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electronics

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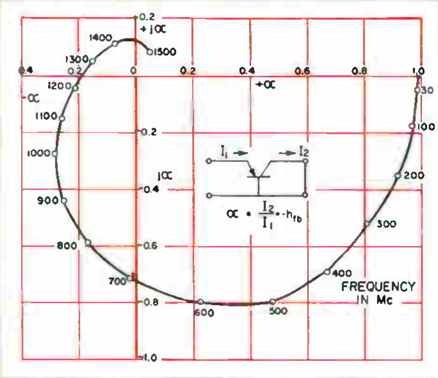

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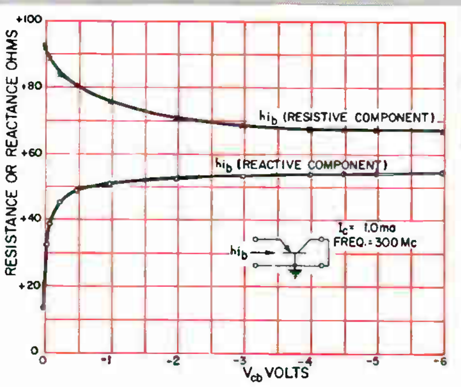

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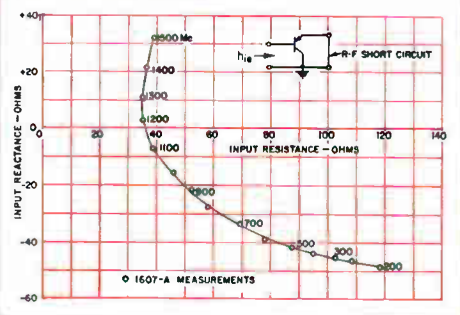

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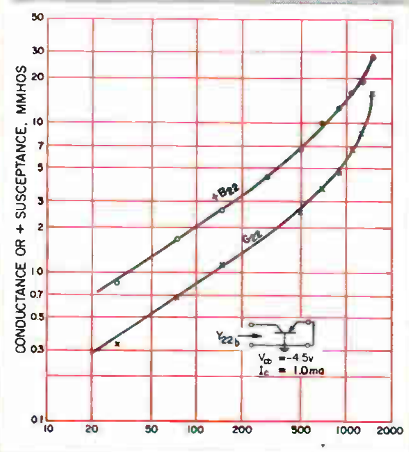

Plot of short-circuit output admittance as a function of frequency

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★ Measures h_{fb}, h_{fe}, h_{rb}, h_{ib}, h_{ie}, h_{ob}, h_{oe} of transistors directly, *plus* any desired short-circuit or open-circuit input, output, or transfer function of either active or passive networks.

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electronics

DECEMBER 25, 1959

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Vol. 32 No. 52

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Issue at a Glance

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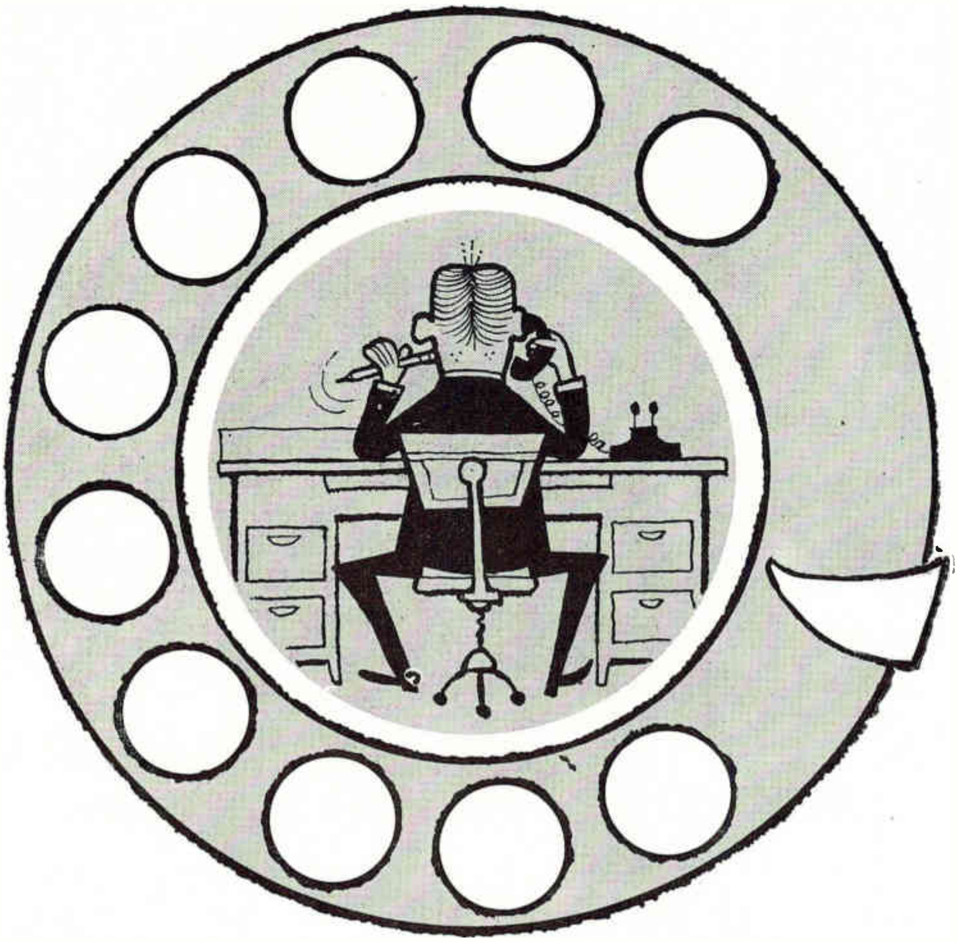
What's his number?



LOOK IN THE NEW

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You'll find the local representative . . . his name, telephone number . . . his address. You'll find such detailed information about more than 25,000 local sales offices of more than 4,000 major manufacturers.

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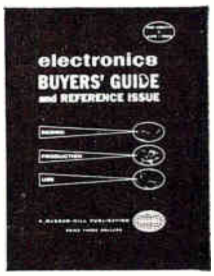

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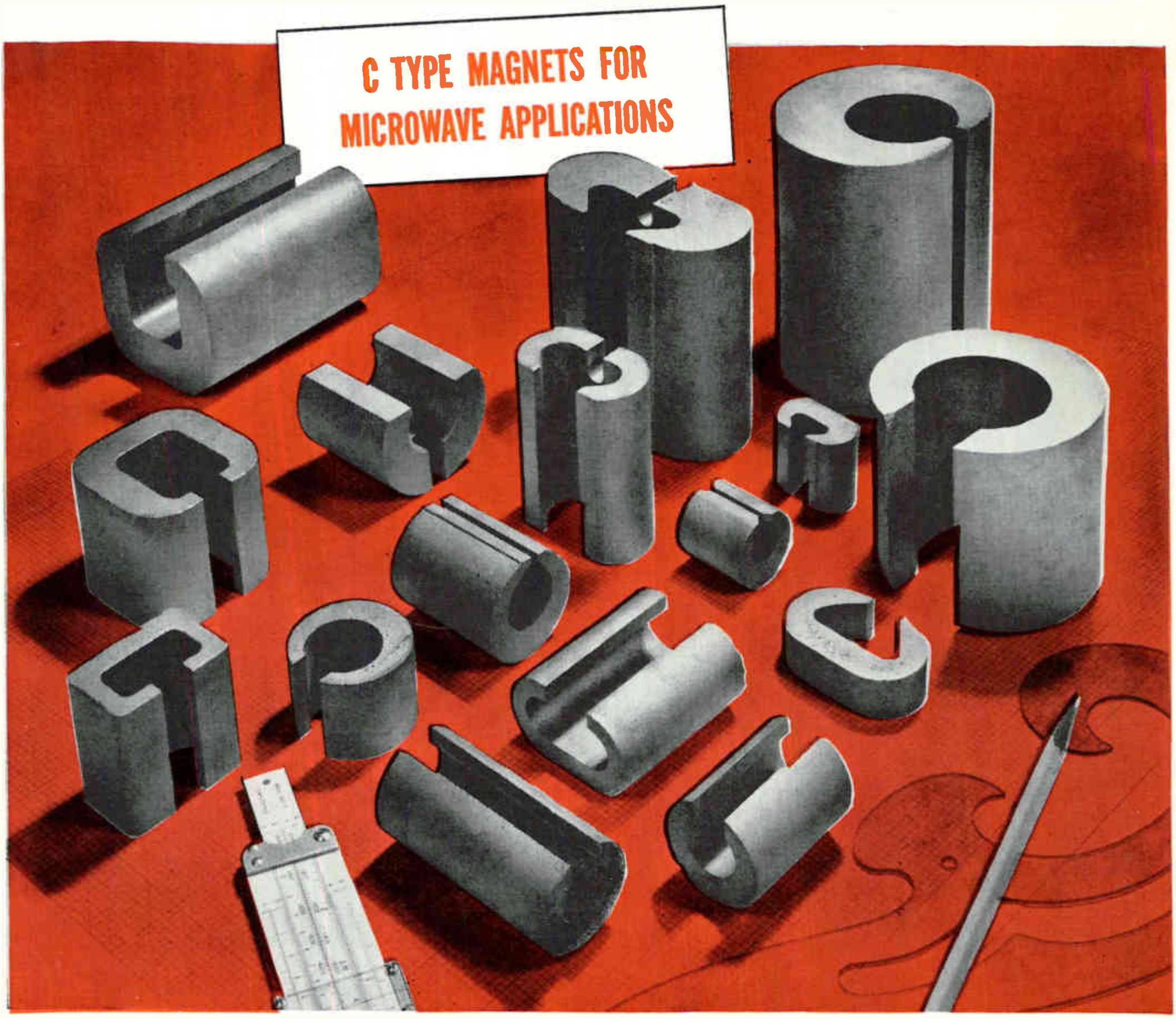

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December 25, 1959 Vol. 32, No. 52

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SHOPTALK . . . editorial

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.

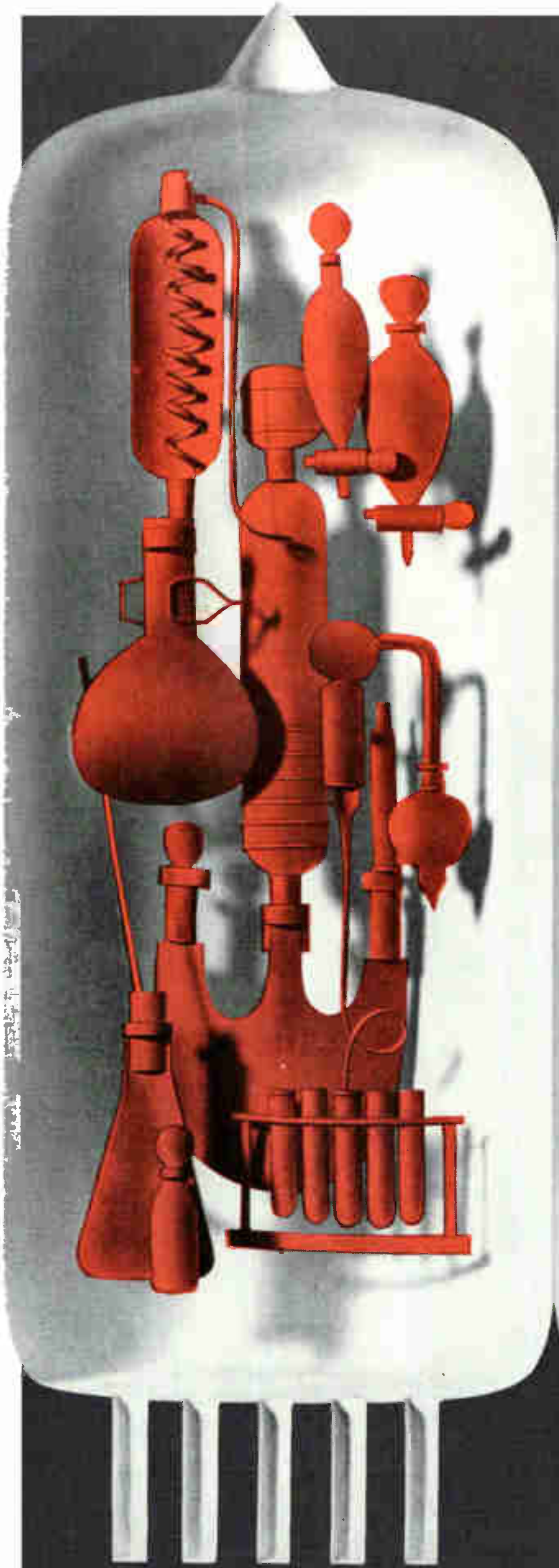
At a season dedicated to peace, we take little comfort in contemplating the fact that more than half our industry is dedicated to war. To redress the balance will require the best efforts of all the fine minds and spirits in the industry.

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.



RCA ELECTRON TUBE... A CHEMICAL SYSTEM!

In electron tube manufacture, precise control of the chemistry of the tube's heart—the cathode—can greatly increase the life of the tube and enhance its performance.

This fundamental consideration has led RCA tube research scientists to develop a unique process for cathode-base material manufacture—and ultimately, to produce **the remarkable N-132 cathode base material.**

N-132 is a "true balance" of essential chemical elements—nickel, carbon, magnesium, manganese and silicon. High-vacuum melting of the purest metal eliminates oxidation and reduces to lowest levels contaminants such as copper and sulphur. Precise control of process timing—to the second—yields exceptional uniformity from one melt to another, making it possible to hold cathode characteristics within strict limits. In addition, the process eliminates the use of solid deoxidizing agents usually employed in producing air-melted nickel. This feature eliminates unwanted residues and enhances purity of the alloy.

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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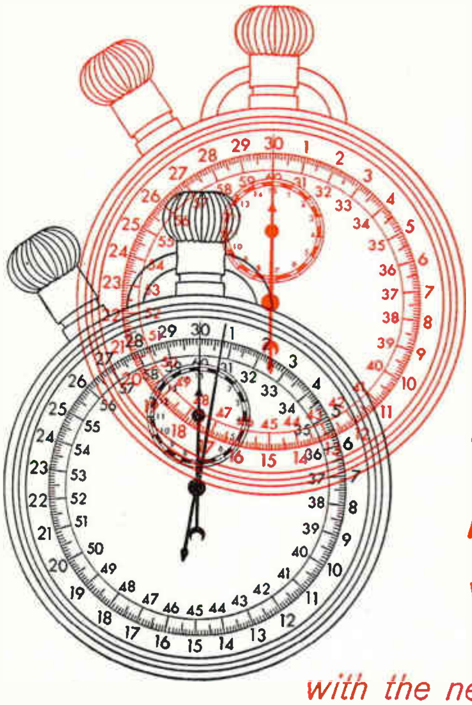

INSTANTLY...

measure and supply DC voltages to 0.02%

with the new KIN TEL DC voltage standard and null voltmeter

LABORATORY ACCURACY. The Model 301 is an extremely compact and accurate variable DC power supply and calibrated null voltmeter. It employs KIN TEL's proved chopper circuit to constantly compare the output voltage against an internal standard cell. As a DC voltage standard, it combines the stability and accuracy of the standard cell with the current capabilities and excellent dynamic characteristics of the finest electronically regulated power supplies. The self-contained null voltmeter indicates the voltage difference between the supply in the 301 and the DC source being measured, affording simple and rapid measurement of DC voltages to an accuracy of 0.02%.

PRODUCTION LINE SPEED. DC voltage measurements can be made as fast as changing ranges on a VTVM. Merely set the direct reading calibrated dials on the 301 to exactly null out the unknown DC input voltage. The reading on the dials then indicates the value of the unknown input voltage to within 0.02%. As a variable DC standard or power supply, the calibrated dials provide instant voltage selection to an accuracy normally attained only with standard cells.

VERSATILITY. The KIN TEL Model 301 is ideal for rapid and accurate production calibration of precision measuring instruments and DC power supplies . . . design of DC amplifiers and complex electronic circuitry . . . computer reference . . . versatile precision reference for calibration and measurement laboratories.

0.01% stability

0.02% accuracy

1 to 501 volts at 20 ma

4 accurate null ranges

0.002% regulation

Less than 100 µv ripple

IMPORTANT SPECIFICATIONS

Output Voltage & Current	1 to 501 volts at up to 20 ma
Full Scale Meter Ranges (Zero Center)	
DC Output Range	±500, 50 volts
DC Input Range	±500, 50 volts
DC Null Meter Range	±50, 5, 0.5, 0.05 volts
Long Time Stability	±100 parts per million
Output Voltage Calibration	±0.02% or 2 mv
Output Hum and Noise	Less than 100 µv RMS
Line and Load Regulation	0.002%
DC Output Impedance	Less than 0.01 ohm
Response Time	0.2 millisecond
Model 301 or Model 301R (Rack Mount)	Price $795.

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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, Daddyo, 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 vibraharps 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 timesaving 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.

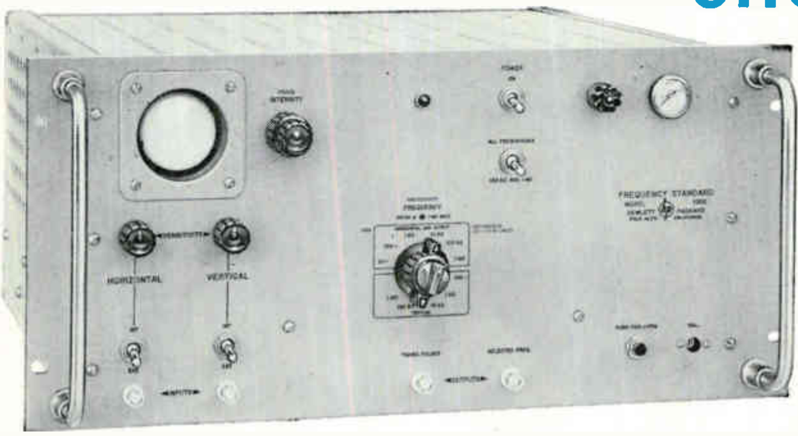
Another requirement involves encapsulation of all electrical equipment used for missiles and rockets—dipping the entire electrical unit in a plastic insulating mixture. When dry, the insulation will absorb shock as well as prevent electrical failure.

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.

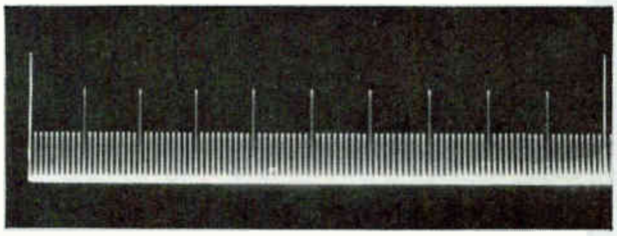
New, compact PRECISION FREQUENCY STANDARD

offers $5/10^8$ stability, just 8¾" 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

Stability:	$5/10^8$ parts per week, $3/10^8$ short term.
Outputs:	Sinusoidal 10 cps, 100 cps, 1 KC, 10 KC, 100 KC and 1 MC. Rectangular 10 cps, 100 cps, 1 KC and 10 KC.
Output Voltages:	Sinusoidal 5 v rms min.; rectangular approx. 15 v peak. Harmonics to 5 MC obtainable.
Rated Load:	1 MC and 100 KC, 50 ohms nominal; 10 KC, 1 KC, 100 cps, 10 cps, 5000 ohms nominal.
Distortion:	(Sinusoidal) Less than 4%.
Frequency Adjustment:	Screwdriver tune adjusts 1 ppm.
Size:	8¾" high, 19" wide, 18" deep behind panel. Weight 35 lbs.
Price:	$900.00.

Data subject to change without notice.
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This compact, highly convenient new hp 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 hp representative or write direct.

