electronic camera, flash power unit for	SR53	July 31	Circuits, techniques for designing for reliability	SR65	May 29	Strip-chart recorder for radio propagation research	78	Dec 18
Ultrasonic tv camera supplements x-rays in displaying internal structures	RD124	Sept 11	Circulator, Y-type microwave, with wide bandwidth and high power-handling capabilities	81	Dec 18	Tap-proof, tamper-proof tv, telephone and wire photo cables	CM81	Dec 11
Vidicon-type television camera tubes, characteristics of	46	Apr 17	Citizens' radio revision spurs equipment design	55	Apr 10	Transistor circuits for communicating with power-line carriers	70	May 15
Capacitance measurements in design and production	SR89	Sept 11	Cleaners, characteristics of typical commercially available ultrasonic types	65	June 5	Transistorized communications system developed by Japanese	109	Sept 11
<b>Capacitors</b>			Cleaning delicate parts using ultrasonics	PT80	Jan 9	Commutator, electronic, tabulation of representative types used for multiplex telemetering	76	Sept 25
Automatic winder for metalized capacitors	PT110	May 29	Cleaning efficiency of ultrasonic wash methods improved	PT96	Oct 16	Commutator, transistor, for encoder used to measure random event time intervals	48	Mar 20
Capacitors for thermionic integrated micromodules	CM80	May 15	Cleaning units, automatic solvent, discussed at IRE show	PT70	Apr 17	Commutators, mechanical and electronic, for airborne multiplex telemetering	46	July 3
Capacitors, use in transistor circuits	SR53	July 31	Cleaning with hydrogen peroxide-formic acid-water combination is safe and sure	PT76	Oct 2	Commutators, specifications, performances and applications for typical electromechanical commutators	54	Oct 2
Choosing and using capacitors to obtain reliability	SR65	May 29	Clipper, silicon diode, for radar modulator	70	June 12	<b>Comparison Circuits</b>		
Circuit design using voltage-variable silicon capacitors	48	Sept 18	Clock pulse generators, design of high frequency	56	Aug 28	Comparison of h-f transistor with short circuit to measure f <sub>co</sub>	ER554	Jan 2
Environmental limits of materials used for capacitors	SR81	Dec 4	Clock track recorder, transistorized, for writing timing signals on magnetic drum	74	Oct 9	Comparison of physical and electrical properties of chrome-copper alloy, copper and reinforced strand wires	CM74	Jan 9
General characteristics of capacitors made under micromodule program	62	May 15	Clocking technique permits high-density recording on magnetic tape	72	Oct 16	Double-sweep comparator for making contour map of microwave device's properties	RD7	June 12
Hyperlytic capacitors have 10-year working and shelf life	CM134	Oct 23	Megapulse generator for 3- and 4-phase 10-mc clocking	66	Aug 14	Electronic switch using high-gain d-c operational amplifiers	66	Nov 6
Machine stacks glass capacitors	PT82	Feb 20	Transistors provide computer clock signals	70	Feb 27	Flying-spot closed-circuit tv system for comparing photographs	66	May 8
Ratings for metal-encased, fixed-paper, d-c capacitors	53	July 3	Cloud-height data analyzed using computer	RD88	Oct 16	Phase comparator for digital feedback, frequency multiplier	60	July 17
Solid-circuit capacitors formed from diode junctions	110	Aug 7	Clutter, radar, simulation of during a number of consecutive sweeps	78	Sept 25	Phase comparison circuit for servo phase control used to shape antenna pattern	50	Jan 2
Solid-circuit lumped and distributed capacitors	CM82	Apr 10	Coatings, compatibility of with contacting materials	SR81	Dec 4	Transistor voltage comparator uses high-speed power switch	56	Jan 30
Spring-leg speed cup to hold capacitors	PT75	Mar 6	Coaxial element extends transistor frequency measurement range up to 1,000 mc	31	Aug 21	Transistorized amplitude comparators for noise-signal analyzer	48	July 24
Stabilizer control of capacitor dielectrics	CM72	May 22	Coil, heat-dissipating, for rotary components	CM108	May 29	Voltage comparator for monitoring sawtooth generator output	44	Feb 6
Voltage-tunable ferroelectric capacitors, circuits using	52	Jan 16	Coil winders discussed at IRE show	PT70	Apr 17	<b>Components</b>		
Voltage-variable capacitor selection guide	52	July 24	Collision avoidance system for aircraft does not require range data	RD60	July 24	Air-oscillated rod automatically steps series coil winder	PT84	Dec 11
Wafer-thin, silvered-mica, cement-insulated capacitors	CM56	Dec 25	Colorimeter of photoelectric type developed by Japanese	109	Sept 11	Automatic component sorting using time sample detector to measure waveforms	56	Feb 13
Working and shelf life of electrolytic capacitors extended to ten years	CM134	Oct 23	Combiner for ganging four r-f transmitters on common antenna to overcome jamming	68	Nov 27	Characteristics of micromodule components	51	May 22
Carrier transmission system for closed-circuit television	76	June 12	<b>Communications</b>			Choosing, using and testing components to obtain reliability	SR65	May 29
Casting metal in ceramic shells	CM99	Nov 13	Air-ground communications system for space testing at High Range	53	Mar 27	Components for a 100-mc computer	CM66	July 10
<b>Cathode Ray Tubes</b>			Amplitude modulation sidebands transmit stereo	RD78	Apr 10	Computer design may foster development of microscopic components	RD124	Sept 11
Cathode-ray storage tubes for direct viewing	40	Jan 23	Analyzing multipath delay in communications studies	52	Sept 4	Crackle-free potentiometer uses CdS photo-resistors	CM80	Dec 11
Cathode-ray storage tubes for special purposes	52	Jan 30	Automatic voice data link for communications	47	Jan 9	Direct-view, halftone storage tube capable of selective erasure and nonstorage writing	31	Dec 25
Cathode ray tube display, computer-controlled, using photoelectric light pen	85	Nov 20	Average time for one-way communication to planets	SR65	Apr 24	Electroforming intricate and complex-shaped electronic components	114	Sept 11
Cathode ray tube display system uses analog techniques to form characters	116	Oct 23	Bandwidth problems in data transmission	SR93	Oct 23	Electroluminescent panels as storage and display devices	31	Dec 25
Cathode ray tube storage has geometrical guns	CM60	Jan 2	Characteristics of communication in space	SR65	Apr 24	Epoxy resins used to assemble and pot electrical components	PT58	Dec 25
Cathode ray tube used in open-loop photoelectric function generator	52	Jan 9	Charts show which unwanted harmonics of two signals will cause interference in mixer	ER867	Dec 11	Glass parts formed precisely by shrinking	PT72	Sept 4
Cathode ray tube with eight completely independent guns in one envelope	CM113	Apr 24	Communications of the future—what we learned from the IGY	37	July 3	Grid-controlled, secondary-emission electron multiplier tube delivers 6-amp output for 20-30 ma input	31	Dec 25
Parallax-free scales applied as black pattern on inside of crt screen	RD68	Oct 2	Communications-tracking system for Project Courier	RD72	Nov 6	Heat transfer in component design	CM92	Oct 16
Celometer measures cloud-height using computer for analysis	RD88	Oct 16	Communications used at missile test ranges	47	Jan 16	High-density packaging of components to reduce size of electronic units	62	Oct 9
<b>Ceramics</b>			Controlled-carrier communication system reduces transmitter power and offsets fading	60	Jan 30	How to choose precision fine wire	CM78	Dec 11
Casting metal in ceramic shells	CM99	Nov 13	Correlation devices to detect weak signals against noisy backgrounds	58	May 22			
Ceramic cartridge designs for stereo applications	CM78	Feb 13	Digital data transmission using compact coincident-current technique for buffer	50	Oct 2			
Ceramic material takes temperatures of 5,000F	CM81	Feb 13	Elevation-azimuth antennas for radio propagation research program	RD74	Dec 11			
Ceramic printed circuit boards made on punch press	PT78	Oct 2	PERNA voice radio system reduces noise by transmitting frequency and amplitude components of speech on separate channels	53	Dec 11			
Ceramic-type, inorganic materials used for high-temperature electrical insulations	65	Nov 27						
Ceramic wafer tubes for modular units	CM94	Sept 25						
High temperature ceramic insulations discussed at Electrical Insulation Conference	CM54	Dec 25						
Strength of ceramics being investigated by NBS	CM99	Aug 14						
Chemical conversion coatings, tabulation of characteristics of	58	Nov 6						
Chemical, gyro flotation, remains viscous down to -65F	CM76	Jan 16						

How to reclaim potted components CM78	Nov 6	Classification of electronic position computers . . . . .	112	Aug 7	Servo-setting potentiometer module for analog computers . . . . .	CM82	Mar 27
Instrument-grade variable air ca- pacitors machined from solid aluminum blocks . . . . .	PT82	Clutter computer finds new use as aircraft navigational aid . . . . .	RD105	May 29	Size of digital and analog com- puters reduced using high-den- sity packaging . . . . .	42	Oct 9
International standards for elec- tronic devices . . . . .	CM94	Coincident-current technique for digital data buffer permits com- pact construction . . . . .	50	Oct 2	Solid-state digital Gray-to-straight binary code converter . . . . .	60	Dec 11
Kitting components smooths pro- duction flow . . . . .	PT70	Components for a 100-mc com- puter . . . . .	CM66	July 10	Telephone traffic data recording simplified by using ferrite mem- ories . . . . .	88	Oct 9
Knurl broaching joins small metal components . . . . .	PT76	Computer design may foster de- velopment of microscopic com- ponents . . . . .	RD124	Sept 11	Testing high-speed digital compu- ter circuits . . . . .	50	July 17
Machine assemblies components in modules automatically . . . . .	PT70	Computer design using magnet- ostrictive filters . . . . .	72	June 19	Thin magnetic films for digital computer memories . . . . .	44	June 26
Making component test fixtures more versatile . . . . .	CM74	Computer pre-input system de- veloped . . . . .	RD46	Aug 21	Trainer shows digital computer operation . . . . .	RD63	July 24
Micro-elements in microminiatur- ization approaches sponsored by military services . . . . .	49	Computer relays are packaged in transparent plastic blisters . . . . .	PT60	Dec 25	Transistor, stable 100-kc oscillator for computer electronic counters . . . . .	76	Apr 10
Micromodule components for mili- tary application . . . . .	62	Computer simulators for automatic voice data link . . . . .	47	Jan 9	Transistor that acts like gas step- ping tube developed for digital counting . . . . .	CM58	Sept 18
Modular design reduces space, weight and cooling requirements CM58	Jan 23	Computer switching with semicon- ductors and relays . . . . .	64	Aug 14	Transistorized binary counter cir- cuit counts backward or for- ward . . . . .	82	Sept 25
Modular fixtures speed environ- mental testing of components PT86	Nov 27	Computer-type logic networks tests human ability to carry out logi- cal analysis and synthesis . . . . .	70	Oct 16	Transistorized clock track recorder for writing timing signals on magnetic drum . . . . .	74	Oct 9
Modular strip transmission line components . . . . .	CM73	Current developments in switching transistors for computer appli- cations . . . . .	SR53	July 31	Transistorized d-c operational am- plifier for analog computers . . . . .	94	Apr 24
Molecular electronics—hope for the future . . . . .	CM110	Data storage and display with po- larized phosphors . . . . .	39	Aug 28	Transistorized flip-flop circuit for digital control computer . . . . .	SR53	July 31
Monolithic circuits for fitting evaporated films to shape of component . . . . .	125	Design of electronic switches using high-gain d-c operational ampli- fier . . . . .	66	Nov 6	Transistorized system for sending digital data over narrow-band communication lines . . . . .	72	June 5
Multiple dip-brazing for assem- bling components . . . . .	PT100	Design of high-frequency clock pulse generators . . . . .	56	Aug 28	Transistorized variable-frequency pulse source for high-speed digi- tal computers . . . . .	47	Apr 3
Parts delivered by rotating drum PT80	Jan 16	Digital computer designed for re- liability . . . . .	SR85	May 29	Transistors provide computer clock signals . . . . .	70	Feb 27
Parts molded into epoxy mirrors for infrared and optical use PT86	Apr 10	Digital computers aid radio propa- gation studies . . . . .	RD50	Dec 25	Translating information into ma- chine language using 10-word handwriting reader . . . . .	RD100	Nov 20
Physical and electrical parameters of deflection yokes . . . . .	58	Digital computers translate data gathered by surveying and map- ping instruments . . . . .	113	Oct 23	Translator, English to Japanese RD76	Mar 27	
Quick-disconnect circuit board for assembling components during technician training . . . . .	CM109	Digital data system monitors mete- orological environment of intru- sion alarms . . . . .	RD120	Dec 4	Using inductive control in compu- ter circuits . . . . .	31	Sept 18
Reflected-beam kinescope uses electrostatic components to re- duce size and weight . . . . .	31	Digital readout system for auto- matically preparing address la- bels . . . . .	RD126	Aug 7	Using thin ferromagnetic films in high-speed memories . . . . .	55	June 5
R-f cables and connectors for mili- tary applications (See Jan. 1st issue for 2nd part of this article) 42	Dec 25	Diodes perform role of core-switch- ing array in memory . . . . .	RD80	Oct 9	Wooden mockups to develop effi- cient techniques for computer and data processor production PT82	Dec 11	
Rollers straighten bent axial com- ponent leads . . . . .	PT86	Dynamic testing of high-speed digital computer building blocks 66	Aug 14	Electromechanical analog compu- ter solves mortar location prob- lem . . . . .	34	Sept 18	
Shaker tests space components RD74	Feb 20	Error computer reduces error in loaded potentiometers . . . . .	34	Aug 21	Forming handwritten-like digits on crt display . . . . .	138	Mar 13
Solid-circuit components . . . . .	110	Influence of cryotrons, solid-state switching triodes and stepping transistors on computers . . . . .	39	Apr 17	Insulating ferrite memory cores CM131	Sept 11	
Solid-circuit components . . . . .	CM82	Integrated semiconductor devices for microminiaturizing compu- ters . . . . .	35	June 26	Japanese develop tunnel diode computer . . . . .	RD50	Dec 25
Sorting components by automati- cally measuring waveforms with time-sample detector . . . . .	56	Linear selection magnetic core array for memory with one mi- crosecond cycle time . . . . .	125	Mar 13	Magnetic amplifier for zero, d-c or very low-frequency current com- puter applications . . . . .	84	Nov 13
Synthetic sapphires offer engineer- ing advantages in electronic component design . . . . .	110	Magnetic-disk digital memory sys- tem keeps circuits simple . . . . .	130	Mar 13	Magnetic-film memory speeds read- write cycle time . . . . .	RD90	Sept 25
Tap-proof, tamper-proof tv, tele- phone and wire photo cables CM81	Dec 11	Memory windings may be printed PT86	June 19	Microminiature circuits for com- puters . . . . .	49	Dec 11	
Testing failure rates of common electronic and electromechanical parts . . . . .	RD74	Microwave computer adds two digits at frequencies approach- ing speed of light . . . . .	39	May 1	Microwave computers for 50 to 100 mc clock rate operation . . . . .	125	Mar 13
Thermionic integrated micromod- ules . . . . .	CM80	Microwave techniques for millimi- crosecond computer logic and switching circuits . . . . .	77	Nov 20	Outdiffusion technique produces 2- to-3 millimicrosecond switching diodes . . . . .	66	June 5
Thermoelectric junction on the market . . . . .	CM106	Parametrons cut digital computer cost, increase reliability and de- crease size . . . . .	RD66	Mar 20	Photoconductive - electrolumines- cent elements for digital-to-dis- play translator . . . . .	31	Dec 25
Traveling-wave tube for C-band gives 20-db gain with noise fig- ure in 4.5-db range . . . . .	31	Photoelectric light-pen links com- puter to operator . . . . .	85	Nov 20	Probability computer for imitat- ing learning techniques . . . . .	125	Mar 13
Traveling-wave tubes and paramps for low-noise reception of ex- tremely weak signals . . . . .	106	Programmed servo speeds short- run production of computer printed circuit boards . . . . .	54	Mar 6	Rivets form channel for computer wiring . . . . .	PT86	June 5
Voltage-variable capacitance di- odes for frequency modulating vlf oscillators . . . . .	112	Rodiac, rotary dual input analog computing element for solving three-dimensional equations . . . . .	CM80	Mar 27	Russian transistorized analog com- puter . . . . .	37	July 24
Welding components directly to- gether gives high packing den- sity . . . . .	CM82	Self-clocking permits high-density recording on magnetic tape . . . . .	72	Oct 16	Self-sustained emission tube re- duces power drain of computer circuits . . . . .	CM66	Feb 6
What the military expects from future components . . . . .	52						
Window-frame module technique CM66	July 10						
<b>Computers</b>							
Analog computer estimates heat flow within building materials or construction . . . . .	RD76						
Analog computer for joy-stick controlled, command servo posi- tioner . . . . .	87						
Analog computer predicts thermal behavior and cooling load of dwellings . . . . .	34						
Analog computer simulator trains nuclear ship crews . . . . .	RD124						
Analog computer used to measure volumetric output of blood dur- ing heart ailment diagnosis . . . . .	56						
Analog-to-digital encoder for con- tinuous conversion of analog voltages at one bit per 4 microsec 101	Dec 4						
Analyzing transonic wind-tunnel data . . . . .	RD76						
Automatic system for detecting transmission errors in 5-level punched tape . . . . .	72						
Biax, high-speed ferrite memory and logic element . . . . .	43						
Characteristics of a-c resolver sizes 8, 10 and 11 for analog computation . . . . .	32						
Characteristics of a-c resolver, size 15 for analog computation . . . . .	62						
Characteristics of a-c resolver sizes 18, 23 and 25 for analog computation . . . . .	50						
Circuit board covers all functions of analog and digital circuits . . . . .	CM132						
	Aug 7						



Infrared detector covers 8-to-14-micron range.....CM69	May 1	Digital techniques for generating time scales on paper and tape.....80	Nov 13	Pulse-width discriminator for reducing scanning loss in radar transmitters.....39	July 10
Infrared detector for firing forest fires and guiding fire-fighting missiles to area.....RD69	Mar 20	Digital techniques used in production line diode sorter.....PT72	Aug 28	Sampling f-m discriminators for data reduction from magnetic tape.....70	Mar 27
Infrared gold-doped germanium crystal detector is microwave energized.....CM70	Jan 30	Digital telemetry system (Telet-bit) for space communications.....43	Oct 30	Transistor power discriminator for power-line carrier communications system.....70	May 15
Lead sulfide cell for infrared detector used in remote controlled moving target system.....60	Nov 6	Digital-to-analog encoder Hall-effect device, diagram for.....63	Jan 16	<b>Displays</b>	
Lead telluride infrared detectors for response to long wavelengths.....125	Mar 13	Digital-to-display translator using photoconductive electroluminescent elements.....31	Dec 25	Basic optical data for electronics engineers.....48	July 10
Liquid level detectors, four configurations of.....49	Jan 2	Digital transmission of data.....SR93	Oct 23	Computer-controlled crt display using photoelectric light-pen.....85	Nov 20
Long wavelength infrared detector cooling systems.....36	Aug 21	Measuring and remote control equipment using digital techniques developed by Japanese.....109	Sept 11	Data display with polarized phosphors.....39	Aug 28
Micrometeorite detectors for Explorer I satellite.....39	Feb 6	Size of digital circuits reduced using high-density packaging.....62	Oct 9	Display system uses analog techniques to form characters.....116	Oct 23
Microwave devices for detection of power, tables to help select.....59	July 17	Transistorized binary counter using small digital building block functions forward or backward.....82	Sept 25	Display unit with five cascaded Dekatron tubes for digital tachometer.....58	Apr 10
Multichannel interrogator and signal separator scheme detects single signal.....50	Aug 28	<b>Diodes</b>		Electroluminescent panels for automatic displays.....44	July 10
Multiple-cell infrared detectors for sensing low-level energy.....5	June 26	Action and properties of tunnel diodes explained using electron energy band diagrams.....54	Nov 6	Forming handwritten-like digits on crt display.....137	Mar 13
Neutron detector ignores gamma rays.....CM77	Jan 16	Characteristics of micromodule transistors and diodes.....51	May 22	Solid-state panels for display and/or storage.....46	Jan 30
Operating principles and range of temperature detectors.....55	July 10	Characteristics of silicon voltage-regulator diodes.....55	Apr 17	Static display circuit for Gray-to-straight binary code converter.....60	Dec 11
Phase detector for servo phase control used to shape antenna pattern.....50	Jan 2	Characteristics of two-terminal diode switches.....62	Feb 27	Distributor rotary transformer for distributing memory bit sequentially.....130	Mar 13
Radiation detection telemeter transmitter and modulator weight reduced using transistors.....136	Mar 13	Circuit design using voltage-variable silicon capacitors.....48	Sept 18	Distributor, transistorized, receive for high-speed electrostatic teletypewriter.....83	May 29
Radiation detectors for nuclear bomb alarm system.....53	May 8	Circuits and applications using tunnel diodes.....60	Nov 27	Divider, four-cascaded Eccles-Jordan binary, for digital tachometer.....58	Apr 10
Self-adjusting vhf intrusion alarm used as motion detector.....RD62	Aug 28	Choosing and using diodes to obtain reliability.....77	May 29	Divider, power, for antenna split signal n-ways.....CM64	July 3
Simple coherent detector for monitoring NBS 60-kc standard frequency transmission.....48	Oct 30	Coincidence diodes gate electronic switch for radar indicators.....66	Feb 20	Document retrieval system for practical use has been developed.....RD88	Oct 16
Solid moisture detector, work simplification programs cuts cost of.....PT74	Jan 30	Cold cathode gas trigger tube.....CM72	Oct 2	<b>Doppler Systems</b>	
Soliton linear detector used for pressure or flow transducer.....53	Feb 27	Crystal diode switches classified by bandwidth, power capability, isolation and speed.....71	June 5	Doppler navigation systems.....112	Aug 7
Sonar fish detector uses compact scan system.....54	Apr 3	Current integration with soliton liquid diodes.....53	Feb 27	Doppler proximity warning radar for autos.....RD62	May 1
Sorting components by automatically measuring waveforms with time-sample detector.....56	Feb 13	Current ratings and peak inverse voltages of silicon power rectifiers.....71	Apr 10	Doppler radar detects tornadoes.....RD76	June 12
Synchronous detector for magnetic modulator playback system.....58	Mar 6	Digital techniques used in production line diode sorter.....PT72	Aug 28	Doppler radar navigation systems, design feature of.....62	May 8
Tank gunners trained for combat with infrared detector.....60	Nov 6	Diode circuit, avc overload, for portable transistor receivers.....56	Jan 9	Doppler radar speed meter helps enforce traffic laws.....48	Mar 6
Tape-flaw detector, for checking out recorded magnetic tape.....50	Jan 9	Diode-compressor design data for tv audio application.....ERS74	Feb 27	Doppler radar uses increased by automatic digital cycle counter.....46	May 22
Television sound detector uses drift transistor.....62	Feb 20	Diode damage caused by neutron and electron radiation.....55	Nov 27	Dosimeter, transistor noise, using soliton for visual readout integration.....53	Feb 27
Time-constant detectors remotely control tv sets.....RD62	Sept 4	Diode harmonic generator for solid-state microwave power generator.....39	Apr 17	Dosimeters for protecting against microwave health hazards.....49	Feb 20
Time-interval detector for writing circuit of pulse-duration tape recording system.....56	Feb 6	Diode pump used in ratemeter for probe-mounted transistorized Geiger counter.....64	Jan 16	Drafting, hand detailing replaced by photographic techniques.....PT78	Jan 9
Transistor detector for system sending digital data over narrow-band lines.....72	June 5	Diodes perform role of comm. switching array in memory.....RD50	Oct 9	Driller, gearless multiple spindle, discussed at IRE show.....PT70	Apr 17
Transistorized Geiger-Muller detection circuit for radiation monitor.....42	June 26	Hard vacuum diodes for microwave detection.....CM110	Apr 24	Driver circuit for cathode ray tube deflection yokes.....58	Dec 11
Transistorized infrared detector for proximity control of auto brakes.....86	Oct 16	Measuring setup for evaluating logarithmic behavior of germanium diodes.....RD64	Mar 6	Drivers, current, for high-speed thin-film memories.....55	June 5
Tunnel diodes used in low-level r-f detectors.....60	Nov 27	Outdiffusion technique produces 2-to-3 millimicrosecond switching diodes.....66	June 5	Drum, rotating, delivers parts.....PT80	Jan 16
Yield-point detector for metal working machine automatic controller.....41	Mar 6	Reverse-biased p-n junction diode used as variable capacitor in oscillator circuit.....38	Aug 21	Dynamic high-Q.....64	Jan 9
Dewline extended to Aleutians.....RD78	June 5	Selection guide to back-biased, voltage variable diode capacitors.....52	July 24	<b>Ear defenders, quality testing of</b> .....RD76	May 15
Dielectric materials being researched to understand properties exhibited.....CM34	Oct 9	Silicon duo-diode has high photosensitivity.....CM53	Mar 27	Electrodeposition, metal, enables production of integrated metal-plastic components.....PT128	Dec 4
Dielectric plate array microwave antenna saves space.....RD54	Sept 18	Silicon junction diode used in new electronic scanner.....RD48	Aug 21	<b>Electroluminescent Devices</b>	
Dielectrics, fluoride, for space-age insulation.....CM80	June 12	Solid-circuit capacitors formed from diode junctions.....110	Aug 7	Electroluminescent panel outputs increased by static inverter.....CM75	May 22
Dielectrics, silicone, selection guide for.....64	Apr 10	Solid-circuit transistors.....CM82	Apr 10	Electroluminescent panels for automatic displays.....44	July 10
<b>Digital Techniques and Devices</b>		Switching vhf power in antennas with silicon diodes.....58	June 19	Electroluminescent typewriter with ferro-resonant storage and switching.....101	Dec 4
Digital and analog data, combination recording of.....101	Dec 4	Technique for making silicon carbide diodes.....CM82	June 12	Hot-cold panel for lighting and heating.....CM82	Feb 27
Digital cycle counter, automatic, increases Doppler radar uses.....46	May 22	Thermionic diodes as power sources for future space-age electronics.....43	Mar 20	Photoconductive electroluminescent elements for code translation in display systems using segmented EL panels.....31	Dec 25
Digital data system monitors meteorological environment of intrusion alarms.....RD120	Dec 4	Triggering sensitivity of monostable multivibrators increased using series diode feedback loop.....90	Apr 24	Solid-state panels for display and/or storage.....46	Jan 30
Digital data transmission over narrow-band communication lines.....72	June 5	Ultrasonic grinder forms mesa diodes.....PT112	May 29	Usefulness of electroluminescent panels as storage and display devices.....31	Dec 25
Digital feedback circuit for frequency multiplication.....60	July 17	Using silicon diodes in radar modulators.....70	June 12	Electrometer, sensitive, potted electrodes speed testing with.....PT62	Jan 23
Digital Gray-to-straight binary code converter uses solid-state devices.....60	Dec 11	Vacuum and gas diodes for thermoelectron engines.....69	Nov 13	Electrometer uses feedback to give high sensitivity and wide bandwidth.....71	Oct 9
Digital input for precision variable frequency generator.....56	Oct 30	Varactor diode for high-frequency operation.....SR53	July 31	Electron bombardment, affect on semiconductor devices.....55	Nov 27
Digital instruments for design and production.....SR89	Sept 11	Zener diode eliminates damped oscillations and regulates pulse height.....RD78	Nov 27	Electron bombardment technique of processing materials.....39	Sept 4
Digital phase meter for Vanguard Minitracker system.....33	Jan 2	<b>Diplexer, resonant ring, for forward scatter systems.....54</b>	July 3	Electron bombardment welds tough metals.....PT110	May 29
Digital system positions shafts over phone line.....62	Feb 13	<b>Discriminators</b>		Electron flight velocity obtained directly from graphs.....ERS58	July 24
Digital systems, transistorized alarm circuit warns of faults in.....48	July 3	Amplitude discriminator for gated-amplitude infrared ratio indicator.....64	Mar 27	Electroplating, production methods and application data for.....58	Feb 20
Digital tachometer aids in steam turbine design.....58	Apr 10	Discriminator circuit for inexpensive sound system in television receivers.....66	Feb 27	Encapsulants, environmental limits of materials used for.....SR81	Dec 4
Digital techniques applied to measurements in behavioral sciences.....70	Oct 16	Discriminator, dual-cavity microwave.....CM74	Jan 16	Encoder, analog-to-digital, for continuous conversion of analog voltages at one bit per 4 microsec.....101	Dec 4
		Discriminator for radio propagation testing system.....44	Jan 23	Encoder, digital techniques for generating time scales on paper or tape.....80	Nov 13
		Four-channel discriminator for sorting high-altitude cosmic rays.....52	Aug 28	Encoder for high-speed electrostatic teletypewriter.....83	May 29

Encoder, transistor, measures random event time intervals.....	48	Mar 20
Engine cylinder gas temperature measured by gated-amplitude ratio indicator.....	64	Mar 27
<b>Environmental Testing</b>		
Arc plasma jet used to determine thermal characteristics of re-entry vehicle antenna.....	RD66	Oct 30
Design of electronic components for space use.....	SR65	Apr 24
Environment, effect on properties of infrared transmitting materials.....	56	Jan 16
Environment, nuclear, magnetic materials for operating at 500 C in.....	63	Jan 9
Environmental effects on radio wave propagation.....	SR93	Oct 23
Environmental testing, piezoelectric accelerometers mounted on plastic blocks used for.....	RD70	Jan 16
Flight acceptance and type-approval tests for the Explorer I satellite.....	39	Feb 6
Importance of heat, humidity, vibration and shock tests in determining component reliability.....	SR65	May 29
Materials for environmental extremes.....	SR81	Dec 4
Missile shock and vibration protection methods, materials and devices.....	CM68	Mar 6
Modular fixtures speed environmental testing of components.....	PT86	Nov 27
Shaker tests space components.....	RD74	Feb 20
Shock tube developed to study missile entry into atmosphere of neighboring planets.....	CM60	Sept 18
Solders for nuclear and space environments.....	50	Sept 4
What designers should know about humidity.....	50	Oct 30
What the military expects from future components.....	52	July 17
Error reduction circuit for loaded potentiometers.....	34	Aug 21
Ether, automatic control circuit for monitoring administration of.....	43	Jan 30
European developments in transistor circuits.....	41	May 22
Exciter frequency unit for radio propagation testing system.....	44	Jan 23
Exciter, precision, for transistorized core displacement measuring unit.....	52	July 10
Exciters, grid excitation circuit input circuit for audio amplifiers.....	72	Apr 10
Explorer I satellite, instrumenting of.....	39	Feb 6
Eye pupil movement accurately measured by electronic pupillo-graph.....	67	Sept 25
Eyeglass frame houses 4-transistor trf radio.....	88	Sept 25

## F

Facsimile system for high-speed scanning and direct reproduction or transmission.....	RD126	Aug 7
Fail-safe circuits for conveyor systems.....	60	July 10
Fail-safe electro-optical inspection systems for industrial gaging.....	74	July 31
Failure rate of circuits, determination of.....	SR65	May 29
Failure rate for electronic circuits.....	SR65	May 29
Fan, exhaust, relieves sneezes at solder benches.....	PT80	Jan 16
Fan, muffin, has outside rotor.....	CM71	Mar 6
Fasteners—tabulation of design, characteristics and applications of retaining rings.....	88	Nov 20
Fencing judged by transistor indicator.....	114	Aug 7
<b>Ferrite Devices</b>		
Active ferrite switch used as attenuation element in radar system.....	43	Oct 30
Blax, high-speed ferrite memory and logic element.....	43	Oct 30
C-band ferrite isolator for radar system.....	CM67	July 3
Characteristics of micromodule ferrite core inductors.....	51	May 22
Characteristics, properties and applications of ferrites.....	67	Feb 13
Environmental limits of ferrites.....	SR81	Dec 4
Ferrite configurations for Y-type microwave circulators.....	81	Dec 18
Ferrite core memory arrays may be printed.....	PT86	June 19
Ferrite material, called Blax, permits nondestructive interrogation of memories.....	RD80	Oct 9
Ferrite memories simplify telephone traffic data recording.....	68	Oct 9
Ferrite memory core inspection standards.....	PT79	Oct 2
Ferrite monocrystals grown better and in more quantity for magnetic research.....	CM134	Oct 23
Ferrite phase shifters for S-band and lower frequencies.....	27	Aug 21
Ferrite waveguide switches classified by bandwidth, power capability, isolation and speed.....	71	June 5

Impulse switching using incompletely magnetized conventional ferrite cores.....	125	Mar 13
Insulating ferrite memory cores.....	CM131	Sept 11
Magnetically-controlled ferrite attenuators reduce receiver intermodulation and cross-modulation interference.....	64	Nov 6
Nickel zinc ferrite for magnetostrictive filters.....	72	June 19
Nonreciprocal-loss ferrite elements in traveling-wave paramp increase gain.....	31	Dec 25
Parametrons for computers with 4-mc clock frequencies.....	125	Mar 13
Pulse sorting with transistors and ferrite cores.....	64	May 15
<b>Ferroelectric Devices</b>		
Ferroelectric capacitors, voltage-tunable, circuits using.....	52	Jan 16
Ferroelectric converter changes heat into high-voltage d-c or a-c.....	RD88	Dec 18
Ferroelectric crystals for switching applications.....	58	Aug 14
Ferroelectrics tune electronic circuits.....	52	Jan 16
Selection guide to ferroelectric voltage variable capacitors.....	52	July 24
Solid-state panels for display and/or storage.....	46	Jan 30
<b>Ferromagnetic Devices</b>		
Coincident-current ferromagnetic core memory makes digital data buffers more compact.....	50	Oct 2
Ferromagnetic thin films are future logic elements for microwave computer circuits.....	77	Nov 20
Ferromagnetic toroid used in magnetic demodulator for color tv.....	RD56	Jan 2
High magnetic fields help investigation of ferromagnetic and antiferromagnetic materials.....	43	Oct 2
Low-frequency parametric amplifier uses thin ferromagnetic inductive film.....	RD92	Nov 13
Ring source gives even vacuum deposition of metallic films.....	PT84	June 12
Toroidal ferromagnetic cores used in Gray-to-straight binary code converter.....	60	Dec 11
Using thin ferromagnetic films in high-speed memories.....	55	June 5
Ferro-resonant storage and switching for electroluminescent typewriter.....	101	Dec 4
<b>Filters</b>		
Automatic tracking filter for digital Doppler cycle counter.....	46	May 22
Circuit design using magnetostrictive filters.....	72	June 19
Crossover filter for automatic video processing amplifier.....	96	May 29
Dynamic test of filter choke inductance at rated average current.....	RD54	Jan 23
Electronic infrared filters for space vehicle receiver.....	38	Sept 18
How to design low cost audio filters.....	68	Apr 10
How to design triple bandpass filters.....	41	Aug 21
Low-pass filter for spectrum analyzer.....	56	May 1
Narrow-passband filter for Vanguard Minitrack system.....	33	Jan 2
Network transformations for wave filter design simplified with charts.....	58	June 26
Rejection filter, Wien bridge used as.....	RD58	Jan 2
Selective filters in transmission line to reduce r-f intermodulation.....	71	Nov 27
Transistorized 1,300-cps bandpass filter for dual-conversion marker beacon receiver.....	59	May 8
Waveguide data charts for precision design of X-band filters.....	ER560	Feb 6
<b>Films, insulation, environmental limits of materials used for.....</b>		
Finishes, electroplated, tabulation of characteristics of.....	SR81	Dec 4
Finishes for magnesium electronic components.....	58	Nov 6
Fire-control equipment controlled using joystick controlled, command servo positioner.....	87	Apr 24
Fire endurance of building materials or construction estimated by analog computer.....	RD76	Feb 27
Fishing sonar uses compact scan system.....	54	Apr 3
Fishing, trawl, using underwater sonic telemeter system for determining depth of net.....	66	Mar 27
Fishing with portable d-c pulse unit which electronarcotizes fish.....	31	Jan 23
Flowmeter calibration, four liquid level detector configurations for.....	49	Jan 2
Fluids, cooling and insulation, environmental limits of materials used for.....	SR81	Dec 4
Foam plastic trays handle small parts.....	PT71	July 3
Foams, environmental limits of materials used for.....	SR81	Dec 4
Food preservation by electron bombardment using low-cost accelerator.....	RD72	Aug 14
Forest fires, infrared detectors for finding and for guiding fire-fighting missiles to.....	RD69	Mar 20

Foresters use pen recorder for monitoring weather.....	RD66	Mar 20
Frequency separation to reduce r-f intermodulation.....	71	Nov 27
Fuel cell, hydrogen-oxygen, for converting heat to electricity.....	125	Mar 13
Fuel cells for converting chemical energy to electricity for future space-age electronics.....	43	Mar 20
<b>G</b>		
Gages, electronic and mechanical, for checking high vacuums.....	76	Oct 16
Gallium phosphide promising for high-temperature applications.....	CM70	Oct 2
Galvanometer, variable-area recording, for tv remote film camera.....	58	Jan 16
Garage-door opener, radio-controlled transistor circuit for operates between 5 and 10 kc.....	RD62	Apr 17
Gases, cooling and insulation, environmental limits of materials used for.....	SR81	Dec 4
Gas-flow data measured using saturable-core transistor oscillator integrator.....	42	Jan 23
<b>Gate Circuits</b>		
Coincidence diodes gate electronic switch for radar indicators.....	66	Feb 20
Diode-amplifier gate for microsecond sampling switch.....	36	Jan 23
Diode gating circuit for automatic video processing amplifier.....	96	May 29
Electronic switch using high-gain d-e operational amplifiers.....	66	Nov 6
Gate circuit for multiplexer used with satellite applications.....	58	Oct 30
Gated-amplitude infrared ratio indicator measures engine cylinder gas temperature.....	64	Mar 27
Gating circuit for digital tachometer.....	58	Apr 10
Gating receivers or detectors in tracking radars to reduce pulsed interference.....	39	July 10
Time-controlled gates and pulse-synchronized, for pulsing circuits.....	RD72	Jan 16
Transistor gating circuit for computer clock.....	70	Feb 27
Transistor gating circuit for encoder used to measure random event time intervals.....	48	Mar 20
Transistorized gated clamp for radar and television sweep circuits.....	46	June 26
Gear packages, precision miniature types for guidance control systems.....	CM73	Oct 30
<b>Generators</b>		
Audio generator heats stellarator plasmas to 100 million C.....	57	Oct 9
Calibrated pulse generator produces millimicrosecond pulses.....	56	Apr 17
Clock pulse generator for magnetic disk digital memory system.....	130	Mar 13
Color-burst gating-signal generator for automatic video processing amplifier.....	96	May 29
Commercially available precision rate generators.....	69	Mar 27
Constant-current generator for transistor power supply.....	60	Oct 9
Cosine-squared pulse generator to reduce radar interference in frequency domain.....	39	July 10
Crystal harmonic generator for 7-14 kmc microwave band.....	CM106	Nov 20
Damped 40-mc damped oscillation generator for scanner used to recognize and count atomic particle tracks.....	58	Mar 27
Design of high-frequency clock pulse generators.....	56	Aug 28
Determining generator vswr required to produce particular load vswr using curves.....	ERS64	Oct 2
Digital techniques for generating time scales on paper and tape.....	80	Nov 13
Encoder line sweep generator for remoting radar information over narrow-bandwidth circuits.....	48	Apr 17
Event generator for digital recorder memory which holds data after shock.....	60	Mar 20
Function generator for analog computer used to diagnosis heart ailments.....	56	Oct 2
High magnetic field generator for advanced research.....	43	Oct 2
High-voltage generator for probe-mounted transistorized Geiger counter operates off 6-volt battery.....	64	Jan 16
Induction heating generator uses hydrogen thyatrons as rapid switches.....	51	Feb 13
Linear frequency sweep generator design using voltage-variable capacitors.....	38	Aug 21
Magneto-hydrodynamic generator for extended space flight.....	CM82	Nov 27
Megapulse generator for dynamic testing of computer building blocks.....	66	Aug 14
Multiwaveform generator uses double-bootstrap sweep controlled by polarity-sensitive trigger.....	83	Nov 13
Number generators for forming handwritten-like digits on crt display.....	138	Mar 13

