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electronics

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MISMATCHING FOR STABILITY

Design of better tuned amplifiers, p 50

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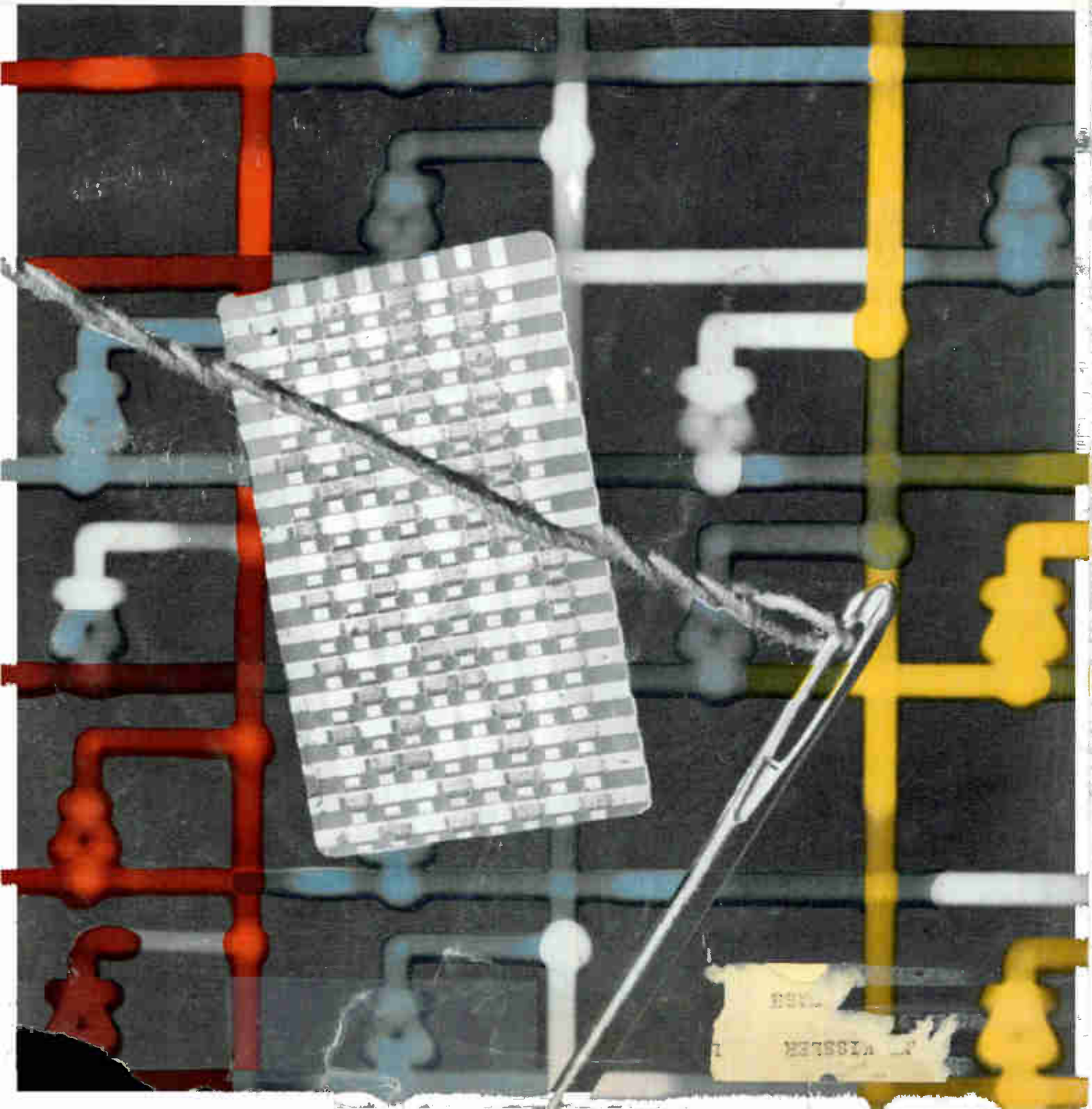
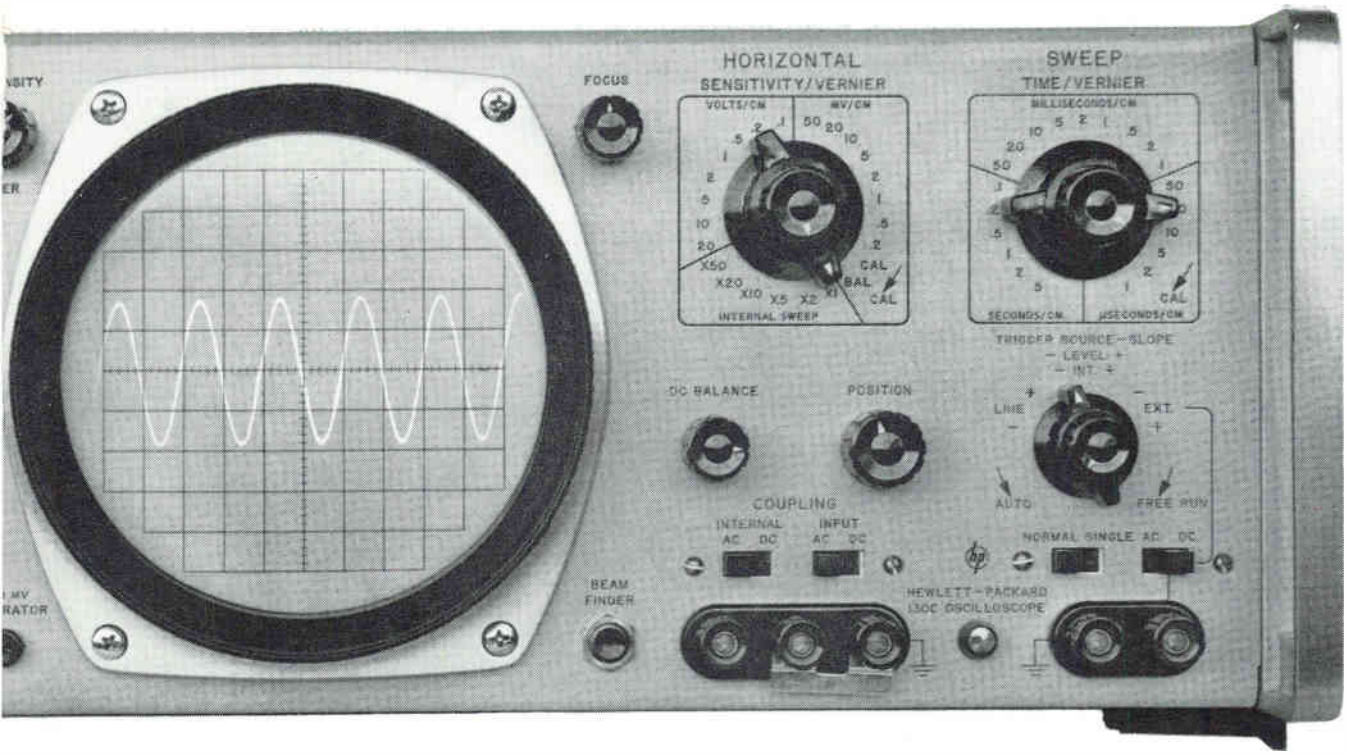
Scheme transmits asynchronously, p 58





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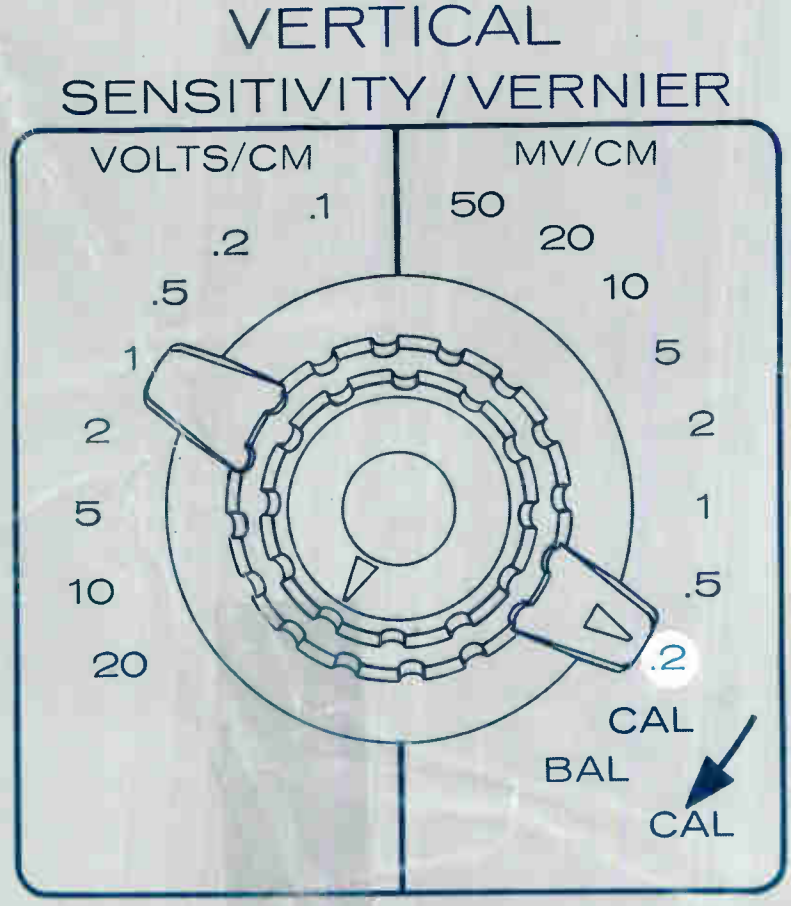

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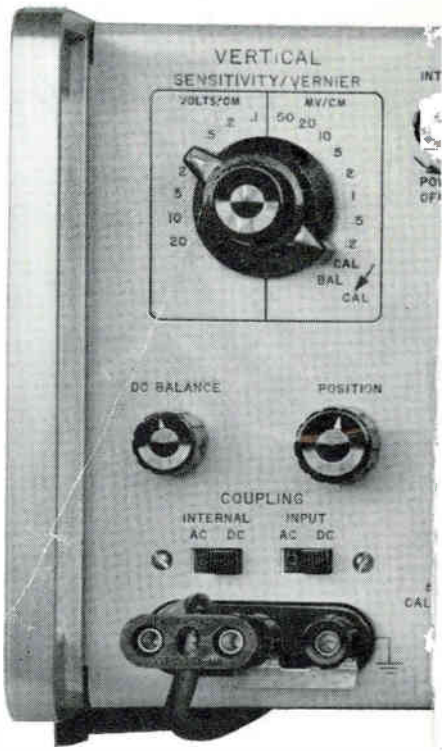

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electroni

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COMMUTATING MATRIX of 64 semiconductor junction diodes with darning needle to show relative size is superimposed on its schematic. The diodes are created by thin-film deposition. *Thin films are one of three microelectronics techniques discussed and compared beginning on p 45* COVER

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Japan, Revisited

TWO YEARS AGO we worked our way around Nippon and reported that its electronics industry was jumping (Electronics in Japan, May 27, 1960). We've just done it again, this time at the invitation of the Japanese Electronic Industries Association, and a more gracious and helpful host could not be hoped for.

Modern as production machinery was in industrial cities of Honshu like Tokyo, Osaka and Kyoto, it is more so now. Interest is, however, still largely concentrated on consumer goods such as radios and television. Color sets can quickly be produced in quantity if and when the market will pay prices engineering has not yet found a way to materially reduce. Fully automatic cameras incorporating photocells are selling well, and small thermoelectric household refrigerators are being sampled.

Japan is still very much wedded to the production of products that can be marketed in quantity, rather than more specialized electronic items. Thus the country, in common with others that advanced rapidly in this respect following the war, is feeling the pinch as the initial rush to purchase subsides. It appears to be, in fact, even more handicapped than most, due to what appear to be discriminatory tariffs and other restrictions imposed against Japanese goods in many areas of the world. Whatever temporary protection this may give certain nationals, it could boomerang internationally, for the Japanese must now continue to raise their standard of living, and are smart enough and industrious enough to do it. They know they must sell more to themselves, but they also know they are essentially an exporting nation. For many reasons their new generation of progressive young people in particular would prefer to do business with the West. Among the reasons are the present political and economic disadvantages applying to trade with the East. But they must have external markets regardless of the difficulties, and others know this. Already quiet but serious overtures are being made by the Russians and Red Chinese.

Meanwhile, the Japanese are making every effort to break down a largely mythical but persistent American idea that their products are all cheap and shoddy. Manufacturer after manufacturer stressed quality, quality, quality during our plant visits, and there was considerable evidence that this new kick was not just for publication. Final inspection techniques are becoming almost a phobia. And on top of this, random samples of increasing numbers of consumer items must now pass inspection by a government-supported independent laboratory before they can be exported (see p 18).

More specialized and sophisticated electronic products are currently being talked about by Japanese manufacturers, under the too-broad heading of "industrial electronics," but not much has yet been done to ready them for either production or marketing.

There are several reasons for this, including the preference for mass-produced items already mentioned; a wish to avoid further competition with American manufacturers in particular; and obvious puzzlement concerning suitable distribution methods. This should not be interpreted to mean that Japanese research and engineering are marking time. Although nothing that would represent a major technical breakthrough was disclosed at the several major laboratories visited, it could happen.

While most Japanese engineers encountered said they thought they were perhaps six months behind America in fundamental semiconductor research, much is going on here. Properties of ceramics are also being more closely studied, as are other materials useful not only for electronic circuitry but for use in outer-space environments too. Thin-film techniques are under scrutiny, as in most other major countries, although immediate non-military uses for them are just as obscure here as elsewhere. Computers are advancing rapidly in design and are being thought about as a possible means for further refining Japan's already highly mechanized manufacturing operations as well as for export. Hand labor is slowly but surely declining, with attendant long-range disadvantages as well as advantages to an economy that has utilized it quite heavily.

From what we saw it can safely be said that Japan's technical knowledge if not experience in most areas of our field compares quite favorably with that of major European countries visited just a little over a year ago (Electronics in Europe, June 9, 1961) and, as in those countries, could be quickly utilized if government-supported projects warranted. As for Nippon itself, we must, because of limited time and space at this writing reluctantly limit ourselves to saying that the good manners and the good taste of the people with whom we came in contact made it difficult to say Sayonara.

In many ways, Japan is a Quiet Brightness.

COMMENT

Analog Computer

Having admired your presentation of the latest in the computer fields, I am sending a reproduction of the *Instrumentation* column of *Analytical Chemistry* magazine, in case it may not have come to the attention of your researchers.

G. F. BROCKMAN, M.D.
Greenville, Kentucky

Here are portions of the column, by Ralph H. Muller, from page 91A of the July, 1962, issue of Analytical Chemistry:

We have been designing a new computer. It is an analog computer (any new answer, logical or goofy) which has been assigned the code name of ASEP (anodyne for sloppy economic panaceas). It is completely transistorized and contains four tranquilizer stages in push-pull. A variety of inputs is available. It will accept: executive pronouncements or scoldings, opinions of Harvard professors temporarily on relief in Washington, threats of labor leaders, or corporate releases from any chairman of the board over 70. The first stage immediately extracts the reciprocal of the input information, one of the principal factors contributing to reliability. One hundred and five per cent inverse feedback is employed. This reduces noise and irrelevancy.

Output collation and assimilation have been improved in the Mark II version. At first, printed tape was fed directly to a waste basket. In the improved data assimilation scheme, data are fed directly to the incinerator chute. It was found that monthly progress reports can be rendered more uniform, concise, and less ambiguous by making thermal conductance measurements of the incinerator effluent.

Coaxial Transistor

In my *Comment* item in the issue of August 10 (p 4), I wrote of the results obtained with "the new Siemens AF 139 transistor in a coaxial housing" since submitting my article, Pushing Transistors Above Their Frequency Limits With Parametric Conversion Operation (p. 46, June 22). The semiconductor division of Siemens has asked me to publish the following statement:

Dr. Rüchardt of the Siemens semiconductor division has asked the author to inform the readers of ELECTRONICS that, although Siemens is now making samples of a coaxial AF 139 transistor, no samples of this new transistor were used, but rather a coaxial transistor by Hughes Aircraft with the development number of the U.S. Navy research program.

Since the fact that Siemens was planning a coaxial transistor was known only to me, Siemens is now asked by other firms why they were not given this information, and we do hope that this note will prevent Siemens from further trouble.

ULRICH L. ROHDE
Munich, West Germany

International Quiet Sun Year

The article, Scientists Prepare to Study Quiet Sun (p 20, Sept. 14), is a good summary of the IQSY program, but there are two points in the article that should be clarified.

The countries listed in the upper left corner were those from which scientists came to attend the first international IQSY meeting in March 1962, or from which confirmation was received concerning plans for participation in IQSY. There remains one more year of planning and a second international conference to be held in early 1963. It is hoped that many additional countries will be added to the list by the time of the beginning of the IQSY, January 1, 1964. The list you quote is provisional and as of March 1962.

The caption on the photo on p 21 might confuse some readers on the nature of the neutron monitor. The radioactive sample shown being inserted in the pile is for calibration and test purposes; the instrument itself monitors natural cosmic-ray intensity and therefore is located away from radioactive sources.

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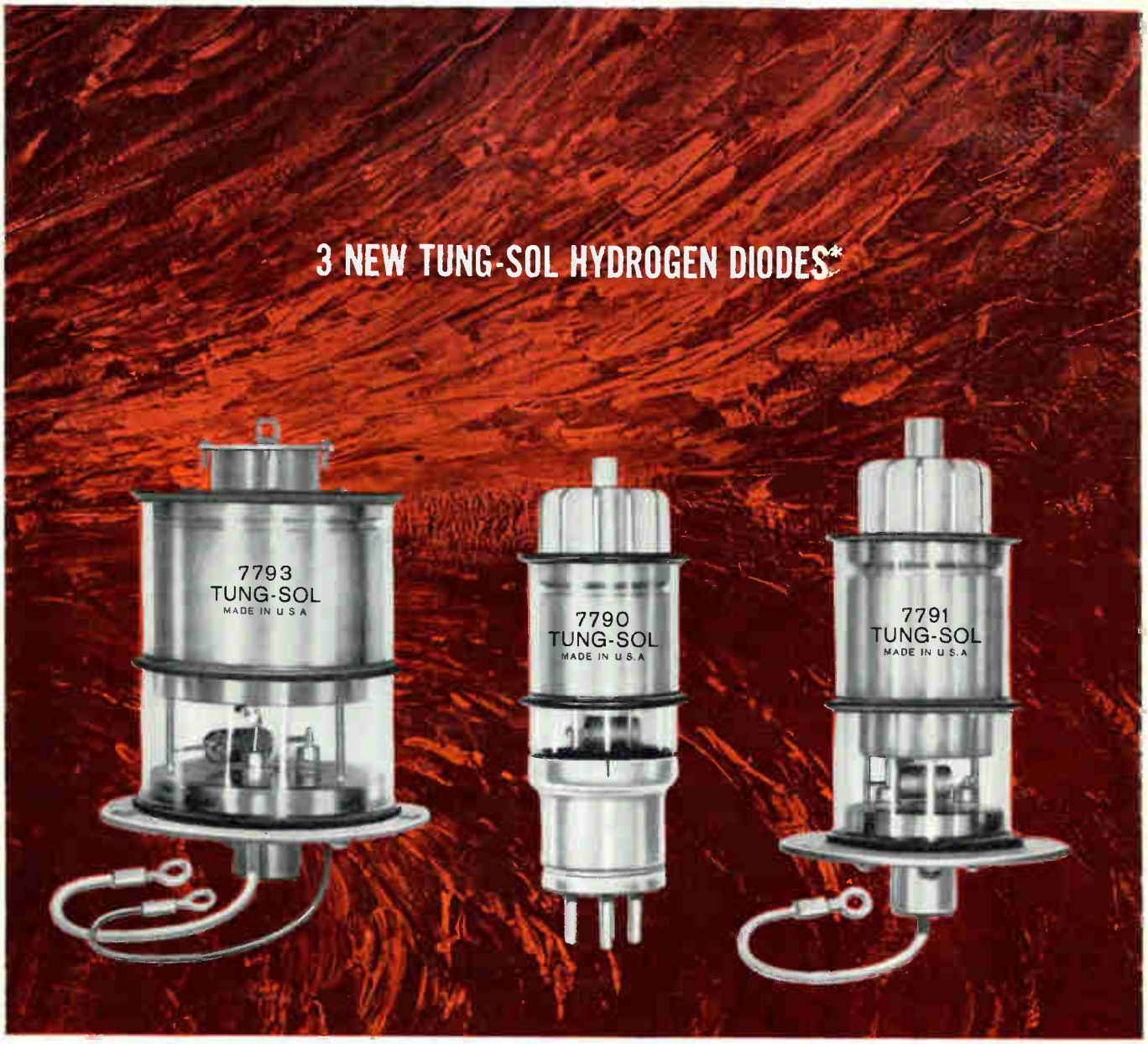

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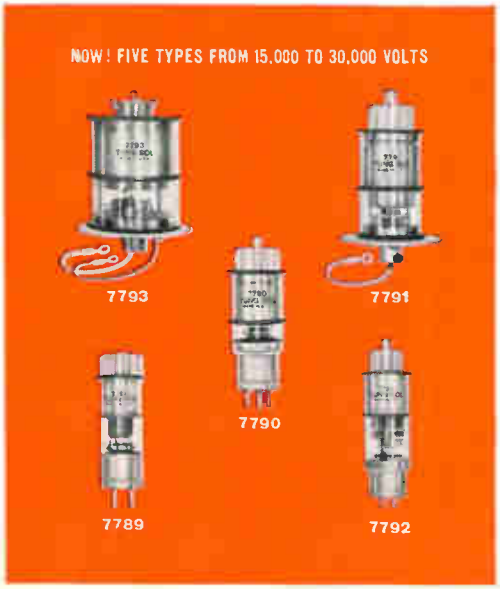

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7793*	30,000	4.0	flange

In many cases, 7789 and 7790 are direct plug-in replacements for vacuum tube type 576A, while 7792 replaces type X80. ■ Complete technical data and basic rectifier design charts available on request. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX:201-621-7977. ■ Technical assistance is available through the following Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Melrose Park, Ill.; Newark, N. J.; Seattle, Wash. CANADA: Montreal, Que.; Abbey Electronics, Toronto, Ont.; Prairie Pacific Distributors, Ltd., Edmonton, Alta.

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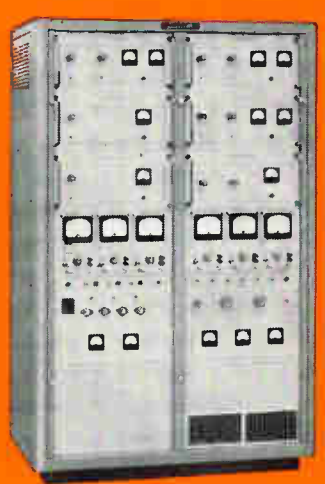

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Model 290C Calorimeter Test Set. Accuracy 1% limit of error, 30-1000 watts or 2-3% error, 10-1500 watts. DC to 12.4 GC, three modes of operation. $4,500.00. Dual water loads available for use with 290C, DC to 12.4 GC. $1,500.00 to $1,600.00.

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ELECTRONICS NEWSLETTER

New Military Computer Gets Telstar Workout

BURROUGHS' new modular computer—slated for extensive use in the Air Force's Backup Interceptor Control system (Buic)—got the Telstar treatment last week. Data generated by the computer (and in another test, by a Honeywell 800) were used to show the satellite's long-distance data-relaying capabilities.

The Air Force has put in a $24.5-million order for 17 of the Burroughs computers, for use in Buic (p 28, April 20). The computer, the D825, can operate even if part of it is knocked out. It has no central elements whose failure could immobilize the system, Burroughs said.

Switching interlocks and the program direct data flow through modules according to operating priorities and equipment availability. If a module fails, its work is reassigned. The modular design also permits new modules, memories and peripheral equipment to be added and provides for simultaneous processing of multiple problems.

Thin-film memories with 1-μsec access speed up processing, the company said, by being "scratch-pad" memories for the arithmetic units. If power fails, information being processed is retrieved without loss of data after power is restored.

Microwave Signal Phase Shifted by Electron Beam

CHICAGO—Applications in phased-array radar were seen for an electron-beam phase shifter demonstrated by G. Ryan, of Zenith, at the National Electronics Conference research preview last week.

The device exploits cyclotron rotation of free electrons in a beam. Phase is changed by varying the magnetic field in the drift region with a small solenoid. The entire tube is in a longitudinal field.

Depending primarily on solenoid induction, response speed can reach tens of megacycles. Phase-transfer function may be varied hundreds of degrees over a range of 200 to 4,000 Mc with 10 to 20 percent bandwidth. Insertion loss is 1 to 2 db. Transmitted r-f power can range from microwatts to many kilowatts.

Ryan said the relationship between phase shift and externally applied control current is linear and that the tube is highly stable.

Possible uses include an array of phase shifters operated from a single source by a linear resistance network, d-c to vhf modulators and phase-correcting feedback loops. The device can also be an isolator; input and output impedances are matched and reverse attenuation is about 60 db.

Solar-Pumped Laser Development Reported

RCA LABORATORIES announced this week that it has achieved coherent output from a laser pumped by the sun. The laser uses a 12-inch hemispherical mirror to focus sunlight and a liquid-neon-cooled, calcium-fluoride crystal. The laser emitted at 2.36 microns wavelength when exposed to about 50 watts of radiant power, RCA said.

For space applications, a liquid-nitrogen coolant would be used. The nitrogen temperature could be maintained in space with heat-radiating fins. The experiment was performed by Z. J. Kiss, H. R. Lewis, R. C. Duncan and R. D. Marotte.

Data Processor Features Changeable Storage Packs

NEW YORK—Low-cost, solid-state computer called the 1440, aimed at small and medium-size businesses, was announced here last week by IBM.

Interchangeable magnetic disk packs composed of six magnetic memory disks and ten read/write heads provide storage capacity of almost 3 million characters in each pack. Other features include a card read-punch that uses solar cells, and a printer equipped with interchangeable type bars.

The computer will rent for roughly 40 percent less than IBM's 1401 and will be manufactured in the U.S. and in Germany. Eventually the computer will be made in Japan and in South America, either in Brazil or Argentina.

Phased-Array Radar Is Ordered by Air Force

AIR FORCE has awarded Bendix Radio division a contract to develop and build a 150-foot-high phased-array radar (p 113, Nov. 17, 1961) for the Air Defense Command's Space Detection and Tracking System (Spadats—see p 32, Nov. 24, 1961).

Bendix said that it would be an

Economist Says Electronics Will Be No. 1

ROBERT R. DOCKSON, economist for the Union Bank of Los Angeles, predicted last week that "even with its problems" the electronics industry will eventually dominate the national economy.

He said the industry's total sales should rise to between $23 billion and $25 billion by 1970 and to between $33 billion and $36 billion by 1975. His figure for 1961 was $12 billion.

His sales breakdowns were, in billions of dollars: military, 6.5 in 1961, 11 to 12 in 1970 and 16 to 18 by 1975; consumer, 2.4 in 1961, 4 in 1970 and 5.5 by 1975; industrial, 2.6 in 1961, 5.3 to 5.6 in 1970 and 9.5 by 1975; replacement parts, 1.2 in 1961, 2.4 in 1970 and 3.4 in 1975.

Los Angeles' share of the total market, he said, may reach only $2.8 billion by 1970 and $3.6 billion by 1975. Dockson is also dean of the USC School of Business Administration

updated version of its electronically steerable array radar (Esar), with increased range. Esar has nearly 9,000 antennas and can track hundreds of targets at one time. Air Force said the new radar will be able to detect and track satellites at altitudes up to several thousand miles.

The radar will take two years to design and build and nine months for testing and evaluation. It will be installed at Eglin AFB, Fla. Bendix subcontractors include IBM, computer, storage and programming; Airborne Instruments Laboratories, signal processors between the radar receiver and computer; Sanders Associates, beam-forming networks, and Whitman, Requardt, and Associates, housing.

Laser Phase Modulator Has Bandwidth of 1 Gc

DEVELOPMENT of a wideband, low-power laser modulator at Sylvania's Applied Research Laboratory was announced last week by General Telephone and Electronics. The modulator requires 10 watts and has been tested over a range of 30 Kc to 1 Gc.

A phase modulator, it varies the velocity of light in a crystal sandwiched between two brass rods. The rods are a transmission line to which the voltage is applied.

The detector used in the tests was a Sylvania traveling-wave tube photodetector (p 18, Aug. 31, and p 37, July 20). C. J. Peters designed and developed the modulator, GT&E said.

Air Force Spacecom Is Reorganized for Big Job

BOSTON—A new Directorate of Communications Programs has been formed at AF Electronic Systems Division, Bedford, Mass. It replaces the 480-L command-control system office, but will keep the name, Spacecom. The scope of Spacecom got too big for a single system program office. It now embraces about 50 programs.

The new directorate, headed by Col. Joseph A. Plihal, has four divisions—wideband, survivable, secure and satellite. Its main aim is development of global communications system that will always provide two channels, technically and physically separated, between commands anywhere in the world. Among Spacecom programs are troposcatter systems in Europe and Vietnam, communications for Bmews and SAC, and R&D projects like Haystack.

Argentines Build Their Own Digital Computer

BUENOS AIRES—An electronic digital computer—reportedly the first developed in South America—will be used at the Engineering School of the University of Buenos Aires for training people in maintenance, operation and programming.

The computer is an all-transistor machine with a drum memory, paper tape reader input and electric typewriter output. It has an internal speed of 50 Kc, a storage capacity of 1,024 32-bit words and is the size of a desk.

Project engineer has been Felipe R. Tanco, formerly with RCA.

Transistor Plant Planned By Hong Kong Companies

HONG KONG—Industry sources report that manufacturers of transistor radios here are planning to make their own transistors and diodes to make the colony less dependent on foreign sources. They are hoping to set up a local-foreign joint venture, at an estimated cost of $1 million.

Hong Kong imports about 90 percent of its transistors from Japan. Local dealers are reportedly riled by Japanese complaints about Hong Kong competition in radio exports and are also reportedly worried by recent threats of restrictions on supplies.

Some 678,000 transistor radios were exported from Hong Kong during the first eight months of this year to the U.S. and United Kingdom (for earlier figures, see p 24, Sept. 28). The plants here do mainly assembly work, with the largest turning out about 40,000 sets a month. One shop specializes in $3 kits.

Manufacturers are establishing a Radio and Electronics Manufacturers Association.

In Brief . . .

RANGER 5 was to be launched this week in NASA's third try (p 26, Feb. 23, and p 8, May 4) to take tv pictures of the moon.

SPECIALITIES, INC., has a $1.5 million production order for approach power control systems, all-weather aircraft carrier landing aid for Chance Vought's F8U airplane.

RADIATION INC. is to develop a molecular-circuit pcm telemetry system, handling 100 channels in 60 cubic inches, under a $400,000 Air Force contract. Fairchild Semiconductor is circuit fabrication subcontractor.

RADIO-COMMAND system for Gemini launch vehicles, to be built by General Electric, will be similar but lighter than those used in Mercury flights. Airborne portion will weigh 32 pounds.

ARMY is consolidating Ordnance and Signal procurement in Los Angeles area into a single office at 125 S. Grand Ave., Pasadena. It will administer some $2 billion a year in contracts.

FORD MOTOR'S Aeronutronic division will study for Air Force the best way to compute and display battle damage information.

MARCONI is to complete a 30-station, multichannel radiotelephone and telegraph network in Angola.

OCEANIC INSTRUMENTS has a navy research contract to investigate salinity measurement with sensors ultrasonically vibrated to prevent biological fouling.

MARTIN MARIETTA has developed a 4½-pound manpack transceiver for its Racep system.

CONTINENTAL ELECTRONICS will build 1-Mw and 10-Mw mobile vhf radar transmitters for Stanford Research Institute missile-tracking system.

MOTOROLA and Societe Anonyme pour l'Equipment Electrique des Vehicles have formed S.E.V. Motorola, in Paris, to produce electronic ignition and other automotive electronic products for the European market.

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TODAY'S FASTEST MEMORIES are driven by SPRAGUE ECDC* TRANSISTORS

2N2100 High-Speed High-Voltage DRIVER			2N2099 High-Speed Low-Cost DRIVER
BV_{CBO}	40 volts	BV_{CBO}	25 volts
h_{FE}	70	h_{FE}	40
V_{CE} (SAT)	0.2	V_{CE} (SAT)	0.35
t_r	10 nsec	t_r	15 nsec

*Sprague Trademark

ECDC transistor technology, a Sprague development, provides the highest-voltage high-speed memory drivers available . . . and does it all at the lowest possible cost!

The 2N2100 is now widely used as *the* basis for new high-speed computer memory designs. Have you tried this highly-successful transistor in your circuits?

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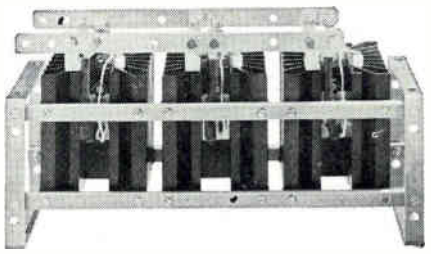
The 150 Ampere silicon controlled-rectifier can increase reliability in your high power applications by eliminating paralleling now necessary with lower current devices. This new Westinghouse silicon controlled-rectifier is rated 150 amperes at 85°C—5° higher allowable stud temperature than competitive types. The 20% higher PRV is standard in all Westinghouse silicon controlled-rectifiers. The hard-soldered construction prevents deterioration under long-term thermal cycling. A glazed ceramic forms an encapsulation that virtually eliminates arc-over caused by moisture or dust. It has an auxiliary cathode lead for convenient gate return connection.

SPECIFICATIONS: 3,500 amp surge rating; 150 amp average output at 85°C case temperature; 235 amp RMS rating, PRV through 480 volts.

APPLICATIONS: Inverters, converters, battery chargers, frequency changers, motor controls.



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APPLICATIONS: High frequency lighting supplies, motor generator sets, static inverters, light dimmers, and battery chargers.

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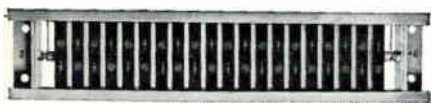
We invite you to contact the Westinghouse Electronic Components field representative. Or dial the number of the distributor near you. You'll get a first-hand sampling of Westinghouse reliability and quick servicing of your electronic component needs. Transistors 7.5A to 30A; Rectifiers .5A to 240A; SCR's 7.4 RMS to 235A. Westinghouse Semiconductor Division, Youngwood, Penna. SC-1083

new silicon power devices



NEW MODULAR DESIGN

MOLDED-BLOCK HIGH VOLTAGE RECTIFIER ASSEMBLIES

They're new—yet with proven Westinghouse reliability. The same components that have delivered 35 million stack hours of failure-free operation are now available in more compact and environment-resistant packaging systems. Encapsulated modules permit doubling the component density without danger of flash-over or corona. The building block construction allows the stack size to be conveniently tailored to suit the voltage requirements. These assemblies will provide currents up to 1.6 amperes with peak reverse voltages to 140 kv. They feature low radio noise and R/C shunted cells for even voltage distribution.

APPLICATIONS: High voltage supplies, precipitators, modulators, and pulse networks; Replacement of mercury vapor, vacuum tube and mechanical rectifiers.

HERE'S THE HIGHEST POWER-TO-WEIGHT RATIO

NEW 20 AMP SILICON TRANSISTORS

Extremely lightweight. Very powerful. This silicon NPN power transistor weighs a mere 0.9 ounce. Continuous power dissipation is 200 watts. Maximum current rating is 20 amps, with voltage ratings from 30 to 200 volts.

Efficiency is unsurpassed, too. The new 20 amp transistor has a typical saturation resistance of .037 ohms at a collector current of 20 amps. Maximum thermal resistance junction to case is 0.5°C/watt.

OTHER SPECIFICATIONS: Hard-soldered construction, welded case, maximum junction temperature rating of 175°C, 15 volt VEB for input circuit flexibility, and it is 100% power tested.

APPLICATIONS: Airborne inverters, power supplies, regulators, and servo amplifiers.

LOOKING FOR THE HIGHEST CURRENT RATING OF ALL?

NEW 30 AMP SILICON TRANSISTORS

It always has had the highest current rating in the industry. You benefit by having a new gain rating on an NPN silicon transistor with proven performance.

The maximum current rating is 30 amps, with a gain of 10 at 25 amps. These transistors have a continuous power dissipation of 250 watts. Peak power output in switching applications is 6,000 watts. The operating junction temperature is 175°C. Maximum saturation resistance is .06 ohms at 25 amps; typical saturation resistance is only .035 ohms.

Both flexible-lead (series 2N1830-1833) and flag-type (series 2N2130-2133) transistors are available in production quantities. Use them to up-grade your existing germanium and silicon systems.

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WASHINGTON OUTLOOK

ACCELERATE MILITARY SPACE R&D? NO, SAYS DOD

THE ADMINISTRATION has again rejected widespread demands for major expansion of the military space program. Last week, Asst. Defense Secretary John H. Rubel, a former executive of Hughes Aircraft, presented the most definitive view ever made of the Administration's stand. He sharply rebuked those in industry, Congress, and the Air Force who are plumping for a much bigger military space program.

Rubel said the Pentagon's space program is probably "too generous," not too restricted. Despite heavy spending in recent years, space planners "have not evolved any very new ideas for military applications in space," he said. "Unless we can satisfy ourselves that (expenditures on military space R&D projects) contribute to our military mission, or are likely to, we are not justified in supporting them."

Rubel said that 20 to 25 percent of the Pentagon's $7.1-billion R&D program is for space projects. Nearly $200 million has been spent on communications satellite systems and another $100 million will be spent this year. Navigational satellite development, almost $100 million so far, is to get another $50 million this year. Cost of missile warning satellite systems is nearly $300 million to date, and up to $100 million more this year "despite great technical difficulties and disappointments."

Rubel hit at what he called the "mystique of space" to debunk some of the proposals for military applications in space.

AUDITS OF FIXED-PRICE AWARDS, TOO

INDUSTRY REPRESENTATIVES here are up in arms over a Defense Department plan to expand its auditing authority over contractor records. Right now, procurement agencies can have audits made on cost-reimbursement-type, incentive-type, and price-redetermination contracts.

Under a proposed change in the Armed Services Procurement Regulations, auditing authority would also be provided in firm fixed-price contracts over $100,000 awarded to sole sources without competition, in change orders (normally "noncompetitive") to any kind of contract, and to other contracts for which contractors are now required by law to certify pricing data.

DOD BUYING ON PLATEAU— A HIGH ONE

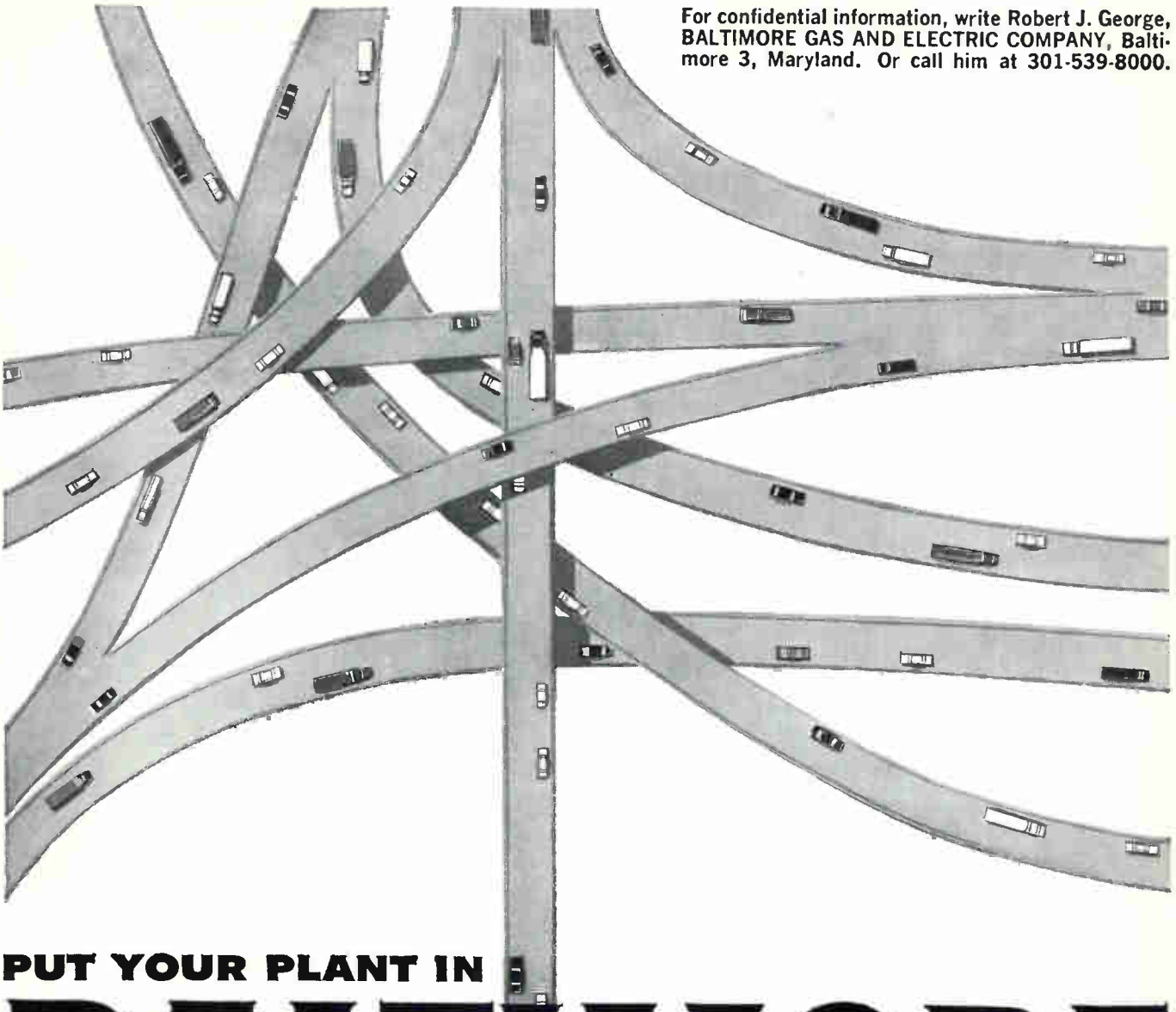
PENTAGON OFFICIALS provide this long-range outlook of annual military procurement:

- Missile production is expected to level off at slightly over $6 billion after a sharp rise in recent years.
- Military aircraft production is on a $5.6-billion plateau after sharp decline in the past few years. The shot in the arm is increased procurement of tactical and transport planes.
- The largest boost in procurement is planned for electronics and communications, and ordnance.
- Shipbuilding will hold steady at about $2.9-billion.