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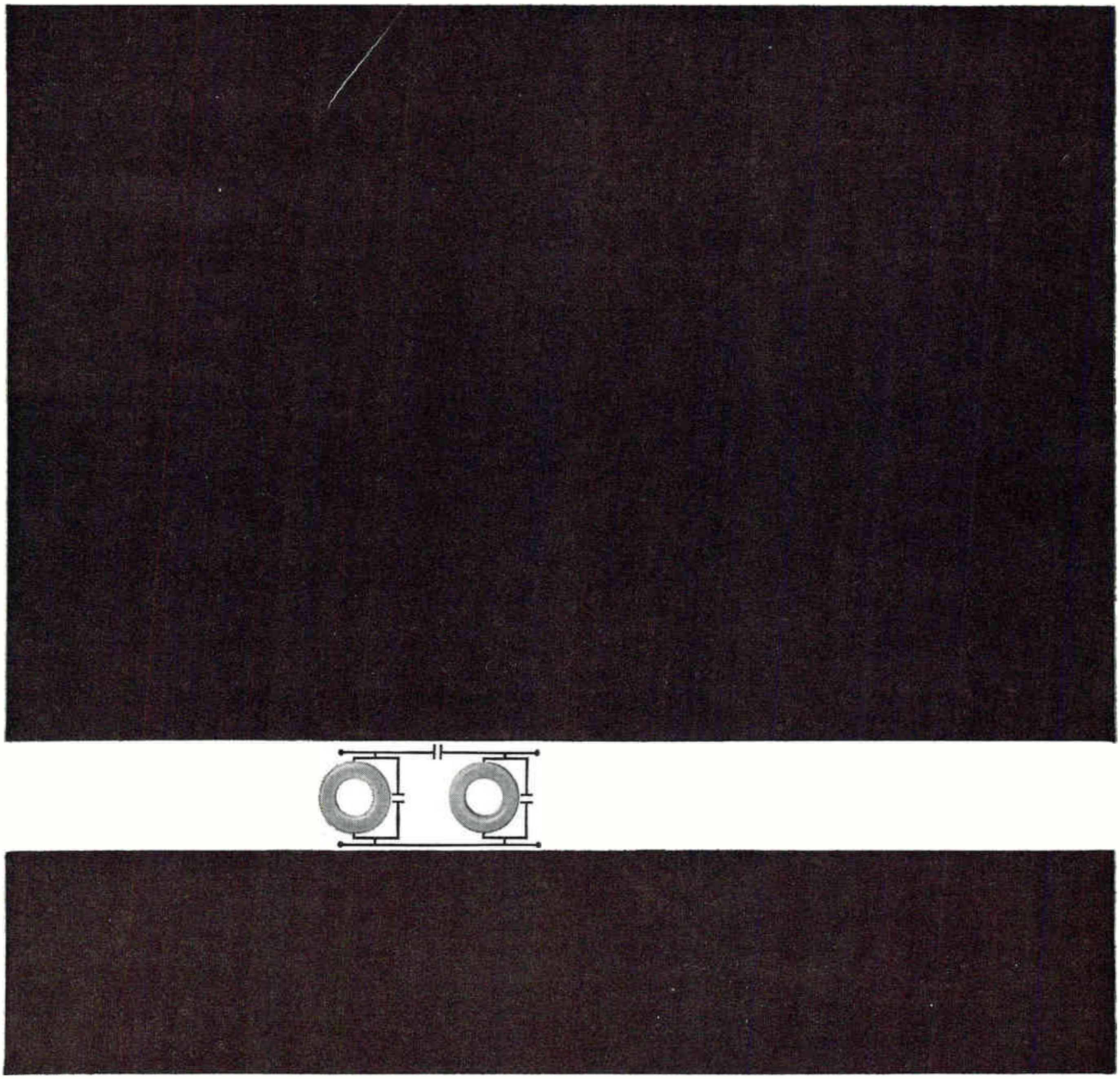

Smaller filters ease the squeeze!

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.

FINANCIAL ROUNDUP

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	16⅝	14¾	16⅝
Elec & Mus Ind	2,597	12¾	11¾	12⅛
Sperry Rand	2,552	27½	25½	25¾
Reeves Sndcrft	1,202	13½	12	12¾
Philco Corp	912	37½	29¼	30⅜
Collins Radio	876	56⅜	47⅝	55½
Lear Inc	843	22⅜	19¾	20⅝
Gen Electric	798	97¾	91⅞	93⅞
Univ Control	782	20¼	18⅞	19⅛
Int'l Resistance	683	20¾	17¾	18⅞
RCA	679	72¼	70¼	71¼
Muntz TV	664	4¾	3⅝	4½
Amer Bosch Arma	635	31⅞	27⅝	30⅞
Gen Tel & Elec	623	81⅜	77½	81
Standard Coil	622	18⅜	16½	16½
Int'l Tel & Tel	609	41⅜	39⅛	40
Clevite	586	53¾	44⅜	53½
Gen Transistor	506	32⅞	29½	31⅞
Varian Assoc	445	48	44	45½
Raytheon	418	57⅞	53½	53½
Gen Dynamics	415	50⅜	47⅜	47½
Burroughs	389	37⅛	35⅛	35⅜
Emerson	353	19⅛	17½	19
Westghse Elec	351	110	105	107½
Siegler Corp	317	36¾	33⅜	33⅝

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	$ *
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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As fast as subscription orders are received they are examined individually—by Hugh J. Quinn, Circulation Manager, who stamps each card:

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QUESTIONNAIRE — to delay acceptance until information concerning the subscriber—his function, his company, his title are definitely known.

REJECTED — whenever the order indicates that the individual is NOT within the editorial field of the publication.

electronics is a member of a select group too—The Audit Bureau of Circulation publications—comprised of those magazines and newspapers whose publishers believe that a reader's interest in a publication is best demonstrated when he pays to receive it—those publishers willing to submit to exhaustive periodic audits in order to prove that their circulation is among those individuals they are pledged to serve, and among screened *selected* individuals ONLY.

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PROBLEM-SOLVING CAPACITORS for

High density packaging

Good-All CAPACITORS

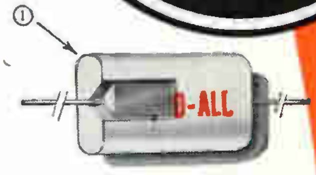
SPACE SAVING. Significant size reduction over film-foil and paper-foil designs can save vital space. The net volume saved increases with capacity value.

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%

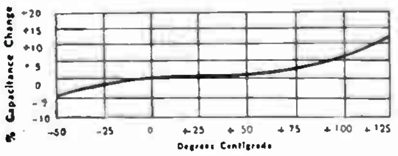
TEMPERATURE RANGE. Full rated voltage from —55°C to +100°C, to +125°C with 50% derating

TYPICAL SIZES-SHOWING THICKNESS • WIDTH • LENGTH

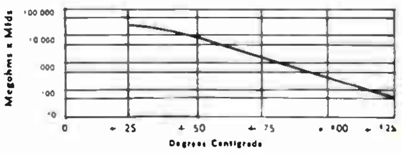
CAP IN MFDS	100 VOLTS T	W	L	200 VOLTS T	W	L
.01	156	203	[illegible]	125	187	[illegible]
.1	250	359	[illegible]	250	359	[illegible]
.33	296	484	[illegible]	328	500	[illegible]
.47	359	546	[illegible]	343	625	[illegible]
.68	343	515	[illegible]	421	750	[illegible]

CAP IN MFDS.	100 VOLTS T	W	L	200 VOLTS T	W	L
1.00	421	593	[illegible]	453	687	[illegible]
2.00	406	718	1¼	453	734	[illegible]
3.00	453	765	1½	546	903	[illegible]
4.00	500	890	[illegible]	656	1 015	[illegible]
5.00	484	843	[illegible]	625	1 250	1¼

Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



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. . . where there's electronics business, there's

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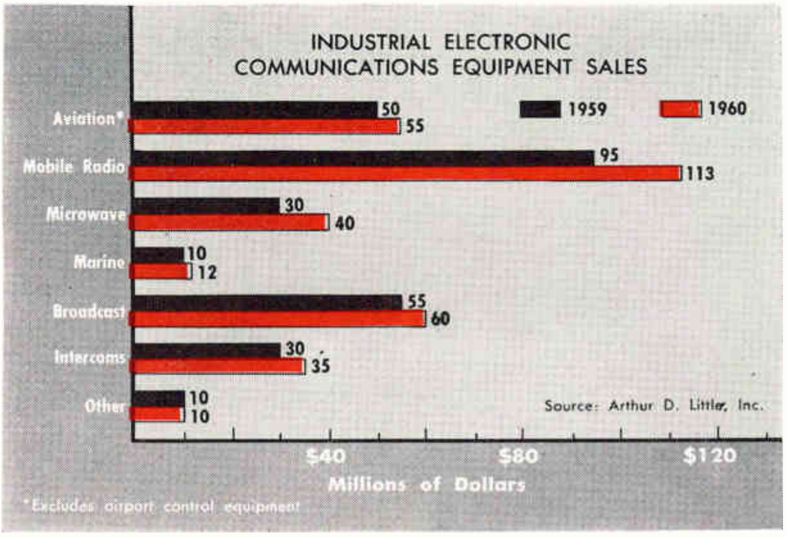
One of a series of advertisements prepared by the ASSOCIATED BUSINESS PUBLICATONS



Communications Sales to Rise

COMMUNICATIONS EQUIPMENT is one of the most promising areas of indutrial 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

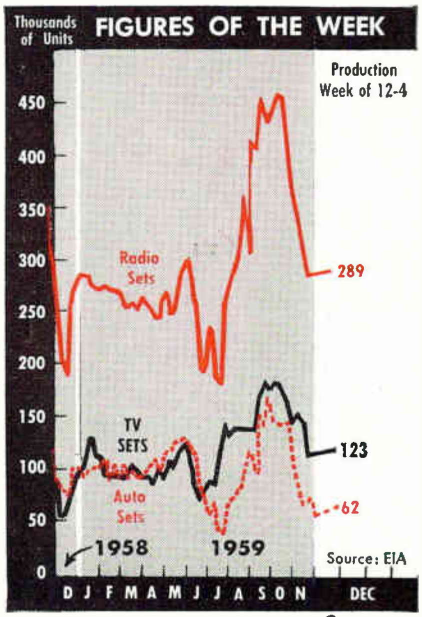
The consistent gains in communications equipment sales are exemplified by the phenomenal growth of mobile radio service, Thompson points out. In 1947, there were only 36,000 mobile radio transmitters authorized by FCC. By the end of 1958, there were about 700,000 authorized. Mobile radios serve in many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

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

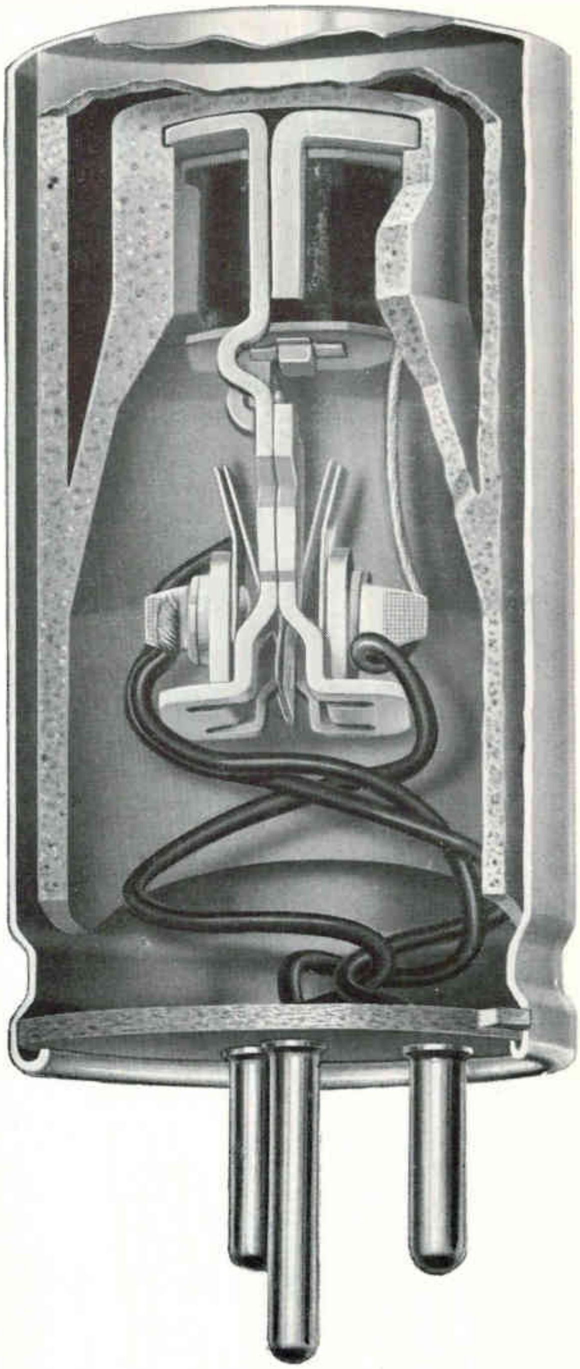
The expected liberalization by the FCC of point-to-point microwave authorizations for industry is expected to result in a wave of installations by industry to serve the pent-up demand for data handling and communications facilities between banks and their branches, between warehouses and branch stores,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



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.

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.

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Electromagnetic Department

P. R. MALLORY & CO. Inc.
MALLORY

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Starting with the January 1, 1960 issue of **electronics**, and in all subsequent first-of-the-month issues, there will appear on the Reader Service Card a Reprint Order Form for Special Reports and selected feature articles. Additional Reprint Order Forms will also appear in all other issues that contain Special Reports during 1960 period.

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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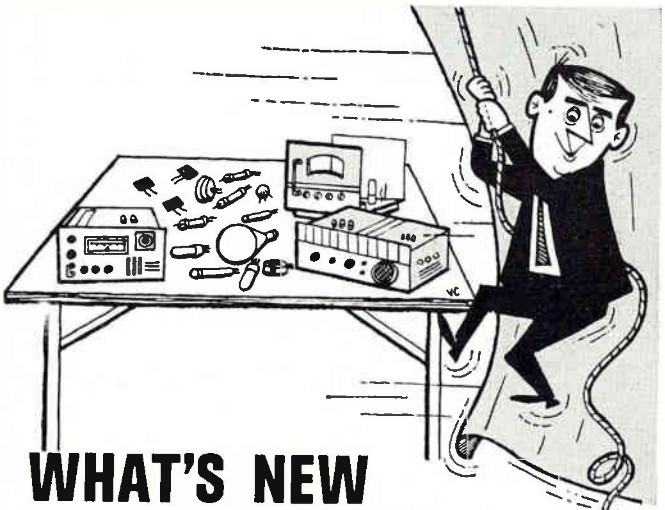

WHAT'S NEW IN COMPONENTS?

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). Fill in box on Reader Service Card. Easy to use. Postage free.

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Prepared especially by the 25-man editorial staff of *electronics*, this 64-page section is designed to assist the buyer by providing him with market data, electronics applications, market distribution, market reports and books, industry organizations and services.

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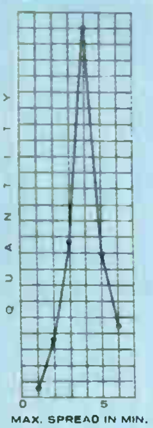
SYNCHROS *for* GYRO PLATFORMS by cppc



6′ max. error spread Synchro for Gyro Pick-Off

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.

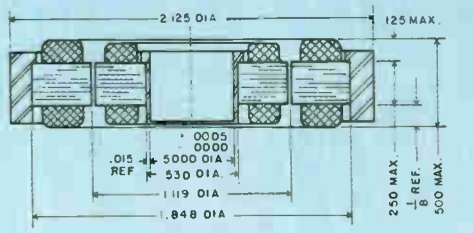
These units have been manufactured in large quantity and are readily available for prototype breadboarding. The high accuracies shown on the left are obtainable in standard 26v or 115v units.

Custom Designed Pancakes

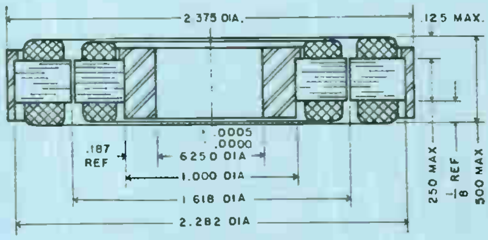
CPPC has developed a number of special pancakes (drawings below) with relatively large bores and narrow stack heights.

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

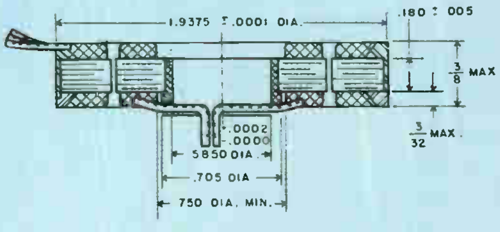
Special accuracies have been maintained where required. Let us know your needs.



RESOLVER



TRANSMITTER OR RESOLVER



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

ENGINEERS — Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. J7

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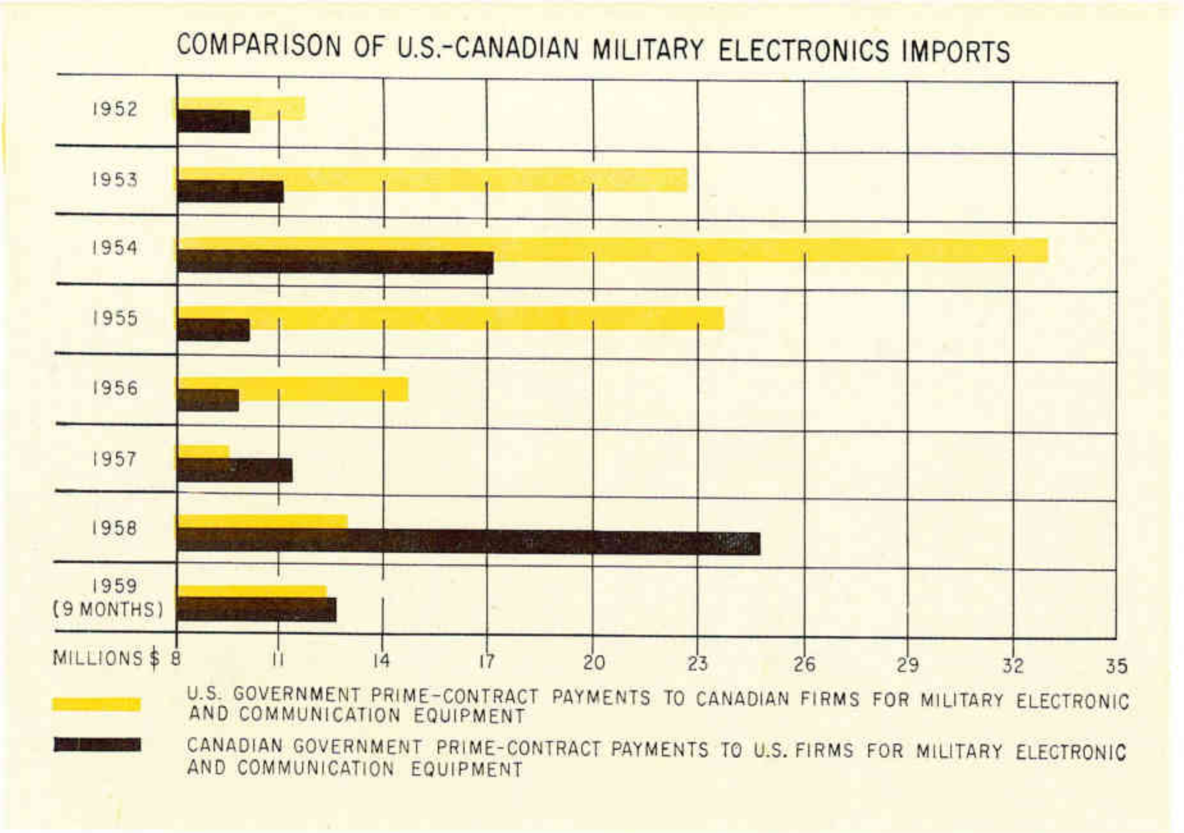


More Military Business Spanning Canadian Border

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 Principles 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, telephone, 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 teleprinter receivers from Canadian Aviation Electronics Ltd.; and AN/CNH-501 recording systems from Sonograph Ltd.