Open-loop photoelectric function generator for radar simulator . . . . .	52	Jan 9	High-density packaging reduces size of electronic units for guidance systems . . . . .	62	Oct 9	<b>Infrared</b>	Casting pure polycrystalline silicon for infrared optics . . . . .	CM130	Sept 11
Outline generator for educational television . . . . .	52	Apr 3	Inertial guidance for space flight . . . . .	SR65	Apr 24	Experimental infrared communications receiver for space vehicles . . . . .	38	Sept 18	
Photoformer signal generator for heat flow simulation analog computer . . . . .	RD76	Feb 27	Infrared detector for finding forest fires and guiding fire-fighting missile to area . . . . .	RD69	Mar 20	Gated-amplitude indicator measures ratio of two infrared radiation intensities . . . . .	64	Mar 27	
Plasma generator used for heat tests . . . . .	RD66	Oct 2	Land-vehicle radar guidance not requiring special highways . . . . .	39	May 1	Graphite fabric as infrared emitter . . . . .	CM80	May 8	
Plasma generator used to flame spray refractory oxides and ceramics . . . . .	CM70	Oct 2	Miniature X-band radar with high resolution for aircraft landing guidance . . . . .	48	Jan 30	Grown silicon lenses for infrared sensing . . . . .	CM85	June 19	
Precision variable frequency generator uses digital input . . . . .	56	Oct 30	Remote sensing head in transducer provides remote control of one-tube crystal oscillator . . . . .	48	Oct 2	Infrared detector covers 8- to 14-micron range . . . . .	CF69	May 1	
Precision variable time-interval generator for radar range calibration . . . . .	58	Apr 3	Silver-coated lens for missile guidance radar . . . . .	CM75	May 22	Infrared detectors for finding forest fires and guiding fire-fighting missiles to area . . . . .	RD69	Mar 20	
Pulse generator improves stroboscope versatility . . . . .	116	Aug 7	Gyrators, using field-effect solid-state tetrodes as . . . . .	66	May 15	Infrared gold-doped germanium crystal detector is microwave energized . . . . .	CM70	Jan 30	
Radio frequency alternating field generator for plasma thermonuclear converter . . . . .	50	July 3				Infrared range determined using new figure of merit and nomograph . . . . .	ERS94	Nov 20	
Ramp strobe and staircase generator for millimicrosecond sampling oscilloscope . . . . .	69	July 31				Infrared transmitting materials, properties of . . . . .	56	Jan 16	
Reference-pulse generator for Vanguard Minitrack system . . . . .	33	Jan 2	Hall-effect devices . . . . .	63	Jan 16	Large sapphire infrared lens developed . . . . .	CM83	Feb 27	
Sawtooth and pulse generators use high-speed switching transistor . . . . .	64	Dec 11	Hall-effect is used in tape recorder playback heads . . . . .	RD52	Dec 25	Long wavelength infrared detector cooling systems . . . . .	36	Aug 21	
Sawtooth generator for magnetic drum recorder for designing continuous processing system . . . . .	44	Feb 6	Hall-effect probe uses magnetic field detector to detect interference . . . . .	CM83	June 12	Multiple-cell infrared detectors for sensing low-level energy . . . . .	33	June 26	
Signal generator for controlling target drones . . . . .	52	May 1	Hall-generator type electronic chopper reduces field-switching transient duration . . . . .	RD66	Oct 2	Parts molded into epoxy mirrors for infrared and optical use . . . . .	PT86	Apr 10	
Single-pulse generator using vacuum tube and solid-state thyatron . . . . .	70	Aug 14	Handwriting recognition system with ten word vocabulary . . . . .	RD100	Nov 20	Remote controlled moving target system simulates battle conditions . . . . .	60	Nov 6	
Solid-state generator for producing microwave power . . . . .	39	Apr 17	Harmonic amplitude measured with tuned vtvm . . . . .	68	Jan 16	Transistorized infrared detector for proximity control of auto brakes . . . . .	86	Oct 16	
Solid-state generator for producing microwave power . . . . .	42	Sept 4	Harmonic analysis of complex waves simplified using tabular form . . . . .	84	Dec 18	<b>Instruments</b>			
Staircase generator for microsecond sampling switch . . . . .	36	Jan 23	Health hazards of microwaves, research on . . . . .	49	Feb 20	Adjustable stroboscope analyzer for studying complex mechanical motions . . . . .	62	June 5	
Sweep and harmonic generators, voltage-tunable ferroelectric capacitors used in . . . . .	52	Jan 16	Heart block corrected by portable pacemaker . . . . .	RD92	Sept 25	Air gage measures radome wall thickness . . . . .	PT86	Apr 10	
Thermoelectric generator produces 100 watts of power from heat of gas flame . . . . .	CM70	July 17	Heart faults found with industrial strip-chart recorder . . . . .	RD74	Feb 20	Analyzer statistically evaluates noise-signal amplitudes . . . . .	48	July 24	
Thermoelectron engines: future power sources . . . . .	69	Nov 13	Heart rate regulator . . . . .	38	Jan 2	Battery-operated, transistorized radiation monitor for radioisotope tracing in industry . . . . .	42	June 26	
Timing-signal generator with flexible output . . . . .	52	Mar 6	Heat, effect of on materials . . . . .	SR81	Dec 4	Biological pressures of vital body liquids measured and recorded by photoelectric manometer . . . . .	41	Dec 25	
Tone generator for monophonic keyboard timbre synthesizer . . . . .	92	May 29	Heat effects of microwave energy on animal tissue . . . . .	49	Feb 20	Blister packing for instrument bearings . . . . .	PT113	May 29	
Transistor and magnetic circuits for radar pulse generator . . . . .	42	July 3	Heat expansion of metals, plastics, ceramics and natural insulators . . . . .	95	May 29	Calibrated pulse generator produces millimicrosecond pulses . . . . .	56	Apr 17	
Transistor pulse generator for computer clock . . . . .	70	Feb 27	Heat flow within building materials for construction estimated by analog computer . . . . .	RD76	Feb 27	Capacitance micrometer detects failures in jets and turbines . . . . .	RD78	June 5	
Transistorized function generator for sines or cosines . . . . .	48	Jan 23	Heater circuit, transformerless power supply for . . . . .	ERS56	June 26	Cellometer measures cloud-height using computer for analysis . . . . .	RD88	Oct 16	
Transistorized horn signal generator for digital system alarm circuit . . . . .	48	July 3	High Range—combination flight-test and missile-test facility . . . . .	53	Mar 27	Common mode rejection amplifiers for strain gages and thermocouples . . . . .	43	July 24	
Transistorized radar and television sweep generator using low power . . . . .	46	June 26	Highway construction, new family of instruments solve unique problems of . . . . .	69	Dec 18	Control instruments increase tire life by maintaining manufacturing tolerances . . . . .	RD90	Dec 18	
Transistorized variable-frequency generator for pulse circuit design . . . . .	47	Apr 3	Humidity—what designers should know about it . . . . .	50	Oct 30	Control, survey and coolant monitoring electronic instruments for nuclear power reactors . . . . .	62	June 12	
Trigger and reset pulse generator for multipath delay analyzer . . . . .	52	Sept 4	Hybrid complementary symmetry amplifier for transistorized broadcast monitor . . . . .	118	Sept 11	Conventional synchros used as difference frequency generator and as direct reading frequency deviation meter . . . . .	84	Sept 25	
Trigger generator for high-speed multiplexer . . . . .	48	June 26	Hybrid rings for millimicrosecond microwave computer circuits . . . . .	77	Nov 20	Design of highly sensitive, wide-bandwidth electrometer . . . . .	71	Oct 9	
Triggered bistable semi-conductor circuits . . . . .	ERS58	Aug 28	Hybrid tube-transistor circuits provide design economy . . . . .	68	June 5	Designing a power density meter . . . . .	RD66	July 17	
Ultrasound generator for ultrasonic neurosurgical instrument . . . . .	53	May 15				Digital tachometer aids in steam turbine design . . . . .	58	Apr 10	
Using high-gain d-c operational amplifiers for function generation . . . . .	66	Nov 6	Ignitrons for fast switching in industrial control . . . . .	51	June 26	Doppler radar speed meter helps enforce traffic laws . . . . .	48	Mar 6	
Using synchros as difference frequency generators . . . . .	84	Sept 25	Impedance transfer ring for finding unknown antenna impedances . . . . .	ERS82	July 31	Drift-free, magnetic d-c amplifier for instrument applications . . . . .	RD62	Apr 17	
Word generator for testing high-speed digital computer circuits . . . . .	50	July 17	Impregnants, environmental limits of materials used for . . . . .	SR81	Dec 4	Dual-beam oscilloscope displays vibrating beam parameters . . . . .	RD49	Aug 21	
Zero-crossing synchronized wave-train generator for testing ultrasonic equipment . . . . .	64	May 8	<b>Indicators</b>			Electronic and mechanical gages for checking high vacuums . . . . .	76	Oct 16	
Geodimeter for measuring distances in surveying . . . . .	113	Oct 23	Automatic indicator for controlling bus traffic . . . . .	50	July 10	Electronic measurement of physiological factors affecting future spacemen . . . . .	65	Oct 16	
Geomagnetic effects of nuclear bombs . . . . .	RD72	Aug 14	Coincidence diodes gate electronic switch for radar indicators . . . . .	66	Feb 20	Errors in test instruments reduced with transistor circuit to maintain constant current . . . . .	78	Oct 9	
Glassworking simplified using magnetic arc method . . . . .	PT80	Nov 6	Electroluminescent alpha-numerica indicators for typewriter . . . . .	101	Dec 4	Eye pupil movement accurately measured by electronic pupillograph . . . . .	67	Sept 25	
Goniometer, use of in radio direction finder with automatic readout . . . . .	52	Apr 17	Electroluminescent panels for automatic displays . . . . .	44	July 10	Fall-safe electro-optical inspection systems for industrial gaging . . . . .	74	July 31	
Graphical analysis of coupling networks . . . . .	ERS122	Aug 7	Gated-amplitude infrared ratio indicator measures engine cylinder gas temperature . . . . .	64	Mar 27	Flying-spot closed-circuit tv system measures size changes of variable stars . . . . .	66	May 8	
Gravity locator balances nose cones . . . . .	RD78	Nov 27	Miss distance indicator scores miss distance accuracy . . . . .	42	Apr 17	Forming handwritten-like digits on crt display . . . . .	138	Mar 13	
Gravity meters used to make topographical maps . . . . .	113	Oct 23	Miss distance indicator to assist in training air-to-air rockets . . . . .	39	May 1	Frequency (spectrum) analyzer provides two reference signals . . . . .	56	May 1	
Group organization for modernization of electronics firms . . . . .	49	Nov 6	Moving target indicator radar systems, charts simplify finding blind spots of . . . . .	ERS62	May 22	Gas-flow data measured using saturable-core transistor oscillator integrator . . . . .	42	Jan 23	
<b>Guidance Systems</b>			Operating principles and range of temperature detectors for industry and laboratories . . . . .	55	July 10	Gated-amplitude infrared ratio indicator measures engine cylinder gas temperature . . . . .	64	Mar 27	
Azimuth theodolite references Jupiter inertial guidance system . . . . .	RD62	Feb 6	Radar indicator storage crt with symmetrical guns used as . . . . .	CM60	Jan 2	Gravity locator balances nose cones . . . . .	RD78	Nov 27	
Ballistic rocket guidance for space flight . . . . .	SR65	Apr 24	Shunt bridge balancing in strain-gage indicators . . . . .	50	July 24	High-resolution angle transducer and encoder for missile tracking . . . . .	78	Oct 16	
Communications of the future—what we learned from the IGY . . . . .	37	July 3	Slotted line with vtvm standing wave indicator for measuring impedances between 10 and 100 mc . . . . .	64	Mar 20	High-speed switching of low-level signals for instrument used to measure and record data . . . . .	54	Mar 20	
Guidance considerations in space travel . . . . .	SR65	Apr 24	Transistor indicator judges fast-moving sports contests . . . . .	114	Aug 7				
Guidance system of missile tested with low-cost, active, fm radar, miss-distance indicator . . . . .	91	Nov 20	Inductors, characteristics of micro-module ferrite core . . . . .	51	May 22				
Guidance systems for manned space flight . . . . .	49	Aug 14	Information retrieval, practical system developed . . . . .	RD88	Oct 16				
			Information theory and transmission in communications . . . . .	SR93	Oct 23				

Industrial strip-chart recorder finds heart faults	RD74	Feb 20
Instrument checks wheel toe-in	RD150	Mar 13
Instrument makes accurate four maps	RD78	Apr 10
Instrument package in weather-eye satellites used to track earth's weather	44	May 1
Instrumentation system for intelligibility evaluation of voice communications	88	May 29
Instrumenting the explorer I satellite	39	Feb 6
Instruments for design and production	SR89	Sept 11
Instruments: Key to missile programs	47	Jan 16
Magnetism and meters test TV transformers automatically	PT64	Jan 23
Measurement of harmonic amplitude with tuned vvm	68	Jan 16
Measuring instruments for surveying	113	Oct 23
Microphotometer helps biologists see cell growth	RD62	July 10
Microwave spectrometer tests electron resonance of paramagnetic materials and masers	142	Mar 13
Mirror of magnifying shaving type used to make dial setting easier	PT102	Nov 13
Mold glass fiber into small instrument cases	PT63	June 26
New family of instruments solve unique problems of highway construction	69	Dec 13
Nose-cone thickness measurement using ultrasound	CM78	Aug 14
Phase meter capable of measuring small phase differences	60	June 5
Phase meter for radio direction finder with automatic readout	52	Apr 17
Portable frequency standard uses transistors and new quartz crystal unit	RD76	June 12
Potted electrodes speed testing with sensitive electrometer	PT62	Jan 23
Precise vernier changes binary-counter type frequency divider to synchronize with WWV	44	July 3
Precision variable time-interval generator for radar range calibration	58	Apr 3
Radiation measuring device made from infrared communications receiver	38	Sept 18
Radioactive sources for noncontacting thickness gages	57	May 22
Radiological vacuum gage to measure low pressures has digital output	60	June 19
Radiometers and dosimeters for protecting against microwave health hazards	49	Feb 20
Sampling oscilloscope displays millimicrosecond pulses	69	July 31
Satellite checkout instrumentation	RD74	Nov 6
Semiconductors for strain gages	CM63	Feb 6
Sensitive microphotometer uses magnetic modulation of photocell current	CM61	Sept 18
Silicon and germanium strain gages for measuring static, low-frequency and high-frequency stresses	125	Mar 13
Slotted line with vvm standing wave indicator for measuring impedances between 10 and 100 mc	64	Mar 20
Soviets give data on sun satellite	RD66	Jan 30
Technique for quickly checking frequency standard against WWV	RD76	Mar 27
Tensionmeter measures tension in moving web of paper	RD76	May 15
Test set for evaluating noise quality of fixed composition resistors	RD60	June 26
Thickness measurement using improved non-destructive inductive Eddy current technique	42	Aug 23
Transistor device for viewing repetitive millimicrosecond pulses on conventional scopes	RD66	Aug 23
Transistor noise dosimeter using solen for visual readout integration	53	Feb 27
Transistor voltmeter is accurate, linear	RD53	Jan 23
Transistorized glow-tube counter for nuclear instrumentation	112	Sept 11
Transistorized variable-frequency generator for pulse circuit design	47	Apr 3
Two-element flash tube improves stroboscope versatility	116	Aug 7
Ultrasensitive balanced thermistor bridge for measuring low-level r-f power	101	Dec 4
Unconventional techniques for measuring vswr using easy-to-set-up meter	120	Oct 23
Using a traveling-wave tube oscilloscope to measure switching time of outdiffused diode	63	June 5
Vacuum tube voltmeter for ultrasonic neurosurgery instrumentation	53	May 15
Vernier chronotron times nuclear particle flight	44	Mar 6

Vibration analyzer gives strobe effect	RD76	May 15
Waviness measuring instrument for nondestructive testing of mica flatness	PT110	May 29
Ways to measure light intensity at a distance for process control	48	July 17
<b>Insulation</b>		
Advances in materials discussed at Electrical Insulation Conference	CM54	Dec 25
Ceramic-type, inorganic, materials used for high-temperature electrical insulations	65	Nov 27
Environmental limits of materials used for insulations	SR81	Dec 4
Film and tape insulation, physical and electrical properties and applications for	42	Jan 2
Insulating ferrite memory cores	CM131	Sept 11
Insulation coatings for printed circuits	CM73	July 17
Insulation for space-age circuitry	CM80	June 12
Insulations for special purpose magnet wire, characteristics of	60	Feb 13
Insulator electron energy band diagrams	54	Nov 6
Low-cost material insulates in uhf applications	CM71	Mar 6
Pressure sensitive insulating tape makes electroplating mask	PT136	Aug 7
Silicone insulating materials, selection guide for	64	Apr 10
<b>Integrators</b>		
Current integration with solion liquid diodes	53	Feb 27
Double integrator using subminiature pentodes measures distances	RD64	May 22
Integrator circuit for speech intelligibility measuring system	83	May 29
Integrator resetting circuits using high-gain d-c operational amplifiers	66	Nov 6
Integrator used in precision variable frequency generator	56	Oct 30
Integrators for stabilization systems used in manned space flight	49	Aug 14
Saturable-core transistor oscillator integrates gas-flow data	42	Jan 23
Intensifier, image, for photographically recording atomic particle reactions	CM66	June 26
Interference charts show which unwanted harmonics of two signals will cause interference in mixer	ERS67	Dec 11
Intergranular corrosion, causes and cures	SR81	Dec 4
International Geophysical Year—what we learned about communications of the future	37	July 3
Interrogator, multichannel, and signal separator scheme detects single signal	50	Aug 23
Interrupter, d-c, for portable pulse unit used to electronarcotize fish	31	Jan 23
Inverter, static, ups electroluminescent panel outputs	CM75	May 22
Inverter, transistorized, for missile use	SR53	July 31
Inverter, transistorized phase, for Gray-to-straight binary code converter	60	Dec 11
Inverters, four-transistor square-wave, drives two-phase induction motor	60	Feb 20
Ion rockets for low-thrust propulsion of space vehicles	SR55	Apr 24
Ion source, high-yield electron-addition, for developing molecular mass spectrometers	125	Mar 13
Ionospheric scatter for over-the-horizon systems	SR93	Oct 23
Isolator, determining attenuation using load curves	ERS64	Oct 2
Isolator Hall-effect device, diagram for	63	Jan 16
Isolator, using field-effect solid-state tetrodes as	66	May 15
<b>J</b>		
Jamming problem, off-target, radar interference nomograph for finding solution of	116	Dec 4
Japanese develop tunnel diode computer	RD50	Dec 25
Japanese electronic devices, a survey of	109	Sept 11
Japanese video tape recorder uses only one revolving magnetic head	RD76	Dec 11
<b>K</b>		
Kinematic environment, when variables will merge	SR81	Dec 4
Kits streamline prototype tests	PT78	Jan 16
Kitting components smooths production flow	PT70	Feb 6
Klystron frequency is regulated by magnetic amplifiers and transistor circuits	68	Feb 13
Klystron, largest shown	CM72	Apr 3

<b>L</b>		
Laminates, composite, developments in	CM128	Sept 11
Larynx, electronic circuit substitutes for	RD60	July 3
Latin square, use of for determining effects of various environmental parameters	SR65	May 29
Lens, silver-coated, for missile guidance radar	CM75	May 22
Lenses, grown silicon, for infrared sensing	CM85	June 19
Lenses, infrared, properties of materials used for	56	Jan 16
Light intensity, ways of measuring at a distance for process control	48	July 17
Limiter, modified precision, using high-gain d-c operational amplifiers	66	Nov 6
Limiter noise for silencing ignition interference in citizen's radio	55	Apr 10
Limiter solid-state field effect as a circuit element	39	Apr 17
<b>Logic Circuits</b>		
Logic circuit uses photoconductive-electroluminescent element for digital-to-display translation	31	Dec 25
Logic circuits, square hysteresis-loop cores for	RD70	Jan 9
Logic networks test human ability to carry out logical analysis and synthesis	70	Oct 16
Logic symbology for static switching elements	98	Apr 24
Solid-state integrated, direct-coupled transistor logic circuit	35	June 26
Solid-state logic circuit capable of withstanding short-duration, high-flux neutron plus gamma pulses	55	Nov 27
Loudspeakers, column, for public address systems	64	June 12
Lubricants, environmental limits of materials used for	SR81	Dec 4
<b>M</b>		
Machine tools for mechanization of electronics firms	49	Nov 6
<b>Magnetics</b>		
Environmental limits of materials used for magnetic cores	SR81	Dec 4
Environmental limits of materials used for permanent magnetics	SR81	Dec 4
Iron powder for magnetic cores, properties of	141	Mar 13
Magnet wire for high temperatures available in various sizes	CM73	Oct 30
Magnetic alloys, temperature characteristics of	119	Aug 7
Magnetic amplifier for zero, d-c or very low-frequency current applications	84	Nov 13
Magnetic amplifiers and transistor circuits regulate frequency of klystrons	68	Feb 13
Magnetic amplifiers used in four-quadrant multiplying device	58	Jan 9
Magnetic arc method simplifies glassworking	PT80	Nov 6
Magnetic cartridge design for stereo applications	CM78	Feb 13
Magnetic core firing circuit, saturable, used with controlled rectifiers to drive a-c and d-c motors	73	Nov 13
Magnetic core materials for magnetic amplifiers, characteristics of	55	Feb 6
Magnetic core operates counter	RD130	Oct 23
Magnetic demodulators for color tv	RD56	Jan 2
Magnetic discharge network for radar pulse generator	42	July 3
Magnetic-disk digital memory system keeps circuits simple	130	Mar 13
Magnetic drum recording provides analog time delay for designing continuous-processing systems	44	Feb 6
Magnetic drum stores tv x-ray pictures	RD77	Dec 11
Magnetic field detector uses Hall-effect probe	CM83	June 12
Magnetic field meter, transducer Hall-effect device, diagram for	63	Jan 16
Magnetic field variation meter Hall-effect device, diagram for	63	Jan 16
Magnetic fields produced by ohmic heating circuits control the monolayer power	57	Oct 9
Magnetic-film memory speeds read-write cycle time of digital computer	RD90	Sept 25
Magnetic interlock for fail-safe operation of conveyor systems	60	July 10
Magnetic lens improves microwave tube efficiency	CM70	July 17
Magnetic materials for use at 500 C	63	Jan 9
Magnetic modulation of photocell current used for sensitive microphotometer	CM61	Sept 18

Magnetic modulator playback head reads tape at zero speed.....	58	Mar 6	Fluorocarbon resin, a true thermoplastic, is developed.....	CM71	Aug 28	Matrixing magnetic demodulators for color tv.....	RD56	Jan 2
Magnetic recording for airborne data acquisition.....	101	Dec 4	Foamed pure silica absorbs microwave energy at ultra-high temperatures.....	CM68	Sept 4	<b>Mavars</b>		
Magnetic researchers get more and better ferrite monocrystals.....	CM134	Oct 23	Glass fiber sleeving for high-temperature operation.....	CM73	Jan 30	Electron-beam parametric amplifiers for uhf operation and diode-type mavars for low noise operation.....	125	Mar 13
Magnetic storms and their effect on radio wave propagation.....	SR93	Oct 23	Graphite becomes available as a fabric.....	CM80	May 8	Low-noise parametric amplifier (mavar) in production in San Francisco.....	103	Aug 7
Magnetic storms, effect on communications.....	37	July 3	Gyro flotation material remains viscous down to -65 F.....	CM76	Jan 16	New microwave systems using junction diode mavars.....	27	Aug 21
Magnetic tape detector for pinpointing flaws.....	50	Jan 9	Heat expansion of metals, plastics, ceramics and natural insulators.....	95	May 29	Maximum energy product (BH) of magnetic materials.....	63	Jan 9
Magnetic tape recorder for weather-eye satellite.....	44	May 1	Heat-resistant plastic available.....	CM85	Apr 10	Mechanical stress, effect of on materials.....	SR81	Dec 4
Magnetic tape recording at high densities using self-clocking technique.....	72	Oct 16	High-fired ceramic for 4,600 F.....	CM66	June 26	Mechanization—when, what and how for electronic firms.....	49	Nov 6
Magnetic wire, special purpose, characteristics of insulations used for.....	60	Feb 13	Infrared transmitting materials, properties of.....	56	Jan 16	<b>Medical Electronics</b>		
Magnetically-controlled ferrite attenuators reduce intermodulation and cross-modulation receiver interference.....	64	Nov 6	Insulating ferrite memory cores.....	CM131	Sept 11	Automatic control circuit monitors depth of anesthesia during operations.....	43	Jan 30
Magnetics and meters test transformers automatically.....	PT64	Jan 23	Insulation coatings for printed circuits.....	CM73	July 17	Biological pressures of vital body liquids measured and recorded by photoelectric manometer.....	41	Dec 25
Magnetics, high magnetic fields for advanced research.....	43	Oct 2	Insulation for space-age circuitry.....	CM80	June 12	Blood pressure and heart rate regulator.....	38	Jan 2
Magnets, permanent, nominal properties of those produced by powder metallurgy.....	69	Feb 27	Low-cost accelerator for bombarding materials with electrons.....	RD72	Aug 14	Circuit substitutes as larynx.....	RD60	July 3
Magnetohydrodynamic power generator for extended space flight.....	CM82	Nov 27	Low-cost material insulates in uhf applications.....	CM71	Mar 6	Environmental testing of future spacemen.....	65	Oct 16
Magnetometer for measuring earth's magnetic field from Pioneer satellite.....	55	June 19	Low-melting glasses useful for potting.....	CM82	May 8	Eye pupil movement accurately measured by electronic pupillo-graph.....	67	Sept 25
Magnetron beam switching tubes for preferential and sequential scanning of electroluminescent panels.....	31	Dec 25	Magnetic materials for use at 500 C.....	63	Jan 9	Finger plethysmograph uses miniature photocell to measure blood volume.....	122	Sept 11
Magnetron, reflex, voltage control frequency in.....	56	July 10	Materials for bonding sapphire to metals.....	110	Dec 4	Flying-spot closed-circuit tv system for comparing x-ray plates.....	66	May 8
Magnetrons, nuclear environment, high temperature magnetic materials for.....	63	Jan 9	Materials for environmental extremes.....	SR81	Dec 4	Heart ailments diagnosed using analog computer to measure volumetric output of blood.....	56	Oct 2
Mail-cancelling and facing machine, automatic.....	RD70	Jan 9	Materials for infrared windows, domes, lenses.....	56	Jan 16	High-speed multiplexing with closed-ring counters for data processing and recorders.....	48	June 26
Manipulator, mobile, for reactor repair remotely controlled by ultrasonic system.....	RD64	Apr 17	Metal fatigue shown by fast electronic camera.....	RD60	July 3	Impulse counter tests drug reactions.....	RD78	Apr 10
Manipulator that feels and hears for working on nuclear aircraft machinery.....	RD102	May 29	Microscopic bits of material may be used to form future computer components.....	RD124	Sept 11	Industrial strip-chart recorder finds heart faults.....	RD74	Feb 20
Map making using electronic devices.....	113	Oct 23	Missile shock and vibration protection methods, materials and devices.....	CM68	Mar 6	Instrumentation for ultrasonic neurosurgery.....	53	May 15
Maps, contour, instrument for making.....	RD78	Apr 10	Multiform glass, seals to copper directly.....	CM63	Jan 2	Logic networks test human ability to carry out logical analysis and synthesis.....	70	Oct 16
<b>Masers</b>			NBS investigates strength of ceramics.....	CM79	Aug 14	Low-cost accelerator for sterilizing with electron bombardment.....	RD72	Aug 14
Feasibility of using a maser amplifier in an active radar system demonstrated.....	43	Oct 30	New film deposits improve resistors.....	CM132	Oct 23	Magnetic drum stores tv X-ray pictures.....	RD77	Dec 11
Maser sensitivity curves for determining receiver sensitivity and noise figure relationships.....	ERS70	Feb 20	New frontiers for semiconductors determined from study of periodic table.....	43	July 17	Manipulator that feels and hears for working on nuclear aircraft machinery.....	RD102	May 29
Maser, solid-state, influence of on communications.....	39	Apr 17	New nose cone protective material.....	CM92	Oct 16	Microphotometer helps biologists see cell growth.....	RD62	July 10
Masers for millimicrosecond microwave computer circuits.....	77	Nov 20	New standards for laminated plastics.....	48	Aug 28	Nerve impulses control artificial hand.....	RD79	May 8
Microwave spectrometer tests electron resonance of paramagnetic materials and masers.....	142	Mar 13	Physical and electrical properties of silicone insulating materials, selection guide for.....	64	Apr 10	Neuron simulated by transistor circuit.....	RD74	Feb 13
New microwave systems using masers.....	Aug 21		Polarized phosphors used for data storage and display.....	39	Aug 28	Neurophysiological studies of frog help computer designers simulate the human brain.....	125	Mar 13
Portable maser amplifiers, traveling-wave masers and four-level masers for frequency above 6 kmc.....	125	Mar 13	Polyurethane foam cushions missile nose cone during shipment.....	PT110	Nov 20	Nonhazardous sensing head in transducer provides remote control of one-tube crystal oscillator.....	48	Oct 2
<b>Materials</b>			Polyvinyl chloride conductive compound for extrusion, calendaring and injection molding.....	CM182	May 8	Portable pacemaker aids heart-block victims.....	RD92	Sept 25
Adhesive for dip-soldering printed circuit boards.....	CM83	Mar 27	Printed circuit can take 1,300 F.....	CM82	June 19	Portable, transistorized artificial cardiac pacemaker.....	39	May 1
Advances in materials discussed at Electrical Insulation Conference.....	CM54	Dec 25	Processing materials with electron bombardment.....	39	Sept 4	Researching microwave health hazards.....	49	Feb 20
Alloy gives continuous getter for electron tubes.....	CM81	Feb 13	Properties for parallel laminates of glass-fiber reinforcements used for rigid radomes.....	CM66	Apr 17	Transistor plethysmograph for impedance measurement of living tissue.....	62	Apr 10
ARDC digs into molecular electronics.....	CM83	May 8	Properties of dielectric materials being researched.....	CM84	Oct 9	Transistorized radio carried on mouse transmits biological data to satellite telemetry system.....	RD128	Oct 23
Automatic neutron activation analysis of materials.....	RD81	Nov 27	Pyrographite solves high-heat problems in missiles, electronics and nuclearics.....	CM124	Dec 4	Ultrasonic tv camera supplements x-rays in displaying internal structures.....	RD124	Sept 11
Automatic transistor production using flat ribbons of semiconductor material.....	CM128	Sept 11	Radiation effects on electronic materials being studied.....	CM82	June 19	Ultraviolet image-converter tube for biological microscope.....	CM78	Feb 20
Beryllium dish to shield satellites.....	CM68	July 10	Radome material developed for supersonic aircraft.....	CM133	Aug 7	<b>Memories</b>		
Casting pure polycrystalline silicon for infrared optics.....	CM130	Sept 11	Resin and glass cloth laminates for reinforcing plastic radar reflectors.....	PT76	May 22	Biax, high-speed ferrite memory and logic element.....	43	Oct 30
Ceramic material takes temperatures of 5000 F.....	CM81	Feb 13	Rhenium available commercially.....	CM157	Mar 13	Coincident-current technique for digital data buffer permits compact construction.....	50	Oct 2
Ceramic-type, inorganic materials used for high-temperature electrical insulations.....	65	Nov 27	Russian advances in semiconductor material development.....	37	July 24	Data storage with polarized phosphors.....	39	Aug 28
Characteristics of four materials used in deflection yokes.....	59	Mar 20	Silicon carbide crystals of high purity grown from solution of alloy metals.....	CM128	Sept 11	Digital recorder memory holds data after shock.....	49	Mar 20
Characteristics of magnetic amplifier core materials.....	55	Feb 6	Silicon rubber compounds that are easy to process.....	CM94	July 31	Diodes perform role of core-switching array in memory.....	RD80	Oct 9
Characteristics of radioactive materials for noncontacting thickness gages.....	57	May 22	Silicone potting gel is transparent.....	PT70	Apr 17	Ferrite core memory for automatic telephone switchboard using silicon diode switching.....	101	Dec 4
Characteristics, properties and applications of ferrites.....	67	Feb 13	Silicone treated alumina powder becomes potting compound that pours.....	CM92	Dec 18	Ferrite memories simplify telephone data analysis.....	68	Oct 9
Computer tape solves signal dropouts.....	CM80	June 12	Solders for nuclear and space environments.....	50	Sept 4	Ferro-resonant storage and switching for electroluminescent typewriter.....	101	Dec 4
Copper-clad laminates for printed circuits.....	CM52	Aug 21	Stereo cartridge uses rubber adhesive.....	CM83	May 8	Foldback memories for noise cancellation in high speed printers.....	125	Mar 13
Developments in composite laminates.....	CM128	Sept 11	Surfaces: Key to semiconductor progress.....	CM70	Oct 2	Insulating ferrite memory cores.....	CM131	Sept 11
Examination of properties of intermetallic compounds for rectification purposes.....	69	June 12	Synthetic rubber-resin adhesive.....	CM157	Mar 13	Linear selection magnetic core array for memory with one microsecond cycle time.....	125	Mar 13
Flame-spraying refractory oxides and ceramics using high-temperature plasma jet.....	CM70	Oct 2	Tellurium compounds for semiconductors.....	CM68	Mar 6	Magnetic-disk digital memory system keeps circuits simple.....	130	Mar 13
			Thermosetting plastic is water clear.....	CM73	Apr 3	Magnetic drum stores tv X-ray pictures.....	RD77	Dec 11
			Thin film deposition for microcircuits.....	44	Sept 4			
			Ultrasonic tv camera supplements x-rays in displaying internal structures.....	RD124	Sept 11			
			Vapor phase deposition of chromium, tungsten and molybdenum improved.....	CM71	Sept 4			
			Weight and volume used to measure soft material parts.....	PT117	Apr 24			

Memory capacity may be increased by using microscopic bits of material to form computer components	RD124	Sept 11	erators on microwave communications	39	Apr 17	mouse transmits biological data to satellite telemetry system	RD128	Oct 23
Memory uses magnetic film to speed read-write cycle of computer	RD90	Sept 25	Infrared gold-doped germanium crystal detector is microwave energized	CM70	Jan 30	Tube generates current from rocket's exhaust	CM94	Dec 18
Memory windings may be printed	PT86	June 19	Magnetic amplifiers and transistor circuits regulate frequency of klystrons	68	Feb 13	Ultrasound measures nose-cone thickness	CM78	Aug 14
Single magnetic wire memory element used in shift register	CM76	Jan 9	Microwave communication system handles all forms of signals used in power business	72	Dec 18	Mixer, charts show which unwanted harmonics of two signals will cause interference in	ERS67	Dec 11
Standards for ferrite memory core inspection	PT79	Oct 2	Microwave computer adds two digits at frequencies approaching speed of light	39	May 1	Mixer oscillator circuits greatly simplified by tunnel diodes	43	Oct 30
Symmetrical switches and stepping devices using tunnel diodes for memory applications	60	Nov 27	Microwave computers for 50 to 100 mc clock rate operation	125	Mar 13	Mixer transistor for power-line carrier communications system	70	May 15
Telephone switching system uses photographic plates as permanent memory	RD78	Nov 27	Microwave detection using hard vacuum diodes	CM110	Apr 24	Mockups, wooden, to develop efficient techniques for computer and data processor production	PT82	Dec 11
Thin magnetic films for digital computer memories	44	June 26	Microwave devices for detection or measurement of power, tables to help select	59	July 17	Modernization methods for electronic firms	49	Nov 6
Transistorized clock track recorder for writing timing signals on magnetic drum	74	Oct 9	Microwave directional couplers	40	Sept 18	<b>Modular Construction</b>		
Triggered bistable semiconductor circuits	ERS53	Aug 28	Microwave energy to power sky platform	RD76	June 12	Digital building blocks used to form binary circuits for counting backward or forward	82	Sept 25
Ultrasonic delay line memory used for realistic simulation of radar clutter	78	Sept 25	Microwave parametric amplifier uses gold bonded diode	103	Aug 7	Machine assembles circuit modules	PT70	July 10
Using thin ferromagnetic films in high-speed memories	55	June 5	Microwave phase shifter for improving scanning of vhf and uhf radar antenna	125	Mar 13	Microminiaturization of modules	49	Dec 11
Message programming	47	Jan 9	Microwave polarimeter provides crt presentation of electromagnetic wave polarization characteristics	RD74	Feb 13	Modular concept applied to instruments for design and production	SR89	Sept 11
Metal corrosion, causes and cures	SR81	Dec 4	Microwave rotation switch makes use of Faraday effect	CM70	May 22	Modular design increases capacity of digital data buffer memory	50	Oct 2
Meteor bursts for propagation in over-the-horizon systems	SR93	Oct 23	Microwave spectrometer tests electron resonance of paramagnetic materials and masers	142	Mar 13	Modular design promises better system reliability	SR65	May 29
Meteor trails studied by radar to find their effect on radio transmission	RD80	Oct 9	Microwave switches for isolating radar duplexing circuit	120	Aug 7	Modular design reduces space, weight and cooling requirements	CM58	Jan 23
<b>Meters</b>			Microwave techniques for millimicrosecond computer logic and switching circuits	77	Nov 20	Modular fixtures speed environmental testing of components	PT86	Nov 27
Digital phase meter for Vanguard Minitrack system	33	Jan 2	New microwave systems using low-noise devices	27	Aug 21	Modular strip transmission line components	CM73	Mar 20
Easy-to-set-up meter for measuring vswr	120	Oct 23	Nomograph for finding separation between microwave transmitting and receiving antennas	ERS76	June 5	Modular units using ceramic wafer tubes	CM	Sept 25
Magnetics and meters test tv transformers automatically	PT64	Jan 23	Plastic microwave antenna horns	CM80	Feb 27	Mother board takes small modules	PT136	Oct 23
Moisture meter errors reduced with transistor circuit to maintain constant current	78	Oct 9	Researching microwave health hazards	49	Feb 20	Packaging at high-densities reduces size of electronic units	62	Oct 9
Power density meter, design of	RD66	July 17	Solid-state generator for producing microwave power	42	Sept 4	Window-frame module technique	CM66	July 10
Using synchros as direct reading frequency deviation meters	84	Sept 25	Test system provides contour map of microwave device's properties	RD78	June 12	Modulation meters for design and production	SR89	Sept 11
Micrometer, capacitance, detects failures in jets and turbines	RD78	June 5	Two-way microwave link for high-power airport radar system	RD120	Dec 4	<b>Modulators</b>		
Micrometer, electronic, checks printed circuits	44	Jan 2	Uhf link for Army's air-transportable 3,000-mile radio system	44	Aug 28	Balanced modulators for removing radar information over narrow-bandwidth circuits	48	Apr 17
<b>Microminiaturization</b>			Voltage-tunable millimeter-wave oscillator tubes	62	June 19	Blocking oscillator modulator for miniature X-band radar with high resolution	48	Jan 30
Characteristics of micromodule components	51	May 22	Y-type microwave circulators with wide bandwidth and high power-handling capabilities	81	Dec 18	Characteristics of modulators for d-c amplification by d-c to a-c conversion	47	Jan 23
Developments in microminiaturization technology	101	Dec 4	<b>Missiles</b>			Hard tube modulator for high-resolution, dual-channel radar	RD64	Apr 3
Integrated semiconductor devices for microminiaturization	35	June 26	Amplifier, 200-kw, for testing Polaris missile parts	RD65	May 1	Modulator-demodulator for portable transistorized multiplexer used in telephone communications	60	Jan 9
Machine assembles circuit modules	PT70	July 10	Analog tester speeds missile craft checks	RD77	Feb 20	Pulse modulator for controlled-carrier communication system	60	Jan 30
Microcircuits and solid circuits hold promise of giving better reliability	SR65	May 29	Arc plasma jet used to determine thermal characteristics of re-entry vehicle antenna	RD66	Oct 30	Stable transistorized f-m oscillator and modulator	64	Jan 30
Micromodule components for military application	62	May 15	Atlas engines watched by closed-circuit tv	RD65	May 1	Transistor circuits improve telemeter transmitter and modulator	136	Mar 13
Network design of microcircuits	44	Sept 4	Atlas gets final check	RD76	Feb 13	Transistor modulator for closed-circuit tv carrier transmission system	66	June 12
Semiconductor solid circuitry	CM82	Apr 10	Azimuth theodolite references Jupiter inertial guidance system	RD62	Feb 6	Transistor modulators for power-line carrier communications system	70	May 15
Solid circuits, approaches and developments	SR53	July 31	Boy's missile detector wins science fair	RD88	Oct 16	Transistorized modulator for digital shaft positioning over phone line	62	Feb 13
Solid circuits formed from single-crystal semiconductor wafers	110	Aug 7	Checkout sequencer for Polaris	RD86	July 31	Using field-effect solid-state tetrodes as nondistorting modulators	66	May 15
Thermionic integrated micromodules	CM80	May 15	Electronic circuits for Pioneer satellite launching missile	55	June 19	Using silicon diodes in radar modulators	70	June 12
Three approaches to microminiaturization being sponsored by military services	49	Dec 11	Gravity locator balances nose cones	RD78	Nov 27	Molecular electronics, ABCD	CM83	May 8
Welding components directly together gives high packing density	CM82	Apr 10	Guided missiles, range instrumentation for testing of	47	Jan 16	Molecular electronics, development of microminiaturized circuits using	49	Dec 11
Microphotometer helps biologists see cell growth	RD62	July 10	Hawk missile radome wall thickness measured by air gage	PT86	Apr 10	Molecular electronics—hope for the future	CM110	Apr 24
Microscope, biological, ultraviolet image-converter tube for	CM78	Feb 20	Infrared detector for finding forest fires and guiding fire-fighting missiles to area	RD69	Mar 20	Molecular electronics promises to give better reliability	SR65	May 29
<b>Microwaves</b>			Miss distance indicator scores missile accuracy	42	Apr 17	<b>Monitors</b>		
Advantages of using coiled waveguide	CM50	Aug 21	Miss distance of missile determined with low-cost active f-m radar	91	Nov 20	Azimuth theodolite references Jupiter inertial guidance system	RD62	Feb 6
Backward wave oscillator, ridge-loaded ladder circuit	CM66	May 1	Missile shock and vibration protection methods, materials and devices	CM68	Mar 6	Battery-operated, transistorized radiation monitor for radioisotope tracing in industry	42	June 26
Calibrating lower range microwave variable attenuators	RD120	Dec 4	New nose cone protective material	CM92	Oct 16	Closed-circuit tv for monitoring reactor repair	RD64	Apr 17
Carrier lifetime in semiconductor crystals measured using principle of microwave absorption	39	May 1	Polyurethane foam cushions missile nose cone during shipment	PT110	Nov 20	Coherent oscillator jitter checker for moving target radar	56	July 17
Comparison method of microwave frequency determination	74	May 8	Pyrographite solves high-heat problems in missiles, electronics and nucleonics	CM124	Dec 4	Control survey and coolant monitoring electronic instruments for nuclear power reactors	62	June 12
Crystal harmonic generator for 7-14 kmc microwave band	CM106	Nov 20	Satellite checkout instrumentation	RD74	Nov 6	Digital data system monitors meteorological environment of intrusion alarms	RD120	Dec 4
Dielectric plate array microwave antenna saves space	RD54	Sept 18	Shock tube developed to study missile entry into atmosphere of neighboring plants	CM60	Sept 18	Low-distortion, high-fidelity transistor monitor amplifier for broadcast duty	118	Sept 11
Distance measuring in surveying using microwaves	113	Oct 23	Silver-coated lens for missile guidance radar	CM75	May 22	Monitoring multiple inputs simultaneously	50	Aug 28
Dual-cavity microwave discriminator	CM74	Jan 16	Slot-antenna array for missiles and aircraft	56	Feb 27	Monitoring of performance of outboard motors, electronic timer for	RD75	Nov 6
Effect of dielectric properties on microwave propagation through materials being investigated	CM84	Oct 9	Television transmitter for missiles uses battery power	RD153	Mar 13	Monitoring system for electronic pupillograph used to accurately measure eye pupil movement	67	Sept 25
Electroforming intricate and complex-shaped microwave hardware	114	Sept 11	Transistorized, level sensitive switch for missile count-downs, production lines and industrial processes	76	July 31			
Foamed pure silica absorbs microwave energy at ultra-high temperatures	CM68	Sept 4	Transistorized radio carried on					
Improving microwave tube efficiency	CM70	July 17						
Influence of solid-state power gen-								