WHAT IF PEACE BREAKS OUT?

SEN. HUMPHREY (D.-Minn.), Senate Disarmament Subcommittee chairman, has released the general finding of a recent survey of 370 major defense contractors. The companies reported unanimously that U.S. defense industry "can shift to peacetime production (in case of disarmament) with adequate government-business planning now."

For confidential information, write Robert J. George, BALTIMORE GAS AND ELECTRIC COMPANY, Baltimore 3, Maryland. Or call him at 301-539-8000.



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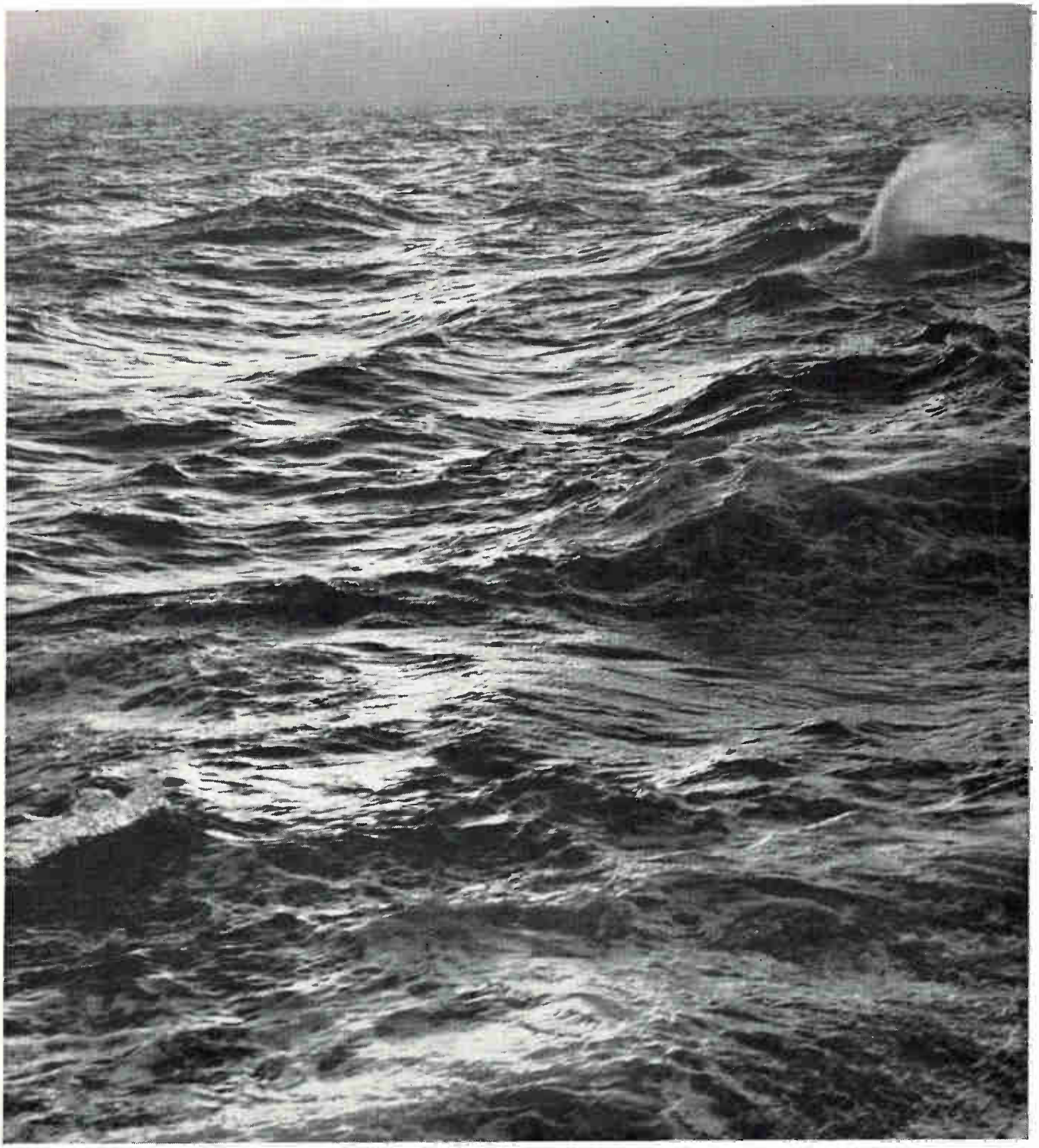

There's business out there.

You're looking at more than a horizon. It's a future, yours and America's. Out there is Europe and Latin America and Asia and Africa. But in 1960, of all U.S. manufacturers, less than 5% saw these foreign shores for what they are worth: a 19-billion-dollar export market, a vast source of foreign trade.

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Even if you've never sold overseas, you have a rare opportunity to start—now. Your U.S. Department of Commerce will help with counsel by experts on what, where and how to sell—with data on credits, payments and financing. A package of invaluable know-how is yours for the asking.

Now's the time to discover the many ways in which your business can grow. In the lucrative export markets. In new U.S. markets. In developing new products. In attracting new industry to your community. Just write or phone the U.S. Department of Commerce Office of Field Services in your city, or Washington 25, D.C. They are ready to help you grow with America!

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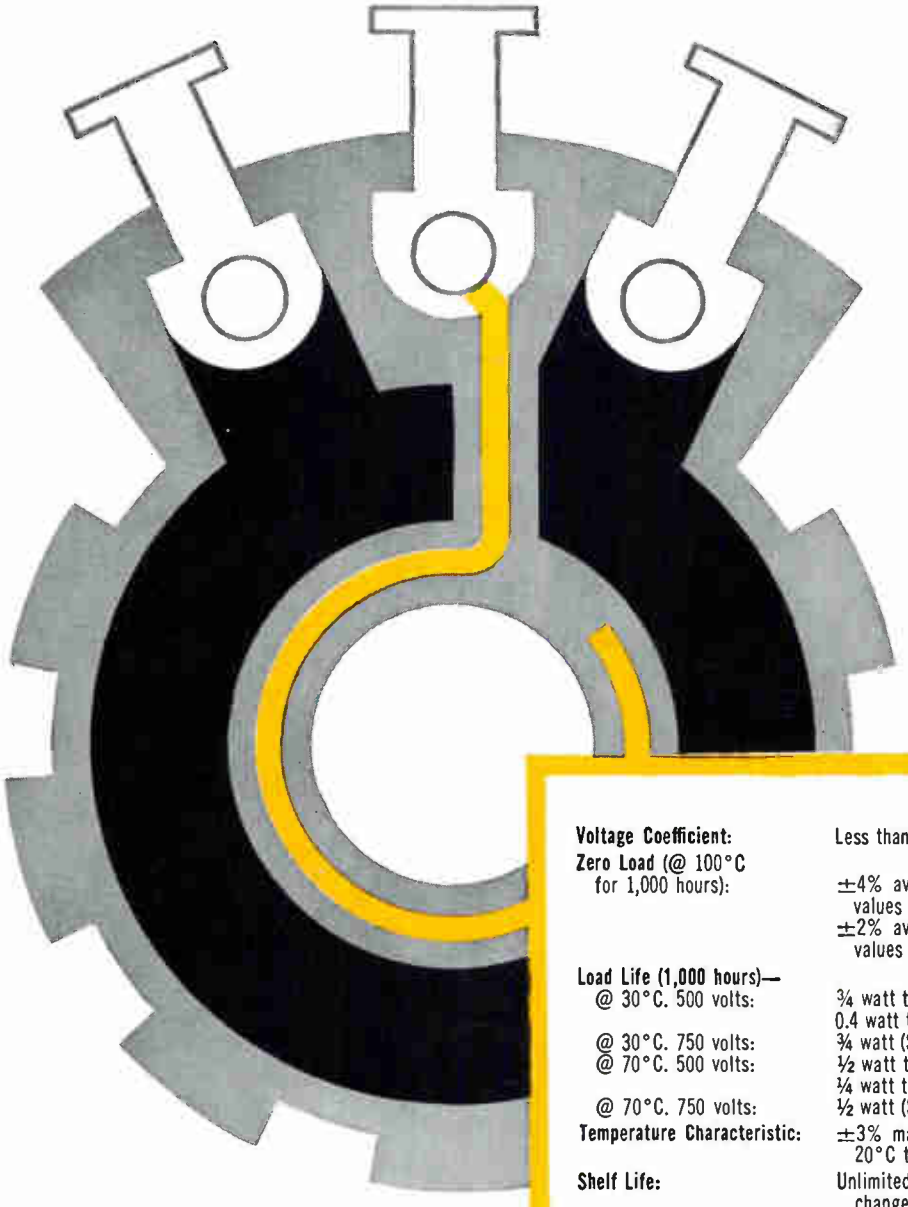

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Voltage Coefficient:	Less than 0.01% per volt.
Zero Load (@ 100°C for 1,000 hours):	±4% avg. resistance change, values to 100,000 ohms. ±2% avg. resistance change, values above 100,000 ohms.
Load Life (1,000 hours)—	
@ 30°C. 500 volts:	¾ watt to 1 watt (Series L, LX, D & T). 0.4 watt to 0.5 watt (Series F controls).
@ 30°C. 750 volts:	¾ watt (Series L, LX, D & T controls).
@ 70°C. 500 volts:	½ watt to ¾ watt (Series L, LX, D & T). ¼ watt to 0.4 watt (Series F controls)
@ 70°C. 750 volts:	½ watt (Series L, LX, D & T controls).
Temperature Characteristic:	±3% maximum resistance change. 20°C to 105°C
Shelf Life:	Unlimited (No measurable resistance change.)
Mechanical Life:	Less than ±3% change in resistance after 25,000 cycles.
Noise (7 vdc across terminals A & C):	3 to 8 millivolts, values below 250,000 ohms. 8 to 12 millivolts, values above 250,000 ohms.
Humidity Test (95% RH @ 40°C for 240 hours)— reversible change:	±5% maximum resistance change, values to 250,000 ohms. ±9% maximum resistance change, values above 250,000 ohms.

NEW DESIGN DATA BULLETIN 70-101 gives complete details. Write for your copy to: **Electro-Mechanical Products Div.**, Stackpole Carbon Co., Johnsonburg, Pa.

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More watts per dollar. More power per cubic inch. Tighter specifications right down the line. That's the sum and substance of the new QB series by Sorensen.

There are 12 QB's . . . 12 compact dc power supplies for the most demanding applications. Nominal outputs: 6 through 28 volts; .5 to 8 amps. Check these QB features:

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- QB Output impedance as low as .0001 + .3 μh.
- QB Remote sensing available.

Price? Sorensen QB units are priced substantially below what you would expect to pay for other (and less desirable) power supplies. Prices start at $140.

QB power supplies are designed to satisfy the most sophisticated applications . . . computers . . . communication, test, and instrumentation equipment . . . general laboratory use . . . industrial OEM applications. For more information on Sorensen QB's consult factory or use reader service card number **256.**

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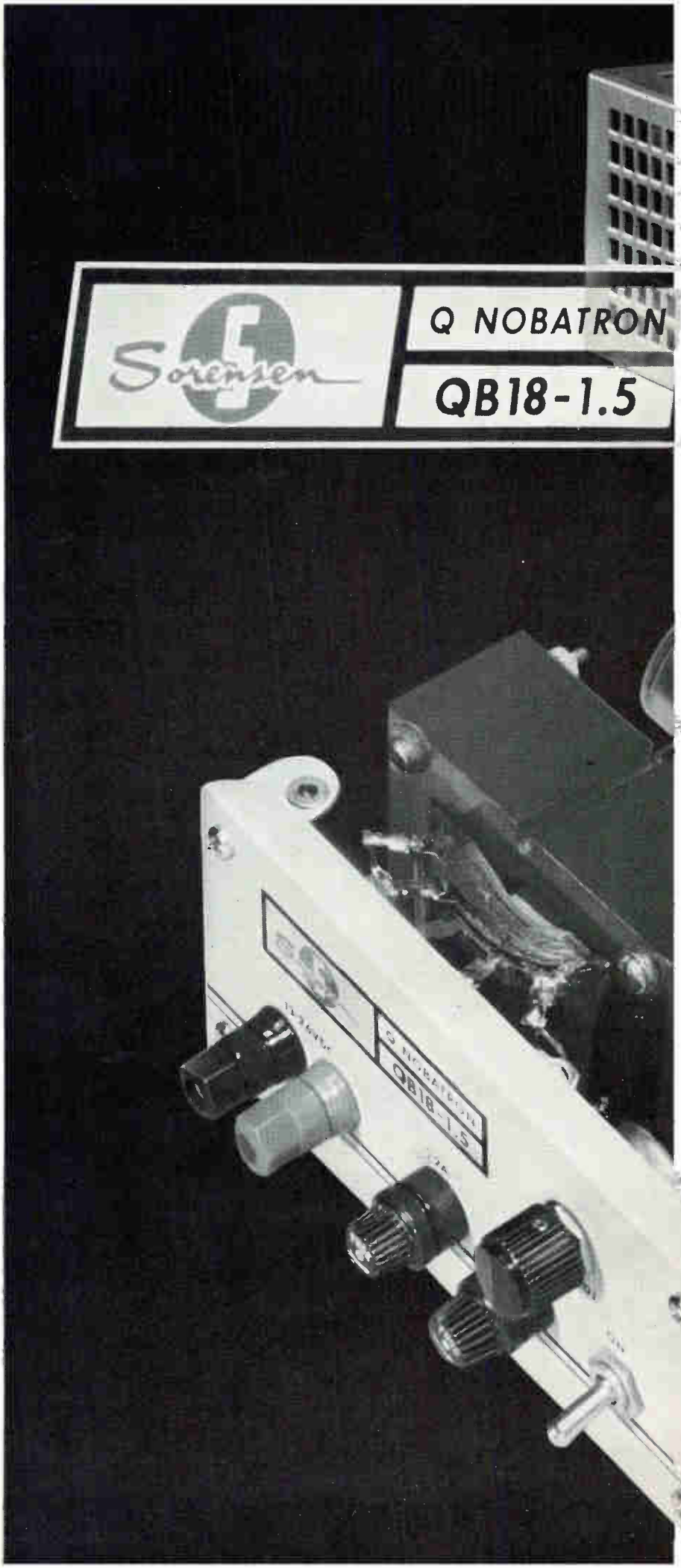
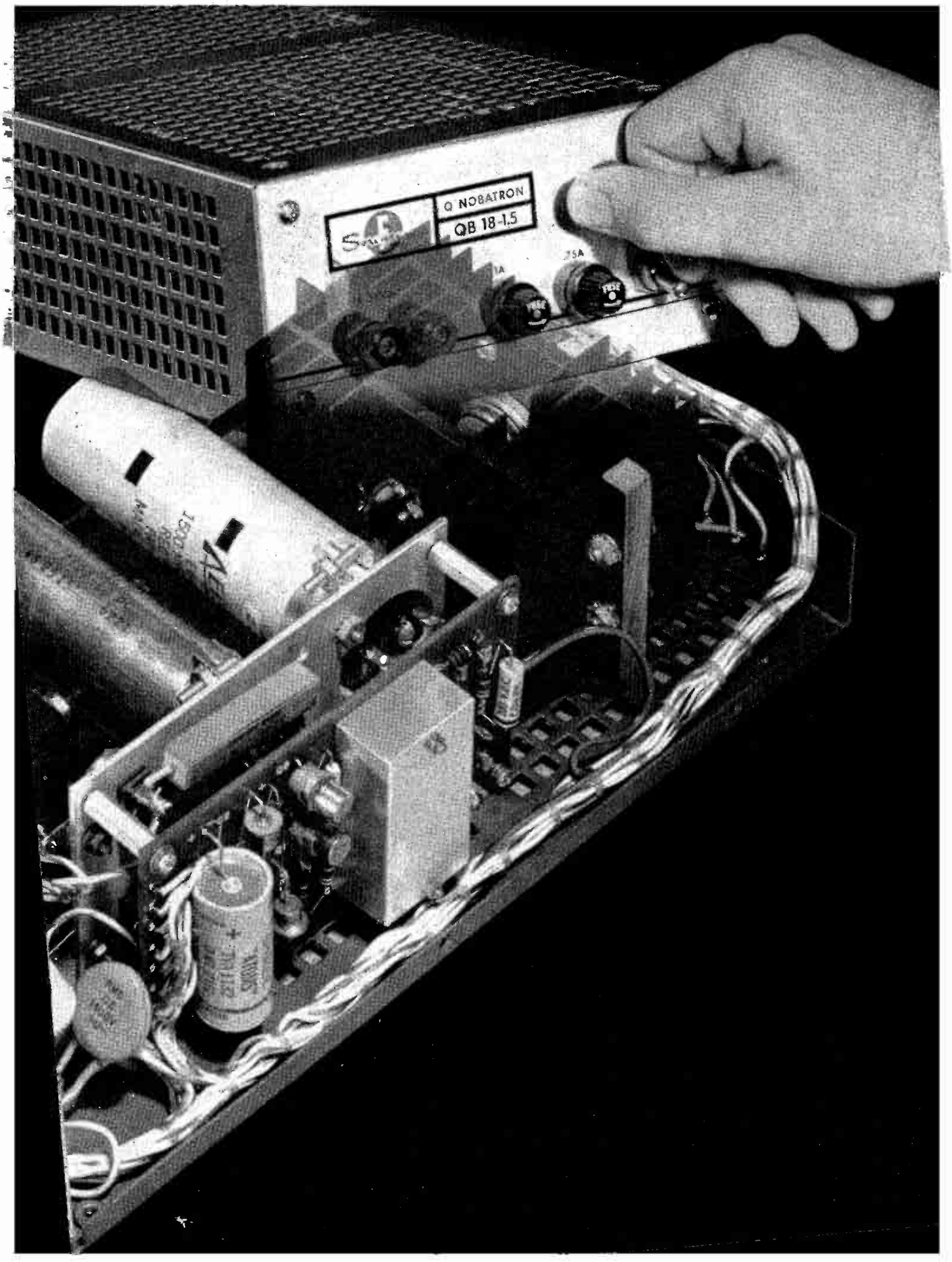


CIRCLE 16 ON READER SERVICE CARD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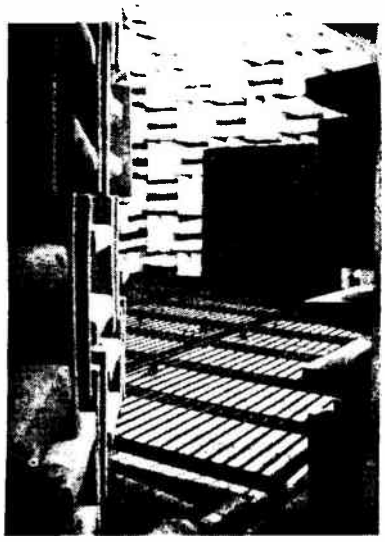
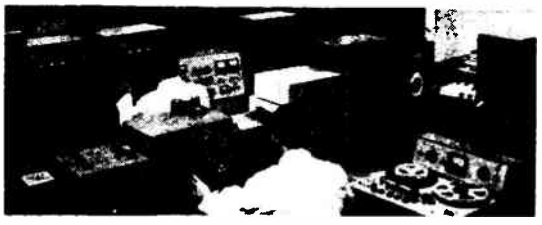


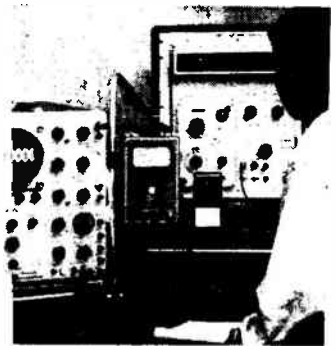
ANECHOIC ROOM *is one of several specialized test facilities*



TRANSISTOR CHARACTERISTICS *are measured with these instruments*

MAIN OFFICE *of the Japan Machinery and Metals Inspection Institute in Tokyo*

TAPE RECORDER *inspection station. Mass-produced products like these are spot-checked by taking samples from export crates*



INSPECTION *of transistor radio*

Japan Intensifies Electronics

Inspection institute now checks manufacturing inspection instruments

TOKYO—The Japan Machinery and Metals Inspection Institute (JMI) is starting a new phase in its monitoring of the quality of Japanese electronics exports.

Now, in addition to inspecting products made for export, it inspects the inspection instruments used by the manufacturers themselves. Institute officials explain that even if manufacturers properly follow inspection procedures, inspection results would be inaccurate if instruments malfunction.

Since July 1, instrument approval has been mandatory for manufacturers of export goods. JMI personnel also make inspections at factory sites. Instrument inspection will be extended to other electronics manufacturers requesting instrument approval.

Another new function of JMI is to inspect electronic exports for compliance with the U. S. Federal Communications Commission standards for emitted radio frequency interference.

JMI has also completed a transistor standards laboratory at the request of the Electronic Industries Association of Japan. Since transistors are still considered a developmental product, no specific quality standards have been set. JMI will examine new transistors types.

TRADE LAWS — Inspection of transistor radios is mandatory under the Export Inspection Law, voluntary in the Trade Control Law.

Oceanographers Decide

Requests for channels in six maritime bands urged by 44-nation group

PARIS—Investigations of the bounding main now are bounding so rapidly that chances are oceanographers' telemetering buoys and stations to monitor them will one day constitute the world's largest communications network.

Looking forward to that time, the Intergovernmental Oceanographic Commission (IOC) recommended at its recent meeting that its 44 member countries urge their national telecommunications authorities to allocate for oceanographic use exclusive 3.5-Kc channels in each of the six existing ITU mobile maritime high-frequency bands. The allocations, IOC emphasized, should be coordinated among countries so that oceanographers would have the same channels to work with throughout the world.

CHANNELS—The communications working group that drafted the proposal adopted by IOC plumped for 3-Kc channels originally (ELECTRONICS, p 26, Sept. 7) but shifted to 3.5 Kc when ITU pointed out the slightly wider channel better matched the existing split-up for the six bands involved: 4.063 to 4.438 Mc, 6.200 to 6.525 Mc, 8.195 to 8.815 Mc, 12.330 to 13.200 Mc, 16.460 to 17.360 Mc, and 22.000 to 22.720 Mc. And the added channel width also will provide a "cushion" between the channels above and below.

Under the proposal adopted by IOC, the channels will have multiple use—full width for telephony, facsimile, continuous wave and the like; 300-cycle subchannels for digital data transmission, restricted to binary signals. The 300-cycle width includes allowance for oscillator drift. Telemetry standard adopted for the subchannels calls for 300-bit capacity messages transmitted at a maximum rate of 100 bits per second with input power to the antenna limited to

Export Quality Control

JMI officials indicate that if a problem of substandard exports should arise, authorities would probably require inspection. The Japanese EIA has been cooperating with JMI on this question.

Customs officials do not permit the export of goods without an inspection certificate and, in addition to JMI inspections, customs officials occasionally inspect cargoes.

JMI inspectors also monitor the use of trademarks and proprietary designs of export goods. If piracy is discovered, steps are taken to ban the export of the goods.

For feedback on how popular Japanese products are in the U.S., and as a check on whether substandard products are getting through, JMI has representatives in New York, Chicago and San Francisco.

MACHINERY INSTITUTE

This month marks the fifth anniversary of the Japan Machinery and Metals Inspection Institute (in Japan, machinery means any apparatus with a moving part, including electronic equipment and even thermometers).

The institute was established on Oct. 28, 1957, and began operating on Jan. 16, 1958. It is a nonprofit organization operating under the auspices of the Ministry of International Trade and Industry.

Among the major export categories it inspects are transistor radios and spare parts, since April 1, 1958, and phono-radio combinations and tape recorders, since Aug. 1, 1961

on Frequencies

By ARTHUR ERIKSON
McGraw-Hill World News

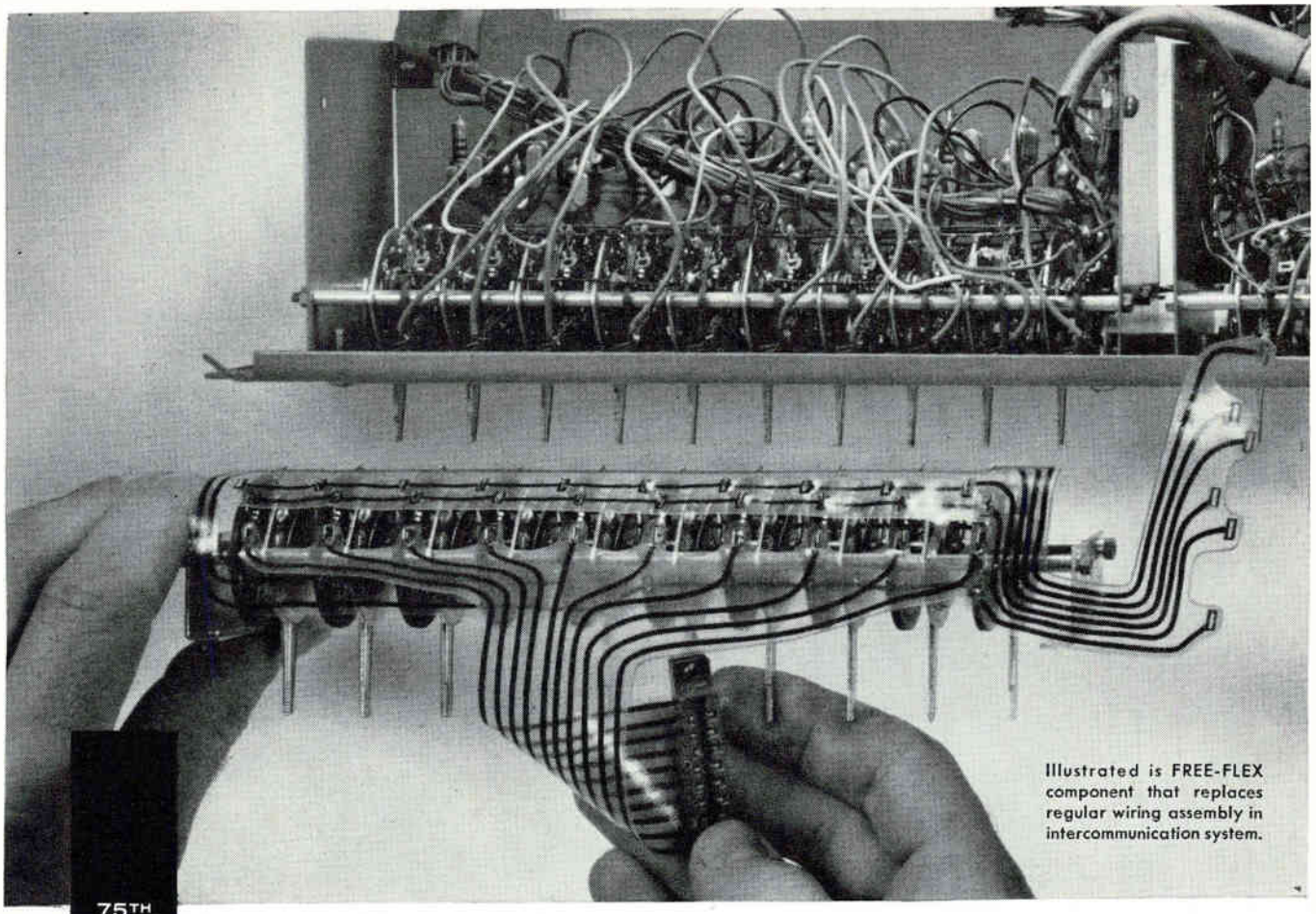
100 watts. At that power range up to 2,000 nautical miles is possible at the proposed frequencies if the monitoring stations are properly located, a member of IOC's communications working group points out.

The frequencies selected were based in part on studies made at U.S. National Bureau of Standards Central Radio Propagation Laboratories. One computer run on frequency-power-range relationships indicated that at 100 watts, an h-f signal from a buoy in the Atlantic could be picked up at Madison, Wis.

BUOY PROGRAMS—The IOC proposal sanctions clock-programmed buoys only as an interim solution; eventually all buoys will be of the "call-up" or interrogated type. However, IOC plans later to set requirements for "trigger" transmission so that automatic buoys can give advance warning of Tsunamis, hurricanes or typhoons.

When called up, a buoy will transmit a 3-second message three times. If two or all three of the messages check, the monitoring station will reply with an "erase" signal, if not, with a second call-up. This method, rather than sophisticated parity techniques, was selected to permit relatively simple buoy circuitry and still insure accurate message transmission at speeds consistent with the heavy traffic expected to develop in the oceanography channels. Another advantage: little effect on transmission by h-f "black-out" pulses, since they last 2.5 to 2.6 seconds, shorter than one of the three 3-second repeats.

In its request for frequency allocations, IOC puts priority on the three lower h-f mobile maritime bands. However, IOC also recommended that its member countries get together on a 3.5-Kc channel near the center of the 510 to 525-Kc band. It would be reserved for oceanographic use in polar regions, where auroral disturbances make higher frequencies worthless.



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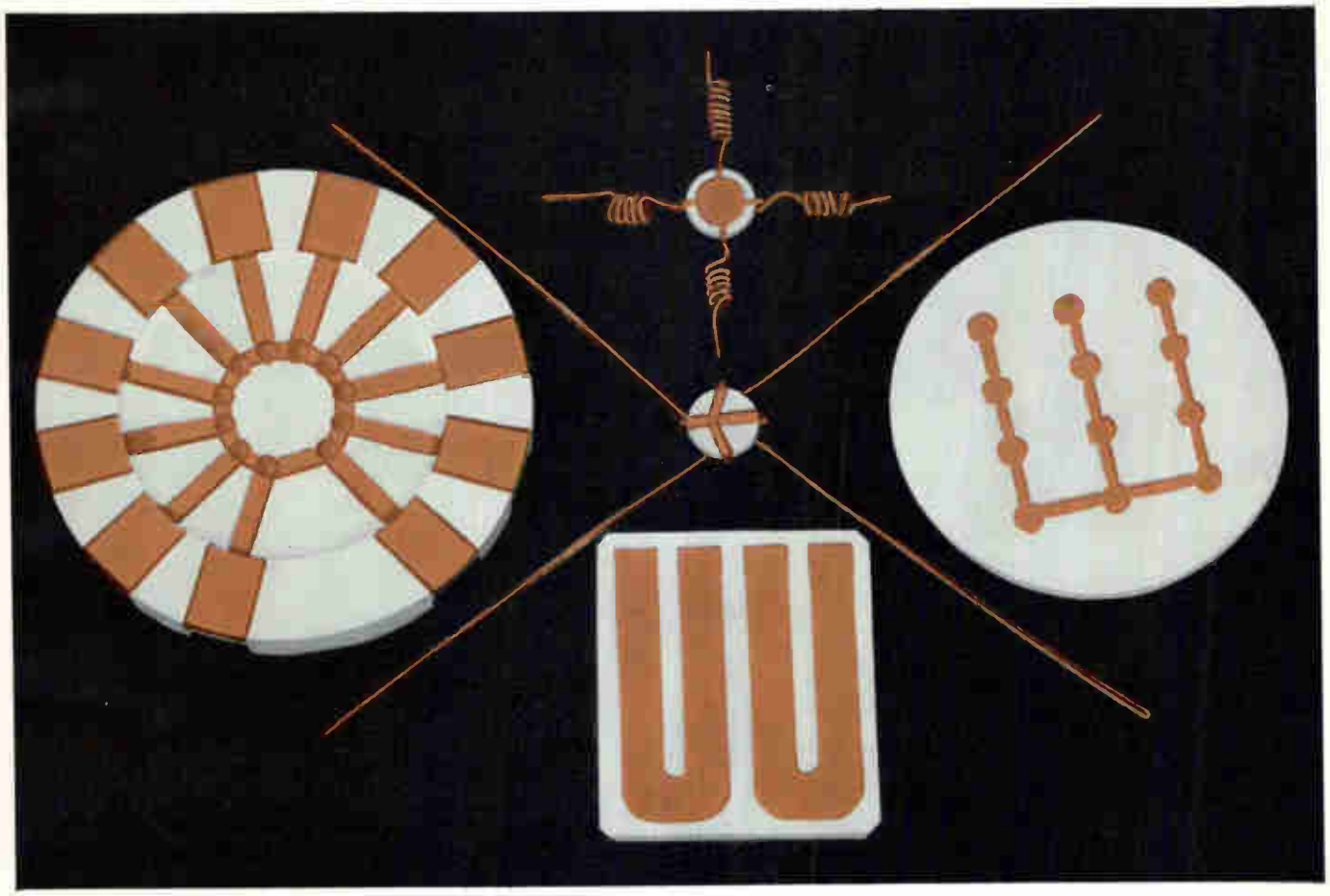

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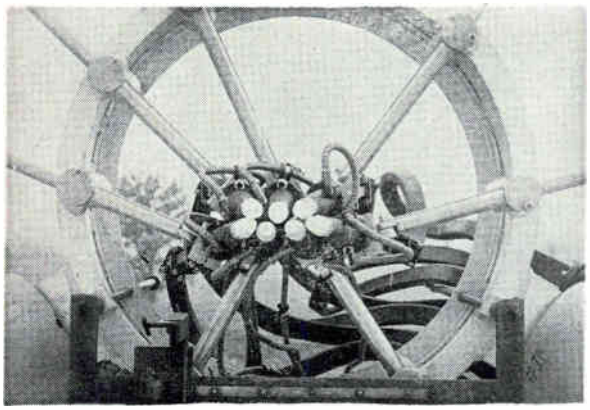


SEVEN HORNS *on a 28-foot dish provide seven beams that receive signals over a wide arrival angle*

Tropo Systems Better With

New techniques will move scatter systems to higher frequencies

By LAURENCE D. SHERGALIS
Associate Editor

UTICA—Troposcatter system performance can be improved by going to higher frequencies with angular diversity techniques and reevaluating design curves used to calculate loss in antenna gain, according to J. L. Levatich, of Bendix Corp.

The loss in antenna gain for large aperture antenna systems has been greatly overestimated, he said at the IRE Eighth National Communications Symposium. Present methods of prediction have placed an unnecessary limit on the usefulness of tropospheric scatter systems. Higher frequency systems are much better than present theoretical predictions indicate, he added.

GAIN PREDICTION—Loss in antenna gain is the ratio of power received by a large aperture antenna to that received by a small aperture reference antenna divided by the corresponding ratio of received powers of the same antennas in free space.

The only way to predict the system antenna gain, Levatich pointed out, is to determine the free space antenna gain then reduce this by a predicted amount of loss. Actual measurements indicate that present prediction techniques fall short for long path lengths at low uhf frequencies and short path lengths at shf frequencies (1-10 Gc).

Loss has been greatly exaggerated. For example, for a 400-mile path at 5 Gc using a 28-foot dish, loss in antenna gain is calculated to be about 22 db. An empirical curve developed from actual measurements shows a loss of only 6 db. Levatich blames this discrepancy on the difficulty in making accurate measurements.

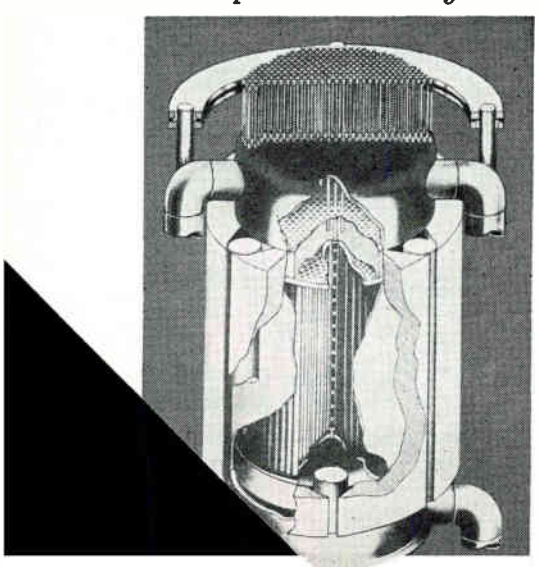
ELIMINATE LOSS—If the receiving antenna of a troposcatter system were capable of tracking all the angles of arrival of the signal, there would be no loss in antenna gain.

While it is not possible to make a tracking system to accomplish this, it is possible to provide a number of feeds with a large aperture parabola. Each feed results in a narrow beam slightly displaced from the boresight. If enough feeds are provided to cover all possible angles of arrival, the full antenna gain will be realized despite variation in arrival angle. An antenna system of this type was described by I. A. Fantera, RADC, and D. Surenian, ITT Federal Laboratories.

Seven angle-diversity beams are clustered about the great circle azimuth. These are provided by illuminating the reflector by seven

LASERS Can Aid Plasma Propulsion

High-intensity photon source could help raise plasma density



THERMIONIC *power design employs liquid-metal cooling, integral nuclear thermionic fuel element*

CINCINNATI—Possibility of fusion plasma propulsion system practical for space travel—systems light and powerful enough to propel themselves and a useful payload—has been greatly enhanced by progress in lasers, high-power superconductive magnets and cryogenic pumping.

That optimistic outlook was reported this month by William I. Linlor, of Hughes Research Labs, in a paper coauthored by Milton U. Clauser. The paper was given at the Third Symposium on Advanced Propulsion Techniques, cosponsored by the Air Force Office of Scientific Research and General Electric's Flight Propulsion division.

Massive amounts of power is one of the biggest needs of the propulsion program, pointed out M. M. Slawsky, AFOSR director of engineering sciences.

PLASMA PROPULSION—Linlor stressed that a number of research and engineering problems remain before fusion plasma propulsion is practical (see also ELECTRONICS, p 29, Sept. 1, 1961). But he felt that the anticipated performance of such systems would be worth the effort involved in developing them.

By marrying advanced tech-

Seven Beams

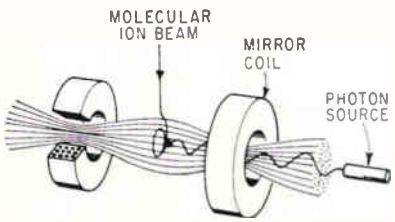
horns (see photo) allowing seven beams to emanate with the 3-db points of adjacent beams touching. The transmitter provides seven independent carriers, each delivering 2 Kw to each of the horns.

In tests over a 185-mile path in the 8-Gc range, a receiver was used with two reflectors, each containing seven horns. Signal energy received on various beams is not much lower than that received on the center beam, which indicates that angle diversity may be employed only at the receiver and may not be necessary at the transmitter. Considerable improvement in signal-to-noise ratio was found, but because of present antenna alignment problems, the tests are incomplete.

However, results indicate that angle diversity at higher frequencies will provide performance equal to that at lower uhf frequencies, and can be expected to relieve uhf crowding. At higher frequencies, antenna gain increases more rapidly than path loss, thus resulting in more system gain. Also diversity reception reduces the effect of instantaneous fading.

By CLETUS M. WILEY
Midwest Editor

niques in electronics and plasma devices, he suggested a propulsion system weighing 100,000 kilograms, including 50,000 Kg in fuel and a 25,000-Kg payload. The system could provide a velocity increment



FUSION PLASMA *propulsion system could use this arrangement for increasing plasma density by photoelectric dissociation of injected ions*

INTERSTELLAR TRAVEL THEORETICALLY FEASIBLE

It isn't true that a voyage to the stars would be possible only with a photon rocket (and therefore impossible in the foreseeable future), D. F. Spencer and L. D. Jaffe, of Jet Propulsion Laboratory, said at the propulsion symposium.

They presented a mathematical analysis of the problem indicating that with a fission rocket Alpha Centauri (4.3 light years away) could be reached in 9 to 14 years, or in 6 or 7 years with a fusion rocket.