Business to Come

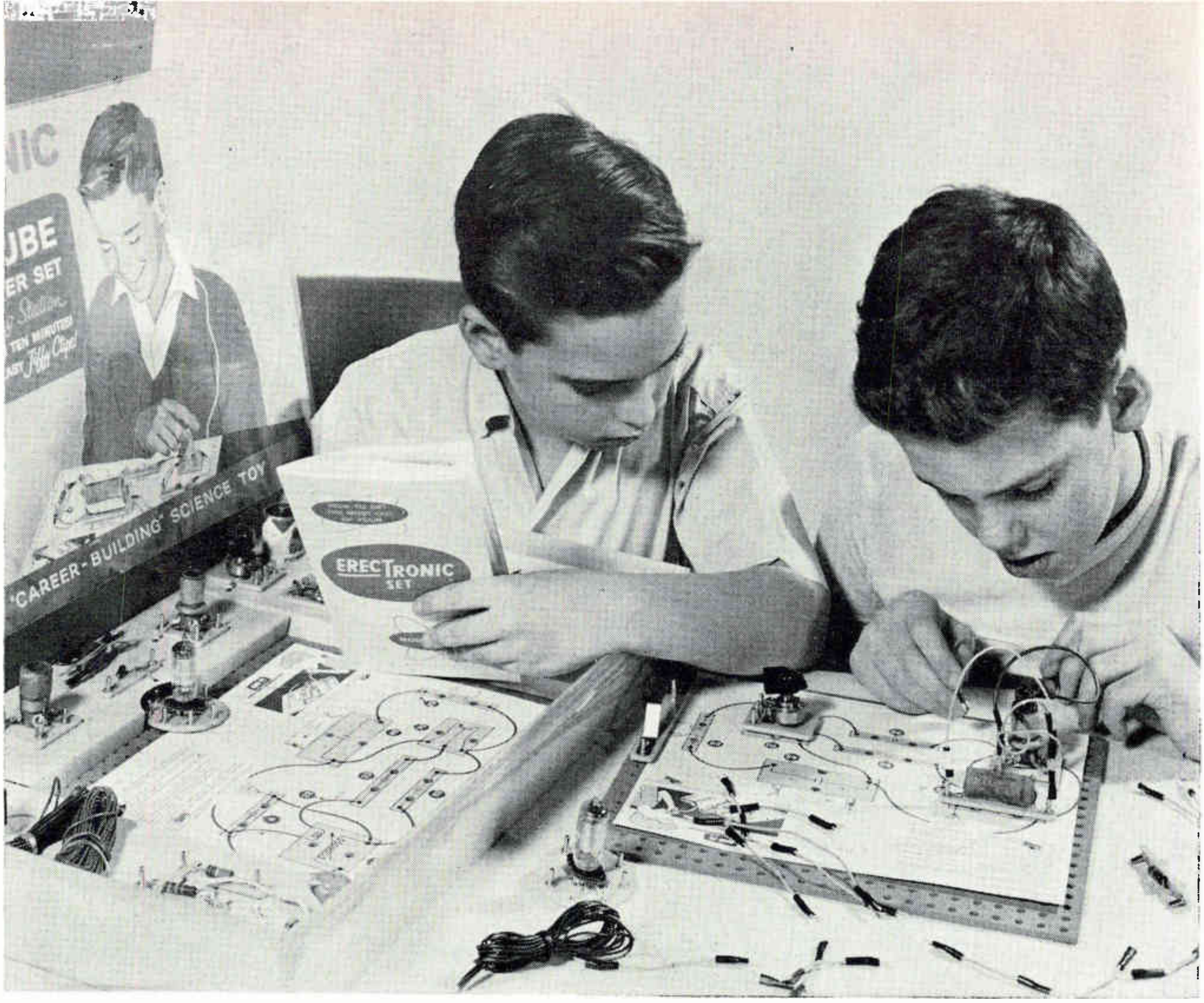
Canada's biggest buying from the U. S. is yet to come. Purchasing for the Sage-Bomarc complex has barely started. Some equipment that will be needed includes computers, communications and radar gear, and the hundreds of thousands of components needed for this equipment. Canada expects to spend close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

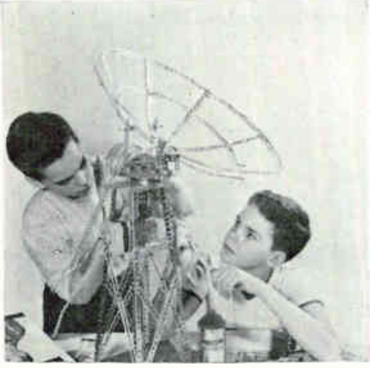
Toy Radios, Too

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 necessity for every well-equipped marshalling yard in toyland.



Rotating "satellite tracker" is featured in mechanical toy line

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, economical way to **DETECT "LEAKERS"** *in hermetically sealed components*

RADIFLO

Leading manufacturers of hermetically sealed components have installed RADIFLO and proven it to be the most sensitive, fastest and economical method of leak detection available for mass production.

100 TIMES MORE SENSITIVE—Components can be tested as high as 10^{-12} cc/sec. Super-sensitive RADIFLO reveals microscopic imperfections often undetected by less critical test methods.

TESTS NON-DESTRUCTIVELY—Rejected components need not be scrapped. The RADIFLO test method allows less-than-perfect components to be used in non-critical applications.

CAN BE PROGRAMMED AND AUTOMATED—Automatic programming feature permits modern automated mass production inspection of entire output, with immense savings in production time and labor.

ELIMINATES HUMAN ERROR—Components under test by RADIFLO are subjected to inert, radioactive gas, under pressure. During a "soaking" time the gas is forced into all existing leaks in the units. Then an air wash removes radioactive material from external surfaces. Each component is then placed in a scintillation counter for "go-no-go" inspection. A pre-selected acceptance leak rate allows non-technical workers to perform the test without error.

These leading manufacturers are among the many RADIFLO users:

SYLVANIA ELECTRIC PRODUCTS, INC.
GENERAL ELECTRIC COMPANY
Syracuse, N.Y. and Waynesboro, Va.
BULOVA WATCH COMPANY
HUGHES AIRCRAFT COMPANY
Tucson, Ariz. and Middletown, Pa.
WESTERN ELECTRIC COMPANY
ELGIN NATIONAL WATCH COMPANY
NIPPON ELECTRIC COMPANY
U. S. ARMY ORDNANCE, Frankford Arsenal
EITEL-McCULLOCH, INC.
U. S. ARMY CHEMICAL CORPS,
Research and Development Command
POTTER & BRUMFIELD, INC.
FAIRCHILD SEMICONDUCTOR CORP.
ALLEN-BRADLEY COMPANY
ARMY BALLISTIC MISSILE AGENCY

Let us help with your component leak problems. Write for complete details of automatic RADIFLO testing equipment. Manufacturers with limited production volume will be interested in RADIFLO TESTING SERVICE—now available at low cost on the east and west coasts.

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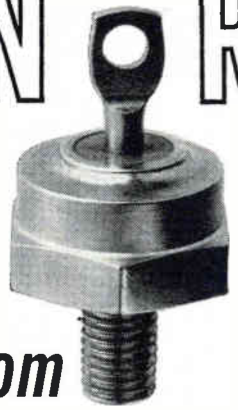
AMERICAN NUCLEAR DIVISION
9459 WEST JEFFERSON BOULEVARD, CULVER CITY, CALIFORNIA

CIRCLE 21 ON READER SERVICE CARD

Announcing...

SILICON RECTIFIERS



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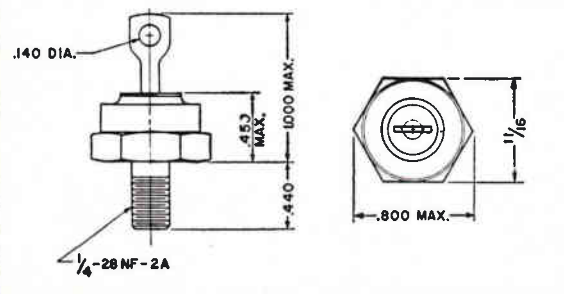
DELCO RADIO

High Quality
High Performance
Extreme Reliability

From the leading manufacturer of power transistors, new Silicon Power Rectifiers to meet your most exacting requirements. Even under conditions of extreme temperatures, humidity and mechanical shock, these diffused junction rectifiers continue to function at maximum capacity! Thoroughly dependable, completely reliable—new Delco Rectifiers are an important addition to Delco Radio's high quality semiconductor line.

Conservatively rated at 40 and 22 amperes for continuous duty up to case temperatures of 150°C.



TYPE	AVG. DC CURRENT	PIV	NORMAL MAX. TEMP.	MAX. FORWARD DROP	MAX. REVERSE CURRENT
1N1191A	22A	50V	150°C	1.2V at 60 amps.	5.0 MA
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 at 150° C case temperature and rated PIV

For full information and applications assistance, contact your Delco Radio representative.

Newark, New Jersey	Chicago, Illinois	Santa Monica, California
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DELCO
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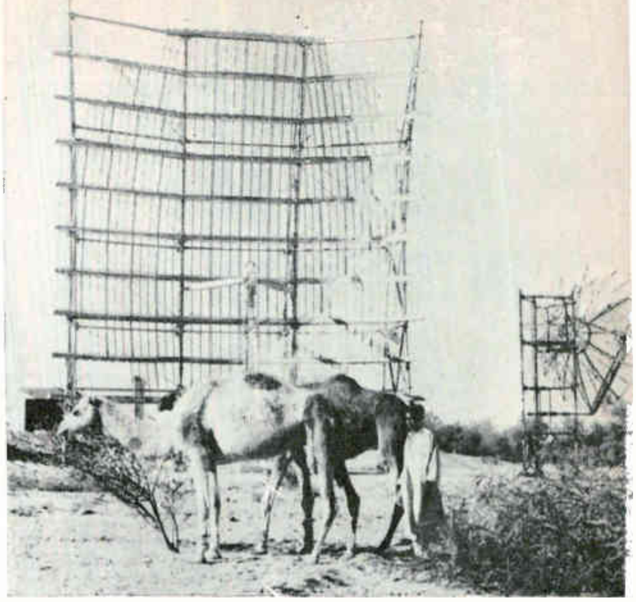
Libya Network Expands Fast

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. Overwater 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 wideband 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

PORTABLE, VERSATILE UNIT PINPOINTS SOURCE OF INTERFERENCE

This improved instrument is a compact, rugged and highly sensitive interference locator—*with the widest frequency range of any* standard available unit.

New improvements in Model 500 include: *greatly increased sensitivity,* meter indications proportional to carrier strength, transistorized power supply. Engineered and designed for practical, easy-to-operate field use, it is the ideal instrument for rapid pinpointing of interference sources by electric utility linemen and industrial trouble shooters. Model 500 tunes across the entire standard and FM broadcast, shortwave, and VHF-TV spectrums from 540 Kc to 216 Mc. For full details send for brochure IL-102.

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THE MARK OF RELIABILITY

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.

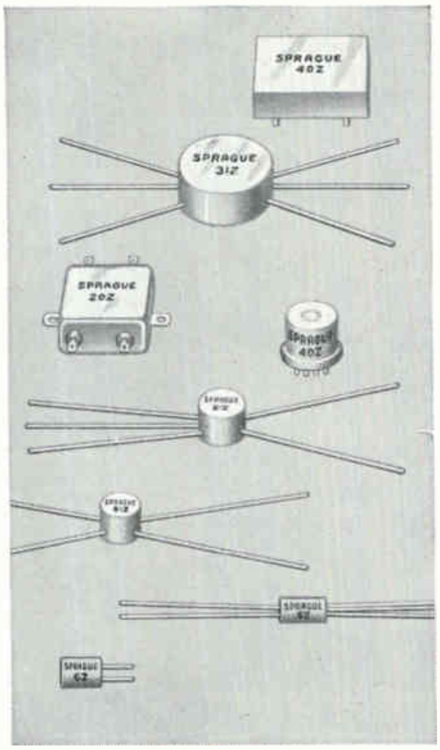
One example is a major oil producer which leases one of the largest analog computer facilities operated by a private company.

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



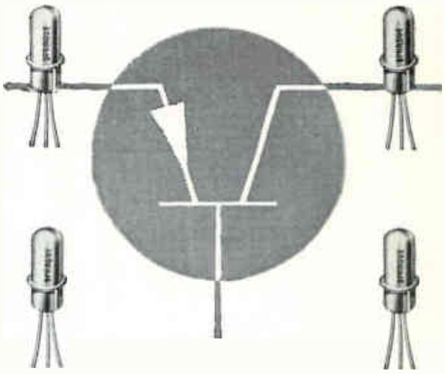
Sprague miniature pulse transformers are ideally suited for application in low-power, high-speed computer circuitry where pulse signals may range up from 20 millimicroseconds and wider in duration, at repetition rates as high as 10 megacycles, with pulse levels ranging from fractions of a volt to several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

CIRCLE 201 ON READER SERVICE CARD



HIGH-SPEED HIGH-GAIN 2N393 MICRO-ALLOY TRANSISTORS*

for modern computer circuitry

Sprague 2N393 Micro-Alloy Transistors combine high gain with excellent high frequency response to meet demands of high-speed computer switching applications in the megacycle range. Low saturation resistance, low hole storage, and exceptionally good life characteristics make these micro-alloy transistors top performers in computer circuits as well as in general high frequency applications.

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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Ucinite Electrical Assemblies

PRINTED CIRCUIT TEST JACKS

For permanent assembly to ptd. circuit bds. Accessible to std. .080 probes without adaptors. Gold-over-silver berylco contacts . . . color coded nylon bodies.

TEST JACKS

Ucinite's quality jack for .080 probes. Beryllium copper contacts. Nylon insulation in colors. Metal shell for firm, dependable mounting. MS16108 types available.

STAMPED CIRCUITS

"Printed circuitry" by a stamping process free of electrolytic contamination. Injection and thermoset molded housings simplify miniaturization of intricate packages and permit complete flexibility of basic raw materials.

PRINTED CIRCUIT CONNECTORS

Unique torsion-bar contacts, provide consistent performance unaffected by repeated insertions of maximum and minimum tolerance boards. Available in various multiples of contacts.

SPECIAL ASSEMBLIES

Stamped circuits, molded housings, special contacts custom-designed in a complete package to fit the application.

BANANA PINS

Four sizes of plugs with one-piece beryllium-copper springs. Adaptable mounting ends in threaded, staking or solder lug types. Mating jacks also available.

"PK" MOLDED SWITCH

Single wafer rotary switches in rugged, molded construction. Economical, durable. Single pole, two or three position types available.

AIRCRAFT SNAP SWITCHES

Precision, momentary contact, push-button types made to MS25089. Small and dependable. Hermetically sealed and other special versions are available.

AIRCRAFT COMMUNICATION PLUGS AND JACKS

4-conductor type made to rigid Mil. Specs . . . U92A/U Jack . . . U93A/U Plug . . . U94A/U Switch-Jack combination.

VIBRATION ISOLATORS

Equiflex (1:1 ratio) metal mounts ensure long life, fit small spaces; can be used in any direction. A range of sizes, cup or plate mountings.

With years of specialized experience in the electronics field and complete facilities for the volume production of small metal stampings as well as the assembly of metal to plastic and ceramic components, Ucinite is fully equipped to supply you with special electrical parts and assemblies . . . designed, assembled, wired and marked to your specifications.

* * *

For complete design, engineering and production service, call your nearest Ucinite field engineer.

ELECTRICAL ★ DOT ★ ASSEMBLIES

Manufactured by

The UCINITE COMPANY

Division of United-Carr Fastener Corporation, Newtonville, Mass.

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 occuring 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 axisymetric 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.

Cushions Insulates & Deadens Sound.

Utilized by Manufacturers and Users

of Electronic Equipment, Systems, Component Parts, Accessories, in all fields — Military (including missiles program) — Industrial — Entertainment — Home.

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FOAMSTIK® TAPE

SELF-ADHERING PLASTIC FOAM MATERIAL

Solves production problems. Improves product performance.

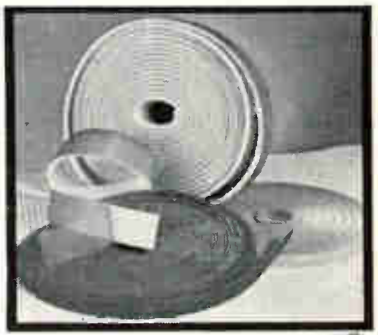
TESAMOLL Foam Stik tape is a highly flexible, resilient, extremely light weight plastic foam material. Backed by an aggressive, quick-sticking adhesive. Protected by a poly vinyl chloride liner which can easily be peeled off as Tesamoll Foam Stik Tape is applied.

Adheres instantly and firmly on contact by gentle finger pressure to metal, wood, glass, plastic, etc. (some textiles). No moistening, no mess. No waste of time or material. Cuts with snip of scissors.

IN CONVENIENT ROLLS

Thickness: 1/8", 1/4", 1/2"
Widths: 1/4" to 18 1/2".
Other sizes on request.
Standard colors: White, Grey, Black.

Characteristics: Uniform texture. Chemical stability. Excellent compressability. Low compression set. High thermal insulating efficiency. High co-efficient of friction. Electrostatically negative. Neutral pH factor. Odorless. Weight 1/3 that of foam rubber. Unaffected by water, grease, lubricants, most chemicals. Does not rot. Proof against fungus, mildew, insects.



Complimentary Booklet

Gives complete technical data; present applications in electronics, engineering, chemistry, aviation; present uses in commercial products.

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WORK PIECE—Electronic Chassis—10" x 14"—23 holes—5 sizes—4 different shapes—4 corner notches

SETUP TIME—9.3 minutes

PRODUCTION RUN—5 pieces

PRODUCTION TIME PER PIECE—2.8 minutes

For short or pilot runs—model shop and experimental work—no other single machine can match the production capabilities and profit potential of the Strippit Fabricator.

PUNCHES—any round or shaped hole up to 3½" diameter in sheet material—up to ¼" mild steel.

NOTCHES—90° corners—rectangular, radii, vee and special shape edge notches—up to ⅛" capacity in mild steel.

NIBBLES—straight line or contour shearing up to a 38" diameter circle, at 165 strokes per minute, ⅛" mild steel.

ACCURATE, QUICK-SET GAUGING—a unique, multiple-stop system permits exact positioning of the work to any layout specifications in seconds instead of minutes.

QUICK-CHANGE PUNCHES AND DIES—changed from one size to another in less than 20 seconds—within easy reach in labeled, built-in file drawers.

EASY CONVERSION—to a production punching unit by adding the Strippit Duplicator for high speed production of hundreds of pieces—and the Dupl-O-Scope to punch Duplicator templates from a drawing, layout or sample part.

WRITE TODAY—for Catalog 10 AA and an actual demonstration right at your own plant of the capabilities of this high-profit fabrication system, by a Strippit Mobile Demonstration Unit.

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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.

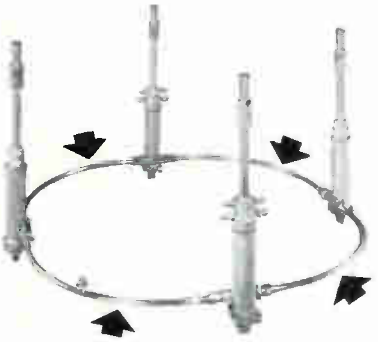
S.S.White

DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with flexible shafts

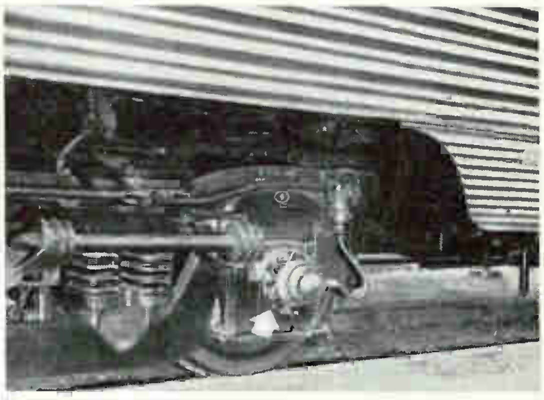
REMOTE CONTROL

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 ¼-hp motor suspended over the table at speeds up 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.

1056

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

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10 East 40th Street, New York 16, N. Y.