Monitoring volumetric output of blood during diagnosis of heart ailments using analog computer	56	Oct 2	Noise reduction in extremely weak signals using twt's and paramps	106	Dec 4	Scanner recognizes and counts atomic particle tracks	53	Mar 27
Transistorized alarm circuit warns of faults in digital systems	43	July 3	<b>Nomographs</b>			Servos control atomic manipulator	RD79	Feb 27
Wide-angle, closed-circuit tv monitor	RD72	Aug 14	Computing loaded Q of capacitor - shortened, quarter wave transmission line	ERS52	Sept 18	Strontium 90 may produce electricity	RD66	Mar 20
Motor, d-c, with armature made of two-sided printed circuit	CM70	Mar 20	Determination of free-space transmission loss at various distances from earth	BR65	Apr 24	Thermoelectron engines for converting nuclear energy into electricity	69	Nov 13
Motor design boosts efficiency	CM80	May 8	Determining range of radar beams	ERS60	Sept 4	Thermonuclear converter, plasma, r-f alternating field generator for	50	July 3
Motor, one-half hp induction, with completely inorganic electrical insulation survives 500 hours at 500 C	65	Nov 27	Finding prof of radar causing running rabbit interference patterns with nomograph	ERS58	July 3	Thermonuclear power controlled using ohmic heating circuits	57	Oct 9
Motor, two-phase induction, four-transistor square-wave inverter for driving	60	Feb 20	Infrared range determined using new figure of merit and nomograph	ERS94	Nov 20	Transistorized glow-tube counter for liquid scintillation spectrometers	112	Sept 11
Motorola system for broadcasting stereo television sound	41	Apr 3	Nomograph for calculating the minimum signal detectable by a radar receiver	ERS62	Apr 3	Vernier chronotron times nuclear particle flight	44	Mar 6
Motors, small, nuclear environment, high temperature magnetic materials for	63	Jan 9	Nomograph for computing transistor switching dissipation	ER74	Nov 27	Nuvisator, a miniature tube, adopts cantilever design	CM70	Apr 3
Multiplexer, high-speed multiplexing with closed-ring counters for data processing and recorders	49	June 26	Nomograph for designing resistor coupling networks	ERS122	Aug 7	<b>Optics</b>		
Multiplexer, portable, 4-channel, ppm for telephone communications	60	Jan 9	Nomograph for determining safety factor of a given thermal design for power transistor circuits	ERS58	Apr 17	Azimuth theodolite references Jupiter inertial guidance system	RD62	Feb 6
Multiplexing systems for stereo broadcasting, recent developments, in	41	Apr 3	Nomograph for finding dropping capacitor reactance for transformerless heater supply	ERS56	June 26	Basic optical data for electronics engineers	48	July 10
Multiplexing techniques for satellite applications	58	Oct 30	Nomograph for finding separation between microwave transmitting and receiving antennas	ERS76	June 5	Fail-safe electro-optical inspection systems for industrial gaging	74	July 31
Multiplexing with f-m for studio-transmitter links	44	May 22	Nomograph for finding thermistor resistance at desired application temperatures	ERS72	Feb 13	Optical instrumentation used at missile test ranges	47	Jan 16
Multiplier, diode harmonic, for solid-state generator producing microwave power	42	Sept 4	Nomograph for obtaining fin thickness in design semiconductor cooling device	53	June 12	Optical tracking using high-resolution angle transducer and encoder	78	Oct 16
Multiplier, frequency, uses digital feedback method	60	July 17	Nomograph for obtaining heat transfer coefficient for forced convection cooling	53	June 12	Optics for weather-eye satellite	44	May 1
Multiplier-phototube control circuit for electronic micrometer	44	Jan 2	Nomograph for obtaining total fin area in designing semiconductor cooling device	53	June 12	Parts molded into epoxy mirrors for infrared and optical use	PT86	Apr 10
Multiplier tube, grid-controlled secondary emission electron, delivers 5-amp for 20-30 ma input	31	Dec 25	Nomographs for designing complete resistance-coupled amplifiers	ERS102	Apr 24	Properties of infrared transmitting materials used in optical systems	56	Jan 16
Multipliers, modified, for spectrum analyzer	56	May 1	Nomographs for finding lifetime and tolerable neutron dosage for different transistor types	38	Dec 25	Solid-state panels for display and/or storage	46	Jan 30
<b>Multivibrator</b>			Predicting performance of precision deflection yoke design from a nomograph	ERS74	Mar 27	Use of optics to orient semiconductor crystal	PT76	Apr 3
All-silicon, solid-circuit, phase-shift oscillator	CM82	Apr 10	Radar augmenter and power nomographs	ERS146	Mar 13	<b>Oscillators</b>		
Bistable multivibrator made of thermionic integrated micro-modules	CM80	May 15	Radar interference nomograph for finding solution of off-target jamming problem	116	Dec 4	All-silicon, solid-circuit, phase-shift oscillator	CM82	Apr 10
Choke - controlled free running multivibrator for computers	31	Sept 18	Wire shielding parameters calculated with nomogram	ERS88	Nov 13	Amplitude-regulated, wide-range controlled oscillator for digital Doppler cycle counter	46	May 22
Electronic switch using high-gain d-c operational amplifiers	66	Nov 6	<b>Nucleonics</b>			Audio-modulated, 1-mc tuned oscillator withstands wide temperature range	60	Nov 27
Microminiaturized multivibrator	SR53	July 31	Analog computer simulator trains nuclear ship crews	RD124	Sept 11	Backward-wave oscillator harmonics boost receiver frequency range	58	Feb 27
Monostable multivibrator triggering sensitivity increased using series diode feedback loop	90	Apr 24	Automatic neutron activation analysis of materials	RD81	Nov 27	Backward wave oscillator uses ridge-loaded ladder circuit	CM66	May 1
Multivibrator for self-gated blocking oscillator with ten-to-one synchronization ratio	58	Nov 27	Control, survey and coolant monitoring electronic instruments for nuclear power reactors	62	June 12	Blocking oscillator for dynamic computer building block testing	66	Aug 14
Solid circuit bistable multivibrator	110	Aug 7	Definitions of nuclear energy units	SR81	Dec 4	Blocking oscillator light intensity measure	48	July 17
Stable multivibrator made with distributed parameter microcircuit technique	44	Sept 4	Geomagnetic effects of nuclear bombs	RD72	Aug 14	Blocking oscillators for magnetic disk digital memory system	130	Mar 13
Ten-mc free-running multivibrator using tunnel diodes	60	Nov 27	High magnetic fields help advance cyclotron and stellarator research	43	Oct 2	Cohrent oscillator jitter checker for moving target radar	54	July 17
Transformer-controlled free-running multivibrator for computers	31	Sept 18	Logarithmic and period transistor amplifiers for nuclear reactor control	52	May 22	Cold cathode gas trigger tube used as r-c oscillator	CM72	Oct 2
Transistorized magnetic-coupled multivibrator with controlled output frequency	54	July 24	Manipulator that feels and hears for working on nuclear aircraft machinery	RD102	May 29	Crystal-controlled autodyne oscillator for transistorized marker beacon receiver for light planes	76	Nov 13
Triggered bistable semiconductor circuits	ERS58	Aug 28	Multiparticle variable energy cyclotron being designed for flexibility	RD104	Nov 20	Crystal-controlled transistor oscillator for closed-circuit tv carrier transmission system	66	June 12
Tube-transistor hybrid used as single-shot or free running multivibrator circuit	68	June 5	Nuclear and space environments, solders for	50	Sept 4	Electron-coupled Colpitts oscillator for speech intelligibility measuring system	88	May 29
Musical electronics, monophonic keyboard instrument for synthesizing timbre of electronic musical tones	92	May 29	Nuclear bomb alarm systems	53	May 8	Emitter-coupled crystal oscillator for encoder used to measure random event time intervals	48	Mar 20
			Nuclear density-determination system measures uniformity of test pavements	69	Dec 18	Excitation oscillator for magnetic modulator playback system	58	Mar 6
			Nuclear environment, magnetic materials for operating at 500 C in	63	Jan 9	Gas-tube relaxation oscillator controls portable pacemaker	RD92	Sept 25
			Nuclear power for power generation during space flight	BR65	Apr 24	Intrusion alarm using vhf or uhf oscillator is self-adjusting	RD62	Aug 28
			Nuclear power sources for space-age electronics	43	Mar 20	Microwave oscillator built with integrated circuit using tunnel diode	CM70	Oct 30
			Nuclear propulsion studied for space use	RD79	May 8	Mixer-oscillator and uhf transmission line oscillator circuits using tunnel diodes	43	Oct 30
			Nuclear radiation absorption detector for measuring liquid levels	49	Jan 2	One-transistor blocking oscillator for diodes and counters	46	Sept 18
			Nuclear radiation, affect on semiconductor devices	55	Nov 27	One-tube crystal oscillator for use with sensitive transducers	48	Oct 2
			Nuclear radiation, affect on tunnel diodes	60	Nov 27	Operation of conventional transistor blocking oscillator	60	Aug 14
			Nuclear radiation, predicting change in transistor current gain with	38	Dec 25	Oscillator circuit supplies 100-ke signal source for forming handwritten-like digits on crt display	138	Mar 13
			Nuclear thermal pulse simulator	RD66	Oct 30	Oscillator design using voltage-variable capacitors	38	Aug 21
			Ohmic heating circuits for maintaining hydrogen isotopes at 100 million C	57	Oct 9	Oscillator for high-frequency clock pulse generator	56	Aug 28
			Pyrographite solves high-heat problems in missiles, electronics and nucleonics	CM124	Dec 4	Oscillator, r-c, made with distributed parameter microcircuit technique	44	Sept 4
			Radio-frequency alternating field generator for plasma thermonuclear converter	50	July 3	Oscillator-trigger circuit improves stroboscope versatility	116	Aug 7
			Remote ultrasonic system controls complex maintenance machinery for reactor repair	RD64	Apr 17	Phase-locked oscillator for millimicrowave microwave computer circuits	77	Aug 20
						Phase-locked oscillator for automatic chroma control and color-killer voltage	RD90	Sept 25
						Phase-shift oscillator for frequency analyzer	56	May 1

Plasma study may open way to development of oscillators between microwave and infrared ranges RD60	July 3	Pavement deflection, strain gages for measuring RD69	Dec 18	Plastic blocks mount accelerometers RD70	Jan 16
Pulsed crystal oscillator for precision variable time-interval generator 58	Apr 3	Pen with photoelectric sensing device links computer to operator 85	Nov 20	Plastic microwave antenna horns CM80	Feb 27
Quartz crystal oscillators used to achieve precise frequency control CM76	Nov 6	Persistent internal polarization (p.i.p.) of phosphors permit data storage and display 39	Aug 28	Plastic radar reflectors reinforced with glass cloth and resin laminates PT76	May 22
Relaxation oscillators using tunnel diodes 60	Nov 27	Phasemeter capable of measuring small phase differences 60	June 5	Plastic rods help in adding new connections to plug PT56	Aug 21
Relaxation timing oscillator for multiplexer used in satellite applications 58	Oct 30	Phasemeter, digital, for Vanguard Minitrack system 33	Jan 2	Thermosetting plastic is water-clear CM73	Apr 3
Resistance and current-controlled oscillators used in Explorer I transmitters 39	Feb 6	Phasemeter for radio direction finder with automatic readout 32	Apr 17	Treatment of plastics used in electroforming intricate and complex-shaped electronic components 114	Sept 11
Saturable-core transistor oscillator integrates gas-flow data 42	Jan 23	Photo sailing for low-thrust propulsion of space vehicles SR65	Apr 24	Plethysmograph, finger, uses miniature photocell to measure blood volume 122	Sept 11
Self-gated blocking oscillator for obtaining ten-to-one synchronization ratios 58	Nov 27	Photocell, miniature, used to measure blood volume in finger plethysmograph 122	Sept 11	Plethysmograph, transistor, for impedance measurement of living tissue 62	Apr 10
Single-transistor oscillator on phono arm is frequency modulated by stylus 79	Nov 13	Photoconductor research shows polarized phosphors can store and display data 39	Aug 28	Polarimeter, microwave, provides crt presentation of electromagnetic wave polarization characteristics RD74	Feb 13
Stable, low-cost, transistorized, one-mc oscillator for communications and radar systems 50	Feb 6	Photoelectric function generator, open-loop, for radar simulator 52	Jan 9	Polarized phosphors used for data storage and display 39	Aug 28
Stable transistorized f-m oscillator and modulator 64	Jan 30	Photoelectric light-pen links computer to operator 85	Nov 20	Police communications improved using dynamic trap to capture weak f-m signals 64	Jan 9
Subcarrier oscillator for balloon-borne circuits used to sort high-altitude cosmic rays 52	Aug 28	Photoelectric manometer measures and records biological pressures of vital body liquids 41	Dec 25	Potentiometers, induction, tabulation of commercial available types 97	Apr 24
Subharmonic oscillator for microwave computer 39	May 1	Photoelectric scanners control bus traffic 50	July 10	Potentiometers, loaded, how to reduce errors in 34	Aug 21
Transistor amplitude-stable, low-distortion oscillator with d-c coupled multiple feedback 62	Mar 6	Photoelectric systems, fail-safe electro-optical inspection systems for industrial gaging 74	July 31	Power-line carrier, transistor circuits for communicating with 70	May 15
Transistor multifrequency oscillator for transmitting data over phone lines RD76	Feb 27	Photoelectromagnetic cell for infrared detectors 125	Mar 13	Power line, high-voltage, telemetering stress of RD120	Dec 4
Transistor oscillator for power-line carrier communications system 70	May 15	Photoemissive television camera tubes, tabulation of commercially available types 92	Apr 24	<b>Power Sources and Supplies</b>	
Transistor oscillator for solid-state generator producing microwave power 42	Sept 4	Photogalvanic devices for converting light energy into electrical energy 43	Mar 20	Cascaded differential amplifiers reduce errors caused by power supply variations 54	July 17
Transistor oscillator for solid-state microwave power generator 39	Apr 17	Photographic processing using closed temperature control of hot rollers 40	July 24	Chemical, nuclear and solar energy power sources for space-age electronics 43	Mar 20
Transistor oscillator for voltage comparator using high-speed power switch 56	Jan 30	Photographic techniques replace hand detailing and assembly drafting PT78	Jan 9	Constant-current-coupled transistor power supply 60	Oct 9
Transistor oscillator used in low-frequency parametric amplifier RD92	Nov 13	Photography, electrostatic unit prints photos dry for use in aerial mapping RD102	May 29	Design techniques for making extremely low-voltage transistor power supplies 70	Sept 25
Transistor oscillator-mixer circuit for European short-wave and broadcast receivers 41	May 22	Photography, magnetic drum stores tv x-ray pictures RD77	Dec 11	Dry cell current sources stabilized with transistorized inverse feedback circuit 78	Oct 9
Transistor sine-wave and synch blocking oscillators for variable-frequency pulse generator 47	Apr 3	Photography telephone switching system uses photographic plates as permanent memory RD78	Nov 27	Dry cells, tabulation of internal resistance and life test results 65	Feb 20
Transistor, stable, 100-kc oscillator for electronic counters 76	Apr 10	Photoprinting black pattern on inside of crt screen gives parallax-free scale RD68	Oct 2	Equations for designing transistor power supplies 122	Oct 23
Transistor test tone, oscillator for tape-flaw detector 50	Jan 9	Photorectifier array in production CM72	Apr 3	Isotope powers thermo converter CM80	Feb 13
Tuned-plate triode oscillator for powering ultrasonic neurosurgical instrument 53	May 15	Photorectifiers, solid-state panels for display and/or storage 46	Jan 30	Large power supply uses silicon diodes as high-voltage, high-current rectifiers 60	Oct 2
Voltage-controlled oscillator for digital feedback frequency multiplier 60	July 17	Photoreproduction using polarized phosphors for data storage and display 39	Aug 28	Magnetohydrodynamic generator for extended space flight CM82	Nov 27
Voltage-controlled oscillator used in precision variable frequency generator 56	Oct 30	Photovoltaic solar cell for powering computers 125	Mar 13	Microwave energy to power sky platform RD76	June 12
Voltage-tunable ferroelectric capacitors used in oscillators 52	Jan 16	Plant layout for modernization of electronics firms 49	Nov 6	Power from thermonuclear generator controlled using ohmic heating circuits 57	Oct 9
Voltage - variable capacitance diodes for frequency modulating vhf oscillators 112	Dec 4	<b>Plasma Physics</b>		Power generation for space flight SR65	Apr 24
<b>Oscilloscopes and Oscillographs</b>		Arc plasma jet used to determine thermal characteristics of re-entry vehicle antenna RD66	Oct 30	Power measurements in design and production SR89	Sept 11
Dual-beam oscilloscope displays vibrating beam parameters RD49	Aug 21	Magnetohydrodynamic power generator using high-temperature air plasma CM82	Nov 27	Power system analysis with tuned vtm 68	Jan 16
Oscillograph, pen, four-quadrant analog multiplying device with magnetic amplifier square-law circuit for making 58	Jan 9	Ohmic heating circuits for maintaining hydrogen isotopes at 100 million C 57	Oct 9	Precision regulated high-voltage power packs for satellite instrumentation CM96	Nov 13
Oscillographs for design and production SR89	Sept 11	Plasma engine verifies pinch-effect theory RD86	July 31	Rechargeable cells for powering transistorized devices developed by Japanese 109	Sept 11
Oscilloscopes for design and production SR89	Sept 11	Plasma generator used for heat tests RD86	Oct 2	Regulating high voltage with magnetic amplifiers 64	July 17
Sampling oscilloscope displays millimicrosecond pulses 69	July 31	Plasma rockets for low-thrust propulsion of space vehicles SR85	Apr 24	Silicon solar cell, characteristics and design comparison data for 59	Jan 30
Transistor device for viewing repetitive millimicrosecond pulses on conventional scopes RD66	Aug 28	Plasma study may open radio bands RD60	July 3	Solar cells aid photosynthesis study RD56	Sept 18
Outline generator for educational television 52	Apr 3	Plasma thermoelectric cells for power generation during space flight SR65	Apr 24	Solid-state generator for producing microwave power 39	Apr 17
Over-the-horizon system in communications SR93	Oct 23	Radio-frequency circuits for plasma physics 50	July 3	Strontium 90 may produce electricity RD86	Mar 20
		Research on plasma intensified at MIT and Harvard RD69	Oct 30	Thermoelectric devices, and solar and hydrogen oxygen fuel cells for converting heat to electricity 125	Mar 13
		Sun bottle of plasma formed by researchers at CalTech 103	Aug 7	Thermoelectric generator produces 100 watts of power from heat of gas flame CM70	July 17
		Ultrasonic pulse system measures temperature of plasma jet flame CM70	Oct 2	Thermoelectron engines: future power sources? 69	Nov 13
				Transformless heater circuit power supplies ERS86	June 26
		<b>Plastics</b>		Transistor d-c power supply for repeaters in closed circuit tv carrier transmission system 66	June 12
		Adjustable fixture grinds plastic parts PT160	Mar 13	Transistor rectifier gives d-c of either polarity 76	June 19
		Computer relays are packaged in transparent plastic blisters PT60	Dec 25	Tube generates current from rocket's exhaust CM94	Dec 18
		Developments in composite laminates CM128	Sept 11	Preampifiers, transistorized, low-noise, for broadcast monitor 118	Sept 11
		Electrical grade plastic, compatibility of with contacting materials SR81	Dec 4	Precompensator for compatible stereo radio communication using a-m/f-m multiplex 56	May 8
		Fluorocarbon resin, a true thermoplastic, is developed CM71	Aug 28	<b>Printed Circuits</b>	
		Heat-resistant plastic available CM85	Apr 10	Adhesive for dip-soldering printed circuit boards CM83	Mar 27
		Injection-molded plastic transistor mounting pads CM85	Nov 27	Air press prevents printed circuit board warping PT86	May 8
		Metal electrodeposition enables production of integrated metal-plastic components PT128	Dec 4	Aluminum rods and strips make printed circuit frames PT96	July 31
		New standards for laminated plastics 48	Aug 28	Armature of d-c motor is made of two-sided printed circuit CM70	Mar 20
				Assembly village handles medium-	

sized lots of printed circuit board assemblies	PT86	June 5	Computer relays are packaged in transparent plastic blisters	PT60	Dec 25	Metal working machines, automatic controls for	41	Mar 6
Chemically machined, high-temperature printed circuit boards produced	PT70	May 1	Connector strip wires are locked by die-cast, V-groove cams	PT90	Oct 9	Methods for modernization of electronic firms	49	Nov 6
Circuit board printed in full color	CM130	Aug 7	Connectors tested in portable force gage	PT84	Feb 27	Miniature vises hold small circuit boards	PT66	Jan 2
Circuit boards cover all functions of analog and digital circuits	CM132	Aug 7	Construction of high-density packages used to reduce size of electronic units	62	Oct 9	Modular fixtures speed environmental testing of components	PT86	Nov 27
Copper-clad laminates for printed circuits	CM52	Aug 21	Copper brazing permits high-temperature heat treating of steel afterwards	PT98	Sept 25	Modular strip transmission line components	CM73	Mar 20
Copper-on-glass printed circuits	CM61	Jan 23	Delicate stampings, clean by ultrasonics	PT80	Jan 9	Mold glass fiber into small instrument cases	PT63	June 26
Environmental limits of materials used in printed circuit boards	SR81	Dec 4	Dice, transistor, machine for measuring	PT78	Jan 16	Mother board takes small modules	PT136	Oct 23
Foaming flux improves cascade multiwave soldering system for printed circuits	PT83	Aug 14	Digital techniques used in production line diode sorter	PT72	Aug 28	Multiple dip-brazing for assembling components	PT100	Nov 13
Guide for wiring terminals on printed circuit boards	PT77	July 17	Dip solder metal radio chassis	PT54	Aug 21	New crystal growing method provides better and more ferrite monocrystals	CM134	Oct 23
High-speed electrostatic teletypewriter for data processing	83	May 29	Electroforming intricate and complex-shaped electronic components	114	Sept 11	New method of casting metal in ceramic shell	CM99	Nov 13
Home dishwashers rinse flux and resist from printed circuit boards	PT90	June 5	Electron bombardment welds tough metals	PT110	May 29	Nickel plate protects tinning dip from brass	PT89	June 19
Induction soldering and desoldering of printed circuit board components	PT136	Oct 23	Epoxy resins used to assemble and pot electrical components	PT58	Dec 25	Numbered strip guides board terminal wafers	PT77	July 17
Insulation coatings for printed circuits	CM73	July 17	Etching and cleaning with hydrogen peroxide-formic acid-water combination is safe and sure	PT76	Oct 2	Numerically-controlled series of turret punch presses are introduced	PT74	Oct 30
Memory windings may be printed	PT86	June 19	Extra cation exchanger purifies water for semiconductor device processing	PT68	July 3	Parts molded into epoxy mirrors for infrared and optical use	PT86	Apr 10
Pegboard makes prototype transistor printed circuit card	PT74	Mar 20	Fall-safe electro-optical inspection systems for industrial gaging	74	July 31	Pasteups speed circuit drafting	PT74	Apr 3
Printed circuits are fluxed and soldered with wave dip soldering machine	PT82	Aug 14	Ferrules shortened to shield multiconductor cable compactly and economically	PT98	Sept 25	Pegboard makes prototype transistor printed circuit card	PT74	Mar 20
Printed circuit boards of ceramic made on punch press	PT78	Oct 2	Fiber drums cut cost of presentation backs	PT86	May 15	Photographic techniques replace hand detailing and assembly drafting	PT78	Jan 9
Printed circuit can take 1,300F	CM82	June 19	Fixture, motorized, speeds fluxing of awkward contours	PT78	Jan 9	Plastic radar reflectors reinforced with glass cloth and resin laminates	PT76	May 22
Printed circuit ceramic wafers tubes for modular units	CM94	Sept 25	Fixture, rotating holding, makes spray coating easy	PT64	Jan 2	Plastic rods help in adding new connections to plug	PT56	Aug 21
Printed circuits checked with electronic caliper	44	Jan 2	Foam plastic trays handle small parts	PT71	July 3	Pneumatic tube shoots screws to gun driver	PT67	Sept 18
Printed circuit jack	CM95	Oct 16	Foaming flux improves cascade multiwave dip soldering system for printed circuits	PT83	Aug 14	Poly-glycol soldering fluxes avoid fire risk	PT96	July 31
Printed wiring boards assembled using miniature vises	PT66	Jan 2	Freon protects epoxy in ultrasonic cleaner	PT86	May 8	Polyvinyl chloride conductive compound for extrusion, calendaring and injection molding	CM82	May 8
Programmed servo speeds short-run production of computer printed circuit boards	54	Mar 6	Grounding multiconductor cable shields using shorter ferrules	PT98	Sept 25	Potted electrodes speed testing with sensitive electrometer	PT62	Jan 23
Punch press edge-mounts printed circuits board terminals	PT114	Apr 24	Guide and stop eliminate wire stripping hazard	PT131	Dec 4	Printed circuit boards are fluxed and soldered with wave dip soldering machine	PT82	Aug 14
Service data is printed on circuit board	RD54	Sept 18	Hand tool quickly strips wire shield	PT98	July 31	Printed-circuit boards, high-temperature, produced by chemical machining	PT70	May 1
Twist fastens wires to printed circuit board	PT158	Mar 13	Heat treating of steel at high temperatures possible after convolution	PT98	Sept 25	Production considerations of component reliability	SR65	May 29
Use of flexible printed wiring to reduce cabling volume and weight discussed at IRE show	PT70	Apr 17	Heated hydrogen bonds leads to transistors	PT74	Mar 6	Production methods and application data for organic coatings	58	Feb 20
<b>Production Techniques</b>			Holder prevents soldering iron from burning own cord	PT98	Nov 27	Production testing h-f transistor face	ERS54	Jan 2
Additive to rinse water protects metal surface	PT91	June 5	Hole, blind housing, drilled with taper extension	PT67	Jan 2	Programmed servo speeds short-run production of computer printed circuit boards	54	Mar 6
Adhesive for dip-soldering printed circuit boards	CM83	Mar 27	Holes and stud align parts for screwdriver	PT72	May 1	Progressive die forms flag-mounted getters for electron tubes	PT82	Feb 13
Adjustable fixture grinds plastic parts	PT160	Mar 13	Home dishwashers rinse flux and resist	PT90	June 5	Prototype testings streamlined with equipment kits	PT78	Jan 2
Air cylinders operate switch assembler	PT84	May 8	Hot iron unharnesses teflon-covered wire	PT77	Jan 30	Punch press edge-mounts printed circuit board terminals	PT114	Apr 24
Air gage measures radome wall thickness	PT86	Apr 10	How to detect contaminant traces on electronic parts	PT62	Sept 18	Punch press makes ceramic printed circuit boards	PT78	Oct 2
Air-oscillated rod automatically steps series coil winder	PT84	Dec 11	How to reclaim potted components	CM78	Nov 6	Punched-card automatic production tester sorts transistors	PT134	Aug 7
Air press prevents printed circuit board warping	PT86	May 8	Induction brazing in inert gases	PT68	June 26	Racks simplify assembling, encapsulating and storing inductors in batches	PT110	Nov 20
Air pulses measure abrasive transistor case filler	PT84	Feb 13	Induction soldering and desoldering of printed circuit board components	PT136	Oct 23	Retaining rings automatically put on shaft assemblies with tapered mandrel	PT103	Sept 25
Aluminum extrusion houses module units	PT77	Oct 30	Inspection standards for ferrite memory cores	PT79	Oct 2	Retaining rings satisfying different fastening requirements, tabulation of	88	Nov 20
Aluminum rods and strips make printed circuit frames	PT96	July 31	Instrument-grade variable air capacitors machined from solid aluminum blocks	PT82	Dec 11	Revolving disks spray color code on wire	PT84	Mar 27
Argon gas simplifies protective packaging	PT91	June 5	Insulating tape, pressure sensitive, makes electroplating mask	PT136	Aug 7	Revolving drum delivers parts	PT80	Jan 16
Assembly drawings replace photographic technique	PT78	Jan 9	Kitting components smooths production flow	PT70	Feb 6	Ring source gives even vacuum deposition of metallic films	PT84	June 12
Assembly village handles medium-sized lots of printed circuit board assemblies	PT86	June 5	Knurl broaching joins small metal components	PT76	Mar 20	Rivets form channel for computer wiring	PT86	June 5
Automatic placement of retaining rings on shaft assemblies with tapered mandrel	PT103	Sept 25	Lazy susan brings 100 wires into easy reach for cable building	PT114	Apr 24	Rollers straighten bent axial component leads	PT86	Feb 27
Automatic transistor manufacture	CM70	Jan 30	Machine assembles circuit modules	PT70	July 10	Rotating fixture improves induction brazing of internal parts	PT113	Nov 20
Automatic transistor production using flat ribbons of semiconductor material	CM128	Sept 11	Machine sorts transistor dice	PT78	Jan 16	Semiconductor dice gaging system developed	PT54	Aug 21
Automatic transistor tester prints results	PT77	July 17	Machine stacks glass capacitors	PT82	Feb 20	Shrinking forms glass parts precisely	PT72	Sept 4
Automatic winder for metallized capacitors	PT110	May 29	Magnetic arc method simplifies glassworking	PT80	Nov 6	Silicone potting gel is transparent	PT70	Apr 17
Backoff protects crystal wafers in automatic slicing machine	PT68	July 3	Magnetics and meters test transformers automatically	PT64	Jan 23	Skates roll potted parts to cure oven	PT72	Feb 6
Barrel finishing delicate parts for electron tube	PT84	Feb 27	Magnifying shaving mirror makes dial setting easier	PT102	Nov 13	Slicing and wire cutters modified	PT83	Nov 6
Big balloons cushion shipments in trucks	PT83	Nov 6	Making component test fixtures more versatile	PT84	May 15	Soldering irons center shafts in plastic case	PT76	Apr 3
Blister packing for instrument bearings	PT113	May 29	Mandrel automatically puts retaining rings on shaft assemblies	PT103	Sept 25	Soldering on aluminum-clad laminates	CM132	Oct 23
Bonded wires form wire stripping brush	PT71	June 26	Mechanical bond not factor in glass seal	PT73	Apr 17	Spray-coating made easy with rotating holding fixture	PT64	Jan 2
Brazing with copper permits high-temperature heat treating of steel afterwards	PT98	Sept 25	Mechanized transistor assembly	PT132	Sept 11	Spring-leg speed cup to hold capacitors	PT75	Mar 6
Breath pressure helps tube production	PT74	Oct 30	Memory windings may be printed	PT86	June 19	Standardized measurement of cap surface to ceramic on crt disk cathode	PT88	Apr 10
Cathodes, spray-coating of made easy with rotating holding fixture	PT64	Jan 2	Metal electrodeposition enables production of integrated metal-plastic components	PT128	Dec 4			
Cold soldering hermetically seals transistor assemblies	PT158	Mar 13						
Commercially available ultrasonic cleaners	65	June 5						

Static switching techniques for machine tool safety control...	57	June 12
Steel heat-treating at high temperatures possible after copper brazing	PT98	Sept 25
String returns jeweler's lathe tool traverse	PT61	Dec 25
Studs in electron gun structure are welded semiautomatically	PT88	Oct 9
Tape recorder speeds panel wiring tests	PT79	May 22
Tape recordings speed assembler's learning time	PT88	July 24
Tension box assists square wire winding	PT70	July 3
Terminating multiconductor cable with short ferrule shields	PT98	Sept 25
Test set automatically measures 18 transistor parameters	PT80	Aug 14
Thermostatic soldering iron holds constant temperature	PT99	Oct 16
Thin film depositing, printed cables, transistor testers, tube stem makers, coil winders, cleaning units and drillers discussed at IRE show	PT70	Apr 17
Thin metal parts produced by etching	PT74	Jan 30
Titanium racks help aluminum anodizing	PT70	July 24
Tracer displays Zener diode curves	RD76	May 8
Transistorized, level sensitive switch for missile count-downs production lines and industrial processes	76	July 31
Traveling masking strips limit spray coating area	PT98	Oct 16
Twist fastens wires to printed circuit board	PT158	Mar 13
Two-level tote tray avoids waste motions	PT139	Oct 23
Ultrasonic energy piped to several workpieces	PT72	Mar 6
Ultrasonic grinder forms mesa diodes	PT112	May 29
Use outlets to orient semiconductor crystal	PT76	Apr 3
Waviness measuring instrument for nondestructive testing of mica flatness	PT110	May 29
Ways to measure light intensity at a distance for process control	48	July 17
Weight and volume used to measure soft material parts	PT117	Apr 24
Wheeled cart aids in radio system assembly	PT70	July 24
Wheels make spray-coating easy AND gate	54	Feb 20
Wiring and electrical connections plated together using new technique	PT96	Dec 18
Wooden mockups to develop efficient techniques for computer and data processor production	PT42	Dec 11
Work simplification program cuts costs	PT74	Jan 30
Workpieces integral part of shaft drill controller	PT72	Mar 6
Wrap-around rubber tails hold writing	PT73	Feb 6
Profilometer to measure variations of riding surfaces of a road	69	Dec 18
Programmer, message, for automatic voice data link	47	Jan 9
Progressive die forms flag-mounted getters for electron tubes	PT82	Feb 13
Project Courier for long range communications	SR93	Oct 23
Project Echo for long range communications	SR93	Oct 23
Projector, optical, for electronic micrometer	44	Jan 2
Propagation characteristics for communications in space	SR65	Apr 24
Propagation of electromagnetic waves through materials, effect on dielectric properties	CM84	Oct 9
Propagation of radio waves	SR93	Oct 23
Propagation research, radio, strip-chart recorder for	78	Dec 18
Propulsion, electronic, for continuously powered space flights	SR65	Apr 24
Propulsion systems, plasma engine verifies pinch-effect theory	RD86	July 31
Psychological testing using logic networks	70	Oct 16
Public address system, column speaker for	64	June 12
<b>Pulse Circuits</b>		
How to design pulsed distributed amplifiers for radars or high-level pulse amplifications	56	Mar 20
Pulse code modulation for data transmission	SR93	Oct 23
Pulse-duration tape recording system speeds data processing	56	Feb 6
Pulse modulation and its relation to modern communication	SR93	Oct 23
Pulse-position telemetry demodulator using modified two-input and gate	54	Feb 20
Pulse shaping networks for radar pulse generator	42	July 3
Pulse simulator uses double-discharge circuit to simulate nuclear thermal radiation	RD66	Oct 30
Pulse source for dynamic testing of computer building blocks	66	Aug 14
Pulse synchronizer uses precise vernier to change binary-counter type frequency divider	44	July 3
Pulse technique of producing very high magnetic field	43	Oct 2
Pulse unit electronarcotizes fish	31	Jan 23

Time-controlled and pulse-synchronized pulsing circuits	RD72	Jan 16
Transistorized variable-frequency generator for pulse circuit design	47	Apr 3
Video pulse shaper for modulator in portable transistorized multiplexer used for telephone communications	60	Jan 9
Zener diode eliminates damped oscillations and regulates pulse height in pulse transmission	RD78	Nov 27
Pumps, vacuum, tabulation of representative types for electronic needs	66	Oct 9
Pyrographite solves high-heat problems in missiles, electronics and nucleonics	CM124	Dec 4
Pyromagnetic converters as power sources for future space-age electronics	43	Mar 20
Pyrometers, radiation, operating principle and range of	55	July 10

**Q**

Q loaded, nomograph for calculating for capacitor-shortened, quarter-wave transmission line	ER852	Sept 18
Quantity testing in design and production	SR89	Sept 11
Quantum-mechanical theory explains action and properties of tunnel diode	54	Nov 6

**R**

<b>Radar</b>		
Airport dual-channel radar has high resolution for ground traffic control	RD64	Apr 3
Antenna for airfield control radar has 2.25-deg beamwidth	RD66	July 17
Automatic digital cycle counter increases Doppler radar uses	46	May 22
Boxcar radar antenna for defense network	RD75	Nov 6
C-band ferrite isolator for radar system	CM67	July 3
Chart for finding radar tracking losses	ERS100	May 29
Charts simplify finding of radar blind spots	ERS42	May 22
Coherent oscillator jitter checker for moving target radar	56	July 17
Coincidence diodes gate electronic switch for radar indicators	66	Feb 20
Communications of the future—what we learned from the IGY	37	July 3
Continuous wave Doppler radar navigation system for airliners	RD66	May 22
Correlation devices to detect weak signals against noisy backgrounds	58	May 22
Cryogenic tests for countermeasure systems	RD57	Sept 18
Crystal switches bring greater radar utility	120	Aug 7
Curves for finding probability of observing radar targets	ERS58	May 1
Design features of Doppler radar navigation systems	62	May 8
Dewline extended to Aleutians	RD78	June 5
Doppler radar design using magnetostrictive filters	72	June 19
Doppler radar detects tornadoes	RD76	June 12
Doppler radar speed meter helps enforce traffic laws	48	Mar 6
Feasibility of using a maser amplifier in an active radar system demonstrated	43	Oct 30
Finding prof of radar causing running rabbit interference patterns with nomograph	ERS58	July 3
High-power, 50-cm airport radar reduces clutter	RD120	Dec 4
How radar techniques improve induction heating	51	Feb 13
How to design pulsed distributed amplifiers for radars or high-level pulse amplifications	56	Mar 20
Inflatable radome made of dacron protects radar antennas	CM71	Sept 4
Land-vehicle radar guidance not requiring special highways	39	May 1
Low-cost, active, f-m radar for determining miss-distance of a missile	91	Nov 20
Microwave phase shifter for improving scanning of vhf and uhf radar antennas	125	Mar 13
Phase shifter, microwave, for improving scanning of vhf and uhf radar antennas	125	Mar 13
Miniature X-band pulse radar has high resolution	48	Jan 30
Nomograph for calculating the minimum signal detectable by a radar receiver	ERS62	Apr 3
Nomograph for determining range of radar beacons	ERS60	Sept 4
Nomograph for finding separation between radar antenna and target	ERS76	June 5
Open-loop photoelectric function generator for radar simulator	52	Jan 9
Optical sighting of sun and measurement of solar noise calibrates radars	44	Dec 25
Params and twt's for increasing sensitivity of early warning radars	106	Dec 4

Phasemeter for multiple-target discrimination in high-resolution radars	60	June 5
Plastic radar reflectors reinforced with glass cloth and resin laminates	PT76	May 22
Precision variable time-interval generator for radar range calibration	58	Apr 3
Prestressed truss rods lighten radar antenna	RD78	May 15
Properties of real radar clutter	78	Sept 25
Proximity warning radar for autos	RD62	May 1
Pulse transformer tank for long-range radar	RD90	Oct 16
Radar acquisition system used with joy-stick controlled, command servo positioner	87	Apr 24
Radar augments and power nomographs	ERS146	Mar 13
Radar helps study of meteor particles and their effect on radio transmission	RD80	Oct 9
Radar interference nomograph for finding solution of off-target jamming problem	116	Dec 4
Radar system tester shortens checkout time	58	June 5
Radar techniques used to study ionosphere	RD128	Aug 7
Radar tracking to determine space position of spacecraft	53	Mar 27
Removing radar information over narrow-band with circuit using scan-conversion storage tube	48	Apr 17
Retarded wave surface radar antenna with high gain and low silhouette	RD100	Nov 20
Silver-coated lens for missile guidance radar	CM75	May 22
Simulation of actual clutter received during a number of consecutive sweeps	78	Sept 25
Simulator provides a functional test of radar performance	39	May 1
Space radar will have 1,000-ft spherical antenna	RD69	July 17
Stable, low-cost, transistorized, one-mc oscillator for communications and radar systems	50	Feb 6
Storage crt with symmetrical guns used as radar indicator	CM60	Jan 2
Techniques for reducing mutual radar interference	39	July 10
Tracking radar, used at missile test ranges	47	Jan 16
Trailer-mounted radar uses Foster scanner to pinpoint enemy mortars	34	Sept 18
Transistor and magnetic circuits for radar pulse generator	42	July 3
Transistorized radar and television ppt sweep circuits using low power	46	June 26
Using silicon diodes in radar modulators	70	June 12
<b>Radiation</b>		
Effect of radiation on materials	SR81	Dec 4
Measuring radiation intensity using probe-mounted transistorized Geiger counter	64	Jan 16
Radiation belts in earth vicinity	SR65	Apr 24
Radiation detection telemeter transmitter and modulator weight reduced using transistors	136	Mar 13
Radiation effects on electronic materials being studied	CM82	June 19
Radiation hazards, designing power density meter to guard against	RD66	July 17
Radiation—how neutrons and electron bombardment affect semiconductor devices	55	Nov 27
Radiation intensity measured with probe-mounted transistorized Geiger counter	64	Jan 16
Radiation makes Teflon wire bondable	CM87	Oct 9
Radiation measuring device made from infrared communications receiver	38	Sept 18
Radiation monitor for radioisotope tracing in industry is battery operated and transistorized	42	June 26
Radiation monitor incorporating alpha, beta and gamma detector developed by Japanese	109	Sept 11
<b>Radio</b>		
Air-transportable Army radio system has 3,000-mile range	44	Aug 28
Citizens radio revision spurs equipment design	55	Apr 10
Classification of classical radio navigation methods	112	Aug 7
Digital computers aid radio propagation studies	RD50	Dec 25
Dip solder metal radio chassis	PT54	Aug 21
Direction-finding vans for locating radio interference are used by Germans	RD80	Nov 27
Effect of dielectric properties on radio wave propagation through materials being investigated	CM84	Oct 9
Frequency modulation multiplexing for studio-transmitter links	44	May 22
Frequency stepper for radio propagation testing system	44	Jan 23
Linear class-B audio amplifier for high-efficiency and fidelity in portable radios	54	May 22

Mobile radio repeater design trends	32	Nov 20	Panoramic receivers, voltage-tunable ferroelectric capacitors used in	52	Jan 16	ard silicon high-voltage cart-ridge rectifiers	57	Apr 3
Plasma study may open radio bands	RD60	July 3	Portable transistor receivers, special circuits for	56	Jan 9	Current ratings and peak inverse voltage of silicon power rectifiers	71	Apr 10
Radio-frequency, stage untuned, for portable transistor receivers	56	Jan 9	Receiver for digitally positioning shafts over phone line	62	Feb 13	Examination of properties of intermetallic compounds for rectification purposes	69	June 12
Radio direction finder with automatic readout	52	Apr 17	Receiver for high resolution X-band radar with high resolution	48	Jan 30	Photorectifier array in production	CM73	Apr 3
Radio-frequency circuits for plasma physics	30	July 3	Receiver for radio propagation testing system	44	Jan 23	Saturable magnetic core firing circuit used with controlled rectifiers to drive a-c and d-c motors	73	Nov 13
Radio-frequency, untuned, for portable transistor receivers	56	Jan 9	Receiver for trailer-mounted radar used to pinpoint mortar positions	34	Sept 18	Silicon diodes as high-voltage, high-current rectifiers in large power supplies	60	Oct 2
Radio telescope antenna gets checked	RD68	July 17	Receiver for underwater sonic telemeter for trawl fishing determines depth of net	66	Mar 27	Silicon rectifiers, operational and storage life of	82	Oct 16
Radio telescope multiple-disk has high resolution	RD126	Aug 7	Receiver frequency translator improves multipath pulse communications	66	June 19	Solid-state controlled rectifiers for fast switching in industrial control	51	June 26
Radio using 4-transistor trf circuit is housed in eyeglass frame	38	Sept 25	Receiver sensitivity limitations caused by cosmic atmosphere and receiver noise sources	SR65	Apr 24	Transistor rectifier gives d-c of either polarity	76	June 19
Remotely controlling bulldozer by radio	RD126	Aug 7	Receivers for target and missile transponders used in nonradar miss distance indicator	42	Apr 17	Tunnel diodes used in voltmeter rectifier	60	Nov 27
Russian home radio receivers	37	July 24	Receiving station for Vanguard Minitrack system	33	Jan 2	Refrigerator, electronic, for cooling lead-sulphide infrared sensor	125	Mar 13
Vanguard Minitrack radio system, determines satellite orbits	33	Jan 2	Russian tv and home radio receivers	37	July 24	Regional developments, technical and business growth in the eleven western states	103	Aug 7
Wheeled cart aids in radio system assembly	PT70	July 24	Short-wave, broadcast and vhf transistor receivers developed by European firms	41	May 22	Register, shift, formed from inductive counter	31	Sept 18
Radioactive compounds as potential semiconductor materials	43	July 17	Ssh receivers for FRENA and FRENAC voice radio systems	53	Dec 11	Register, shift, uses single magnetic wire as memory element	CM76	Jan 9
Radioactive sources for noncontacting thickness gages	57	May 22	Superregenerative receiver, transistorized, for control of target drone	52	May 1	Register, solid-state, integrated shift	35	June 26
Radiography, Samarium-153 new radioisotope source for	CM63	Jan 2	Techniques for reducing mutual radar interference	39	July 10	<b>Regulators</b>		
Radioisotopes, new source reported for	CM63	Jan 2	Television receiver sound detector uses drift transistor	62	Feb 20	Cascaded voltage regulator for biological microphotometer	RD62	July 10
Radiological vacuum gage to measure low pressures has digital output	60	June 19	Transistor receiver for radio-controlled garage-door opener	RD62	Apr 17	Characteristics of silicon voltage-regulator diodes	55	Apr 17
Radiometers for protecting against microwave health hazards	49	Feb 20	Transistorized dual-conversion superheterodyne marker beacon receiver	59	May 8	Design techniques for making extremely low-voltage, stable, transistorized power supplies	70	Sept 25
Radiometers to detect weak signals against noisy background	58	May 22	Transistorized marker beacon receiver for light planes	76	Nov 13	Heart regulator rate	38	Jan 2
Radome, inflatable, made of dacron, protects radar antennas	CM71	Sept 4	Transistorized telemeter receiver for Pioneer satellite	55	June 19	Magnetic amplifiers and transistor circuits regulate frequency of klystrons	68	Feb 13
Radome material developed for supersonic aircraft	CM133	Aug 7	Two-receiver technique for quickly checking frequency standard against WWV	RD76	Mar 27	Magnetic amplifiers replace voltage-sensitive relays in d-c bus voltage regulator	101	Dec 4
Radome, rigid, design for ground use	CM66	Apr 17	Reconnaissance equipment, electrostatic unit prints photos dry for use in aerial mapping	RD102	May 29	Regulating high voltage with magnetic amplifiers	64	July 17
Radome wall thickness measured by air gage	PT86	Apr 10	<b>Recorders</b>			Regulators for controlling blood pressure and heart rate	38	Jan 2
Radomes, environmental limits of materials used for	SR81	Dec 4	Automatic recording system using one-transistor clocking oscillators to drive cold-cathode counters	46	Sept 18	<b>Relays</b>		
Rate-meter for improved stroboscope using two-element flash tube	116	Aug 7	Digital recorder memory holds data after shock	60	Mar 20	Adjustable, transistor time delay relay for industrial control	74	Sept 25
Rate-meter for probe-mounted transistorized Geiger counter	64	Jan 16	Eye pupil movement accurately measured by electronic pupillo-graph	67	Sept 25	Choosing and using relays to obtain reliability	SR65	May 29
Ratiometers power and vswr for design and production	SR89	Sept 11	Foresters use pen recorder for monitoring weather	RD66	Mar 20	Computer relays are packaged in transparent plastic blisters	PT60	Dec 25
Reactor, saturable, for zero, d-c or very low-frequency current applications	84	Nov 13	Four-quadrant analog multiplying device with magnetic amplifier square-law circuit for driving recorder	58	Jan 9	Dual relay provided by two-transistor circuit	RD62	May 1
Reactors, saturable, for fast switching in industrial control	51	June 26	Hall-effect is used in tape recorder playback heads	RD62	Dec 25	Electromagnetic relay, design trends of	CM68	Sept 4
Reader, card, for use with multifrequency oscillator to transmit data over phone lines	RD76	Feb 27	Industrial strip-chart recorder finds heart faults	RD74	Feb 20	High-speed polarized relay used in tape-flaw detector	50	Jan 9
Reading system recognizes handwritten words	RD100	Nov 20	Japanese video tape recorder uses only one revolving magnetic head	RD76	Dec 11	Mercury relay switch for electronic micrometer	44	Jan 2
<b>Readout Devices</b>			Magnetic drum recording provides analog time delay for designing continuous-processing systems	44	Feb 6	Relays for computer switching	64	Aug 14
Forming handwritten-like digits on crt display	138	Mar 13	Magnetic modulator playback head reads tape at zero speed	58	Mar 6	Sealed-contact reed relay characteristics	79	July 31
Radio direction finder with automatic readout	52	Apr 17	Operating principles and ranges of temperature detectors for industry and laboratories	55	July 10	Unipolar transistors serve as voltage-controlled relays	35	June 26
Readout circuit for digital recorder memory which holds data after shock	60	Mar 20	Pulse-duration tape recording system speeds data processing	56	Feb 6	Reliability, designing for	SR56	May 29
Readout integrators, visual and electrical, using solion liquid diodes	53	Feb 27	Recorders used for data gathering at missile test ranges	47	Jan 16	Reliability of systems, verification of	RD74	Dec 11
Readout system, digital, for high-speed scanning and direct reproduction of transmission	RD126	Aug 7	Recording attenuation of waveguide components	126	Oct 23	<b>Remote Control</b>		
Transistor output circuit for obtaining desired waveforms from encoder used to measure random event time intervals	48	Mar 20	Recording galvanometer, variable-area, for tv remote film camera	58	Jan 16	Remote control and measuring equipment using digital techniques developed by Japanese	109	Sept 11
<b>Receivers</b>			Recording manometer, photoelectric for measuring biological pressures of vital body liquids	41	Dec 25	Remote control of tv sets with time-constant detectors	RD62	Sept 4
All solid-state uhf receiver made possible with 220-mc parametric amplifier requiring only 0.05 milliwatt of pump power	31	Dec 25	Recording on magnetic tape at high densities using self-clocking technique	72	Oct 16	Remote control simplified using voltage-variable silicon capacitors	48	Sept 18
Applications of tunnel diodes in reflexed receiver circuits	60	Nov 27	Recording system for weather-eye satellite	44	May 1	Remote controlled moving target system simulates battle conditions	60	Nov 6
Carcinotron harmonics boost receiver frequency range	58	Feb 27	Records of telephone traffic data simplified using ferrite memories	68	Oct 9	Remote tv film camera, transistorized sound amplifier for	58	Jan 16
Chart relates receiver sensitivity to noise figure and to video and r-f bandwidth	ERS52	Jan 23	Sampling f-m discriminators for data reduction from magnetic tape	70	Mar 27	Remote ultrasonic system controls complex maintenance machinery for reactor repair	RD64	Apr 17
Conventional receiver adapted for compatible stereo broadcasting using a-m/f-m multiplex	56	May 8	Strip-chart recorder gives continuous, simultaneous recording of radio signal strength and fading rates	78	Dec 18	Remotely controlling bulldozers by radio	RD126	Aug 7
Crystal switches bring greater radar utility	120	Aug 7	Tape recorder speeds panel wiring tests	PT79	May 22	Remoting radar information over narrow bandwidth circuits using scan-conversion storage tube	48	Apr 17
Experimental infrared communications receiver for space vehicles	38	Sept 18	Tape recordings speed assembler's learning time	PT68	July 24	Repeater, orbital radio, for artificial earth satellites	106	Dec 4
Five-transistor automobile broadcast receiver	42	Sept 18	Transistorized clock track recorder for writing timing signals on magnetic drum	74	Oct 9	Repeater, transistor, for closed circuit tv carrier transmission system	66	June 12
How to design reflexed transistor broadcast receivers	70	May 8	Video tape recorder with 30 db signal-to-noise ratio	125	Mar 13	Repeaters, mobile radio, design trends in	82	Nov 20
Inexpensive sound for television receivers	66	Feb 27	<b>Rectifiers</b>			Reproduction, digital readout system speeds document reproduction	RD126	Aug 7
Japanese transistorized a-m/f-m portable radio	109	Sept 11	Characteristics of military stand-			<b>Resistors</b>		
Magnetically-controlled ferrite attenuators reduce intermodulation and cross-modulation interference	64	Nov 6				Choosing and using resistors to obtain reliability	SR65	May 29
Maser sensitivity curves for determining receiver sensitivity and noise figure relationships	ERS70	Feb 20				Environmental limits of materials used for resistors	SR81	Dec 4
Miniature automobile radio behind rear-view mirror	SR53	July 31				Film deposits improve resistors	CM132	Oct 23
Nomograph for calculating the minimum signal detectable by a radar receiver	ERS62	Apr 3				Film resistors for thermionic integrated microduals	CM80	May 15