Those are the times for ideal systems providing 1-g acceleration for a few months. With a reasonable system, they said, a probe could reach the star in less than 50 years.

Earlier analyses of the problem, they said, incorrectly assumed the use of chemical rockets, or the use of single-stage instead of multistage nuclear rockets.

They proposed a multistage vehicle with a 10,000-pound payload, almost half of which would be a 1-Mw X-band communications system transmitting to a 200-foot dish on earth

of 15,300 m/sec (50,000 ft/sec), a specific impulse of 2,200 seconds and an acceleration of 1 g.

A major problem in attaining a practical system has been that containable plasmas have not been sufficiently dense and that dense plasmas have not been containable for useful periods of time. Stable fusion plasmas have not yet been achieved.

This is where the work on lasers can help, he said. By using ion injection into the plasma and a technique known as photoelectric dissociation, the injected beam can be trapped in the plasma. Plasma density could be raised gradually and controllably to the instability region, or at least give researchers clues to solving instability.

To usefully raise density, a photon intensity of 1 Kw/cm^2 is desirable. Programs are underway at Hughes and elsewhere to provide sources with intensities several times that, Linlor said.

The work in superconductive magnets promises lightweight apparatus to contain and direct the plasma with magnetic fields. The solenoid in his suggested system would weight some 4,000 Kg and produce a field of 400 kilogauss.

Cryogenic pumps can achieve the vacuums needed—one developed at Hughes can pump 100,000 liters/sec at a pressure of 10^{-9} mm Hg, he said.

Linlor proposed several propulsion system configurations. In one, the same magnetic field would contain the fusion reaction plasma zone and the thrust augmenting zone. Another would transfer plasma from a Stellarator-type reactor to the thrust augmenting chamber, where the propellant (lithium vapor) would be heated by fusion power. Another version is a mirror-machine fusion chamber.

OTHER SYSTEMS—M. A. Zipkin, of GE's Missile and Space division, said that a one-megawatt turbonuclear power system is attainable within this decade. He described a system designed to furnish power for an unmanned vehicle propelled by ion engines and reported on the progress made in solving problems in materials, nuclear, thermodynamic and mechanical design.

Herman Miller, of GE's Special Purpose Nuclear Systems Operation, reported on the state of the art in thermionic-nuclear reactor space power systems. Maximum outputs of 20 w/cm^2 and efficiencies over 15 percent—half of theoretical efficiency—have been obtained in tests, he said.

Miller outlined several thermionic converter concepts, including one with the converters placed directly on the reactor surface. Called Star-R, it is attractive for power levels below 100 Kw and would be cooled by direct radiation. The others, for power into the megawatt range, would have liquid-metal cooled reactors with the converters integral with the fuel elements, or placed in the heat exchanger or on the radiator.

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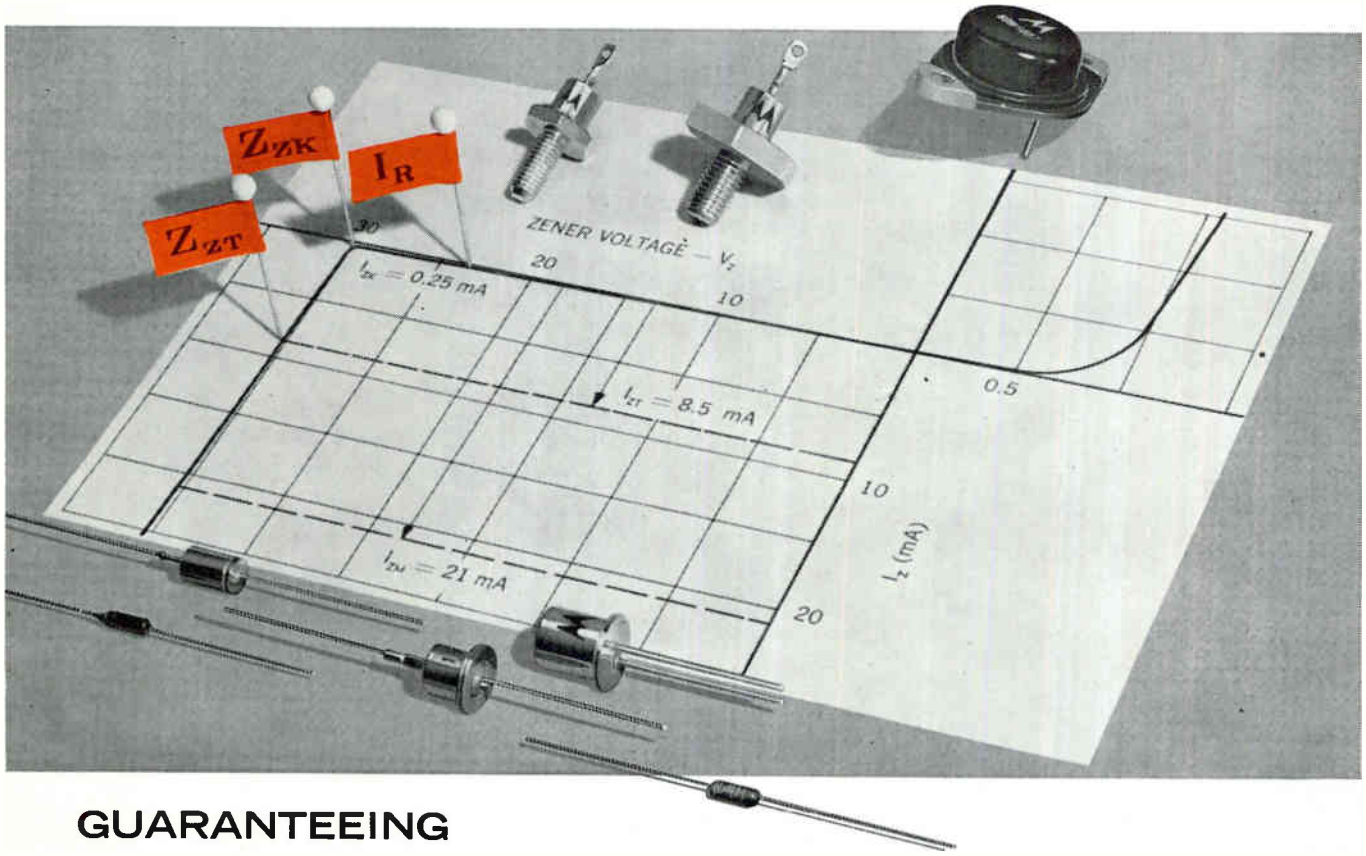

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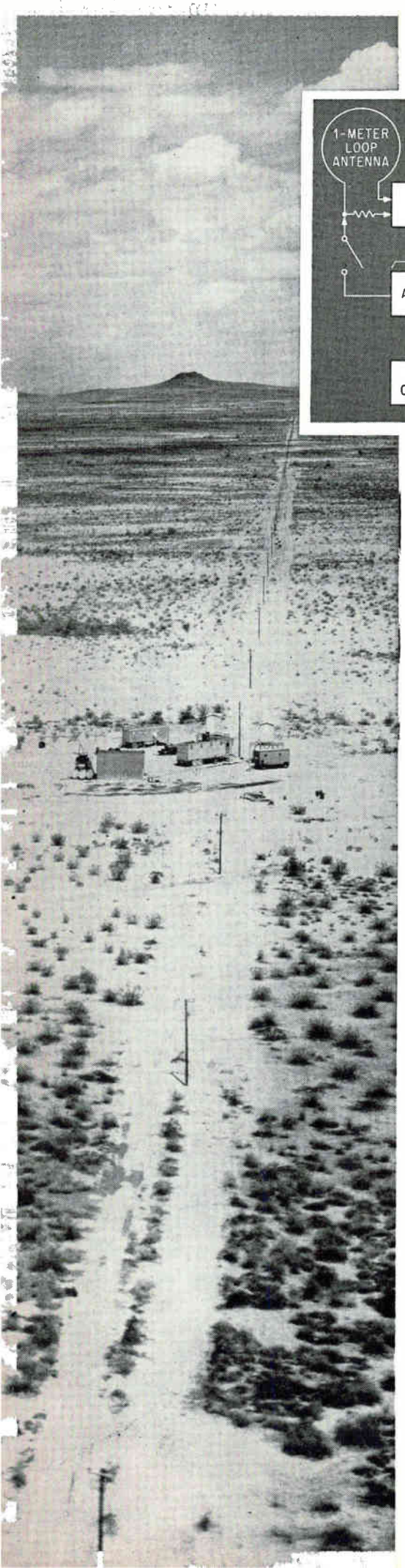
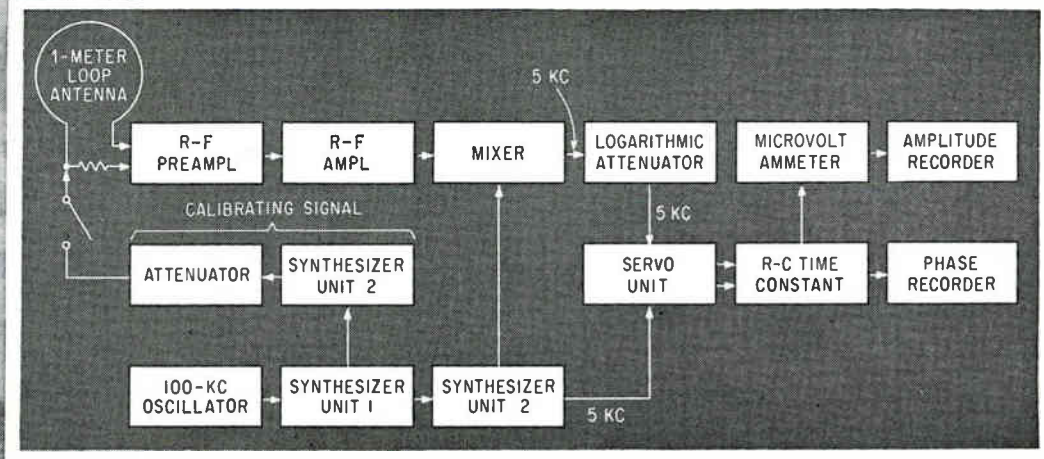




RECEIVER *measures fluctuation in phase and amplitude of vlf signals reflected from ionosphere's D layer*

Navy Prepares for VLF Detection of Nuclear Blasts

Ionospheric sounder with 5½-mile antennas gathers data on short-path effects

By ROY J. BRUUN
Assistant Editor

RADIATION from nuclear blasts in the atmosphere instantly causes an increase in ionospheric electron density. Very-low-frequency signals passing through the disturbed region instantaneously advance in phase (p 20, July 20). Over a short path, vlf signal phase and amplitude are highly sensitive to electron density changes.

If ionospheric sounders with a nearly vertical angle of incidence were used for short-path vlf propagation, they could detect nuclear explosions. Navy Electronics Laboratory personnel have recommended such a detection system and suggest that short-path data could also be extrapolated to form the basis of a long-path system.

DATA PROBLEM—One of the big hitches in developing such a system, is the lack of adequate short-path data on transient vlf phase changes, according to V. R. Noonkester, W. F. Moler, M. R. Paulson and E. E. Gossard, of NEL. Especially lacking is sufficiently accurate information about the ionospheric D layer—its electron density profile, short-path propagation characteristics, effect of inhomoenenties on vlf signals and other data. Long-path data is of little use. It is difficult to isolate the cause of an effect and effects can average out over a long path. The D layer is of particular interest to vlf detection because it reflects vlf.

Lying below an altitude of 100 Km, the D layer normally has only a thin electron density. Pulsed, swept-frequency, vertical ionospheric sounders used for upper-ionosphere investigation are not

TRANSMITTING ANTENNA *dipoles stretch 5½ miles across desert near Sentinel, Ariz.*

suited to D-layer probing; vlf cannot be successfully pulsed and the D layer reflects only vlf.

Nor can conventional vlf systems be used for short-path ionospheric propagation. Vlf transmitters have vertically polarized antennas. At close range, receivers would get a strong signal from the transmitter and only a weak signal reflected from the D layer.

VLF SOUNDER—To gather the needed data as quickly as possible, the Radio Physics division of NEL has built a vlf ionospheric sounder.

The system consists of a transmitter with an antenna designed to minimize groundwave to the receivers, and three receivers spaced at distances of 50 to 150 Km.

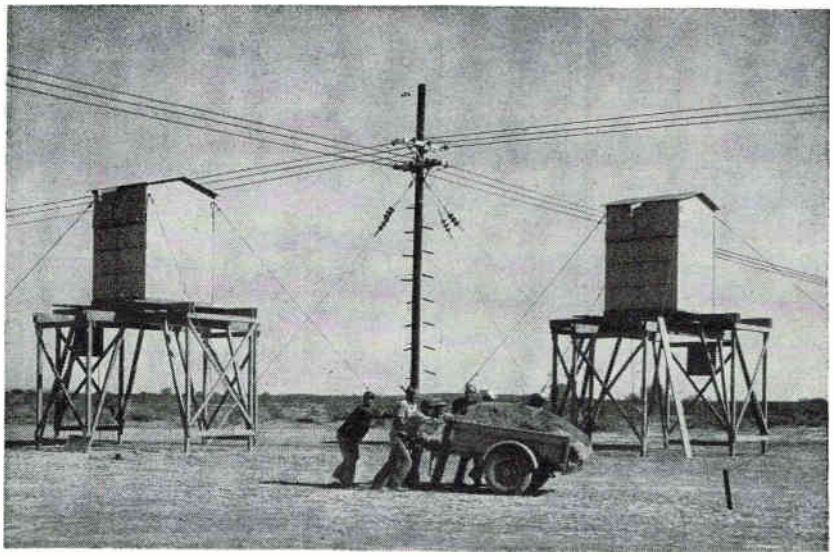
Receiver locations permit the spatial pattern of reflected signal phase and amplitude to be determined. This information is used to determine scale size, drift direction and velocity of ionospheric inhomogeneities. Spaced receivers will also permit determination of whether inhomogeneities are anisotropic as a result of geomagnetic field lines.

Transmitter and receiver oscillators, stable to 1 part in 10^9, are tuned to the same frequency before each operation. Receiver oscillators are used as a phase variation reference. The transmitter has a rubidium frequency standard. Digital clocks time the receivers.

RECEIVERS—As illustrated, the incoming signal is mixed to provide a 5-Kc output from the mixer. The synthesizer provides the oscillator frequency needed for a 5-Kc mixer output.

Mixer output and a 5-Kc reference signal are compared in a servo unit. If the incoming signal's phase varies, the unit drives a phase-shifting capacitor to keep the two signals in phase and the phase change is recorded.

Amplitude and amplitude variations of the incoming signal are measured by shifting the mixer output 90 degrees in phase and comparing it with the reference. Signals in noise can be measured because only signals consistently 90 degrees out of phase with the ref-



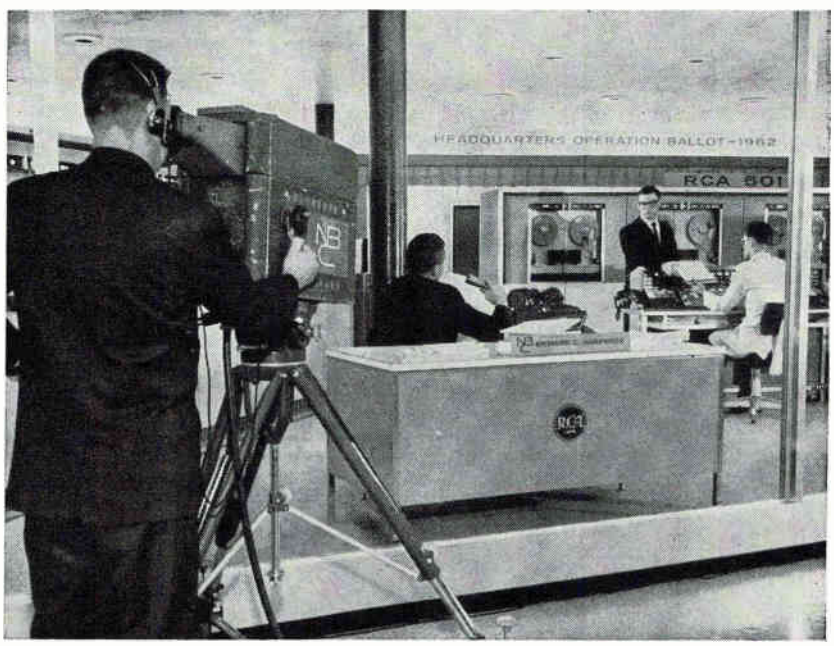
ANTENNA ARRAY CENTER. *To achieve maximum upward radiation, antennas are made of three wires in horizontal plane*

erence contribute to the amplitude indication.

ANTENNA—The transmitting antenna configuration is a horizontal dipole over a conducting plane, to provide maximum upward radiation. Two dipoles are used, each made of three parallel strands of aluminum wire strung on power-line poles.

The dipoles cross at their centers, with one parallel to the horizontal component of the earth's magnetic field and the other perpendicular to it. Each is 5½ miles long, or one-half wavelength at 14 Kc. Knife switches at intervals shorten the dipoles for use at higher frequencies. For frequencies to below 10 Kc and for fine tuning, two 1.5-millihenry coils are used.

1962 Elections Give Computers More Work



NBC AND RCA *have teamed up in a project to report voting trends in all Congressional contests and key gubernatorial races Nov. 6. The setup, much more elaborate than the one used in the 1960 presidential election, will use five computers—three RCA 501's and two 301's—and some 300 people in two centers linked by a data communications system. A special programming technique, called federation, that combines data with political analyses, was devised for the operation*

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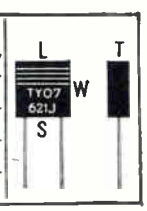
	Min.	Max.	L±.005"	W±.010"	T±.005"	S±.020"
TY06	1	560	.300"	.200"	.115"	.200"
TY07	560	1000	.300"	.300"	.115"	.200"
TY08	1001	2700	.500"	.300"	.115"	.400"
TY09	2701	10000	.900"	.700"	.195"	.800"



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ELECTRONIC RELIABILITY CONFERENCE, IRE-PGRQC, PGPEP, PGCP; Stevens Institute of Technology, Hoboken, N. J., **Oct. 19.**

MOTION PICTURE AND TELEVISION ENGINEERS Convention and Equipment Exhibit; Drake Hotel, Chicago, Ill., **Oct. 21-26.**

AEROSPACE & NAVIGATION ELECTRONICS EAST COAST CONF., IRE-PGANE; Baltimore, Md., **Oct. 22-24.**

COMPUTER APPLICATIONS SYMPOSIUM, Armour Research Foundation; Morrison Hotel, Chicago, **Oct. 24-25.**

ELECTRON DEVICES MEETING, IRE-PGED; Sheraton Park Hotel, Washington, D. C., **Oct. 25-27.**

QUALITY CONTROL MIDWEST CONFERENCE, Amer. Soc. for Quality Control; Statler-Hilton Hotel, Denver, Colo., **Oct. 26-27.**

MEDICINE & BIOLOGY ELECTRONICS TECHNOLOGY CONFERENCE, IRE-PGBME, AIEE, ISA; Edgewater Beach Hotel, Chicago, Ill., **Oct. 29-31.**

MISSILE & SPACEBORNE COMPUTER ENGINEERING TECHNIQUES CONFERENCE, IRE-PGEC; Disneyland, Anaheim, Calif., **Oct. 30-Nov. 1.**

TRI-SERVICE ELECTROMAGNETIC COMPATIBILITY CONFERENCE, Office of the Director of Defense Research, Armour Research Foundation; at ARF, Chicago, Ill., **Oct. 30-Nov. 1.**

PRODUCT ENGINEERING & PRODUCTION NATIONAL CONFERENCE, IRE-PGPEP; Jack Tar Hotel, San Francisco, Calif., **Nov. 1-2.**

INDUSTRIAL RESEARCH INSTITUTE MEETING; Queen Elizabeth Hotel, Montreal, Canada, **Nov. 1-3.**

MEDICINE & BIOLOGY ELECTRONIC TECHNIQUES CONFERENCE, IRE, AIEE, ISA; Conrad-Hilton Hotel, Chicago, **Nov. 4-7.**

NORTHEAST RESEARCH AND ENGINEERING MEETING, IRE; Somerset Hotel and Commonwealth Armory, Boston, Mass., **Nov. 5-7.**

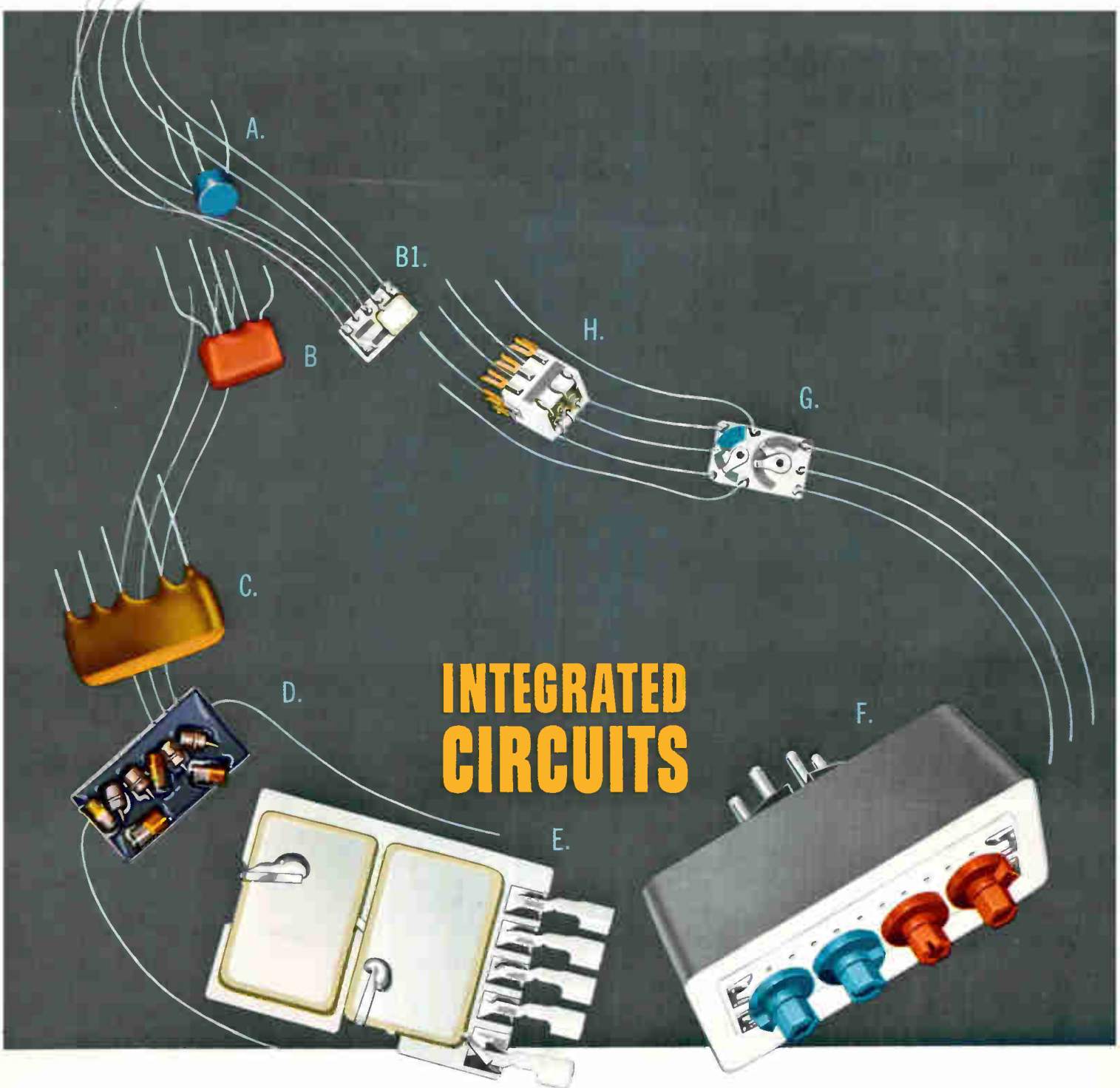
LASERS & LASER APPLICATIONS, Ohio State University, at OSU, Columbus, Ohio, **Nov. 7-8.**

ACOUSTICAL SOCIETY OF AMERICA FALL MEETING; Olympic Hotel, Seattle, Wash., **Nov. 7-10.**

IEEE INTERNATIONAL CONVENTION, Institute of Electrical and Electronic Engineers; Coliseum and Waldorf-Astoria Hotel, New York, N. Y., **March 25-28.**

ADVANCE REPORT

AEROSPACE SUPPORT SYSTEMS INTERNATIONAL CONFERENCE, IEEE, *et al; Washington, D. C., Aug. 4-9, 1963. Dec. 3 is the deadline for submitting abstracts of not more than 250 words to: Technical Sessions Committee, Technical Papers, P. O. Box 6635, Washington 9, D. C. Objective of conference is to encompass as broad a subject area as possible within the Aerospace Support context. Subjects include but are not limited to: electrical-electronic systems and techniques; guidance control; telemetry; communications; instrumentation and checkout; training and education; management and administration.*



INTEGRATED CIRCUITS

ALL UNITS SHOWN ACTUAL SIZE

A. Subminiature 1 KC tone generator. Contains one transistor, 4 resistors, 2 capacitors. Measures 0.2″ x 0.28″ diam.

B & B1. Computer mix gate. Contains 5 resistors and one capacitor. Repetitive circuit application uses thousands of perfectly matched units. Measures 7/16″ x 3/8″ x 3/16″.

C. High stability computer circuit with ±1% deposited metal resistors. Contains 4 resistors, one capacitor. Measures 1 1/16″ x 23/64″ x 1/4″.

D. Complete 4-stage amplifier, 78 db gain. Contains 4 transistors, 12 resistors, 5 capacitors. Measures 1 1/8″ x 5/8″ x 1 1/4″.

E. High reliability arc-suppression circuit. Minimum life of 20,000 hours continuous operation. Potted in case, 1 1/2″ x 2 1/8″ x 1/4″, in actual use. Contains 4 resistors, 4 capacitors.

F. Twin-T network mounted on space-saving octal plug. Contains 4 trimmer potentiometers, 5 resistors, 6 capacitors. Measures 7/8″ x 1 1/16″ x 2 19/32″.

G. "Two-dimensional" triple trimmer potentiometer for restricted space application — 0.1″ thick. Contains 6 fixed resistors in addition to trimmers.

H. Gate circuit with plug-in mating connectors. Contains 6 diodes, 5 resistors. Measures 1 13/32″ x 13/32″ x 5/8″.

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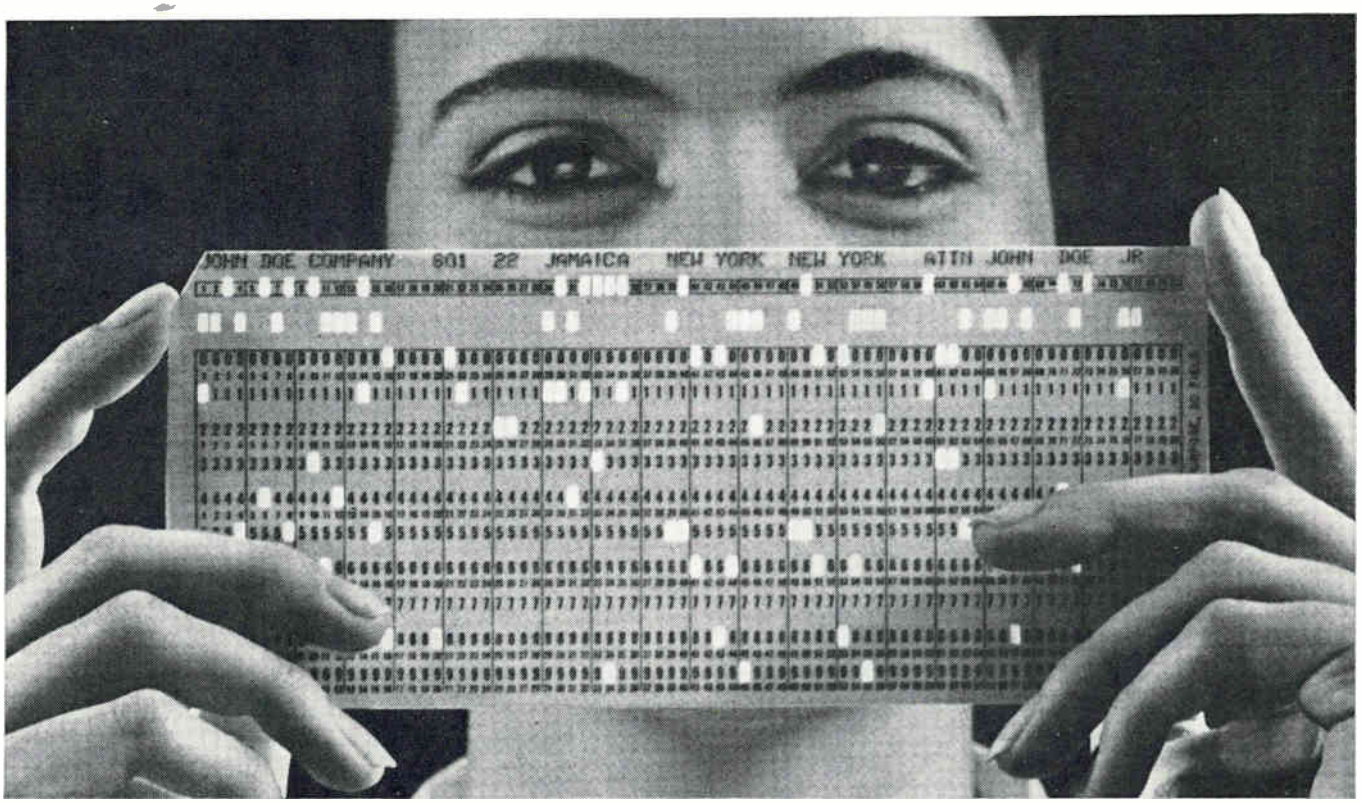

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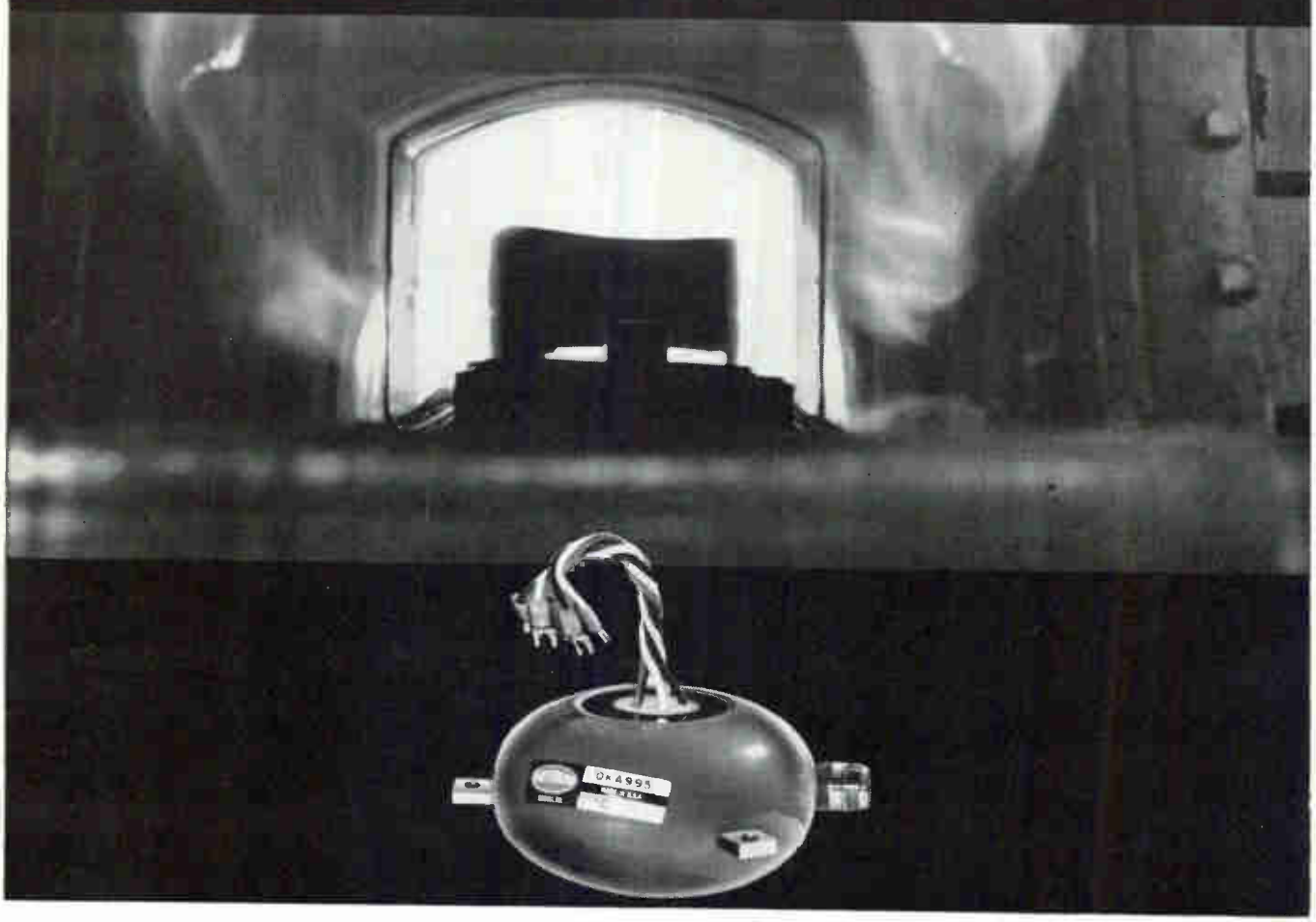
Raytheon selects NORTON "HOT RODS" for long trouble-free service life



Mr. Elliott Anderson, Heating Engineer of the Raytheon Company plant in Waltham, Mass., endorses the performance of Norton CRYSTOLON* heating elements — "Hot Rods" — in the production of Raytheon Backward Wave Oscillators in a conveyor-type furnace — both of which are shown above.

To assure ruggedness and reliability in space and missile use, the high alumina bodies for these Oscillators are accurately brazed and soldered in these furnaces. Furnace temperatures are quickly raised from a non-operative 790°C. to an operative 1140°C. and maintained at ±4 or 5°C for this operation. Mr. Anderson reports that "Hot Rods" are used because of their long, dependable service life.

"Hot Rod" applications include the firing of ceramics for electronics and other industries... hardening of metals... sintering, calcining, refining . . . melting of glass and metals.

For details of "Hot Rod" advantages in your own kiln or furnace operations, write to NORTON COMPANY, Refractories Division, 689 New Bond St., Worcester 6, Massachusetts.

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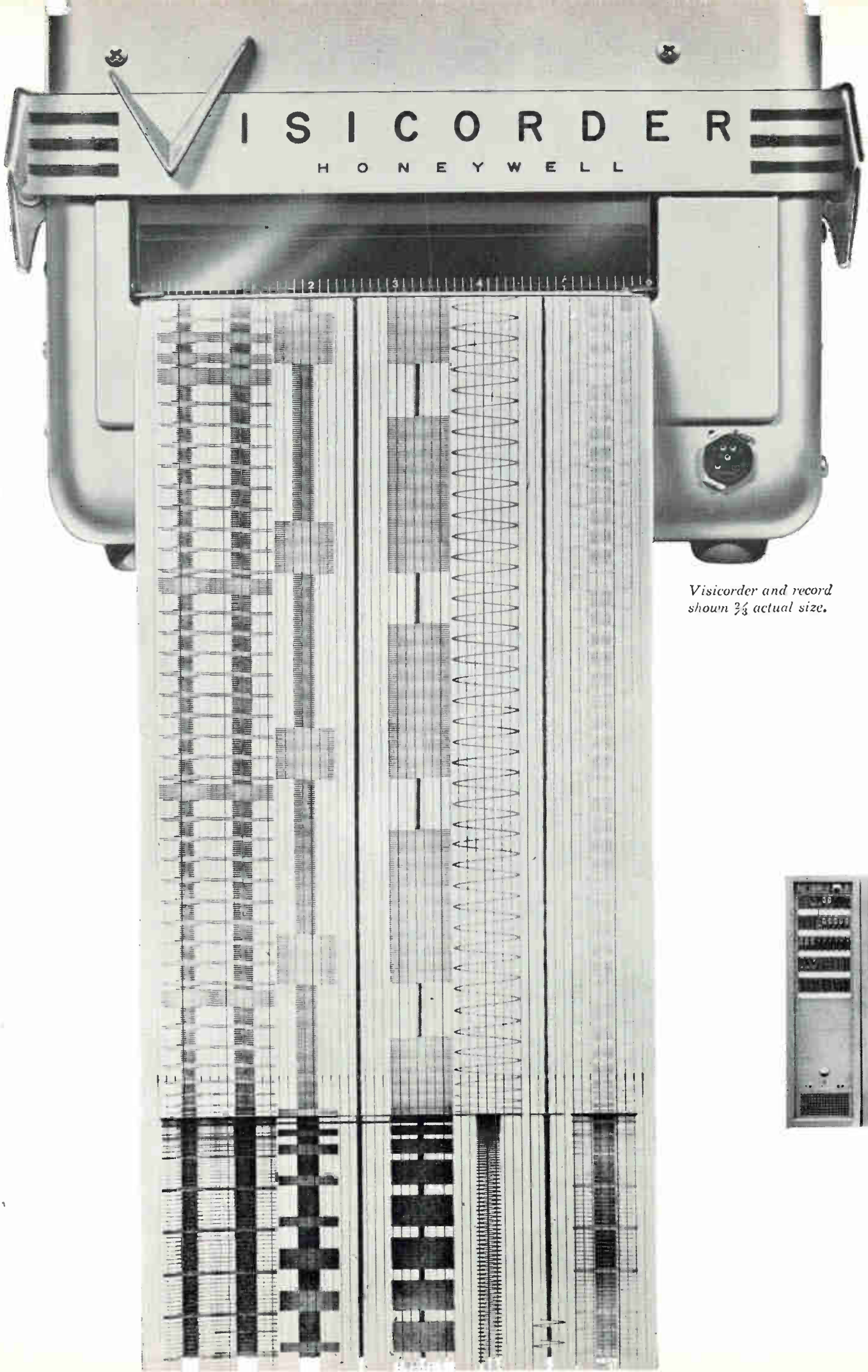
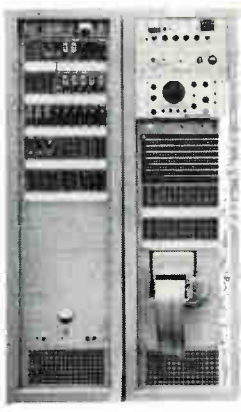


Visicorder and record shown ⅔ actual size.



"MASTER CLOCK"

for the missile range uses 15 Honeywell Visicorder oscillographs

The Timing Operations Center designed and built by Epsco-West for the Navy's Pacific Missile Range is now in use at Point Mugu, California. It makes use of 15 Honeywell Visicorders to read out (as shown on the unretouched record at left) the modulated timing codes distributed as balanced outputs to the Center's "customers."

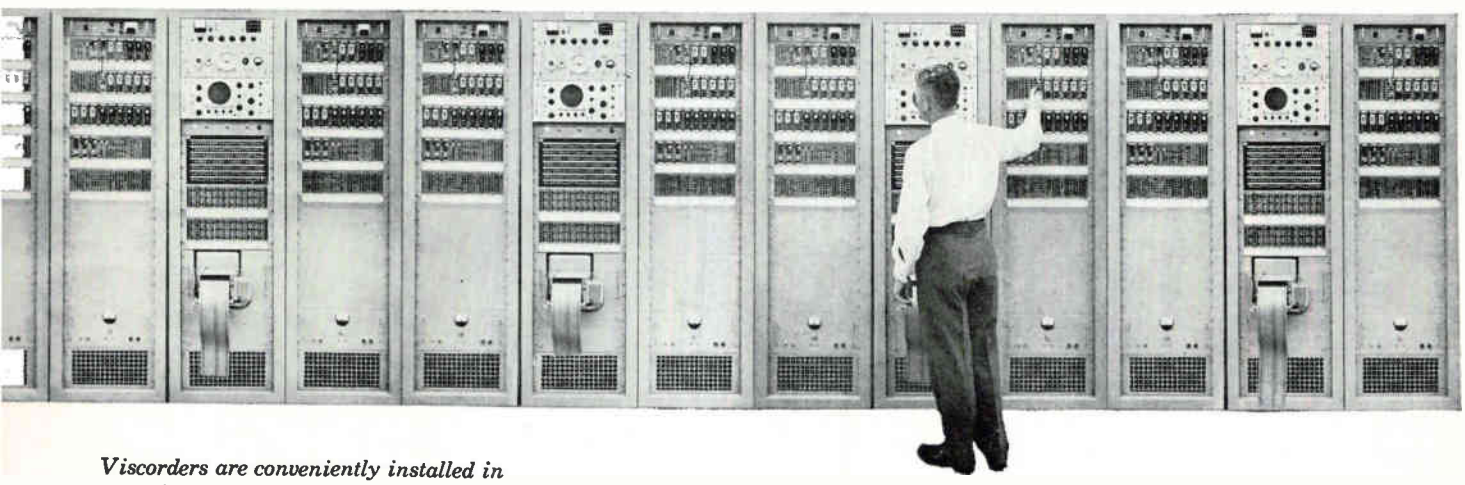
These customers are the test and development crews on weapons systems, satellites, space vehicles or any other users of the facility who depend upon extremely accurate timing signals for many purposes including satisfactory correlation of telemetry data. The TOC generates as many as eleven separate timing signals, any one of which may be delivered to any of 36 users at one time.