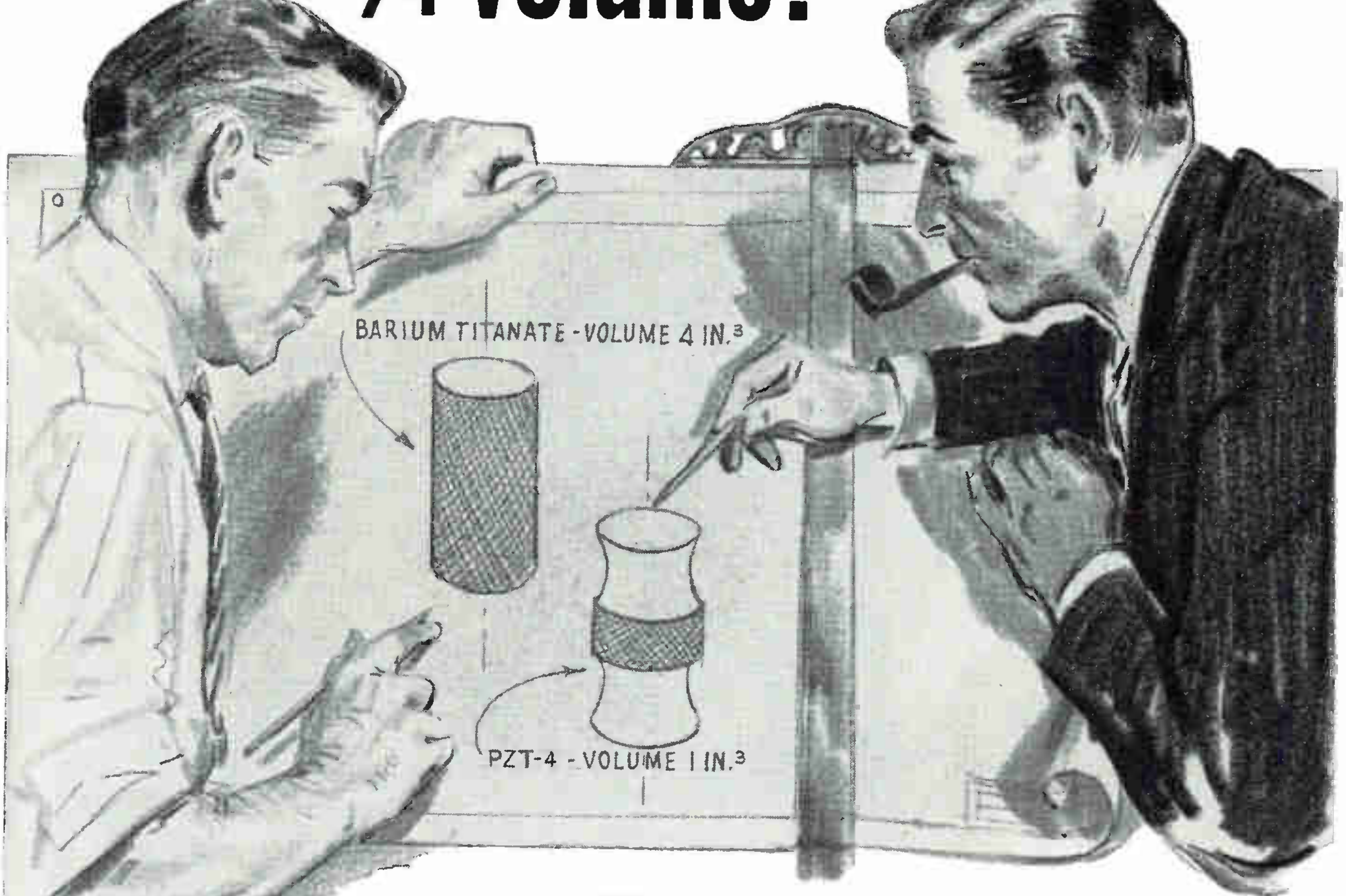
Standard S. S. White flexible shafts are available "off the shelf," making many savings possible. **Write for bulletin 5801.**

USEFUL DATA ON SELECTION and APPLICATION!

S. S. White also offers engineering service and comprehensive selection of flexible shaft sizes and types to meet special requirements. **Write for bulletin 5601.**

CIRCLE 29 ON READER SERVICE CARD

Same acoustic output-
1/4 volume!



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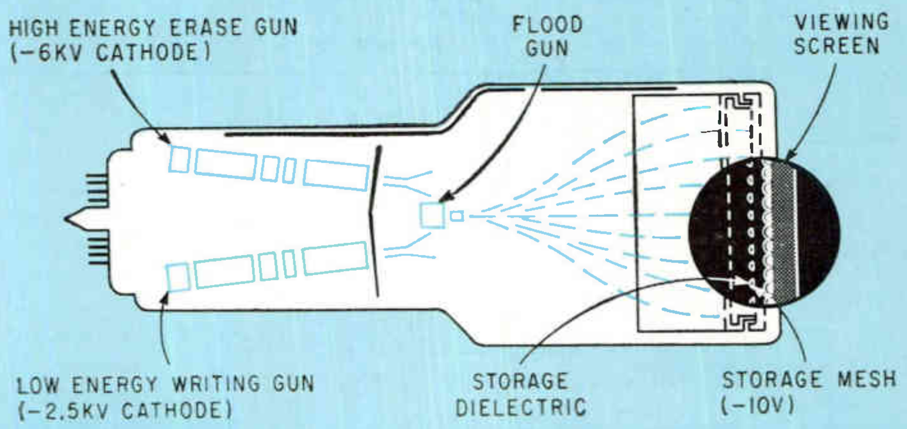


FIG. 1—Five-inch bombardment induced conductivity tube uses dual effects target for selective erasure

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[1]. 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

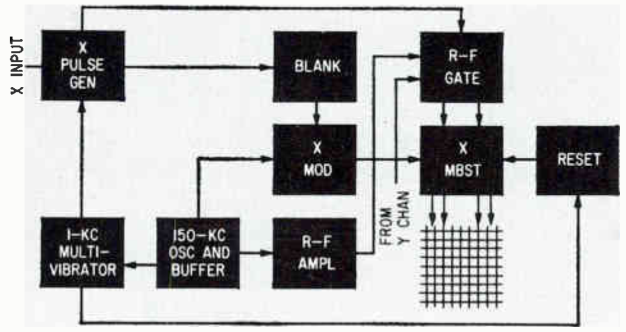


FIG. 2—Preferential access to EL panels is obtained with magnetron beam switching tubes (MBST)

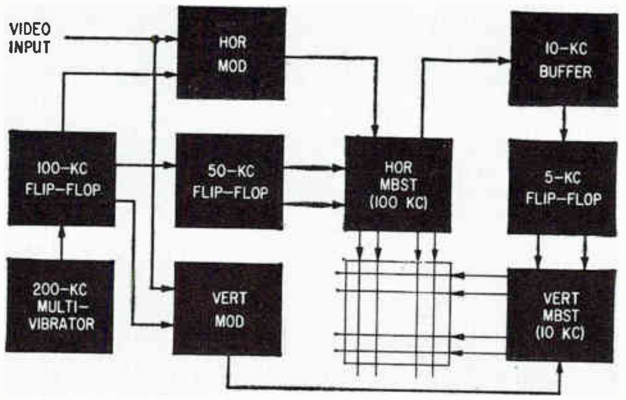


FIG. 3—Sequential scan system uses beam switching tubes to scan a 5 sq in., 100 × 100 panel at 20 frames a second

panels[2]. Crossed-grid panels have a continuous layer of glass-imbedded 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[3]. 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[4].

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.

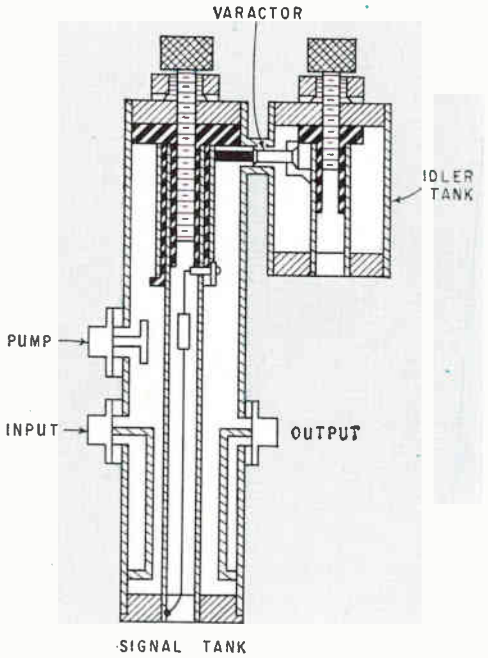


FIG. 4—Low pump power, 220-mc parametric amplifier does not require circulator or isolator

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.[5] 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[6]. 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 milliampere input to a 5-ampere output pulse has been constructed at the Naval Research Laboratory[7]. 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 6*AG*7 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[8]. The Bell Laboratories device tracks in gain to ± 0.2 db over 10-percent bandwidth and tracks in phase to ± 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.

REFERENCES

The papers listed below were all presented at the 1959 Electron Devices Meeting:

(1) N. H. Lehrer, Selective Erasure and Non-Storage Writing In Direct-View Storage Tubes.

(2) J. Matarese and M. S. Wasserman, Crossed-Grid Electroluminescent Panel Displays with Sequential and Random Access.

(3) A. J. Marko and A. L. Solomon, Code Translation by an Electroluminescent-Photoconductive Panel Array.

(4) H. B. Law and E. C. Ramberg, The Reflected-Beam Kinescope.

(5) G. Schaffner, A 220 MC Parametric Amplifier Requiring Low Pump Power.

(6) K. P. Grabowski, R. D. Weglein and M. R. Currie, S-Band Traveling-Wave Parametric Amplifier Using A Filter Circuit.

(7) G. L. Stambach, W. J. Graham and T. E. Hanley, A Secondary Emission Multiplier Tube.

(8) J. M. Hammer, J. P. Laico, H. J. Halvorsen and E. G. Olsen, Low Noise C-Band Traveling-Wave Tube.

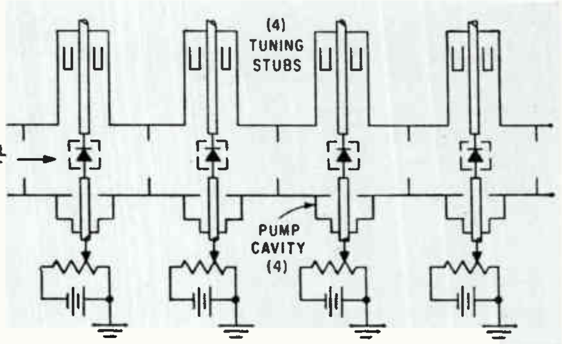


FIG. 5—Signal-idler circuit of traveling wave paramp has four rectangular cavities centrally loaded by variable capacitance diodes

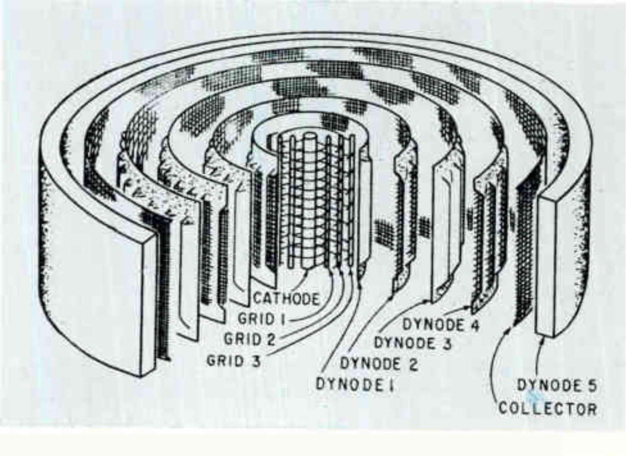
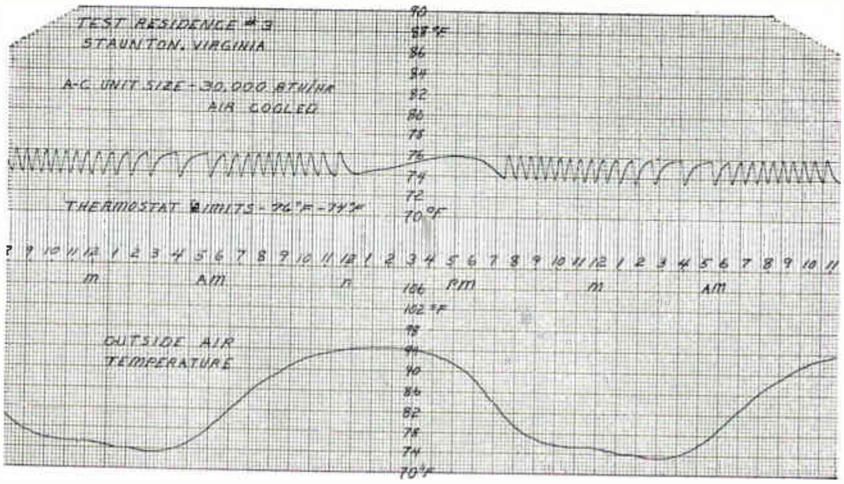


FIG. 6—Secondary emission multiplier tube has transconductance of 600,000 μmhos. Tube is suited to coaxial input and output

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

RESIDENTIAL 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[1-4] and to the use of a general purpose analog computer as a tool in predicting residential cooling loads[5]. 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.



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

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 picture of the thermal system.

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

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_{OA}, 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 amplifiers. These amplifiers convert 60-cps signals into currents which are directly proportional to the net solar radiation in Btu/hr/ft^2 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

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_{TA}, as repre-

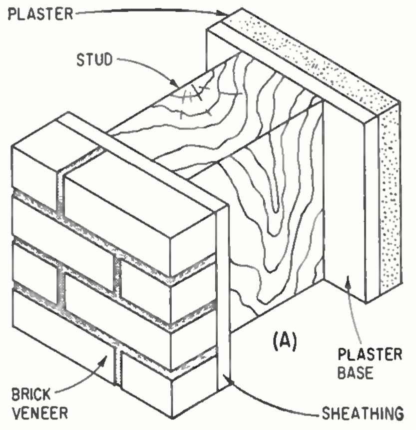
DETERMINING THERMAL BEHAVIOR OF DWELLINGS

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 structrual 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.



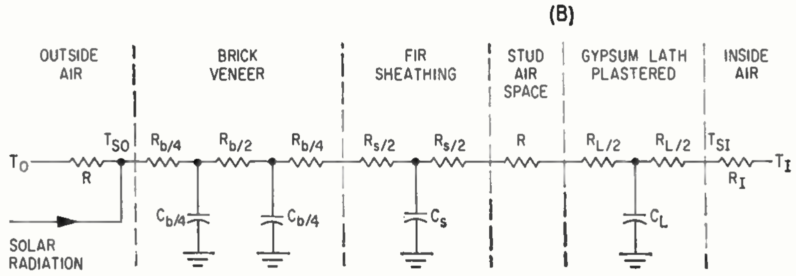


FIG. 1—Typical wall unit (A) and its thermal circuit representation (B)

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

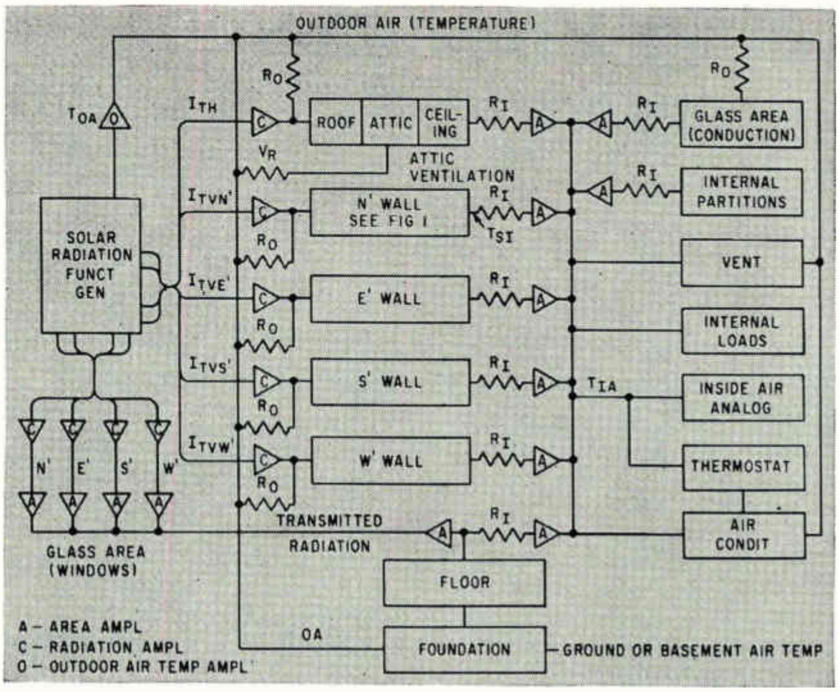


FIG. 2—Block diagram of computer used to determine air-conditioning capacity

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 μ 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 drops across αR_1 and R_2 the same. The voltage drop across αR_1 is $I_{in} \alpha R_1$; therefore, the current through R_2 will be $I_2 = \alpha (I_{in} R_1/R_2)$ and the output current will be $I_{out} = I_{in} + I_2 = I_{in} [1 + \alpha R_1/R_2]$.

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 α. Furthermore the magnitude of the multiplier is linearly dependent upon α.

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 connected 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 ±0.25 percent ±5 μa 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 μf 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 μf.

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-

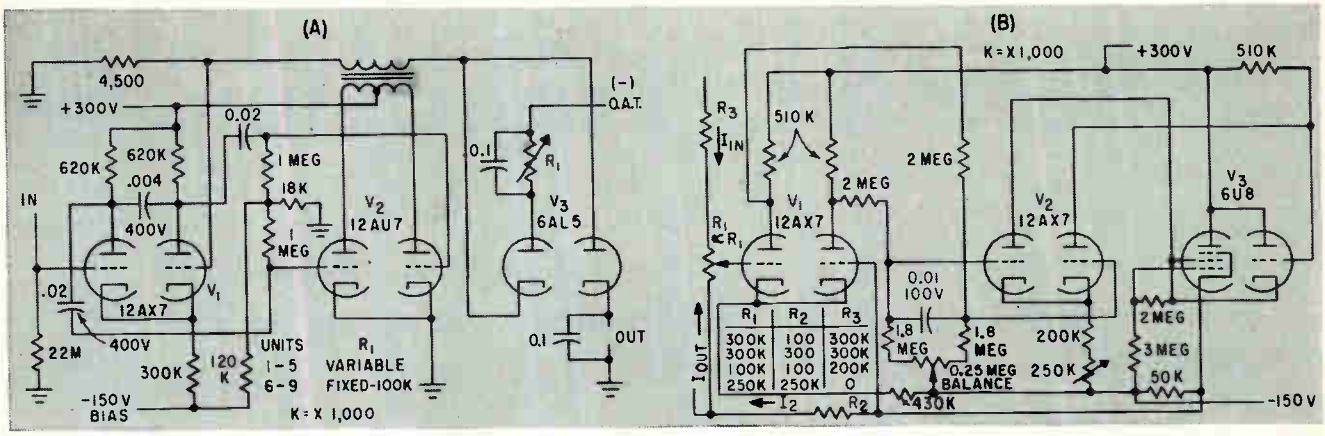


FIG. 3—Solar radiation amplifier (A) and area amplifier (B) used in the WARAC computer

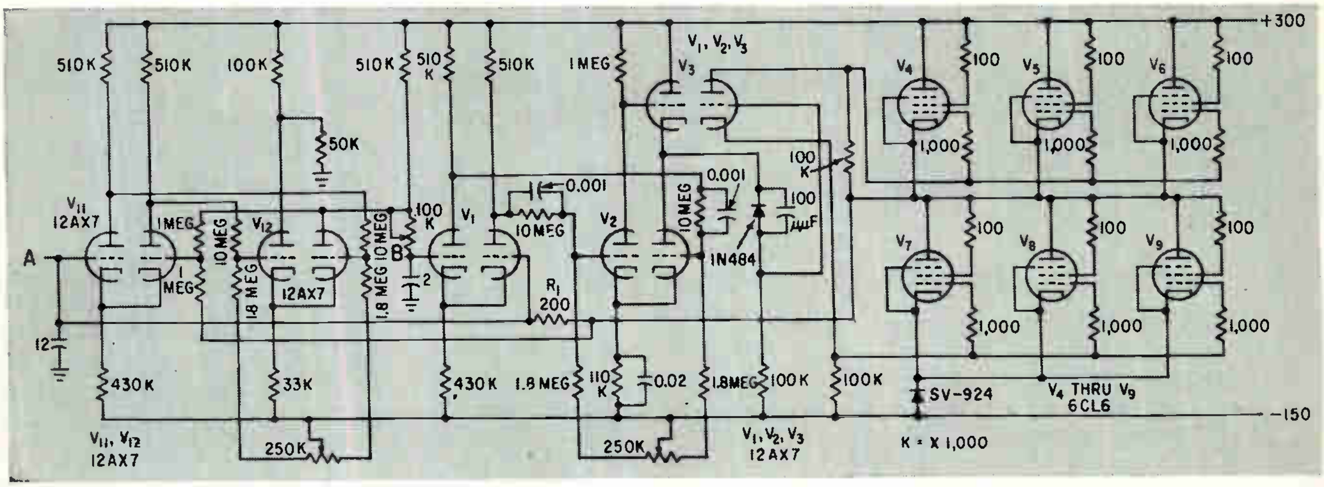


FIG. 4—Thermal air storage circuit uses configuration similar to the area amplifiers

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.