Resistor coupling networks, graphical analysis for designing	ERS129	Aug 7	Selector, computer simulator, for automatic voice data link	47	Jan 9	very low-frequency current servo systems	84	Nov 13
Silicon resistors, use in transistor circuits	SR53	July 31	Selector, transistorized print-head, for high-speed electrostatic teletypewriter	83	May 29	Mode centering servo for miniature X-band radar with high-resolution	48	Jan 30
Solid-circuit resistors	CM82	Apr 10	<b>Semiconductors</b>			Nuclear environment servo components, high temperature magnetic materials for	63	Jan 9
Solid circuit resistors formed from ohmic contacts	110	Aug 7	Action and properties of tunnel diodes explained using electron energy band diagrams	54	Nov 6	Precision miniature gear packages for guidance control systems	CM73	Oct 30
Stripline resistors have thin film mica base	CM69	Feb 6	Alloyed-junction pnp Trisistor for millimicrosecond switching	125	Mar 13	Programmed servo speeds short-run production of computer printed circuit boards	54	Mar 6
Test set for evaluating noise quality of fixed composition resistors	RD60	June 26	Alphanumeric characters formed by analog techniques	116	Oct 23	Rotary dual input analog computing element for servo applications	CM80	Mar 27
Tolerance for resistor dividers given on graph	RD54	Jan 23	Backoff protects crystal wafers in automatic slicing machine	PT68	July 3	Servo phase control shapes antenna pattern	50	Jan 2
Resolvers, a-c computing, characteristics of typical size 8, 10 and 11 types	52	Mar 20	Carrier lifetime in semiconductor crystals measured using principle of microwave absorption	39	May 1	Servo preamplifiers using direct-coupled transistors	74	May 15
Resolvers, a-c computing, characteristics of typical size 15 type	62	Mar 27	Characteristics of two-terminal semiconductor switches	62	Feb 27	Servo-setting potentiometer module for analog computers	CM82	Mar 27
Resolvers, a-c computing, characteristics of typical size 18, 23 and 25 types	50	Apr 3	Depletion-region transistor is made	CM84	June 19	Servo systems using f-m to reduce harmonic pickup	125	Mar 13
Respiration rate measurement used to check physiology of future spacemen	65	Oct 16	Environmental limits of materials used for semiconductors	SR81	Dec 4	Servoing sweep frequency of f-m radar to determine missile miss-distance	91	Nov 20
Retaining rings automatically put on shaft assemblies with tapered mandrel	PT103	Sept 25	Examination of properties of intermetallic compounds for rectification purposes	69	June 12	Servos control atomic manipulators	RD9	Feb 27
Retaining rings satisfying different fastening requirements, tabulation of	88	Nov 20	Extra cation exchanger purifies water for semiconductor device processing	PT68	July 3	Telescope controlled using joystick to command servo positioner	87	Apr 24
Rocket engine characteristics	SR165	Apr 24	Faraday rotation used to measure effective mass in semiconductors	43	Oct 2	Tensionmeter measures tension in moving web of paper	RD76	May 15
Rodiac, rotary dual input analog computing element for solving three-dimensional equations	CM80	Mar 27	Growing high-purity silicon carbide crystals from solution of alloy metals	CM128	Sept 11	Unusual applications of conventional synchros	84	Sept 25
<b>S</b>								
Safety features of missile test ranges	47	Jan 16	How radiation, neutron and electron affects semi-conductor devices	55	Nov 27	Shaft position data set over phone lines using digital system	62	Feb 13
Safety standards of army to prevent microwaves from being health hazards	49	Feb 20	Integrated semiconductor devices for microminiaturization	35	June 26	Shaker tests space components	RD74	Feb 20
Sapphires, synthetic, offer engineering advantages in electronic component design	110	Dec 4	New frontiers for semiconductors determined from study of periodic table	43	July 17	Shaper, video pulse, for modulator in portable transistorized multiplexer used for telephone communications	60	Jan 9
<b>Satellites</b>			Operational and storage life of silicon rectifiers	82	Oct 16	Shifter, phase, for servo phase control used to shape antenna pattern	50	Jan 2
Artificial earth satellite serves as orbital radio repeater	106	Dec 4	Outdiffusion technique produces 2-to-3 millimicrosecond switching diodes	66	June 5	Shocker, pulsed d-c, electronarcotizes fish	31	Jan 23
Cloud-cover satellites track earth's weather	44	May 1	Pure and doped semiconductor electron energy band diagrams	54	Nov 6	Silicon, its place in the new frontiers of semiconductors	43	July 17
Design considerations for satellite communication systems	SR93	Oct 23	Semiconductor alloy junction device switches in 50x10 <sup>-12</sup> sec	CM72	Jan 30	Silistor, use in transistor circuits	SR53	July 31
Ferroelectric generator changes solar energy to high-voltage d-c or a-c	RD88	Dec 18	Semiconductor devices and associated components	SR53	July 31	<b>Simulators</b>		
Instrumenting the Explorer I satellite	39	Feb 6	Semiconductor dice gaging system developed	PT54	Aug 21	Analog computer simulator trains nuclear ship crews	RD124	Sept 11
Multiplexing techniques for satellite applications	58	Oct 30	Semiconductor solid circuitry	CM82	Apr 10	Analog simulation with magnetic drum recorder for designing continuous processing system	44	Feb 6
Parametric amplifier and antenna combination receive signals from Pioneer IV	RD80	June 5	Semiconductor testing in design and production	SR89	Sept 11	Analog system with single operational amplifier simulates second-order differential equations	RD64	Mar 6
Relay satellites for space communications	SR65	Apr 24	Semiconductors for computer switching	64	Aug 14	Computer simulator, for automatic voice data link	47	Jan 9
Satellite orbits determined by Vanguard Minitrack system	33	Jan 2	Semiconductors for strain gages	CM68	Feb 6	Nuclear thermal pulses simulated with double-discharge circuit	RD66	Oct 30
Satellite telescope-tv system for ultraviolet mapping of celestial sphere	RD76	Mar 27	Silicon diodes as high-voltage, high-current rectifiers in large power supplies	60	Oct 2	Radar simulator, open-loop photoelectric function generator for	2	Jan 9
Satellites and space probes launched in U.S. and USSR	46	July 24	Solid circuits formed from single-crystal semiconductor wafers	110	Aug 7	Radar transmitter leakage simulator for testing crystal switches	120	Aug 7
Self-sustained emission tubes reduce power drain of satellite circuits	CM66	Feb 6	Surfaces: key to semiconductor progress	CM70	Oct 2	Simulation of actual radar clutter received during a number of consecutive sweeps	78	Sept 25
Soviets give data on sun satellite	RD66	Jan 30	Tabulation of high-vacuum pumps used for evaporation and deposition	66	Oct 9	Simulator provides a functional test of radar performance	39	May 1
Vanguard silicon solar cell power source	43	Mar 20	Taking the heat off semiconductor devices	53	June 12	Tank gunners trained for combat with infrared detector	60	Nov 6
Scaler, transistor, used as scintillation counter in high-altitude balloons	52	Aug 28	Technique for measuring effective mass in semiconductors using high magnetic fields	43	Oct 2	Scaler amplitude for signal and noise analysis	64	Feb 27
<b>Scanners</b>			Tellurium compounds for semiconductors	CM68	Mar 6	Sockets, use in transistor circuits	SR53	July 31
Basic optical data for electronics engineers	48	July 10	Tensor or directional conductivity of semi-conductors being investigated	CM84	Oct 9	Solar bodies, motions and physical characteristics of	SR65	Apr 24
Cathode ray tube scanner for telephone switching system using photographic plates as permanent memory	RD78	Nov 27	Theory and use of field-effect solid-state tetodes	66	May 15	Solar cells aid photosynthesis study	RD56	Sept 18
Compact scan system for sonar fish locator	54	Apr 3	Thermal changes of thermistors plotted as straight line on chart	RD128	Oct 23	Solar cells, discussion of	SR53	July 31
Currency-identification scanner issues permutual wager tickets automatically	RD53	Dec 25	Thermoelectric properties of semiconductors	70	Jan 19	Solar cells for powering transistorized, 150-mc transmitter-receiver	125	Mar 13
Flexible scanner for studying pattern-recognition systems	RD106	Apr 24	Three-element field-effect-cutoff semiconductor (Tecontron) for 10,000-mc operation	125	Mar 13	Solar energy changed to high-voltage d-c or a-c with ferroelectric generator	RD88	Dec 18
Foster scanner in trailer-mounted radar pinpoints enemy mortars	34	Sept 18	Triggered bistable semiconductor circuits	ERS53	Aug 28	Solar energy converted to electricity by thermoelectron engines	69	Nov 13
New technique of electronic scanning uses silicon junction diode	RD48	Aug 21	Use optics to orient semiconductor crystal	PT76	Apr 3	Solar energy effects on communications	37	July 3
Photoelectric scanners control bus traffic	50	July 10	Sensistor silicon resistor used for temperature compensation of stable d-c differential amplifier	60	Jan 16	Solar energy power sources for space-age electronics	43	Mar 20
Scan conversion equipment for air traffic control	CM135	Oct 23	Sensistor, uses in transistor circuits	SR53	July 31	Solar noise measurement and optical sighting of sun calibrates radars	44	Dec 25
Scan-conversion storage tube for removing radar information over narrow-bandwidth circuits	48	Apr 17	Separator clammed sync circuit for automatic video processing amplifier	96	May 29	Solar power used for power generation during space flight	SR65	Apr 24
Scanner recognizes and counts atomic particle tracks	58	Mar 27	Separator, signal, and multichannel interrogator scheme detects single signal	50	Aug 28	Solar radiation amplifier for analog computer used to predict thermal behavior and cooling load of dwellings	34	Dec 25
Scanning units for electronic pupilograph used to accurately measure eye pupil movement	67	Sept 25	Separator, synchronization, for portable multiplexer used in telephone communications	60	Jan 9	Solar shock waves simulated by tube	CM84	June 5
Scatter problems in communications	SR93	Oct 23	<b>Servomechanisms</b>			<b>Soldering Techniques</b>		
Scintillation spectrometers, liquid, transistorized glow-tube counters for	112	Sept 11	Armature of d-c motor is made of two-sided printed circuit	CM70	Mar 20	Cold soldering hermetically seals transistor assemblies	PT158	Mar 13
Seals, environmental limits of materials used for	SR81	Dec 4	Automatic control circuit monitors depth of anesthesia during operations	43	Jan 30	Environmental limits of materials used for soldering	SR81	Dec 4
Seebeck effect, use in thermoelectric heat converters	69	Nov 13	Commercially available push-pull magnetic amplifiers for servo systems	134	Mar 13	Soft solder, tabulation of characteristics of	119	Oct 23
SEFAR, directive long-range sonar transducer	43	Oct 30	Constant-current technique cuts servo response time	52	July 10	Solder bench sneezes relieved by exhaust fan	PT80	Jan 16
			Magnetic amplifier for zero, d-c or			Soldering iron holds constant temperature	PT99	Oct 16
						Soldering irons center shafts in plastic case	PT76	Apr 3

Soldering on aluminum-clad laminates	CM132	Oct 23	Radar techniques used to study ionosphere	RD128	Aug 7	Strontium 90 may produce electricity	RD66	Mar 20
Solders for nuclear and space environments	50	Sept 4	Satellite telescope-tv system for ultraviolet mapping of celestial sphere	RD76	Mar 27	Sun bottle of Calma formed by researchers at CalTech	103	Aug 7
<b>Solid-State Physics</b>			Satellites and space probes launched in U.S. and USSR	46	July 24	Surfaces: key to semiconductor progress	CM70	Oct 2
Approaches and developments in solid circuits	SR53	July 31	Solders for space and nuclear environments	50	Sept 4	Surveillance, miniature X-band radar with high resolution for	48	Jan 30
Behavior of solid-state circuits under neutron radiation	55	Nov 27	Space radar will have 1,000-ft spherical antenna	RD89	July 17	Surveying using electronic devices	143	Oct 23
Characteristics of two-terminal solid-state switches	62	Feb 27	Testing spacecraft at combination flight-test and missile-test range	53	Mar 27	Sweep circuit for crt used with high-resolution dual-channel radar	RD64	Apr 3
Circuit design using voltage-variable silicon capacitors	48	Sept 18	Tracking earth's weather with cloud-cover satellites	44	May 1	Sweep circuit using tunnel diodes	60	Nov 27
Circuits and applications using tunnel diodes	60	Nov 27	Speaker, vibrating armature, gives more output from transistor audio amplifier used on hearing aid	RD72	Jan 9	Sweep circuits using voltage-variable silicon capacitors	48	Sept 18
Crack-free potentiometer uses CdS photo-resistors	CM80	Dec 11	Spectrometer, microwave, for testing electron resonance of paramagnetic materials and masers	142	Mar 13	Switchboards, automatic telephone, pnp silicon diodes eliminate electromechanical switching in	101	Dec 4
Developments in microminiaturization technology	101	Dec 4	Spectrometers, liquid scintillation, transistorized glow-tube counters for	112	Sept 11	<b>Switches</b>		
Electroluminescent panels for automatic displays	44	July 10	Speech compression for saving bandwidth in data transmission systems	SR93	Oct 23	Active ferrite switch used as attenuation element in radar system	48	Oct 30
High magnetic fields help advance semiconductor and maser research	43	Oct 2	Speech intelligibility measuring system	88	May 29	Air cylinders operate switch assembler	PT84	May 8
New frontiers for semiconductors determined from study of periodic table	43	July 17	Sports contests, fast-moving, judged by transistor indicator	114	Aug 7	Alloyed-junction pnp Trisistor for millimicrosecond switching	125	Mar 13
Silicon diodes as high-voltage, high-current rectifiers in large power supplies	60	Oct 2	Squeelch circuit for reducing noise interference in citizens' radio	55	Apr 10	Characteristics of two-terminal solid-state switches	62	Feb 27
Silicon solar cell as future space-age power source	43	Mar 20	Stabilization systems for manned space flight	49	Aug 14	Commutators, mechanical and electronic, for airborne multiplex telemetering	46	July 3
Single-pulse generator using vacuum tubes and solid-state thyatron	70	Aug 14	Standard frequency of 60-kc broadcast by NBS	48	Oct 30	Cryotrons, solid-state switching triode and stepping transistors for computer applications	39	Apr 17
Solid circuits formed from single-crystal semiconductor wafers	110	Aug 7	Standard sources, portable frequency standard uses transistors and new quartz crystal unit	RD76	June 12	Crystal switches bring green radar utility	120	Aug 7
Solid-state devices and their applications	39	Apr 17	Standards considerations for instruments used in design and production	SR89	Sept 11	Current developments in transistor switches	SR53	July 31
Solid-state digital Gray-to-straight binary code converter	60	Dec 11	Standards, international, for electronic design	CM194	Oct 16	Curves for finding rms value of chopped current or voltage wave generated by switches	ERS46	Dec 25
Solid-state panels for display and/or storage	46	Jan 30	Static eliminators, using Krahite fabric as	CM80	May 8	Diagram for switch Hall-effect device	63	Jan 16
Solid-state research aided by sound waves at 10 kmc	RD108	Apr 24	Steam turbine design aided by digital tachometer	58	Apr 10	Fast switching devices for industrial control	51	June 26
Solid-state theory used to probe molecular behavior responsible for dielectric phenomena	CM84	Oct 9	Stellarator breakdown generator for plasma thermonuclear converter	50	July 3	High-speed power switch used in transistor voltage comparator	56	Jan 30
Solid-state thyatron controlled by magnetic amplifier	RD68	Mar 20	<b>Stereophonics</b>			How liquid-state switch controls a-c	CM76	Aug 14
Solid-state thyatron made available	CM72	Apr 3	Amplitude modulation sidebands transmit stereo	RD78	Apr 10	Induction heating generator uses hydrogen thyratrons as rapid switches	51	Feb 13
Tabulation of solid-state thyratrons available today	50	Mar 6	Compatible stereo radio communication using a-m/f-m multiplex	56	May 8	Magnetically-operated, mercury-wetted coaxial switch calibrated pulse generator	56	Apr 17
Theory and use of field-effect solid-state tetrodes	66	May 15	Compatible stereo system, recent developments in	41	Apr 3	Mercury relay switch for electronic micrometer	44	Jan 2
Thin ferromagnetic inductive film used in low-frequency parametric amplifier	RD92	Nov 13	Frequency modulation tuner adapter for separating multiplexed stereo broadcasts	52	Feb 6	Mesa, switching transistor, new, fast type	CM60	Jan 2
Transistor that acts like gas stepping tube is developed	CM58	Sept 18	Precompensator for compatible stereo radio communication using a-m/f-m multiplex	56	May 8	Microsecond sampling switch handles 126 input channels for display on crt	36	Jan 23
Tunnel diodes used in 30-mc i-f amplifier	43	Oct 30	Recent developments in stereo broadcasting	41	Apr 3	Microwave rotation switch makes use of Faraday effect	CM70	May 22
What is upper frequency limit of tunnel diode?	CM70	Oct 30	Stereo cartridge uses rubber adhesive	CM83	May 8	Nonograph for computing transistor switching dissipation	ERS74	Nov 27
Solion liquid diodes, current integration with	53	Feb 27	Stereo pickup uses push-pull coils	CM78	Feb 20	Outdiffusion technique produces 2-to-3 millimicrosecond switching diodes	66	June 5
Sonar, directive long-range sonar transducer called SEFAR	43	Oct 30	Stereophonic tv sound sent over conventional transmitter	64	Oct 30	Sampling oscilloscope displays transistor rise times down to 0.4 millimicroseconds	69	July 31
Sonar fish locator uses compact scan system	54	Apr 3	Tunable f-m multiplex adapter for stereo	66	Apr 10	Semiconductor alloy junction device switches in 50 x 10 <sup>-12</sup> sec	CM72	Jan 30
Sorter circuit for fail-safe photoelectric inspection systems used for industrial gaging	74	July 31	<b>Storage Devices</b>			Short-slot hybrid absorption switches for wideband radar applications	12	Aug 7
Soviet equipment design stresses reliability, ease of maintenance	37	July 24	Cathode-ray storage tubes for direct viewing	40	Jan 23	Solid-state proximity switch that can be triggered by metal in sensing zone	125	Mar 13
Soviets give data on sun satellite	F66	Jan 30	Cathode ray storage tubes for special purposes	52	Jan 30	Solid-state synchronous switch provides a-c excitation for variable reluctance d-c transducer	CM68	Aug 28
<b>Space Electronics</b>			Direct-view, half-tone storage tube capable of selective erasure and nonstorage writing	31	Dec 25	Specifications, performance and applications for typical electro-mechanical commutators	54	Oct 2
Balloon-borne circuits sort high-altitude cosmic rays	52	Aug 28	Era of storage tube just beginning?	CM66	July 10	Switch with built-in thermal tripper	CM81	Feb 20
Beryllium dish to shield satellites	CM68	July 10	Ferroelectric crystals used for information storage	58	Aug 14	Switching speed of solid-state thyratrons	50	Mar 6
Challenge of space—environment, propulsion, communication, navigation and guidance, and power generation	SR55	Apr 24	Photoconductive - electroluminescent elements for digital-to-display translator	31	Dec 25	Switching vhf power in antennas with silicon diodes	58	Jan 19
Chemical, nuclear and solar energy power sources for space-age electronics	43	Mar 20	Solid-state panels for display and/or storage	46	Jan 30	Symmetrical switches and stepping circuits using tunnel diodes	60	Nov 27
Dielectric materials being researched to understand properties exhibited	CM84	Oct 9	Storage crt has symmetrical guns	CM60	Jan 2	Thin magnetic film switch for digital computer memories	44	June 26
Effect of space environment on materials	SR81	Dec 4	Usefulness of electroluminescent panels as storage and display devices	31	Dec 25	Thyatron switching for low-pulse jitter applications	60	May 15
Electromagnetic navigation systems for space vehicle tracking using artificial earth satellites	39	May 1	Vocabulary storage unit for automatic voice data link	47	Jan 9	Transient duration during field-switching reduced in electronic chopper	RD66	Oct 2
Electronic circuits for Pioneer satellite	55	June 19	Strain-gage indicators, shunt bridge balancing in	50	July 24	Transistor commutator for encoder used to measure random event time intervals	48	Mar 20
Environmental testing of future spacecraft	65	Oct 16	Strain gages, common mode rejection amplifiers for	43	July 24	Using high-gain d-c operational amplifiers to design electronic switches	66	Nov 6
Experimental infrared communications receiver for space vehicles	38	Sept 18	Strain gages, d-c stable differential amplifier for	60	Jan 16	Voltage sensitive switch, using cold cathode gas trigger tube as	CM72	Oct 2
Guidance systems for manned space flight	49	Aug 14	Stripline for millimicrosecond microwave computer circuits	77	Nov 20	Waveguide switches classified by bandwidth, power capability, isolation and speed	71	June 5
High-resolution angle transducer and encoder for space probes	78	Oct 16	Stripline resistors have thin film mica base	CM69	Feb 6	<b>Switching Circuits</b>		
Instrumenting the Explorer I satellite	39	Feb 6	Strobe lights on wingtips make flying safer	CM70	Sept 4	Automatic control of industrial equipment using static switching circuits	98	Apr 24
Insulation for space-age circuitry	CM80	June 12	Stroboscope analyzer, adjustable, for studying complex mechanical motions	62	June 5	Automatic video processing amplifier holds video level while switching studios	96	May 29
Interplanetary communications using space probes and satellites	43	Oct 30	Stroboscope versatility improved using two-element flash tube	116	Aug 7	Coincidence diodes gate electronic switch for radar indicators	66	Feb 20
Magnetohydrodynamic generator for extended space flight	CM82	Nov 27	<b>Space Electronics</b>			Computer switching with semiconductors and relays	64	Aug 14
Microwave energy to power sky platform	RD76	June 12	Balloon-borne circuits sort high-altitude cosmic rays	52	Aug 28	<b>Space Electronics</b>		
Nuclear propulsion studied for space use	RD79	May 8	Beryllium dish to shield satellites	CM68	July 10	Challenge of space—environment, propulsion, communication, navigation and guidance, and power generation	SR55	Apr 24
One-watt transistorized transmitter for space telemetry	RD109	Apr 24	Chemical, nuclear and solar energy power sources for space-age electronics	43	Mar 20	Chemical, nuclear and solar energy power sources for space-age electronics	43	Mar 20

Controlled transistor switches for square-wave inverter used to drive two-phase induction motor	60	Feb 20
Electronic switching circuit for radio direction finder with automatic readout	52	Apr 17
Electronically switched phase meter for measuring small phase differences	60	June 5
Ferroelectric crystals for switching applications	58	Aug 14
Ferroresonant storage and switching for electroluminescent type-writer	101	Dec 4
High-speed switching of low-level signals using beam-switching tube	54	Mar 20
Impulse switching using incompletely magnetized conventional ferrite cores	125	Mar 13
Liquid-state switch for controlling a-c	CM76	Aug 14
Magnetron beam switching circuit for multipath delay analyzer	52	Sept 4
Magnetron beam switching tubes for preferential and sequential scanning of electroluminescent panels	31	Dec 25
Measuring circuit for determining switching time of outdiffused diodes	66	June 5
Measuring ultrasonic velocity in solid with thyratron switching circuit	60	May 15
Microwave techniques for millimicrosecond switching circuits	77	Nov 20
Optimizing switching of multiple antenna systems	55	Aug 14
Oscillator keying circuits for ultrasonic neurosurgical instrument	53	May 15
Silicon diodes eliminate electro-mechanical switching in automatic telephone switchboard	101	Dec 4
Spark gap switch for fast high-voltage switching	72	July 31
Static switching circuits for automatic industrial controls	98	Apr 24
Static switching techniques for machine tool safety control	57	June 12
Switching problems solved using monostable multivibrators using series diode feedback loop	90	Apr 24
Switching vhf power in antennas with silicon diodes	58	June 19
Telephone switching system uses photographic plates as permanent memory	RD78	Nov 27
Transistor that acts like gas stepping tube developed for telephone switching	CM58	Sept 18
Transistorized, level sensitive switch for missile count-downs, production lines and industrial processes	76	July 31
Triggered bistable semiconductor circuits	ERS58	Aug 28
Synchronizer for portable transistorized multiplexer used in telephone communications	60	Jan 9
Synchronizer, precise vernier changes binary-counter type frequency dividers to synchronize with WWV	44	July 3
Synchronizer receiver for digital shaft positioning over phone line	62	Feb 13
Synchronizer zero-crossing for testing ultrasonic equipment	64	May 8
Synchroreader developed by Japanese	109	Sept 11
Synchros, tensionmeter measures tension in moving web of paper	RD76	May 15
Synchros, unusual applications for conventional synchros	84	Sept 25
Synthesizer, monophonic keyboard instrument for synthesizing timbre of electronic musical tones	92	May 29
Systems, reliability of	SR65	May 29
<b>T</b>		
Tachometer, digital, aids in steam turbine design	58	Apr 10
Tachometers, commercially available precision induction type	69	Mar 27
Tacitron, Tesla hydrogen-extended-range gas-filled triode thyratron	CM108	Nov 20
Talking book developed by Japanese	109	Sept 11
<b>Tape Recording</b>		
Tape and film insulation for electronic equipment	42	Jan 2
Tape, insulation, physical and electrical properties and applications for	42	Jan 2
Tape recorder speeds panel wiring tests	PT79	May 22
Tape recording at high densities using self-clocking technique	72	Oct 16
Tape recordings speed assembler's learning time	PT68	July 24
Tape transport control circuit for pulse-duration tape recording system	56	Feb 6
Tape-controlled profiler reduces cost and time for producing aircraft	RD80	Oct 9
Tape-flaw detector checks out recorded magnetic tape	50	Jan 9
Tapes, insulation, environmental limits of materials used for	SR81	Dec 4
Task Steer for long range communications	SR93	Oct 23
Tecnetron, a three-element field-effect-cutoff semiconductor, for 10,000-mc operation	125	Mar 13
Tee, frequency-selective, for sensitive wide-frequency range receiving system	58	Feb 27
Teletel, digital teletext system for space communications	43	Oct 30
Telegraph system, 26-channel carrier, uses frequency-shift keying	72	Dec 18
<b>Telemetering</b>		
Communications of the future—what we learned from the IGY	37	July 3
Commutators, mechanical and electronic, for airborne multiplex telemetering	46	July 3
D-c stable differential amplifier for telemetering	60	Jan 16
Digital telemetry system (Teletel) for space communications	43	Oct 30
P-m/p-m telemetering system for Pioneer satellite	55	June 19
High-speed multiplexing with closed-ring counters for data processing and recorders	48	June 26
Omnidirectional circularly-polarized broadband antennas for beacon telemetry	CM106	May 29
One-watt transistorized transmitter for space telemetering	RD109	Apr 24
Pulse-position telemetry demodulator using modified two-input AND gate	54	Feb 20
Remote electronic measurement of physiological factors affecting future spacemen	65	Oct 16
Representative tabulation of electronic commutators for multiplex telemetering	76	Sept 25
Specification, performance and applications for typical electro-mechanical commutators	54	Oct 2
Telemeter coding system for receiving data from high-altitude balloons	52	Aug 28
Telemeter design using magnetostrictive filters	72	June 19
Telemetering stress in power lines carrying high voltages	RD120	Dec 4
Telemetering system for transmitting pilot and spacecraft data at High Range	53	Mar 27
Telemetering systems at missile test ranges	47	Jan 16
Telemetering transmitter used in the Explorer I satellite	39	Feb 6
Telemetry improved using dynamic trap to capture weak f-m signals	64	Jan 9
Television-type pictures transmitted from cloud-cover satellites tracking earth's satellites	44	May 1
Transistor circuits improve telemeter transmitter and modulator	136	Mar 13
Underwater sonic telemeter for trawl fishing determines depth of net	66	Mar 27
Ways to measure light intensity at a distance for process control	48	July 17
Wideband recording of telemetry signals in airborne data acquisition systems	101	Dec 4
Telephone carrier system, transistorized developed by Japanese	109	Sept 11
Telephone communications, 4-channel ppm portable multiplexer for	60	Jan 9
Telephone switching system uses photographic plates as permanent memory	RD78	Nov 27
Telephone system, economical detector permits use of dsh, suppressed carrier a-m in	72	Dec 18
Telephone traffic data recording simplified using ferrite memories	68	Oct 9
Teletypewriters, transistorized system for sending digital data over narrow-band communication lines	72	June 5
Telescope, astronomic multiple dish radio has high resolution	RD126	Aug 7
Telescope controlled using joy-stick to command servo positioner	87	Apr 24
Telescope, energy-loss, for sorting high-altitude cosmic rays	52	Aug 28
Telescope's observing power increased with new image tube	CM97	Sept 25
Teletypewriter, high-speed electrostatic, for data processing	83	May 29
Teletypewriter transmission on Army's air-transportable 3,000-mile radio system	44	Aug 28
<b>Television</b>		
Antenna tower 154 ft higher than Empire State Building	RD77	Dec 11
Automatic controls for color television	58	May 15
Automatic video processing amplifier holds video level while switching studios	96	May 29
Carrier transmission system for closed-circuit television	66	June 12
Characteristics of commercially available vidicon-type television camera tubes	46	Apr 17
Closed-circuit tv for monitoring reactor repair	RD64	Apr 17
Closed-circuit tv watches Atlas engine	RD65	May 1
Color hold circuit provides automatic chroma control and color-killer voltage	RD90	Sept 25
Color, television, magnetic demodulators for	RD56	Jan 2
Diode-compressor design data for tv audio application	ERS74	Feb 27
Flying-spot closed-circuit tv system for astronomical use	66	May 8
High - transconductance picture tube for transistor tv	125	Mar 13
Horizontal-deflection and high-voltage circuits using two transistors	60	Aug 14
Inexpensive sound for television receivers	66	Feb 27
Japanese video tape recorder uses only one revolving magnetic head	RD76	Dec 11
Magnification system reduces required tv scan power	RD77	Feb 13
Narrow band television relay equipment for remoting radar information over narrow-bandwidth circuits	48	Apr 17
Outline generator for educational television	52	Apr 3
Picture tube reduces scanning power requirements for portable sets	125	Mar 13
Reflected-beam kinescope uses electrostatic components to reduce size and weight	31	Dec 25
Revival prospects of uhf tv boosted by junction diode mixers	27	Aug 21
Russian tv transmitter and receiving equipment	37	July 24
Satellite telescope-tv system for ultraviolet mapping of celestial sphere	RD76	Mar 27
Stereophonic tv sound sent over conventional transmitter	64	Oct 30
Tabulation of commercially available photo-emissive camera tubes	92	Apr 24
Television antenna provides unusual pattern	RD64	Aug 28
Television servicing made easier with service data printed on circuits	RD54	Sept 18
Television sound detector uses drift transistor	62	Feb 20
Television spot scanner recognizes and counts atomic particle tracks	58	Mar 27
Television steers remote controlled moving target system	60	Nov 6
Television transmitter for missiles uses battery power	RD153	Mar 13
Television-type pictures transmitted from cloud-cover satellites tracking earth's weather	44	May 1
Time-constant detectors remotely control tv sets	RD62	Sept 4
Transistorized sound amplifier for remote film television camera	58	Jan 16
Transistorized tv sets developed by Japanese	109	Sept 11
Ultrasonic tv camera supplements x-rays in displaying internal structures	RD124	Sept 11
Wide-angle, closed-circuit tv monitor	RD72	Aug 14
Tellurium compounds for semiconductors	CM68	Mar 6
Tellurometer for measuring distances in surveying	113	Oct 23
Temperature limits of conventional electronic components	SR65	Apr 24
Temperature limitations, present and anticipated, for various protective finishes	SR81	Dec 4
Temperature limits of materials	CM124	Dec 4
Tensionmeter measures tension in moving web of paper	RD76	May 15
<b>Testers and Testing</b>		
Analog tester speeds missile, aircraft checks	RD77	Feb 20
Automatic transistor tester prints results	PT74	July 17
Automatic transistorized checker measures transistor base current and beta	114	Dec 4
Can tube testing spot early failures?	CM64	July 24
Checker, electronic micrometer, for printed circuits	44	Jan 2
Checkout sequencer for Polaris	RD86	July 31
Connectors tested in portable force gage	PT84	Feb 27
Dynamic test of filter choke inductance at rated average current	RD64	Jan 23
Frequency stepper for radio propagation testing system	44	Jan 23
High-volume transistor tester constructed of plug-in in-line modular test station discussed at IRE show	PT70	Apr 17
Improved nondestructive testing using induced eddy current	42	Aug 28
Magnetics and meters test tv transformers automatically	PT64	Jan 23
Making component test fixtures more versatile	PT84	May 15
Punched-card automatic production tester sorts transistors	PT134	Aug 7
Radar system tester shortens checkout time	58	June 5

Test equipment kits streamline prototype tests	PT78	Jan 16	Hydrogen thyratrons used as rapid switches in induction heating generator	51	Feb 13	Stereo pickup uses push-pull coils	CM78	Feb 20
Test set automatically measures 18 transistor parameters	PT80	Aug 14	Removing the jitter from thyatron pulses	60	May 15	Three audio approaches to stereo pickup design	CM78	Feb 13
Test set for evaluating noise quality of fixed composition resistors	RD60	June 26	Solid-state thyatron controlled by magnetic amplifier	RD68	Mar 20	Three-part mode transducer for converting angular into circular wave	125	Mar 13
Test system provides contour map of microwave device's properties	RD78	June 12	Solid-state thyatron made available	CM72	Apr 3	Transducer for detecting stress in power line carrying high voltages	RD120	Dec 4
Testers, tape-flaw detector check out recorded magnetic tape	50	Jan 9	Solid-state thyatron used in single-pulse generator	70	Aug 14	Transducer package includes demodulator	CM177	Jan 9
Testing $f_{\alpha 0}$ of h-f transistors	ERS54	Jan 2	Tabulation of solid-state thyratrons available today	50	Mar 6	Transfer ring for finding unknown antenna impedances	ERS82	July 31
Testing high-speed digital computer circuits	50	July 17	Thyatron interval timer made more linear	RD166	Jan 30	Weather transducers monitor low-level winds	RD91	Dec 18
Testing spacecraft at combination flight-test and missile-test range	53	Mar 27	Thyatron used for bistable circuit	RD64	Feb 6	Transformer attenuator, ferrite, for reducing intermodulation and cross-modulation receiver interference	64	Nov 6
Testing systems to verify reliability	RD74	Dec 11	Thyratrons for fast switching in industrial control	51	June 26	Transformer, special ferrite core, for closed-circuit television carrier transmission system	66	June 12
Tests for measuring reliability of components	SR65	May 29	Thyristor for microsecond switching speeds	SR53	July 31	Transformerless heater circuit power supplies	ERS56	June 26
Tracer displays Zener diode curves	RD76	May 8	Thyristor, use of in high-speed switching circuit for accurate sawtooth and pulse generators	64	Dec 11	Transformers, audio, efficiency tests for when used with transistor receivers	RD72	Jan 9
Wettability tests detect contaminants on electronic parts	PT62	Sept 18	Time delay, variable, formed by passive elements	RD70	Jan 16	Transformers, tv, magnetics and meters test automatically	PT64	Jan 23
Tetrahedron theory and use of field-effect solid-state types	66	May 15	<b>Timers</b>			Transformers, use in transistor circuits	SR53	July 31
Theodolite tracking aided by joystick controlled, command servo positioner	87	Apr 24	Electronic switch using high-gain d-c operational amplifiers	66	Nov 6	Transformers, using field-effect solid-state tetrodes as	66	May 15
Theodolites, azimuth, references Jupiter inertial guidance system	RD62	Feb 6	Electronic timer monitors outboard motor	RD75	Nov 6	Transient suppression of high-voltage, high-current rectifiers used in large power supplies	60	Oct 2
Theodolites used at missile test ranges	47	Jan 16	Simple timing circuit, using cold cathode gas trigger tube as	CM72	Oct 2	<b>Transistor Circuits</b>		
Thermal behavior and cooling load of dwellings predicted by analog computer	34	Dec 25	Television sync generator timer for Russian tv broadcast transmitter	37	July 24	Adjustable, transistor time delay relay for industrial control	41	Sept 25
Thermal changes of thermistors plotted as straight line on chart	RD128	Oct 23	Thyatron interval timer made more linear	RD66	Jan 30	Analyzer, statistically evaluates noise-signal amplitude	48	July 24
Thermal environment, when variables will merge	SR81	Dec 4	Time measuring circuits using inductive control	31	Sept 18	Balloon-borne circuits sort high-altitude cosmic rays	52	Aug 23
Thermionic integrated micromodules	CM80	May 15	Timer for holding equipment inactive during warmup interval	RD44	Aug 21	Bandpass transistor amplifier design method	RD74	Feb 20
Thermistor bridge, ultrasensitive, for measuring low-level r-f power	40	Dec 4	Timer for operating recorder to check frequency standard against WWV	RD76	Mar 27	Binary, transistorized counter functions backwards or forwards	82	Sept 25
Thermistor resistance, nomograph for finding at desired application temperatures	ERS72	Feb 13	Timing panel for digital tachometer	58	Apr 10	Carrier transmission system for closed-circuit television	66	June 12
Thermistors, table for selecting to measure microwave power	59	July 17	Tire life increased using control instruments to maintain manufacturing tolerances	RD90	Dec 18	Circuit substitutes as larynx	RD60	July 3
Thermistors, use in transistor circuits	SR53	July 31	Titanate, barium, stacked for better capacitance-per-unit-volume ratios	125	Mar 13	Constant-current-coupled transistor power supply	60	Oct 9
Thermocouples, common mode rejection amplifiers for	43	July 24	Tone sensitive device for selective signaling in citizens' radio	55	Apr 10	Constant-current technique cuts servo response time	55	July 10
Thermocouples, d-c stable differential amplifier for	60	Jan 16	Tone timbre synthesizing, portable transistor monophonic keyboard instrument for	92	May 29	Control circuits for target drone	52	May 1
Thermocouples, operating principle and range of	55	July 10	Tracer, current-voltage curve, using tunnel diodes	60	Nov 27	D-c operational amplifier for analog computers	94	Apr 24
Thermoelectron engines: future power sources?	69	Nov 13	Tracer displays Zener diode curves	RD76	May 8	Design of transistor power converters	56	Sept 4
<b>Thermoelectricity</b>			Tracking orbits of man-made moons	33	Jan 2	Design techniques for making extremely low-voltage power supplies	70	Sept 25
Graphite fabric doped with boron used as thermoelectric elements	CM80	May 8	Tracking systems, telescope tracking aided by joystick controlled, command servo positioner	87	Apr 24	Designing high-quality audio-frequency transistor amplifiers	60	June 12
Hot-cold panel for lighting and heating	CM82	Feb 27	Tracking the earth's weather with cloud-cover satellites	44	May 1	Differential-input chopper-stabilized amplifier for strain gages and thermocouples	43	July 24
Isotope powers thermo converter	CM80	Feb 13	Traffic law enforcement aided by Doppler radar meter	48	Mar 6	Digital data buffer memories made compact using coincident-current technique	50	Oct 2
Prototype thermoelectric generators being studied	69	Nov 13	Trainer shows digital computer operation	RD63	July 24	Digital techniques for generating time scales on paper and tape	80	Nov 13
Thermoelectric converters as power sources for future space-age electronics	43	Mar 20	Transceiver, transistorized, 150-mc solar cells for powering	125	Mar 13	Easy-to-set-up meter for measuring vswr	120	Oct 23
Thermoelectric generator for converting heat to electricity	125	Mar 13	Transceiver, typical class-B, for citizens' radio	55	Apr 10	Equations for designing transistor power supplies	122	Oct 23
Thermoelectric generator produces 100 watts of power from heat of gas flame	CM10	July 17	<b>Transducers</b>			European developments in transistor circuits	41	May 22
Thermoelectric junction on the market	CM106	May 29	Acoustic transducer for ultrasonic neurosurgical instrument	53	May 15	Experimental infrared communications receiver for space vehicles	38	Sept 18
Thermoelectric properties of semiconductors	70	June 19	Differential transformer transducer packaged together with phase-sensitive demodulator	CM67	Jan 9	Feedback design for transistor amplifier stages	52	Aug 14
Thermometers, operating principle and range of	55	July 10	Electronic measurement of physiological factors affecting future spacemen	65	Oct 16	Five-transistor automobile broadcast receiver	42	Sept 18
<b>Thin Films</b>			Environmental limits of materials used for transducers	SR81	Dec 4	Four-transistor square-wave inverter drives two-phase induction motor	60	Feb 20
Experimental methods of depositing thin films discussed at IRE show	PT70	Apr 17	Ferroelectric crystals used as transducers	58	Aug 14	Four-transistor trf radio in hearing-aid eyeglass frame	88	Sept 25
Ferromagnetic films are future logic elements for microwave computer circuits	77	Nov 20	Hall-effect is used in tape recorder playback heads	RD52	Dec 25	Gray-to-straight binary code converter uses solid-straight devices	60	Dec 11
Ring source gives even vacuum deposition of metallic films	PT84	June 12	High-resolution angle transducer and encoder for missile tracking	78	Oct 16	Highly sensitive transistor chopper reduces field-switching transient duration	RD66	Oct 2
Stripline resistors have thin film mica base	CM69	Feb 6	Integral pressure transducer amplifier for working with a strain gage signal in millivolt range	125	Mar 13	High-speed electrostatic teletypewriter for data processing	83	May 29
Superconductors for new memory element made of thin evaporated film	125	Mar 13	Magnetic modulator playback head reads tape at zero speed	58	Mar 6	Horizontal-deflection and high-voltage circuits using two transistors	60	Aug 14
Tabulation of high-vacuum pumps used for evaporation and deposition	66	Oct 9	Multipower transducer offers improved design for ultrasonics applications	CM90	July 31	How to construct a miniature f-m transmitter	80	July 31
Thin-film cryotrons for computer applications	39	Apr 17	Nuclear environment transducers, high temperature magnetic materials for	63	Jan 9	How to design reflexed transistor broadcast receivers	70	May 8
Thin film deposition for microcircuits	44	Sept 4	Pressure transducer logs explosive forces	CM76	Nov 6	Inductive control provides current storage for transistorized computers	31	Sept 18
Thin films improve resistors	CM132	Oct 23	Pressure-sensing transducer for radiological vacuum gage	60	June 19	Infrared detector for proximity control of auto brakes	86	Oct 16
Thin films used to make parametric amplifier	RD92	Nov 13	Reliable high-output variable-reluctance d-c transducer	CM68	Aug 28	Integrator amplifier for manned space flight guidance system	49	Aug 14
Thin magnetic films for digital computer memories	44	June 26	SEFAR, directive long-range sonar transducer	43	Oct 30	Japanese come up with new transistor devices	109	Sept 11
Thin metal parts produced by etching	PT74	Jan 30	Sensitive transducers use one-tube crystal oscillator	48	Oct 2	Logarithmic and period transistor amplifiers for nuclear reactor control	52	May 22
Use of thin films to form micro-miniaturized circuits	49	Dec 11	Shunt bridge balancing in strain-gage indicators	50	July 24	Logical networks test human ability to carry out logical analysis and synthesis	70	Oct 16
Using thin ferromagnetic films in high-speed memories	55	June 5	Single-transistor oscillator on phono arm is frequency modulated by stylus	79	Nov 13	Low-distortion, high-fidelity transistor monitor amplifier for broadcast duty	118	Sept 11
Vapor phase deposition of chromium, tungsten and molybdenum improved	CM71	Sept 4	Soliton linear detector used for pressure or flow transducer	53	Feb 27	Low-frequency parametric amplifier uses thin ferromagnetic inductive film	RD92	Nov 13
<b>Thyratrons</b>			Stereo cartridge uses rubber adhesive	CM83	May 8			
Hydrogen thyatron has ceramic-metal envelope	CM154	Mar 13						