Entirely solid-state, the Epsco-West TOC consists of a precision frequency standard, the 100-kc/sec output of which is accepted by the timing signal generator and divided down to one pulse per sec by digital divider units. The 1-pps signal is accumulated in binary-coded decimal format by a counter-type register permuted to read out in hours, minutes, and seconds. Recycling occurs at 23:59:59. Controls include advance or retard in 10-microsecond increments.

The 906B Visicorder also performs a supplementary function as a monitor on the timing and test-patch panel, and as permanent "record-keeper" for the built-in indicators and test oscilloscopes. Visicorders were selected for their jobs with the TOC because of their versatility, reliability, low cost, and compact size (10" x 10" x 15½"; weight, 37 lbs.).

Pioneer and acknowledged standard in the field of high frequency direct-recording oscillography, the Visicorder is available in several models, from 6 to 36 channels, DC to 5000 cps response, up to 20,000"/sec writing speed. Honeywell engineering is at your service through 120 field offices for help in applying one Visicorder or a full system to your data acquisition program; or a quantity of Visicorders for OEM application in your products.

Call your local Honeywell office now or write today for Catalogs HC 906B, 1012, 1108 and 1406 to Minneapolis-Honeywell, Heiland Division, 4800 E. Dry Creek Road, Denver 10, Colorado. Our DDD phone number is 303-794-4311.



Viscorders are conveniently installed in control consoles of three-rack TOC modules. Records are immediately legible without chemicals or developing.

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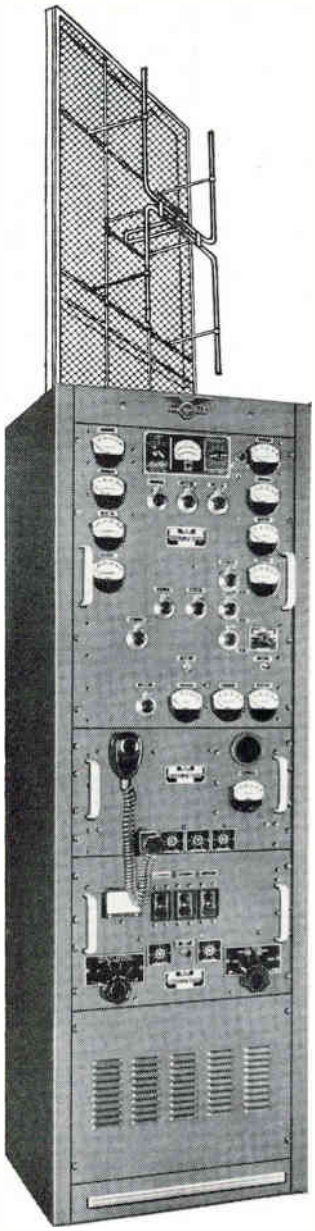
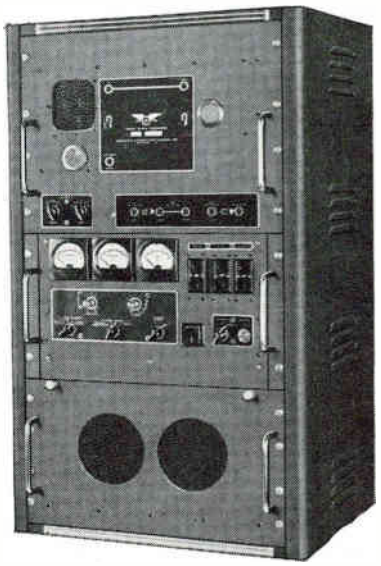
CIRCLE 37 ON READER SERVICE CARD



AEROCOM PRESENTS VHF AM TRANSMITTERS and RECEIVERS

AEROCOM communications equipment is designed with both performance and reliability in mind, and is produced by experienced personnel using high-quality materials. The following features are found in all three transmitters: Single crystal controlled frequency (plus an additional frequency ½% away from main frequency): stability ± .003% or ± .001% over temperature range of 0° C to + 55° C, any humidity up to 95%; audio system incorporates high level plate modulation, with compression; forced ventilation with air filter is employed. Welded steel cabinets.



Model 10V1-A—1000 Watts output—Successfully being used in Troposcat service for communications with aircraft beyond the optical horizon. Frequency range 118-153 mc. Can be completely remote controlled by using AEROCOM's remote control equipment. All tuning from front panel by means of dials. Power requirements 210-250 V 50/60 cycles, single phase.

Model VH-200—200 Watts output in range 118-132 mc. Excellent for both point-to-point and ground-to-air communications. Press-to-talk and audio input may be remoted using single pair of telephone lines. Power requirements 105-120V 50/60 cycles. Also available for use above 132 mc; output drops gradually to 150 watts at 165 mc.

Model VH-50—50 Watts output. Frequency range 118-153 mc. Outstanding low power transmitter for ground-to-air service. With remote control provisions; main power control with front panel switch. Convection cooling for press-to-talk service—otherwise forced air cooling. Power requirements 115/230 V 50/60 cycles.

Model 85 VHF Receiver. A high performance, low noise, single channel crystal controlled, single conversion VHF receiver. Stability normally ± .001% (with oven crystal ± .0005%) over temperature range 0° C to + 55° C. Sensitivity ½ microvolt or better for 1 watt output with 6 db signal to noise ratio. Standard selectivity bandwidth 30 kc; other widths available. Spurious response down 90 db. Frequency range 118-154 mc. Power requirements either 115 V or 230 V 50/60 cycles. Made for standard rack panel mounting.

As in all AEROCOM products, the quality and workmanship of this VHF equipment is of the highest. All components are conservatively rated. Replacements parts are always available for all AEROCOM equipment.

Complete technical data available on request

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ALITE — with its completely equipped facilities for producing high quality, vacuum-tight, ceramic-to-metal seals — is geared to meet all your requirements for high alumina ceramic-metal components. From design to finished assembly, every manufacturing step — including formulating, firing, metalizing and testing—is carefully supervised in our own plant. Result: effective quality control and utmost reliability.

Hermetic seals and bushings made of high alumina Alite are recommended for electromechanical applications where service conditions are extremely severe or critical. Alite has high mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide frequency and temperature range. It resists corrosion, abrasion and nuclear radiation. Its extra-smooth, hard, high-fired glaze assures high surface resistivity.

To simplify design problems and speed delivery, Alite high voltage terminals, feed-throughs and cable end seals are available in over 100 standard sizes. However, when specifications call for special units for unusual applications, you can rely on expert assistance from Alite engineers to help you take full advantage of Alite's superior properties.

Write us about your specific requirements today.

WRITE FOR HELPFUL FREE BULLETINS

Bulletin A-8 gives useful comparative data. Bulletin A-40-R describes Alite facilities and complete line of Alite Standard Bushings.

ALITE DIVISION

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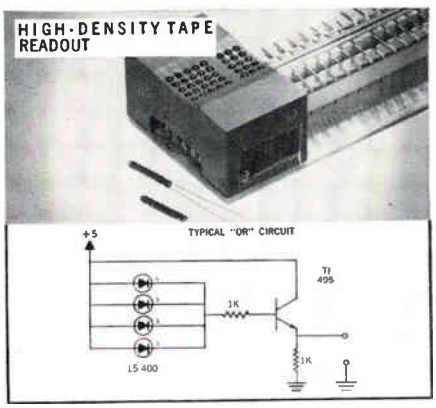
141-H

NEW WAYS TO REDUCE

A STATUS REPORT FROM

Get higher sensitivity and greater economy with advanced LS-400 planar silicon light sensors from TI

Now you can utilize the most advanced micro-miniature light sensor available today for your character recognition; tape, card, or microfilm scanning; cataloging; storing or information retrieval equipment. With these exclusive new sensors you get extreme sensitivity, higher density package and use-proved reliability, allowing you to design more economical circuits, reduce the number of components, and increase over-all circuit performance.



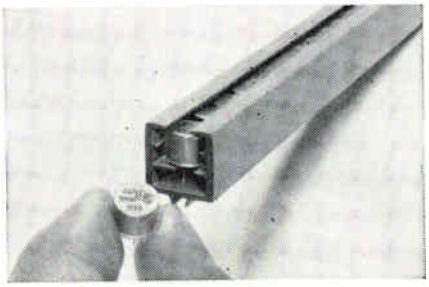
Texas Instruments LS-400 photoconductive sensors give you cycle capability to 25,000/sec — sensitivity ten times that of other subminiature photovoltaic or photoconductive sensors (typical output 9 ma @ 1000 ft-c), eliminating the need for extra gain stages — temperature stability to 1%/°C — off-storage-on stability to ±5%. Its highly reliable, planar, surface-passivated construction gives extremely low leakage — two decades lower, typically .01 μa in the dark condition. You can design more compact scan heads as the LS-400 exclusive end-reading design requires less space to accommodate the desired number of sensing units.

Slide-Pak* feed magazine greatly reduces transistor handling costs

Slide-Pak feed magazine — a new concept in packaging, shipping, and using transistors — is now available from Texas Instruments.

This unique transistor-handling method offers the volume transistor user many cost-saving advantages, such as: all transistor leads are pre-clipped to desired length; leads are straightened and kept straight; each transistor is uniformly oriented for identical insertion. Though ideally suited and specially designed for automatic insertion equipment, the Slide-Pack magazine offers important time-and-cost saving advantages for manual insertion operations as well.

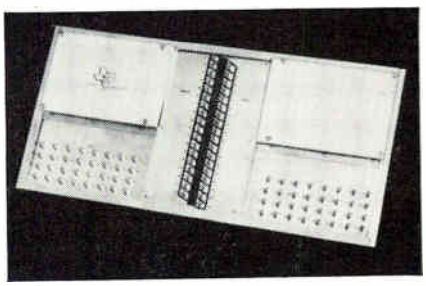
You also realize important space and weight savings in shipment and storage. Made of rugged, dimensionally stable plastic, the Slide-Pak magazine will not warp or crack and will hold its tolerance, thereby eliminating transistor jamming. You can utilize this new packaging technique with either TO-5 or TO-18 devices.



Texas Instruments can offer you valuable production experience in the application of this packaging technique to your special needs.

Greater bit-per-second economy with new high-speed magnetic memories

Texas Instruments is now offering the computer designer operating speeds to 5 mc in random-access word-organized memory systems. These new memory systems offer special promise for military and commercial application because of their inherent high speed coupled with potential low cost.



Typical of the systems now being designed is a memory of 8000 words, 50 bits per word, and 1.0 microsecond cycle time. The storage medium in these new systems is continuous sheets of thin magnetic

SEMICONDUCTOR-COMPONENTS DIVISION

COMPUTER PRODUCTION COSTS

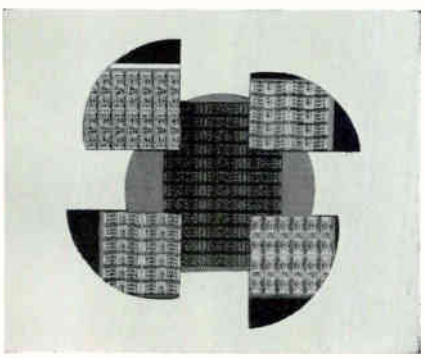
TEXAS INSTRUMENTS

film deposited on aluminum substrates. This aluminum substrate adds excellent mechanical rigidity to the over-all low-noise, low-drive-power systems.

To simplify engineering evaluation of the memory systems Texas Instruments provides a pair of magnetic-film memory planes arranged in a word-organized array comprising 64 words of 18 bits each. The designer can combine conventional electronics components with this new MS-1 memory stack to yield a small memory system capable of 0.2 microsecond cycle time.

New economical Solid Circuit* semiconductor networks customized with "Master Slice"

Today you can get the exceptional reliability and miniaturization benefits of SOLID CIRCUIT semiconductor networks in many customized circuit design variations — at only slightly more cost than standard, catalog circuits. The flexible "master slice" design concept developed by Texas Instruments makes this achievement possible.



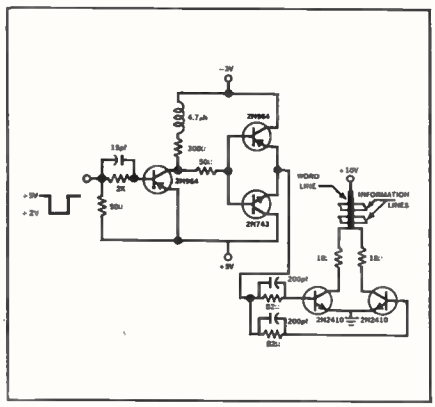
First, standard "master slice" integrated circuit bars — complete except for interconnections — are taken from established, high-volume production lines. Second, a special interconnection pattern mask for your circuit is prepared. Third, your special interconnection pattern is photo-etched in aluminum on the "master slice" circuit bar.

You get a complete semiconductor network — integrating resistors, capacitors, diodes and transistors into a single, high-purity silicon wafer—to your specifications. Evaluation samples can be available within four weeks from final design approval. Because preparation of the special interconnection pattern is the only custom step in the manufacturing process, you get most of the economy and delivery benefits of standard TI production units.

Now . . . reduce circuit costs and switch 1 amp in 39 nsec with new Snowflake* transistor

Now . . . you can greatly increase computer information-handling capacity and reduce circuit cost by designing TI 2N2410 Snowflake transistors into your thin-film driver circuitry.

As shown in the following circuit above, two TI 2N2410 transistors will perform the same function as ten less-advanced transistors — made possible by the high-current switching capability of Snowflake. Typically, the 2N2410 will switch 0.5 amp in 85 nanoseconds and 150 ma in 75 nanoseconds. Guaranteed total switching times are 120 nanoseconds at 150 ma and 130 nanoseconds at 500 ma. The ideal combination of high current and fast switching you need for advanced, high-speed computers can now be obtained with these NPN silicon epitaxial planar Snowflake transistors. Your circuits will be



capable of operating at higher frequencies with faster switching of higher current. You have the high-speed at high-current advantage of TI's epitaxial planar process combined with the new "Snowflake" six-point emitter geometry . . . available now in production quantities.

For further information, contact your Texas Instruments sales engineer, or write to Department 442, P. O. Box 5012, Dallas 22, Texas.

"TI cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement."

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Maybe the picture of Mom ironing Dad's trousers while sunning herself may be a bit far-fetched. A portable iron (battery-powered?) may be even more so. Probably impractical.

Our point is this—your present design problem may seem just as impractical, just as the drill, shaver, mixer and other cordless products did a few years ago. But Gould-National research engineers developed a package of concentrated power using NICAD® Hermetically Sealed Rechargeable Cells that helped to make these products a reality.

Have a design problem that could be solved with Nicad portable power? Write us, we may be able to help you solve your problem.

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NICAD BATTERY DIVISION

GOULD-NATIONAL BATTERIES, INC. / St. Paul 1, Minnesota

SG-5000

Transitron offers computer circuit designers a highly reliable, better performing, subminiature glass silicon planar epitaxial diode. Careful development, supported by stringent environmental and life tests, has solved all mechanical and electrical problems. The result is the SG-5000 — a premium unit that fully meets military specifications.

At the same time, Transitron has improved upon the selected performance of silicon planar epitaxial diodes now available. In addition to the recognized features of higher forward conductance, faster switching and lower capacitance, the uniformity of planar epitaxial construction lets Transitron offer tightly controlled forward voltages at specified current levels. The SG-5000 is available in quantity with digital marking for quick diode type identification.

Another step in Transitron's continuing efforts to offer the industry's widest variety of silicon diode types is the introduction of the 1N3604-6 and 1N3062-9 series of silicon planar epitaxial diodes. All Transitron silicon diodes, including the newest types, can be packaged as multiple-chip assemblies to your specification. All are now available through your Transitron distributor.

SPECIFICATIONS AT 25°C					
Type	Maximum Forward Voltage @ 200mA	Maximum Inverse Current @ −75V	Minimum Inverse Voltage @ 100μA	Maximum Capacitance @ 0V @ 1Mc	Maximum Reverse Recovery Time*
SG-5000	1.0V	0.1μA	100V	2 pf	2 nsec

*(I_F = 10mA, V_R = −6V, recovery to 1 mA, R_L = 100 ohms)

Transitron invites your inquiry regarding further details of its silicon planar epitaxial diodes. Write today.

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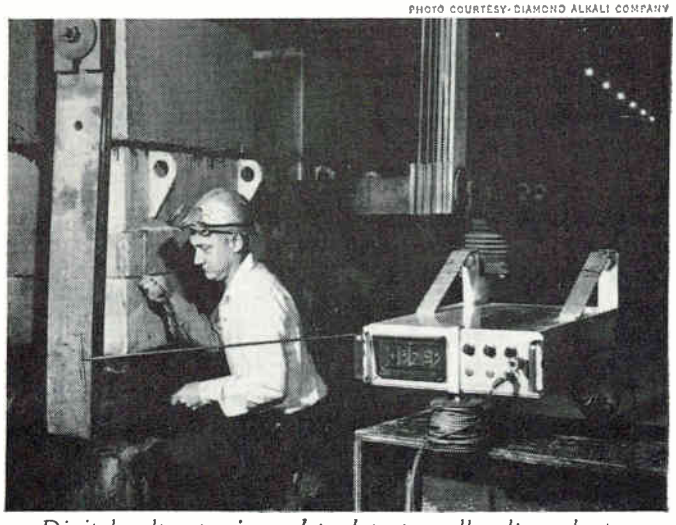
CIRCLE 43 ON READER SERVICE CARD

By SAM PUCKETTE
District Manager
Non-Linear Systems, Inc.
Del Mar, California
and
HENRY W. LAUB
Project Engineer, Cell Development
Diamond Alkali Company
Deer Park, Texas

Digital Measuring Technique Yields up to $8,000 Annual Saving

Wide application seen for highly accurate method to detect small changes in voltage and voltage drop – Diamond Alkali uses it to optimize efficiency of production project.

PHOTO COURTESY-DIAMOND ALKALI COMPANY



Digital voltmeter is used to detect small voltage drops.

A simple, digital measuring technique that can result in significant savings in AC or DC power helped solve a production problem for Diamond Alkali Company.

The problem centered around the question: *"How do you measure very small changes in voltage quickly and accurately?"*

The method used by Diamond Alkali to solve the problem is applicable wherever large amounts of AC or DC power are used. By detecting small voltage drops in electrical distribution systems, the technique can provide power savings in such applications as electrolytic processing, electrical power generation, and in the nuclear sciences. More broadly, it can serve as a general design tool by accurately and automatically measuring a wide range of voltages.

In the specific case of Diamond Alkali, personnel at the diaphragm plant in Deer Park, Texas, had believed that optimum placement of internal cell components would provide more efficient use of power in producing chlorine from sodium chloride brines by electrolysis. Also, voltage drops in bus bar connections had to be minimized to reduce power loss. In fact, a voltage drop of 0.01 volt at 30,000 amps would result in a loss of $8,000 a year. But because the voltage changes involved were only several hundredths of a per cent, it was difficult to recognize them with existing equipment.

The answer was a bit of ingenuity and an automatic digital voltmeter made by Non-Linear Systems, Inc., originator and world's leading manufacturer of DVMs. By allowing one or two men to make the measurements and observe instantly and accurately changes as small as one millivolt in 5 volts, the NLS 4-digit voltmeter (now $1,460) aided in producing power savings of up to $8,000 annually in this one area. Of significance was the fact that personnel making measurements could observe the digital readings from as far as 30 feet away. A long cable permits the operator to place the input probes anywhere along the long line of chlorine cells.

This means that the operator need only connect the digital voltmeter input probes and immediately note any changes displayed by the large digital readout of the DVM.

For information on how digital voltmeters and other digital measuring instruments and systems might be of assistance to you, please contact one of the 19 NLS factory offices or write Non-Linear Systems, Inc., Del Mar, California.

electronics

October 19, 1962

PROGRESS AND PITFALLS IN Microelectronics

Two of the most important problems in microelectronics are to resolve the difficulties of making transistors and diodes with thin-film deposition techniques, and conversely, of forming resistors and capacitive components with techniques developed for semiconductor work.

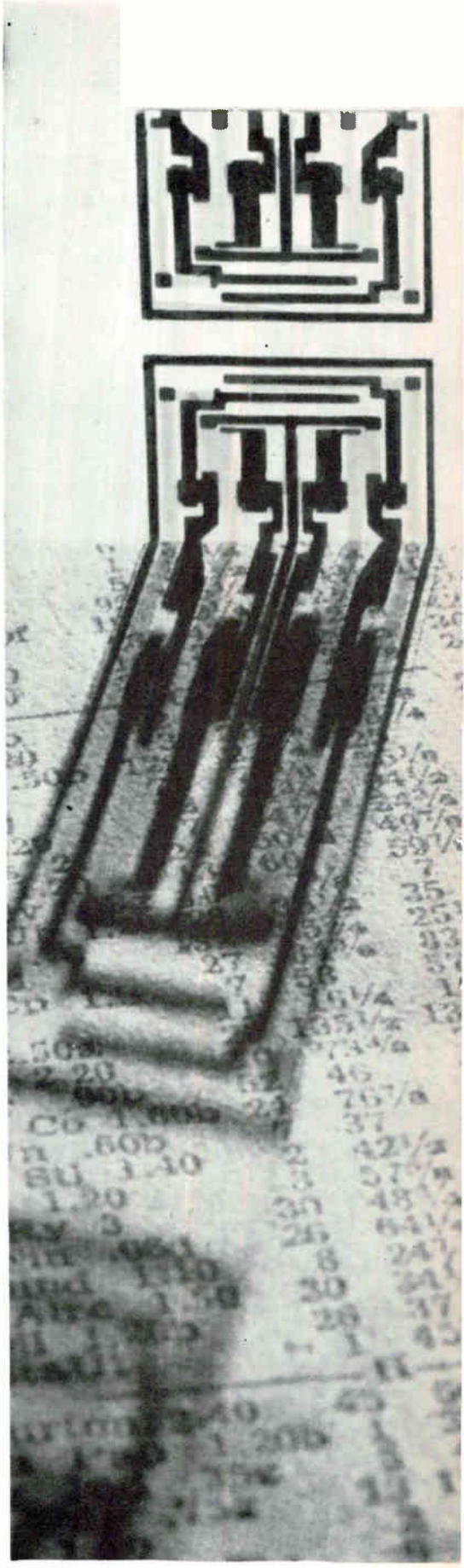
By J. J. SURAN

Electronics Laboratory, General Electric Company, Syracuse, New York

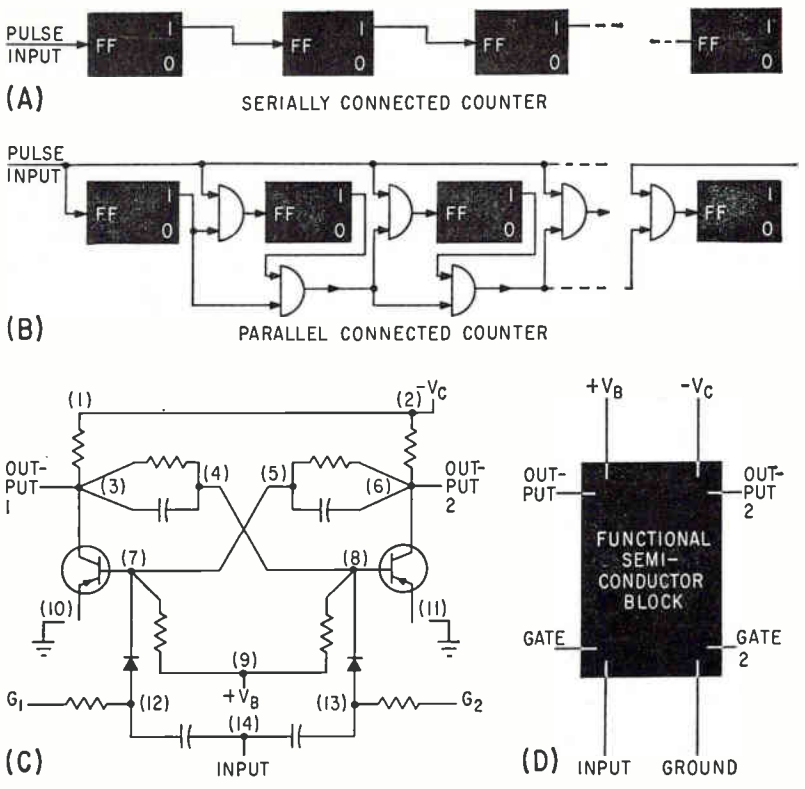
AMONG the objectives of microelectronics are reduction of size, weight and cost, plus increased reliability, improved power utilization and more functional capabilities per unit volume of equipment. Size and weight reduction is to be achieved by new fabrication techniques such as electrolytic deposition, or evaporation of thin films. Increased reliability will come through use of fewer solder connections, or through their replacement by chemically bonded material interfaces, by improved control of materials and processes used in fabricating the circuit elements, and finally, by increased use of redundancy on the componenet or circuit level. Cost reduction will be a by-product of improved construction and assembly techniques. The vast efforts in material technology may also lead to basic new devices ultimately superseding the transistor and related devices because of improved performance and more efficient power utilization.

To appraise the objectives of microelectronics, it is first necessary to consider that the end result of microelectronics is equipment and systems, not devices. To realize the best possible microelectronic system it is necessary to maintain a high degree of flexibility in the choice of component technologies and to appreciate that any technology selected for implementation must be subject to manufacturing process control, production standardization, acceptance testing and must be compatible with other technologies used in the same system.

APPLICABLE TECHNOLOGIES —The gamut of technologies applicable to microelectronics includes semiconductors, dielectrics, magnetics, superconductors, thermionics, metallic films and optoelectronics, and others that may become significant as time goes on. It will probably be necessary to integrate several of these technologies in microelectronics to achieve op-



DIFFICULTIES *of fabricating semiconductors making use of thin film techniques are overcome in this thin-film flip-flop*



LOGIC *in a serial counter (A) is considerably simpler than in a parallel counter (B); the serial version has fewer interconnections. Bistable circuit from individual components has 14 connection points (C); functional block arrangement has 8 (D)—Fig. 1*

ABILITY OF FOUR TECHNIQUES TO FULFILL CIRCUIT FUNCTIONS—TABLE I

Component	Semiconductor	Metallic Film	Ferrite	Optoelectronic
Inductor			✓	
Transformer			✓	
Memory		✓	✓	
Resistor		✓		
Capacitor		✓		
Diode	✓			
Switch	✓			
Amplifier	✓			
Display				✓

timum system results. For example, Table I shows how four of these technologies: semiconductors, metallic films, ferrites and optoelectronics, fulfill nine device functions. None of the four technologies meets all the requirements for components in conventional electronic systems. Hence an optimum design will select from the available techniques to best fulfill its needs.

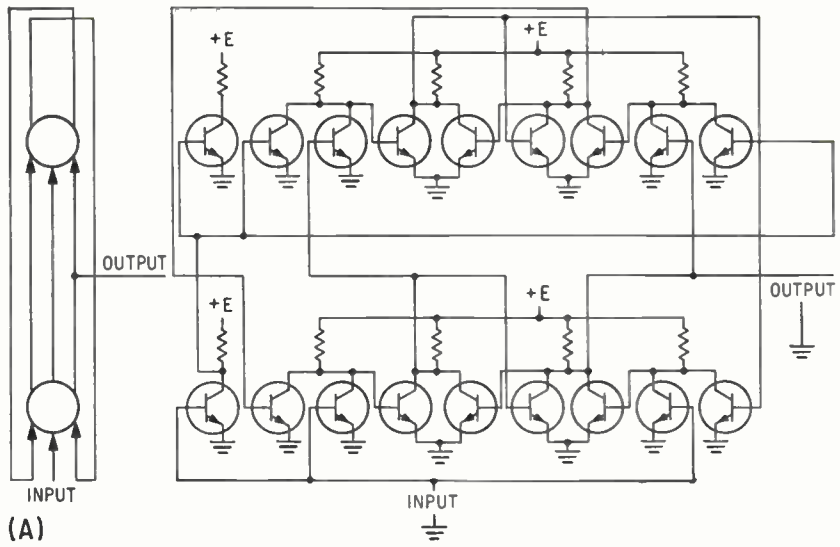
SYSTEM CONSIDERATIONS—Figure 1 illustrates two binary-counter configurations capable of performing the same counting function. One is a serially connected counter, the other parallel connected. Although the parallel configuration is more complicated, it is used where the serial counter's propagation time prevents operation at high speed. Comparing a 10-stage counter assembled from conventional, discrete components with a counter made up of functional semiconductor circuits emphasizes their relative complexity. Figure 1 also illustrates the two building blocks used for comparison. The semiconductor functional circuit allows a 45-percent reduction in interconnection nodes.

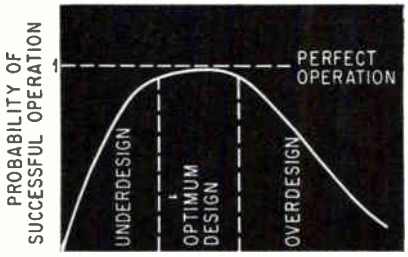
Table II shows the total number of interconnection nodes for the serial and parallel counter configurations, with both types built first from discrete components, and then from functional blocks. The functional block version of the serial counter produces a 50-percent reduction of interconnections, while the functional block parallel counter produces only a 28-percent improvement. The difference between the 28-percent and 50-percent advantage of the functional block configurations comes through the extra connections required for additional logic in the parallel design.

An example of how undue component constraints can obviate the advantages of microelectronics on the system level can be shown by considering the use of direct-coupled transistor logic (DCTL) in applications which are clearly not advantageous for it. The DCTL principle is attractive because it attempts to realize all logical functions using only resistors and transistors. However, the DCTL approach sometimes leads to considerable system complexity through lack of capacitors and diodes, which often contribute to a more straightforward design.

Figure 2 shows a DCTL flip-flop configuration, commercially available in microelectronic form, which performs the same function as the Eccles Jordan flip-flop and pulse transmission gate shown in Fig. 1. Even on the circuit level, the DCTL flip-flop is more complicated than the flip-flop of Fig. 1. Table III illustrates the additional system complexity encountered by using DCTL for the 10-stage binary counter. Considering the serial counter configuration, the first two entries in the table show the number of interconnection nodes required when the counter is realized with discrete components using resistors, capacitors, diodes and transistors and when only resistors and transistors are used in DCTL circuits. The significant increase in complexity due to DCTL is impossible to overcome even if semiconductor functional blocks are used.

RELIABILITY—Another question commonly arising in microelectronics depends upon component tolerances for a solution. What constitutes an allowable tolerance for a deposited resistor or transistor in a functional block? From a circuit point of view, most component





(B) DESIGN TOLERANCE

DIRECT-COUPLED *transistor logic often brings added complexity and increased interconnections that could be avoided with capacitors or inductors, (A). Optimum circuit design implies tolerances that are not so loose that drift may prevent operation, nor so tight that increased stress may cause catastrophic failure (B)—Fig. 2*

COMPARISON OF CONNECTIONS IN FUNCTIONAL BLOCK AND SEPARATELY WIRED BINARY COUNTERS—TABLE II

Ten Stage Binary Counter	Discrete Components	Semiconductor Functional Blocks
Serial Configuration		80
Parallel Configuration	227	

COMPARING INTERCONNECTIONS FOR BINARY COUNTERS USING THREE TYPES OF LOGIC—TABLE III

Ten Stage Binary Counter	Discrete Components		Semiconductor Functional Blocks
	RCDTL	DCTL	
Serial Configuration		500	
Parallel Configuration	227	690	230

tolerances or drift can be taken into account in circuit design with increased dissipation as the price paid for broader tolerances.[1] Some minimum power dissipation exists in every circuit, even if ideal components with zero tolerance are used. But as component tolerances increase, more power must be dissipated if the circuit is to work despite the component variations. As circuit power levels are increased, however, the components themselves become subject to greater stresses and consequently the higher power levels may lead cumulatively to an increase in component catastrophic failures. An optimum design tolerance, therefore, balances drift failures against catastrophic failures, as illustrated in Figure 2. Overdesigned circuits may fail catastrophically, while underdesigned circuits may be subject to too many component-drift failures. A great deal has been published about designing micropower circuits to increase packing densities in microelectronic systems. However, considering the relationship between system reliability and circuit power dissipation, micropower circuits may well sacrifice reliability to accommodate component packing densities. In a review article on microelectronics, it was stated, "Recent in-microcircuit transistor failures tend to fall in the out-of-spec rather than the catastrophic category."[2] This could indicate that the microcircuits referred to have been underdesigned from a reliability point of view.

Besides concluding that an optimum tolerance design point exists for maximum system reliability, implying in turn an optimum circuit power level, the reliability penalty for overdesign or underdesign becomes increasingly worse as the system complexity increases. And for a given system reliability, it is necessary to tighten component tolerances as the complexity of the system increases.

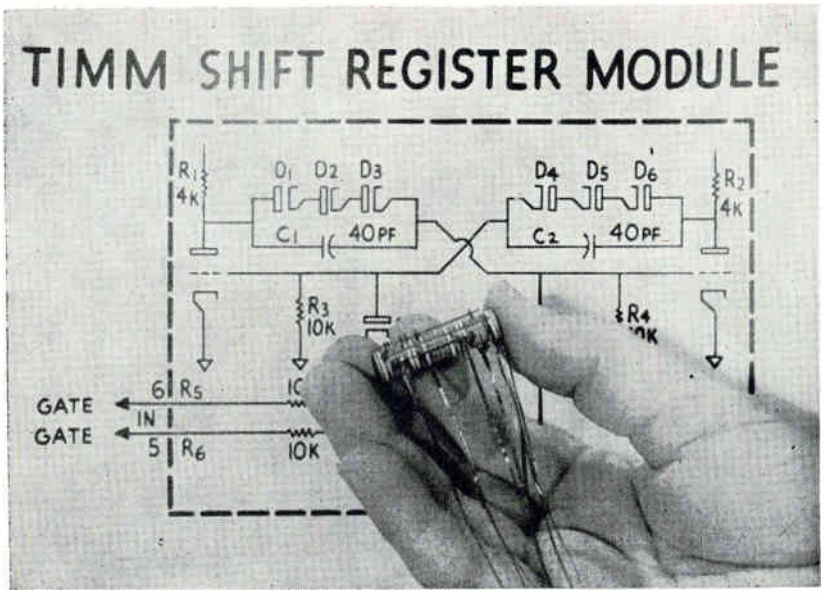
Redundancy as a cure for tolerance troubles is much easier to suggest than to apply in practice. Reserve components must be connected to allow the system to work even if components fail catastrophically. Some degree of inetrnal feedback should be employed in the system to protect against drift failures if the component tolerance problem is to be solved without use of cooling or without exceedingly tight component tolerance control. Furthermore, a means for testing the redundant blocks after production must be devised to make certain that all of the internal components are functioning properly. This requirement is important because, by the nature of redun-

BACK TO THE BEGINNING

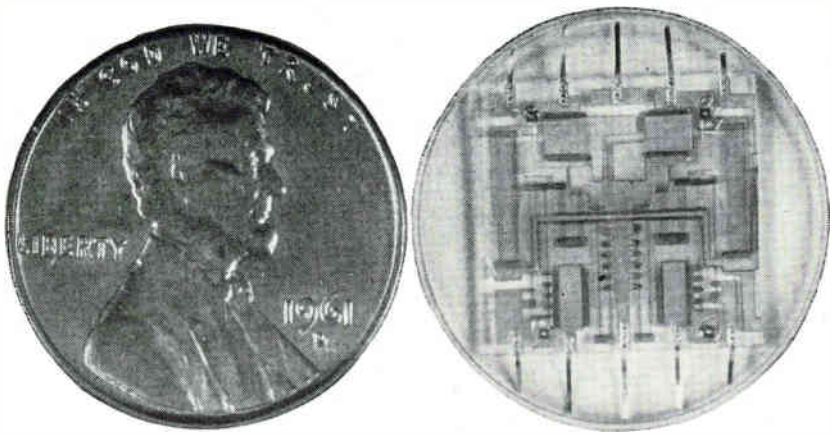
Just when transistor technology has evolved empirical but valid rules for designing reliable circuits, we land back into the laboratory with microelectronic methods of synthesizing systems.

Microelectronics cannot be dismissed as just a method of building transistor circuits along conventional lines only under a microscope. New fabricating techniques have been developed for preparing active and passive components. And new methods must be produced to resolve their incompatibilities.

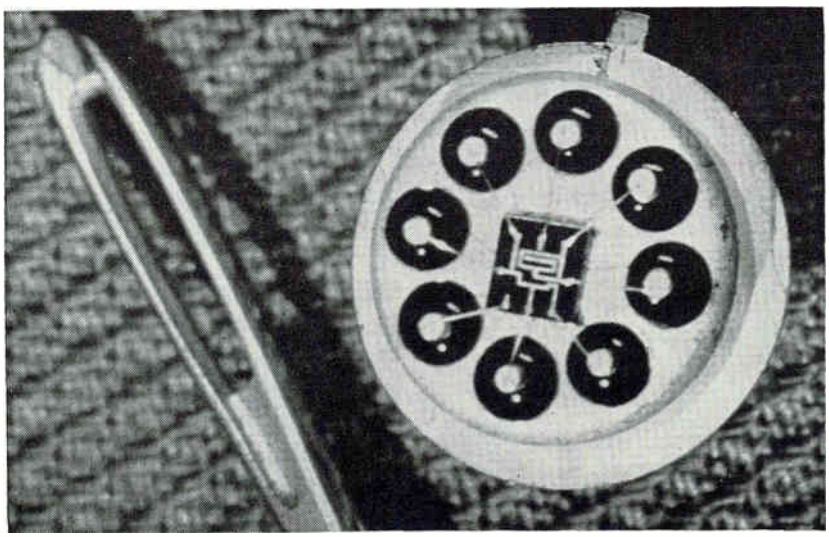
Although much of microelectronic knowledge draws heavily on thin-film deposition techniques, and on methods developed by semiconductor manufacturers over the past decade, microelectronics is more than the sum of its individual parts. It offers many future advantages including increased reliability, small size and reduced cost per system



THERMIONIC *integrated module is one way to find a use for heat generated by electronic components. The module works like a package of vacuum-tube circuits, withstands high temperature and radiation—Fig. 3*



SEMICONDUCTOR DESIGN *used in fabricating a functional circuit flip-flop. It achieves the highest packing density of present day microelectronic techniques—Fig. 4*



RESISTORS *and capacitors are deposited on an insulating substrate using thin-film techniques. Microdiodes and microtransistors are then attached to the deposited passive components—Fig. 5*

dancy, it would be possible to have many components fail in production while terminal measurements before shipment indicate that the system is operational.

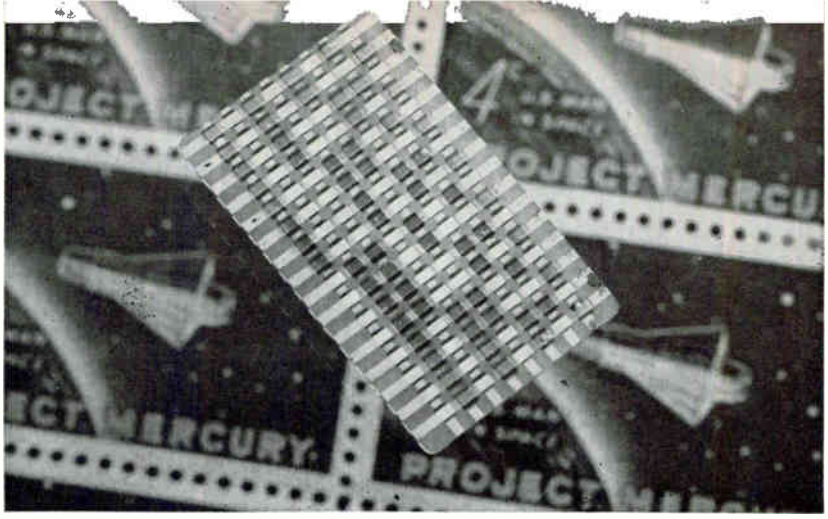
PRESENT AND FUTURE—The capability in microelectronics spans the gamut from vacuum tubes to semiconductor functional components. The tube approach is to use thermionic integrated micromodules (TIMM) that permit operation at high temperatures and in high-radiation ambients, Fig. 3. In fact, the thermionic approach may be the only microelectronic technology at the present time capable of operating reliably at temperatures exceeding 150 deg. C or in radiation fields exceeding 10^{16} nvt. Another feature of the TIMM technique is that it is the only microelectronic technology today that actually utilizes heat as an operational component in the system. However, the thermionic approach has disadvantages as well as advantages. At the present time, the TIMM tubes have limited gain-bandwidth and, consequently, are of comparatively low speed. The high temperature required to operate TIMM components severely limits the types of components that can be used, particularly capacitors. Other disadvantages include the difficult maintenance procedures encountered because of the heat environment and also the necessity for a finite warmup time.