REFERENCES

(1) G. Burnand, The Study of the Thermal Behavior of Structures by Electrical Analogy, *British Jrl App Phys*, 3, p. 50-53, Feb. 1952.

(2) H. B. Nottage, G. F. Palmerlee, Circuit Analysis Applied to Load Estimating, *Heating and Piping*, 27, p 118-121, p 157-166, June, 1954; *Heating and Piping*, 27, p 117-122, p 123-131, Feb., 1955.

(3) G. F. Palmerlee, Analysis of an Air Conditioning Thermal Circuit by an Electronic Differential Analyzer, *Heating and Piping*, 28, p 117-123, Sept., 1956.

(4) Electrical Analogue Prediction of the Thermal Behavior of an Inhabitable Enclosure, *HPAC*, p 131, June, 1955.

(5) Analogue Computer Analysis of Residential Cooling Loads, *Heating, Piping and Air Conditioning*, 26, p 134-143, p 149-159, Oct. 1954.

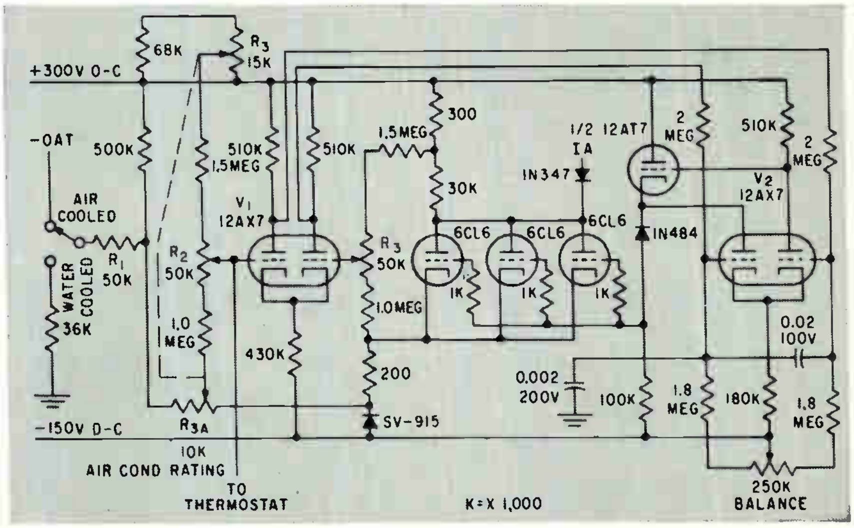


FIG. 5—Air-conditioner circuit simulates either air or water cooled air units with capacities up to 90,000 btu/hr.

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.

NUCLEAR 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

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

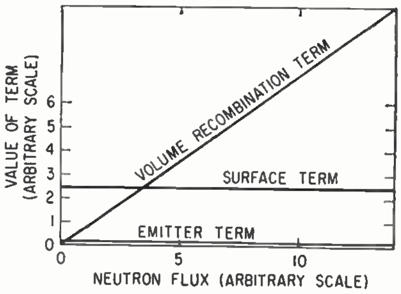


FIG. 1—Change in terms of Eq. 1 with neutron flux for typical transistor

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.[1] These values are determined primarily by high energy neutrons.

Effects on Transistors

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

$$\frac{1}{\beta} = \frac{SWA_s}{D_pA_e} + \frac{\sigma_bW}{\sigma_eL_{ne}} + \frac{1}{2}\left(\frac{W}{L_{pb}}\right)^2 \quad (1)$$

A similar relationship can be obtained for an *npn* 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

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

the volume recombination term can be written as

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

Equation 1 can be written as

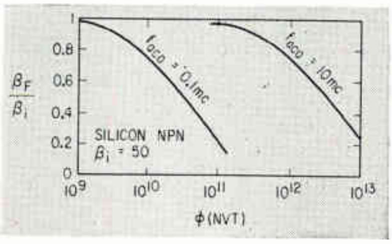


FIG. 2—Graph shows radiation resistance improving as $f_{\alpha co}$ increases

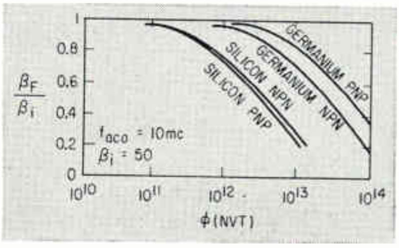


FIG. 3—Graph shows change in β as a function of neutron dosage

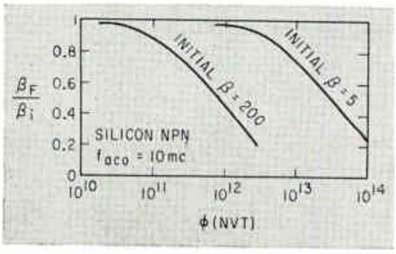


FIG. 4—Graph shows variation in initial β with radiation resistance

Radiation Environments

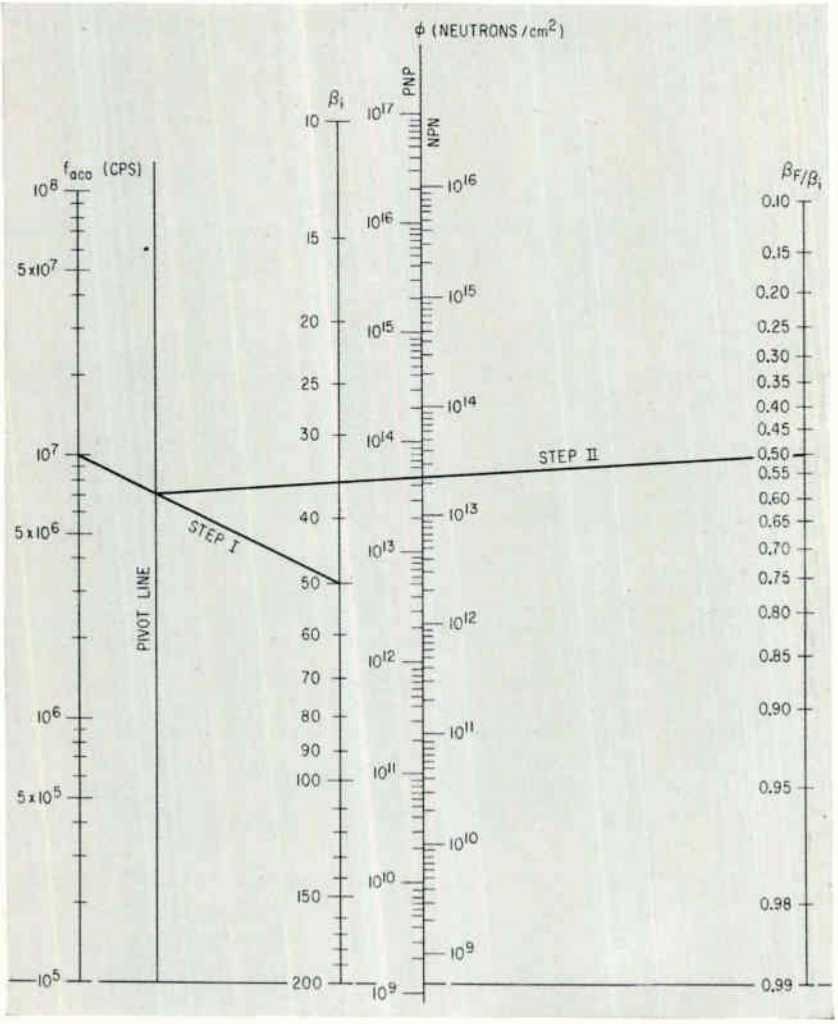


FIG. 5—Nomograph for obtaining variation in grounded emitter current gain of germanium npn and pnp transistors with neutron flux

$$\frac{1}{\beta} = \frac{SWA_s}{D_pA_e} + \frac{\sigma_b W}{\sigma_e L_{ne}} + \left(\frac{1.22}{2\pi}\right)\left(\frac{1}{f_{\alpha co}}\right)\left(\frac{1}{\tau_p}\right) \qquad (2a)$$

Under radiation

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

Substituting this expression in Eq. 2a gives

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

This leads to

$$\frac{1}{\beta_F} = \frac{1}{\beta_i} + \left(\frac{1.22}{2\pi}\right)\left(\frac{\phi}{Kf_{\alpha co}}\right) \qquad (3)$$

Normalizing

$$\frac{\beta_F}{\beta_i} = \frac{1}{1 + \left(\frac{1.22}{2\pi}\right)\left(\frac{\phi\beta_i}{Kf_{\alpha co}}\right)} \qquad (4)$$

Although Eqs. (3) and (4) were developed for a *pnp* transistor, they apply equally well to an *npn* 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_{co} is observed during irradiation. This increase is transient, and when the transistor is removed from the radiation, the I_{co} may decay to its original value or to an intermediate permanent damage value. In a fission environment, I_{co} begins to increase at approximately the same radiation dose at which β begins to decrease. The product βI_{co} can be considered as remaining constant, with I_{co} increasing as β decreases.

The change in I_{co} 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_{co}, even though the transient damage predominates.

Table I—Symbols

β	grounded emitter current gain
β_F	β after irradiation
β_i	β before irradiation
σ_b	base conductivity
σ_e	emitter conductivity
τ	minority carrier lifetime
τ_F	τ after irradiation
τ_i	τ before irradiation
ϕ	integrated neutron flux (nvt)
A_e	area of emitter junction
A_s	effective surface recombination area around emitter
D_p	diffusion constant for holes
$f\alpha_{co}$	alpha cutoff frequency
I_{co}	leakage current
I_e	emitter current
K	lifetime damage constant
L_{ne}	diffusion length for electrons in the emitter
L_{pb}	diffusion length for holes in the base
S	surface recombination velocity
W	base width

Radiation Resistance

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

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

which shows that the maximum neutron flux a transistor can tolerate, for a given allowable change in β, 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 ϕ by the same factor.

The lifetime damage constant, K, depends upon the type of material, as shown by Table II. The change in β 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)
n-type Ge	*pnp* Ge	$5.0 \pm 2.0 \times 10^7$
p-type Ge	*npn* Ge	$2.4 \pm 0.4 \times 10^7$
n-type Si	*pnp* Si	$2.8 \pm 0.8 \times 10^6$
p-type Si	*npn* Si	$3.2 \pm 1.1 \times 10^6$

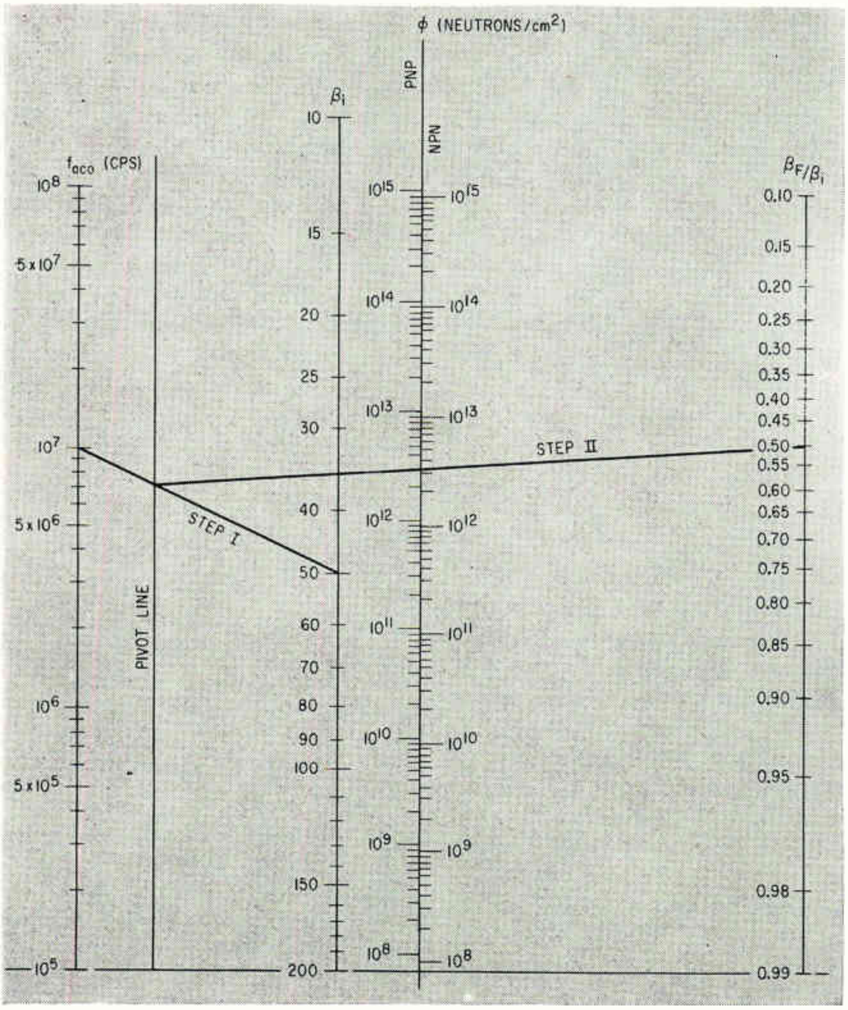


FIG. 6—Nomograph for obtaining variation in grounded emitter current gain of silicon *npn* and *pnp* transistors with neutron flux

Fig. 4 shows the variation of initial β with radiation resistance. The smaller the β_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 β_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 β_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 β_F/β_i value found tolerable. Read on the ϕ scale (*npn* or *pnp* depending on type transistor) the neutron dose that will cause the reduction in β.

As an example, if the manufacturer of a silicon *npn* transistor specifies an f_{aco} = 10 mc and β_i = 50, and if the design tolerance is β_F/β_i = 50 percent, then from Fig. 6, $\phi = 3.3 \times 10^{12}$ neutrons/cm².

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 ϕ, as described, and dividing this value by the neutron flux.

REFERENCE

(1) Messenger and J. P. Spratt, The Effects of Neutron Irradiation on Germanium and Silicon, *Proc. IRE*, 46, June 1958.

BIBLIOGRAPHY

H. Y. Fan and K. Lark-Horovitz, Irradiation Effects in Semiconductors, "*Effects of Radiation on Materials*," Reinhold Publishing Co., New York, 1958.

J. H. Crawford and J. W. Cleland, Radiation Effects in Semiconductors, "Progress in Semiconductors," Vol. II, John Wiley & Sons, New York, 1957.

J. J. Loferski, Analysis of the Effect of Nuclear Radiation on Transistors, *Jnl Appl Phys*, 29, January 1958.

W. M. Webster, On the Variation of Junction-Transistor Current Amplification Factor with Emitter Current, *Proc IRE*, 42, June 1954.

N. H. Fletcher, Note on the Variation of Junction Transistor Current Amplification Factor with Emitter Current, *Proc IRE*, 44, October 1956.

W. V. Behrens and J. M. Shaull, The Effects of Short Duration Neutron Radiation on Semiconductor Devices, *Proc IRE*, 46, March 1958.

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.

BIOLOGICAL 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[1], 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[2].

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.

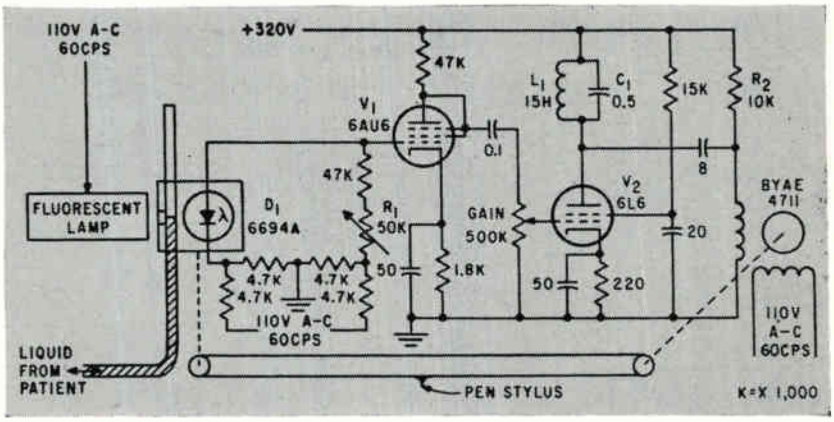


FIG. 1—Servo loop maintains photocell at meniscus level of liquid. Mechanical linkage also drives recording pen stylus

Servo Loop

The resistance of cadmium-sulphide 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. 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 reenforced 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.

REFERENCES

(1) W. E. Gilson, Manometer Recorder for Physiological Research, ELECTRONICS, p 152, Dec. 1954.
(2) M. Javid, Urea-New Use for an old Agent, Reduction of Intracranial and Intraocular Pressure, *The Surgical Clinics of North America*, p 907, Aug. 1958.

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 Impedance (ohm)	Diameters (inches) Inner Cond (nom)	Over Diel (nom)	Outer Cond (max)	Overall (nom)	Max Oper Volts RMS	Attenuation (db/100 ft) 400 mc	3 kmc	Remarks
(I) RG-5B/U	50	0.051	0.181	0.260	0.328	3,000	6.5	ND[a]	
(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[c]	5,000	6	ND[a]	armored version of RG-8A/U
(II) RG-215/U	50	0.089	0.285	0.34	0.475[c]	5,000	5.5	19	armored version of RG-213/U
(I, II) RG-12A/U	75	0.0177	0.285	0.34	0.475[c]	5,000	5.2	18.5	
(I) RG-13A/U	74	0.0477	0.28	0.355	0.42	5,000	5.7	ND[a]	
(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[c]	11,000	2.8	11	armored version of RG-17A/U
(II) RG-219/U	50	0.195	0.68	0.76	0.945	11,000	2.5	11	armored version of RG-218/U
(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
(II) RG-221/U	50	0.26	0.91	0.99	1.12	14,000	2.3	7.5	armored version of RG-221/U
(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[b]	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[c]	1,900	11.7	10	
(II) RG-223/U	50	0.035	0.116	0.176	0.216[c]	1,900	11.7	40	
(I, II) RG-58C/U	50	0.0375[c]	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
(II) RG-224/U	50	0.106	0.37	0.463	0.545	7,000	4.3	14	armored version of RG-217/U
(I, II) RG-81/U	50	0.0625	0.321	0.375[d]	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[c]	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
(II) RG-225/U	50	0.0936	0.285	0.36	0.43	5,000	5	14	high power (Teflon) version of RG-214/U
(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
(II) RG-226/U	50	0.127	0.37	0.44	0.5	7,000	3.8	14	high power (Teflon) version of RG-217/U
(I) RG-117/U	50	0.188	0.62	0.67	0.73	7,000	2.3	ND[a]	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[a]	armored version of RG-117/U
(II) RG-228/U	50	0.19	0.62	0.67	0.78	7,000	2.3	10	armored version of RG-211/U
(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
(II) RG-143A/U	50	0.059	0.185	0.25	0.325	3,000	6	18	high power (Teflon) version of RG-212/U
(II) RG-187/U	75	0.012	0.06	0.084	0.11[c]	1,200	21	ND[a]	miniature Teflon cable
(II) RG-188/U	50	0.02	0.06	0.081	0.11[c]	1,200	20	ND[a]	miniature Teflon cable
(II) RG-195/U	95	0.012	0.102	0.124	0.155[c]	1,500	17	ND[a]	miniature Teflon cable
(II) RG-196/U	50	0.012	0.034	0.054	0.08[c]	1,000	29	ND[a]	miniature Teflon cable

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

for Military Applications

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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 USASRDL 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.

BIBLIOGRAPHY

Specification MIL-C-17B, Cables, Radio Frequency, Coaxial, Dual Coaxial, Twin Conductor and Twin Lead, Supplement 1C, Jan. 2, 1959.

Armed Services Index of R. F. Transmission Lines and Fittings, ASESA Pub. 49-2B.

M. Pomerantz, USASEL Tech. Memo. TM-1896, Modification of Existing RF Coaxial Connectors.

Table II—Connectors for Group II Cables

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

(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

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

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,
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SUPERSONIC 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 performed 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[1]. 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[2], and atmospheric refraction[3], may be obtained if the radar system is sensitive enough to detect this solar noise. This technique is limited 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.

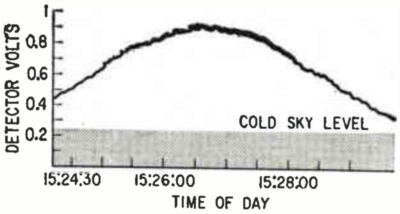

FIG. 1—Receiver second-detector voltage varies as sun drifts past antenna beam

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 occationally 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.