Magnetic amplifiers and transistor circuits regulate frequency of klystrons	68	Feb 13	Transistor voltage comparator uses high-speed power switch	56	Jan 30	Properties of typical high-power silicon transistors	76	Dec 18
Magnetic-coupled multivibrator with controlled output frequency	54	July 24	Transistor voltmeter is accurate, linear	RD56	Jan 23	Punched-card automatic production tester sorts transistors	PT134	Aug 7
Multiform generator uses double-bootstrap sweep controlled by polarity-sensitive trigger	83	Nov 13	Transistorization of instruments for design and production	SR89	Sept 11	Russian developments in transistors	37	July 24
Neuron simulated by transistor circuit	RD74	Feb 13	Transistorized alarm circuit warns of faults in digital systems	48	July 3	Sampling oscilloscope displays transistor rise times down to 0.4 millimicrosecond	69	July 31
Nomograph for determining safety factor of a given thermal design for power transistor circuits	ERS58	Apr 17	Transistorized clock track recorder for writing timing signals on magnetic drum	74	Oct 9	Solid-circuit transistors	CM82	Apr 10
One-transistor blocking oscillator drives cold-cathode counter	46	Sept 18	Transistorized computer system uses photo-electric light-pen as communication link	85	Nov 20	Stepping transistors for computer applications	39	Apr 17
One-watt transistorized transmitter for space telemetry	RD109	Apr 24	Transistorized dual-conversion superheterodyne marker beacon receiver	59	May 8	Transistor damage caused by neutron and electron radiation	55	Nov 27
Portable frequency standard uses transistors and new quartz crystal unit	RD176	June 12	Transistorized function generator for sines or cosines	48	Jan 23	Transistor dice measuring machine	PT78	Jan 16
Portable, transistorized artificial cardiac pacemaker	39	May 1	Transistorized Geiger counter fits in probe	64	Jan 16	Transistor selection in designing circuits	SR53	July 31
Portable, transistorized monophonic keyboard instrument for synthesizing timbre of musical tones	92	May 29	Transistorized inverse feedback circuit stabilizes instrument dry cell current sources	78	Oct 9	Transistor that acts like gas stepping tube is developed	CM58	Sept 18
Precision regulated high-voltage power packs for satellite instrumentation	CM96	Nov 13	Transistorized, level sensitive switch for missile count-downs, production lines and industrial processes	76	July 31	Tube-transistor hybrids provide design economy	68	June 5
Pulse sorting with transistors and ferrite cores	64	May 15	Transistorized marker beacon receiver for light planes	76	Nov 13	Unipolar transistor for solid-state integrated circuits	35	June 26
Saturable-core transistor oscillator integrates gas-flow data	42	Jan 23	Transistorized portable multiplexer for telephone communications	60	Jan 9	Translating information into machine language using handwriting reader	RD100	Nov 21
Sawtooth and pulse generators use high-speed switching transistor	64	Dec 11	Transistorized radar and television ppi sweep circuits using low power	46	June 26	Translator, digital-to-display, uses photoconductive - electroluminescent elements	31	Dec 25
Sense amplifier and current drivers for high-speed thin-film memories	55	June 5	Transistorized radio carried on mouse transmits biological data	RD128	Oct 23	Translator, English to Japanese	RD76	Mar 27
Servo preamplifiers using direct-coupled transistors	74	May 15	Transistorized system for sending digital data over narrow-band communication lines	72	June 5	Translator used in testing high-speed digital computer circuits	50	July 17
Silicon diodes eliminate electro-mechanical switching in automatic telephone switchboard	101	Dec 4	Transistorized variable-frequency generator for pulse circuit design	47	Apr 3	<b>Transmitters</b>		
Single-ended transistor amplifiers for class-B, high-fidelity operation	86	May 29	Transistorizing 16-mm tv remote film camera	58	Jan 16	Amplitude modulation sidebands transmit stereo	RD78	Apr 10
Single-transistor magnetic core-circuit operates counter	RD130	Oct 23	Transistorizing electronic equipment	SR53	July 31	Frequency modulation/continuous wave radar transmitter for target drone used with miss-distance indicator	91	Nov 20
Single-transistor oscillator on phono arm is frequency modulated by stylus	79	Nov 13	Transistors, hi, measuring face of	ERS54	Jan 2	Frequency modulation multiplexing for studio-transmitter links	44	May 22
Single-transistor output circuit approximates push-pull class-B audio output	74	June 12	Transistors lower cost by one-half and increase reliability of glow-tube counters	112	Sept 11	Ganging four r-f transmitters on common antenna to overcome jamming	68	Nov 27
Solid circuits formed from single-crystal semi-conductor wafers	110	Aug 7	Transistors provide computer clock signals	70	Feb 27	How to construct a miniature f-m transmitter	80	July 31
Stable, low-cost, transistorized, one-mc oscillator for communications and radar systems	50	Feb 6	Transistors used to control tuning of voltage-variable silicon capacitors	48	Sept 18	Linear class-B audio amplifier for high efficiency and fidelity in broadcast transmitter	54	May 22
Stable transistorized f-m oscillator and modulator	64	Jan 30	Triggered bistable semiconductor circuits	ERS58	Aug 28	One-watt transistorized transmitter for space telemetry	RD109	Apr 24
Starved transistors raise d-c input resistance of buffer stages	54	Jan 30	Two-transistor circuits provides dual relay	RD62	May 1	Rugged, efficient transmitter for miniature X-band radar with high resolution	48	Jan 30
Television sound detector uses drift transistor	62	Feb 20	Zero-crossing synchronized wave-train generator for testing ultrasonic equipment	64	May 8	Russian tv transmitting equipment	37	July 24
Ten-channel multiplexer for satellite applications	58	Oct 30	<b>Transistors</b>			Ssb transmitters for FRENA and FRENAC voice radio systems	33	Dec 11
Three-stage transistor proximity switch	125	Mar 13	Air pulses measure abrasive transistor case filler	PT84	Feb 13	Techniques for reducing mutual radar interference	39	July 10
Tracer displays Zener diode curves	RD76	May 8	Automatic transistor manufacture	CM70	Jan 30	Television transmitter for missiles uses battery power	RD153	Mar 13
Transistor adder attenuator amplifier takes bumps out of automatic flight control	106	Aug 7	Automatic transistor production using flat ribbons of semiconductor material	CM128	Sept 11	Thyratron switch transmitter for measuring ultrasonic velocity	60	May 15
Transistor amplifier using silicon transistor has input impedance of 8 megohms	RD130	Mar 13	Automatic transistor tester prints results	PT74	July 17	Tone-modulated control transmitter for citizen's radio	55	Apr 10
Transistor amplitude-stable, low-distortion oscillator with d-c coupled multiple feedback	62	Mar 6	Automatic transistorized checker measures transistor base current and beta	114	Dec 4	Transistor circuits improve telemeter transmitter and modulator	136	Mar 13
Transistor and magnetic circuits for radar pulse generator	42	July 3	Characteristics of European-made vhf transistors	57	May 22	Transistor transmitter for radio-controlled garage-door opener	RD62	Apr 17
Transistor audio amplifier for hearing aid uses vibrating armature speakers	RD72	Jan 9	Characteristics of micromodule transistors and diodes	51	May 22	Transistorized telemeter transmitter for Pioneer satellite	55	June 19
Transistor circuits for communicating with power-line carriers	70	May 15	Characteristics of uhf transistors	57	Mar 6	Transmitter for digitally positioning shafts over phone line	62	Feb 13
Transistor circuits improve telemeter transmitter and modulator	136	Mar 13	Choosing and using transistors to obtain reliability	SR65	May 29	Transmitter for pulse-position telemetry system	54	Feb 20
Transistor circuits used in instrumenting the Explorer I satellite	39	Feb 6	Cold soldering hermetically seals transistor assemblies	PT158	Mar 13	Transmitter for radio propagation testing system	44	Jan 23
Transistor differential amplifier with adequate d-c stability	60	Jan 16	Current developments in high-frequency power and switching transistors	SR53	July 31	Transmitter for underwater sonic telemeter for trawl fishing determines depth of net	66	Mar 27
Transistor direct-coupled amplifiers, techniques for limiting load and power dissipation of	68	Jan 9	Depletion-region transistor is made	CM84	June 19	Transmitter frequency translator improves multipath pulse communications	66	June 19
Transistor encoder measures random event time intervals	48	Mar 20	Determining transistor high-frequency limits	31	Aug 21	Transmitter power reduced with controlled-carrier communications system	60	Jan 30
Transistor generator produces microwave power	42	Sept 4	Easing transistor loads	68	Jan 9	Transmitters for target and missile transponders used in non-radar miss distance indicator	42	Apr 17
Transistor indicator judges fast-moving sports contests	114	Aug 7	Dual-hook collector transistor performs complex logical operations for full binary addition	101	Dec 4	Two independent radio transmitters used in Explorer I satellite	39	Feb 6
Transistor multifrequency oscillator for transmitting data over phone lines	RD76	Feb 27	Germanium mesa transistors and microalloy diffusion transistor for high-frequency operation	125	Mar 13	Transponder, target and missile for nonradar miss distance indicator	42	Apr 17
Transistor plethysmograph for impedance measurement of living tissue	62	Apr 10	Grain-boundary transistor works at cryogenic temperatures	34	Jan 23	Trap, dynamic high-Q, permits pick up of weak f-m signals by tracking and attenuating strong signals	64	Jan 9
Transistor radio-controlled garage-door opener operates between 5 and 10 kc	RD62	Apr 17	Heated hydrogen bonds leads to transistors	PT74	Mar 6	Trinistor for microsecond switching speeds	SR53	July 31
Transistor receivers, special circuits for	56	Jan 9	Injection-molded plastic transistor mounting pads	CM85	Nov 27	Triode, solid-state switching, for computer applications	39	Apr 17
Transistor rectifier gives d-c of either polarity	76	June 19	Measuring transistor $f_{max}$	ERS54	Jan 2	Triode magnetic for thermoelectric engines	69	Nov 13
Transistor sound amplifier for remote tv film camera	58	Jan 16	Mechanized transistor assembly	PT132	Sept 11	Trisitor, an alloyed-junction npn device for millimicrosecond switching	125	Mar 13
Transistor test tone oscillator for tape-flaw detector	50	Jan 9	Mesa transistor, new fast-switching type	CM160	Jan 2	Tropospheric scatter system, typical geometry of	SR93	Oct 23
			New geometry improves performance of silicon power transistors	CM130	Aug 7	Tube testing in design and production	SR89	Sept 11
			Nomograph for computing transistor switching dissipation	ERS74	Nov 27	<b>Tubes</b>		
			Nomographs for finding lifetime and tolerable neutron dosage for different transistor types	38	Dec 25	Absorption principle of exhausting vacuum tubes	RD78	June 19
			Pegboard makes prototype transistor printed circuit card	PT74	Mar 20	Alloy gives continuous getter for electron tubes	CM81	Feb 13
						Backward wave oscillator uses ridge-loaded ladder circuit	CM66	May 1

Barrel finishing delicate parts for electron tube	PT84	Feb 27	Thyratron used for bistable circuit	RD64	Feb 6	Vidicon, infrared thermal type proposed	38	June 26
Bifilar helices used to electrostatically focus a traveling-wave tube	46	Jan 2	Traveling-wave tube for 55-kmc operation with bandwidth of 10 kmc	125	Mar 13	Vidicon-type television camera tubes, characteristics of	46	Apr 17
Bonded-shield tv picture tube	CM183	Feb 27	Traveling-wave tube for C-band gives 20-db gain with noise figure in 4.5-db range	31	Dec 25	Voice radio systems reduce noise by transmitting frequency and amplitude speech components on separate channels	53	Dec 11
Breath pressure helps tube production	PT74	Oct 30	Traveling-wave tubes and paramps for low-noise reception of extremely weak signals	106	Dec 4	Voltmeter, rectifier, tunnel diodes used in	60	Nov 27
Can tube testing spot early failures?	CM64	July 24	Traveling wave tubes for millimicrosecond microwave computer circuits	77	Nov 20	Voltmeter transistor is accurate, linear	RD56	Jan 23
Cathode-ray storage tubes for direct viewing	40	Jan 23	Triple triode makes debut	CM84	Apr 10	Voltmeter, vacuum tube, tuned, for reading harmonic amplitude	68	Jan 16
Cathode-ray storage tubes for special purposes	52	Jan 30	Tube exhaust methods use simple gear	RD78	June 19	Voltmeters, digital and analog, for design and production	SR89	Sept 11
Cathode ray tubes with eight completely independent guns in one envelope	CM113	Apr 24	Tube generates current from rocket's exhaust	CM94	Dec 18			
Characteristics of commercially available vidicon-type television camera tubes	46	Apr 17	Tube simulates solar shock waves	CM84	June 5			
Choosing and using electron tubes to obtain reliability	SR65	May 29	Tube waveguide switches classified by bandwidth, power capability, isolation and speed	71	June 5			
Cold-cathode decade counter tube driven by one-transistor blocking oscillator	46	Sept 18	Tube-transistor hybrids provide design economy	68	June 5	WARAC predicts cooling load and thermal behavior of dwelling using analog networks	34	Dec 25
Cold cathode gas trigger diode	CM72	Oct 2	Two-element flash tube improves stroboscope versatility	116	Aug 7	Waveforms, complex, harmonic analysis of simplified using tabular form	84	Dec 18
Design, fabrication and processing of ceramic wafer tubes for modular units	CM94	Sept 25	Ultraviolet image-converter tube for biological microscope	CM78	Feb 20			
Direct-view, half-tone storage tube capable of selective erasure and non-storage writing	31	Dec 25	Voltage control of reflex magnetron frequency	56	July 10			
Double integrator using subminiature pentodes measures distance	RD64	May 22	Voltage-tunable millimeter-wave oscillator tubes	62	June 19	Waveguides		
Electron flight velocity obtained directly from graphs	ERS58	July 24	Tuner, f-m adapter, for separating multiplexed stereo broadcasts	52	Feb 6	Advantages of using coiled waveguide	CM50	Aug 21
Electron tube stem-making machinery discussed at IRE show	PT70	Apr 17	Tunnel Diodes			Reducing waveguide microphonics in low-noise microwave systems	27	Aug 21
Electrostatics, used to focus traveling-wave tube	46	Jan 2	Action and properties explained using electron energy band diagrams	54	Nov 6	Waveguide components, measurement and recording attenuation of	126	Oct 23
Environmental limits of materials used in electron tubes	SR81	Dec 4	Circuits and applications using tunnel diodes	60	Nov 27	Waveguide data charts for precision design of X-band filters	ERS60	Feb 6
Era of storage tube just beginning?	CM66	July 10	Japanese develop tunnel diode computer	RD50	Dec 25	Waveguide switches classified by bandwidth, power capability, isolation and speed	71	June 5
Extended range gas-filled triode thyratron with hot cathode	CM108	Nov 20	Technique for making silicon carbide diodes	CM82	June 12	Waveguides for logic and gating in microwave computer circuits	77	Nov 20
Field-effect tetrodes, theory and use of	66	May 15	Tunnel diode for high-frequency operation	SR53	July 31	Waveguides manufactured in intricate and complex-shaped forms by electroforming	114	Sept 11
Gas stepping tube functions can be taken over by transistor	CM58	Sept 18	Tunnel diode gives 1,000-Mc operation	CM69	July 10	Waveguides, rectangular and circular millimeter, mechanical and electrical characteristics of	50	May 1
Glass envelopes for tube formed precisely by shrinking	PT72	Sept 4	Tunnel diodes used in 30-mc i-f amplifiers and oscillators	43	Oct 30	Wax models speed broadband dielectric antenna design	RD58	June 26
Grid-controlled, secondary-emission electron multiplier tube delivers 5-amp output for 20-30 ma input	31	Dec 25	What is upper frequency limit on tunnel diode?	70	Oct 30	Weather, automatic data analysis using computers	RD88	Oct 16
Guns, writing and flooding, for storage crt are symmetrical	CM60	Jan 2	Typewriter with electroluminescent alpha-numeric indicators and ferro-resonant storage and switching	101	Dec 4	Weather, digital data system monitors meteorological environment of intrusion alarms	RD120	Dec 4
Hard vacuum diodes for microwave detection	CM110	Apr 24				Weather, Doppler radar detects tornadoes	RD76	June 12
Heaterless field-emission cathode developed at Portland University	103	Aug 7	Ultrasonics			Weather-eye satellite tracks earth's weather	44	May 1
Heaterless tubes for thermionic integrated micromodules	CM80	May 15	Commercially available ultrasonic cleaners	65	June 5	Weather, foresters use pen recorder for monitoring weather	RD66	Mar 20
High-definition photomultiplier	CM66	July 3	Freon protects epoxy in ultrasonic cleaner	PT86	May 8	Weather transducers monitor low-level winds	RD91	Dec 18
High-speed switching of low-level signals using beam-switching tube	54	Mar 20	Improving ultrasonic cleaning efficiency	PT96	Oct 16	Welding using electron-beam gun	39	Sept 4
How constant-power tubes perform	CM82	June 5	Instrumentation for ultrasonic neurosurgery	53	May 15	Wescon, new components head developments	43	Oct 30
Hydrogen thyratron has ceramic-metal envelope	CM154	Mar 13	Measuring ultrasonic velocity in solid with thyratron switching circuit	60	May 15			
Image intensifier for photographically recording atomic particle reactions	CM66	June 26	Multipower transducer offers improved design for ultrasonics applications	CM99	July 31	Wire		
Image tube ups observing power of present optical telescopes	CM97	Sept 25	Remote ultrasonic system controls complex maintenance machinery for reactor repair	RD64	Apr 17	Bonded wires form wire stripping brush	PT71	June 26
Improving microwave tube efficiency	CM70	July 17	Sonar fish locator uses compact scan system	54	Apr 3	Characteristics for insulation used for special purpose magnetic wire	60	Feb 13
Line scan crt uses rotating anode	CM79	Nov 6	Sound waves at 10 kmc find application in solid-state research	RD108	Apr 24	Environmental limits of materials used for wires	SR81	Dec 4
Magnesium oxide cold cathodes for self-sustained emission tube	CM66	Feb 6	Ultrasonic delay line used for realistic simulation of radar clutter	78	Sept 25	Glass-served wire for high-temperature use	65	Nov 27
Magnetic triodes and vacuum and gas diodes for thermoelectron engines	69	Nov 13	Ultrasonic energy piped to several workpieces	PT72	Mar 6	Guide and stop eliminate wire stripping hazards	PT131	Dec 4
Multiple-cell infrared detectors for sensing low-level energy	38	June 26	Ultrasonic grinder forms mesa diodes	PT112	May 29	Hand tool quickly strips wire shield	PT98	July 31
Nuvistor, a miniature tube, adopts cantilever design	CM70	Apr 3	Ultrasonic pulse system measures temperature of plasma jet flame	CM70	Oct 2	Hard-harness wiring system saves space	CM85	June 5
Power tubes log long life	CM70	Aug 28	Ultrasonic tv camera supplements x-rays in displaying internal structures	RD124	Sept 11	Hot iron unharnesses teflon-covered wire	PT77	Jan 30
Progressive die forms flag-mounted getters for electron tubes	PT82	Feb 13	Ultrasonics cleans delicate stampings	PT80	Jan 9	How to choose precision fine wire	CM78	Dec 11
Scan-conversion storage tube for remote radar information over narrow-bandwidth circuits	48	Apr 17	Ultrasound measures nose-cone thickness	CM78	Aug 14	Revolving disks spray color code on wire	PT84	Mar 27
Shock tube developed to study missile entry in atmosphere of neighboring planets	CM60	Sept 18	Underwater sonic telemeter for trawl fishing determines depth of net	66	Mar 27	Tape recorder speeds panel wiring tests	PT79	May 22
Special purpose tubes receive attention in Japan	109	Sept 11	Zero-crossing synchronized wave-train generator for testing ultrasonic equipment	64	May 8	Teflon wire when irradiated becomes bondable	CM87	Oct 9
Standardized measurement of cap surface to ceramic on crt disk cathode	PT88	Apr 10	Ultraviolet image-converter tube for biological microscope	CM78	Feb 20	Tension box assists square wire winding	PT70	July 3
Studs in electron gun structures are welded semiautomatically	PT88	Oct 9	Ultraviolet mapping of celestial sphere using satellite telescope-tv system	RD76	Mar 27	Twist fastens wires to printed circuit board	PT158	Mar 13
Tabulation of commercially available photoemissive television camera tubes	92	Apr 24				Wire, breaking strength of silver-plated annealed-copper conductors, and comparison of physical and electrical properties of chrome-copper alloy, copper and reinforced strand conductors	CM74	Jan 9
Television scanning tube developed for detecting ultrasonic images	RD124	Sept 11	Vanguard Minitrack system determines satellite orbits	33	Jan 2	Wire, single magnetic, used in shift register as memory element	CM76	Jan 9
			Vapor-what designers should know about humidity	50	Oct 30	Wiring and electrical connections plated together using new technique	PT96	Dec 18
						Wrap-around rubber tails hold wiring	PT73	Feb 6
						Work simplification program cuts costs	PT74	Jan 30

**X**

Xerography, electrostatic unit prints  
photos dry for use in aerial map-  
ping .....RD102 May 29  
X-ray pictures transmitted over  
closed-circuit tv stored on mag-  
netic drum .....RD77 Dec 11

**BUSINESS INDEX**

**AUDIO**  
A-m stereophonic broadcasting sys-  
tem demonstrated .....EN11 Mar 13  
Compatible stereo transmitting sys-  
tem uses precedence effect .....EN11 Mar 6  
Midwest executives expect very big  
stereo market in 1959 .....24 Jan 23  
Monophonic audio feed device devel-  
oped for use in Halstead multi-  
plex system .....EN11 Mar 6  
Standards for stereo records ap-  
proved by Record Industry Asso-  
ciation of America .....39 Jan 30  
Stereo broadcast standards to be  
recommended by FCC .....EN9 Jan 23  
Stereo equipment at British show  
lags U.S. ....31 May 15  
Stereo radio transmission system  
shown in England .....EN11 Mar 20  
Stereo sound selling for \$125 to be  
available in cars in a few years .....EN11 Apr 3  
Stereo sound to command attention  
at IRE show .....44 Mar 13  
Stereo specifications due this year .....26 Jan 30  
Stereo tv makes debut .....27 Jan 23

**AUTOMOBILE ELECTRONICS**  
British electronic control system  
guides two driverless tractor trail-  
ers .....EN11 Feb 27  
Doppler radar proximity warning  
device for autos being tested .....EN11 Mar 20  
Electric cars: Parts market? .....24 May 32  
F-m auto radio selling for \$125 to be  
marketed in Feb, 1960 .....EN11 Dec 18  
High-voltage transistorized ignition  
compatible with conventional auto  
electrical components .....EN11 Feb 27  
Radar locating device being tested  
on experimental car .....EN11 Mar 6  
Radar locating device for autos .....31 Mar 20  
Stereo sound system may be avail-  
able in cars in a few years .....EN11 Apr 3  
Thickness gage checks engine cylin-  
der walls .....35 Mar 6  
Transistorized ignition system or-  
dered by Detroit Tank Arsenal  
.....EN11 Feb 6

**AVIATION**  
Aeronautics committee cites inter-  
ference hazard from airlines' com-  
munication equipment .....42 May 15  
Aircraft firms push electronics ex-  
pansion to provide full weapons  
capability .....34 Oct 9  
Aircraft systems to command atten-  
tion at IRE show .....44 Mar 13  
Airline Electronic Engineering Com-  
mittee adopts ssb standards, dis-  
cusses indicators and transistors .....38 Dec 11  
ANIP symposium reveals marked  
progress in flight-data presenta-  
tion .....21 Sept 18  
Beacon extends radar range of air-  
traffic control system .....43 Sept 23  
British denounce international tech-  
nical meeting which approved  
U.S.'s Vortac system .....29 May 22  
Checking out helicopter electronic  
system .....45 Apr 24  
Computer aids air traffic control .....36 Dec 18  
Doppler radar navigating equipment  
for fighter planes .....51 Nov 27  
Electronic computers lighten flight-  
plan information load at airports  
.....47 July 31  
Electronics industry grows in north-  
west .....52 Sept 11  
Environmental testing centrifuge .....42 May 15  
FAA plans Doppler-type vhf omni-  
range installations compatible  
with present airborne receivers .....29 May 1  
FAA takes charge of CAA including  
its air traffic control system .....25 Jan 23  
FAA to test blind landing gear .....36 Dec 18  
ICAO divides into two camps over  
short-range air-navigation system  
for world's civil airplanes .....30 Feb 27  
Induction coils for Mach 20 wind  
tunnel being wound .....38 June 19  
Infrared detection system for  
F4H-1 .....49 Dec 18  
Jet airliner flight simulator .....29 May 1  
Navy plans to increase radar traffic  
centers for air control using  
Spanrad .....54 Nov 13  
Picture flying arrives with inte-  
grated instrumentation system .....38 Sept 25  
Prime ignition batteries for jet air-  
lines .....35 May 8  
Role of manned interceptors in fu-  
ture military business .....35 Nov 6  
Stratovision—new business of tele-  
vising courses from airplanes .....42 Nov 6  
Surveillance drones to be bought in  
volume .....35 Sept 4

Yoke, deflection, physical and elec-  
trical parameters of .....58 Dec 11  
Yoke design, precision, deflection  
nomograph for predicting per-  
formance of .....ERS74 Mar 27  
Yoke driver circuit, transistorized,  
for radar and television sweep cir-  
cuits .....46 June 26  
Yokes, deflection, characteristics of  
four materials for cores used in .....59 Mar 20

Two pilotless six-jet drones with  
radio command guidance are being  
completed .....32 Mar 6  
X-15 manned rocket ship due for  
early series of airborne tests .....38 Feb 27

**BUSINESS AND FINANCE**

Airborne early warning project  
means \$½ billion in new busi-  
ness .....26 Jan 2  
Aircraft firms push electronics ex-  
pansion to provide full weapons  
capability .....34 Oct 9  
Are we missing an export bet? .....25 July 3  
Boston to stage NEREM show .....46 Nov 13  
Capital observers predict more mili-  
tary and government spending for  
electronics .....34 Jan 9  
Coalition concept gives new look for  
small companies .....40 Feb 20  
Commerce Department sees 16 per-  
cent climb in military buying .....41 Jan 16  
Department stores: A ripe market  
for automatic data processing sys-  
tem? .....29 Jan 2  
Developments in the electronics in-  
dustry in Hungary .....33 Dec 11  
ETA opposes unified buying by  
armed services .....42 Mar 27  
Electronic industry executive urges  
revamping of renegotiation .....37 June 5  
Electronic industry grows in north-  
west .....52 Sept 11  
Electronic office dictating machine  
help stenographers .....29 May 22  
Electronic parts distributors air  
complaints .....42 June 19  
Electronic watchdog system devel-  
oped to guard plants .....61 Nov 13  
Electronics industry brings boom to  
Danbury, Conn. ....53 Sept 25  
Electronic toy sales rise .....20 Dec 20  
Federal military budget means rec-  
ord dollars for electronics industry  
.....30 Jan 30  
Federal spending for electronic data  
processing gear increases .....39 Oct 9  
Financial underwriters are seeking  
new yardsticks to measure elec-  
tronics firm's health .....39 Mar 27  
Golden opportunity for electronics  
firms to raise money this year  
.....31 Jan 16  
How prime contractors pick sub-  
contractors .....23 July 10  
How to impress financial men when  
seeking new capital .....26 July 17  
Increased numbers of customers at-  
tracted to computer service groups  
.....39 May 15  
Inside the defense market .....51 Oct 23  
Japan acts to slow licensing to U.S. ....38 Feb 13  
Japanese transistor import situation  
heads for showdown .....32 Nov 6  
Leasing market leaps ahead .....24 Dec 25  
Magnetic ink character recognition  
system sorts checks .....46 Sept 25  
Magnetic-ink character recognition  
systems signal major advance in  
automatic banking .....40 May 29  
Magnetic recorder makers say busi-  
ness is good, but will get better  
.....23 June 26  
Magnetically coded checks pave way  
for bank automation in 1960 .....EN11 July 31  
More electronics firms are designing  
trade show exhibits in modular  
form .....28 July 3  
More military business spanning  
Canadian border .....18 Dec 25  
Navy's annual statistical survey  
shows growth in electronics in-  
dustry .....40 June 5  
Net sales of cut-rate tubes in '59  
may hit \$20 million .....31 Oct 2  
New character sensing equipment  
as key to bank data processing  
Retailers seek input devices to speed  
up computer processing .....30 Feb 20  
Role of manned interceptors in  
future military business .....35 Nov 6  
SAC to increase buying of existing  
as well as brand new electronic  
systems .....30 Feb 13  
Sales-order system pays off .....54 Aug 7  
Soviets pin hopes of success for new  
seven-year plan on electronics de-  
velopments .....31 Jan 9  
Soviets reveal trade aims to Elec-  
tronic editor .....30 Feb 6  
U.S. missile and satellite tracking  
network will get much bigger  
soon .....24 Mar 6  
What if peace breaks out? .....32 June 5  
Why mutual fund groups invest in  
electronics industry .....38 June 12

Zeeman effect produced by genera-  
tion of high continuous magnetic  
fields .....43 Oct 2  
Zener diode eliminates damped os-  
cillations and regulates pulse  
height .....RD78 Nov 27  
Zener diodes, applications of .....SR53 July 31  
Zone leveling and refining with elec-  
tron bombardment .....39 Sept 4

**COMMUNICATIONS**

Aeronautics committee cites inter-  
ference hazard from airlines' com-  
munication equipment .....42 May 15  
Air Force buys new synchronous  
single-sideband system .....45 Nov 27  
Airlines Electronic Engineering Com-  
mittee adopts ssb standards .....38 Dec 11  
Antennas for Army's retransmission  
station .....38 June 12  
Army opens big market in air-to-  
ground transmission equipment  
for surveillance drones .....35 Sept 4  
Army's airborne communications  
center to control ground troops  
.....33 Mar 6  
Chicago tests bus identification in-  
terrogator system .....43 Nov 13  
Communications, surveillance gear  
and weapons for foot soldiers  
dominate AUSA meeting .....28 Aug 28  
Communications system for orbiting  
Atlas missiles satellite .....37 Jan 9  
Communications system for Score  
satellite .....27 Jan 23  
Controllable satellite carrying micro-  
wave radio relay for military  
communications .....37 May 22  
Design trends and marketing possi-  
bilities of communications gear  
for boats .....34 Jan 30  
Digital and analog transmitters relay  
moon photos taken from satellite  
.....35 Oct 9  
Direct troposcatter defense com-  
munications between continents  
may become reality .....27 Sept 4  
Educator lectures Japanese on mi-  
crowave techniques .....57 Nov 20  
Electronic watchdog system devel-  
oped to guard plants .....61 Nov 13  
Explorer VI transmitting well .....59 Sept 11  
FCC's proposal cuts down distances  
between tv stations .....30 May 15  
Full-scale mockup of Courier com-  
munications satellite shown .....52 Sept 11  
General LeMay lists communica-  
tions' top needs .....31 June 26  
Geneva International Telecommuni-  
cations conference picks up speed  
.....42 Nov 13  
Global weather central forecasts  
world's weather using communica-  
tions link from remote areas .....26 Jan 16  
Global weather system feasibility  
demonstrated .....43 Nov 13  
High-frequency radiotelephones col-  
lect real-time tactical data from  
experimental areas .....46 Dec 4  
How SAC communicates .....35 Feb 20  
Libyan network expands .....23 Dec 25  
Low-frequency roadside radio sys-  
tem demonstrated .....47 May 15  
Microwave boom expected in wake  
of FCC's opening of spectrum  
above 890 mc .....22 Aug 21  
NASA announces timetable for proj-  
ect Echo .....44 Dec 18  
Nationwide reservation communica-  
tions system uses general-purpose  
digital computer .....46 Nov 27  
New advances in microwave tube  
technology announced at MEREM  
.....45 Nov 20  
New air-transportable radio com-  
munications system developed for  
Signal Corps .....47 July 31  
New orders due for USAF world-  
wide communications system .....33 May 1  
New photo-transmission system  
quickly relays air photographs to  
ground .....47 June 5  
New spectrum reallocation study  
urged .....47 Apr 10  
New tv channels pondered .....35 Mar 6  
Nonthermal biological effects of  
r-f energy .....38 Dec 4  
Oceanographic expansion to play  
key role in defense .....40 Nov 20  
Outer space requirements force radio  
spectrum changes .....29 Oct 30  
Police use more communication gear  
.....62 Oct 23  
Politics clouds vhf-uhf spectrum re-  
allocation .....34 Mar 27  
Radio sextant guides Navy's experi-  
mental navigation ship .....34 Mar 20  
Sales of two-way radio will go up  
as transistors reduce size .....34 July 17  
Selective calling systems for micro-  
wave and mobile radio users .....52 May 29  
Stereo broadcasting specifications  
due this year .....26 Jan 30  
Stereo tv makes debut .....27 Jan 23  
Stratovision—new business of tele-  
vising courses from airplanes .....42 Nov 6  
Study award for Army's global  
communication system, UNICOM  
to be let .....42 Apr 10

Television tape goes mobile.....	43	Aug 14	Digital computers may soon control production lines.....	27	Oct 30	European projection color tv systems getting increasing attention from medical groups.....	25	Jan 2
Transistors front ends.....	46	Dec 4	Doctors seek optical-electronic (scanner-computer) for automatic analysis of human smear specimens.....	49	Dec 18	Evolution is key to British show.....	31	May 15
Translators, boosters and community antennas pose question of who owns a tv signal.....	35	June 12	Efforts to find a common computer language are growing.....	38	Nov 27	Geneva International Telecommunications Conference picks up speed.....	42	Nov 13
Transponder traces rolling stock for railroads.....	57	Apr 24	Electronic computers lighten flight-plan information load at airports.....	47	July 31	How good is USSR test gear?.....	27	Aug 28
Tropospheric scatter antenna form link in test range communications network.....	38	Nov 27	Federal spending for electronic data processing gear increases.....	39	Oct 9	How USSR guided lunik.....	22	Feb 6
Two pilotless six-jet drones with radio command guidance are being completed.....	32	Mar 6	Global weather central processes data to make 2,400 reports an hour.....	26	Jan 16	International cooperation stressed in ISA conference.....	37	Oct 2
USSR exhibit shows gains in communications gear.....	30	July 10	Heartbeat pulsations recorded by vasocomputer.....	39	Apr 24	Japan acts to slow licensing to U.S. firms.....	38	Feb 13
World-wide communications planning calls for updating of USAF network.....	35	May 8	Japanese digital computer development is climbing sharply.....	26	Sept 13	Japanese digital computer development is climbing sharply.....	26	Sept 18
X-15 manned rocket ship to test effects of Mach 5 speeds on radio communications.....	38	Feb 27	Magnetic ink character recognition system sorts checks.....	46	Sept 25	Japanese portable tv set using 32 transistors going into trial manufacture.....	47	Apr 10
<b>COMPONENTS</b>			Magnetic-ink character recognition systems signal major advance in automatic banking.....	40	May 29	Japanese transistor import situation heads for showdown.....	32	Nov 6
Atomic generator, a radioisotope battery, undergoes test.....	32	Apr 17	Nationwide reservation system uses general-purpose digital computer.....	46	Nov 27	Mexican companies enter U.S. market.....	29	July 3
Commercial electronic parts distribution marketing revolution spreads.....	39	Apr 10	New ferrite element Biax promises speed, economy for computers.....	31	Aug 28	New tv uses probed at British Institution of Radio Engineers' convention.....	39	July 31
Components for space equipment highlight of Southwest IRE show.....	38	May 8	New markets in basic metals.....	50	Apr 24	Russian operational reconnaissance satellite in orbit?.....	39	Mar 20
Components to command attention at IRE show.....	44	Mar 13	New transistorized numerical control positioning system announced.....	51	Dec 4	Russian tape recorder.....	67	Oct 23
Cryosar for 10-millimicrosecond switching revealed.....	46	Nov 18	Optical techniques for data processing discussed at National Convention on Military Electronics.....	28	July 24	Soviet exposition in New York to cover broader range than U.S. show in Moscow.....	47	May 29
Developments in tubes and transistors effect future equipment applications.....	45	Apr 24	Remote computers guide Nike and Bomarc missiles.....	26	Jan 9	Soviet gap between equipment design and plant production reported.....	32	May 1
Electric cars: parts market?.....	24	May 22	Retailers seek input devices to speed up computer processing.....	30	Feb 20	Soviet seven-year plan rushes computer development.....	39	Jan 30
Electronic components are available for 600 F operation.....	39	July 17	SAC buys automated data acquisition, processing and display system.....	35	Feb 27	Soviet's claim oceanographic research ship has no equal.....	40	Nov 20
Evolution in computer components.....	36	Nov 20	Solid-state computers for Sage going underground.....	45	May 8	Soviets pin hopes of success for new seven-year plan on electronic developments.....	31	Jan 9
Exploding wires simulate reentry.....	38	Apr 24	Solid-state data-processing system may account for 10 percent of year's transistor production.....	29	Mar 6	Soviets reveal trade aims to Electronics editor.....	30	Feb 6
Induction coils for Mach 20 wind tunnel being wound.....	39	June 19	Solid-state digital computer is in operation.....	41	June 5	Training men for overseas jobs.....	47	Sept 11
Infrared quantum counters and synthesized magnets evolving from solid-state research.....	57	Apr 24	Soviet computer technology is advancing rapidly.....	43	Dec 4	U.S. firms turn to licensing to offset competition of European Common Market.....	30	May 8
Magnetic devices discussed at technical conference on nonlinear magnetic and magnetic amplifiers.....	42	Oct 9	Soviet seven-year plan rushes computer development.....	39	Jan 30	USSR exhibit shows gains in communications gear, analog computers and entertainment products.....	30	July 10
Micromodules shrink equipment by building components on ceramic wafers.....	38	Apr 24	TAC's overseas Sage will cost close to \$75 million.....	29	Apr 17	Was Moonshot 4th USSR Try?.....	26	Oct 2
Multimillion-watt klystron for Sage radar system.....	43	Sept 25	Tubeless memory machine for searching data.....	42	Apr 10	West Germany plans to buy U.S. electronics products.....	59	May 29
Net sales of cut-rate tubes in '59 may hit \$20 million.....	31	Oct 2	USSR exhibit shows gains in analog computers.....	30	July 10	What are converted Russian fishing trawlers and oceanographic ships looking for.....	31	Mar 20
New advances in microwave tube technology announced at NEREM.....	45	Nov 20	What's different about new computers.....	36	Nov 20	<b>GOVERNMENT</b>		
New ferrite element Biax promises speed, economy for computers.....	31	Aug 28	<b>CONSUMER PRODUCTS</b>			Air Materiel Command survey shows up industry measurement problems.....	13	Aug 21
Prime ignition batteries for jet airplanes.....	35	May 8	Bigger screens in offering for portable tv sets.....	34	Jan 16	Agencies study noises appearing on earth from outer space.....	46	Oct 23
Rain and sunshine test chamber for electronic components.....	38	Feb 13	Electronic oven on market in France.....	26	June 26	Automatic mail sorter sorts 43,000 letters and hour.....	28	Oct 30
Receiver-type components backbone of British show.....	31	May 15	Electronic toy sales rise.....	29	Dec 25	Beacon extends radar range of FAA's air-traffic control system.....	43	Sept 25
Research on 58,000-mc reflex klystron in progress.....	57	Nov 20	Enlarger for color photos which is electronically controlled is announced.....	EN11	Nov 6	Cabinet-level Department of Science and Engineering backed by Engineers Joint Council.....	EN11	May 15
Rising sales in battery-operated recorders hold promise of brisk component sales.....	27	Feb 6	Japan announces multifunction portable tape recorder.....	EN11	Oct 30	Capital observers predict more military and government spending for electronics.....	34	Jan 9
Tunnel diode: Predictions indicate influence will compare to that of transistor.....	61	Aug 7	Japanese transistor radios to be marketed in USA by Bulova Watch Co.....	EN11	Sept 4	Chicago tests bus identification interrogator system.....	43	Nov 13
<b>COMPUTERS AND DATA PROCESSORS</b>			Magnetic recorder makers say business is good, but will get better.....	23	June 26	City tests infrared system to detect carbon monoxide and other air pollutants.....	38	May 8
Airborne computers for integrated instrumentation system used for picture flying.....	38	Sept 25	Midget tape recorder to be put on market by Japan.....	EN11	Mar 6	Commerce Department sees 16 percent climb in military buying.....	41	Jan 16
Army field computer MOBIDIC explained.....	47	May 15	Midwest executives expect higher 1959 consumer sales.....	24	Jan 23	Defense: What Lies Ahead?.....	46	Oct 16
Army opens big market in data processing equipment used with surveillance drones.....	35	Sept 4	More transistors and printed circuits in new electronic devices for boats.....	45	Feb 13	Electronic industry executive urges revamping of renegotiation.....	37	June 5
Army plans to purchase mobile field data-processing equipment through 1970.....	37	Apr 3	Net sales of cut-rate tubes in '59 may hit \$20 million.....	31	Oct 2	FAA plans Doppler-type vhf omnirange installations compatible with present airborne receivers.....	29	May 1
Automatic mail sorter sorts 43,000 letters an hour.....	28	Oct 30	Radio-controlled lawn mower will be marketed in 1960 by British firm.....	EN11	July 17	FAA takes charge of CAA including its air traffic control system.....	25	Jan 23
Automatic programming system for numerical control of machine tools is nearer.....	43	Feb 27	Selective calling systems for microwave and mobile radio users.....	52	May 29	FAA takes over CAA and AMB functions.....	EN9	Jan 2
Bank check processing with solid state automatic data processor is offered.....	EN11	Sept 18	Small battery-operated recorder sales climb.....	27	Feb 6	FAA to test blind landing gear.....	36	Dec 18
Braille printing plate made by computer.....	EN11	May 8	Standards for stereo records approved by Record Industry Association of America.....	29	Jan 30	FCC considers amendments to space communications frequency allocation.....	EN11	Jan 30
Combat data processing enters new era with delivery of first Mobidic computer.....	30	Dec 11	Stereo sound system may be available in cars in a few years.....	EN11	Apr 3	FCC's proposal cuts down distances between tv stations.....	30	May 15
Computer aids air traffic control.....	36	Dec 18	Thermo generators for appliances.....	EN11	Feb 6	Industry and scientific leaders call for more research dollars.....	67	Oct 23
Computer controls production of electricity in ten generating stations.....	39	July 17	USSR exhibit shows gains in entertainment products.....	30	July 10	Invention and contributions board set up.....	EN11	Jan 16
Computer service groups expanding.....	39	May 15	<b>FOREIGN ELECTRONICS</b>			Municipalities become customers for noise meters.....	34	Oct 2
Computer simulation to command attention at IRE show.....	44	Mar 13	British denounce international technical meeting which approved U.S.'s Vortac system.....	29	May 22	NASA and ARPA agencies get \$790 million, will get \$2 billion for space in 1970.....	35	July 10
Computermen are learning how computers can be used to do engineering design.....	20	Jan 2	British ship radar gives not only range and bearing to target, but also altitude.....	19	Aug 21	NASA contracts for satellite developments awarded in May.....	EN11	July 17
Computers with new abilities take on new jobs.....	52	Oct 16	British show advanced h-f and fast-switching transistors.....	47	June 19	NASA expansion reflects top government support of civilian agency.....	28	Nov 6
Cryosar for 10-millimicrosecond switching revealed.....	46	Nov 13	Canada buying 84-foot radio telescope.....	43	May 15	NASA to alter patent regulations.....	29	Dec 11
Data processing equipment shown at ISA conference.....	37	Oct 2	Closed-circuit tv monitors help speed output at steel company in Wales.....	37	May 22	New look for federal research and development?.....	24	July 24
Department stores: A ripe market for automatic data processing systems?.....	29	Jan 2	Did Lunik drop moon package?.....	42	Oct 23	New security clearance policy coming.....	34	July 31
Digital computers collect and process data in oil refineries.....	20	Jan 23	Electronic oven on market in France.....	26	June 26	New spectrum reallocation study urged.....	47	Apr 10
			European developments in new computers.....	36	Nov 20	Police using more electronics for detecting and preventing crimes.....	62	Oct 23
						Politics clouds vhf-uhf spectrum reallocation.....	34	Mar 27
						State and local governments regulate ionizing radiation.....	22	Oct 30
						Study of Government Scientific Programs Underway.....	EN9	Jan 9
						Translators, boosters and community antennas pose question of who owns a tv signal.....	35	June 12