A second present capability is the semiconductor functional circuit illustrated in Fig. 4. Shown here is a flip-flop fabricated on a silicon wafer 70 mils square. The principal advantage of the semiconductor approach, as distinct from the thin-film deposition approach, is that it comes closer than any other device technology in achieving the high packing density and small number of interconnections expected from integrated electronics. In addition, the semiconductor functional circuit is fabricated from well-controlled materials with well-understood fabricating processes based upon some 10 years of transistor experience. Among the disadvantages of semiconductor functional approaches to microelectronics are the isolation problems encountered by packing many components on a noninsulating substrate. Other dis-

advantages include the limited range of passive components particularly resistors and capacitors and the difficult testing procedures required to determine whether or not closely-packed components fall into specified tolerance ranges.

A third production capability is the deposited integrated circuit illustrated in Fig. 5. Shown here is a flip-flop circuit consisting of six evaporated resistors and four evaporated capacitors, with two microdiodes and two microtransistors attached to the deposited passive components. The principal advantage of the deposited integrated circuit is that it starts with an insulating substrate, thus providing excellent isolation between all components. It also provides the greatest flexibility for fabricating different types of resistors and capacitors. From a speed point of view, the highest frequency circuits can be obtained with this approach. The principal disadvantage of the deposited integrated circuit is the need to interconnect separately-fabricated semiconductor elements, thus increasing the number of interconnections over the semiconductor functional circuit approach.

Considering the limitations of the present state-of-the-art in microelectronics, it is reasonable to expect laboratory efforts under way to play a significant role in the future of microtechnology. Present research and development effort in microelectronics is aimed at overcoming the disadvantages inherent in any one of these approaches. For example, semiconductor technology offers the best way of realizing active elements and diodes while thin metallic films offer the best approach to resistors, capacitors and memory elements. It is natural, therefore, to expect r&d efforts to be aimed at combining these two technologies into a compatible integrated approach to microelectronics. Several laboratories are experimenting with deposited metallic resistors and capacitors on passivated semiconductor substrates. If this effort is successful, it should be possible to combine transistors and diodes in semiconductor functional arrays directly with deposited metallic-film passive components, without the need of welding or soldering connections between them. This would combine the advantages of semiconductor active devices with the greater capability of the metal-film art in making passive components. A second approach to consolidate the semiconductor and metal-film technologies is aimed at depositing single-crystal semiconductors on insulating substrates. If this can be achieved successfully, technology will have advanced to a state where advantages of both metal-film and semiconductor devices would be available in integrated form while the disadvantages of either approach alone would have been overcome.



ACTIVE ELEMENTS *such as diodes and transistors are most easily fabricated by conventional techniques. However, this matrix of 64 diodes was deposited onto its substrate by thin-film techniques—Fig. 6*

Other research and development efforts under way in several laboratories are aimed at overcoming the deficiency of metal films in the diode and active triode areas. Some success has already been achieved in evaporating metal film diodes on insulating substrates. Shown in Fig. 6, for example, is a matrix consisting of 64 diodes designed to operate as a commutator in a telemetry system.

It may be possible to make an active triode by combining evaporated metallic and insulating films to produce a device analogous to a vacuum tube or thin-film tunnel triode. Ultimate success of these approaches will depend on controlling a deposition process for films of the order of 10 atomic layers thick. Several approaches are being explored in an attempt to produce usable active triodes not requiring such ultrathin films but which are compatible with thin metallic-film components. These other approaches include research and development in the deposition of cadmium sulfide layers to achieve space-charge and field-effect triodes.

CONCLUSIONS — Considerable progress has been made in developing fabrication techniques for microelectronic circuits. However, no single approach available today achieves all the system advantages that comprise the general goals of microelectronics. Considerable research and development is under way to combine the semiconductor and thin-metallic film technologies and also to increase the capability of each. The introduction of microelectronic techniques and devices to practical systems will probably progress in evolutionary stages, starting today with arithmetic and logic sections of military computers and ultimately spanning the entire gamut of electronics as both economic realities and technological advances catch up with expectations.

The author is grateful to many colleagues for information and discussion, and acknowledges the assistance of L. Ragonese and B. Rutter of the Electronics Laboratory, M. Clark of the Semiconductor Products Department, J. Crittenden of the Receiving Tube Department and G. Siegel of the Light Military Electronics Department.

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(2) *Electronic Design*, Feb., 1962.

NEW TECHNIQUE:

Get Stability Through Mismatching

IN DESIGNING tuned transistor amplifiers, one important factor that must be considered is the effect of the internal feedback inherent in transistors. Much of the available literature dealing with such amplifiers discusses the use of unilateralizing circuits for gain stabilization. In most cases, however, unilateralization is not a practical method of obtaining stable operation because the required network will be a function of frequency, bias and temperature, it requires adjustment when transistors or other components are replaced in the circuit, and it may become a very complex network in certain frequency ranges.

Another method of obtaining stable operation uses the mismatch technique. Mismatching is not accompanied by the undesirable features related to neutralization, although some power gain is sacrificed. Except where power gain is at a premium, it is becoming common practice to mismatch for stabilization.

Mismatching single-tuned amplifiers is little more than a simple matter of impedance matching so that the correct load is presented to the transistor. Applying mismatch to double-tuned amplifiers is also a problem of impedance matching, but is considerably more complex than in the single-tuned case because the circuit Q's are a function of the degree of mismatch desired. To a limited extent, the type of coupling, that is, critical or transitional, is also dependent upon the mismatch.

The basic double-tuned circuit equations used here are primarily those from Valley and Wallman.[1] The definitions are, for the most part, from the same source. Some have been added so that terms relating to transistors may be included. When using the definitions, reference should be made to Fig. 1.

DERIVATION OF EQUATIONS—*A. The General Case:* To facilitate the following discussion a quantity, which shall be termed the load ratio, D, will be introduced and defined as that portion of the total load resistance provided by the swamping resistance, R_s, or, symbolically,

$$D = R_n/(R_n + R_s) \tag{1}$$

From Fig. 1B, and the definition of M_m,

$$R_L = R_s R_n/(R_s + R_n) = R_o/M_m \tag{2}$$

A combination of Eq. 1 and 2 to eliminate R_n results in the following expression for R_s:

$$R_s = R_o/M_m D \tag{3}$$

Combining Eq. 2 and 3 and solving for R_n gives

$$R_n = R_o/[M_m(1 - D)] \tag{4}$$

Since R_1 consists of R_o in parallel with R_s, an expression for R_1 in terms of R_o, M_m and D may be determined from Eq. 3. That is,

$$R_1 = R_o/(M_m D + 1) \tag{5}$$

Equations 3, 4 and 5 permit determining R_s, R_n, and R_1, respectively, when the degree of mismatch and the load ratio have been chosen. The next step is to find a relationship between the latter two quantities and the bandwidth desired.

Obtaining the expressions for driving-point resistance and midband impedance, and rearranging, gives:

$$S^2 + 1 = \frac{R_1}{R_o}(M_m + 1) \tag{6}$$

B. The Critically Coupled Case: Valley and Wallman state that, for critical coupling, $S = 1$. Equation 6, then, may be reduced to

$$R_1 = 2R_o/(M_m + 1) \tag{7}$$

For critical coupling, $R_1 = R_n$, where

$$R_n = 2R_o/(M_m + 1) \tag{8}$$

Equations 1 and 8 may be combined to form:

$$D = (M_m - 1)/2M_m \tag{9}$$

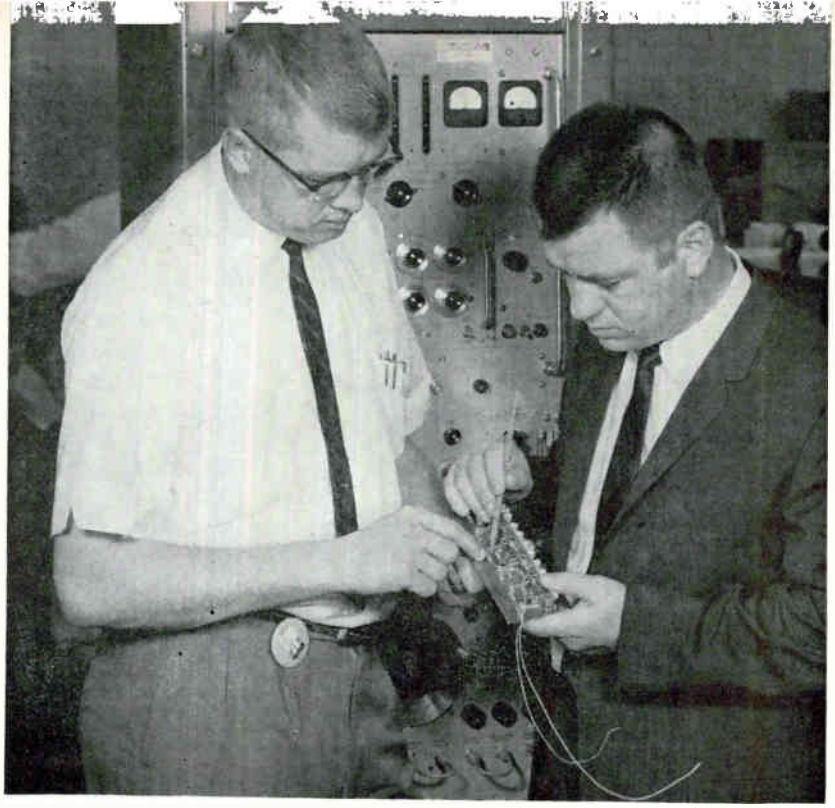
C. The Transitionally Coupled Case: The following expression has been shown[2] to be applicable for tran-

DEFINITIONS

f_0 = the midband frequency
B_w = the 3-db stage bandwidth
$W_0 = 2\pi f_0 = \dfrac{1}{\sqrt{L_1C_1}} = \dfrac{1}{\sqrt{L_2C_2}}$
$K = \dfrac{m}{\sqrt{L_1L_2}} \approx \dfrac{C_c}{\sqrt{C_1C_2}}$, the coefficient of coupling
$Q_1 = W_0R_1C_1$, the uncoupled Q of the primary circuit.
$Q_2 = W_0R_2C_2$, the uncoupled Q of the secondary circuit.
$S = K\sqrt{Q_1Q_2}$
$b = \dfrac{Q_1}{Q_2} + \dfrac{Q_2}{Q_1}$
R_{11} = driving point resistance of the entire network.
R_o = output resistance of the transistor under the desired operating conditions
R_{in} = input resistance of the transistor under the desired operating conditions
R_s = swamping resistance used across L_1
R_n = input resistance of the coupled double tuned circuit.
R_L = load presented to the transistor, the parallel combination of R_s and R_n
$M_m = \dfrac{R_o}{R_L}$, the mismatch ratio

By W. D. REXROAD
Collins Radio Company,
Cedar Rapids, Iowa

Mismatch minimizes the effects of internal feedback. Formulas developed here relate the degree of mismatch to circuit Q and transistor output impedance, so that a double-tuned circuit may be designed for any suitable transistor and with any required degree of mismatch



AUTHOR REXROAD *(left) discusses a 63-Mc i-f amplifier that contains five transitionally coupled double-tuned stages, giving a total gain of about 100 db with a 3-db bandwith of 2 Mc and a 60-db bandwith of 6.5 Mc*

sitional coupling:

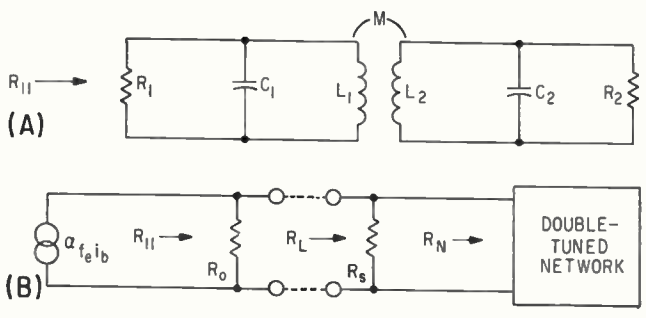
$$S^2 = \tfrac{1}{2}b = \tfrac{1}{2}\left(\frac{Q_1}{Q_2} + \frac{Q_2}{Q_1}\right) \qquad (10)$$

Combining Eq. 5, 6 and 10 results in a quadratic equation which in turn is solved for the Q ratio. The result is shown in Eq. 11.

$$\frac{Q_1}{Q_2} = \frac{M_m(1 - D) \pm \sqrt{M_m^2(1 - 2D) - (2M_mD + 1)}}{M_mD + 1} \qquad (11)$$

In Eq. 11 the choice of the plus or minus sign is determined from a knowledge of the relative sizes of the two Q's. The Q_1 is greater than Q_2 when the plus sign is used. (It is difficult to imagine a practical circuit where $Q_2 > Q_1$.)

Examination of the quantity under the radical in Eq. 11 also reveals that the maximum value of load ratio D is determined by the mismatch, and has as its upper limit the value 0.5 when $M_m \rightarrow \infty$. For convenience, the ratio Q_1/Q_2 is shown plotted against load ratio D in Fig. 2A, for various values of mismatch.



BASIC *double-tuned circuit (A); load presented to the transistor (B)—Fig. 1*

It will be useful at this point to borrow an expression[3] for stage bandwidth. That expression is

$$B_w = \frac{\sqrt{1 + S^2}}{2\pi\sqrt{C_1C_2}\sqrt{R_1R_2}} \qquad (12)$$

Multiplying Eq. 12 by the factor f_0/f_0 and rearranging gives

$$Q_2 = \frac{1}{Q_1}\left(\frac{f_0}{B_w}\right)^2(S^2 + 1) \qquad (13)$$

Combining Eq. 5, 6, 10 and 13 yields

$$Q_2 = \frac{1}{Q_1}\left(\frac{f_0}{B_w}\right)^2\left(\frac{M_m + 1}{M_mD + 1}\right) \qquad (14)$$

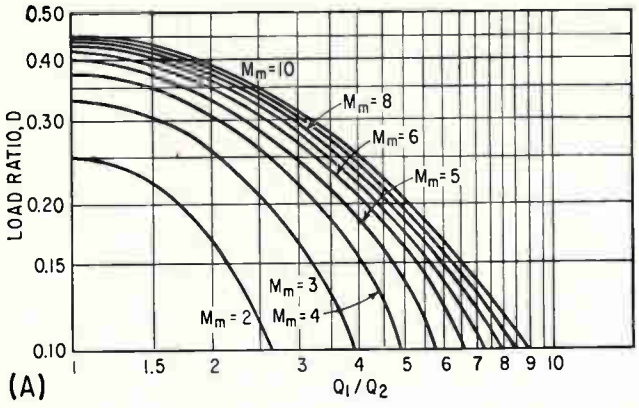
Substituting the result for Q_2 from Eq. 14 in to Eq. 11 and simplifying gives relationship between Q_1 and the stage bandwidth:

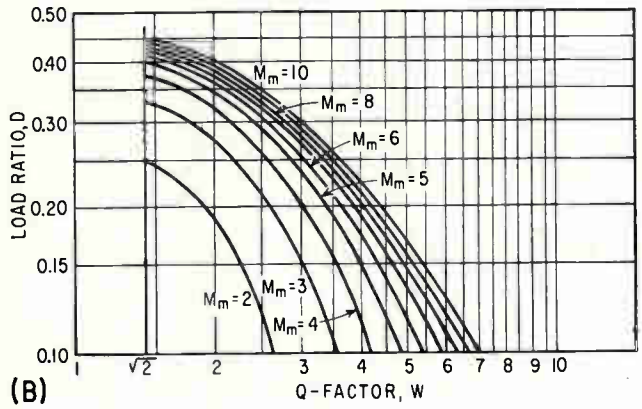
$$Q_1 = \frac{f_0}{B_w} \cdot \frac{\sqrt{M_m+1}\sqrt{M_m(1-D) \pm \sqrt{[M_m+1][M_m(1-2D)-1]}}}{M_mD+1} \qquad (15)$$

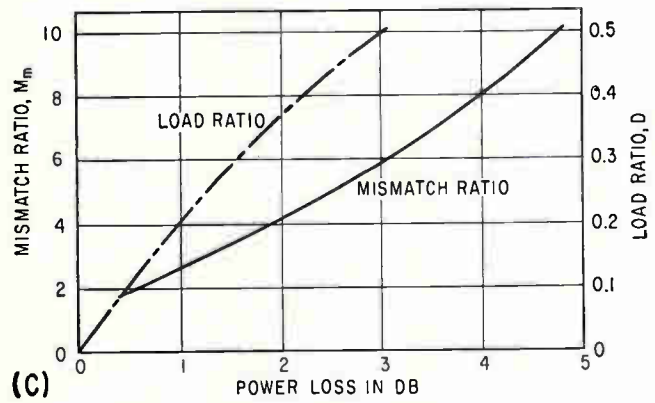
$$Q_1 = \frac{f_0}{B_w} \cdot W \qquad (16)$$

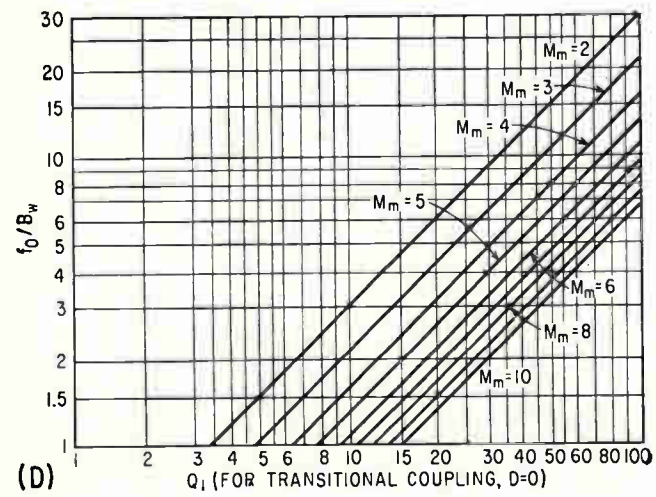
where W is defined as the Q-factor and consists of the large quotient on the right of Eq. 15. Again, the plus sign is used when $Q_1 > Q_2$. Notice in Eq. 15, that D is still restricted to values not greater than 0.5 and, in addition, there are certain values of mismatch and load ratio that also make the radical unreal. For any given mismatch, D may be no larger than that value that makes W equal $\sqrt{2}$.

While Eq. 15 is essential to the designer, it is much too complex to be put to practical use. For this reason, Fig. 2B is provided. It shows a family of curves relating Q-factor W to load ratio D for values of mis-









Q RATIO *versus load ratio D (A) and Q factor versus load ratio D (B) for various values of mismatch; power loss versus mismatch ratio and load ratio (C); Q_1 versus f_0/B_w for transitional coupling, when D is zero (D)—Fig. 2*

match from 2 through 10. So that the designer may consider power losses when determining mismatch and load ratio, Fig. 2C is also included. From it, the loss that results from various values of mismatch and from different load ratios may be determined.

D. The Case of Infinite R_s: Figure 2C clearly shows the desirability of making D as small as possible to improve efficiency. Naturally, the most efficient operation results when R_s is infinite. In some instances, when f_0/B_w is small enough, it is possible to design such a circuit. Consequently, when making R_s infinite ($D = 0$), the previously developed equations may be greatly simplified.

From Fig. 1B, when R_s is infinite, $R_0 = R_1$, and $R_n = R_L = R_0/M_m$. Therefore, Eq. 6 reduces to

$$M_m = S^2 \tag{17}$$

As previously mentioned, S is equal to unity for critical coupling (this includes the equal-Q case). Thus, only transitional coupling may be used when $D = 0$, because when $S = 1$, $M_m = 1$, which obviously is no mismatch. Simplification of Eq. 11 is also possible when D is zero. That is,

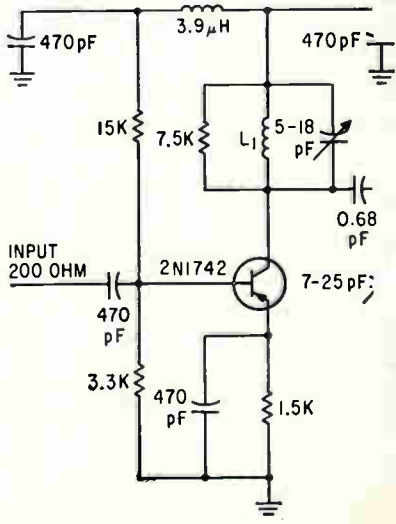
$$\frac{Q_1}{Q_2} = M_m \pm \sqrt{M_m^2 - 1} \tag{18}$$

Once again the plus or minus sign indicates which Q will be larger. For reasons discussed previously, the plus sign will be chosen, making $Q_1 > Q_2$. The expression for Q_1, given by Eq. 15, may also be simplified. When $D = 0$, it reduces to

$$Q_1 = \frac{f_0}{B_w} \cdot \sqrt{M_m + 1}\sqrt{M_m + \sqrt{M_m^2 - 1}} = \frac{f_0}{B_w} \cdot E \tag{19}$$

where E represents the product of the radicals. Notice that once again $Q_1 \geqq (f_0/B_w)(\sqrt{2})$. However, in this case, $Q_1 = (f_0/B_w)(\sqrt{2})$ only when $M_m = 1$.

As previously mentioned, it is not always possible to let $D = 0$. The restriction is a physical one; namely, the maximum unloaded Q obtainable in L_1. It is difficult to wind coils such as are necessary for this application with an unloaded Q above the 150-200 range. So that the QX_L of the coil should present a negligible loading effect on the circuit, the unloaded Q should be at least five times greater than the loaded Q. In general, then, Q_1 should be no larger than about



60-MC AMPLIFIER *Demonstrates the use of capacitive coupling. Tank-coil data is given in the text—Fig. 3*

40 if R_s is to be infinite. Figure 2D presents a family of curves relating f_o/B_w to Q_1, for values of mismatch from 2 through 10, when $D = 0$. Figure 2D allows the designer to determine rapidly whether he may exclude R_s from his circuit. For a given stage bandwidth and mismatch, one may determine the value of Q_1. If it is lower than approximately 40, the equations developed for the case where $R_s = \infty$ may be used. (Only transitional coupling can be used when $R_s = \infty$.) If Q_1 is greater than 40, R_s should be included in the design, and the equations outlined in sections B or C used.

DESIGN PROCEDURE—The design procedure will deal solely with the tank circuit design.

Let it be required to design an i-f amplifier with these characteristics: center frequency = 60 Mc, 3-db bandwidth = 2 Mc, and overall gain = 60 db.

It will be further assumed that a mismatch ratio of 5 has been determined. A type 2N1742 has characteristics that satisfy the requirements. The 2N1742 data sheets give the following parameters for the transistor when $V_{CE} = 10$ v, $I_e = 1.5$ ma and $f_o = 60$ Mc: power gain = 24 db, $R_o = 15$ K, $R_{in} = 200$ ohms, $C_o = 1$ pf, and $C_{in} = 15$ pf.

The shrinkage factor for four stages of double-tuned circuits is 0.66.

The stage bandwidth, then, must be 3.03 Mc. From Fig. 2D, Q_1 would exceed 100 if $D = 0$, so the equations developed for the case of infinite R_s may not be used. To provide the flat response of transitional coupling and the ease of tuning provided when $Q_1 = Q_2$, the case of equal Q's is chosen and, in so doing, the conditions for both transitional and critical coupling must be satisfied since the two coincide when $Q_1 = Q_2$.

The next step is to select a value for D. It would be preferable to make D as small as possible, but to satisfy the conditions of critical coupling, the load ratio must be calculated. From Eq. 9, $D = (M_m - 1)/2\,M_m = 0.4$ and $R_s = 2\,R_o/(M_m - 1) = 30\text{K}/4 = 7.5$ K.

Referring to Fig. 2B, Q factor, W, is equal to 1.414 when $D = 0.4$ and $M_m = 5$. Thus, from Eq. 16, $Q_1 = f_o/B_w \cdot W = 19.8 \times 1.414 = 28$. From Eq. 7, $R_1 = 2\,R_o/(M_m + 1) = 30\text{K}/6 = 5\text{K}$, and $C_1 = Q_1/W_o\,R_1 = 28/(2\pi \times 60 \times 10^6 \times 5 \times 10^3) = 14.9$ pf.

The value of L_1 may be determined from a reactance chart or thusly: $L_1 = 1/4\,\pi^2\,f_o^2\,C_1 = 0.47\ \mu$h.

Since, as initially assumed, $Q_1 = Q_2$ the values of R_2 and C_2 may be determined next. If $R_{in} = R_2$, any variation in R_{in} due to such factors as temperature and supply voltage changes would bring about a resulting change in response which would be undesirable. A swamping resistor, placed in parallel with the base-emitter junction, will reduce such effects although a power loss will result. As an example, assume the value of the swamping resistor to equal that of the input resistance of the transistor: 200 ohms. The resulting power loss is 3 db, and the parallel combination of R_{in} and the swamping resistor is 100 ohms. This, of course, is too small to permit a reasonable value for C_2. Consequently, it is helpful to assume a value for C_2 and calculate R_2, utilizing impedance-matching to achieve it. Let $C_2 = 25$ pf. Then $L_2 = 0.28\ \mu$h and $R_2 = Q_2/W_o\,C_2 = 2{,}970$ ohms. The tap on each L_2 coil is selected so that R_{in} in parallel with the swamping resistor reflects a resistance of 2,970 ohms across L_2.

All that remains to complete the design is to determine the coupling. Noting that, for the equal-Q situation, $S = 1$, the coefficient of coupling may be calculated using the expression in the definitions. That is, $K = S/\sqrt{Q_1\,Q_2} = 1/28 = 0.0357$.

Capacitive coupling may be used when $K < 0.1$. Again, from the definitions $C_c = K\sqrt{C_1\,C_2} = 0.69$ pf, which is very close to a standard value, 0.68 pf.

A schematic diagram illustrating the results of the above design procedure is shown in Fig. 3.

The author wishes to acknowledge the assistance of H. J. Nieuwsma, R. A. Pyatt and C. P. Womack.

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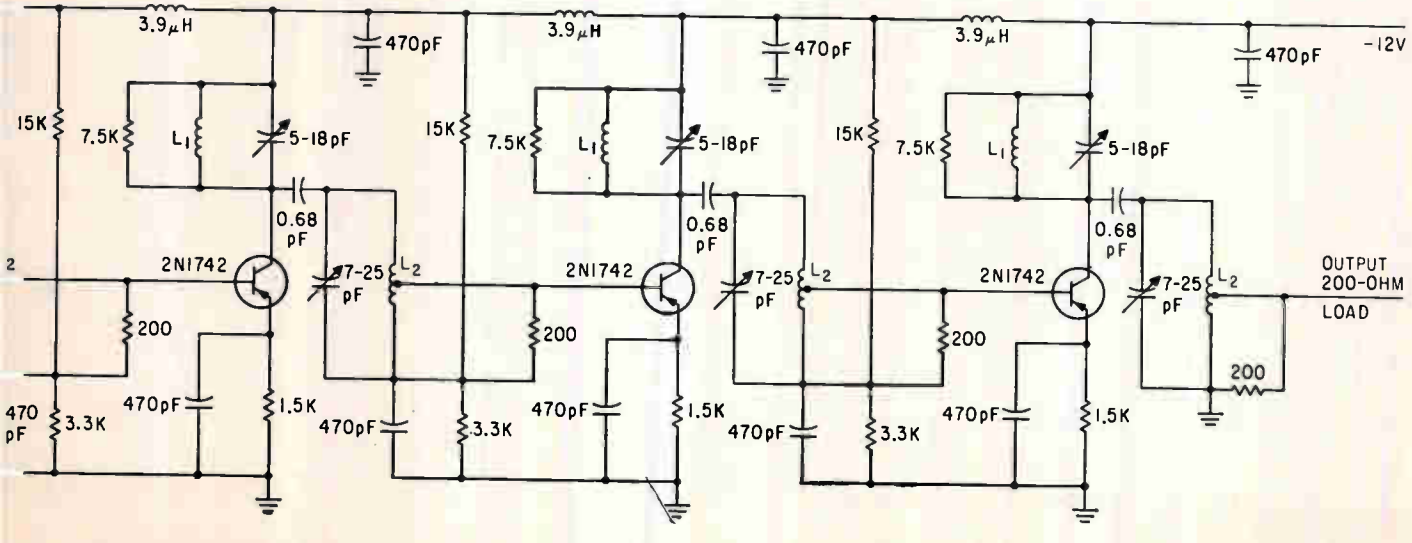
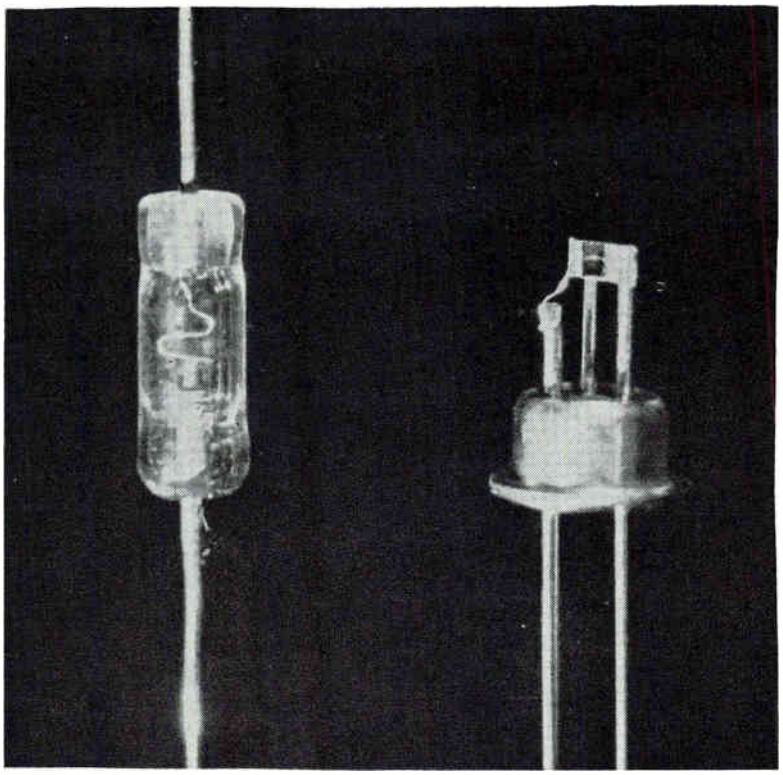


Faster Zener

By KAZUO KIMURA,
Electrical Communication Laboratory.
Nippon Telegraph and Telephone Public Corp.,
Musashino-shi, Tokyo, Japan

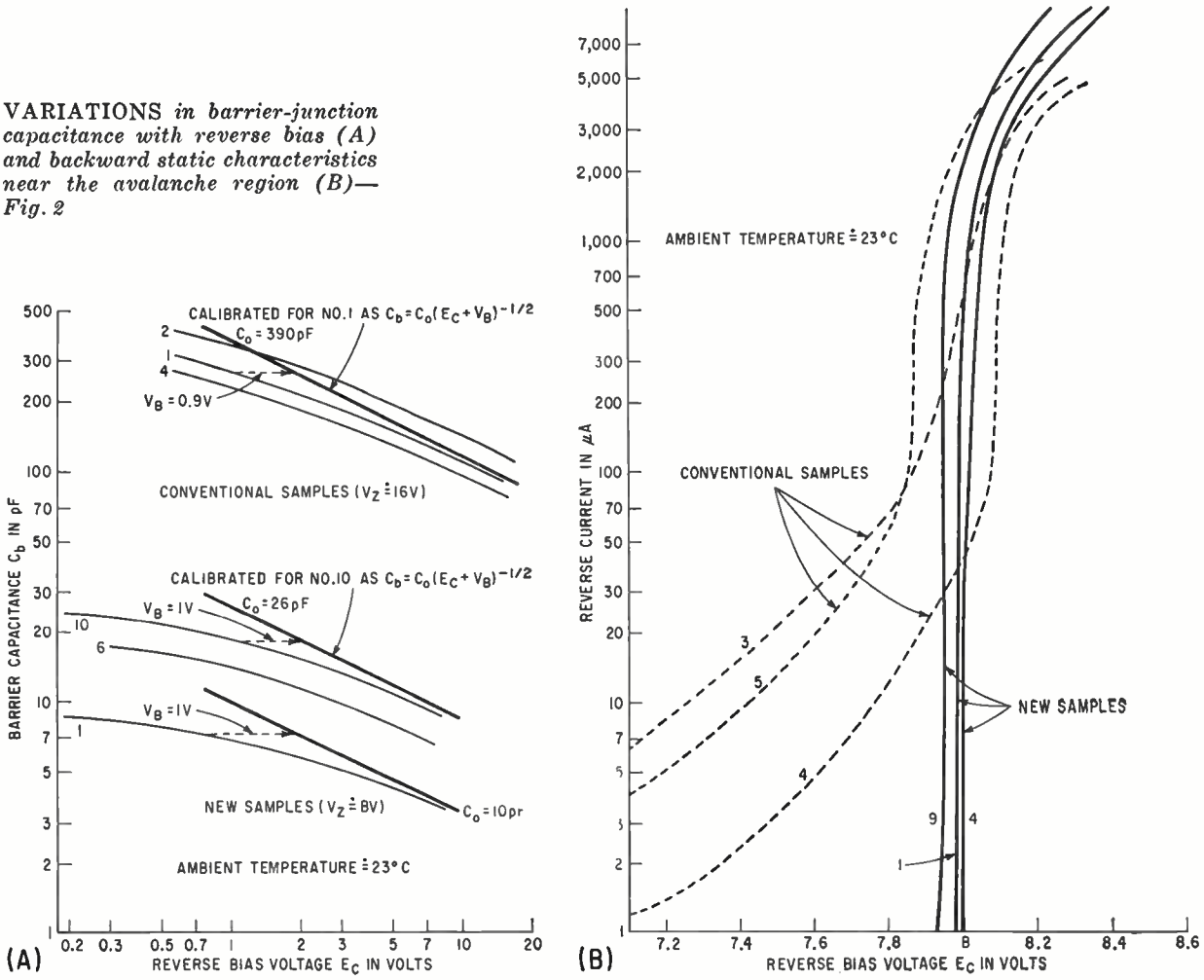


INTERNAL STRUCTURES *of conventional (left) and high-frequency diode (right)—Fig. 1*

HIGH-SPEED, HIGH-FREQUENCY ZENER DIODES

A new contender enters the zener diode lists in the form of a bonded p-n junction diode with excellent high-frequency characteristics. This diode has a junction barrier capacitance as small as 1/100 that of conventional zeners which makes it suitable for use at frequencies above 10 Mc

VARIATIONS *in barrier-junction capacitance with reverse bias (A) and backward static characteristics near the avalanche region (B)—Fig. 2*



Diodes Make New Uses Possible

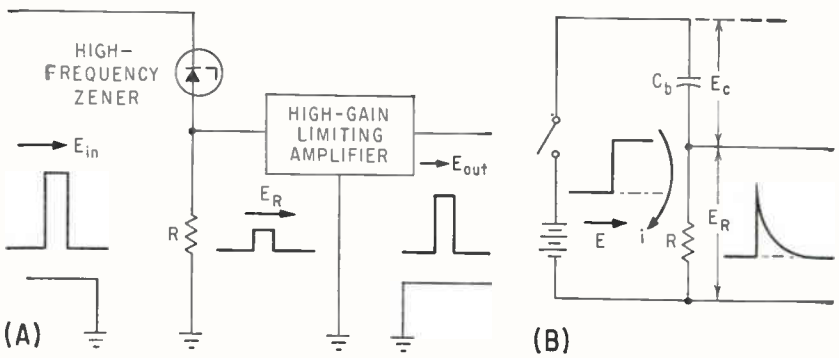
Device has substantially lower barrier-junction capacitance permitting use at frequencies over 10 Mc and with pulse-widths less than 0.5 microsecond

ZENER DIODES are widely used in low-frequency amplifier and wave-shaping circuits. However, high capacitance and soft avalanche (reverse) characteristics of conventional alloyed diodes prevents similar application in high-frequency and pulse circuits.

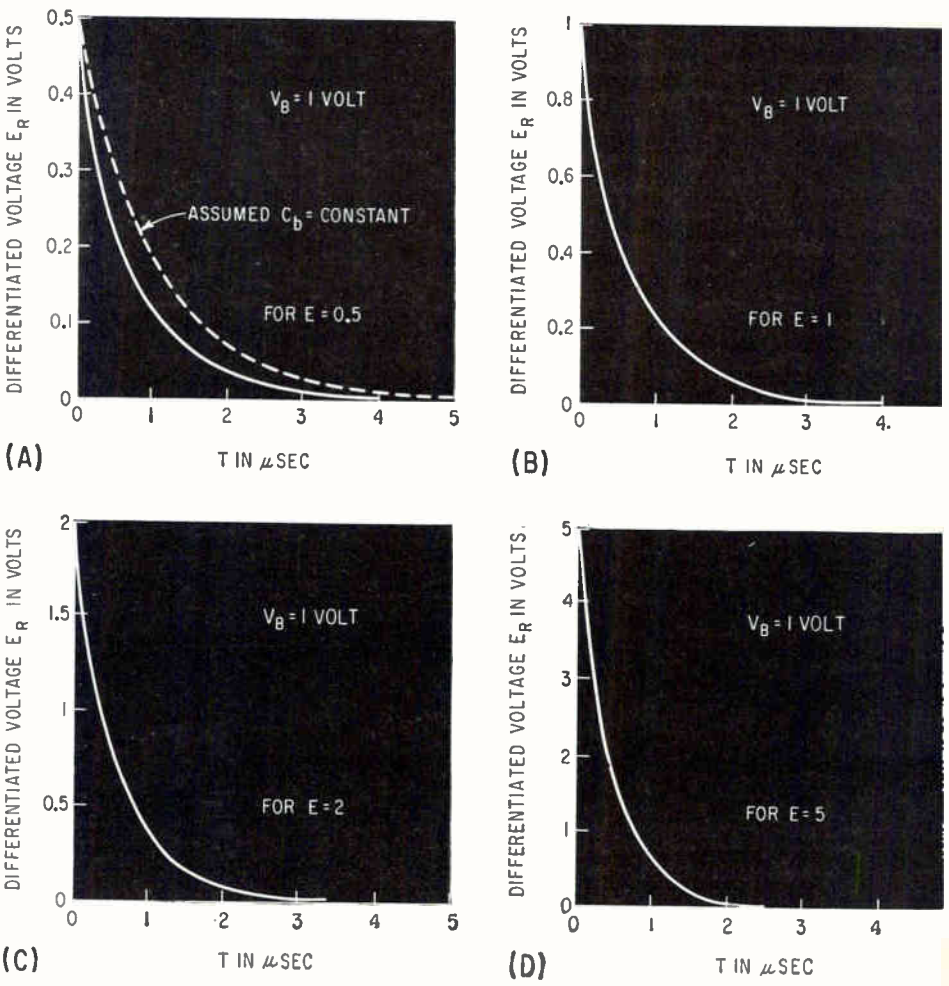
It would be of interest for the computer industry to incorporate the properties of fast switching devices such as tunnel diodes and four-layer pnpn switches, to breakdown diodes. Thus, the desirable characteristics of zener diodes would have wider uses.

To obtain diodes suitable for high-speed pulse-code modulation equipment, h-f bonded zener diodes have been developed. These new diodes have a barrier-junction capacitance that is 1/30 to 1/100 that of conventional devices, making them suitable for use at frequencies over 10-Mc and with pulses having a width of less than 0.5-μsec.