Calibrates Radars

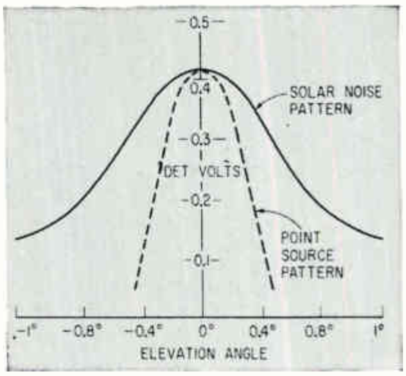

FIG. 2—Solar noise pattern compared with point source pattern, as a function of elevation angle

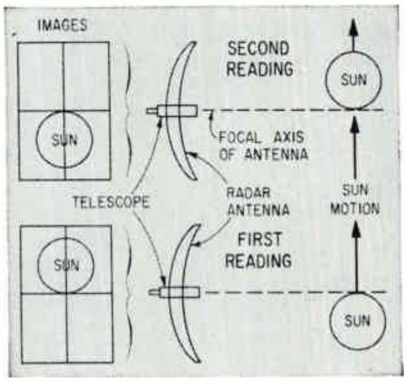

FIG. 3—With antenna stationary in path of sun, second detector voltage is measured at sun upper and lower limbs

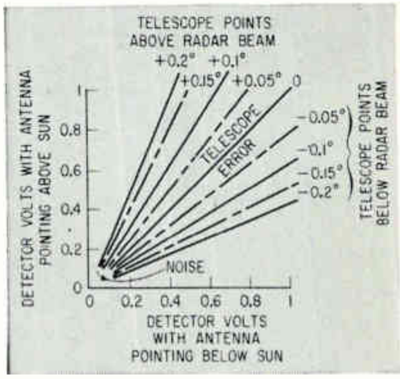

FIG. 4—Boresight correction chart determines degree of misalignment between boresight telescope and radar beam

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 distention 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 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 μsec 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 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.

REFERENCES

(1) G. Reber, Cosmic Static, *Astrophys J*, 100, p 279.

(2) S. Matt and J. D. Kraus, The Effect at Source Distribution on Antenna Patterns, *Proc IRE* 43, p 821, July, 1955.

(3) J. Aarons, W. R. Barron and J. P. Castelli, Radio Astronomy at VHF and Microwaves, *Proc. IRE*, 46, p 325, Jan. 1958.

(4) J. S. Hey and V. A. Hughes, A Method of Calibrating Radiometers Using a Standard Noise Source, *Proc IRE*, 46, p 119, Jan. 1958.

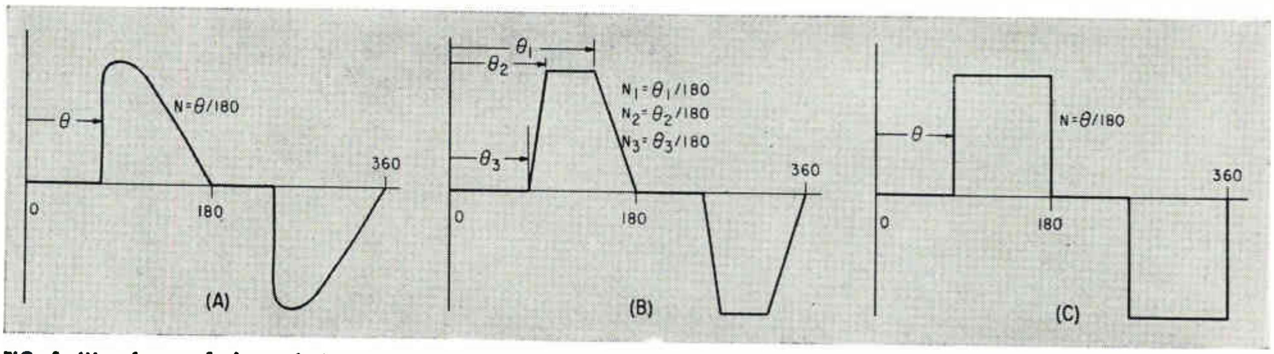

FIG. 1—Waveforms of chopped sine wave (A), assymetrical chopped trapezoidal wave (B) and chopped square wave (C) show angle measurements required

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.

FREQUENTLY, 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 θ. 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

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

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 I—Glossary of Terms

θ—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 $F = E_{rms}/E_{d-c}\ 1.11 =$

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

Equation (1) is plotted in Fig.

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2 as a function of N and θ and is labeled SINE.

Square Wave

For the trapesoidal 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

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

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

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

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

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

$$\therefore F = \frac{1}{1.11}\frac{1}{\sqrt{1-N}} \quad (4)$$

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:

$E_{rms} = 1.27 \times 110 = 140$ v
$I_{rms} = 1.27 \times 2 = 2.54$ amp

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

$E_{rms} = 1.31 \times 110 = 144$ v
$I_{rms} = 1.31 \times 2 = 2.6$ amp

Thus, the actual power output for these conditions would be 144×2.6 or 375 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 $N = 120/180 = 0.67$.

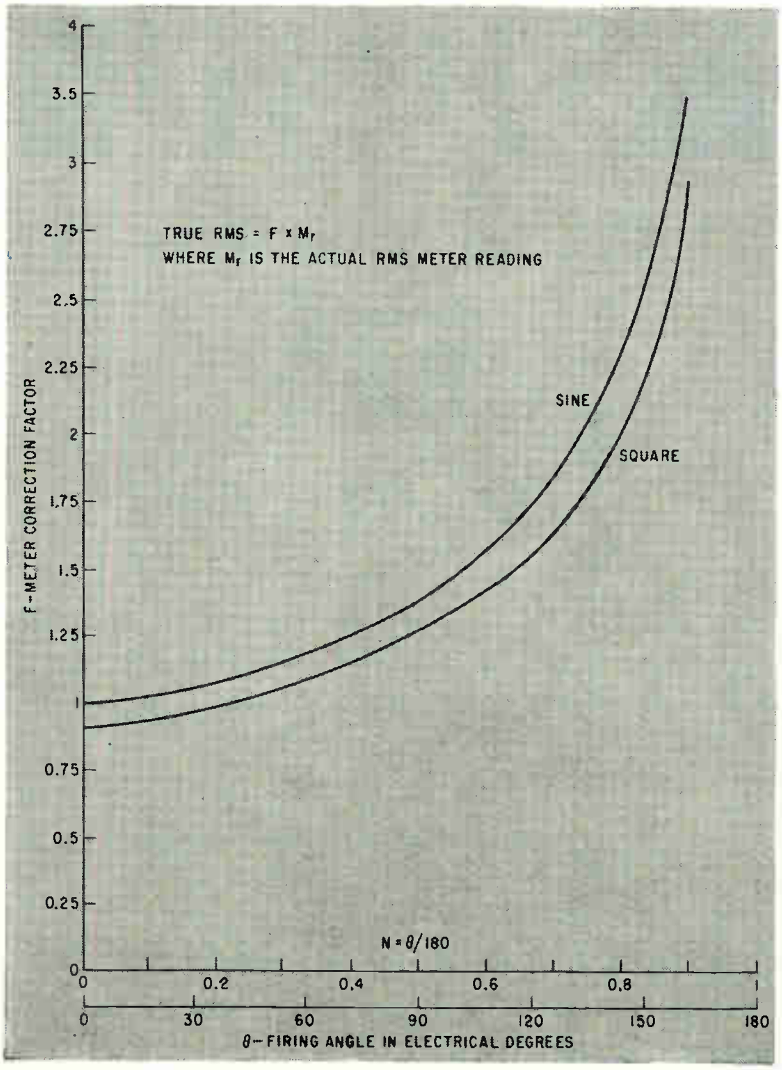
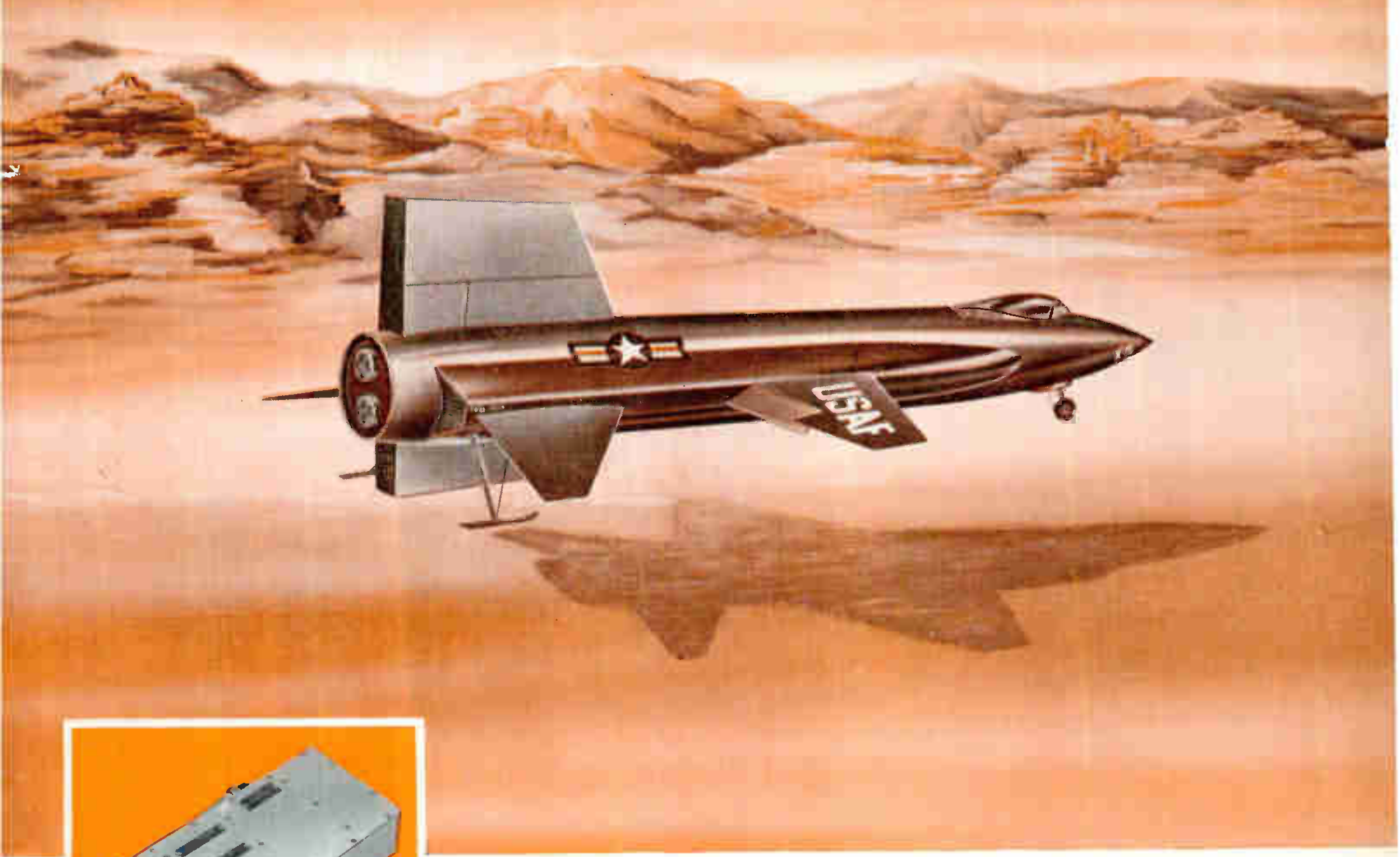


FIG. 2—Relationship of firing angle to correction factor is indicated

Another example of LFE capability in airborne electronics



LFE Magnetic Amplifier controls frequency and load division between alternators. It is employed in the power supply systems of both the X-15 and B-52.

How LFE *helped solve power control problems for the X-15*

When the X-15 zooms to the outer fringes of the atmosphere where there is inadequate natural combustion, two auxiliary systems . . . fueled by hydrogen peroxide . . . become the sole source of power.

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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 (±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 cros 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.

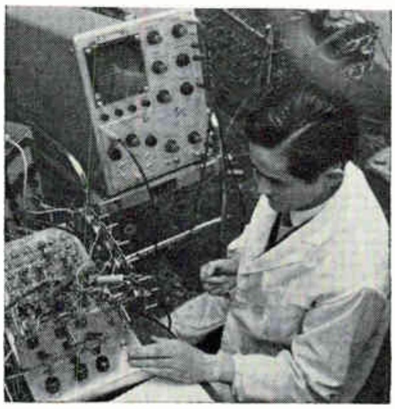
This project is not a mechanization of the Bureau's present prediction program. It is instead an attempt to make the most effective use of high-speed computers.

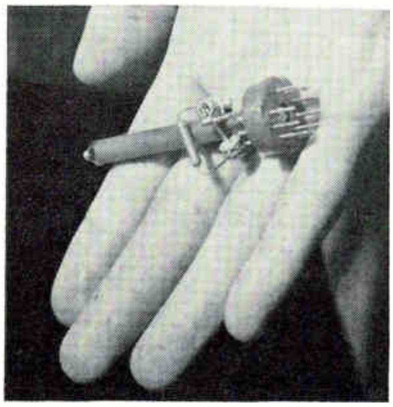
Most data in radio propagation experiments are continuously recorded over a period of time, mostly in analog form. Where a large amount of data must be reduced to not more than between 1 and 5 percent accuracy, special purpose analog computers have been constructed. One is a special application of an 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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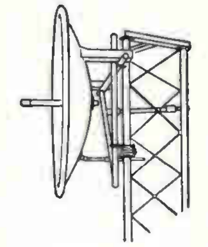
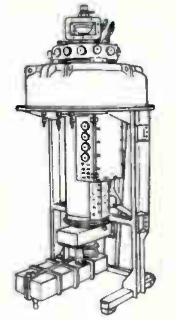
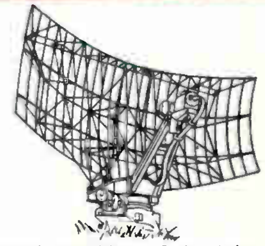


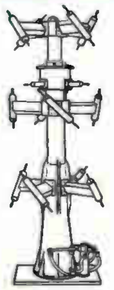
Point-to-Point Communication Antennas



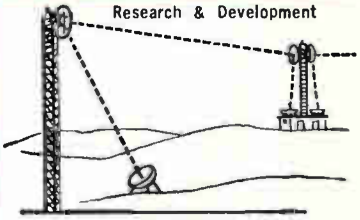
Multi-Channel Rotary Joints



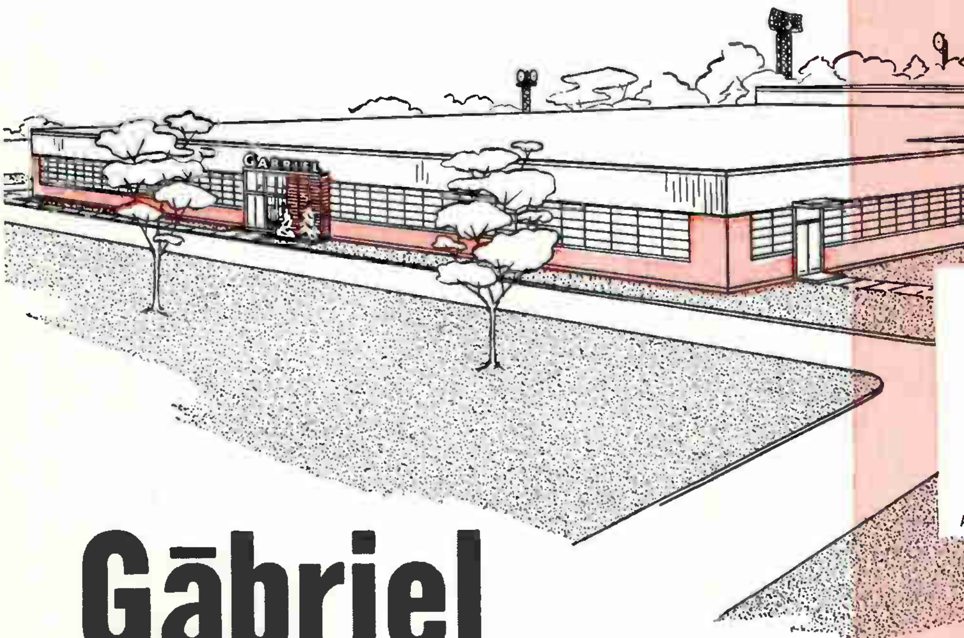
Airport Surveillance Radar Antennas



Drone & Drone Control Antennas



Passive Reflector Study Of Off-Angle Transmission



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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.

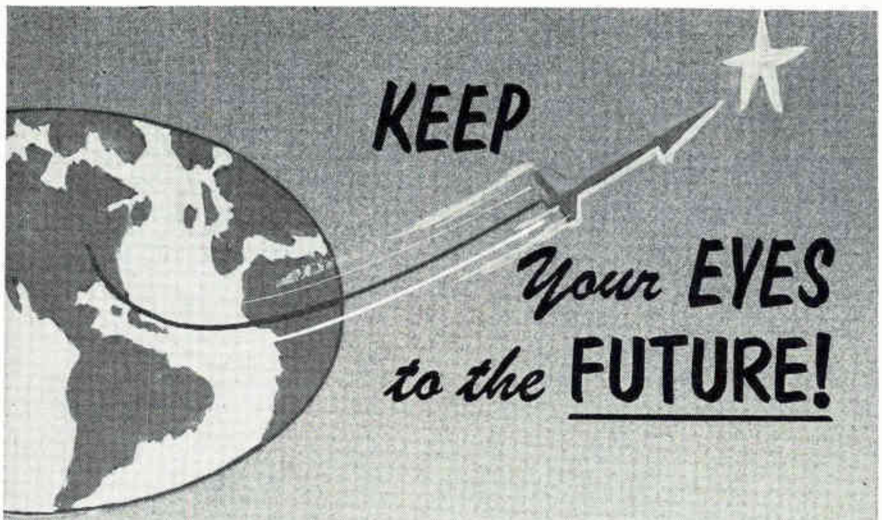
In sferics studies (naturally occurring atmospheric radio signals), signals are analyzed into individual frequency components. This analysis proved valuable in studies of attenuation of sferics and low-frequency radio waves traveling through the atmosphere.

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



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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 μv, 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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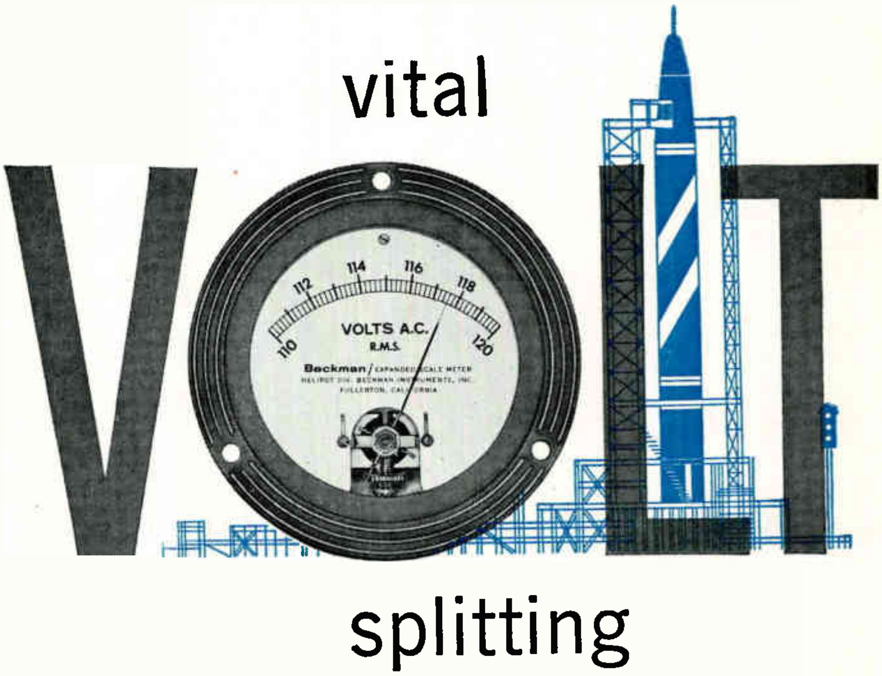

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"WE WOULD LIKE our insulation to occupy no volume, to be weightless, but still perform its function as a dielectric barrier impervious to contaminants and with perfect heat transfer characteristics".[1] This would be the ideal electrical insulation, 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[2]. 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.