Vote-recording system using telephone proposed	EN11 Nov 6	NASA to alter patent regulations	29 Dec 11	Firms seek R&D budget data	MR26 Feb 27
What if peace breaks out?	32 June 5	Nine ideas for engineers who want to write about the electronics industry	47 Mar 27	F-m auto radio selling for \$125 to be marketed in Feb, 1960	EN11 Dec 18
What's ahead in pay television trials by FCC	32 Apr 17	Planning and manufacturing questions examined and answered	24 Apr 17	F-m radio set output rising	MR26 Feb 20
<b>INDUSTRIAL ELECTRONICS</b>		Sales-order system pays off	54 Aug 7	Franco-German electronics market tie-up	EN11 May 1
Automatic programming system for numerical control of machine tools is nearer	43 Feb 27	Suburbs pose hiring problems	27 Jan 2	How prime contractors pick subcontractors	23 July 10
Closed-circuit tv monitors help speed output at steel company	37 May 22	<b>MANPOWER AND EDUCATION</b>		Important factors that win contracts from Army Ordnance Missile Command	33 July 3
Closed-circuit tv monitors rolling of ingots	41 Jan 16	AF Academy cadets study electronics	31 July 17	Industrial commercial electronics can grow to \$6-billion market by 1970	EN11 Aug 28
Computer controls production of electricity in ten generating stations	39 July 17	Business press advances status of industry it serves	42 Oct 9	Industrial electronics to spur	MR22 Nov 6
Deep-sea pipelines checked with closed-circuit tv	35 May 1	Cabinet-level Department of Science and Engineering backed by Engineers Joint Council	EN11 May 15	Infrared device commercial market expanding	32 Apr 3
Digital computers collect and process data in oil refineries	20 Jan 23	Closed-circuit tv carries instruction programs to missilemen	67 Mar 13	Infrared's future promising	MR28 Oct 23
Digital computers may soon control production lines	27 Oct 30	Computermen are learning how computers can be used to do engineering design	20 Jan 2	Inside the defense market	51 Oct 23
Gap between equipment design and plant production in Soviet reported	32 May 1	Control and instrumentation of reactors course to be given in England	EN11 Nov 13	IRE exhibitors expect national sales record to top last year's by 80 percent	51 Mar 13
Industrial electronics to command attention at IRE show	44 Mar 13	Drop in engineering students blamed on Sputnik fever	EN11 Oct 30	Japanese exports to U. S. for October—\$10 million	EN7 Dec 25
Industries become customers for noise measuring meters	34 Oct 2	Esaki tours New York with Electronics editor	38 Nov 6	Japanese transistor import situation heads for showdown	32 Nov 6
Irradiation preserves food	47 Oct 9	Executive pay registers slight gain in 1958	24 Sept 4	Japanese transistor radio to be marketed in USA by Bulova Watch Co.	EN11 Sept 4
Man-made lightning forms steel and titanium alloys	42 Oct 9	FAA looking for 2,000 electronics technicians and engineers	EN11 Aug 14	Japan's electronics industry expects more sales resistance this year in U. S.	EN11 Mar 27
New Markets in Basic Metals	50 Apr 24	Finding tomorrow's engineers	48 Nov 20	Japan's output rises 40%	MR16 June 26
New transistorized numerical control positioning system announced	51 Dec 4	Guided missile school telecasts live courses	EN9 Jan 23	Japan's production jumps 4%	MR26 Oct 9
Production techniques in electronics industry in Hungary	33 Dec 11	Handicapped workers prove value at wide variety of specialized tasks	57 Oct 16	Leasing market leaps ahead	24 Dec 25
Soviets speed up design of automatically controlled lines	34 Nov 27	How to pick sales engineers	24 May 1	Low labor costs in Japan is a two-edged sword	EN11 Oct 16
Tape-controlled machine changes tools automatically	34 Mar 27	John Lyman appointed associate program director for earth science by NSF	EN11 Dec 4	Magnetic amplifier sales rising	MR30 Nov 13
Transponder traces rolling stock for railroads	57 Apr 24	Laboratory equipment for schools developed under National Science Foundation grant	EN11 Sept 25	Magnetic-ink character recognition systems signal major advance in automatic banking	40 May 29
<b>INSTRUMENTS AND TEST EQUIPMENT</b>		Looking ahead to Wescon	44 Aug 7	Marketing possibilities of electronic gear for boats	34 Jan 30
Air Materiel Command survey shows up industry measurement problems	16 Aug 21	NEC program makes a big hit	51 Oct 16	Mexican companies enter U.S. market	29 July 3
Airlines Electronic Engineering Committee discusses cockpit indicators	38 Dec 19	New research grants made to academic institutions	27 Dec 25	Microwave boom expected in wake of FCC's opening of spectrum above 890 mc.	Aug 21
Automatic X-ray fluorescent spectrograph tests composition of metal alloy batches	31 Feb 6	New security clearance policy coming?	34 July 31	Microwave sales to rise	MR34 Oct 16
Battery-powered portable Blast-corder measures peak accelerations from 0 to 1.1 g's	35 July 10	Personnel needed to complement increased use of electronic data processing gear by federal agencies	39 Oct 9	Military market prospects	24 Aug 23
Did Lunik drop moon package?	42 Oct 23	Proposals for construction of better but inexpensive science instruction equipment are requested	EN11 Mar 20	Military spending rises 12%	MR30 Mar 27
Environmental test chamber duplicates rain and sunshine	35 Feb 6	Recruiters at IRE show find rise in business creates more jobs	34 Mar 20	Military transistor needs to rise	MR20 Aug 28
Environmental test equipment market to double	32 May 22	Recruiting and leadership education discussed at NREC	EN11 Oct 9	Missile and aircraft sales to gain 30 percent in 1959	EN9 Jan 23
Gages check Old Man of the Mountains for signs of disintegration	55 Dec 4	Recruiting in 1959 is expected to be more competitive than last year	56 Mar 13	Missiles rise in 3rd quarter	MR18 Feb 6
How good is USSR test gear?	27 Aug 28	Revised physics instruction for U.S. colleges	EN9 Jan 2	More sales to private planes	MR20 Mar 20
Inertial guidance tester	47 Sept 25	Simulator for training jet flight crews	29 May 1	More space business coming	MR22 July 17
Infrared instrument detects carbon monoxide and other air pollutants	38 May 8	Steel industry sets up electronics apprenticeship program	EN11 Oct 16	Most reps still in east	MR24 May 15
Instrument package for Javelin probe checked	27 Oct 30	Stratovision—new business of televising courses from airplanes	42 Nov 6	Net sales of cut-rate tubes in '59 may hit \$20 million	31 Oct 2
Instrument system tests jet engines	35 Oct 2	Symposium on education in materials to be held	EN11 Mar 6	New distributor plan ready	MR20 Apr 17
Instruments for detecting chemical, biological and radiological pathogenic agents	34 Dec 4	Training men for overseas jobs	47 Sept 11	New market head at ETA	MR26 Dec 18
Instruments for space equipment highlight of Southwestern IRE show	38 May 8	Training missilemen: Growing business	32 Dec 18	New markets in Basic Metals	50 Apr 24
Integrated instrumentation system for picture flying	38 Sept 25	Universities report many new developments and activities	57 Nov 20	New orders due for USAF world-wide communications system	33 May 1
ISA conference points to more industrial applications and international cooperation	37 Oct 2	U.S. scientific education undergoing sweeping changes	53 Nov 20	New statistical facts coming	MR28 Sept 25
New Markets in Basic Metals	50 Apr 24	What Wescon exhibitors are saying	51 Aug 7	Noise meter sales increasing	34 Oct 2
Noise meter sales increase	34 Oct 2	<b>MARKETING AND SALES</b>		Nuclear-gear sales \$50 million	MR20 Oct 30
Police using more electronic detectors and instruments	62 Oct 23	\$20 billion sales due in '70	MR36 Aug 7	Nuclear instrumentation market grows	43 Feb 20
Radioactive-isotope moisture meter for testing soil	27 Jan 30	Air Force training gear market spirals	20 Aug 21	Numerical control field for machine tools is blossoming	EN11 Oct 23
Rain and sunshine test chamber for electronic components	38 Feb 13	American Hospital Association show points up hospitals as new electronics market	22 Sept 18	P-C board business rising	MR18 July 10
Regulating of ionizing radiation opens radiological instrument markets	22 Oct 30	Are contract proposals losing military sales?	42 Oct 9	Planning foreign markets	MR24 Dec 11
Ruggedized decade counter for muzzle-velocity chronograph used with atomic cannon	33 July 3	Are we missing an export bet?	25 July 3	Predicts boom for new diode	MR26 Apr 10
Russian tape recorder	67 Oct 23	Army opens big market in surveillance drones	35 Sept 4	Projection color tv getting increasing attention from medical groups	25 Jan 2
Small electron Van de Graaf accelerator probes semiconductors	35 Jan 16	Atomic gear: \$40 million	MR20 Sept 4	Radio, tv set output going up	MR20 Mar 6
Soviets developing new instruments for geophysical exploration	34 Nov 27	British television camera enters broadcast equipment market	EN7 Aug 21	Regulating of ionizing radiation opens radiological instrument markets	22 Oct 30
Telephone engineers develop instruments for medical school	38 Feb 27	Closed-circuit tv sales up	MR16 Jan 23	Relay market show strength	MR26 Dec 4
Thickness gage checks engine cylinder walls	35 Mar 6	Commercial electronics parts distribution marketing revolution spreads	39 Apr 10	Rise seen for color tv sets	MR20 May 1
Transistor sorter and tester	37 Apr 3	Common electrical standards to aid development of six Common Market countries	EN11 June 12	Sales in electronics industry for 1960 will rise at rate twice average for industry as whole	EN7 Dec 25
<b>MANAGEMENT</b>		Communications hiring up	MR30 Mar 13	Sales of two-way radio will go up as transistors reduce size	34 July 17
A new look at technical reports	30 Sept 4	Communications sales to rise	MR14 Dec 25	Semiconductor sales mount	MR22 Jan 30
Computermen are learning how computers can be used to do engineering design	20 Jan 2	Component sales on rise	MR20 May 22	Signal corps lists top contractors	39 May 8
Executive pay registers slight gain in 1958	24 Sept 4	Computers with new abilities take on new jobs	52 Oct 16	Silicon controlled rectifiers	EN11 Dec 18
Financial underwriters are seeking new yardsticks to measure electronics firms' health	39 Mar 27	Data processing sales rise	MR28 Nov 20	Silicon rectifier sales up 35%	MR24 Aug 14
Firms are training men for overseas jobs	47 Sept 11	Defense market holding firm	MR30 Nov 27	Silicon transistors surveyed	MR30 May 29
How to cut engineering cost	24 Apr 3	Defense: What Lies Ahead?	46 Oct 16	Small battery-operated recorder sales climb, also push component sales	27 Feb 6
How to impress financial men when seeking new capital	26 July 17	Department stores: A ripe market for automatic data processing systems?	29 Jan 2	Solar cell sales to soar	MR12 Aug 21
Instrumentation problem in management discussed at ISA conference	37 Oct 2	Electronic parts distributors air complaints	42 June 19	Solid-state data-processing system may account for 10 percent of year's transistor production	29 Mar 6
		Electronic watchdog system developed to guard plants	61 Nov 13	Soviets reveal trade aims to Electronics editor	30 Feb 6
		EMI electronics entering U.S. computer market	EN9 Jan 2	Special-tube sales rising	MR20 Jan 9
		Environmental test equipment market to double	32 May 22	Special-tube sales run high	MR20 Oct 2
		Exports rose 10% in 1958	MR24 June 12	State sales guide issued	MR16 Sept 18
				Stiffening of tariff barriers on European and Asian imports deemed unlikely	EN11 Nov 6
				Stratovision—new business of televising courses from airplanes	42 Nov 6
				Survey gives parts ratios	MR16 Jan 2
				Tantalum capacitor sales rise	MR28 Apr 24
				Test chamber gear sales up	MR24 Feb 13
				Test-instrument sales growing	MR28 Sept 11
				Tomorrow's computer sales	MR26 June 19
				Transistor sales run strong	MR24 June 5
				Transmitter sales rise fast	MR22 Jan 16
				Tube sales: \$ billion in '65	MR28 July 31
				TV set outlook brightens	MR16 July 3
				Two new surveys underway	MR24 May 8
				U.S. firms turn to licensing to offset competition of European Common Market	30 May 8

Vandenberg AFB and Pacific Missile Range new 1/2-billion market. 23 Jan 23  
 West Germany plans to buy U.S. electronics products. 59 May 29  
 Western states sales inch up. MR20 Apr 3  
 Where to get defense data. MR16 July 24

**MATERIALS**

Automatic X-ray fluorescent spectrograph tests composition of metal alloy batches. 31 Feb 6  
 Gold-doped germanium cube for infrared eye. EN9 Jan 2  
 Magnetic ink character recognition system sorts checks. 46 Sept 25  
 Magnetic metals become superconducting at cryogenic temperature. 57 Apr 24  
 Man-made lightning forms steel and titanium alloys. 42 Oct 9  
 Materials for thermoelectric applications under study. EN11 Feb 13  
 Materials to command attention at IRE show. 44 Mar 13  
 Molecular electronics avoid individual components. 38 Apr 24  
 Preformed semiconductor crystal for device fabrication called for. EN11 May 29  
 Push coming toward greater use of molecular electronics in industry. 43 June 12  
 Russian scientists say they have produced 99.9999% pure aluminum. EN11 Apr 10  
 Symposium on education in materials to be held. EN11 Mar 6  
 Thin magnetic films and thermoelectric materials for integrated instrumentation system used in picture flying. 38 Sept 25  
 Tritium now available at \$2 per curie. EN11 May 15

**MEDICAL ELECTRONICS**

American Hospital Association show points up hospitals as new electronics market. 22 Sept 18  
 Biological effects of electromagnetic energy to be explored at medicine and biology conference. EN11 Aug 7  
 Braille printing plate made by computer. EN11 May 8  
 Doctors seek optical-electronic device for automatic analysis of human smear specimens. 49 Dec 18  
 Electron beam sterilization of surgical sutures reported (accelerator scans semiconductors). 35 Jan 16  
 Electronic blood flow measurement using electromagnetic fields. 57 Nov 20  
 Electronic larynx using tiny transducer held against throat under development. EN11 May 29  
 Electronic measurement of human blood flow rate being developed. EN11 July 3  
 German-gas electronic detectors needed. 34 Dec 4  
 Heartbeat pulsations recorded by vasocomputer. 39 Apr 24  
 Infrared detects carbon monoxide and other air pollutants. 38 May 8  
 Instrument package to measure six physiological parameters of man in space developed. EN11 Jan 30  
 Medical use of pulsed radio-frequency energy discussed at doctors' symposium. 42 July 31  
 Missile-type magnetic tape used to record heartbeat pulsations and blood vessel vibrations. EN11 Apr 17  
 Nonthermal biological effects of r-f energy. 38 Dec 4  
 Permanent heartbeat controller attached to heart muscle of patient. EN11 Dec 18  
 Portable electronic iron lung developed in England. EN11 Nov 20  
 Projection color tv getting increasing attention from medical groups. 25 Jan 2  
 Radio transmitter weighing 2-oz embedded in dog's body transmits electrocardiogram data. 41 Dec 11  
 Sanitary codes regulate ionizing radiation. 22 Oct 30  
 Telephone engineers develop instruments for medical school. 38 Feb 27  
 Thermoelectric air conditioning to maintain body temperature. EN11 Oct 23  
 Third International Conference on Medical Electronics planned for London. EN11 Sept 11  
 Third International Conference on Medical Electronics to be held in London. EN11 Dec 18  
 Ultraviolet flying spot tv microscope described at Southwestern IRE show. 38 May 8  
 UNESCO's second medical electronics conference. EN11 Apr 24  
 What's new in medical ultrasonics and instrumentation. 28 Dec 11

**METEOROLOGY**

Flying weather laboratory will probe weather with variety of electronic devices. EN11 Feb 13  
 Global weather central forecasts world's weather. 26 Jan 16  
 High-speed weather chart transmission system being designed. EN11 Feb 20  
 Meteorological rocket radio transmitter smaller than teacup developed by Soviets. EN11 Mar 20  
 Satellites will help weathermen keep tabs on atmosphere. 26 Mar 20

Vanguard II meteorological satellites carried two infrared detectors to measure reflected sunlight intensities. EN11 Feb 27

**MILITARY**

AF Academy cadets study electronics. 31 July 17  
 Air Force buys new synchronous single-sideband system. 45 Nov 27  
 Air Force training gear market spirals. 20 Aug 21  
 Air Materiel Command survey shows up industry measurement problems. 16 Aug 21  
 Aircraft firms push electronic expansion to provide full weapons capability. 34 Oct 9  
 Angular tracker picks up signals from Army's Lacrosse missile. 22 Aug 21  
 ANIP symposium reveals marked progress in flight-data presentation. 21 Sept 18  
 Antenna provides faster target data on approaching aircraft. 29 Nov 6  
 Antennas for Army's retransmission station. 38 June 12  
 Army field computer MOBIDIC explained. 47 May 15  
 Army installs new equipment at satellite tracking center to extend range. 40 Sept 11  
 Army lists funds for surveillance. 47 June 5  
 Army plans to purchase mobile field data-processing equipment through 1970. 37 Apr 3  
 Army to buy surveillance drone in volume. 35 Sept 4  
 Army's airborne communications center to control ground troops. 33 Mar 6  
 Army's new highly-sensitive combat surveillance radars tell target's sex. 33 Aug 14  
 Capital observers predict more military and government spending for electronics. 34 Jan 9  
 Commerce Department sees 16 percent climb in military buying. 41 Jan 16  
 Communications, surveillance gear and weapons for footsoldiers dominate AUSA Meeting. 28 Aug 28  
 Defense: What Lies Ahead? 46 Oct 16  
 Direct troposcatter defense communications between continents may become reality. 27 Sept 4  
 FLA opposes unified buying by armed services. 42 Mar 27  
 Electronically-operated antitank mine simulator developed. 35 Feb 6  
 Federal military budget means record dollars for electronics industry. 30 Jan 30  
 General LeMay lists communications' top needs. 31 June 26  
 Germ-gas electronic detectors needed. 34 Dec 4  
 Global weather system feasibility demonstrated. 43 Nov 13  
 How prime contractors pick subcontractors. 23 July 10  
 How SAC communicates. 35 Feb 20  
 How to cut engineering cost. 24 Apr 3  
 How we're fighting submarine threat. 20 July 3  
 Important factors that win contracts from Army Ordnance Missile Command. 33 July 3  
 Inertial bombing-navigation system and ground support gear for SAC contracted for. EN11 Sept 18  
 Inside the defense market. 52 Oct 23  
 Integrated instrumentation system for picture flying. 38 Sept 25  
 Low-light-level television furnishes eyes for nuclear submarines and space vehicles. 20 June 26  
 Micromodules make military radio small as lump of sugar. 29 Apr 3  
 Military market prospects. 24 Aug 28  
 Military planes patrolling international waters are hottest front in cold war. 22 July 10  
 Military services push microminaturization. 38 Apr 24  
 Military-civil air traffic control using joint facilities being investigated. EN11 July 3  
 More military business spanning Canadian Border. 18 Dec 4  
 More R for defense R&D? 32 June 19  
 Navy plans to increase radar traffic centers for air control using Spanrad. 54 Nov 13  
 New air-transportable radio communications system developed for Signal Corps. 47 July 31  
 New orders due for USAF world-wide communications system. 33 May 1  
 NRL's Project Sunfire II detects 80,000-volt x-rays. 63 Oct 23  
 Oceanographic expansion to play key role in defense. 40 Nov 20  
 Oceanographic research gets much attention as defense must. 18 Sept 18  
 Preparation for tracking Tiros meteorological satellites underway. 51 Nov 13  
 Radio sextant guides Navy's experimental navigation ship. 34 Mar 20  
 Remote computers guide Nike and Bomarc missiles. 26 Jan 9  
 Role of manned interceptors in future military business. 35 Nov 6  
 SAC buys automated data acquisition, processing and display system. 35 Feb 27

SAC to increase buying of existing as well as brand new electronic systems. 30 Feb 13  
 Satellite camera photograph moon. 35 Oct 9  
 Services study noises appearing on earth from outer space. 46 Oct 23  
 Shore test center completely evaluates all navigation gear for Polaris-launching submarines. 33 July 24  
 Signal corps lists top contractors. 39 May 8  
 Solid-state computers for AF's Sage going underground. 45 May 8  
 Study award for Army's global communication system, UNICOM, to be let. 42 Apr 10  
 TAC's overseas Sage will cost close to \$75 million. 29 Apr 17

**MISSILES AND SATELLITES**

Angular tracker picks up signals from Army's Lacrosse missile. 22 Aug 21  
 Army installs new equipment at satellite tracking center to extend range. 40 Sept 11  
 Battery control center for Hawk missile system. 38 Dec 4  
 Blockhouse control for launching Atlas ICBM. 45 May 8  
 Bomarc missiles roll down production lines. 43 June 12  
 Celestial and earth-based signals being investigated by AF teams. 32 Apr 10  
 Challenges to electronics engineers of space age emphasized at Missile Industry Conference. 26 June 26  
 Closed-circuit tv carries instruction programs to missilemen. 67 Mar 13  
 Communications and early warning satellites may promote world peace. 41 Dec 11  
 Communications system for Score satellite. 27 Jan 23  
 Controllable satellite carrying microwave radio relay for military communications. 37 May 22  
 Electronic features of Project Mercury space capsule. 35 Feb 13  
 Electronic stabilization section of Thor inspected. 67 Mar 13  
 Electronics industry growing in northwest. 52 Sept 11  
 Experimental nose cone model undergoes simulated re-entry test. 56 Mar 13  
 Exploding wires simulate reentry. 38 Apr 24  
 Explorer VI reveals larger concentration of low-energy particles than expected. 59 Sept 11  
 Full-scale antenna test mockup of Project Mercury capsule. 23 July 10  
 Full-scale mockup of Courier communications satellite shown. 52 Sept 11  
 High-power search radar for ballistic missile defense. 41 Feb 20  
 How USSR guided lunik. 22 Feb 6  
 Important factors that win contracts from Army Ordnance Missile Command. 33 July 3  
 Inertial system to guide first manned satellite. 42 Mar 27  
 Infrared tracker detects artificial satellites thousands of miles above earth. 59 Sept 11  
 Lorac pinpoints position of missile launching ships. 43 Mar 27  
 Low-light-level television furnishes eyes for nuclear submarines and space vehicles. 20 June 26  
 Missile measurement ship goes to sea. 27 Feb 6  
 Missile systems to command attention at IRE show. 34 Mar 13  
 NASA announces timetable for Project Echo. 44 Dec 18  
 NASA takeover of ABMA reflects top government support of civilian agency. 28 Nov 6  
 Navigation and guidance system for space vehicles discussed at National Convention on Military Electronics. 28 July 24  
 Pioneer IV's instrument package. 39 Mar 27  
 Preparation for tracking Tiros meteorological satellites underway. 51 Nov 13  
 Private industry, government agencies push research toward ruggedized atomic clocks. 39 June 19  
 Relationship of manned interceptors and missiles in future military business. 35 Nov 6  
 Remote computers guide Nike and Bomarc missiles. 26 Jan 9  
 Russia and U.S. attempt to get operational reconnaissance satellites in orbit. 39 Mar 20  
 Satellite camera photographs moon. 35 Oct 9  
 Satellites will help weathermen keep tabs on atmosphere. 26 Mar 20  
 Shore test center completely evaluates all navigation gear for Polaris-launching submarines. 33 July 24  
 Space projects being researched for 1969. 29 Apr 3  
 Sparrow III follow-on production contract awarded. EN11 Apr 10  
 Titan missile on test stand. 35 Apr 17  
 Training missilemen: Growing business. 32 Dec 18  
 U. S. missile and satellite tracking network will get much bigger soon. 24 Mar 6  
 Was Moonshot 4th USSR Try? 26 Oct 2  
 What if peace breaks out? 32 June 5  
 What's inside orbiting Atlas missile satellite. 37 Jan 9

<b>NUCLEONICS</b>			Navy plans to increase radar traffic centers for air control using Spanrad ..... 54 Nov 13			New maser helps detect noises from outer space ..... 46 Oct 23		
Atomic generator, a radioisotopic battery, undergoes tests ..... 32	Apr 17		New direction-finding gear works into VOR system ..... 47	June 19		Push coming toward greater use of molecular electronic in industry ..... 43	June 12	
Closed-circuit tv watches radioactive fuel ..... 47	May 29		New DEWline radar station just completed along Aleutian Island chain ..... 27	July 10		Russians have trouble fabricating transistors with uniform characteristics ..... 43	Dec 4	
Electronic gear controls nuclear cargo ship Savannah ..... 27	July 24		New experimental high-power search radar developed ..... 41	Feb 20		Small electron Van de Graaf accelerator probes semiconductors ..... 35	Jan 16	
Ionizing radiation being regulated by government ..... 22	Oct 30		Preparation for tracking Tiros meteorological satellites underway ..... 51	Nov 13		Solid-state computers for Sage going underground ..... 45	May 8	
Nuclear instrumentation market grows ..... 43	Feb 20		Radar locating device for autos ..... 31	Mar 20		Solid-state data-processing system may account for 10 percent of year's transistor production ..... 29	Mar 6	
Private industry, government agencies push research toward ruggedized atomic clocks ..... 39	June 19		Radar: Misreading scopes, misinterpreting blips, misuse of controls contribute to increased ship collisions ..... 30	June 12		Solid-state digital computer is in operation ..... 41	June 5	
Ruggedized decade counter for muzzle-velocity chronograph used with atomic cannon ..... 33	July 3		Radars systems for integrated instrumentation used for picture flying ..... 38	Sept 25		Solid-state electronics draw attention at Southwestern IRE show ..... 30	May 8	
<b>POWER SOURCES</b>			Scientists push maser, radar and radiometry techniques for second Venus contact ..... 35	Apr 17		Solid-state research headed toward infrared-optical work ..... 57	Apr 24	
100-watt thermoelectric generator developed ..... EN11	June 26		World's largest radome made of fiberglass ..... 47	Mar 27		Theoretical study of Raser, a quantum mechanical amplifier, underway ..... 25	May 1	
Atomic generator, a radioisotope battery undergoes test ..... 32	Apr 17		<b>RADIO ASTRONOMY</b>			Transistor sorter and tester ..... 37	Apr 3	
Atomic-powered electric generator described by AEC ..... 41	Dec 11		Antenna 1,000-ft in diameter for radio astronomy may be built in Puerto Rico ..... EN11	May 22		Transistors soon in tv and f-m receiver front ends ..... 46	Dec 4	
Big Bertha solar cell energy converter shown ..... 39	Dec 11		New 85-ft radio telescope at University of Michigan ..... 47	June 5		Tunnel diode: Predictions indicate influence will compare to that of transistor ..... 61	Aug 7	
BuShips orders 5-kw thermoelectric generator ..... EN11	May 1		Radio telescope at University of Michigan nearing completion ..... 41	Feb 20		Zinc gold-doped germanium photo-transistors studies for use in pathogenic agent detectors ..... 34	Dec 4	
Hydrogen-oxygen fuel cell for generating electricity is announced ..... EN11	June 12		Radio telescope being built by Ohio State University ..... EN11	Apr 17		<b>SPACE ELECTRONICS</b>		
Large-scale plasma generators possible in 5 to 10 years ..... EN11	May 22		Radio telescope for military use is being built by Navy ..... EN11	June 5		85-ft radio telescope at University of Michigan nearing completion ..... 41	Feb 20	
Magneto-hydrodynamic generator uses air plasma as electrical conductor ..... EN11	Nov 6		Radio telescopes hear noises through electromagnetic window of outer space ..... 46	Oct 23		Canada buying 84-foot radio telescope ..... 43	May 15	
Microwave transmission from ground to supply power to space craft ..... EN11	June 5		<b>REGIONAL DEVELOPMENTS</b>			Celestial and earth-based signals being investigated by AF teams ..... 32	Apr 10	
Nuclear thermionic converter produces electricity in experiments ..... EN11	Feb 13		Boston to stage NEREM show ..... 46	Nov 13		Challenges to electronics engineers of space age emphasized at Missile Industry Conference ..... 26	June 26	
Russian molecular generator produces radio waves emitted by ammonia molecules ..... EN11	May 1		Detroit automatic mail sorter sorts 43,000 letters an hour ..... 28	Oct 30		Controllable satellite carrying microwave radio relay for military communications ..... 37	May 22	
Thermionic generator tube converts rocket exhaust heat to power ..... EN11	Dec 11		Electronic industry grows in north-west ..... 52	Sept 11		Did Lunik drop moon package? ..... 42	Oct 23	
Thermo generator's future lies in increasing efficiency of present power plants ..... EN11	Feb 6		Electronics industry brings boom to Danbury, Conn. .... 53	Sept 25		Electronic features of Project Mercury space capsule ..... 35	Feb 13	
Thermoelectric action in metal depends upon mass of impurity atoms ..... EN11	Feb 27		Long Island company finds tomorrow's engineers with unique technique ..... 48	Nov 20		Exploding wires simulate reentry ..... 38	Apr 24	
Thermoelectric air conditioner, space heater and refrigerator-freezer in one system ..... EN11	Sept 11		Long Island Electronic Manufacturers' Council spearhead drive for research facility ..... EN11	July 3		Explorer VI reveals larger concentration of low-energy particles than expected ..... 59	Sept 11	
Thermoelectric generators — future power sources for aircraft and rockets? ..... EN11	Sept 11		Looking ahead to Wescon 1959 consumer sales ..... 24	Jan 23		Full-scale antenna test mockup of Project Mercury capsule ..... 23	July 10	
<b>PRODUCTION</b>			MIT educational program develops engineer-scientists ..... 53	Nov 20		How USSR guided lunik ..... 22	Feb 6	
Automatic production of microalloy diffused transistors underway ..... EN9	Jan 23		New advances in microwave tube technology announced at NEREM ..... 48	Nov 20		Inertial system to guide first manned satellite ..... 42	Mar 27	
Embossing machine electronically translates tape data onto cards or plates ..... EN11	Oct 2		San Francisco's fifty-year story ..... 28	Aug 14		Infrared tracker detects artificial satellites thousands of miles above earth ..... 59	Sept 11	
Gap between equipment design and plant production in Soviet reported ..... 32	May 1		Vandenberg AFB and Pacific Missile Range new 1/2-billion market ..... 23	Jan 23		Instrument package for Javelin probe checked ..... 27	Oct 30	
Handicapped workers prove value at wide variety of specialized tasks ..... 57	Oct 16		Western states growth speeds up ..... 43	Aug 14		Low-light-level television furnishes eyes for nuclear submarines and space vehicles ..... 20	June 26	
Moscow designing programmed control system for steel mills ..... EN11	Jan 16		What Wescon exhibitors are saying ..... 51	Aug 7		Miniature battery-operated tv system for space flights ..... 44	Mar 13	
New method for coating cathodes ..... EN11	Jan 16		<b>RESEARCH AND DEVELOPMENT</b>			Mirror for Navy's tv-type space camera ..... 25	Jan 23	
Planning and manufacturing questions examined and answered ..... 24	Apr 17		Efforts to find a common computer language are growing ..... 38	Nov 27		NASA and ARPA agencies get \$790 now, will get \$2 billion for space in 1970 ..... 35	July 10	
Production techniques to command attention at IRE show ..... 44	Mar 13		Experiments show foods can be safely preserved by irradiation ..... 47	Oct 9		NASA takeover of ABMA reflects top government support of civilian agency ..... 28	Nov 6	
Russians using tape controlled machine tools ..... EN9	Jan 9		Exploding wires simulate reentry ..... 38	Apr 24		New 85-ft radio telescope at University of Michigan ..... 47	June 5	
Sparrow III follow-on production contract awarded ..... EN11	Apr 10		Industry and scientific leaders call for more research dollars ..... 67	Oct 23		Outer space requirements force radio spectrum changes ..... 29	Oct 30	
Tape-controlled combination machine automatically changes 961 tools ..... EN11	Feb 27		Man-made lightning forms steel and titanium alloys ..... 42	Oct 9		Preparation for tracking Tiros meteorological satellites underway ..... 51	Nov 13	
Ultrasonics combined with conventional welding methods may improve metal joining ..... EN11	Apr 10		Molecular electronics avoids individual components ..... 38	Apr 24		Private industry, government agencies push research toward ruggedized atomic clocks ..... 39	June 19	
Underwater lightning device used experimentally for certain metal forming operations ..... EN11	Sept 18		New look for federal research and development? ..... 24	July 24		Project Sunfire II detect 80,000-volt x-rays ..... 63	Oct 23	
<b>RADAR</b>			New research grants made to academic institutions ..... 27	Dec 25		Satellite cameras photograph moon ..... 35	Oct 9	
Airborne early warning project means \$1/2 billion in new business ..... 26	Jan 2		Newest data on development of magnetic devices ..... 42	Oct 9		Scientists push maser, radar and radiometry techniques for second Venus contact ..... 35	Apr 17	
Antenna provides faster target data on approaching aircraft ..... 29	Nov 6		Nonthermal biological effects of r-f energy ..... 38	Dec 4		Space device hold spotlight at National Convention on Military Electronics ..... 28	July 24	
Army installs new equipment at Satellite tracking center to extend range ..... 40	Sept 11		Oceanographic research gets much attention as defense must ..... 18	Sept 18		Space equipment highlight of Southwestern IRE show ..... 38	May 8	
Army lists funds for surveillance ..... 47	June 5		Research program into what makes weather to involve satellites ..... 26	Mar 20		Space projects being researched for 1969 ..... 29	Apr 3	
Army's new highly-sensitive combat surveillance radars tell target's sex ..... 33	Aug 14		Researchers report progress in studies of collisions of gaseous ions ..... 57	Nov 20		Stratolab looks at Venus ..... 41	Dec 18	
Beacon extends radar range of air-traffic control system ..... 43	Sept 25		Solid-state research headed toward infrared-optical work ..... 57	Apr 24		Theoretical study of Raser, a quantum mechanical amplifier, underway ..... 25	May 1	
British ship radar gives not only range and bearing to target, but also altitude ..... 19	Aug 21		Space projects being researched for 1969 ..... 29	Apr 3		Universities report many new developments and activities ..... 57	Nov 20	
DEW-line stations in Aleutian chain monitors skies ..... 59	May 29		What is role of basic research? ..... 38	Aug 14		<b>SOLID-STATE DEVICES</b>		
Doppler radar navigating equipment for fighter planes ..... 51	Nov 27		Airlines Electronic Engineering Committee discusses preferred transistor list ..... 38			Dec 11		
Doppler-type vhf omnirange installations compatible with present airborne receivers planned by FAA ..... 29	May 1		British show advanced h-f and fast-switching transistors ..... 47	June 19		Completely transistorized portable tv set uses transistors ..... 37	June 5	
Electrical characteristics of high strength radomes being tested ..... 35	Jan 9		Completely transistorized portable tv set uses transistors ..... 37	June 5		Cryosar for 10-millimicrosecond switching revealed ..... 46	Nov 13	
ICAO divides into two camps over short-range air-navigation system for world's civil airplanes ..... 30	Feb 27		Developments in transistors and tubes effect future equipment applications ..... 45	Apr 24		Microcircuits for integrated instrumentation system used in picture flying ..... 38	Sept 25	
Lorac pinpoint position of missile launching ships ..... 43	Mar 27		Molecular electronics avoids individual components ..... 38	Apr 24		<b>TELEVISION</b>		

FCC's proposal cuts down distances between tv stations.....	30	May 15
Japanese portable tv set using transistors going into trial manufacture .....	47	Apr 10
Low-light-level television furnishes eyes for nuclear submarines and space vehicles .....	20	June 26
Midwest executives expect significant increase in color tv sales in 1959 .....	24	Jan 23
Miniature battery-operated tv system for space flights.....	44	Mar 13
New tv channels pondered.....	35	Mar 6
New tv uses probed at British Institution of Radio Engineers' convention .....	39	July 31
Projection color tv getting increasing attention from medical groups .....	25	Jan 2
Stereophonic tv makes debut.....	27	Jan 23
Stratovision—new business of televising courses from airplanes.....	42	Nov 6
Television eye tracking system for diagnosing optical defects.....	28	Dec 11
Television tape goes mobile.....	43	Aug 14
Transistors soon in tv and f-m receiver front ends .....	46	Dec 4
Translators, boosters and community antennas pose question of who owns a tv signal.....	35	June 12
What's ahead in pay television trials by FCC .....	32	Apr 17

### TRANSPORTATION

10,000 horsepower nuclear merchant ship to be developed in West Germany .....	EN11	Mar 6
Aeronautics committee cites interference hazard from airlines' communication equipment .....	42	May 15
Auto industry provides bigger electronics market .....	EN11	Oct 9
British electronic control system guides two driverless tractor trailers .....	EN11	Feb 27
Chicago tests bus identification interrogator system .....	43	Nov 13
Crewless automatic train operation being considered by NYC transit authority .....	EN11	Oct 23
Design trends and marketing possibilities of electronic gear for boats .....	34	Jan 30
Electronic gear controls nuclear cargo ship Savannah.....	27	July 24
Experimental fuel cell tractor develops 3,000 lb of drawbar pull.....	EN11	Oct 30
Infrared hot-box detector controls trains .....	32	Apr 3
Low-frequency roadside radio system demonstrated .....	47	May 15
More transistors and printed circuits in new electronic devices for boats .....	45	Feb 13
Orbiting commercial navigation system for use of mariners proposed .....	EN11	Dec 4

Radar: Misreading scopes, misinterpreting blips, misuse of controls contribute to increased ship collisions .....	30	June 12
Self-guided buses being studied by Chicago Transit Authority.....	EN11	Sept 4
Transponder traces rolling stock for railroads .....	57	Apr 24

### ULTRASONICS

Affect of ultrasonics on growth of microorganisms .....	34	Dec 4
Automatic ultrasonic vapor degreasers for aircraft engine components to be supplied to USAF.....	EN11	Mar 13
Magnetic field-ultrasonic technique for probing deep-down crystal structure .....	EN11	May 22
Search sonar for use against subs by destroyers is being developed .....	EN11	June 5
Sonar doesn't solve all problems of oceanography .....	18	Sept 18
Transistorized sonar training aid developed .....	EN11	Sept 11
Ultrasonic energy possible source for controlling burning rate of solid fuels .....	EN11	Aug 7
Ultrasonic thickness gage measures engine cylinder walls.....	EN11	Feb 13
Ultrasonics combined with conventional welding methods may improve metal joining.....	EN11	Apr 10
What's new in medical ultrasonics.....	28	Dec 11

## AUTHORS' INDEX

### A

Adams, J. A., Miss Distance Indicator Scores Missile Accuracy.....	F42	Apr 17
Agusta, B., Dynamic Test of Choke Inductance .....	RD54	Jan 23
Agusta, B., Sorting Components by Measuring Waveforms.....	F56	Feb 13
Ahrons, R. W. & Von Urf, How to Generate Accurate Sawtooth and Pulse Waves .....	F64	Dec 11
Albright, J. D., Determining Isolator Standing-Wave Ratio .....	ERS64	Oct 2
Alexakis, N. G., Digital Input for Precision, Variable Oscillators.....	F56	Oct 30
Allenden, D., Using Feedback in Electrometer Design.....	F71	Oct 9
Allerton, G. L., Microwave Directional Couplers .....	F40	Sept 18
Amicone, R. G., Goldie & Davey, Generating Pulses With Solid-State Thyratrons .....	F70	Aug 14
Ammerman, C. R. & Blair, Receiver Sensitivity .....	ERS52	Jan 23
Amron, I. & Poontz, Improve Ultrasonic Wash Methods.....	PT96	Oct 16
Amron, I., Koontz, Thomas and Craft, Acid-Peroxide Etch Safe, Sure .....	PT76	Oct 2
Anderson, M. E., Magnetic Head Reads Tape at Zero Speed.....	F58	Mar 6
Armstrong, F. E. & Pavelka, Monitoring Radiolotope Tracers in Industry .....	F42	Jun 26
Arnold, J. G., Finding Radio-Frequency Interference Levels.....	F71	Nov 27
Arsem, C., Wideband F-M With Capacitance Diodes .....	F112	Dec 4
Atkin, J., Bickel & Weisa, Realistic Simulation of Radar Clutter.....	F78	Sept 25
Attura, G. M. & Belleville, How Electronics Controls Depth of Anesthesia .....	F43	Jan 30