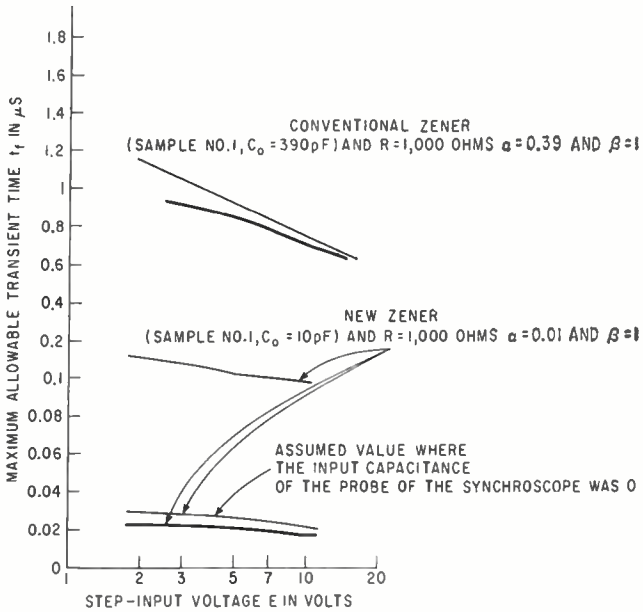
The internal structure of the new zener is shown and compared with that of a conventional diode in Fig. 1. The conventional device is an avalanche diode having a *p-n* alloy junction, while the new diode has a bonded *p-n* junction. This junction is formed with an aluminum wire 50 microns in diameter on an *n*-type silicon pellet of suitable specific resistance. Heavy forming is accomplished by applying a high current through the wire. This results in a junction area 1/30 that derived from usual production processes and is suitable for mass production techniques. Variations of barrier capacitance C_b, due to reverse bias voltage E_c, are shown in Fig. 2A, where the heavy curves are calibrated according to $C_b = C_o (E_c + V_b)^{-\frac{1}{2}}$, showing the relation between C_b and voltage E_c applied to the diode when $E_c < V_z$. Here C_o is a constant value for each sample



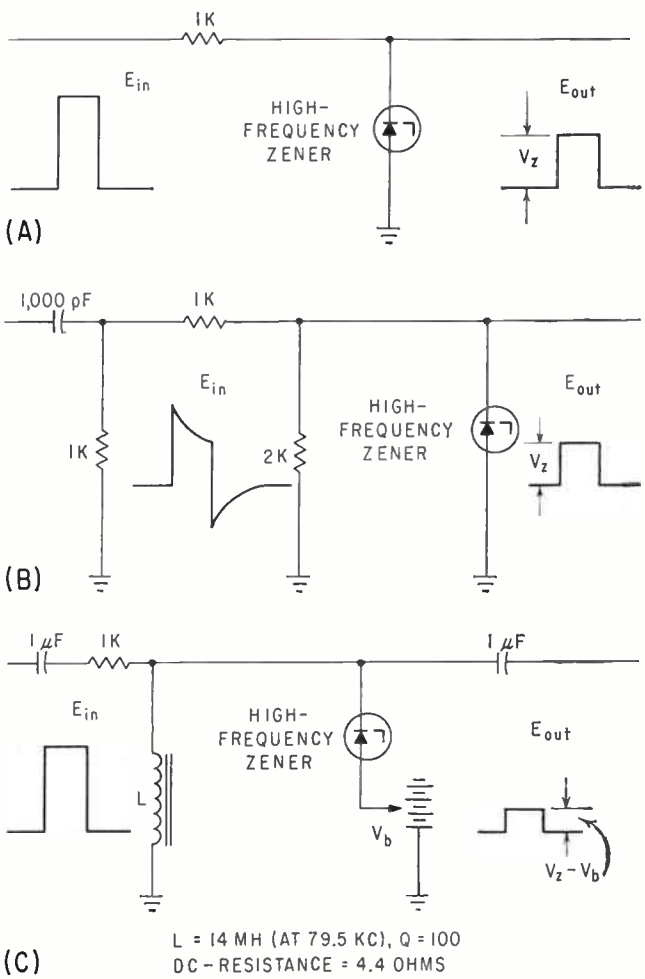
ZENER DIODE *discriminator circuit (A) and equivalent differentiating network due to barrier-junction capacitance (B)—Fig. 3*



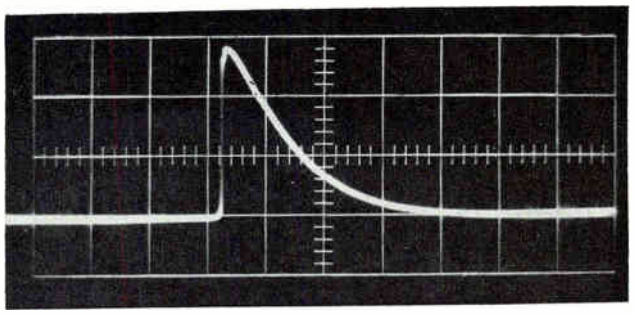
THEORETICAL WAVEFORMS *of differentiated voltage against time for voltages of 0.5, 1.0, 2.0 and 5.0 v where the specific barrier voltage is 1 volt—Fig. 4*



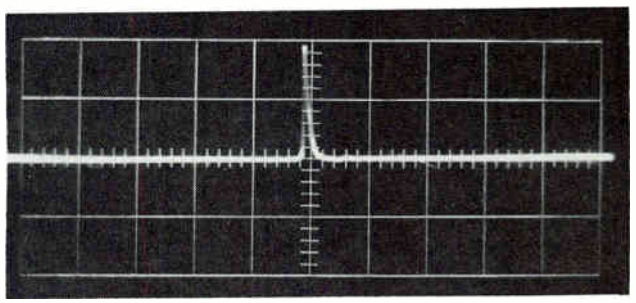
EXPERIMENTAL *and computed values of minimum transient time against step-input voltage for new and conventional zeners—Fig. 5*



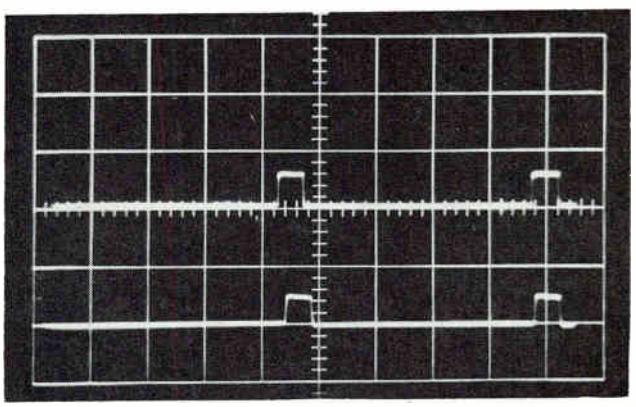
PEAK CLIPPER *circuit and waveforms (A) clamped clipper (B) and circuit for obtaining arbitrary control voltages (C)—Fig. 6*



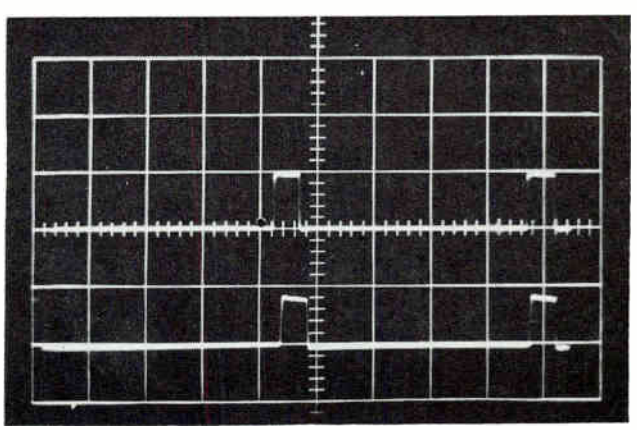
(A)



(B)



(C)



(D)

OSCILLOSCOPE TRACES *show waveforms of differentiated voltage for a 7 volt step input with conventional diodes (A) high-frequency diodes (B) and input and output pulse amplitudes for the circuit of Fig. 6C (C&D)—Fig. 7*

and V_b is the specific barrier voltage. Figure 2A shows that $V_b \doteq 1$ volt for the new zeners and 0.9 volt for the conventional zeners.

Another important factor in estimating zener performance is the hardness or sharpness of the diode's avalanche breakdown. This factor is affected by surface treatments and ambient conditions during production. The samples demonstrated better hardness than conventional diodes as illustrated in Fig. 2B.

Backward current I_{off} when $E_c < V_z$ and dynamic resistance r_{on} when $E_c > V_z$ are criteria of hardness. Current I_{off} is between zero and 0.005 μa at 6 volts and r_{on} is less than 400 ohms at 30 μa for the new diode, while conventional diodes show 0.05 to 1.0 μa at 6 volts and more than 2,000 ohms at 30 μa.

Little dissipation is sacrificed by reducing zener diode junction area. The high-frequency diodes can easily dissipate 100 to 150 milliwatts. The temperature coefficient of V_z is between +0.04 and +0.05 percent per degree C for diodes with $V_z \doteq 8$ volts, which is about the same figure obtained for conventional diodes.

DESIGN AND APPLICATION—One application of the high-frequency zener diode is in a pulse-amplitude discriminator for analog-to-digital converters or pulse-code modulators.

Figure 3A shows a discriminator, where E_{in} and E_{out} are input and output pulse amplitudes respectively and E_R is the potential across resistor R.

Assuming an ideal zener ($C_b = 0$, $I_{off} = 0$ and $r_{on} = 0$), E_{out} will appear as binary 1 when $E_{in} \leq V_z$ because $E_R = E_{in} - V_z$. In condition binary 0, $E_{in} < V_z$, $E_{out} = 0$ because $E_R = 0$, regardless of amplification magnitude. Thus, a simple but accurate ideal discriminator requiring no reference voltage supply can theoretically be realized.

An equivalent differentiating circuit is formed due to C_b, the unavoidable barrier capacitance of the diode. A differentiated voltage E_R appears across R even when $E < V_z$, as shown in Fig. 3B. Now, considering a time-division multichannel pcm system where the sampling frequency is 8-Kc, the multiplicity is 24-channels and the coded binary number is 7 digits per channel, the maximum sampled-signal amplitude at the input to the encoder will be 16 volts, then voltage E_R must decay to less than 0.0625 volt (a minimum detectable voltage V_n computed as $16/2^7 \times 2$ volts) within about 0.093 μsec, which is the maximum permissible transient time t_r for logical operations.

In Fig. 3B, let $E < V_z$. The circuit equation with the switch closed is $E = 1/c\int i dt + iR$ where $iR = E_R$. Thus for an inverse function where t is the elapsed time

$$t = \frac{C_o R}{\sqrt{E+V_b}} \log\left\{\left(\frac{\sqrt{E+V_b}-\sqrt{V_b}}{\sqrt{E+V_b}+\sqrt{V_b}}\right)\left(\frac{\sqrt{E+V_b}+\sqrt{E+V_b-E_R}}{\sqrt{E+V_b}-\sqrt{E+V_b-E_R}}\right)\right\}$$

after switching. The decay characteristic of E_R as a function of t can thus be calculated. It will be easier, however, to use $T = 1/\sqrt{E+V_b} \log\{\ \}$, where $T = (t/\alpha\beta)\ 10^6$, $C_o = 1{,}000\ \alpha$ pf and $R = \beta$ K-ohms.

Figure 4A to 4I shows E_R-T characteristics where $E = 0.5$, 1, 2, and 5, volts respectively and where $V_b = 1$ volt. The dotted line is a curve where C_b is constant. Using the relation $t_r = (1/1{,}000) \times C_o$ (in pf) $\times R$ (in K-ohms) $\times T_r$ (in μsec), t_r can be obtained from T_r, which is a time T up to the moment when $E_r = V_o$. The $T_r - E$ characteristics are computed for $C_o = 0.0625$ volt.

EXPERIMENTAL RESULTS — Experimental results are compared with computed values of t_r in Fig. 5. Heavy curves are for the new devices as measured on a dc to 30-Mc oscilloscope and light lines are computed values with $R = 1{,}000$ ohms for both $C_o = 390$ pf and 10 pf.

The new zeners are difficult to measure because the 10-pf input capacitance of the scope probe is large as compared with the C_b of the device.

Figures 7A and B are oscilloscope traces of the wave-forms of E_R for both the new and conventional zeners against a 7-volt step input E. Thus, $C_o = 41$ pf or $C_b = 15$ pf at $E_c = 6$ volts when $R = 1{,}000$ ohms.

PEAK AND CLAMPED CLIPPERS—Peak and clamped clipper circuits are shown in Fig. 7A and B. The peak clipper removes the part of the input pulse amplitude above V_z. The clamped clipper performs both clamping and clipping simultaneously.

When selecting a zener diode, the first consideration is usually whether the V_z coincides with the circuit voltage that must be clamped or blocked. It is more desirable, however, to design the circuit for use with a diode with a V_z of 7 to 9 volts except where high accuracy is unimportant. This is true because the value of V_z depends upon other factors such as temperature coefficient, dynamic resistance, forward resistance and capacitance that affect accuracy. From this standpoint, zeners with $V_z = 7$ to 9 volts are most desirable. Aside from the fact that diodes of this V_z exhibit the best hardness, temperature coefficients become much larger for units with $V_z = 10$ or more volts and barrier capacitances increase for those with V_z less than 6 volts.

Figure 6C shows a circuit for obtaining arbitrary controlling voltages ($V_z - V_b$) with one of the new high-frequency devices. This diode has a fixed value of V_z and is supplied bias voltage V_b through inductor L. An input pulse E_{in} is peak-clipped and an output pulse amplitude equal to $V_z - V_b$ is obtained. Figure 7C and D shows output-pulse waveforms for input pulses of various amplitudes where $V_z = 7.8$ volts and $V_b = 4.0$ volts. This shows that a controlled voltage of 3.8 v can be achieved with a 7.8-volt zener diode. Due to lowering of base potential, a resistor cannot be substituted for the inductor in Fig. 6C.

These new h-f zener diodes can be manufactured at about the same cost as conventional diodes. Although they don't have as good a hardness as these samples, diodes can be produced with any order of hardness with barrier capacitances as low as 2 pf.

The author acknowledges the assistance of S. Osada, A. Sato, T. Usui and C. L. Cohen in this work.

Synchronism Doesn't Matter in

Receiving and transmitting stations need not be locked together in frequency and phase to make sense out of pcm data. System described here handles pcm speech when both jitter and slip occur between transmitter and receiver timing

By J. D. HOWELLS
English Electric Aviation Ltd.,
Luton, England

IN TRANSMITTING SPEECH over a link by pulse code modulation, it is often convenient to read the incoming data with a clock that is not synchronized to the transmitter clock.

Lack of synchronism between transmission and reception causes samples of the speech waveform to be lost, or requires redundant samples to be inserted, as the clock rates differ by one sample time, Fig. 1.

Here a 6-bit pcm link has been subjected to various asynchronous conditions. Two main features of asynchronous working were examined: the effect of a high rate of slip, and the effect of a small amount of jitter between the two clocks, which can cause multiple slip instead of the single loss or gain of a sample.

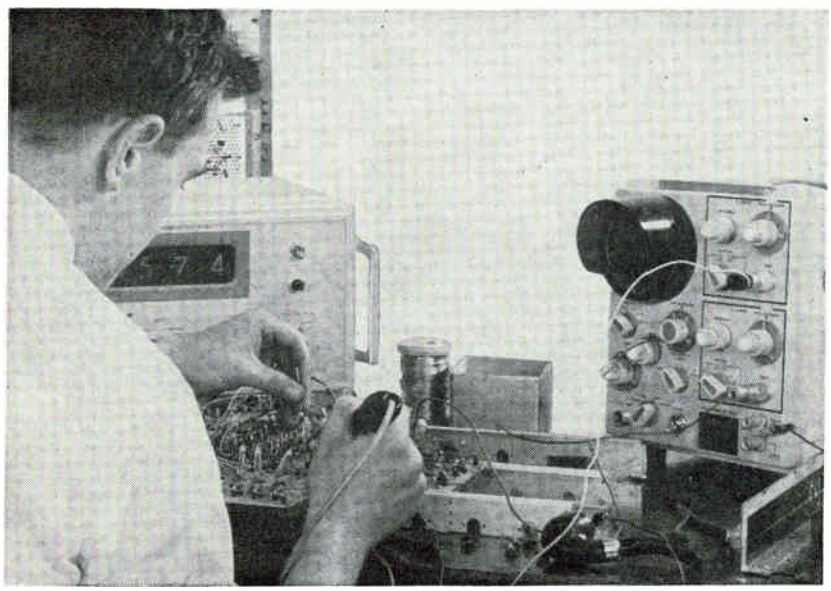
It is possible to handle asynchronous signals, with a word-slip-rate of 1 per second being undetectable in normal speech. This corresponds to clock stabilities of approximately 1 part in 10^4 at the transmit and receive stations.

QUANTIZING THE SPEECH—Since the information is transmitted as voltage samples of the waveform, it is necessary to restrict the input bandwidth to less than half the sampling frequency, with a low-pass filter. The sampling process then produces a step waveform that represents the instantaneous voltage of the input. A gain-compression stage is incorporated, and the resulting series of voltage levels are converted into a 6-bit binary code. Each sample of the speech is therefore replaced by a 6-bit word that consists only of zeros and ones; this train of pulses completely defining the speech envelope[1].

Transmission of speech by pcm involves the allocation of one of a finite number of levels to each sample of the speech waveform. In the 6-bit system there are 2^6 or 64 levels, and the nearest level is selected at each sample. This discontinuity creates quantizing noise that becomes worse as the input amplitude falls. The effect of the quantizing noise is partially offset by using a gain compression or compandor system that provides higher gain for low-level signals. A complementary voltage expansion circuit is used at the receive end.

ASYNCHRONOUS READ-OUT—In transferring pulse coded speech over a single link, there is no advantage to reading the pcm data asynchronously. However, where several pcm links have to be switched in a central exchange that is part of an overall communication network, such a requirement does arise. In such a complex network it is difficult to maintain synchronism between clocks at the various stations. One exchange may therefore be required to accept several time-multiplexed links, which are not synchronized to each other, and which have to be combined and rerouted within the exchange.

This operation could be achieved by reconstituting the waveform on each channel into speech, and reencoding prior to retransmission. However, reconstitution is undesirable, since extra quantizing noise is introduced by the repeated quan-



ENGINEER *adjusts pcm data handling unit; S-shaped pipe in foreground aids in circuit optimization*

Pulse-Code Modulated Speech

tizing process. It is preferable to handle the signals in their original digitized form right through the switching center.

The problem resolves into one of reading the incoming data on the links at a standard clock rate, which is not necessarily synchronized to any of the incoming rates.

ASYNCHRONOUS READ-OUT—Figure 1 shows that if the transmission rate is, say, higher than the incoming rate, a time will be reached when the system has no data to transmit and a redundant pcm word has to be inserted. Conversely, a low transmission rate causes a word to be lost whenever the system has more than one word in hand. Either occurrence is a word slip. Thus an alignment system must drop or insert a whole pcm word at a time, not parts of a word, and the system must operate one word behind, and must have storage capacity for at least one word.

A system fulfilling these requirements and which has demonstrated the asynchronous mode of operation is shown in Fig. 2. This system handled 6-bit pcm signals at a sampling rate of 7 Kc, the speech bandwidth being restricted to 3 Kc.

In Figure 2, the circuit operates by loading a pair of registers (*A* or *B*) alternately with the incoming pcm data, then reading out from the register opposite to the one being loaded. Here data is read-out directly into an audio system; in exchange working, read-out would be into the outgoing link.

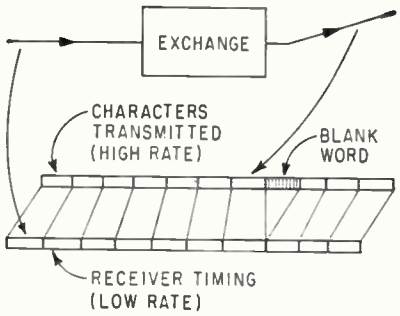
The pcm input is a serial pulse code, that is loaded into one of the shift registers *A* or *B*, Fig. 2. This operation is performed by routing shift pulses to one of the registers through a change-over gate G_1. At the completion of each input word, the setting of G_1 is reversed, allowing the alternate register to be loaded.

Operating in synchronism with G_1 is gate G_2, which reads out pulses from the register not being loaded. Read-out of a register causes its contents to set up voltages in a summing network, which then gives an analog voltage output equivalent to the stored binary number.

During normal operation, the read-out pulses occur interleaved with the incoming word-start or write pulses, and all the data samples will be read, thereby reconstituting the original speech waveform. If, however, the read pulse-rate is slightly lower than the incoming word pulse-rate, a time will be reached when read-out will entirely miss one of the registers. A speech sample is then lost, but the sequence proceeds as before.

If the read pulse rate is higher than the incoming word pulse rate, then one register will be read twice without reloading. If the register is not reset by the read-out operation, a redundant sample is inserted, which is a repeat of the previous sample.

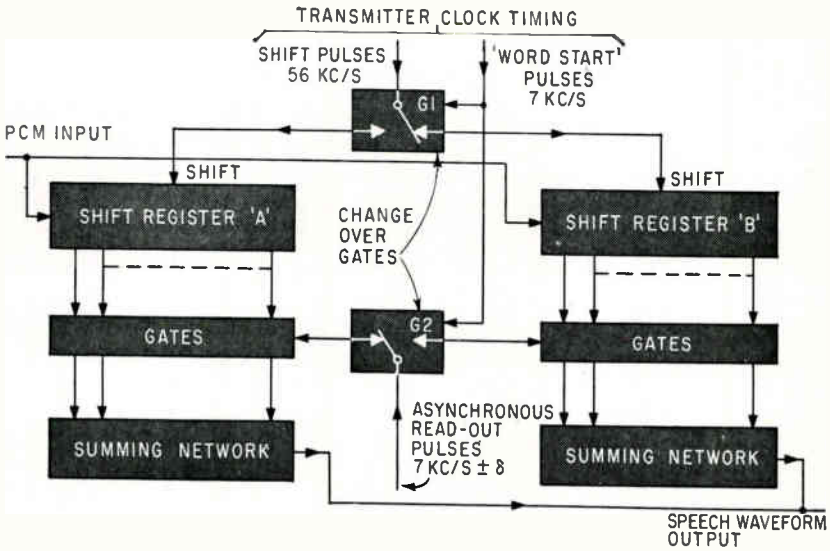
ANTI-JITTER CIRCUITS—In the design of the asynchronous read-



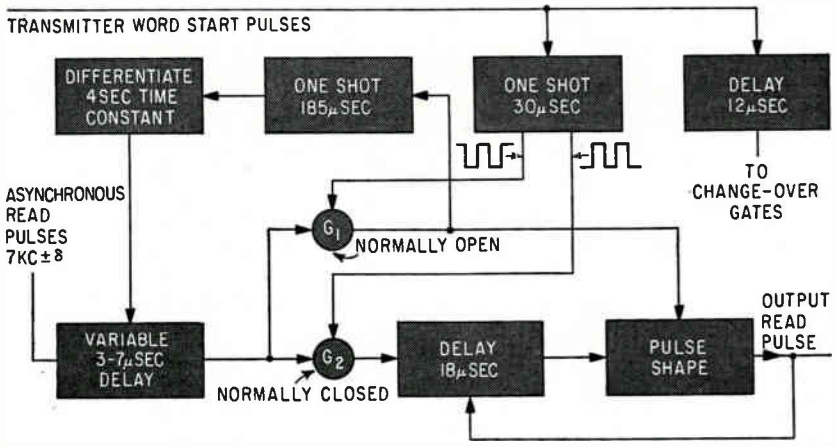
RECEIVER *is set at a lower word rate than transmitter, requiring a word to be generated periodically to fill the gap—Fig. 1*

ONLY A CLICK

What happens in a pcm speech system when the quantized voice samples don't arrive when the receiver-end clock says they should? In this system it doesn't matter. A difference in timing (frequency) between receiver and transmitter clocks gives a barely audible click in the speech output. System operates by filling the gap produced by transmitter-receiver misphasing with a word sample generated by the receiver



INCOMING DATA *is sent alternately to registers A and B. Data is read from the register not being filled—Fig. 2*



ANTIJITTER CIRCUIT *prevents read pulses jittering to either side of write pulses—Fig. 3.*

out system, it is necessary to include circuits that prevent read-out from occurring when the incoming word-start or write pulse is present and which also prevent the read pulse from alternating to one side of the write pulse or the other. This effect, which is caused by a small amount of time jitter on either source, causes multiple word slip to occur instead of a single loss or gain of a sample, and consequently creates severe distortion of the signal. The method of obtaining anti-coincidence and hysteresis is shown in Fig. 3.

The jitter effect is apparent when the read and write pulses are nearly coincident, a small amount of jitter on either causes the system to alternate between reading just before, or just after the information is written in. Speech samples are then alternately lost and gained, and severe distortion results. The hysteresis system overcomes this jitter and operates such that once a word has been lost or gained, additional time delay is inserted in a direction to accentuate the change, ensuring that succeeding read pulses fall on the same side of the write pulse.

The system shown in Fig. 3 is an adaptation of a method evolved for true multiplexing. It inserts a variable delay into the read pulse line that changes whenever a word slip occurs. A slip is detected by monitoring the spacing between the read and write pulses, a change in the read pulse delay being initiated whenever this spacing passes through zero. In Fig. 3 the read pulses are present at G_1 output when they precede the write pulse and at G_2 output when they occur within 30 microseconds after it. The disappearance of pulses from G_1 indicates that read-out has changed from preceding to following the write pulse.

The continued presence of the pulses from G_1 is monitored by a monostable trigger circuit that has a memory time of just greater than one pcm word time. It is held on continuously by the G_1 pulses, but reverts to the off state as soon as one pulse is missed. This causes a step increase in the delay circuit, thereby making the read pulse even later, and hence achieving the required hysteresis effect.

OBSERVATIONS—The first effect examined during tests was that of a rapid asynchronous rate of about 1 word slip per second. Several tests have been made, with the equipment in each of the three possible conditions: (a) words lost at 1 per second, (b) words gained at 1 per second, spaces filled by repeats, and (c) words gained at 1 per second, spaces filled by zeros.

Both tones and voices have been used and the effect of the word slip can be detected only on the steady tone. During a steady tone, each slip is apparent as a slight tick, similar to the sound of a scratched phonograph record. However, it is not possible to detect any difference between the three conditions, and, unlike the tick from a phonograph record, the interference disappears when no signal is present and cannot even be detected in normal speech. Hence, this type of mutilation of pcm data can easily be tolerated on a normal speech link.

The second effect of asynchronous working to be examined is the interference caused by pulse jitter. The effect on the speech transmission produced by setting the read pulse at the jitter point was catastrophic, even with both clocks derived from the same prime source. When the talker is silent, no noise is present, but the speech itself is reproduced with a considerable grating sound. Tests taken with redundant words filled by zeros were slightly worse than those taken with redundancies filled by repeats. Both conditions are unacceptable for a communication link.

Introduction of the hysteresis system into the equipment completely removed the jitter effect, the rate of word slip being reduced to an inaudible level below one in ten seconds.

CONCLUSIONS—When transferring asynchronous pcm speech through an exchange, handling the signals digitally gives best results. A demodulation process would increase the quantizing noise, and restrict the extent of tandem working.

It is possible to devise asynchronous read-out systems, which, for reasonable asynchronous rates produce no detectable distortion of the speech. A frequency stability of 1 part in 10^4 is acceptable, but if this quality of performance is to be achieved with several circuits in tandem, each clock must be stable to one part in 10^5, or better.

A troublesome jitter effect that may occur when the two frequencies are nearly equal can be overcome with a straightforward hysteresis system, one form of which has been demonstrated.

The author thanks the management of English Electric Aviation for permission to publish this work.

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Unique Tunnel-Diode Circuit Performs Odd-and-Even Logic

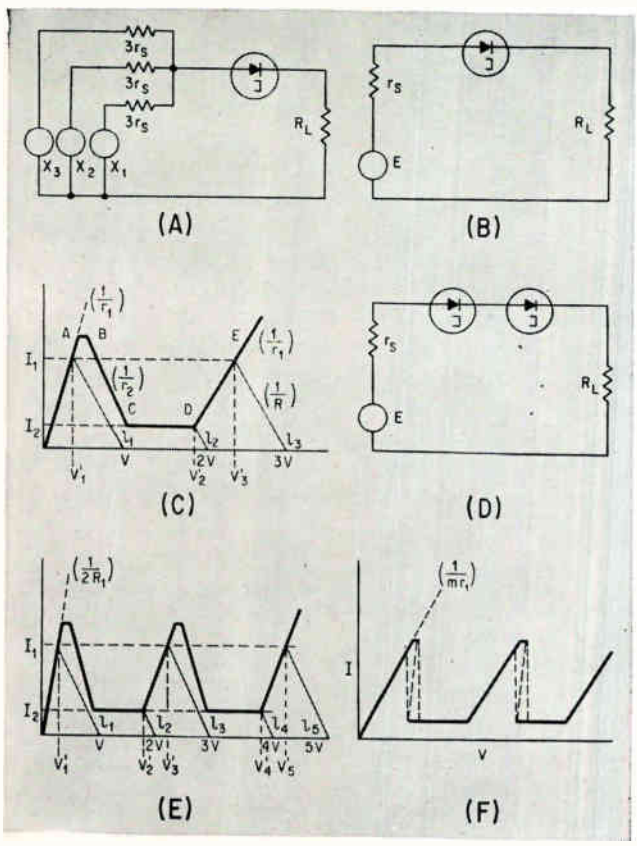
Multivalue property of tunnel-diode characteristic permits design of a logic circuit that accepts five binary inputs and tells whether their sum is odd or even. Circuit can be used as a multi-input adder and in industrial controls

By W. H. Ko, Case Institute of Technology, Cleveland, Ohio

NEGATIVE-RESISTANCE PROPERTIES

Recently there has been much interest in the applications of the negative-resistance region of transistors, double-layer pnpn *switches and tunnel diodes. Binary adders have been described that use this property.*

The performance of logic functions that formerly required several AND *and* OR *gates, can now be achieved economically with tunnel diodes; their multivalue and negative-resistance properties are used*



ODD-AND-EVEN *function generator with three inputs (A), its equivalent circuit (B) and linearized V-I characteristic (one tunnel diode) with load lines (C). Equivalent circuit for five inputs (D), its composite linearized V-I characteristic (two tunnel diodes) (E) and hysteresis loop (F)—Fig 1*

THE MULTIVALUE property of the *V-I* characteristic of tunnel diodes can be used to efficiently perform logic functions. This circuit accepts five binary inputs and gives an output that indicates whether the sum of the inputs is odd or even; it may be modified to accept any number of inputs. The circuit can be used to obtain the first digit of a multi-input adder, to monitor a set pattern of inputs, or to perform symmetrical logic functions in industrial control systems.

LOGIC PERFORMED—The circuit shown in Fig. 1A performs the function

$$Y = ABC + A\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C}$$

with one tunnel diode. The equivalent circuit of this circuit is shown in Fig. 1B, where a single input source and a source resistance represent the three inputs. The combined source, E, is quantized to take on values V, $2V$, $3V$. The tunnel-diode characteristic has been linearized and is shown in Fig. 1C, with the load lines drawn at different values of E. When the source takes the odd number of units, the current through the circuit is I_1 and the voltage across the load is I_1R_L. When the source takes the even number of units, (0 to 2 in this case) the current is either zero or a small value I_2. The voltage across the load is equal to or less than I_2R_L. These two distinct values are used to represent output binary numbers. For tunnel diodes, the valley region CD is large; therefore, when the source is $2V$, the load line intercepts the characteristic in the CD section. However, to have the load lines l_1 and l_3, corresponding to the V and $3V$ source, intercept the characteristic at the same current value I_1, the total load resistance, $R = R_L + r_s$, and the quantized voltage unit, V, should satisfy the equations (Fig. 1C)

$$V = I_1R + V_1'$$
$$3V = I_1R + V_3'$$

Therefore,

$$R = (V_3' - 3V_1')/2I_1 \quad (1)$$

$$V = (V_3' - V_1')/2 \quad (2)$$

For five inputs, two tunnel diodes are required (Fig. 1D and 1E). Again assume that when the source takes an even number of units, the current is I_2, or less, and when the source is odd, the current is I_1. Then the total load resistance, R, and the quantized

voltage unit, V, have to satisfy the following relations:

$$V = I_1R + V_1^1$$
$$3V = I_1R + V_3^1$$
$$5V = I_1R + V_5^1$$

Therefore, $R = (V_3^1 - 3V_1^1)/2I_1$

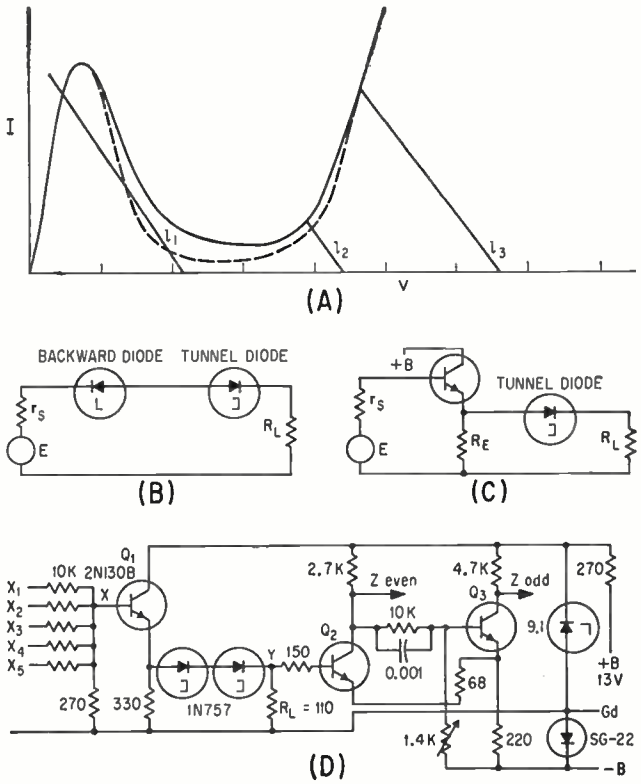
$$V = (V_3^1 - V_1^1)/2$$

and $$V_3^1 - V_1^1 = V_5^1 - V_3^1 \quad (3)$$

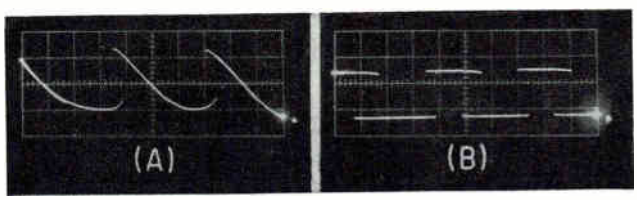
Equation 3 implies that the two tunnel diodes have to be matched in peak and forward voltages.

The above analyses can be generalized to n inputs using $m = (n - 1)/2$ tunnel diodes; but matching of m diodes becomes difficult. The combined m diode V-I characteristic is shown in Fig. 1F. Assume all tunnel diodes are matched and each diode has a characteristic as shown in Fig. 1C, with negative resistance $(-r_2)$. When m increases to a value that causes $| -r_2 + (m - 1)r_1 | > 0$, the characteristic would have hysteresis in each negative resistance region, limiting the number of diodes that can be used in series.

CIRCUIT DESIGN—A suitable I_1 is selected, and then R and V are calculated. The value of I_2 is found graphically from the characteristic curve. The output voltage will be I_1R_L and I_2R_L for odd and even sum of inputs. It is desirable to optimize the quantity $\lambda = (I_1 - i_2)/i_2$. The graphical cut-and-try method as well as the analytical calculation from the equation of the tunnel-diode characteristic may be used for optimization. To obtain proper operation when the source E is either increasing or decreasing, the load lines l_1, l_2 and l_3 should intercept the diode characteristic at one point only. Sufficient marginal distance should be provided between the load line and the diode characteristic curve. For germanium tunnel diodes with a high peak-to-valley current ratio, the negative resistance $(-r_2)$ is small, the load line, l_1, calculated from Eq. 1, usually crosses the characteristic in the negative-resistance region as shown by the dotted high ratio V-I characteristics in Fig. 2A. This can be avoided if V^1_1 is increased to V^{11}_1 such that $(V^1_3 - 3\ V^{11}_1)/2I$, is not much greater than r_2. The value of V^1_1 can be raised by: (1) a series voltage in the loop; (2) a parallel current through R_L; (3) a series backward diode in the loop; and (4) by using the base-emitter diode of a transistor acting as an emitter follower. The schemes (3) and (4) are illustrated in Fig. 2B and 2C.



TUNNEL DIODE *V-I characteristic; dotted line indicates diode with high peak-to-valley ratio (A). Two ways of raising V^1_1: by backward diode (B) and by emitter follower (C) Circuit diagram of five-input odd-and-even-function generator (D)—Fig. 2*



TRANSFER FUNCTION *of y against x (A) and Z_{odd} against x (B)—Fig. 3*

An experimental unit (Fig. 2D) using two tunnel diodes for five inputs, corresponding to the scheme in Fig. 1D, was built. A transistor emitter follower is used to provide V^1_1 and the low source impedance. Following the tunnel diodes and the load resistance, R_L, a schmitt trigger circuit is used to raise the output voltage to 9 volts. The transfer function between the total input, $x = x_1 + x_2 + x_3 + x_4 + x_5$, and the tunnel diode output, y, as well as between the input and the schmitt trigger output, z, is shown in Fig. 3A and 3B respectively. The horizontal represents the sum of the input voltages; each input is represented by two cm length of the horizontal axis. Because the $R = R_L + r$, is greater than the r_2, the y against x transfer function in Fig. 3A shows small hysteresis loops between the two peaks and valleys. The large hysteresis loops shown in the z against x transfer function of Fig. 3B are due to the difference of the upper and the lower trigger points of the schmitt circuit. These hysteresis loops will limit the tolerance of the circuit components and determine the reliability of the unit. If an amplifier is used between the tunnel diodes and the schmitt trigger, the size of the hysteresis loops will be reduced and a more reliable circuit is obtained. The logic function performed by this circuit is

$$Z_{odd} = x_1x_2x_3x_4x_5 = \bar{x}_1\bar{x}_2x_3x_4x_5 + x_1\bar{x}_2\bar{x}_3x_4x_5 + x_1x_2\bar{x}_3\bar{x}_4x_5 + x_1x_2x_3\bar{x}_4\bar{x}_5 + \bar{x}_1x_2x_3\bar{x}_4x_5 + \bar{x}_1x_2\bar{x}_3x_4\bar{x}_5 + x_1\bar{x}_2x_3\bar{x}_4\bar{x}_5 + \bar{x}_1x_2\bar{x}_3\bar{x}_4x_5 + \bar{x}_1\bar{x}_2x_3\bar{x}_4\bar{x}_5 + \bar{x}_1\bar{x}_2\bar{x}_3x_4\bar{x}_5 = (x_1, x_2, x_3, x_4, x_5)_{odd}$$

The output at collector of Q_2 represents the even function of the inputs $Z_{even} = (x_1, x_2, x_3, x_4, x_5)_{even}$.

For more than five inputs, a series parallel combination of the basic two-tunnel diode circuit is recommended.

The author thanks G. K. L. Chien and the Conoflow Corp. of Philadelphia for their support on a part of the study of this circuit.

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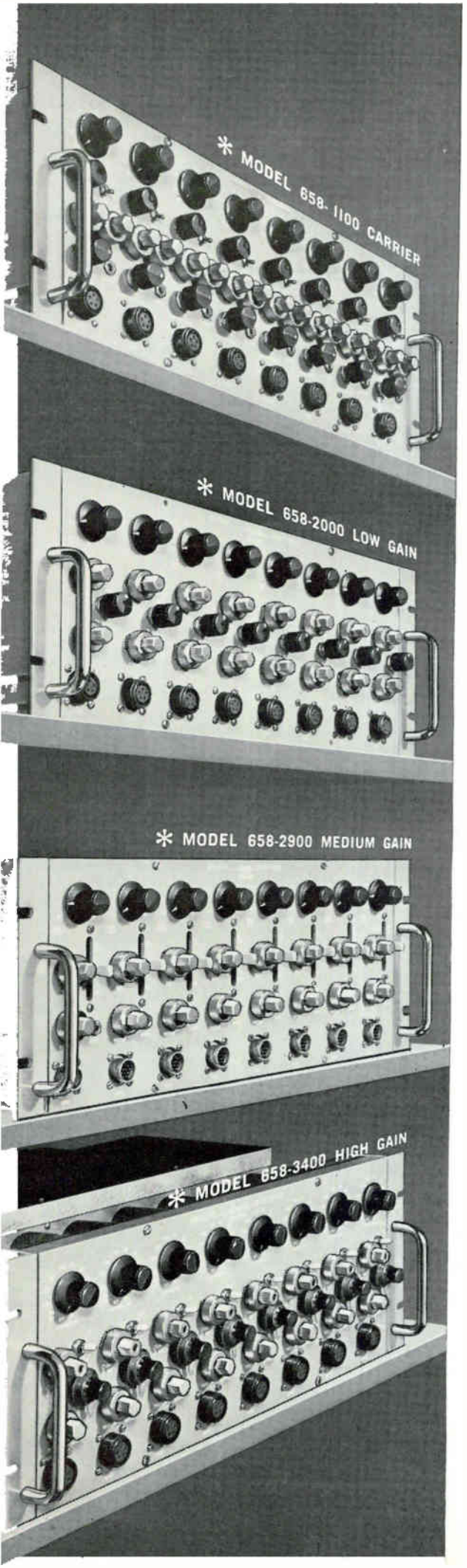

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Handy Nomogram Speeds Infrared System Design

Noise equivalent temperature (NET) defines the sensitivity of an infrared system. This nomogram permits speedy estimation of NET from the six common design variables of an infrared system

By R. GROVE, H. LEVENSTEIN, G. KERN and A. WOODWARD
Servo Corporation of America, Hicksville, N. Y.

IN MANY infrared systems, requirements are readily related to expected temperature differentials between target and background. In particular the sensitivity of the system is usefully expressed by a number called the noise equivalent temperature (NET). Knowing NET one can compute the signal-to-noise ratio obtainable at the output for any given target temperature. NET is widely used today in infrared system specifications.

The noise equivalent temperature of an infrared system is defined as that difference between the temperature of two square-wave chopped radiant sources, which produces a fundamental signal having an rms value equal to the rms noise of the system. In designing an infrared detecting system it is important to be able to predict the NET based on design parameters.