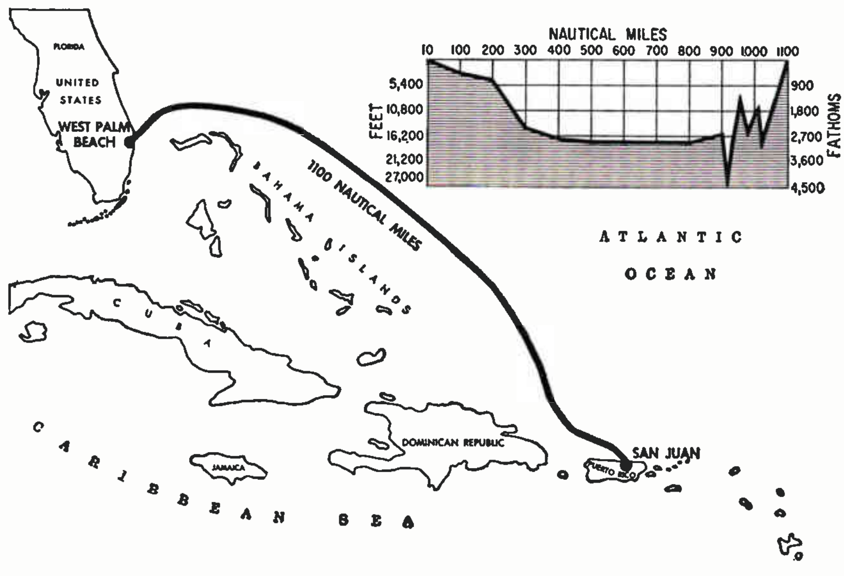
Stable Polymers

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.[3] 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

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

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

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

The session on elevated temperature printed circuits included a paper on reliable printed circuits[15]; a study of high temperature resistance of copper clad laminates[16]; a paper that outlined high temperature peel strength vs conductor lifting on printed circuit laminates[17]; a glass microfiber-reinforced Teflon insulation made by a paper type process[18]; and printed wiring on ceramic bases[19]. 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.[20]

REFERENCES

(1) J. S. David, Insulation System for Low-Voltage, Very Low Speed Rotating D-C Equipment, General Electric, AIEE CP 5087

(2) J. D. Walton, Jr. and J. N. Harris, Ceramics for High Temperature Electrical Insulation, Georgia Institute of Technology, AIEE CP 5058

(3) R. V. Einstman, MK Coated Fabrics—A New High-Temperature Sheet Insulation, E. I. duPont De Nemours & Co., Inc., AIEE CP 5069

(4) C. A. Heiberger, C. W. Johnston and R. M. McFarland, An Improved Diallyl Phthalate Material for Dimensional and Electrical Stability in Electronic Applications, Food Machinery and Chemical Corp., AIEE CP 5060

(5) J. T. Long, Encapsulation with Alkyd Molding Compounds, Allied Chemical Corp., AIEE CP 5061

(6) D. F. Christensen, Dielectric Gel, A New Silicone Potting Compound, Dow Corning Corporation, AIEE CP 5063

(7) D. S. Preston, Development of High-Temperature Flexible Cable, Hughes Aircraft, AIEE CP 5077

(8) R. W. Korb, J. C. Case and V. C. Lazzaro, The Development of a High Temperature Flat Harness for an Electrical Rotary Joint, Hughes Aircraft, AIEE CP 5078

(9) J. J. Casey, High Temperature Performance of Wire and Cable Insulated with Teflon TFE and FEP Fluorocarbon Resins, AIEE CP 5088

(10) L. A. Dixon, Use of One-Component Epoxy Systems in High Reliability Transformers, Houghton Laboratories, Inc., AIEE CP 5076

(11) N. W. Edgerton, Dielectric Strength Test Equipment, Johns-Manville Corp., AIEE CP 5085

(12) K. Wechsler, Conditioning for Dielectric Strength Tests, Westinghouse Electric Corp., AIEE CP 5089

(13) H. S. Endicott, Procedures for Measurement of Dielectric Strength, General Electric Co., AIEE CP 5090

(14) C. L. Craig, Interpretation of Dielectric Strength Results, Sperry Gyroscope Co., AIEE CP 5083

(15) J. Monturo and L. Krauss, Reliable Printed Circuits, Arma Division, American Bosch Arma Corporation, AIEE CP 5055

(16) J. S. Taylor and A. H. Haroldson, A Study of High Temperature Resistance of Copper Foil Clad Laminates, Continental-Diamond Fibre Div., The Budd Co., AIEE CP 5105

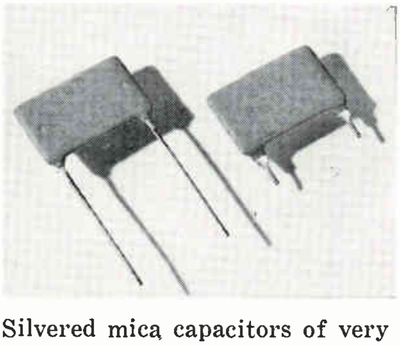
(17) L. A. Gunsaulus, High Temperature Peel Strength vs Conductor Lifting on Printed Circuit Laminates, Photocircuits Corporation, AIEE CP 5036

(18) R. C. Berry and N. L. Greenman, Glass Microfiber-Reinforced Teflon Insulation Made By A Paper Type Process, Rogers Corporation, AIEE CP 5047

(19) J. J. McManus and L. Ferreira, Printed Wiring on Ceramic Bases, Coors Porcelain Company, AIEE CP 5082

(20) J. S. Hurley, Jr., Progress in Silicone Insulation, General Electric Co., AIEE CP 5097

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 ⅛ in. and are available in 7 sizes with overlapping capacitance ranges.

The components are distributed by British Radio Electronics Ltd, Washington 6, D. C.

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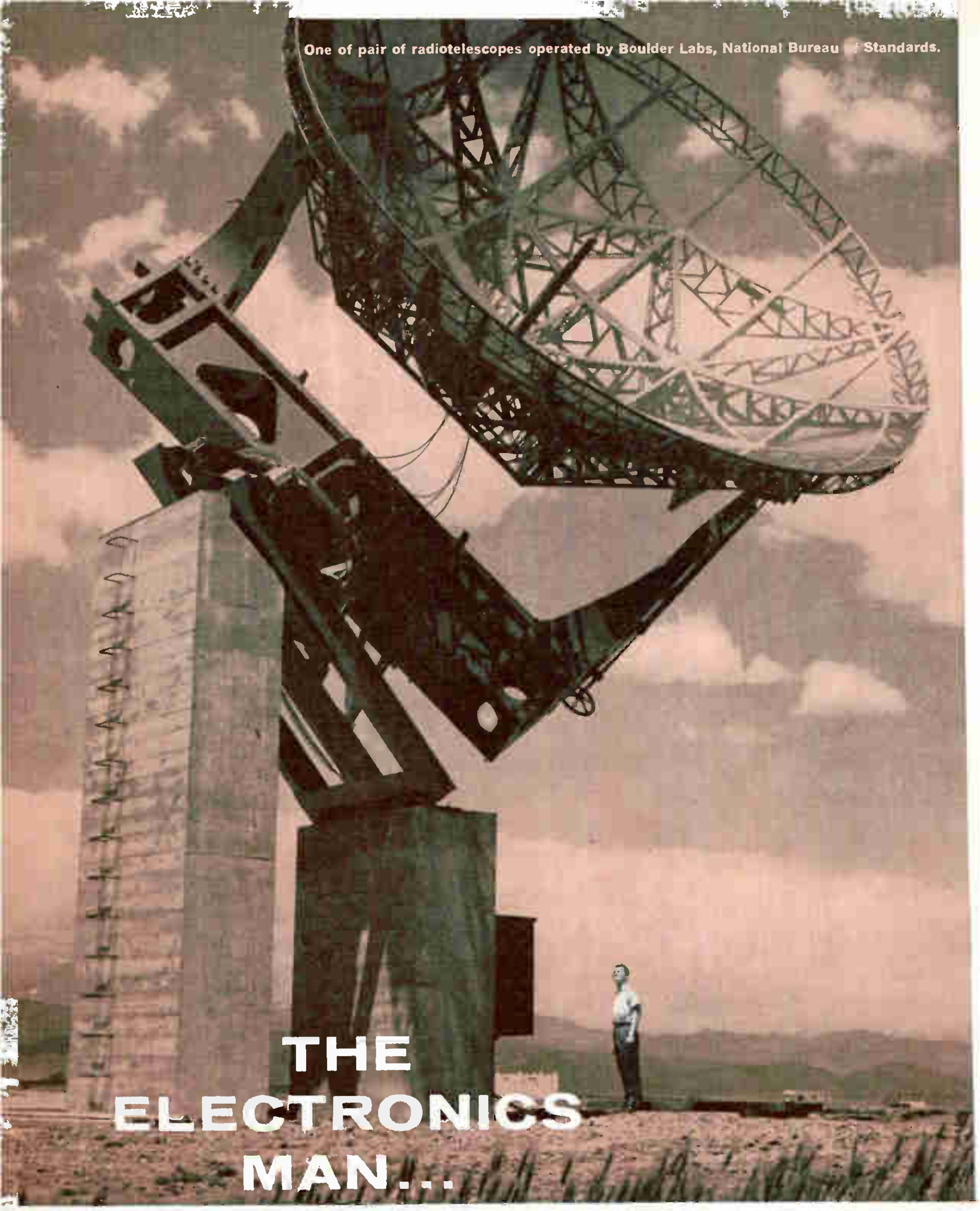

One of pair of radiotelescopes operated by Boulder Labs, National Bureau of Standards.

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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.

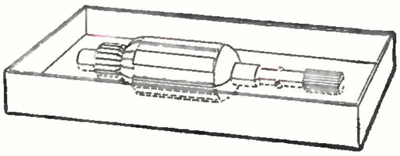

FIG. 2—Armature is placed in frame to pour mold half

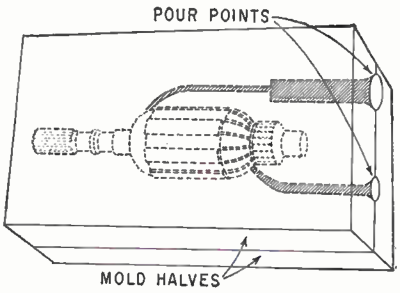

FIG. 3—Phantom view of closed mold

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

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

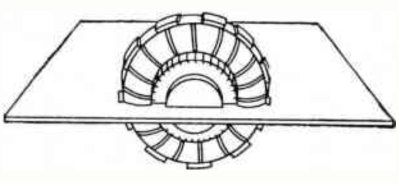

FIG. 1—Establishing mold parting line

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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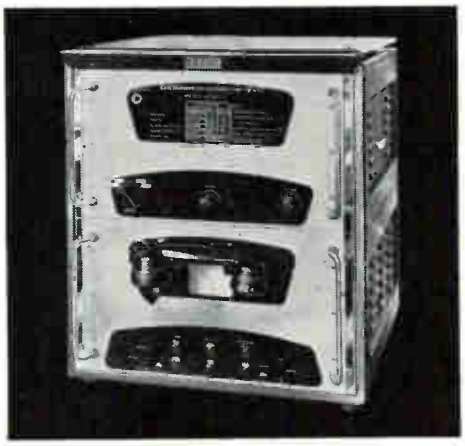

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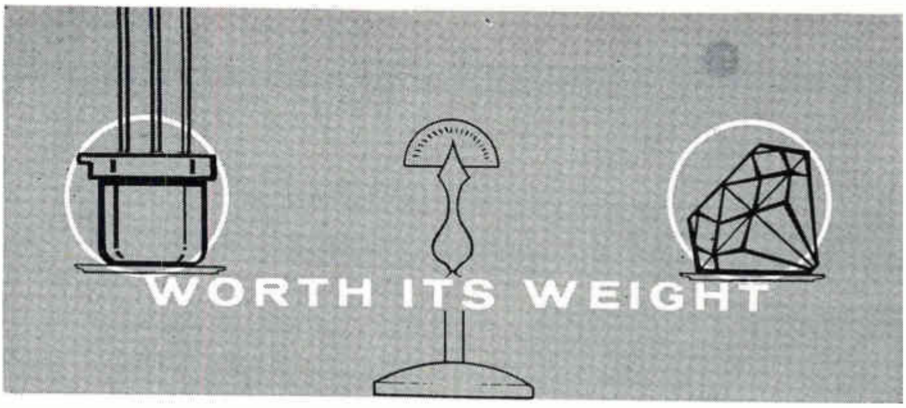

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portion of hardener used. Gravity pour provides a smooth surface, entrained air being displaced by fillers.

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TRANSPARENT PLASTIC blisters are used by International Business Machines Corp., New York, to package computer relays. The sealed blisters protect the relays from dust and humidity and also minimize handling damage.

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-

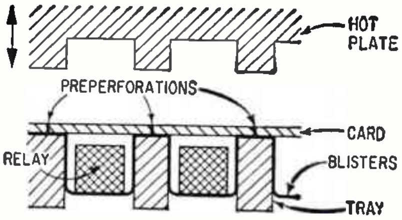
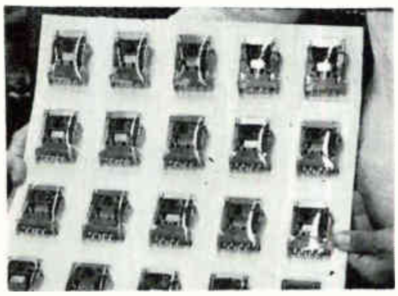


FIG. 1—Hot plate seals blister flanges to card

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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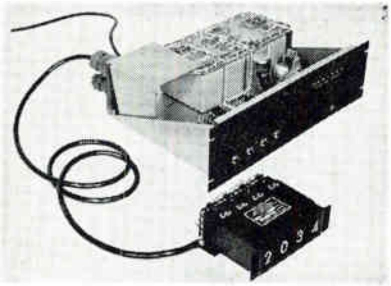

Digital Clock used in process control

PARABAM, INC., 13000 Yukon Ave., Hawthorne, Calif. New standard digital clock is designed for use in process control systems. By utilizing sealed components the clock may be safely operated in areas where explosive gases are present. When used in standard data logging, programming, or computer applications, the clock requires littie preventive maintenance. The unit oil-filled step switches, mercury wetted relays and sealed switches.

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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 output impedance selection 4, 16, 64, 600 or 2,400 ohms. Frequency response of the matching transformers is 30 cps to 150 kc ± 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 actuated 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.

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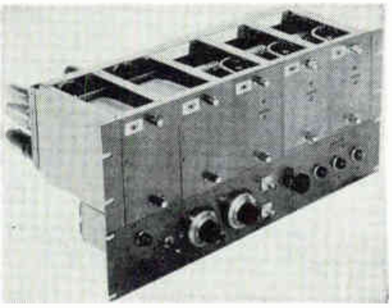

Voltage Comparator precision unit

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 ½ 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.

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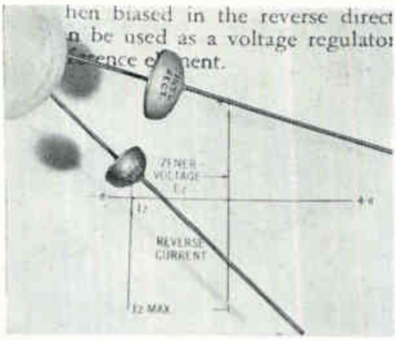

Silicon Zener Diodes
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INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. An economy line of silicon Zener diodes, designed specifically for commercial equipment applications, demonstrate low Zener impedance values and very sharp Zener "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
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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 reduced 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 $\mu\mu$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

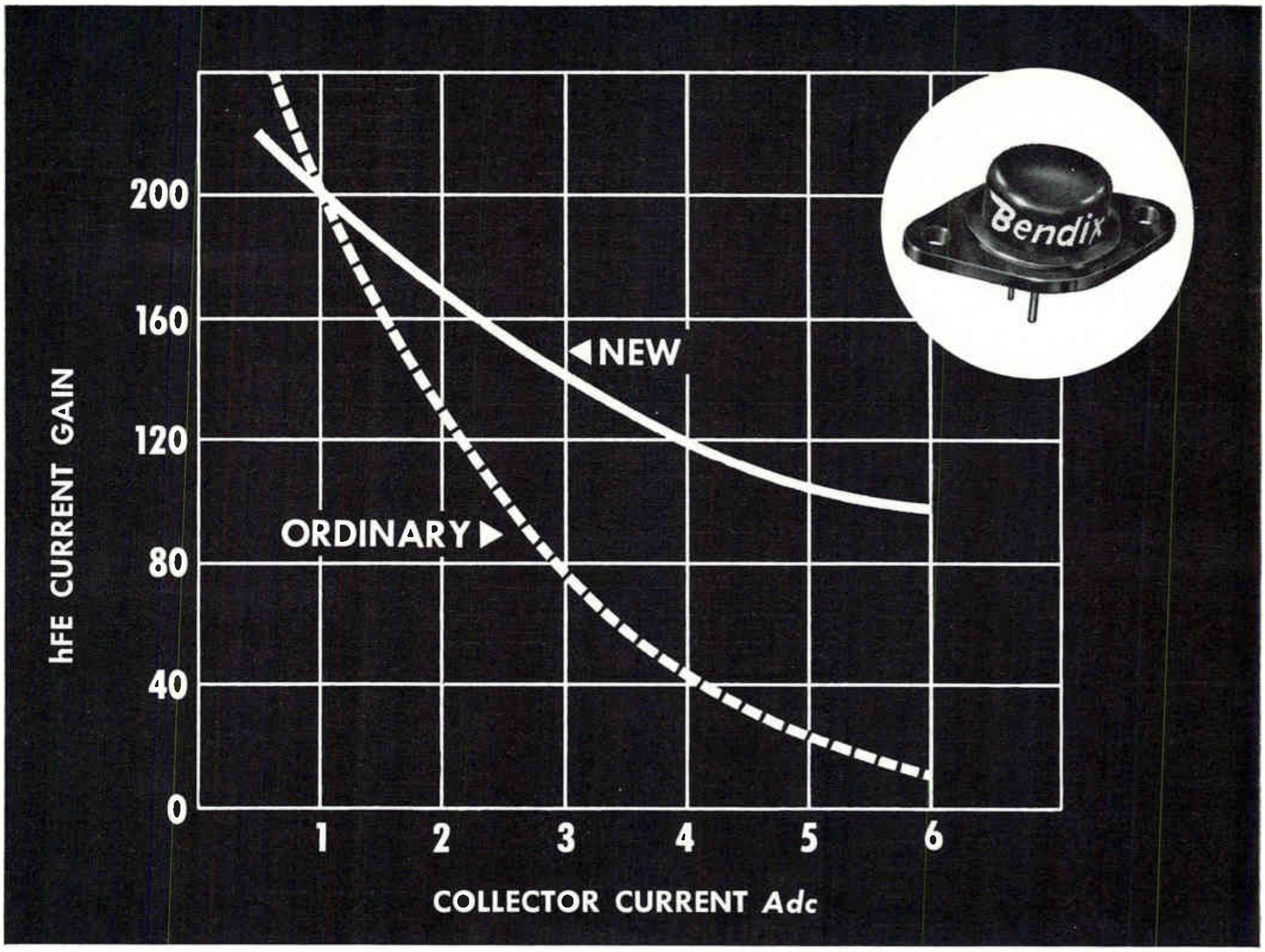
TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas. Type 130 diffused silicon *pnpn* controlled rectifier is a four-layer device expected to be used widely in regulated power supplies, reversing drives, light diming devices, surge voltage suppression, latching relays and many other applications. They feature 50 to 400 v in both piv and breakover voltage with an average rectified forward curent 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 ½ 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	Vcb 90	Vcb 100
	Vce 40	Vce 70	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
New England Sales Office: 4 Lloyd Road, Tewksbury, Massachusetts
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.

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AVIATION CORPORATION

1959 Index to electronics

McGRAW-HILL PUBLISHING CO.
330 West 42nd St. New York 36

January to December Issues Inclusive VOLUME XXXII

TECHNICAL INDEX

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 BF, 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.

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18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338	358	378	398
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	359	379	399
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400

Searchlight Section

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462	465	468	471	474	477	

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THE ELECTRONICS MAN... A SPECIAL BREED

In most industries the management man went to business school and doesn't concern himself with design problems.

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The electronics man is different.

He is many things. He is in Research-Design-Production-Management. His interests are in any or all of the four areas.