### B

Baghdady, E. J. & Rubissow, Dynamic Trap Captures Weak F-M Signals .....	F64	Jan 9
Bagno, S. & Liebman, Impedance Measurements of Living Tissue .....	F62	Apr 10
Baker, B. W., Rudin & Shafer, Dual-Cavity Microwave Discriminator .....	CM74	Jan 16
Baker, D. J. & Thomas, Nuclear Thermal Pulse Simulator.....	RD66	Oct 30
Bakes, H. & Smauz, Transistor Time Delay for Industrial Control .....	F74	Sept 25
Baldinger, E. & Czada, Designing Highly Stable Transistor Power Supplies .....	F70	Sept 25
Barker, J., Radar Meter Helps Enforce Traffic Laws.....	F48	Mar 6
Barrett, L. H., New Circuit Improves Stroboscope Versatility .....	F116	Aug 7
Battista, W. P., Roth & Rachlis, Infrared Detector Trains Tank Gunners for Combat.....	F60	Nov 6
Baum, R. F., Sum and Difference Mixer Design Charts.....	ERS67	Dec 11
Bayer, B. P., Radar Booster Charts .....	ERS146	Mar 13

Beach, J. B., Coincidence Diodes Gate Electronic Switch.....	F66	Feb 20
Becker, R. C. & Coleman, Rectangular and Circular Millimeter Waveguides .....	F50	May 1
Beecher, N., Electronic and Mechanical Gages Check High Vacuum .....	F76	Oct 16
Beecher, N., High Vacuum Pumping for Modern Electronic Needs.....	F66	Oct 9
Beggs, J. E., Grattidge, Molenda, Haase & Dickerson, Thermionic Integrated-Micromodules .....	CM80	May 15
Belle, E. C., Smith & Blanchard, Ferrite Memories Simplify Telephone Data Analysis.....	F68	Oct 9
Belleville, J. W. & Attura, How Electronics Controls Depth of Anesthesia .....	F43	Jan 30
Bengston, P. S., Sampling Discriminators For Data Reduction.....	F70	Mar 27
Bennett, R. R., Gleghorn, Hoffman, McLeod & Shibuya, Circuits for Space Probes .....	F55	Jun 19
Beran, C. J., Flexible Conductor Operates to 250 C.....	CM74	Jan 9
Berger, F. B., Doppler Radar Navigation .....	F62	May 8
Bernard, W. B., Tunable F-M Multiplex Adapter for Stereo.....	F66	Apr 10
Berns, K. L. & Bishop, High-Speed Multiplexing With Closed-Ring Counters .....	F48	Jun 26
Biard, J. R. & Matzen, Differential Amplifier Features D-C Stability .....	F60	Jan 16
Bickart, T. A., Amplitude Slicer for Signal Analysis .....	F64	Feb 27
Bickel, H. J., Weiss & Atkin, Realistic Simulation of Radar Clutter .....	F78	Sept 25
Bilinski, J. R. & Merrill, Selecting Transistors for Radiation Environments .....	F38	Dec 25
Bingham, C. R., Temperature Detectors .....	F55	Jul 10
Bishop, B. E. & Berns, High-Speed Multiplexing With Closed-Ring Counters .....	F48	Jun 26
Bittmann, E. E., Using Thin Films in High-Speed Memories.....	F55	Jun 5
Blair, W. L. & Ammerman, Receiver Sensitivity .....	ERS52	Jan 23
Blakeslee, J. H., Strobe Techniques Analyze Complex Mechanical Motion .....	F62	Jun 5
Blanchard, J. W., Belle & Smith, Ferrite Memories Simplify Telephone Data Analysis.....	F68	Oct 9
Blattner, D. J. & Sterzer, Voltage Tunable Millimeter-Wave Oscillators .....	F62	Jun 19
Blattner, D. J. & Vaccaro, Electrostatically Focused Traveling-Wave Tube .....	F46	Jan 2
Blinchikoff, H. & Zverev, Network Transformations for Wave Filter Design .....	F52	Jun 26
Bockemuhl, R. R., Gated Ratio Indicator Aids Engine Research.....	F64	Mar 27
Bockemuhl, R. R., Transistor Rectifier Gives D-C of Either Polarity .....	F76	Jun 19
Boensel, D. W., Computing Transistor Switching Dissipation.....	ERS74	Nov 27
Boensel, D. W., Switching Circuits for Missile Count-Downs.....	F76	Jul 31
Bogart, W. C., Kits Streamline Prototype Tests .....	PT78	Jan 16

Booker, C. A. & Wright, How Analog Networks Solve Air Conditioning Problems.....	F34	Dec 25
Borek, A., Designing a Power Density Meter .....	RD66	Jul 17
Borgman, J., Using Tv Techniques in Astronomy .....	F66	May 8
Bower, C. M., What if Peace Breaks Out? .....	BF32	Jun 5
Brady, M. M., Oscillator Design Using Voltage-Variable Capacitors.....	F38	Aug 21
Bramson, B. M., Starved Transistors Raise D-C Input Resistance.....	F54	Jan 30
Brockman, H. P., Circuit Provides Dual Relay .....	RD62	May 1
Broderick, D., Hartke & Willrodt, Precision Generator for Radar Range Calibration .....	F58	Apr 3
Brodzinsky, A. & Macpherson, Maser Sensitivity Curves .....	ERS70	Feb 20
Brooks, W. O., Stepping Up Frequency With Counter Circuits.....	F60	July 17
Brown, R. S., Tuned Voltmeter Reads Harmonic Amplitude.....	F68	Jan 16
Brumbach, J. F., Fast WWV Check of Frequency Standard.....	RD76	Mar 27
Buchanan, R. W. & Kautz, Dynamic Testing of Computer Building Blocks .....	F66	Aug 14
Burgess, H. F. & Jones, Using Low-Frequency Standard Broadcasts .....	F48	Oct 30
Burrows, W. H. & Hollis, Antenna Measurements .....	ERS76	Jun 5
Burrus, C. S., Versatile F-M Transducer .....	F79	Nov 13
Burwen, R. S., Amplifiers for Strain Gages and Thermocouples.....	F43	Jul 24
Bushor, W. E., Instruments for Design and Production.....	SR89	Sept 11
Bushor, W. E., Picture Flying Arches .....	BF38	Sept 25
Bushor, W. E., Sample Method Displays Millimicrosecond Pulses.....	F69	Jul 31
Bushor, W. E., Carroll & Weber, Highlights of '59 IRE Show .....	F39	May 1
Butler, T. W., Jr., Ferroelectrics Tune Electronic Circuits.....	F52	Jan 16
Butler, T. W., Jr. & Roberts, Voltage-Variable Capacitor Selection Guide .....	F52	Jul 24
Byatt, D. W. G. & Hatch, Direction Finder With Automatic Readout .....	F52	Apr 17

### C

Cameron, D. B. & Lane, Current Integration With Soliton Liquid Diodes .....	BF53	Feb 27
Cameron, E. G., San Francisco's 50-year Story .....	BF28	Aug 14
Camillo, C., Flexible Coaxial Cable Takes 1,000 F.....	CM64	Jun 26
Campbell, J. O. & Liu, Collision Detection Without Range Data.....	RD60	Jul 24
Cap, S. T. & White, Guidance Systems in Manned Space Flight.....	F49	Aug 14
Card, W. H., Four Transistor Inverter Drives Induction Motor.....	F60	Feb 20
Carey, W. M., Using Inductive Control in Computer Circuits.....	F31	Sept 18
Carpenter, H. E. Jr., Schroeder & Looney, Tracking Orbits of Man-Made Moons .....	F33	Jan 2
Carroll, J. M., Looking Ahead in Engineering Charts.....	SR125	Mar 13
Carril, J. M., Recent Developments in Stereo Broadcasting .....	F41	Apr 3

Carroll, J. M., Soviet Equipment Design	F37	Jul 24
Carroll, J. M., Bushor & Weber, Highlights of '59 IRE Show	F39	May 1
Cassidy, M. E. & Sadowski, How Transistor Drives Cold-Cathode Counter	F46	Sept 18
Chadwick, D. G., Simulating Second-Order Equations	RD64	Mar 6
Chait, H. N. & Curry, New Microwave Circulators	F81	Dec 18
Champeny, J. C., Petrikin & Siciliano, Nuclear Bomb Alarm Systems	F63	May 8
Chanock, I. C., Sullivan, Eastman, Using Digital Techniques in Time Encoders	F80	Nov 13
Chao, S. C., Character Displays Using Analog Techniques	F116	Oct 23
Chase, K. H. & Pierzga, Reducing Mutual Radar Interference	F39	Jul 10
Chen, T. C. & Stram, Digital Memory System Keeps Circuits Simple	F130	Mar 13
Clark, C., Checking Jitter in Moving Target Radar	F56	Jul 17
Clarke, W. W. H. & Riley, Deflection Yoke Cores	F59	Mar 20
Clarke, W. W. H. & Riley, Yoke Performance Chart	ERS74	Mar 27
Cohen, A. & Davis, Rigid Radome Design Considerations	CM66	Apr 17
Cohen, L. D. & Noland, BWO Uses Ridge-Loaded Ladder Circuit	CM68	May 1
Cohn, E., How to Choose Precision Fine Wire	CM78	Dec 11
Coleman, P. D. & Becker, Rectangular and Circular Millimeter Waveguides	F50	May 1
Colley, J. L., Jr., Graph Shows Resistor Tolerance for Dividers	RD54	Jan 23
Compton, B. M. & DuCharm, Finding Radar Blind Spots	ERS62	May 22
Compton, B. M. & DuCharm, Radar Tracking Losses	ERS100	May 29
Constock, D., Peterson, Webb & deBey, High Resolution Angle Transducer and Encoder	F78	Oct 16
Cooke, H. E., Transistor Eyeglass Radio	F88	Sept 25
Cooperman, M., Magnetic Demodulators for Color TV	RD56	Jan 2
Cordi, V. A. & Packard, Tracer Displays Zener Curves	RD76	May 8
Corn, J. H., Microwave Measurements	F74	May 8
Cosman, B. J. & Hueter, Instrumentation for Ultrasonic Neurosurgery	F53	May 15
Craft, W. H., Amron, Koontz & Thomas, Acid-Peroxide Etch Safe, Sure	PT76	Oct 2
Cressey, J., Hanel, Stampf, Licht & Rich, Tracking Earth's Weather With Cloud-Cover Satellites	F44	May 1
Croop, E. J. & Vondracek, Inorganic Insulations For High Temperatures	F65	Nov 27
Cross, K. R. & Whitaker, Time-Constant Detectors Control TV Sets	RD62	Sept 4
Crowles, G. J., Automatic Controls for Metal Working Machines	F41	Mar 6
Cuccia, C. L., Voltage Control of Magnetron Frequency	F56	Jul 10
Currie, C. H., Carcinotron Harmonics Boost Receiver Range	F58	Feb 27
Currin, C. G., Selection Guide for Silicone Dielectrics	F64	Apr 10
Curry, J. E., Multi-Waveform Generator	F83	Nov 13
Curry, T. R. & Chait, New Microwave Circulators	F81	Dec 18
Czaja, W. & Baldinger, Designing Highly Stable Transistor Power Supplies	F70	Sept 25

## D

Dale, H. P., Electronic Fishing With Underwater Pulses	F31	Jan 23
Daniel, A. F. & Linden, New Power Sources For Space-Age Electronics	F43	Mar 20
Daniels, H. L. & Sampson, Magnetic Drum Provides Analog Time Delay	F44	Feb 6
Davey, C. T., Goldie & Amicone, Generating Pulses With Solid-State Thyatrons	F70	Aug 14
Davidson, H. S., Leak Holonyak, The Tunnel Diode-Circuits and Applications	F60	Nov 27
Davidson, D. S. & Wade, Transistor Amplifiers for Reactor Control	F52	May 22
Davis, P. & Cohen, Rigid Radome Design Considerations	CM66	Apr 17
Davis, S., Magnetic Amplifiers for Servo Systems	F134	Mar 13
deBey, L. G., Comstock, Peterson & Webb, High Resolution Angle Transducer and Encoder	F78	Oct 16
Delmonte, J., Epoxy Resin Makes Potting Molds	PT53	Dec 25
DeSautels, A. N., Servo Preamplifiers Using Direct-Coupled Transistors	F74	May 15
Dickerson, A. F., Beggs, Grattidge, Molenda & Haase, Thermionic Integrated-Micromodules	CM80	May 15
Dixon, L. H., Jr. & Hangstefer, Triggered Bistable Semiconductor Circuits	ERS58	Aug 28
Dugatch, I., Optimizing Antenna Switches and Phasers	F55	Aug 14

Dome, R. B., Audio Amplifier Design Cuts Plate Dissipation	F72	Apr 10
Dome, R. B., Diode-Compressor Data	ERS74	Feb 27
Dome, R. B., Inexpensive Sound for Television Receivers	F66	Feb 27
Dorgelo, E. G., How Constant-Power Tubes Perform	CM82	June 5
Doty, W. H., Low-Cost Active Radar For Miss-Distance Data	F91	Nov 20
Douglass, H. H. & Higginbotham, Voltage Comparator with High-Speed Switches	F56	Jan 30
Dubner, H., Schwartz & Shapiro, Detecting Low-Level Infrared Energy	F38	Jun 26
DuCharm, F. & Compton, Finding Radar Blind Spots	ERS62	May 22
DuCharm, F. & Compton, Radar Tracking Losses	ERS100	May 29
Dulberger, L. H., Constant-Current Technique Cuts Servo Response Time	F52	Jul 10
Dulberger, L. H., Improved R-C Oscillator	F62	Mar 6
Dunn, G. A. & Hekimian, Tube-Transistor Hybrids Provide Design Economy	F68	Jun 5
Durrett, W. R., Electronic Judging of Fast-Moving Sports Contests	F114	Aug 7
Dye, N. E., Hessler, Knight, Miesch & Papp, Vacuum-Diode Microwave Detection	CM110	Apr 24

## E

Eastman, L., Chanock & Sullivan, Using Digital Techniques in Time Encoders	F80	Nov 13
Edelcreek, G., Recording Attenuation of Waveguide Components	F126	Oct 23
Edwards, R. P., Multiple Junction Rectifiers	F57	Apr 3
Edwards, R. P., Silicon Power Rectifiers	F71	Apr 10
Edwards, R. P., Voltage-Regulator Diodes	F55	Apr 17
Enemark, D., Balloon-Borne Circuits Sort High-Altitude Cosmic Rays	F52	Aug 28
Enemark, D., Transistors Improve Telemeter Transmitter	F136	Mar 13
Engelmann, R. H., Wideband Amplifier Design Data	F48	Feb 6
Enyedy, R. F., Barrel Finishing Delicate Parts	PT84	Feb 27
Erdmann, R. G., Transistor Dual Conversion for Marker-Beacon Receivers	F59	May 8
Essoffery, C. A., New Frontiers for Semiconductors	F43	Jul 17
Esten, P. W., Ganging Transmitters to Overcome Jamming	F68	Nov 27
Eyraud, J. P., Richter, Pilkington, Shipley & Randolph, Instrumenting the Explorer I Satellite	F39	Feb 6

## F

Fallon, J., Technical Reports: A New Look	BF30	Sept 4
Fasching, G. E., Inverse Feedback Stabilizes Dry Cell Current Sources	F78	Oct 9
Faulkner, W. H., Jr., Radioactive Sources	F57	May 22
Feder, D. O. & Koontz, How to Detect Contaminant Traces	PT62	Sept 18
Feldman, L., F-M Tuner Adapter for Multiplexed Stereo	F52	Feb 6
Fierston, S., Alarm Circuit Warns of Faults in Digital Systems	F48	Jul 3
Fink, F. G., A-C Computing Resolvers: Sizes 8, 10 and 11	F52	Mar 20
Fink, F. G., A-C Computing Resolvers: Size 15 Tabulation	F52	Mar 27
Fink, F. G., A-C Computing Resolvers: Sizes 18, 23 and 25	F50	Apr 3
Fink, F. G., A-C Rate Generators	F69	Mar 27
Fink, F. G., Induction Potentiometers	F97	Apr 24
Fischman, M., Transistorized Horizontal Deflection for Television	F60	Aug 14
Forgacs, R. L., Removing the Jitter From Thyatron Pulses	F60	May 15
Fortini, M. M. and Vilms, Solid-State Generator for Microwave Power	F42	Sept 4
Foster, C. C., Logic Networks Aid Psychological Testing	F70	Oct 16
Freedman, A. L., Square-Loop Cores for Logic Circuits	RD70	Jan 9
Frommer, J. C., Fail-Safe Photoelectric Inspection for Industry	F74	Jul 31
Fry, L. D., Taking the Bumps Out of Automatic Flight Control	F106	Aug 7
Fryer, T. B., Frequency Analyzer Uses Two Reference Signals	F56	May 1
Fryer, W. D., How to Design Low-Cost Audio Filters	F68	Apr 10
Fursey, R. A. E., Sealed Contact Reed Relays	F79	Jul 31

## G

Gabor, A., High-Density Recording On Magnetic Tape	F72	Oct 16
Gambin, R. L., Ohmic Heating Circuits For Plasma Physics	F57	Oct 9

Gambin, R. L., Radio-Frequency Circuits for Plasma Physics	F50	Jul 3
Gangi, S., Isbister, Harding & Kirch, Photos Assist Drafting, Assembly	PT78	Jan 9
Gates, H. W. & Gatfield, Scan Converter Aids Phone-Line Radar Relay	F48	Apr 17
Gatfield, A. G. & Gates, Scan Converter Aids Phone-Line Radar Relay	F48	Apr 17
Gayford, M. L., Column Loudspeakers for Public Address Systems	F64	Jun 12
Gehmlich, D. K. & Skinner, Analog Computer Aids Heart Ailment Diagnosis	F56	Oct 2
Gehmlich, D. K., Skinner & Longson, Blood Pressure and Heart Rate Regulator	F38	Jan 2
Gerhard, F. H. & Hochwald, D-C Operational Amplifier With Transistor Chopper	F94	Apr 24
Geyger, W. A., Frequency Control of Magnetic Multivibrators	F54	Jul 24
Geyger, W. A., Multiplying Circuit Uses Magnetic Amplifiers	F58	Jan 9
Giles, C. N., Plastic Blocks Mount Accelerometers	RD70	Jan 16
Gilson, W. E. & Ludwig, Recording Manometer	F41	Dec 25
Gleghorn, G. J., Bennett, Hoffman, McLeod & Shibuya, Circuits for Space Probes	F55	Jun 19
Goetz, M. & Johnson, Can Tube Testing Spot Early Failures	CM64	Jul 24
Goldie, V. W., Amicone & Davey, Generating Pulses With Solid-State Thyatrons	F70	Aug 14
Goodwin, J. K., Digital Tachometer Aids in Turbine Design	F58	Apr 10
Goodwin, J. K., Time and Pulses Control Gates	RD72	Jan 16
Goodwin, J. K., Wien Bridge Forms Rejection Filter	RD58	Jan 2
Gordy, E. & Hasenbusch, Constant-Current-Coupled Transistor Power Supply	F60	Oct 9
Gordy, E., Microphotometer Aids Biologists	RD62	Jul 10
Gould, J. E., Permanent Magnets at Extreme Temperatures	F119	Aug 7
Goulding, F. S., Transistorized Geiger Counter Fits in Probe	F64	Jan 16
Grattidge, W., Beggs, Molenda, Haase & Dickerson, Thermionic Integrated-Micromodules	CM80	May 15
Gray, M. G., Using Silicon Diodes in Radar Modulators	F70	Jun 12
Greefkes, J. A. & Jager, Voice Radio Systems for High Noise Paths	F53	Dec 11
Greenberg, N. S., Determining Range of Radar Beacons	ERS60	Sept 4
Greenwood, T. L., Liquid Level Detectors	F49	Jan 2
Groce, J. C. & Kelso, Encoder Measures Random Event Time Intervals	F48	Mar 20
Guditz, E. A., Connections Plated with Wiring	PT96	Dec 18
Gutley, B. M. & Woodward, Lights Pen Links Computer to Operator	F85	Nov 20
Guterman, A., Fast Switching for Industrial Control	F51	Jun 26
Guttmann, H. E., Miniature Photocell Measures Blood Volume	F122	Sept 11
Guyer, E. M., Arc Method Simplifies Glassworking	PT80	Nov 6

## H

Haagens, D., Compact Memories Have Flexible Capacities	F50	Oct 2
Haakana, C. H., Shunt Bridge Balancing in Strain-Gage Indicators	F50	Jul 24
Haase, A. P., Beggs, Grattidge, Molenda & Dickerson, Thermionic Integrated-Micromodules	CM80	May 15
Hager, C. K., Network Design of Microcircuits	F44	Sept 4
Hall, E. C. & Jansson, 3-D Packaging Reduces Size of Electronic Units	F62	Oct 9
Halpern, J. & Rediker, Millimicrosecond Switching Diodes	F66	Jun 5
Hamm, T. Jr., Equations for Designing Transistor Power Supplies	F122	Oct 23
Hammerslag, J., Circuit Design Using Silicon Capacitors	F48	Sept 18
Hanel, R., Stampf, Cressey, Licht & Rich, Tracking Earth's Weather With Cloud-Cover Satellites	F44	May 1
Hangstefer, J. B. & Dixon, Triggered Bistable Semiconductor	ERS58	Aug 28
Hanks, C. L., Operational and Storage Life of Silicon Rectifiers	F82	Oct 16
Hanson, J., Unconventional Technique for Measuring VSWR	F120	Oct 23
Hardin, C. D. & Salerno, Miniature X-Band Radar Has High Resolution	F48	Jan 30
Harding, R. T., Isbister, Gangi & Kirch, Photos Assist Drafting, Assembly	PT78	Jan 9
Harding, W. B., Jansen & Koch, Pading Rate Recorder for Propagation Research	F78	Dec 18
Harkins, D., F-M Multiplexing Studio-Transmitter Links	F44	May 22
Harnack, W., Mobile Radio System Has 3,000-Mile Range	F44	Aug 28
Harp, M. C., Nonvacuum Devices Control Klystrons	F68	Feb 13

Harris, A. P. & Parrott, What Designers Should Know About Humidity .....	F50	Oct 30	Johnson, R. H. & Goetz, Can Tube Testing Spot Early Failures? .....	CM64	Jul 24	Kronlage, R., Monitoring Multiple Input Simultaneously .....	F50	Aug 28
Harris, H., Electronics Assists Highway Construction .....	F69	Dec 18	Jones, C. I. & Lyman, Electroluminescent Panels for Automatic Displays .....	F44	Jul 10	Kuecken, J. A., How Solar Noise Calibrated Radars .....	F44	Dec 25
Hartke, D., Broderick & Willrodt, Precision Generator for Radar Range Calibration .....	F58	Apr 3	Jones, H. S. & Morlock, Advantages of Using Colled Waveguide .....	CM50	Aug 21	<b>L</b>		
Hasenpusch, P. & Gordy, Constant-Current-Coupled Transistor Power Supply .....	F60	Oct 9	Jones, M. C. & Burgess, Using Low-Frequency Standard Broadcasts .....	F48	Oct 30	Lander, R. F. & Schock, Flight Testing Spacecraft .....	F53	Mar 27
Hashimoto, T., Nishimura, Kikuchi, Mochizuki & Uchida, Fishing Sonar Uses Compact Scan System .....	F54	Apr 3	Junker, W. E., Wax Models Speed Antenna Design .....	RD58	Jun 26	Lane, R. N. & Cameron, Current Integration With Solen Liquid Diodes .....	F53	Feb 27
Hasler, E. F. & Spurr, Ways to Measure Light Intensity at a Distance .....	F48	Jul 17	Jurgen, R. K., Hall-Effect Devices .....	F63	Jan 16	Langberg, E., Hatsopoulos & Welsh, Thermoelectron Engines: Future Power Sources? .....	F69	Nov 13
Hatch, J. F. & Ryatt, Direction Finder With Automatic Readout .....	F52	Apr 17	Jurgen, R. K., Solid-State Panels for Display or Storage .....	F46	Jan 30	Langley, L. W., Saturable-Core Oscillator Integrates Gas-Flow Data .....	F42	Jan 23
Hatsopoulos, G. N., Welsh & Langberg, Thermoelectron Engines: Future Power Sources? .....	F69	Nov 13	Jurgen, R. K., Transistorizing Electronic Equipment .....	SR53	Jul 31	<b>K</b>		
Hawley, O. D. & Kato, Thermal Design Chart .....	ER58	Apr 17	Kallmann, H. P. & Rennett, Data Storage and Display With Polarized Phosphors .....	F39	Aug 23	LaPorte, G. L. & Marcotte, Computer Switching With Semiconductors and Relays .....	F64	Aug 14
Hedges, C. P., Digital Recorder Holds Data After Shock .....	F60	Mar 20	Kalman, J., Silicon Solar Cells .....	F59	Jan 30	Lapray, D. H., Induction Desolders P-C. Board Components .....	PT136	Oct 23
Hekimian, N. C. & Dunn, Tube-Transistor Hybrids Provide Design Economy .....	F68	Jun 5	Kampf, H. A., Increasing Counting System Reliability .....	F112	Sept 11	Latorre, U. R., Transistor Amplifier Design Method .....	RD74	Feb 20
Henderson, R. A., Chart Finds Loaded Q .....	ERS52	Sept 18	Kampf, H. A., Power Supply Design Using Silicon Diodes .....	F60	Oct 2	Lawley, A., Processing Materials With Electron Bombardment .....	F39	Sept 4
Herzog, G. B., Transistors Simplify Control of Target Drone .....	F52	May 1	Kanner, M., How to Reduce Errors in Loaded Potentiometers .....	F34	Aug 21	Lawson, A. E., Jr., Thermistor Data Chart .....	ERS72	Feb 13
Hessler, J., Jr., Dye, Knight, Miesch & Papp, Vacuum-Diode Microwave Detection .....	CM110	Apr 24	Kato, M. & Hawley, Thermal Design Chart .....	ERS58	Apr 17	Leary, F., Communications of the Future .....	F37	Jul 3
Higginbotham, J. W. & Douglass, Voltage Comparator with High-Speed Switches .....	F56	Jan 30	Kaufman, A. B., Soft Solder Conductivity .....	F119	Oct 23	Leary, F., Designing For Reliability .....	SR65	May 29
Hirsch, R. B., How to Design Bandpass Triples .....	F41	Aug 21	Kaufman, A. B., Solders for Nuclear and Space Environments .....	F50	Sept 4	Leary, F., Instruments: Key to Missile Programs .....	F47	Jan 16
Hochwald, W. & Gerhard, D-C Operational Amplifier With Transistor Chopper .....	F94	Apr 24	Kautz, B. & Buchanan, Dynamic Testing of Computer Building Blocks .....	F66	Aug 14	Leary, F., Microwave Computer Circuits .....	F77	Nov 20
Hoell, E. C., Electromagnetic Relay Design Trends .....	CM68	Sept 4	Keeter, R. E. & Strassman, Clock Track Recorder For Memory Drum .....	F74	Oct 9	Leary, F., Researching Microwave Health Hazards .....	E49	Feb 20
Hoesterey, H. F., Materials for Infrared Windows, Domes, Lenses .....	F56	Jan 16	Kiernan, E. F., More Sound from Transistor Amplifier .....	RD72	Jan 9	Lefevre, H. W. & Russell, Vernier Chronotron Times Nuclear Particle Flight .....	F44	Mar 6
Hoff, W. L., Revolving Disks Color Code Wire .....	PT84	Mar 27	Kelser, B. E., Digital-Counter Techniques Increase Doppler Uses .....	F46	May 22	Lerman, M., Radar Detection Data .....	ERS58	May 1
Hoffman, D. & Schutzman, Statistical Analysis of Noise-Signal Amplitudes .....	F48	Jul 24	Kelly, F. G., Transformerless Supplies .....	ERS56	Jun 26	Lesk, I. A., Holonyak & Davidsohn, The Tunnel Diode-Circuits and Applications .....	F60	Nov 27
Hoffman, L. A., Bennett, Gleghorn, McLeod & Shibuya, Circuits for Space Probes .....	F55	Jun 19	Kelso, R. J. & Groce, Encoder Measures Random Event Time Intervals .....	F48	Mar 20	Levi, L., Basic Optical Data for Electronics Engineers .....	F48	Jul 10
Hoffman, T. R., Feedback Design for Transistor Amplifier Stages .....	F52	Aug 14	Kieh, G. B., Intermetallic Rectifiers .....	F69	Jun 12	Levine, D., Electron Flight Velocity .....	ERS58	Jul 24
Hojak, E. P., Automatic Measurement of Transistor Beta .....	F114	Dec 4	Kiesling, P. W., Jr., Portable Multiplexer for Telephone Communications .....	F60	Jan 9	Licht, J., Hanel, Stampf, Cressey & Rich, Tracking Earth's Weather With Cloud-Cover Satellites .....	F44	May 1
Hollis, J. L., Frequency Shifts Improve Pulse Communication .....	F66	Jun 19	Kikuchi, Y., Hashimoto, Nishimura, Mochizuki & Uchida, Fishing Sonar Uses Compact Scan System .....	F54	Apr 3	Liebman, F. M. & Bagno, Impedance Measurements of Living Tissue .....	F62	Apr 10
Hollis, J. L., Sending Digital Data Over Narrow-Band Lines .....	F72	Jun 5	Kilby, J. S., Semiconductor Solid Circuits .....	F110	Aug 7	Lin, H. C. & White, Single-Ended Amplifiers for Class B Operation .....	F86	May 29
Hollis, J. S. & Burrows, Antenna Measurements .....	ERS76	Jun 5	Kilduff, J., Purpuro, Traite & Welkowitz, Environmental Testing of Future Spacemen .....	F65	Oct 16	Linden, D. & Daniel, New Power Sources For Space-Age Electronics .....	F43	Mar 20
Holonyak, N., Jr., Davidsohn & Lesk, The Tunnel Diode-Circuits and Applications .....	F60	Nov 27	King, G. W., Recording, Pupil Changes For Clinical Diagnosis .....	F67	Sept 25	Lindmayer, J. & Zuleeg, Determining Transistor High-Frequency Limits .....	F31	Aug 21
Holtzman, J., Reducing Variations Caused By Power-Supply Variations .....	F54	Jul 17	King, O. B., Multiplexing Techniques for Satellite Applications .....	F58	Oct 30	Liu, S. H. & Mattson, Switching VHF Power With Silicon Diodes .....	F58	Jun 19
Hood, H. C., Technical and Business Growth in the West .....	F103	Aug 7	Kirch, F. J., Isbister, Harding & Gangi, Photos Assist Drafting, Assembly .....	PT78	Jan 9	Liu, Y. J. & Campbell, Collision Detection Without Range Data .....	RD60	Jul 24
Hood, H. C. & Weber, New Components Head Wescon Developments .....	F43	Oct 30	Klein, J. M. & Thomas, How to Construct a Miniature F-M Transmitter .....	F80	Jul 31	Longson, F. W., Skinner & Gehmlich, Blood Pressure and Heart Rate Regulator .....	F38	Jan 2
Hough, P. V. C., Koenig & Williams, Scanner Recognizes Atomic Particle Tracks .....	F53	Mar 27	Knight, A. J., Dye, Hessler, Miesch & Papp, Vacuum-Diode Microwave Detection .....	CM110	Apr 24	Looney, C. H., Jr., Schoeder & Carpenter, Tracking Orbits of Man-made Moons .....	F33	Jan 2
Hoyler, C. N. & Fike, Synthesizing Timbre for Electronic Musical Tones .....	F92	May 29	Koch, J. G., Graphical Analysis of Coupling Networks .....	ERS122	Aug 7	Lucy, R., Crystal Switches Bring Greater Radar Utility .....	F120	Aug 7
Hueter, T. F. & Cosman, Instrumentation for Ultrasonic Neurosurgery .....	F53	May 15	Kosh, J. W., Harding & Jansen, Fading Rate Recorder for Propagation Research .....	F78	Dec 18	Ludwig, H. & Gilson, Recording Manometer .....	F41	Dec 25
Hugenholtz, E. H., Seljak & Towle, Frequency Stepper for Radio Propagation Tests .....	F44	Jan 23	Koenig, J. A., Hough & Williams, Scanner Recognizes Atomic Particle Tracks .....	F58	Mar 27	Luft, W., Taking the Heat Off Semiconductor Devices .....	F53	Jun 12
Hulcher, F. R., Fail-Safe Circuits for Conveyor Systems .....	F60	Jul 10	Koerner H. & Korn, Function Generation With Operational Amplifiers .....	F66	Nov 6	Lyman, R. C. & Jones, Electroluminescent Panels for Automatic Displays .....	F44	Jul 10
<b>I</b>								
Isaacson, S., Electronic Calliper Checks Printed Circuits .....	F44	Jan 2	Kolm, H. H., High Magnetic Fields for Advanced Research .....	F43	Oct 2 59	Lyons, J. F., Jr. & Marsh, Analyzing multipath Delay in Communications Studies .....	F52	Sept 4
Isbister, J. C., Harding, Gangi & Kirch, Photos Assist Drafting Assembly .....	PT78	Jan 9	Koontz, D. E. & Amron, Improve Ultrasonic Wash Methods .....	PT96	Oct 16	<b>Mc</b>		
Ives, R. L., Adding Sener Diodes Stabilizes Pulses .....	RD78	Nov 27	Koontz, D. E. & Feder, How to Detect Contaminant Traces .....	PT62	Sept 18	McDaniel, W. J. & Tanner, Regulating High Voltage With Magnetic Amplifiers .....	F64	Jul 17
Ives, R. L., Fume Sucker Relieves Solder Bench Sneezes .....	PT90	Jan 16	Koontz, D. E., Thomas, Craft & Amron, Acid-Peroxide Etch Safe Sure .....	PT76	Oct 2	McFarlane, H. B., Spark Gaps for Fast High-Voltage Switching .....	F72	Jul 31
Ives, R. L., Timer Allows Warmup Interval .....	RD46	Aug 21	Korin, S. B. & Spencer, Programmed Servo Speeds Short-Run Production .....	F54	Mar 6	McGonagie, W. J., Renken & Myers, Improved Nondestructive Testing by Eddy-Currents .....	F42	Aug 28
Ives, R. L., Timer Made More Linear .....	RD66	Jan 30	Korn, G. A. & Koerner, Function Generation With Operational Amplifiers .....	F66	Nov 6	McLeod, M. G., Bennett, Gleghorn, Hoffman & Shibuya, Circuits for Space Probes .....	F55	Jun 19
<b>J</b>								
Jacke, S. E., Ultrasonic Cleaners .....	F65	Jun 5	Kowallis, O. K., Reliable High-Output Transducer .....	CM68	Aug 28	<b>M</b>		
Janis, H. K., Electronics in Soviet Planning .....	BF34	Nov 27	Kramer, A. S., Cathode-Ray Storage Tubes for Direct Viewing .....	F40	Jan 23	MacDougall, J., Curves Find Value of Chopped Waveforms .....	F46	Dec 25
Janis, H. K., New Security Policy Coming? .....	BF34	Jul 31	Kramer, A. S., Cathode-Ray Storage Tubes for Special Purposes .....	F52	Jan 30	Mackie, W. L., Plastic Microwave Antenna Horns .....	CM80	Feb 27
Jansen, J. J., Koch & Harding, Fading Rate Recorder for Propagation Research .....	F78	Dec 18	Kramer, A. S., Electromechanical Switches for Telemetering Systems .....	F54	Oct 2	Macpherson, A. C. & Brodzinsky, Maser Sensitivity Curves .....	ERS70	Feb 20
Jansson, R. M. & Hall, 3-D Packaging Reduces Size of Electronic Units .....	F62	Oct 9	Kramer, A. S., Electronic Commutators in Multiplex Telemetering .....	F76	Sept 25	Madigan, T. W., Receiver Sensitivity Graph .....	ERS62	Apr 3
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24	Kramer, A. S., Photoemissive Television Camera Tubes .....	F92	Apr 24	Maguire, T., New Microwave Systems Using Low-Noise Devices .....	F27	Aug 21
<b>K</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24	Kranzler, M. M., Commutators for Airborne Multiplex Telemetering .....	F46	Jul 3	Manoogian, H. A., The Challenge of Space .....	SR65	Apr 24
<b>L</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24	Krinlitz, A., Using Magnetic Circuits to Pulse Radar Sets .....	F42	Jul 3	March, F. C., Ferrules Shield Multi-conductor Cable .....	PT98	Sept 25
<b>M</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24	Kroemmelbein, W. F., Radar Test Systems to Shorten Checkout Time .....	F58	Jun 5	Marcotte, R. A. & LaPorte, Computer Switching with Semiconductors and Relays .....	F64	Aug 14
<b>N</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>O</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>P</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>Q</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>R</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>S</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>T</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>U</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>V</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>W</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>X</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>Y</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						
<b>Z</b>								
Johnson, D. W., Automatic Control With Static-Switching Circuits .....	F98	Apr 24						

Marous, T. J., Highly Sensitive Electronic Chopper.....RD66	Oct 2
Maruy, H. O., Selecting a Deflection Yoke.....F58	Dec 11
Mark, M., System Cooling Methods.....F69	May 15
Marker, T. F., Clock Source for Electronic Counters.....F76	Apr 10
Markow, E. W., Servo Phase Control Shapes Antenna Pattern.....F50	Jan 2
Markus, J., Heat Expansion of Materials.....F95	May 29
Maruden, C. P., Ceramic Wafer Tubes for Modular Units.....CM94	Sept 25
Marsh, H. S. & Lyons, Analyzing Multipath Delay in Communications Studies.....F52	Sept 4
Martin, E. J., Jr., Calibrated Source of Millimicrosecond Pulses.....F56	Apr 17
Mason, J. E., Defense: What Lies Ahead.....RF46	Oct 16
Mason, J. E., Germ-Gas Electronic Detectors Needed.....BF35	Dec 4
Mattson, R. H. & Lin, Switching VHF Power With Silicon Diodes.....F58	Jun 19
Matzen, W. T. & Biard, Differential Amplifier Features D-C Stability.....F60	Jan 16
Meads, S. K., How to Design Pulsed Distributed Amplifiers.....F56	Mar 20
Mercurio, J. F., Jr., Stable, Low-Cost One-Mc Oscillator.....F50	Feb 6
Merrill, R. & Bilinski, Selecting Transistors for Radiation Environments.....F38	Dec 25
Meth, M., Locked Oscillator for Color Tv.....RD90	Sept 25
Meth, M., Tv Sound Detector Uses Drift Transistor.....F62	Feb 20
Miesch, R. A., Dye, Hessler, Knight & Papp, Vacuum-Diode Microwave Detection.....CM110	Apr 24
Millis, E. G., Punched Cards Sort Transistors.....PT134	Aug 7
Minow, D. E., Timed-Signal-Generator With Flexible Output.....F52	Mar 6
Minton, R., Designing High-Quality A-F Transistor Amplifiers.....F60	Jun 12
Mochizuki, K., Hashimoto, Nishimura, Kikuchi & Uchida, Fishing Sonar Uses Compact Scan System.....F54	Apr 3
Moffat, D., Amplifier Design Charts.....ERS102	Apr 24
Molenda, P. J., Beggs, Grattidge, Haase & Dickerson, Thermionic Integrated-Micromodules.....CM90	May 15
Moriarty, T. H., Resonant Ring Duplexing in Forward Scatter Systems.....F54	Jul 3
Morlock, H. K. & Jones, Advantages of Using Coiled Waveguide.....CM50	Aug 21
Mosinski, W., Transistor Voltmeter Is Accurate, Linear.....RD56	Jan 23
Murphy, E. B., Electroforming of Intricate Electronic Components.....F114	Sept 11
Myers, R. G., McGonnagle & Renken, Improved Nondestructive Testing by Eddy-Currents.....F42	Aug 28

**N**

Nadir, M. T., Microsecond Sampler Handles 126 Channels.....F36	Jan 23
Neumann, L., Transistorized Generator for Pulse Circuit Design.....F47	Apr 3
Nisbet, T. R., Double-Integrator Finds Distance.....RD84	May 22
Nishimura, M., Hashimoto, Kikuchi, Mochizuki & Uchida, Fishing Sonar Uses Compact Scan System.....F54	Apr 3
Noland, J. A. & Cohen, BWO Uses Ridge-Loaded-Ladder Circuit.....CM66	May 1
Norquist, R. G., Testing High-Speed Digital Computer Circuits.....F50	Jul 17
Norwalk, T. P., Typical High-Power Silicon Transistors.....F76	Dec 18
Nutting, W. & Wasserman, Solid-State Digital Code-to-Code Converter.....F60	Dec 11

**O**

Oberg, E. A., Pasteups Speed Circuit Drafting.....PT74	Apr 3
Olson, G. O., Design of High-Frequency Clock Pulse Generators.....F56	Aug 28
Olt, R. D., Synthetic Sapphires for Electronic Components.....F110	Dec 4
Osborne, W. E., Infrared Detector Controls Automobile Brakes.....F86	Oct 16
Osborne, W. E., Infrared Communications Receiver for Space Vehicles.....F38	Sept 18
Owen Harries, J. H., Tube Exhaust Methods Use Simple Gear.....RD78	Jun 19

**P**

Packard, C. C. & Cordi, Tracer Displays Zener Curves.....RD76	May 8
Palmiter, R. B., Digital System Positions Shafts Over Phone Line.....F62	Feb 13
Papp, G., Dye, Hessler, Knight & Miesch, Vacuum-Diode Microwave Detection.....CM110	Apr 24

Parrott, E. W. & Harris, What Designers Should Know About Humidity.....F50	Oct 30
Paterson, S. F., Wheels Make Spray-Coating Easy.....PT64	Jan 2
Paterson, W. L., Chart Gives Thermal Changes.....RD128	Oct 23
Pavelka, E. A. & Armstrong, Monitoring Radioisotope Tracers in Industry.....F42	Jun 26
Paz, H. J., Low-Distortion Transistor Monitor Amplifier.....F118	Sept 11
Pearlman, A. R., Pegboard Makes Prototype P-C Card.....PT74	Mar 20
Pearlman, J., How to Cut Engineering Costs.....BF24	Apr 3
Perugini, M. M., Communications Featured at AIEE Fall Meeting.....F	Dec 18
Perugini, M. M. & Solomon, New Developments Revealed at NEC.....F101	Dec 4
Peterson, S. B., Webb, deBey & Comstock, High Resolution Angle Transducer and Encoder.....F78	Oct 16
Petriken, T. E., Champeny, Siciliano, Nuclear Bomb Alarm Systems.....F53	May 8
Pfund, E. T., Jr., High-Temperature Cable.....F69	May 8
Phillips-Smith, R. F., Airport Radar Has High Resolution.....RD64	Apr 3
Pick, T. S. & Readman, Photoelectric Scanners Control Bus Traffic.....F50	Jul 10
Pierzga, J. L. & Chase, Reducing Mutual Radar Interference.....F39	Jul 10
Pike, W. S. & Hoyler, Synthesizing Timbre for Electronic Musical Tones.....F92	May 29
Pilkington, W., Richter, Eyraud, Shipley & Randolph, Instrumenting the Explorer I Satellite.....F39	Feb 6
Planck, R. A., Set Tests 18 Transistor Values.....PT80	Aug 14
Pocock, W. E., Aluminum Finishes for Use in Electronics.....F58	Feb 20
Pomerantz, M., R-F Cables and Connectors for Military.....F42	Dec 25
Ponne, C. W. & Suhr, How Robot Voices Vector Fighter Pilots.....F47	Jan 9
Porter, J. H., Pulse Sorting With Transistors and Ferrites.....F64	May 15
Pruitt, M., Ferroelectric Crystals for Switching Applications.....F58	Aug 14
Pullman, J. O., Microwave Antenna Saves Space.....RD54	Sept 18
Purnuro, C., Traite, Welkowitz & Kilduff, Environmental Testing of Future Spacemen.....F65	Oct 16
Pye, T. R., Design of Transistor Power Converters.....F56	Sept 4