SIGNAL OUTPUT—Assuming no atmospheric attenuation and 100 percent optical efficiency and that radiation received is due not to a single source but rather two sources, one having a temperature T_0 and the other T_1, each of which is seen by the detector in alternate periods of time, then the incremental signal output, dS_{rms}, of the detector is

$$dS_{rms} = R(\lambda)dP_{rms} = \frac{R(\lambda)A_T A}{2\pi r^2}[W_1(\lambda) - W_0(\lambda)] \quad (1)$$

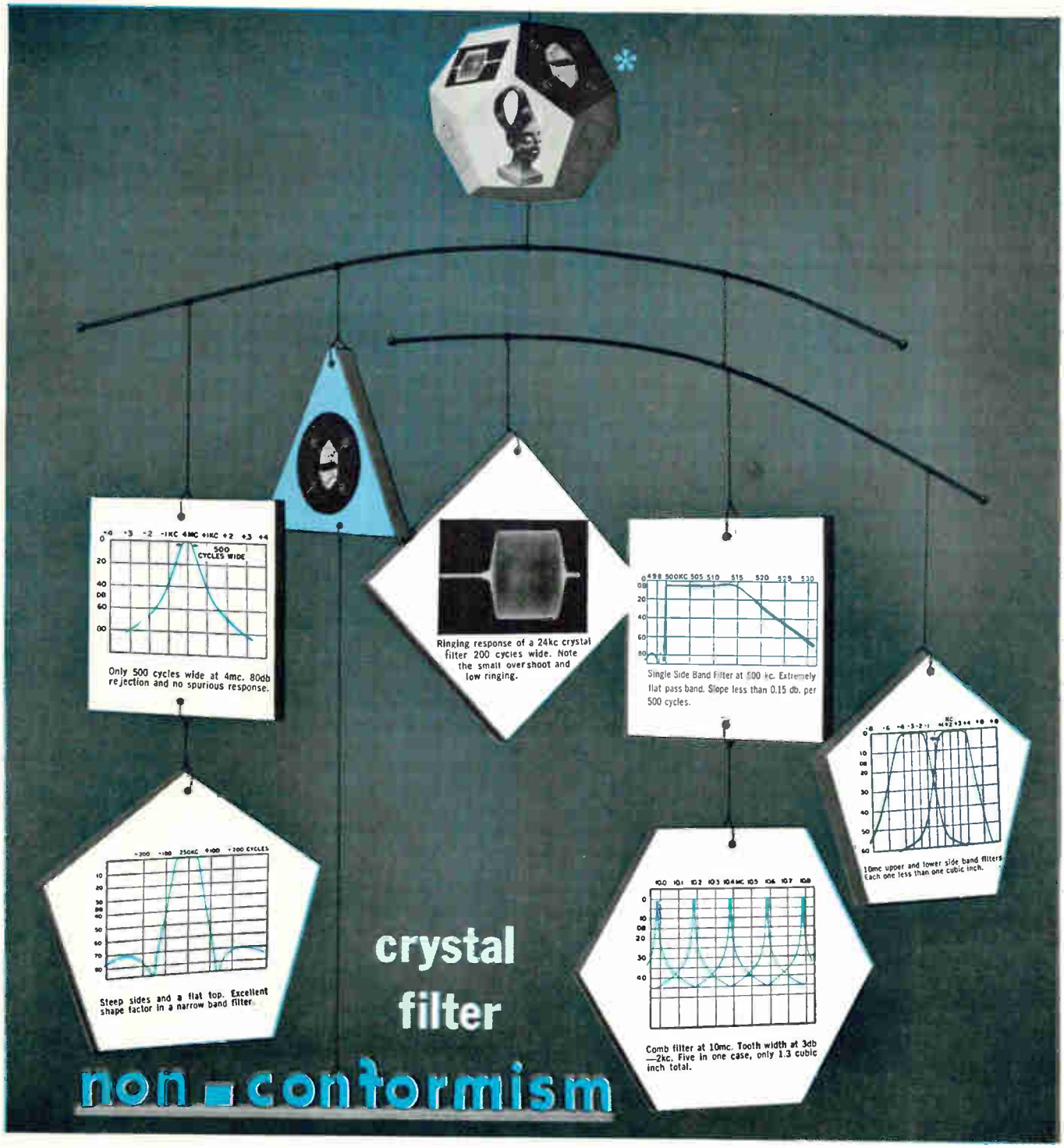
where $R(\lambda)$ = responsivity of the detector in fundamental rms volts per rms watts, dP_{rms} = component of resulting incremental incident radiation, A_T = source area in cm², A = collector optics area in cm², r = distance between source and collector in cm, and $W(\lambda)$ = radiant emittance of source in watts/cm²/cm. For a resolved target and a detector of square cross section

$$A_T = (\rho r)^2 \quad (2)$$

where ρ = system resolution in radians (assumed small).

Assuming temperatures in the neighborhood of 300 K and wavelengths less than 14 microns

$$dS_{rms} = \frac{c\rho^2 A\,\Delta T R(\lambda)W_0(\lambda)}{2\pi T_0^2 \lambda}\,d\lambda \quad (3)$$



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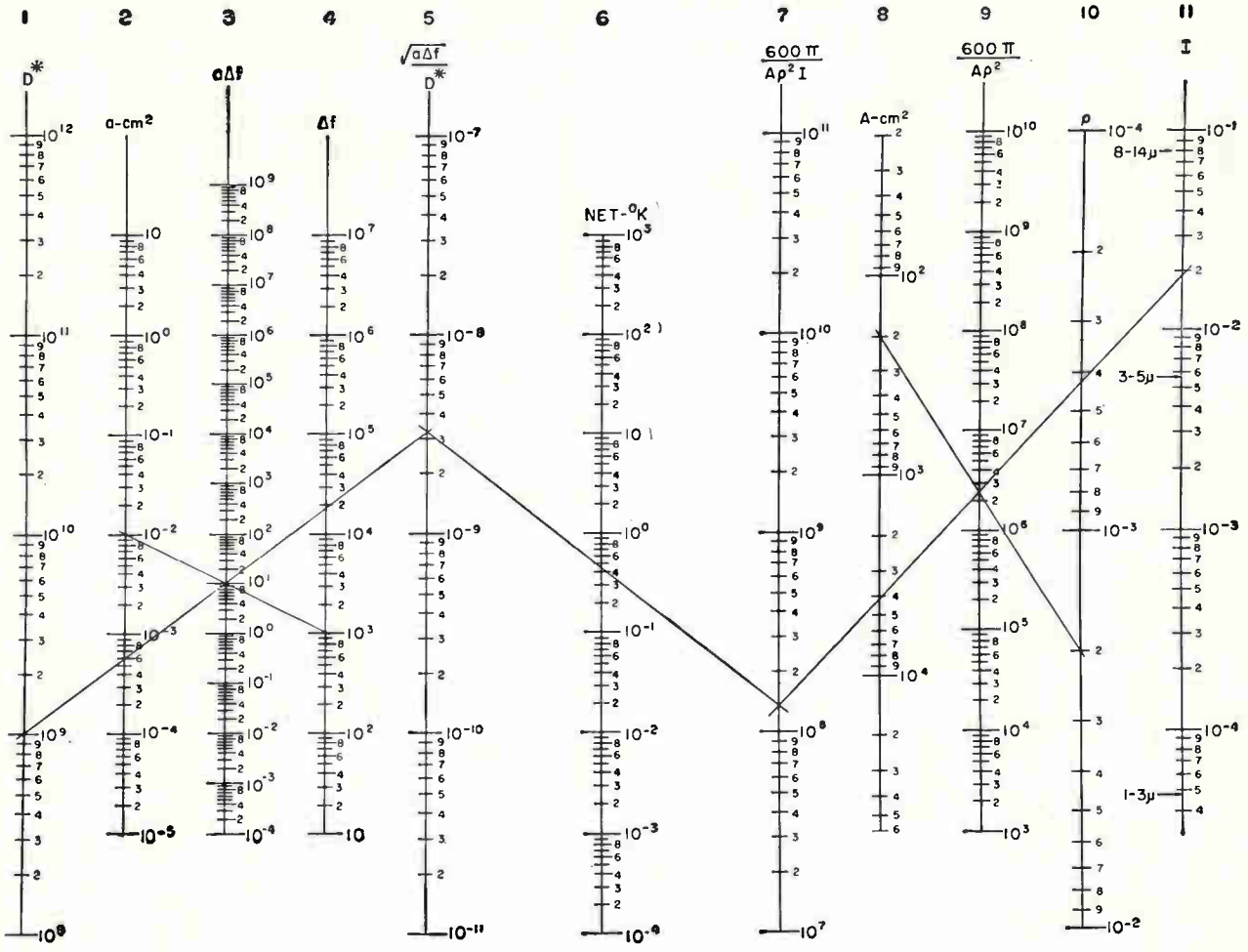

for small ΔT, where $c = 1.43848$ cm degrees.

To obtain the total rms signal, integrate over the spectral band of interest

$$S_{rms} = \frac{c\rho^2 A\ \Delta T}{2\pi T_0^2} \int_{\lambda_1}^{\lambda_2} \frac{R(\lambda)W_0(\lambda)}{\lambda}\, d\lambda \qquad (4)$$

NOISE CONSIDERATIONS—In any well designed system the principal source of noise is the detector itself. For almost all detectors operating in their normal frequency band this noise is white. The noise equivalent power (NEP) of a detector is defined as the power required to fall on the detector to produce a 1:1 signal-to-noise ratio. NEP is usually given at some reference wavelength. If the responsivitiy is R at this reference wavelength, the noise N of the detector is

$$N = \mathrm{R} \times (\mathrm{NEP}) \qquad (5)$$

NEP is often expressed

$$\mathrm{NEP} = \frac{\sqrt{a\ \Delta f}}{D^*} \qquad (6)$$

where a = detector area in cm, Δf = system bandwidth in cps and D^* = detectivity per unit bandwidth per unit detector area in cm sec^{1} watt^{-1}, at reference wavelength.

When the signal, S_{rms} of Eq. 4 is equal to N, ΔT in Eq. 4 is equal to NET. Thus

$$\mathrm{NET} = \frac{2\pi T_0 \sqrt{a\ \Delta f}}{\rho^2 A D^* \displaystyle\int_{\lambda_1}^{\lambda_2} \frac{c}{T_0} \frac{R(\lambda)}{R} \frac{W_0(\lambda)}{\lambda}\, d\lambda} \qquad (7)$$

In many applications the responsitivity of the detector does not vary appreciably in the band of interest: $R(\lambda) = R$. Then the integral I in the denominator of Eq. 7 when integrated by parts yields

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VALUE OF THE INTEGRAL I BETWEEN LIMITS 0 AND λ (T_0 = 300 K)

λ	$\lambda W_0(\lambda)$	$4\int_0^{\lambda} \lambda W_0(\lambda)d\lambda$	I
μ	$\frac{\text{Watt}}{\text{cm}^2}$	$\frac{\text{Watt}}{\text{cm}^2}$	$\frac{\text{Watt}}{\text{cm}^2}$
1.0	4.92×10^{-17}	4.6×10^{-18}	5.38×10^{-17}
1.5	9.84×10^{-11}	1.5×10^{-11}	1.13×10^{-10}
2.0	8.85×10^{-8}	1.7×10^{-8}	1.05×10^{-7}
2.5	4.26×10^{-6}	1.12×10^{-6}	5.38×10^{-6}
3.0	4.92×10^{-5}	1.52×10^{-5}	5.44×10^{-5}
3.5	2.69×10^{-4}	1.00×10^{-4}	3.69×10^{-4}
4.0	8.85×10^{-4}	3.91×10^{-4}	1.28×10^{-3}
4.5	2.06×10^{-3}	1.06×10^{-3}	3.12×10^{-3}
5.0	3.93×10^{-3}	1.91×10^{-3}	5.84×10^{-3}
5.5	6.39×10^{-3}	4.37×10^{-3}	1.08×10^{-2}
6.0	9.34×10^{-3}	7.16×10^{-3}	1.65×10^{-2}
6.5	1.26×10^{-2}	1.08×10^{-2}	2.34×10^{-2}
7.0	1.61×10^{-2}	1.53×10^{-2}	3.14×10^{-2}
7.5	1.92×10^{-2}	2.01×10^{-2}	3.93×10^{-2}
8.0	2.21×10^{-2}	2.59×10^{-2}	4.80×10^{-2}
8.5	2.46×10^{-2}	3.16×10^{-2}	5.62×10^{-2}
9.0	2.69×10^{-2}	3.78×10^{-2}	6.47×10^{-2}
9.5	2.87×10^{-2}	4.39×10^{-2}	7.26×10^{-2}
10.0	3.02×10^{-2}	5.02×10^{-2}	8.04×10^{-2}
10.5	3.12×10^{-2}	5.67×10^{-2}	8.79×10^{-2}
11.0	3.20×10^{-2}	6.25×10^{-2}	9.45×10^{-2}
12.0	3.27×10^{-2}	7.45×10^{-2}	1.07×10^{-1}
13.0	3.25×10^{-2}	8.55×10^{-2}	1.18×10^{-1}
14.0	3.18×10^{-2}	9.57×10^{-2}	1.28×10^{-1}

$$I = W_0(\lambda)\Big|_{\lambda_1}^{\lambda_2} + 4\int_{\lambda_1}^{\lambda_2} W_0(\lambda)\, d\lambda \qquad (8)$$

The form of Eq. 8 is particularly useful because in this form the integral can be readily evaluated using the British Admiralty Research Laboratory radiation slide rule. Often the temperature, T_0, is 300 K. With this assumption NET further reduces to

$$\text{NET}_{(300K)} = \frac{\sqrt{a\,\Delta f}}{D^*}\left(\frac{600\pi}{\rho^2 AI}\right) \qquad (9)$$

In the table the integral I, with T_0 = 300 K, is tabulated between the limits 0 and λ. Values between the limits λ_1 and λ_2 may readily be obtained by subtracting the 0 to λ_1 value from the 0 to λ_2 value.

NOMOGRAM USE—The example shows how to obtain the NET for values of the six variables of Eq. 9, using the figure. The numbers are illustrative and do not represent any attempt to specify a particular infrared system.

Step	Given Value	Procedure
(1)	$\lambda_1 = 10.5\mu$ $\lambda_2 = 12.0\mu$ ($I = 1.9 \times 10^{-2}$ watt/cm^2)	Obtain the value of I from the table and plot this value on scale 11
(2)	A = 200 cm^2	Plot the value of A on scale 8
(3)	$\rho = 2 \times 10^{-3}$ radian	Plot the value of ρ on scale 10
(4)		Mark the point on scale 9 where the straight line connecting the points on scales 8 and 10 intersects scale 9
(5)		Mark the point on scale 7 where the straight line connecting the points on scales 9 and 11 intersects scale 7
(6)	$D^* = 10^9$ cm sec$^{1/2}$ watt^{-1}	Plot the value of D^* on scale 1
(7)	$a = 10^{-2}$ cm^2	Plot the value of a on scale 2
(8)	$\Delta f = 10^3$ cps	Plot the value of Δf on scale 4
(9)		Mark the point on scale 3 where the straight line connecting the points on scales 2 and 4 intersects scale 3
(10)		Mark the point on scale 5 where the straight line connecting the points on scales 1 and 3 intersects scale 5
(11)		Mark the point on scale 6 where the straight line connecting the points on scales 5 and 7 intersects scale 6
(12)		Read the value of NET from scale 6

The intermediate steps on the nomogram yield

$$a\,\Delta f = 10 \text{ cps}$$

$$\frac{\sqrt{a\,\Delta f}}{D^*} = 3.2 \times 10^{-9} \text{ watt}$$

$$\frac{600\pi}{A\rho^2} = 2.4 \times 10^6 \text{ K/cm}^2$$

$$\frac{600\pi}{A\rho^2 I} = 1.3 \times 10^8 \text{ K/watt}$$

Finally, NET = 0.40 K

With changes in procedure the nomogram may be used to find any one of the six variables on the right-hand side of Eq. 9 for a given NET.

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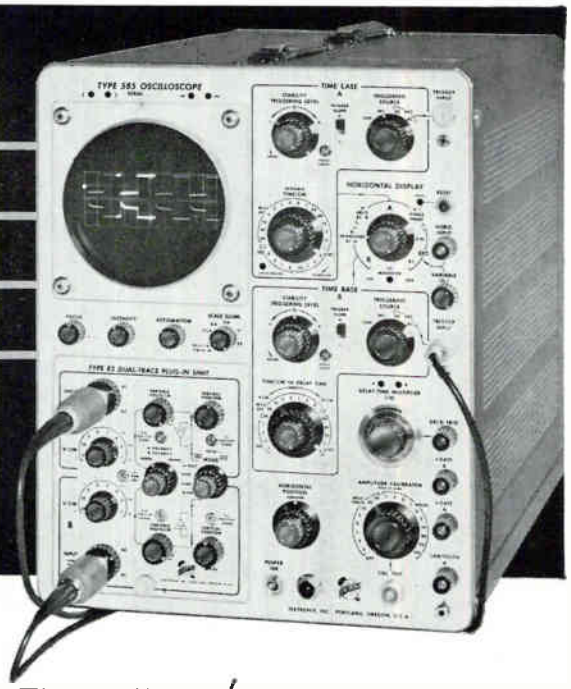

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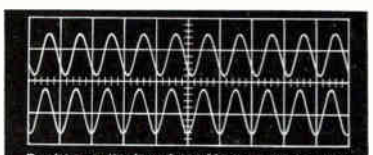
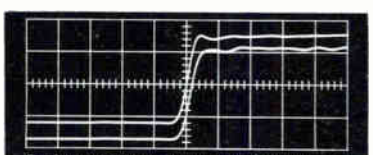


Dual-trace display of 100 Mc sine waves at 10 nsec/cm. Phase difference is approximately 55 degrees. Phase comparison and similar measurements are possible with the stable high-frequency triggering system of the Type 585.



Dual-trace display of input and output pulses of a transistor amplifier at 10 nsec/cm. Lower trace delayed 1 nsec by the amplifier under observation. Note time resolution. The Type 585 Oscilloscope—with 82 Unit—can display time coincidence between input channels with no measurable difference at 10 nsec/cm.

TYPE 585/82 FEATURES

PASSBAND—typically dc-to-85 Mc at 3-db down, dc-to-120 Mc at 6-db down, dc-to-160 Mc at 12-db down.

SENSITIVITY—8 calibrated steps from 100 mv/cm to 20 v/cm, 1-2-5 sequence, continuously variable uncalibrated from 100 mv/cm to 40 v/cm. The dc-coupled 10X Amplifier extends calibrated range to 10 mv/cm to 2 v/cm, 1-2-5 sequence, continuously variable uncalibrated from 10 mv/cm to 4 v/cm.

RISETIME—(of oscilloscope, plug-in unit, supplied probe) at overall sensitivity of 1 v/cm is approximately 5 nsec.

SWEEP RANGE—24 calibrated rates from 50 nsec/cm to 2 sec/cm, 1-2-5 sequence, continuously variable uncalibrated from 50 nsec/cm to 5 sec/cm. 5X Magnifier extends calibrated range to 10 nsec/cm.

SWEEP-DELAY RANGE—continuously variable from 2 μsec to over 10 sec.

TRIGGERING—dc to beyond 100 Mc.

PROBES—increase input R to 10 megohms and decrease input C to approximately 7 pf.

Type 585 (without plug-in) $1725
Type 82 Dual-Trace Unit . . . . . $ 650
(includes 2 low capacitance passive probes)
Type 81 Plug-In Adapter . . . . . $ 135

The Adapter allows insertion of 17 letter-series plug-ins without loss of bandwidth or basic sensitivity of the plug-in.

Type 581 Oscilloscope

Also accepting Type 82 Unit, the Type 581 has all features of Type 585 Oscilloscope, except for sweep delay capability.

Type 581 (without plug-in) $1425

U.S. Sales Prices f.o.b. Beaverton, Oregon

For a demonstration of the new Type 82 Plug-In Unit in a Type 585 Oscilloscope (or Type 581) please call your Tektronix Field Engineer.

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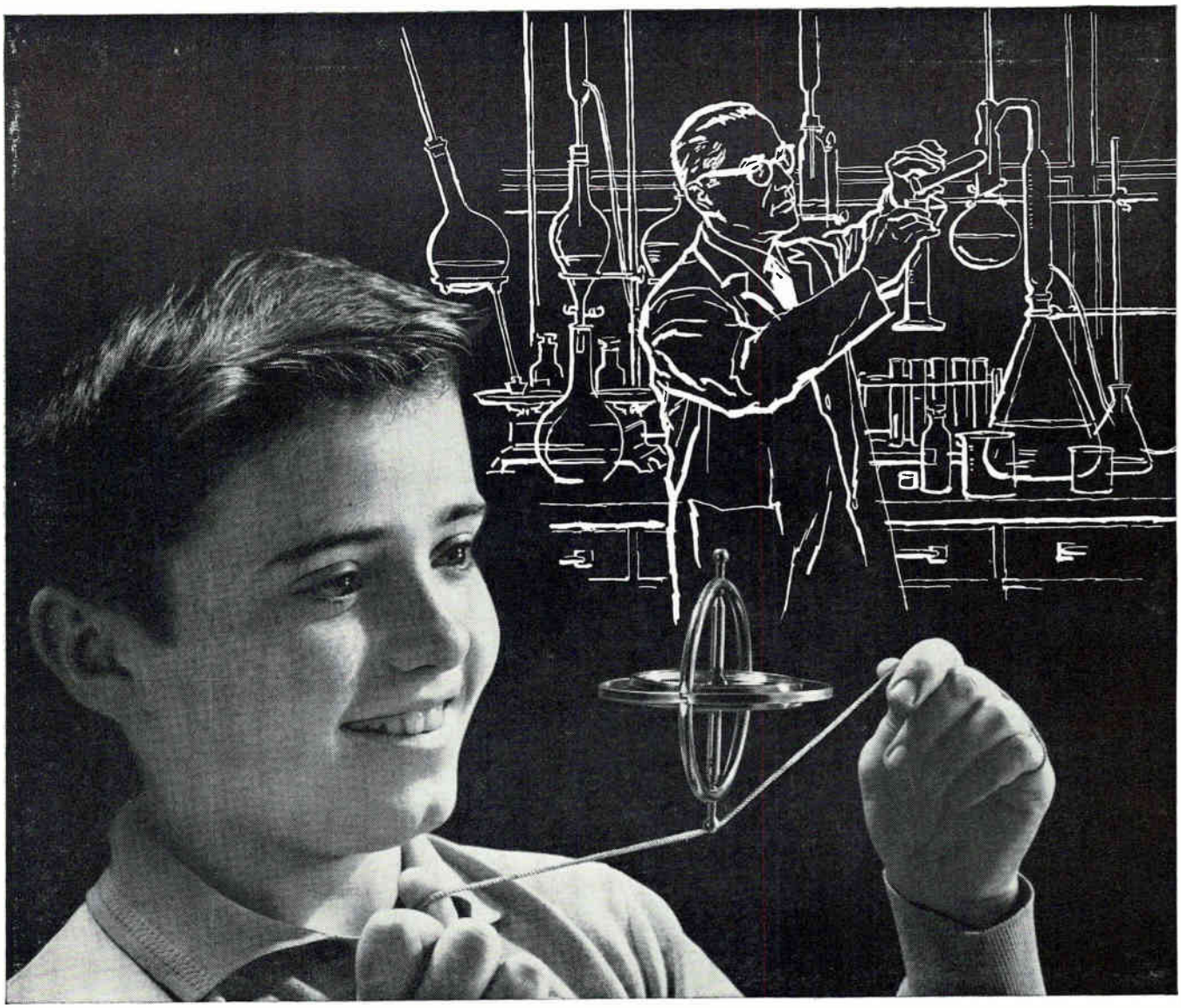

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HIGHER EDUCATION
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News from Bell Telephone Laboratories

WE'RE "FINGERPRINTING" VOICES...TO FIND BETTER WAYS OF TRANSMITTING THEM

Acoustics scientists at Bell Telephone Laboratories study voices to learn how one voice differs from all others, what makes yours instantly recognizable to friends and family, and what the elements of a voice are that give it the elusive qualities of "naturalness."

To enable us to examine speech closely, we devised a method of making spectrograms of spoken words. We call them voiceprints. They are actual pictures of sound, revealing the patterns of voice energy. Each pattern is distinctive and identifiable. They are so distinctive that voiceprints may have a place, along with fingerprint and handwriting identification, as an important tool of law enforcement.

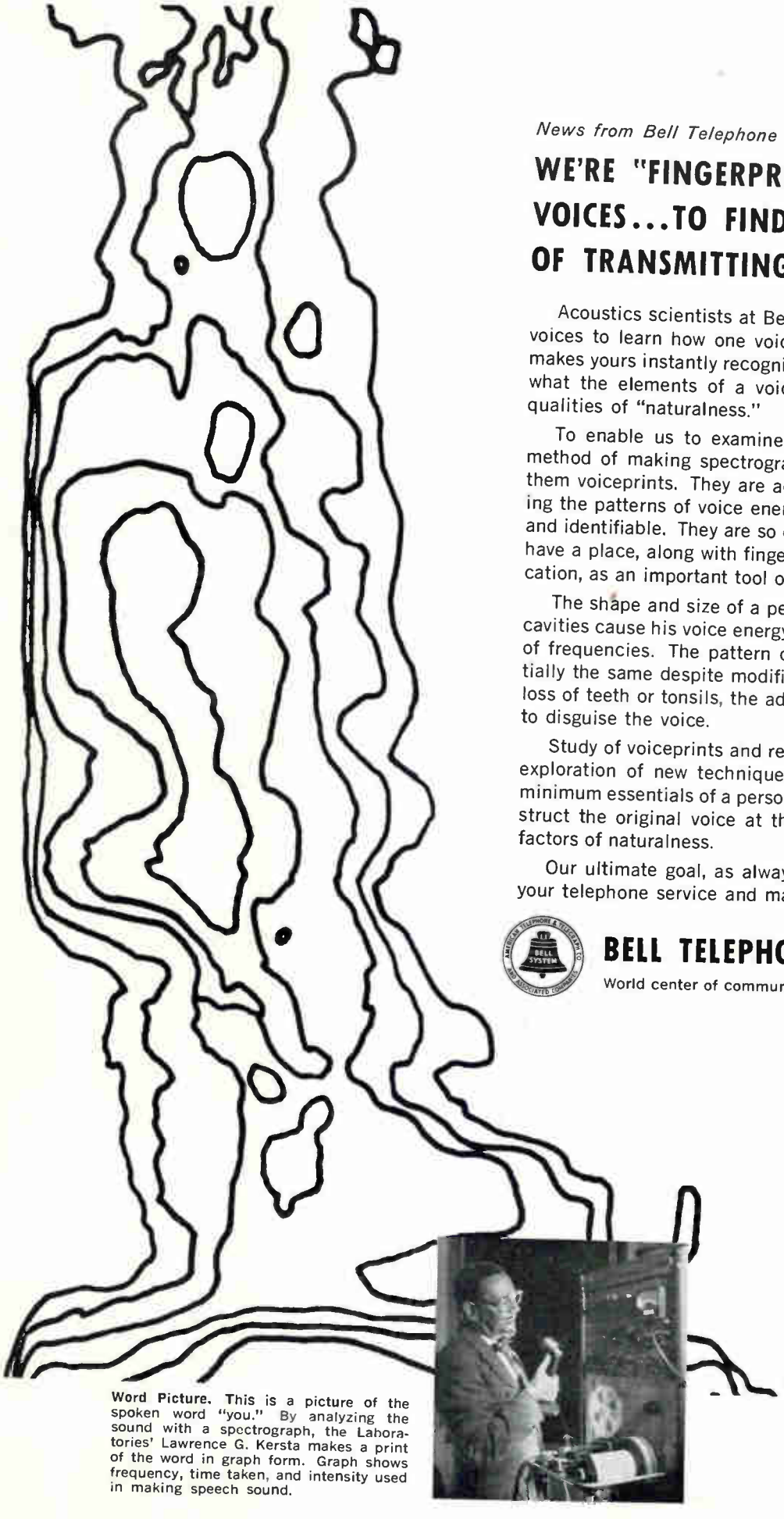
The shape and size of a person's mouth, throat and nasal cavities cause his voice energy to be concentrated into bands of frequencies. The pattern of these bands remains essentially the same despite modifications which may result from loss of teeth or tonsils, the advancement of age, or attempts to disguise the voice.

Study of voiceprints and recognition factors is part of our exploration of new techniques to extract and transmit the minimum essentials of a person's voice and from these reconstruct the original voice at the receiving end, retaining its factors of naturalness.

Our ultimate goal, as always, is to learn how to improve your telephone service and make it a better value.

BELL TELEPHONE LABORATORIES

World center of communications research and development



Word Picture. This is a picture of the spoken word "you." By analyzing the sound with a spectrograph, the Laboratories' Lawrence G. Kersta makes a print of the word in graph form. Graph shows frequency, time taken, and intensity used in making speech sound.

The true scientist, the creative engineer

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For here they can work on a variety of militar

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they find a sense of being, of doing, of accomplishin

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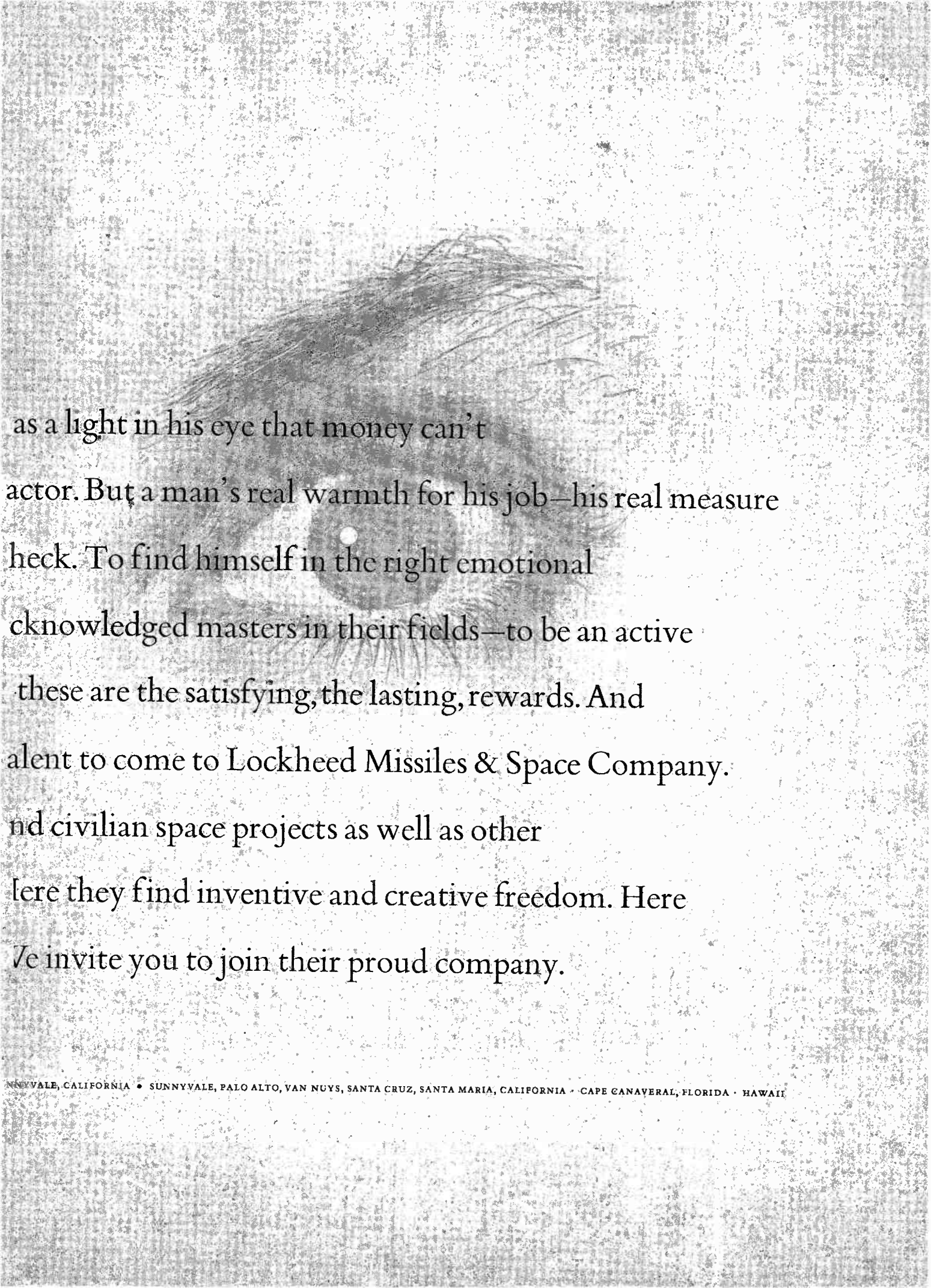

as a light in his eye that money can't

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New Light-Wave Generators Are Tunable

Experimental devices can be modulated in frequency or amplitude

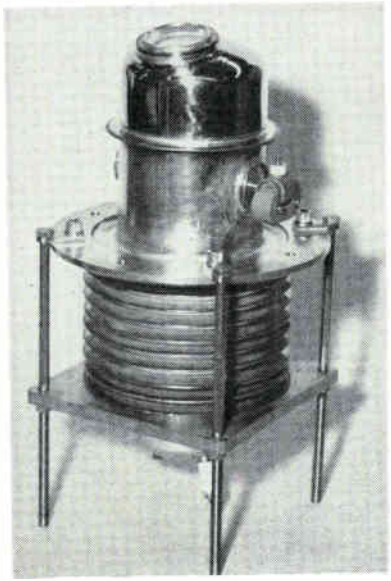
CONTINUOUS-WAVE outputs are generated at frequencies in the terracycle region by an experimental device that is tunable over a broad range of frequencies. Families of the devices are expected to cover frequencies from microwaves through the visible portion of the spectrum.

The new-type generator of electromagnetic radiation, called the Varotron, can readily be either frequency or amplitude modulated. Research leading to its development was sponsored by Varo Inc. and the Research and Development Command of the USAF. An experimental prototype of the device was recently announced by Varo (see ELECTRONICS, p 7, October 5). This prototype, which can be tuned to any frequency between 300 and 600 terracycles, will be used with others like it for research in communications, spectroscopy and optics.

Full capabilities of the Varotron have not yet been established because the program is still in the research and development stage. However, results of experiments thus far and some understanding of its operating principles provide an indication of the potential importance of the Varotron to the electronics industry.

CHARACTERISTICS—The Varotron generates electromagnetic waves directly, so that external resonant circuits or antennas are unnecessary. It has been used in the laboratory for voice communications using both frequency modulation and amplitude modulation.

Work has been restricted to the infrared and visible portions of the spectrum because test equipment is not readily available for higher frequencies. Laboratory tests have also been limited to low-power theoretical analyses, although the concept appears suitable for high-power transmission and lower frequency operation. Tests to determine the degree of coherence have not been completed, but present indications are that the Varotron can be used directly for special-purpose applications that are feasible only with coherent radiation.



EXPERIMENTAL *Varotron is tunable from 300 to 600 terracycles*

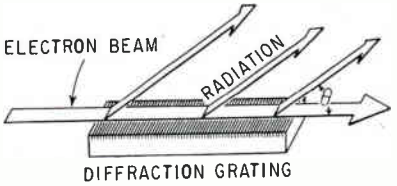
OPERATION—The principle underlying operation of the Varotron is an extension of that governing klystron and traveling-wave tube operation. A high-velocity sheet beam of electrons generated by conventional means interacts with a repetitive structure. The diffraction grating, long familiar in the field of optics, has proved to be a suitable structure for this purpose.

The beam of electrons is directed parallel to the average grating surface and perpendicular to the engraved lines or grooves on the grating, as shown in Fig. 1. The electric flux lines from the electrons are interrupted periodically by the grating surface, resulting in radiation of electromagnetic energy.

A more detailed explanation of the interaction between the electron beam and the diffraction grating can be based on the theory of electrostatic images. This theory indicates that a small spherical charge (usually a point charge like an electron) near a metal surface induces a charge of opposite sign in the surface. The electrostatic image charge is induced at a depth in the surface equal to the distance of the inducing charge from the surface.

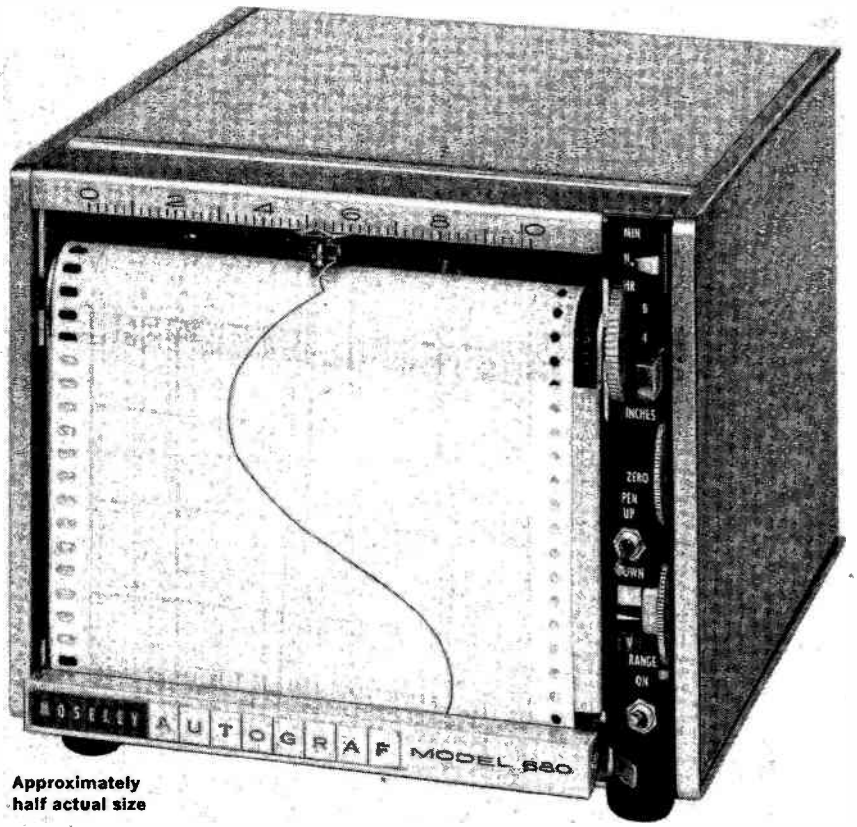
Each electron in the beam parallel to the metal diffraction grating surface induces a positive electrostatic image charge below the surface. Both the electron and its image move together parallel to the surface. However, the distance of the electron from the surface changes periodically because of the grooves. Thus the distance between the electron and its electrostatic image varies periodically forming an oscillating dipole, which is an ideal radiator of electromagnetic energy at the oscillating frequency.

FREQUENCY — Groove spacing, electron velocity and angle of observation to the electron beam determine frequency of the output. The angle of observation affects output frequency because a doppler frequency shift results from movement of the electron and its image toward the observation point. Although relativistic effects must be considered unless electron velocities are low, exactly the same relationships resulted from a relativistic develop-



RADIATION *frequency depends on electron velocity, grating line density and angle of observation—Fig. 1*

New AUTOGRAF Model 680 Series Recorders



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ment of this theory and the simpler approach can be used to determine frequency.

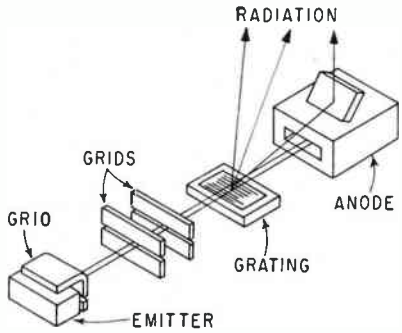
The grating profile affects results. Motion of the electrostatic image apparently duplicates the grating profile with doubled amplitude. Since gratings having sine-wave profiles have not yet been produced, the motion includes frequencies other than the fundamental. Actually, all frequencies expected from a Fourier analysis of the grating profile are present. Frequencies up to those corresponding to the seventh term of the Fourier series have been photographed as colors. One photograph includes the fourth, fifth, sixth and seventh terms represented as spectrum lines.

The simple electrostatic image theory can yield additional information about the behavior of the Varotron by applying the power equations of dipole radiation. These relationships indicate that any degree of bunching of the electron beam would have a significant effect on power output and efficiency. Increasing current or current density to produce traveling-wave tube action or adding resonant chambers that operate like those used in some laser experiments are therefore contemplated as the next step in further development of the Varotron.

MODULATION—Applying a variable deflection voltage to the grating that can move the electron beam an amount equal to beam thickness produces 100 percent amplitude modulation. Oscilloscope photographs of the modulation wave and light output intensity show that the modulating signal is exactly reproduced at 100 percent modulation.

Frequency modulation having a high index is produced by varying acceleration voltage. An interference filter 50 angstroms wide has been used to demodulate the f-m signals. Because of the high modulation index and the absence of frequency modulation in natural light, a signal should be affected little by interference.