No matter where you find the electronics man his engineering background enables him to influence the purchase of electronic components and equipment. Your advertising must reach him if you are to sell electronic goods.

This is the strength of **electronics**, the one magazine published weekly and edited to reach this engineering oriented electronics man, wherever he is.

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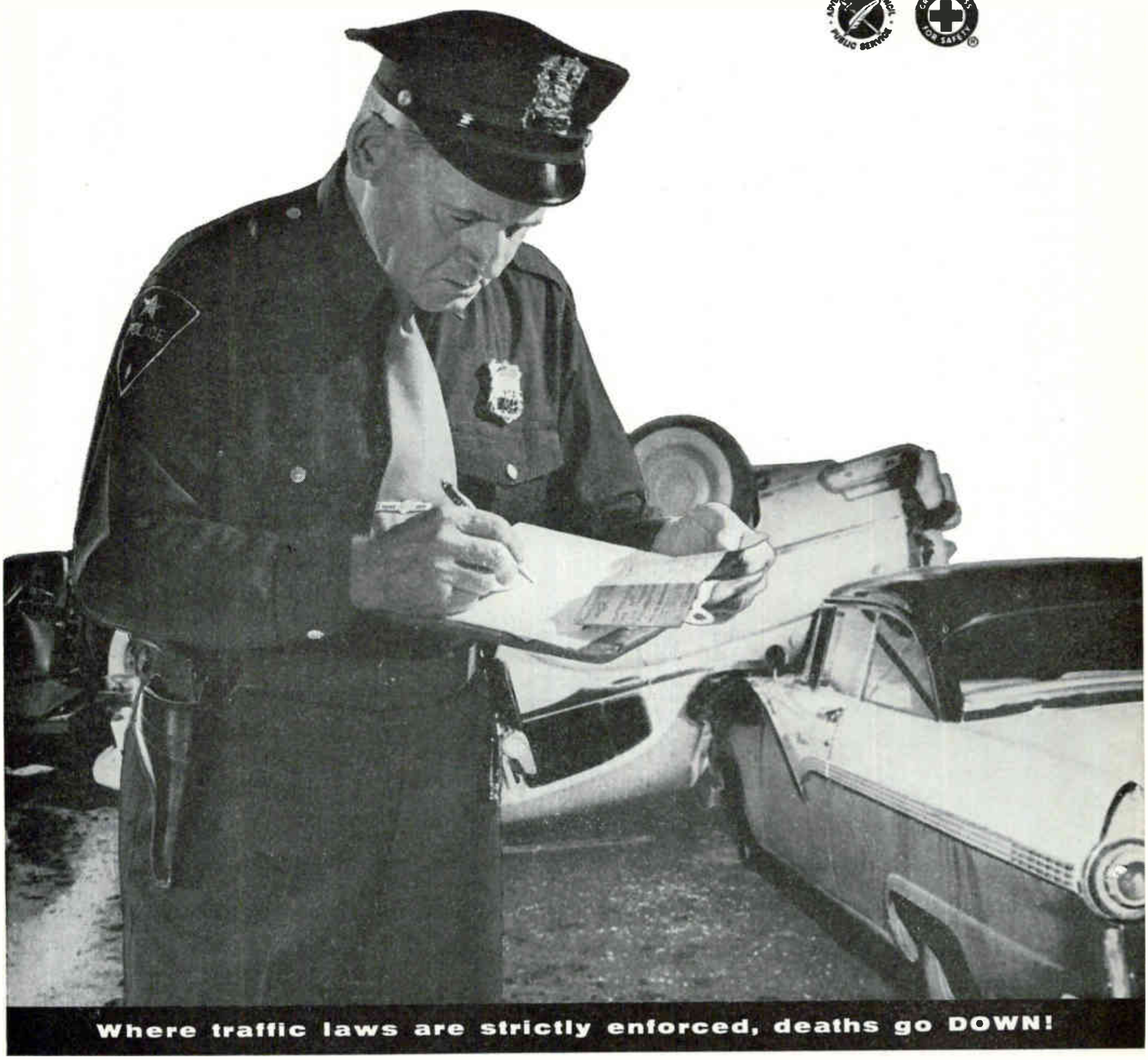
Last year, traffic accidents killed 37,000, injured 1,400,000

...and they wasted Five Billion Dollars!

Traffic accidents' human toll is so tragic we sometimes overlook their staggering economic waste. Five Billion Dollars in lost wages, medical expenses, insurance costs and property damage! Your business—every business—shares in this loss. So you have a double interest in helping reduce traffic accidents. And you *can* help! Drive safely and obey the law yourself . . . certainly. But go further. Use your influence to promote safe driving and urge strict law enforcement. To make your efforts more effective, join with others working actively to reduce traffic hazards in your community. *Support your local Safety Council!*



Published in an effort to save lives, in cooperation with the National Safety Council and The Advertising Council.

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.

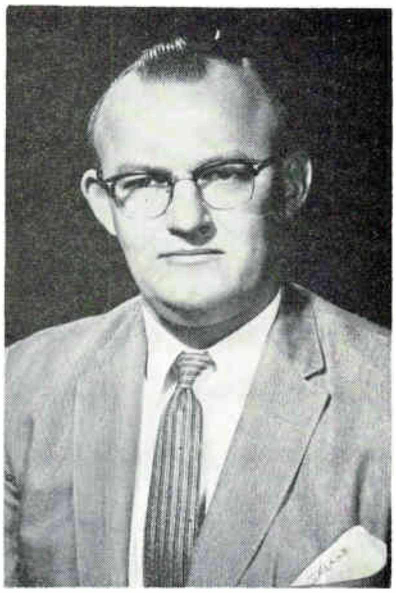
GI Subsidiary Names Exec-VP

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.

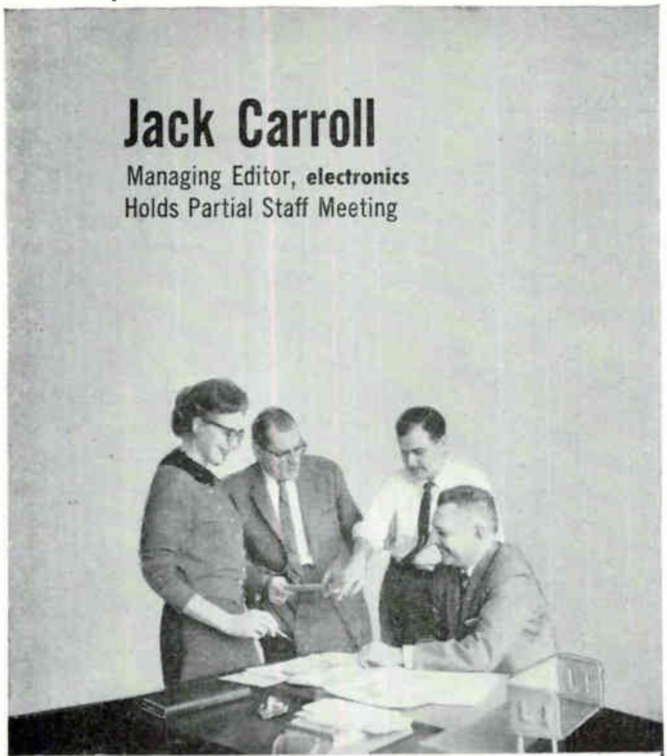
Name Goldberg Section Head

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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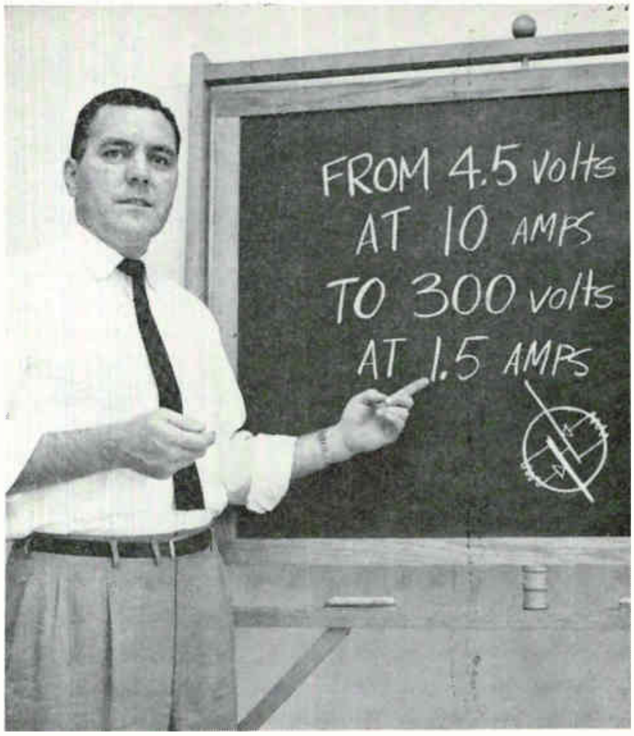

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- For input voltages from 105-125 VAC, 50-62 cps.

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VOLTAGE RANGE (VDC)	250-300	200-250	125-150	25-32	4.5-9.0	100-200
CURRENT RANGE (AMPS)	0-1.5	0-1.5	0-1.5	0-1.5	0-10.0	0-0.4
REGULATION	0.2%	0.2%	0.2%	0.2%	0.2%	0.01%
IMPEDANCE (OHMS) (1) DC to 100KC (2) DC to 1KC	0.2 (1)	0:2 (1)	0.2 (1)	0.2 (1)	0.02 (2)	0.8 (2)
RIPPLE (RMS)	2MV	2MV	2MV	2MV	2MV	2.5MV
METERS	1. output voltage 2. output current 3. transistor monitor voltage				1. output voltage 2. output current	
PANEL HEIGHT	5¼″	5¼″	5¼″	5¼″	9″	9″
DEPTH	12″	12″	12″	12″	9″	9″

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COMMENT

Magazines for Friendship

Your magazine should regularly be found in all large public libraries abroad, and in all large foreign universities. Each copy would then be read by scores of people.

Meantime the Communists are spreading their materials in all foreign languages, while foreigners have little notion of the intellectual life of the USA.

Please urge your readers to send their used copies of ELECTRONICS to some foreign public library or university, where avid readers await them. We would be happy to allot some foreign library to those who write us. India alone needs 2,000 copies.

This is one dynamic way whereby the USA can win the prestige and respect we want from foreign intellectuals. Your magazine can become a powerful ambassador of goodwill—if only your subscribers will mail their copies "over there."

This simple program can do more to win international goodwill than any other measure. . .

ALBERT CROISSANT
MAGAZINES FOR FRIENDSHIP, INC.
OCCIDENTAL COLLEGE
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.

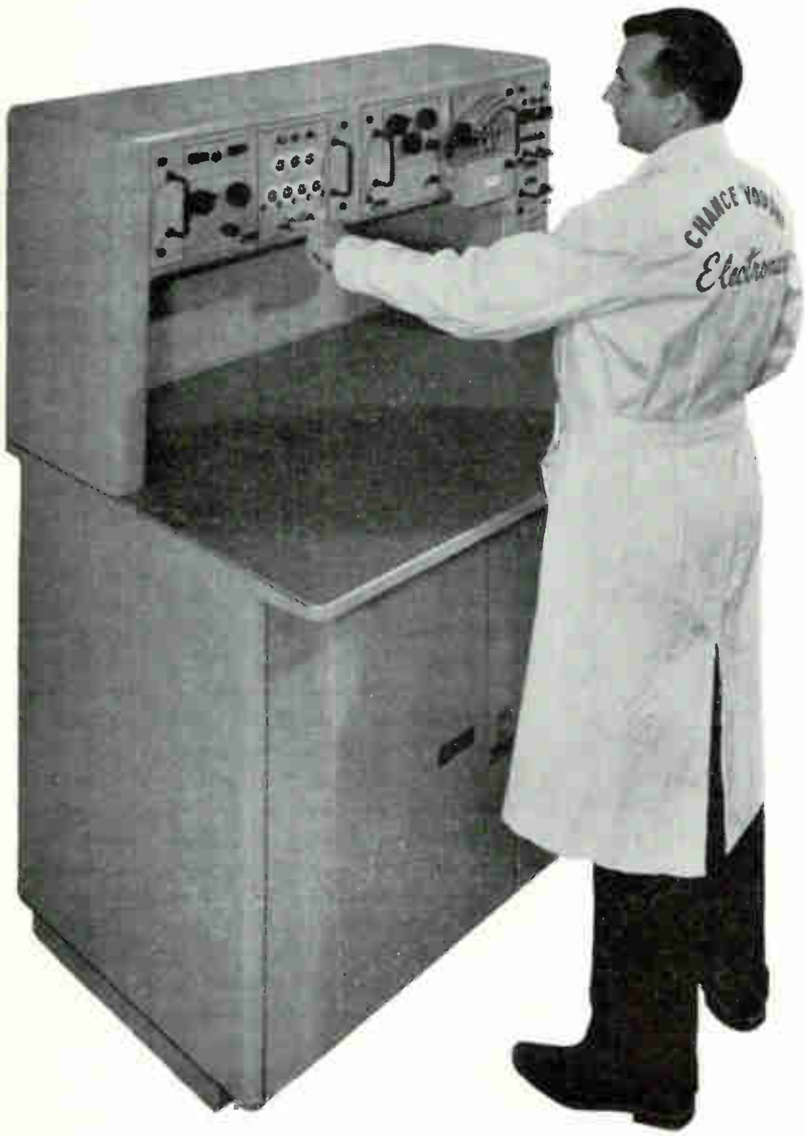
The article says nothing about cellulose-acetate film with a photographic emulsion. What is the status of videotape manufacture at this time? A recent show which starred Gisele McKenzie and Jimmy Durante was, according to the *Milwaukee Journal* tv magazine write-up, recorded in color on tape. Does this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

Transistorized . . . programmed with perforated tape — this set is a versatile means for testing drone radio command guidance systems. Its automatic features are typical of test and checkout equipment produced by Chance Vought's Electronics Division. These people have provided GSE support for radar and inertial guidance; flight stabilization; warhead arming and fuzing; rocket engine and telemetering systems. Altogether, over 4,500 articles of GSE equipment have been delivered in these and other programs.

This capability is available to the company or service that needs it. A recent letter from Vought Electronics describes experience, labs and representative products in detail. It was mailed to military agencies and weapons developers—primarily to guidance system developers.

If you haven't received this letter . . . if you want to know more about an experienced source of GSE support for small and large jobs, write:

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A DIVISION OF CHANCE VOUGHT AIRCRAFT, INCORPORATED • DALLAS, TEXAS

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NATIONAL COVERAGE

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ELECTRONIC COMPONENT ENGINEERS

Unusual opportunity to participate in greatly accelerated and expanded program of product engineering and product development. Engineers with experience in the design of the following components are invited to submit a brief resume.

- Pulse Networks
- High Voltage Capacitors
- Radio Noise Filters
- Plastic Film Capacitors
- Metallized Film and Paper Capacitors
- Delay Lines
- Wave Band Filters
- Component Reliability

Large component manufacturer with multi-plant operation located in the East.

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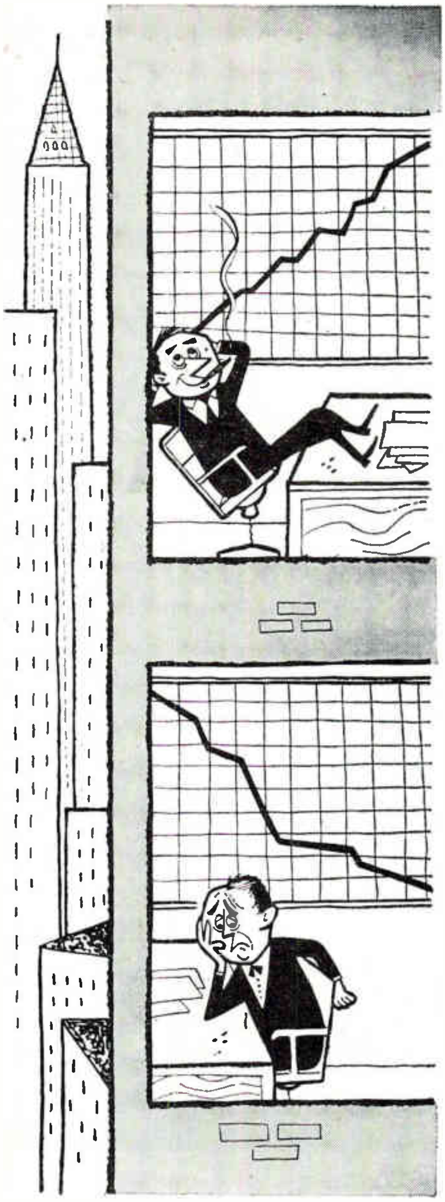

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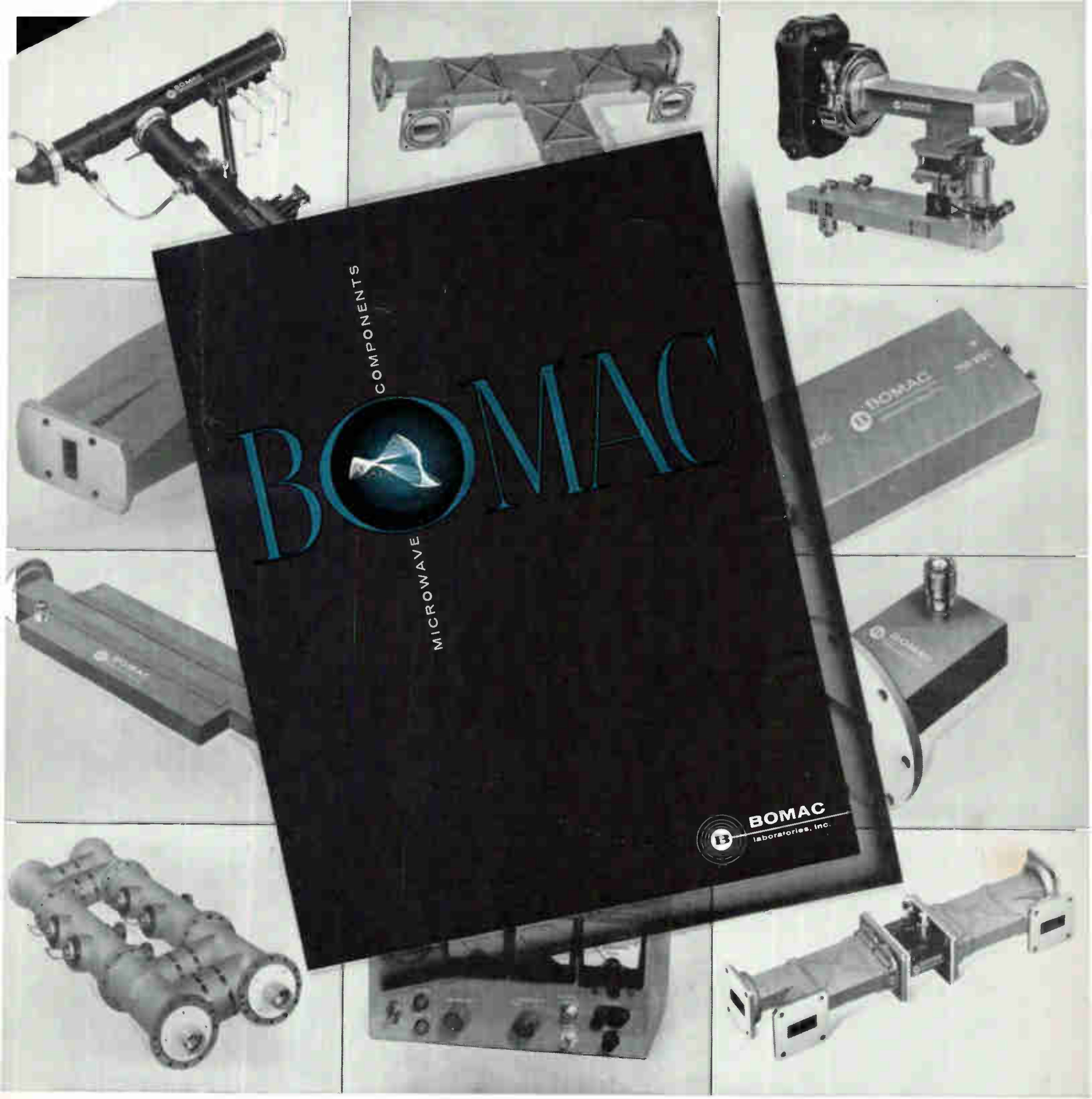

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