**R**

Rachlig, R., Battista & Roth, Infrared Detector Trains Tank Gunners for Combat.....F60	Nov 6
Ramos, H. R. & Reich, Correlation Devices Detect Weak Signals.....F58	May 22
Randolph, L. W., Richter, Pilkington, Eyraud & Shipley, Instrumenting the Explorer I Satellite.....F39	Feb 6
Readman, A. & Pick, Photoelectric Scanners Control Bus Traffic.....F50	Jul 10
Rediker, R. H. & Halpern, Millimicrosecond Switching Diodes.....F66	Jun 5
Redmann, J. J. & Williams, New Figure of Merit For Finding Improved Range.....ERS94	Nov 20
Reece, J. M., Subaudio Tunable Amplifier.....RD72	Nov 6
Reich, A. B. & Renner, Correlation Devices Detect Weak Signals.....F58	May 22
Renken, C. J., Myers & McGonnagle, Improved Nondestructive Testing by Eddy-Currents.....F42	Aug 28
Renner, J. & Kallmann, Data Storage and Display With Polarized Phosphors.....F39	Aug 28
Reynolds, A. J., How Good is USF3 Test Gear?.....F27	Aug 28
Rich, E. J., Hanel, Stampf, Cresney & Licht, Tracking Earth's Weather With Cloud-Cover Satellites.....F44	May 1
Rich, S. R., Transducer Offers Improved Design.....CM90	Jul 31
Richter, H. L., Jr., Pilkington, Eyraud, Shipley & Randolph, Instrumenting the Explorer I Satellite.....F39	Feb 6
Riley, D. F., Thyatron Has Ceramic Envelope.....CM154	Mar 13
Riley, T. A. & Clarke, Deflection Yoke Cores.....F59	Mar 20
Riley, T. A. & Clarke, Yoke Performance Chart.....ERS74	Mar 27
Roberts, G. A. & Butler, Jr., Voltage-Variable Capacitor Selection Guide.....F52	Jul 24
Roberts, H., How Rings Aid Design.....F38	Nov 20
Robinette, S. L., Pre-receiver Attenuator Reduces Intermodulation.....F64	Nov 6
Rogers, L. J., Sensitive Transducers Use One-Tube Crystal Oscillator.....F48	Oct 2
Rosenthal, A. S., Electronic Surveying.....F113	Oct 23
Rosenthal, A. S., New Standards for Laminated Plastics.....F48	Aug 28
Roth, I., Rachlig & Battista, Infrared Detector Trains Tank Gunners for Combat.....F60	Nov 6

Rubissow, G. J. & Baghdady, Dynamic Trap Captures Weak F-M Signals.....F64	Jan 9
Rudin, M., Shafer & Baker, Dual-Cavity Microwave Discriminator.....CM74	Jan 16
Russell, J. T. & Lefevre, Vernier Chronotron Times Nuclear Particle Flight.....F44	Mar 6
Ryer, W. H. & Sheehan, Special Circuits for Transistor Receivers.....F56	Jan 9

**S**

Sadowski, H. & Cassidy, How Transistor Drives Cold-Cathode Counter.....F46	Sept 18
Salerno, J. & Hardin, Miniature X-Band Radar Has High Resolution.....F48	Jan 30
Salonimer, D. J., Unusual Applications for Conventional Synchros.....F84	Sept 25
Sampson, D. K. & Daniels, Magnetic Drum Provides Analog Time Delay.....F44	Feb 6
Sandretto, P. C., Navigating by Electronics.....F112	Aug 7
Sands, L. G., Citizens Radio Revision Spurs Equipment Design.....F55	Apr 10
Sands, L. G., Design Trends in Mobile Radio Repeaters.....F82	Nov 20
Sands, L. G., Electrons Aid Food Storage.....BF47	Oct 9
Santilli, R. A. & Wheatley, Transistorizing Automobile Broadcast Receivers.....F42	Sept 18
Saunders, W. F. III, Easing Transistor Loads.....F68	Jan 9
Savage, D. W. & Shaum, Joy-Stick Control Aids Telescope Tracking.....F87	Apr 24
Schimpf, L. G., Carrier Transmission for Closed-Circuit Television.....F66	Jun 12
Schmid, H., Function Generator for Sines or Cosines.....F48	Jan 23
Schock, R. & Lander, Flight Testing Spacecraft.....F53	Mar 27
Schoen, S., Transistors Provide Computer Clock Signals.....F70	Feb 27
Schroeder, C. A., Looney & Center, Tracking Orbits of Man-made Moons.....F33	Jan 2
Schroeder, J. O., Holding Video Level While Switching Studios.....F96	May 29
Schutzman, E. & Hoffman, Statistical Analysis of Noise-Signal Amplitudes.....F48	Jul 24
Schwartz, J., Dubner & Shapiro, Detecting Low-Level Infrared Energy.....F38	Jun 26
Schwarzlander, H., Intelligibility Evaluation of Voice Communications.....F88	May 29
Seegmiller, W. R., Controlled Rectifiers Drive A-C and D-C Motors.....F73	Nov 13
Seljak, A., Hugenholtz & Towle, Frequency Stepper for Radio Propagation Tests.....F44	Jan 23
Sell, J., Wire Shielding Values.....ERS88	Nov 13
Senior, D. A., Temperature Control for Hot Rollers in Industry.....F40	Jul 24
Shafer, R. C., Mechanized Transistor Assembly.....PT32	Sept 11
Shafer, R. E., Rudin & Baker, Dual-Cavity Microwave Discriminator.....CM74	Jan 16
Shah, R., European Developments in Transistor Circuits.....F41	May 22
Shapiro, S., Dubner & Schwartz, Detecting Low-Level Infrared Energy.....F38	Jun 26
Shaum, R. L. & Savage, Joy-Stick Control Aids Telescope Tracking.....F87	Apr 24
Sheehan, W. E. & Ryer, Special Circuits for Transistor Receivers.....F56	Jan 9
Shepard, H., How To Impress Financial Men.....BF26	Jul 17
Shibuya, Y., Bennett, Gleghorn, Hoffman & McLeod, Circuits for Space Probes.....F55	June 19
Shipley, W. S., Richter, Pilkington, Eyraud & Randolph, Instrumenting the Explorer I Satellite.....F39	Feb 6
Siciliano, S., Champeny & Petriken, Nuclear Bomb Alarm Systems.....F53	May 8
Sideris, G., D-C to A-C Modulators.....F47	Jan 23
Sideris, G., Electronics Production Methods for Modernization.....F49	Nov 6
Sideris, G., Hard Magnets for 500 C.....F63	Jan 9
Sideris, G., Iron Powders for Cores.....F141	Mar 13
Sideris, G., Laminated Core Sizes.....F55	May 1
Sideris, G., Materials for Environmental Extremes.....SR81	Dec 4
Sideris, G., Micromodule Components.....F51	May 22
Sideris, G., Micromodule Components for Military Application.....F62	May 15
Sideris, G., Paper Capacitor Ratings.....F53	Jul 3
Sideris, G., Powdered Magnets.....F69	Feb 27
Sideris, G., Resistances of Dry Cells.....F65	Feb 20

Sideris, G., Soft Magnets for Amplifiers.....F55	Feb 6		
Sideris, G., Special-Purpose Magnet Wire Insulation.....F60	Feb 13		
Sideris, G., Tailor-Made Ferrites.....F67	Feb 13		
Sideris, G., Tape and Film Insulation for Electronic Equipment.....F42	Jan 2		
Sideris, G., What the Military Expects From Future Components.....F52	Jul 17		
Silverberg, B., Function Generator for Radar Simulator.....F52	Jan 9		
Simonsen, O., Impedance Transfer Ring.....ERS82	Jul 31		
Sion, E., Waveguide Data Charts.....F60	Feb 6		
Skinner, R. L. & Gehmlich, Analog Computer Aids Heart Ailment Diagnosis.....F56	Oct 2		
Skinner, R. L., Gehmlich & Longson, Blood Pressure and Heart Rate Regulator.....F38	Jan 2		
Skinner, R. L. & Trump, Simple Heart Pacer Is Highly Reliable.....RD92	Sept 25		
Sklar, B., Reducing Distortion in Class-B Amplifiers.....F54	May 22		
Sklar, B., The Tunnel Diode—Its Action and Properties.....F54	Nov 6		
Skully, J. B., Yaffee & Smith, Mobile Radar Pinpoints Enemy Mortar Positions.....F34	Sept 18		
Smith, D. O., Thin Magnetic Films for Digital Computer Memories.....F44	Jun 26		
Smith, F. P., Transistorized Receiver for Marker Beacon Use.....F76	Nov 13		
Smith, J., Blanchard & Belle, Ferrite Memories Simplify Telephone Data Analysis.....F68	Oct 9		
Smith, W. F., Skully & Yaffee, Mobile Radar Pinpoints Enemy Mortar Positions.....F34	Sept 18		
Sohlberg, E. T., Simplified Method for Harmonic Analysis.....ERS84	Dec 18		
Soisson, H., Electronic Instruments in Nuclear Power Reactors.....F62	Jun 12		
Sokol, B., Glass Cloth, Resin Form Big Dish.....PT76	May 22		
Solomon, L., Stereophonic TV Sound.....F64	Oct 30		
Solomon, L., Survey of Japanese Electronic Devices.....F109	Sept 11		
Solomon, L. & Perugini, New Developments Revealed at NEC.....F101	Dec 4		
Sommerfeld, E. H., Magnetic Core Operates Counter.....RD130	Oct 23		
Southworth, G., Outline Generator for Educational Television.....F52	Apr 3		
Spencer, F. B. & Korin, Programmed Servo Speeds Short-Run Production.....F54	Mar 6		
Spurr, G. & Hasler, Ways to Measure Light Intensity at a Distance.....F48	Jul 17		
Stamppf, R. A., Hanel, Cressey, Licht & Rich, Tracking Earth's Weather With Cloud-Cover Satellites.....F44	May 1		
Stata, R., Microwave Power Detectors.....F59	Jul 17		
Steele, K. A., High-Frequency Microwave Generator.....CM106	Nov 20		
Stenerson, K., Transistor Circuits for Power-Line Carrier.....F70	May 15		
Stephens, F. H., Jr., Underwater Telemeter For Trawl Fishing.....F66	Mar 27		
Sterzer, F. & Blattner, Voltage Tunable Millimeter-Wave Oscillators.....F62	Jun 19		
Stevens, J. A., Finishes for Magnesium Electronic Components.....F58	Nov 6		
Stevens, R. T., Distributed Amplifiers for Wideband Applications.....F64	Jun 19		
Stewart, J. F., Tube Parts Welded Semiautomatically.....PT38	Oct 9		
Stiebel, A., High-Speed Switching of Low Level Signals.....F54	Mar 20		
Stockton, R. F., III & Weinberg, Sales-Order System Pays Off.....BF54	Aug 7		
Stone, H. A., Jr., Theory and Use of Field-Effect Tetrodes.....F66	May 15		
Stram, O. B. & Chen, Digital Memory System Keeps Circuits Simple.....F130	Mar 13		
Strassman, A. J. & Keeter, Clock Track Recorder For Memory Drum.....F74	Oct 9		
Suhr, P. J. & Poppe, How Robot Voices Vector Fighter Pilots.....F47	Jan 9		
Sullivan, R. J., Eastman & Chanock, Using Digital Techniques in Time Encoders.....F80	Nov 13		
Sulmer, F. V., Accelerometers Effect Vertical Gyro Output.....RD64	Jul 10		
Sutherland, J. W., Waveguide Switch Types.....F71	Jun 5		
Sweeney, H. E., Compatible Stereo Radio Using A-M/F-M Multiplex.....F56	May 8		
Sylvan, T. P., Solid-State Thyatrons Available Today.....F50	Mar 6		
Sylvan, T. P., Two-Terminal Solid-State Switches.....F62	Feb 27		
Szmauz, L. & Bakes, Transistor Time Delay for Industrial Control.....F74	Sept 25		
<b>T</b>			
Tanner, T. L. & McDaniel, Regulating High Voltage With Magnetic Amplifiers.....F64	Jul 17		
Teltscher, E. & Weisman, Telemetry Demodulator Using Modified AND Gate.....F54	Feb 20		
Thiele, A. P., Circuit Design Using Magnetostrictive Filters.....F72	Jun 19		
Thomas, C. O., Craft, Amron & Koonz, Acid-Peroxide Etch Safe, Sure.....PT76	Oct 2		
Thomas, D. E. & Baker, Nuclear Thermal Pulse Simulator.....RD66	Oct 30		
Thomas, D. E. & Klein, How to Construct a Miniature F-M Transmitter.....F80	Jul 31		
Thompson, N. J., Detector Pin-Points Magnetic Tape Flaws.....F50	Jan 9		
Tink, E. M., Transistorizing 16-Mm. Tv Remote Film Camera.....F58	Jan 16		
Toohig, M. P., Storage CRT Has Symmetrical Guns.....CM60	Jan 2		
Towle, A., Hugenholz & Seljak, Frequency Stepper for Radio Propagation Tests.....F44	Jan 23		
Traite, M., Welkowitz, Kilduff & Purpuro, Environmental Testing of Future Spacemen.....F65	Oct 16		
Trump, L. D. & Skinner, Simple Heart Pacer Is Highly Reliable.....RD92	Sept 25		
Tulchin, H., UHF Transistor Data.....F57	Mar 6		
Turner, G. I., Measuring Transistor Force.....F54	Jan 2		
<b>U</b>			
Uchida, R., Hashimoto, Nishimura, Kikuchi & Mochizuki, Fishing Sonar Uses Compact Scan System.....F54	Apr 3		
Unterberger, R. R., Microwave Spectrometer Tests Electron Resonance.....F142	Mar 13		
<b>V</b>			
Vaccaro, F. E. & Blattner, Electrostatically Focused Traveling-Wave Tube.....F46	Jan 2		
van der Horst, H. L., How Radar Techniques Improve Induction Heating.....F51	Feb 13		
Vanderschmidt, G. F., Using Isotopes to Measure Low Pressures.....F60	Jun 19		
Vaughan, H. W., Solving Production Problems.....BF24	Apr 17		
Veazie, C. E., Transistorized Radar Sweep Circuits Using Low Power.....F46	Jun 26		
Vilms, J. & Fortini, Solid-State Generator for Microwave Power.....F42	Sept 4		
Vojinovic, M. M., Series Diode Increases Multivibrator Sensitivity.....F90	Apr 24		
Vondracek, C. H. & Croop, Inorganic Insulations For High Temperatures.....F65	Nov 27		
Von Urff, C. A. & Ahrons, How to Generate Accurate Sawtooth and Pulse Waves.....F64	Dec 11		
Vrataric, F., Jr., Electronic Switching in Phase Measurement.....F60	Jun 5		
<b>W</b>			
Wade, E. J. & Davidson, Transistor Transistor Amplifiers for Reactor Control.....F52	May 22		
Wade, G. & Watkins, TWT's and Paramps for Low-Noise Reception.....F106	Dec 4		
Wall, R. A., Radar Jamming Chart.....ERS116	Dec 4		
Wall, R. A., Radar's Running Rabbits.....ERS58	Jul 3		
Wallmark, J. T. & Marcus, Semiconductor Devices for Microminiaturization.....F35	Jun 26		
Walsh, D., Improving Microwave Tube Efficiency.....CM70	Jul 17		
Waring, J., How to Design Reflexed Transistor Receivers.....F70	May 8		
Wasserman, R. & Nutting, Solid-State Digital Code-to-Code Converter.....F60	Dec 11		
Watkins, D. A., More R for Defense R&D.....BF32	Jun 19		
Watkins, D. A. & Wade, TWT's and Paramps for Low-Noise Reception.....F106	Dec 4		
Webb, R. C., deBey, Comstock & Peterson, High Resolution Angle Transducer and Encoder.....F78	Oct 16		
Weber, H. J., Binary Circuits Count Backwards or Forwards.....F82	Sept 25		
Weber, S., Modern Communications Methods.....SR93	Oct 23		
Weber, S., New Solid-State Devices and Applications.....F39	Apr 17		
Weber, S., New Transistor Works at Cryogenic Temperatures.....F34	Jan 23		
Weber, S., Carroll & Bushor, Highlights of '59 IRE Show.....F39	May 1		
Weber, S. & Hood, New Components Head Wescon Developments.....F43	Oct 30		
Weinberg, H. L. & Stockton, III, Sales Order System Pays Off.....BF54	Aug 7		
Weinstein, A. L., Long Wavelength Infrared Detector Cooling Systems.....F36	Aug 21		
Weisman, L. & Teltscher, Telemetry Demodulator Using Modified AND Gate.....F54	Feb 20		
Weiss, M., Atkin & Bickel, Realistic Simulation of Radar Clutter.....F78	Sept 25		
Welkowitz, W., Kilduff, Purpuro & Traite, Environmental Testing of Future Spacemen.....F65	Oct 16		
Welsh, J., Langberg & Hatsopoulos, Thermoelectron Engines: Future Power Sources?.....F69	Nov 13		
Werb, J. A., Jr., Zero-Crossing Technique Syncs Wave Train Outputs.....F64	May 8		
West, R. E., High-Speed Readout for Data Processing.....F83	May 29		
Whately, W. W., Blocking Oscillator for Ten-to-One Synchronization.....F58	Nov 27		
Wheatley, C. F. & Santilli, Transistoring Automobile Broadcast Receivers.....F42	Sept 18		
Whitaker, R. O. & Cross, Time-Constant Detectors Control Tv Sets.....RD62	Sept 4		
White, B. H. & Lin, Single-Ended Amplifiers for Class B Operation.....F86	May 29		
White, N. P. & Cap, Guidance Systems in Manned Space Flight.....F49	Aug 14		
White, R. L., Forming Handwritten-Like Digits on CRT Display.....F138	Mar 13		
Whitehead, C. C., How Magnetic Amplifier Controls Transconductance.....F85	Nov 13		
Whitlow, G. A., VHF Intrusion Alarm Is Self-Adjusting.....RD62	Aug 28		
Wienczek, Z., Automatic Controls for Color Television.....F58	May 15		
Wilkinson, E. J., Power Divider Splits Signal N-Ways.....CM64	Jul 3		
Wilkinson, E. J., Slot Antenna Array for Missiles and Aircraft.....F56	Feb 27		
Williams, C. S. & Redmann, New Figure of Merit For Finding Infrared Range.....ERS94	Nov 20		
Williams, W., Hough & Koenig, Scanner Recognizes Atomic Particle Tracks.....F58	Mar 27		
Willrodt, M., Broderick & Hartke, Precision Generator for Radar Range Calibration.....F53	Apr 3		
Wilson, E. F., Using Divider Vernier to Synchronize Pulses.....F44	Jul 3		
Windsor, A. A., Passive Elements Form Time Delay.....RD70	Jan 16		
Wolff, M. F., How Radiation Affects Semiconductor Devices.....F55	Nov 27		
Wolff, M. F., Latest Trends in Electron Devices.....F31	Dec 25		
Woo, W. D., Tape Recording System Speeds Data Processing.....F56	Feb 6		
Wood, P. W., Transistorized F-M Oscillator.....F64	Jan 30		
Woodward, C. E. & Gurley, Light-Pen Links Computer to Operator.....F85	Nov 20		
Worcester, J. A., One-Transistor "Push-Pull".....F74	Jun 12		
Wright, D. A., Thermoelectric Properties of Semiconductors.....F70	Jun 19		
Wright, W. L. & Booker, How Analog Networks Solve Air Conditioning Problems.....F34	Dec 25		
<b>Y</b>			
Yaffee, M. S., Smith & Skully, Mobile Radar Pinpoints Enemy Mortar Positions.....F34	Sept 18		
Yeh, L. P., Loop Controls Scatter Power to Offset Fading.....F60	Jan 30		
<b>Z</b>			
Zarleng, S. A., Static Switching Techniques For Machine-Tool Safety.....F57	Jun 12		
Zuk, P., Ultrasonic Grinder Forms Mesa Diodes.....PT112	May 29		
Zukerman, I., Slotted Line for 100 Mc.....F64	Mar 20		
Zuleeg, R. & Lindmayer, Determining Transistor High-Frequency Limits.....F31	Aug 21		
Zverev, A. & Blinichikov, Network Transformations for Wave Filter Design.....F52	Jun 26		

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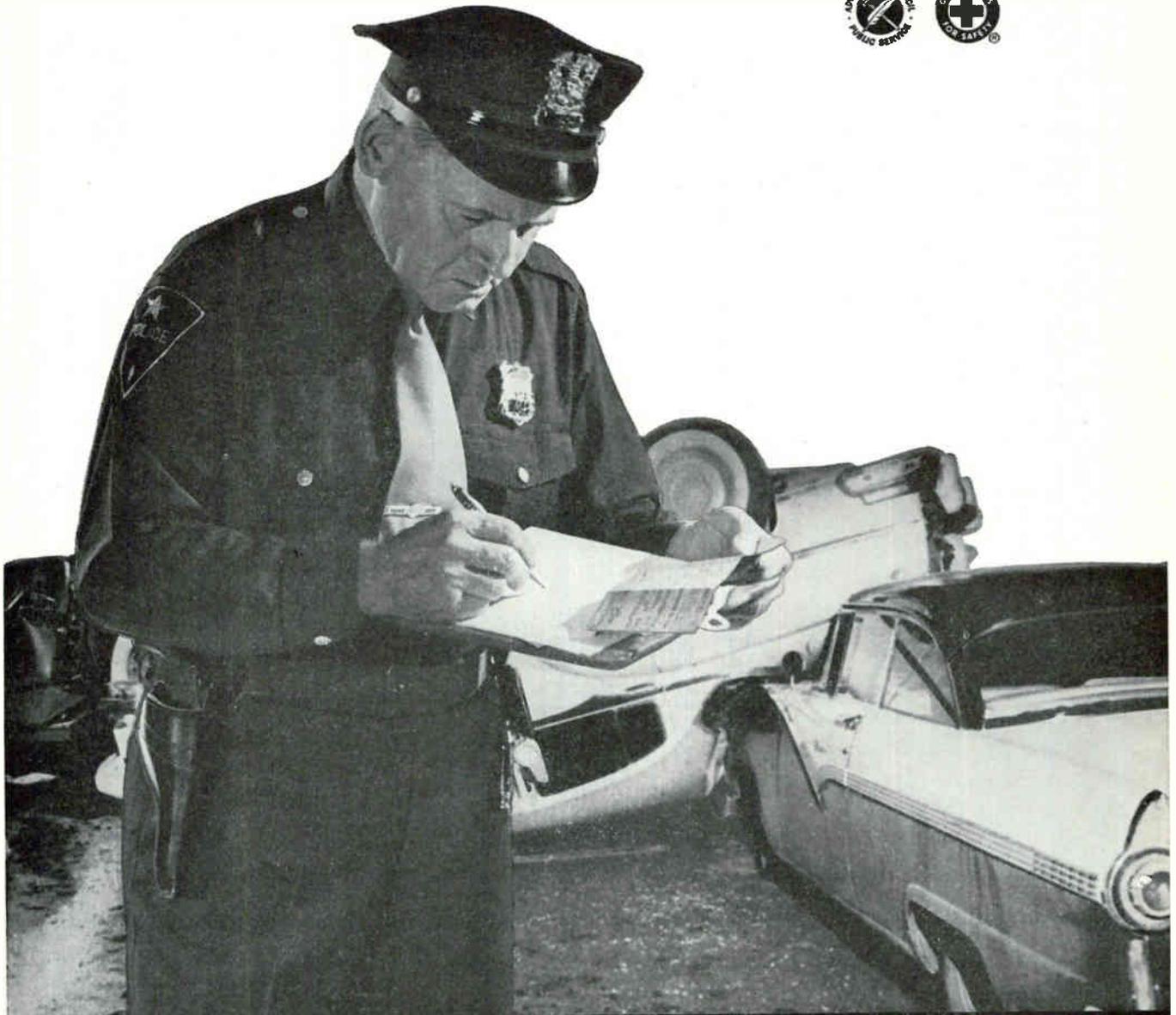
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## Hoffman Opens New Facility

HOFFMAN ELECTRONICS CORP. recently opened a new \$2-million Semiconductor Center, a facility engaged in advanced research and production of solid-state devices, in El Monte, Calif. The 109,000-sq-ft plant is also designed to mass produce solar cells.

H. Leslie Hoffman, president, told industrial, military and scientific leaders attending the dedication ceremony that the center was designed to meet the nation's growing requirements for electrical power generators in space vehicles, including manned "platforms".

All Advanced Research and Development Group personnel have been transferred to El Monte from the Semiconductor division's Evanston, Ill., facilities. This will provide needed space in Evanston for expanded production of rectifiers and regulating devices.

Also transferred from Evanston were the division's administrative and marketing staffs.

Hoffman said completion of the new center more than doubles the division's production capacity and increases its annual sales potential to approximately \$35 million.

The El Monte and Evanston plants, totaling 185,000 sq ft, will employ approximately 2,000 persons when operating at capacity. Hoffman noted that when the company marketed its first semiconductor device seven years ago, the facility covered 5,000 sq ft and had 35 employees.

Since 1953, the division has produced more than 10 million silicon semiconductor devices.



## GI Subsidiary Names Exec-VP

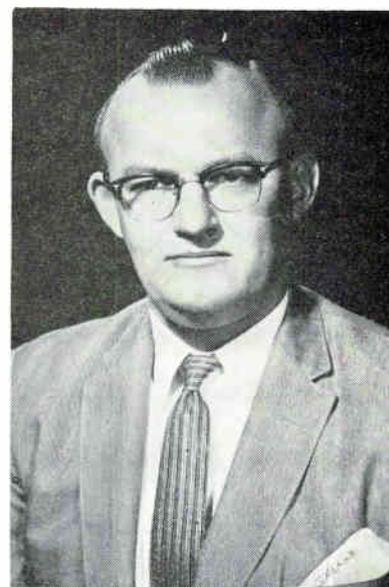
REAR ADMIRAL Richard S. Mandelkorn (USN, Ret.), who has held a number of the Navy's highest engineering-scientific posts, has joined General Instrument Corp. as executive vice president of its Harris Transducer Corp. subsidiary.

Harris Transducer, a key unit in General Instrument's six-plant Defense and Engineering Products Group, develops and produces electronic-acoustical devices in the sonar and antisubmarine warfare fields.

Admiral Mandelkorn, who will

make his headquarters at the Harris Transducer Woodbury, Conn., plant, will be in complete charge of operations and planning there, under direction of Wilbur T. Harris, president of the GI subsidiary.

Immediately prior to joining General Instrument, Mandelkorn had been operations manager and director of planning for Philco Corporation's Lansdale Tube Division since 1957, when he retired from the Navy.



## Wershey Takes New Position

EDWARD J. WERSHEY has been appointed chief engineer and general manager of Electro-Capacitors Co., Oakland, Calif., manufacturer of electrolytic capacitors. He comes to his new position after 14 years with Aerovox Corp., where he was chief engineer of the electrolytic division.

## Name Goldberg Section Head

BERNARD M. GORDON, president of Epsco, Inc., Cambridge, Mass., announces the appointment of Harold S. Goldberg as section head of systems engineering.

Prior to joining Epsco, Goldberg was chief engineer at Consolidated Avionics where he organized, directed and expanded an electronic engineering department.

# Jack Carroll

Managing Editor, *electronics*  
Holds Partial Staff Meeting



## Resumé:

Carroll, John M., (seated in photo) Lehigh University, BS, Hofstra College, MA in Physics, member several I.R.E. committees. Naval electronics, World War II. Electronics engineering officer during Korean war. Background in engineering derives from experience with the National Bureau of Standards, Naval Research Laboratories, Liberty Aircraft, American Instrument Co. Author of technical books for McGraw-Hill Book Company.

## Present Occupation:

Jack Carroll is responsible for "getting-out-the-book" each week within the framework of editorial policy formed by W. W. MacDonald, Editor of *electronics*. Jack is occupied with editorial makeup, with the accuracy of editorial content, with scheduling the workload of a 26-editor staff to provide maximum coverage of technical developments and business information.

## References:

Jack is a dedicated man—dedicated to the interests of the readers of *electronics* magazine. His prime goal is to help edit a publication which will be required reading for the important people in the electronics industry—a publication that will fill the needs of design-research, production, management. If you are not receiving the publication that is edited to keep you best informed, if you are not a subscriber, or if your subscription is expiring, fill in the box on the Reader Service Card. Easy to use. Postage is free.

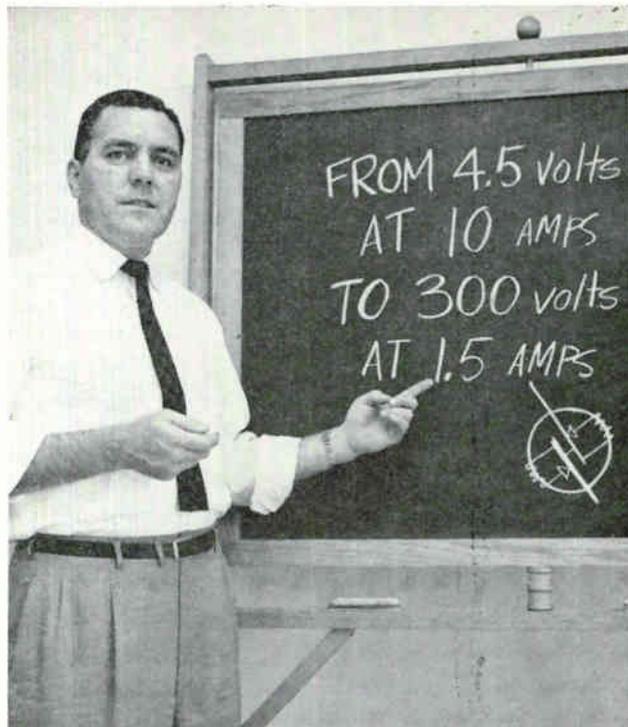


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## COMMENT

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ALBERT CROISSANT  
MAGAZINES FOR FRIENDSHIP, INC.  
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LOS ANGELES, 41

We subscribe strongly to Mr. Croissant's idea. As a matter of fact, at this season of peace and good will, it might make a fine gift with broad ramifications. We hope those of our readers who do not file our issues for reference will communicate with **Magazines for Friendship** and find a worthy target for back issues.

### Videotape

. . . I have been a long-standing subscriber to **ELECTRONICS** during a time when a great deal of research was being undertaken, while television was undergoing experimentation and being introduced. Needless to say, I was very interested in everything **ELECTRONICS** had to say, even the advertisements of the manufacturing companies. . .

I have just been looking through the 1958 index to learn the subjects of articles which have been written about tv tape. I find that there was a brief on p 44 of the

Sept. 14 issue whose relevant sentences say: “Today few commercials have been done in color. Producers say this may be the case for some time.” The next paragraph says “one hour's running time uses \$300 worth of tape.” For commercials in the New York area that is probably not a great deal of money. However, I have never been very enthusiastic about magnetic tape, because I know how easily magnetic conditions in our large cities (which allow only d-c to be distributed within certain limits) could easily spoil or erase a tape which had been made under ideal conditions.

The article says nothing about cellulose-acetate film with a photographic emulsion. What is the status of videotape manufacture at this time? A recent show which starred Gisele McKenzie and Jimmy Durante was, according to the *Milwaukee Journal* tv magazine write-up, recorded in color on tape. Does this mean magnetic or photographic tape?

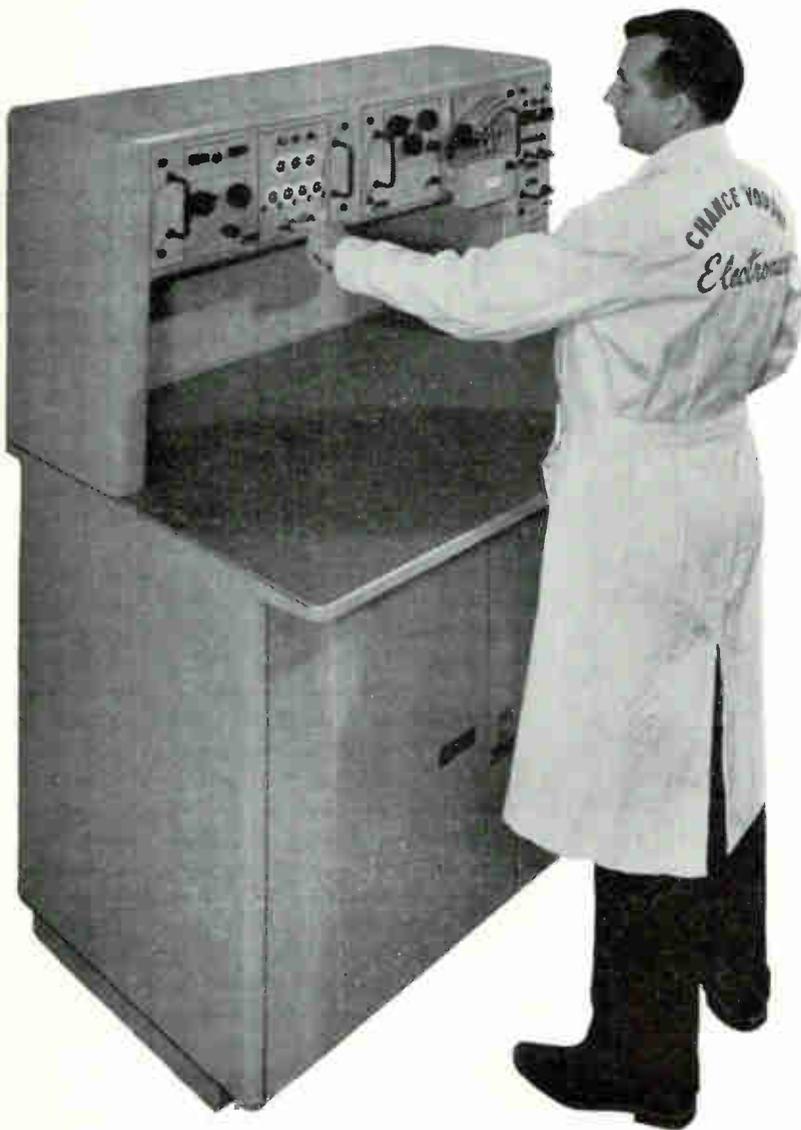
If the sound track which brought sound movies into the film market has been economical and practical, I can see no reason why other than commercials should not be quite as economical when recorded on photographic film. . .

ARTHUR B. ST. GEORGE  
OCONOMOWOC, WISC.

Video tape recording has come into favor for several reasons, including that the resolution is higher than film, that the tape does not have to be processed and can be reused, and that a special scanner is not needed. There is little comparison between movie sound tracks and video recording due to the great difference in bandwidths: 16 cycles to 15 kc for audio, 4.2 mc for video. Color tape is today fully as good as color film and does not have many of the drawbacks which film has for tv transmission.

While we're on our feet, we'd like to deliver ourselves of an old-fashioned but still-valid sentiment: we hope that every one of our friends and subscribers enjoys a Merry Christmas, full of peace and plenty.

# Have you gotten our letter about this test set ?



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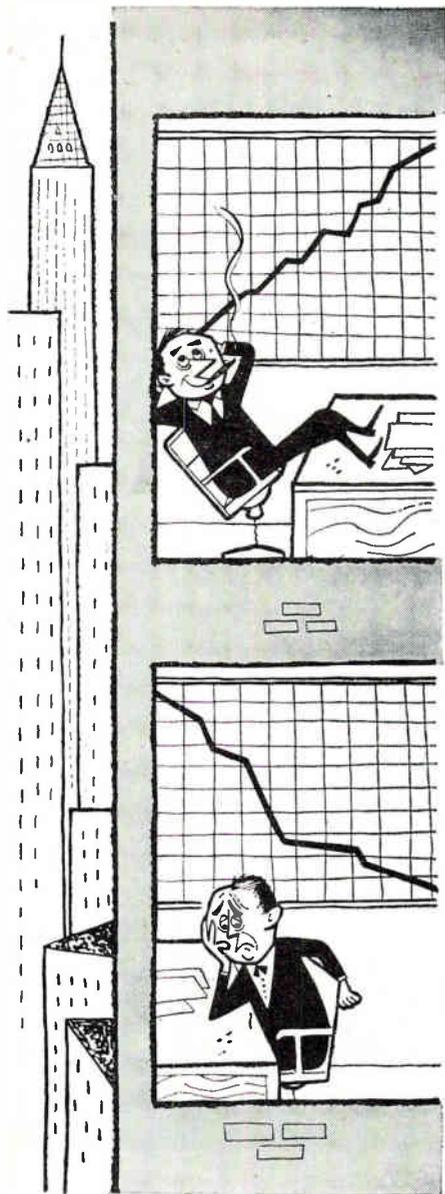
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# INDEX TO ADVERTISERS



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## FIND WHAT YOU NEED IN... electronics

● American Electronics, American Nuclear Div. ....	21	● Power Sources, Inc. ....	101
● Arnold Engineering Company, The....	3	Racal Engineering Ltd. ....	59
		● Radlo Corporation of America	5, 4th Cover
● Bendix Aviation Corporation Red Bank Division .....	64		
Bomac Laboratories, Inc. ....	3rd Cover	Sprague Electric Company.....	24, 25
		Stokes Corp., R. J. ....	11
Chance Vought Aircraft Incorporated..	103		
Cinema Engineering .....	8	● Telrex Laboratories .....	61
● Clevite Electronic Components, a Division of Clevite Corporation.....	30		
● Clifton Precision Products Co., Inc....	17	● Ucinite Company, The .....	26
● Cosmic Condenser Co. ....	56	United Mineral & Chemical Corp.....	27
● Coto-Coll Co., Inc. ....	60	U. S. Transistor Co.....	60
● Cross Co., H. ....	61		
		● Wales Stripit Inc. ....	28
Deleo Radio .....	22		
● Electronics .....	57		
● Gabriel Company .....	51		
● General Electric Company Apparatus Dept. ....	59		
● General Radio Company .....	2nd Cover		
Good-All Electric Mfg. Co.....	13		
● Hellpot Division of Beckman Instruments, Inc. ....	53		
● Hewlett-Packard Company .....	9		
● International Telephone & Telegraph Corporation .....	55		
● Kintel, a Division of Cohu Electronics, Inc. ....	6		
● Laboratory for Electronics Inc.....	49		
● Lampkin Laboratories, Inc. ....	105		
MacDonald Inc., Samuel K.....	105		
● Magnetics, Inc. ....	10		
Mallory & Co., Inc., P. R. ....	15		
● Non-Linear Systems, Inc. ....	47		
● Philco Techrep .....	52		

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EMPLOYMENT OPPORTUNITIES.104-105

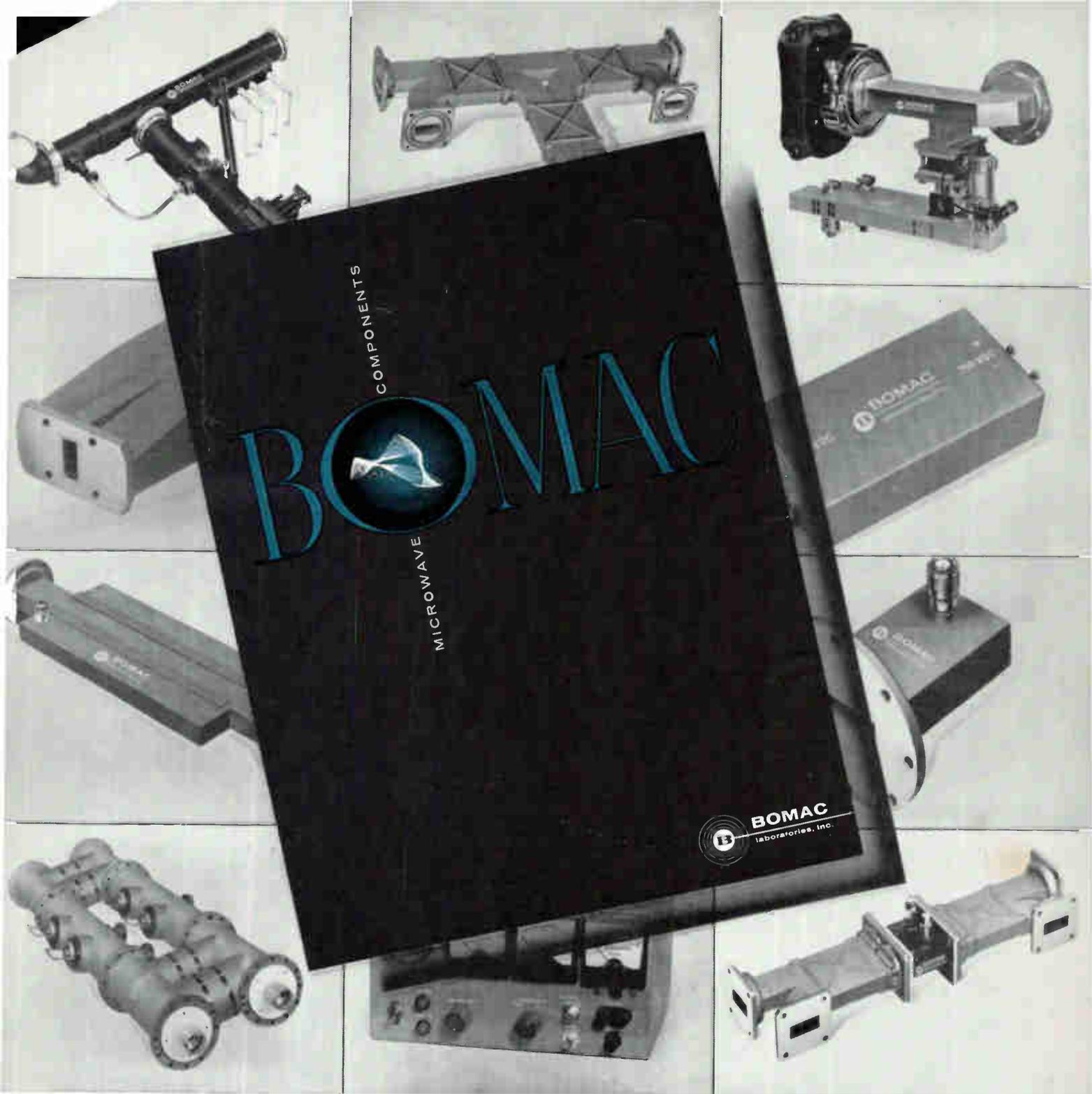
WANTED  
Equipment ..... 105

### ADVERTISERS INDEX

Bristol Co. ....	104
Milgo Electronic Corp.....	105
Telecontrol Div., Hancock Industries....	104
USI Technical Center, Div. of U. S. Industries Inc. ....	105

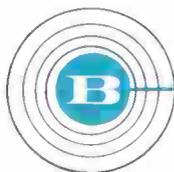
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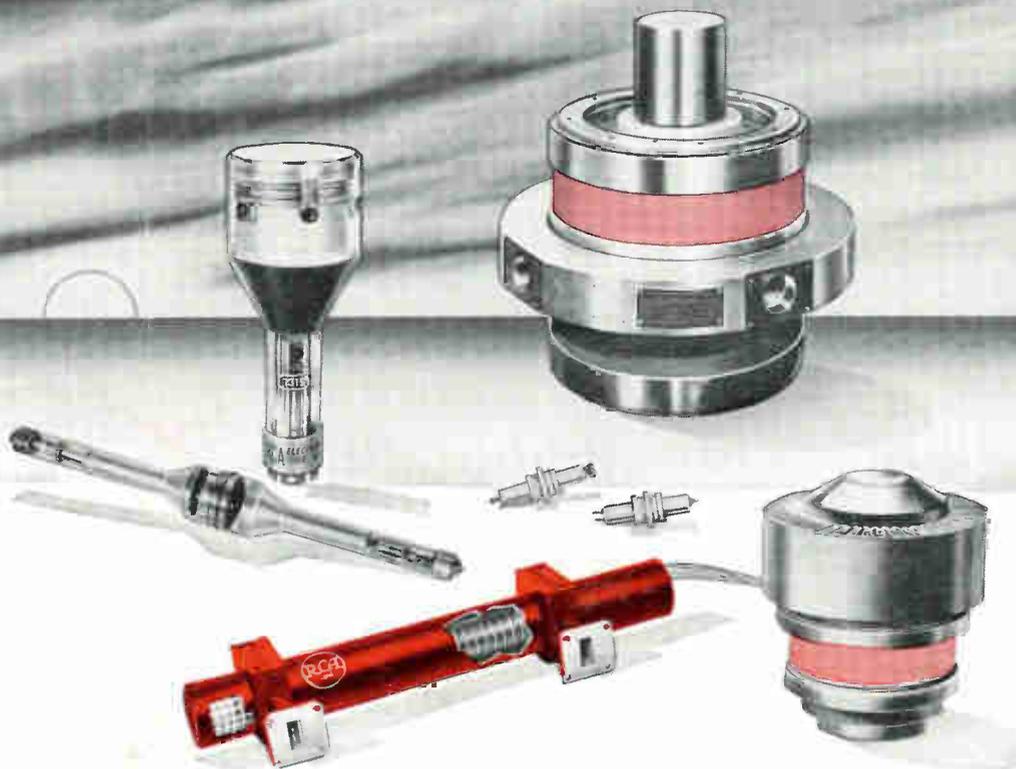
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