The electron beam for the Varotron is formed by Pierce-type electrodes with slot openings from a line emitter that consists of a



ELECTRON *beam is produced in evacuated structure using conventional methods—Fig. 2*

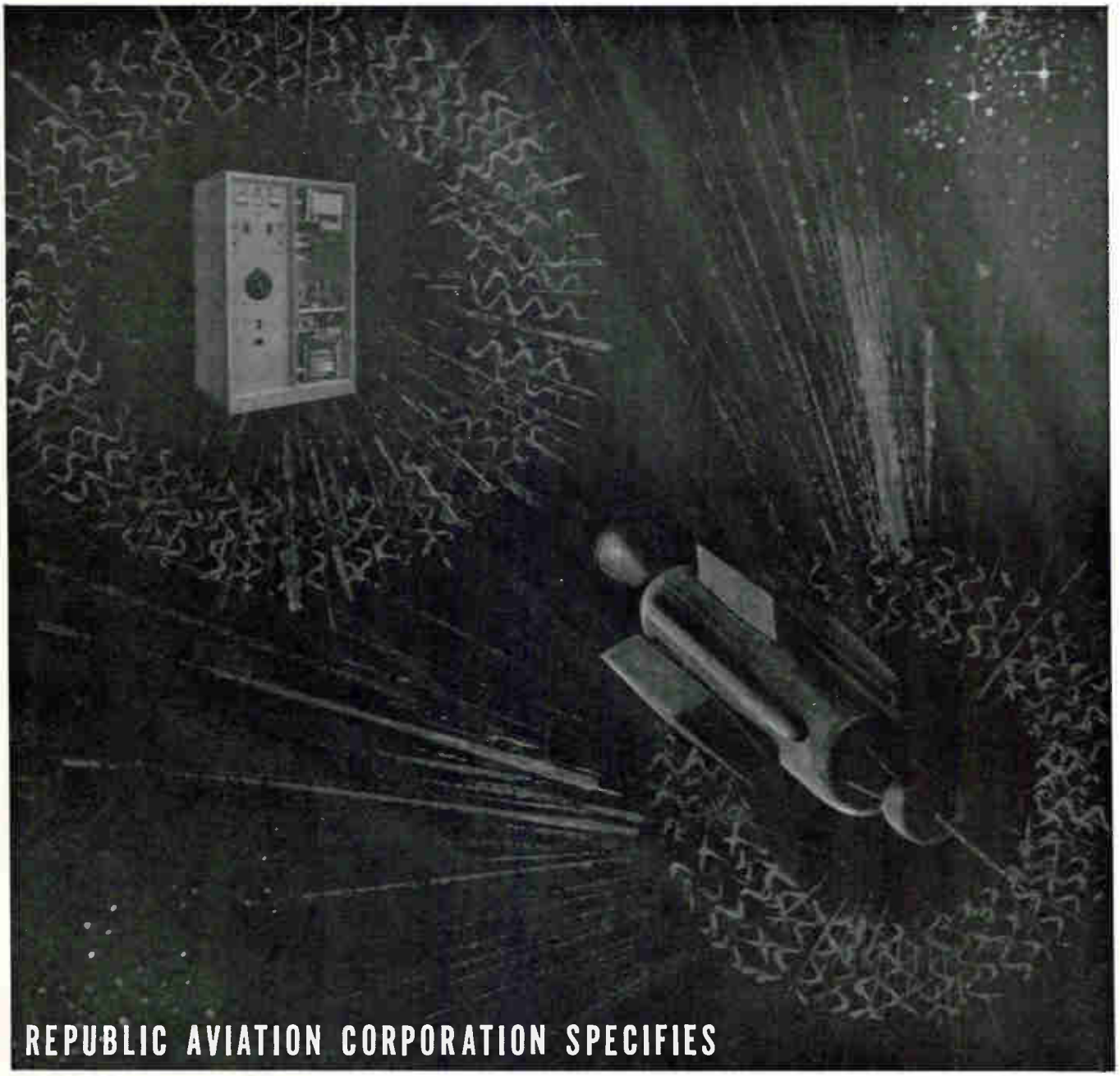
square edge of indirectly heated, oxide-coated nickel, as shown in Fig. 2. The thin sheet beam of electrons is used to produce maximum interaction between electrons and grating. Beam thicknesses up to 60 mils are effective but beam thickness of the present model is 10 mils.

The grating was engraved on a silver surface deposited on a stainless steel blank by Bausch and Lomb Optical Company. The 3-inch grating surface has 45,000 lines per inch engraved on it. The sheet electron beam covers 2 centimeters of the 1-inch wide lines. Electron beam current is 1 milliampere. Under these conditions, the grating produces visual radiation in the fundamental mode from electrons having energies from 65 to 155 Kv. Radiation has been detected at harmonics in the visual part of the spectrum and at infrared and ultraviolet wavelengths.

Satellite Will Test Thermoelectric Panels

SOLAR thermoelectric panels to provide auxiliary electrical power for space vehicles are more resistant to radiation than silicon solar cell systems. These type solar energy converters, which also offer weight and cost advantages, will be tested in an Air Force satellite in the near future.

The solar energy converters were built by General Atomic division of General Dynamics for Lockheed and the USAF Aeronautical Systems Division. The flat panels consist of a large number of semiconductor elements sandwiched between two thin metal sheets. The



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collector sheet faces the sun and converts solar energy into heat. The thermoelectric elements in turn convert the heat into electrical energy with the circuit completed through the other sheet, which acts as a radiator and rejects unconverted heat.

Three 4-inch square panels will be orbited from Vandenberg Air Force Base. In space the panels will be extended from the satellite on a boom and exposed to the sun. Each panel is designed to produce ¼ watt, although this electricity will not be used in the test package.

The thermoelectric panels are resistant to radiation because thermoelectric elements are not dependent on high-purity materials. Silicon photoelectric solar cells are made of high-purity materials, however, and performance may be seriously degraded by exposure to radiation.

Thermoelectric panels to produce from a few watts to several hundred watts should be lighter and less expensive for use in an earth orbiting satellite than any other type of power-generating system. The thermoelectric elements can produce about 20 millivolts at ½ ampere. They weigh 20 milligrams. A power-generating system for space could consist of a number of the $\frac{1}{10}$-inch thick panels joined to form sheets. The sheets could be folded for launching and then extended when the vehicle is in space.

New Method Ionizes MHD Gas Without Heat Source

IONIZING gases by a newly discovered method could facilitate development of lighter, smaller nuclear-electric engines for long-range interplanetary space flights. The technique discovered at General Electric Research Laboratory eliminates the need for extremely high temperatures to ionize gases in a magnetohydrodynamic (MHD) generator. Instead, the magnetic field already present is used.

MHD electrical power generation with nuclear reactors is potentially more efficient than the standard method. The MHD generator is also a promising power source for space vehicles since it has no moving parts.

The high temperatures used to

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ionize the gas in an MHD generator have been unobtainable in nuclear reactors. When external sources have been used, such as rocket exhausts or electric arcs, they have caused rapid deterioration of the material in the MHD generator.

Free electrons in a gas flowing through a magnetic field in the MHD generator produce current. However, when an electric current flows in a gas, the few electrons already present become hotter than the gas itself. These electrons can be made hot enough to ionize a suitable additive gas by adjusting the gas composition and the magnetic field. This method can provide the additional electrons needed for the MHD process without heat from an external source.

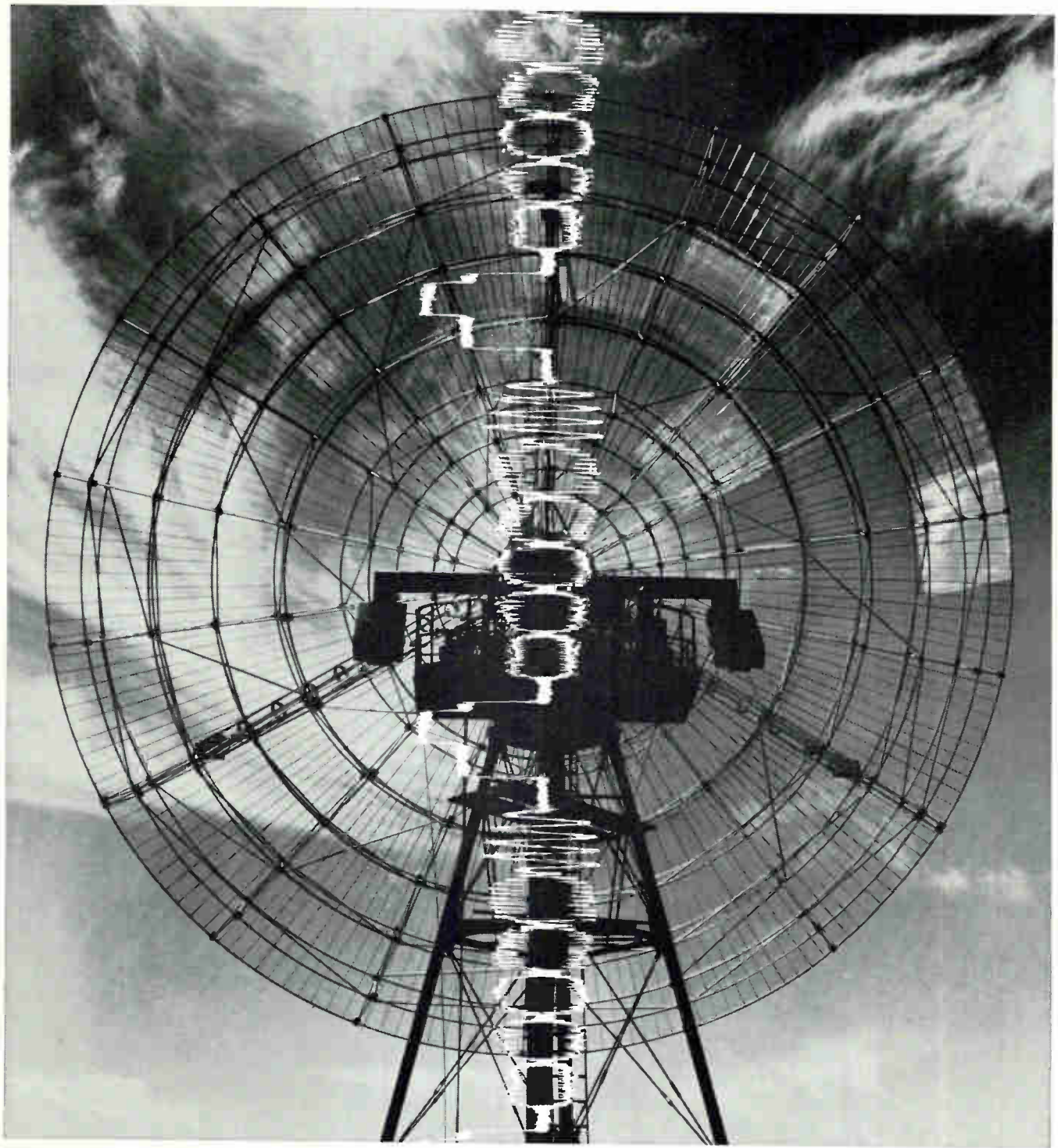
The phenomenon has been verified by simulated experiments at GE, and preliminary confirmation has also been obtained independently at California Institute of Technology. Contracts have been awarded to GE by the Office of Naval Research in conjunction with the Advanced Research Projects Agency and the Air Force Aeronautical Systems Division at Wright Field to develop the principle.

Several MHD generators are under construction at the GE Space Sciences Laboratory. These will be used to test the new principle under simulated atomic reactor conditions.

Analog System Computes Satellite Environments

ENVIRONMENTAL conditions encountered by satellite payloads are being calculated by an analog computer, which then controls tests in which the rapidly changing conditions are reproduced. The combined thermal-vacuum tests are being conducted in a vacuum chamber at Aeronutronic Division of Ford Motor Company. The 24-amplifier analog computer was supplied by Applied Dynamics, Inc.

The test arrangement shown in the figure was devised to program, control and monitor satellite payload temperatures, which may vary as much as 275 degrees during a



What militarized recorder can capture all the noise in the air up to 4 Mc? **AMPEX FR-800**

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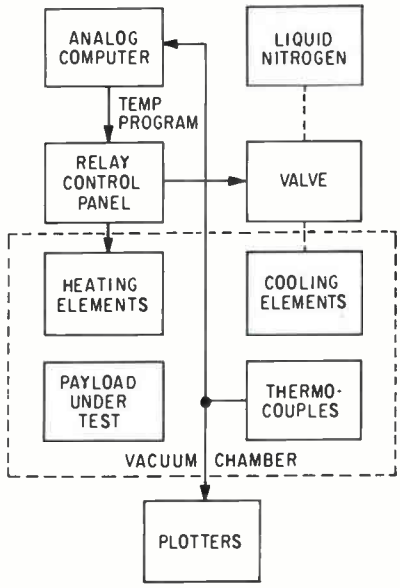


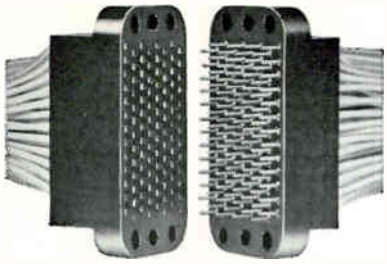
FLEXIBILITY *in simulating rapidly changing satellite payload thermal environments is achieved using computer-derived temperature programs*

single orbit. Satellite payload temperature variations depend on such factors as satellite altitude and its entry into and out of the shadow of the earth. Temperature is also affected by satellite orientation, which may involve a surface constantly facing the earth or the sun when not in the earth's shadow.

The computer generates curves corresponding to temperature differentials encountered by a satellite in a particular orbit. The effects of satellite orientation are derived from individual temperature histories about its periphery.

The computer generates analog signals representing the temperature curves to program temperature in the vacuum chamber. Actual temperatures of the satellite payload under test are measured by thermocouples. Variations from the desired values are determined by the computer, which then supplies the appropriate signal to the relay control panel. Relay contacts either energize heating element contacts or operate the valve of the liquid nitrogen supply.

The computer generated temperature curves are also supplied to an x-y plotter to permit visual observation. Test results can be fed directly to an analog computer for immediate anaylsis. If the results of many tests must be considered for a detailed analysis, test results can be recorded on magnetic tape.

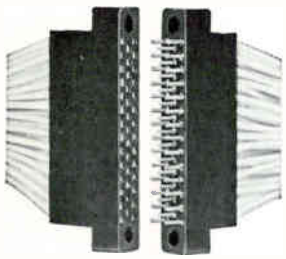


104 POSITION

75 POSITION

50 POSITION

MIL-C-8384?



41 POSITION

34 POSITION

26 POSITION

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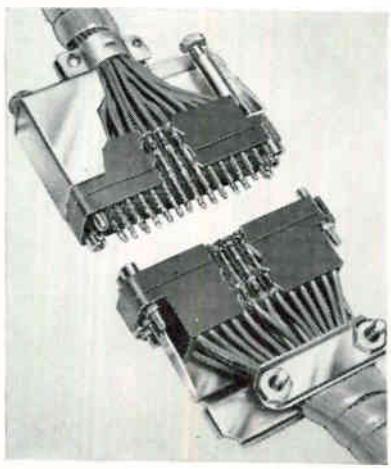
And that's not all! Check these other Series "M" Connector features: • preassembly plating of all parts for maximum conductivity and greater corrosion resistance • cantilever-beam contact retention springs for uniform contact pressures and longer insertion/extraction life • bell-mouthed sockets to permit easy pin alignment and prevent engagement damage • closed entry for high resistance to probe damage • positive shell and insert polarization for correct coupling • alpha-numerical coding for quick circuit identification • wire range 28 thru 16 • complete line of accessory hardware.

STANDARD AMP CONTACT PLATING: .00003" gold over .00003" nickel. Special plating on request.

Put an end to solder pot production clogs, hit-or-miss connections, tedious inspection steps. Make connections snap-in easy. Specify AMPin-cert Series "M" Pin and Socket Connectors. Complete information available on request.



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INCORPORATED
Harrisburg, Pennsylvania

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

*Trademark of AMP Incorporated

Direct Recording Camera Set, Type PM 9300

A new and versatile camera set, of astonishing simplicity and flexibility, producing a brilliant record on Polaroid* or standard film of 10 or 13 cm CRT displays. The basic camera is a Rolleicord,** which may also be used for normal photography in the laboratory or factory. Constant observation of the picture on the ground glass focussing screen is possible; moreover the camera-support can be hinged aside for direct observation of the oscilloscope screen. The set includes camera, Polaroid-Land cassette, camera-support, adaptors and a variety of accessories, all packed in a handy, portable case.

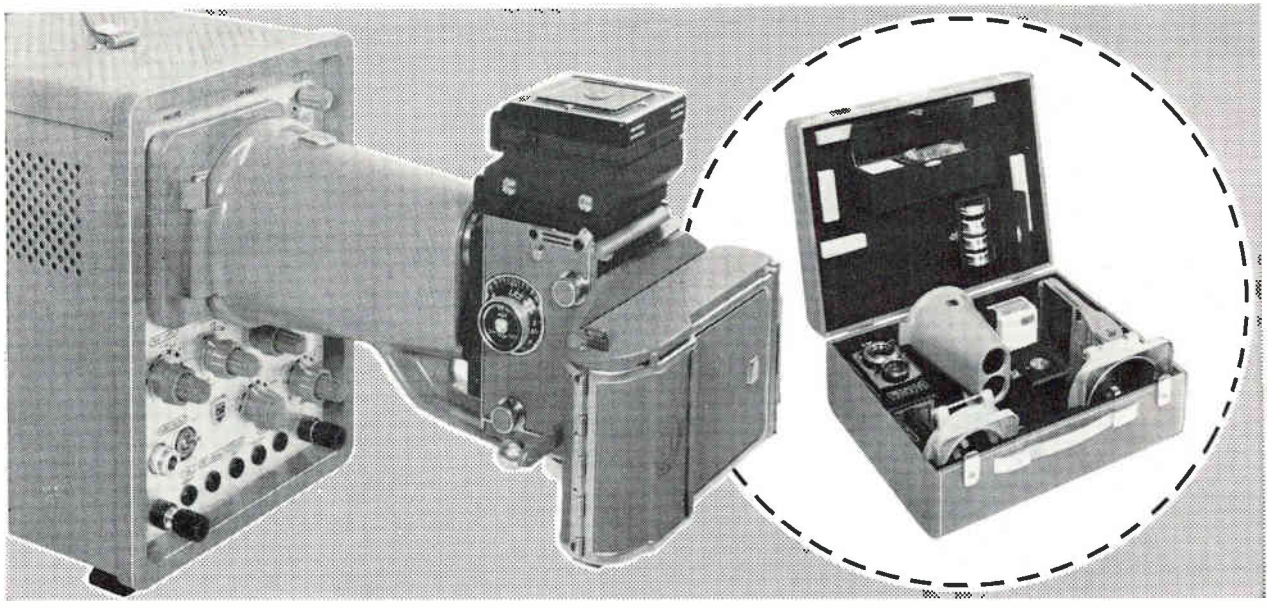
** registered trademark of Polaroid Corporation, U.S.A: ** registered trademark of Rollei-Werke Franke & Heidecke, Germany.*

Rolleicord camera

Lens: Schneider-Xenar f/3.5, focal length 75 mm. Aperture settings: f/3.5 - f/22. Shutter speeds: 1 sec - 1/500 sec and "B"; X and M synchronisation. Distance settings: 90 cm to ∞ (with supplementary lenses 24 to 90 cm). Picture size: 6 x 6 cm (12 exp.), 4 x 6 cm (16 exp.), 3 x 6 cm (24 exp.)

Polaroid-Land cassette

Picture size: 6 x 9 cm (8 exp.), more pictures on this size can be obtained by sliding the cassette. Distance setting: only suitable for the photography of CRT displays



photographic equipment for

Whatever your photographic recording problem,
from studying ***microseconds*** details in a single-shot record extending over ***10 milliseconds*** in all
to taking routine pictures of stationary Lissajous figures
the Philips range of oscilloscope cameras will offer you an optimum solution. These cameras were designed in long and close co-operation between Philips specialists in the field of oscilloscope applications and leading optical manufacturers. Consequently they combine ease of operation with high optical and mechanical quality. With their various adaptors the cameras are suitable for oscilloscopes of many types.

PHILIPS *electronic measuring*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands

For Canada: Philips Electronic Equipment Ltd., 116 Vanderhoof Ave., Toronto 17, Ont.

Standard Recording Camera, Type PP 1014

An oscilloscope camera for cine and single-frame exposures on 35 mm film or paper, featuring: Accurate film speeds by synchronous motor. Ease of operation ensured by the coupling of self-cocking shutter to the film transport mechanism. Sharp focussing on a ground glass screen with magnifying glass. One-turn crank for single-frame film transport. Push-button for marks that can be found in the darkroom.

Film speeds

Synchronously 1.02 - 202 cm/sec (10 steps, accuracy 1%) Asynchronously 3.04 and 4.75 m/sec

Lens

Lytax-Acron f/3.2, focal length 85 mm

Shutter speeds

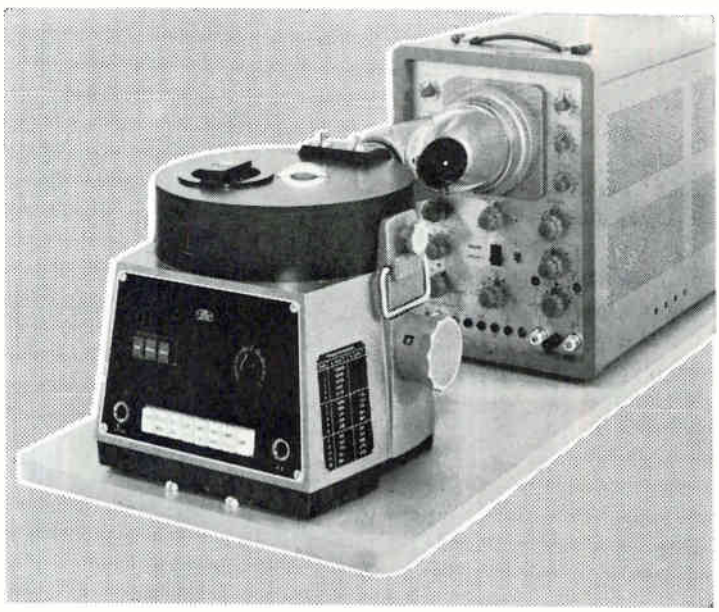
Self-cocking 1 sec - 1/125 sec, "T" and "B"

Recording material

35 mm perforated film or paper (max. length 15 m)

oscilloscopes

new and available now



High-precision Recording Camera, Type PP 1021

A cinecamera -made by Zeiss- with an extremely wide range of accurate film speeds *20 metres of film in 5 seconds or... in 5 days* and single-frame exposures with automatic film transport. Features such as a simple speed switch, record-time presetting, interchangeable cassettes, automatic film stop in case of exhausted film supply, remote control and, in addition, convenient push-button operation make this unique camera suitable for the most complicated problems in photographic recording. A drum cassette with additional control unit extends the field of applications to timed and synchronized record of non-recurrent phenomena with film speeds up to 51 m/sec.

Film speeds

0.04 mm/sec - 4 m/sec (15-step planetary gear, accuracy 1%) with optional drum cassette up to 51 m/sec. Single-frame exposures with automatic film transport

Lens Zeiss-Sonnar f/1.5, focal length 50 mm

Shutter speeds 1 sec - 1/125 sec, "T" and "B"

Recording material 35 mm perforated film or paper (max. length 50 m). Separate film-supply and take-up cassettes

instruments: **quality *tools* for industry and research**

PHILIPS

NEW Openings for EEs & MEs in Product Design and Development

Delco Radio's continuous search for new and improved electronic products provides challenging opportunities—in several areas—for capable engineers; specifically:

MOBILE COMMUNICATIONS (Automobile Radiotelephone) **EQUIPMENT**—

EEs—3-5 yrs. Exper—for design of and production assistance with 150 and 450 mc receiver transmitters; transistorization, packaging, duplex operation and dial mobile. Desire experience or interest in mobile communications equipment, private system or telephone link.

Project Engineers—work includes supervising type tests and FCC qualification testing of automotive radiotelephone equipment. Must audit designs for field reliability.

SUBMINIATURE MILITARY COMMUNICATIONS EQUIPMENT—

EE or ME—for assignment to development group designing all-transistor portable transmitters and receivers, operating in 2-100 mc range. FM—AM—FSK—CW—SSB modulation.

AUTOMOTIVE RADIO DESIGN AND DEVELOPMENT—

EE—to work with Senior Engineer on advanced development of auto radios and other entertainment devices, including FM-AM, miniaturized circuitry and components.

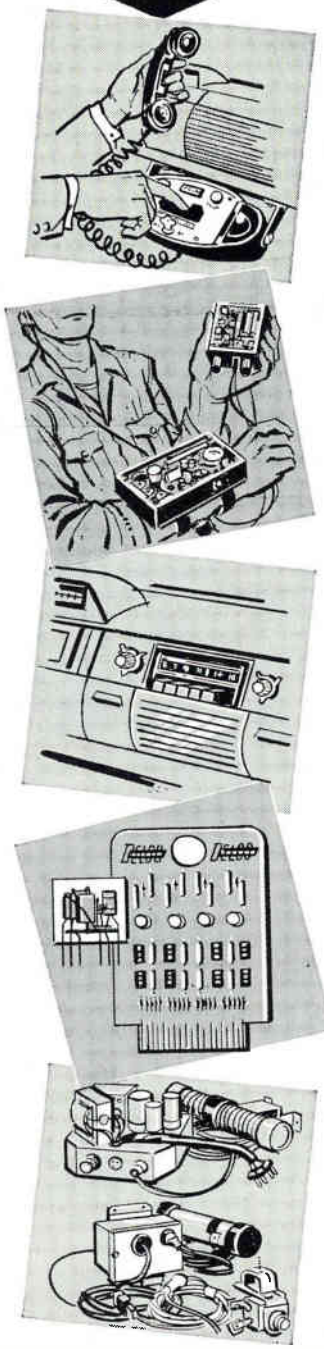
ME—for design of small electronic mechanisms, including FM-AM, Signal Seeking and push-button tuners, and components modules.

EE or ME—for packaging of auto radios and associated tuners, solenoids, etc. Required to make some engineering contacts with automobile manufacturers.

DIGITAL CIRCUITS AND SYSTEMS—includes card, module and digital systems design, and production liaison involving components and special purpose systems operating from 200 kc to 10 mc.

Project Engineer—to direct efforts of design engineers and technicians in designing and releasing digital circuits for production. Supervisory experience highly desirable.

EEs—for design and development testing and packaging of transistorized digital switching circuits from 200 kc to 10 mc.



RELIABILITY ASSURANCE—

Project Engineer—to handle tests and evaluations of transistorized systems and components, both power and small signal type. Must evaluate results and associated statistical data. Also includes failure analysis work with suppliers and production.

EE—for design and development work on test equipment for semiconductors and special products, such as radiotelephone.

AUTOMOTIVE ELECTRONICS—non-entertainment automotive electronic development including radio control for Garage Door Operators; other transistor applications in automobile, usually involving electromechanical transducers—

ME—for advanced development work in electromechanical systems used in automotive field.

EE—for design and development of transistorized automobile equipment.

EE or ME—with electromechanical interests for development of electronic equipment for the automotive service market.

● If your interests and experience fall in the above areas and if you're looking for an opportunity to fully exercise your personal competence . . . among men of like talent . . . in unmatched facilities . . . then let's talk. Send your resume today to the attention of Mr. Carl Longshore, Supervisor Salaried Employment.

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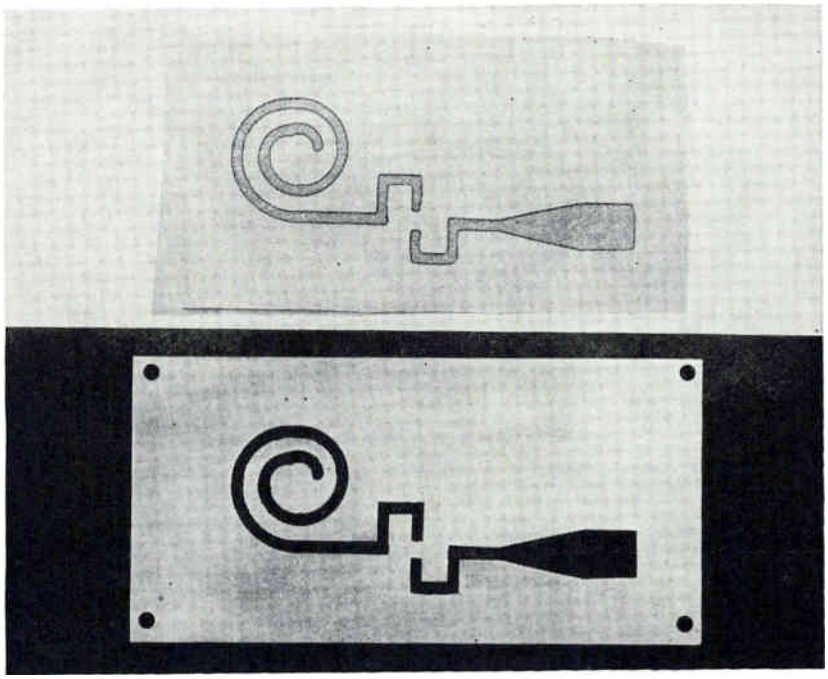
DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

Flash Printing of Circuit Elements



COPPER *circuit, top, was prepared on paper by exposing metal coatings to light flashes. Aluminum stencil, bottom, is used as reflective mask.*

Variations of technique offer many possibilities for simple fusions

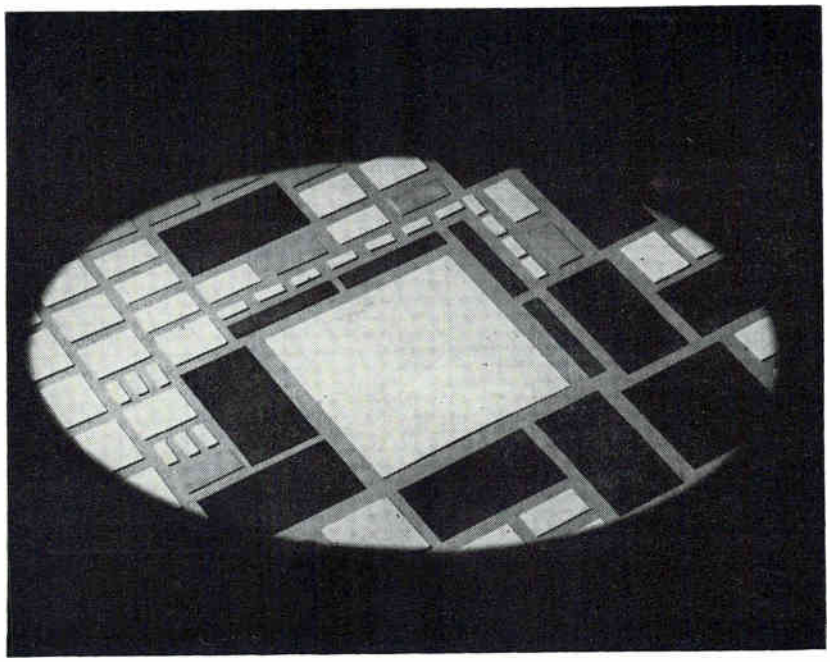
By L. C. KINNEY
E. H. TOMPKINS
Armour Research Foundation of
Illinois Institute of Technology
Chicago, Illinois

GENERATING a circuit of conductors and resistors by exposure of an insulating layer or coating to a light pattern is intriguing because of its simplicity and potential high resolution. (See ELECTRONICS, Feb 9, 1962, p 70 and May 11, 1962, p 70.) In recent work at Armour Research Foundation, conductive and resistive elements have been produced in coatings on plastics, paper and ceramics by exposing the coatings to intense flashes of visible light from xenon flashtubes. By using reflective stencils as masks and by varying coating thickness and composition, a wide range of geometries and square-area resistances have been produced.

When silver bromide and many other solids are exposed to ultraviolet light or to light in the blue end of the visible spectrum they photolyse into their component elements. The metals produced are in too fine a state for most electronic applications, but by using light of sufficient intensity to fuse the metal particles together it is possible to make useful circuits. The intensity required is available from large electronic flash units.

MATERIALS USED—Conductive copper layers have been made by exposing coatings of cupric hydroxide, basic copper carbonate, cupric oxide and cuprous oxide suspended in acrylic resins and other vehicles to light flashes of about one millisecond duration from electronic flash units varying in capacitor storage energy from 2,500 to 50,000 joules. Minimum square-area resistance generated so far on a re-

Ceramics Hold New Tolerances



DIMENSIONAL *tolerances of ±0.008 inch for 0.010 inch ceramics are attained by technique developed by American Lava. Sheets up to 8½ × 11 inches have been produced. Sheets 3.5 × 3.5 inches; strips 2 × 4, by 0.010 in. thick; and parts 1 × 1 inch, by 0.005 in. are common*

TEFLON* CABLES

mil-w-16878C

3 shielded cable constructions — furnished from stock with a Teflon outer jacket, a Teflon impregnated fiberglass outer covering, or with no covering over the shield.

All constructions available from 1 to 4 conductors in gauge sizes #24, #22, #20, #18.

TEFLON* HOOK-UP WIRE

mil-w-16878C

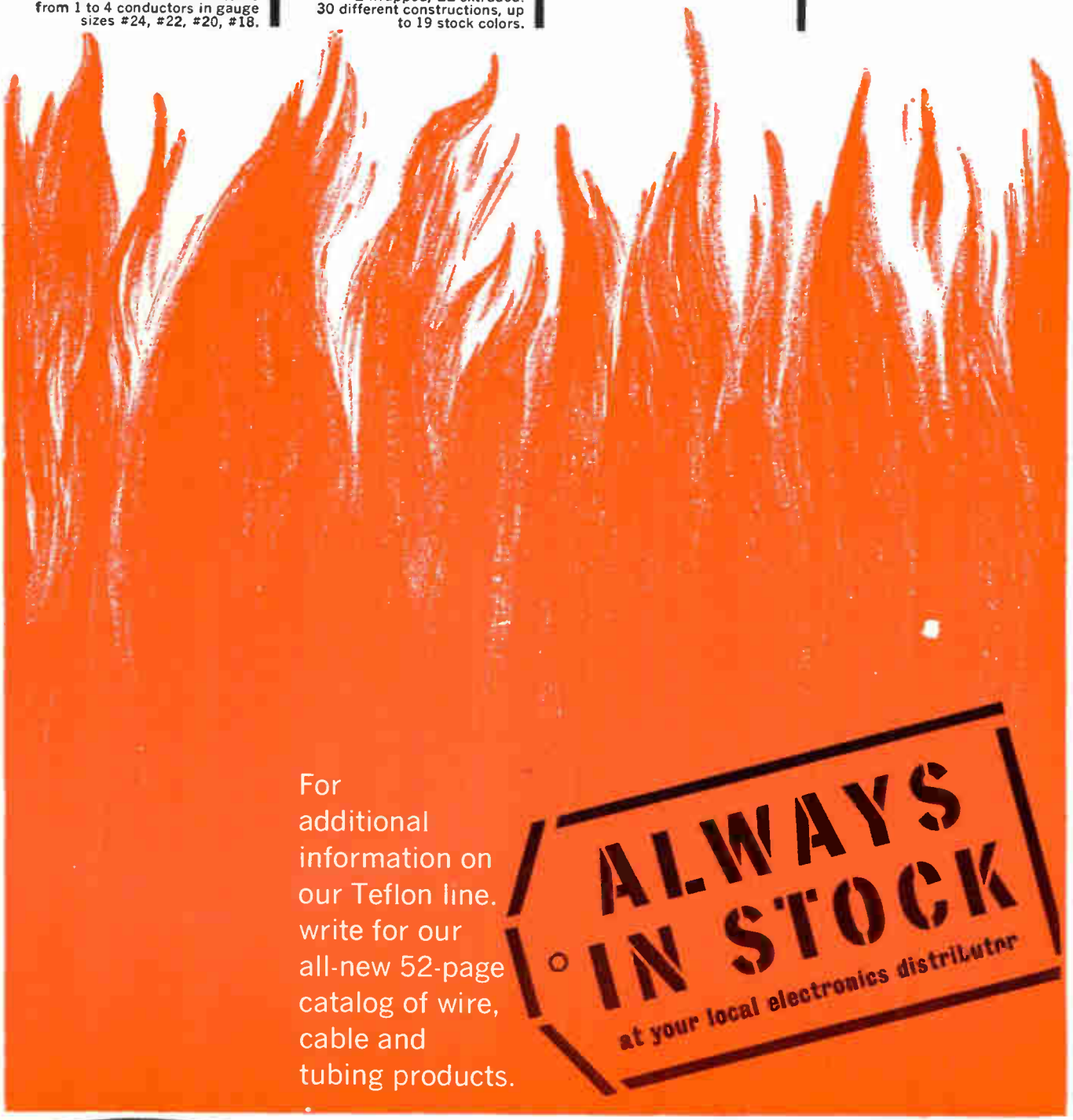
3 different types — E extruded, E wrapped, EE extruded. 30 different constructions, up to 19 stock colors.

TEFLON* TUBING

Complete range of inside diameters from #30 to #0. Up to 4 stock colors.

TEFLON* MAGNET WIRE

15 different gauge sizes from #44 to #30. Meets MIL-W-19583 Type III.



For additional information on our Teflon line. write for our all-new 52-page catalog of wire, cable and tubing products.

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at your local electronics distributor

ALPHA electronic WIRE

ALPHA WIRE CORPORATION
Subsidiary of LORAL Electronics Corporation
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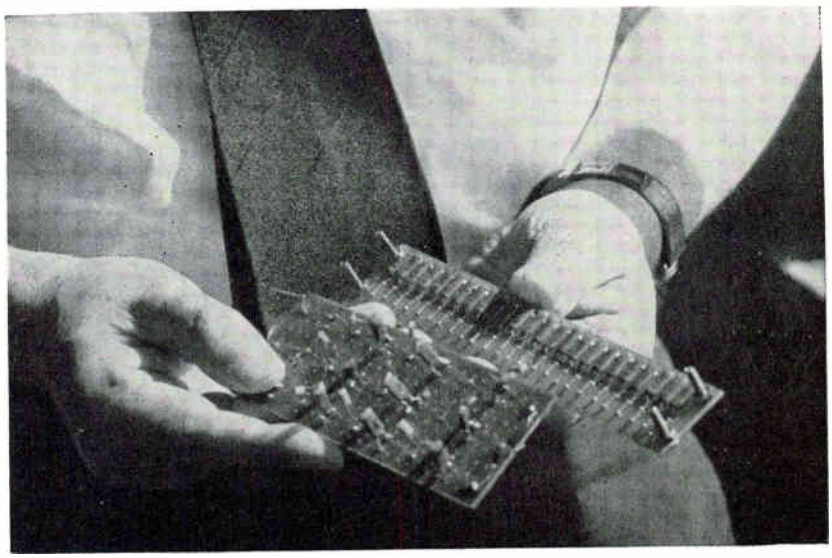
Pacific Division: 11844 Mississippi Ave., Los Angeles 25, California

*T.M. DuPont

producible basis has been 0.1 ohm, but with special fluxes and vehicles lower resistances should be possible. Research is continuing in this area.

Compounds of silver and nickel have been photolysed to conductive layers. The photo-decomposition of nickel and chromium compounds is of special interest because of their possible use in resistive elements. Variations of the technique seem almost unlimited. Top photo, p. 88, shows a copper circuit prepared on paper. Paper was not damaged by the intense light flash, and the circuit was generated in air without vacuum equipment and without wet-chemical etching solutions. We have also demonstrated that tin and solder powders can be fused on copper in the light flashes without damage to parts.

Simple Computation Elements



WIRE *parametrons, commercially available, are easily made*

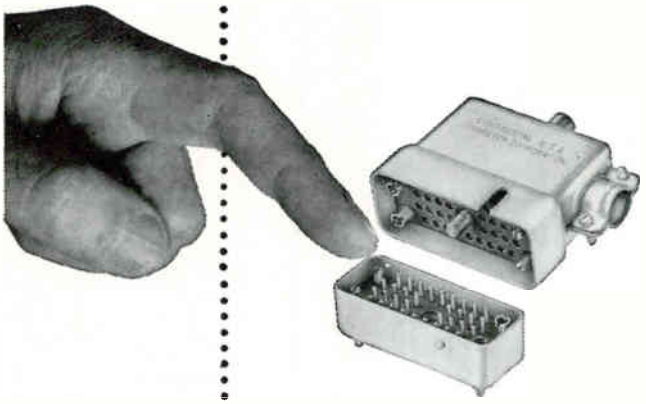
SAMPLE units of wire parametrons having excitation frequencies up to 100 Mc, providing one Mc clock frequency are shown in photo. Power consumption is cut to a few milliwatts at excitation frequency of 10 Mc. Heat resistance is up to 200 deg C, miniaturization is 1/20 size of conventional type. Kokusai Denshin Denwa of Japan claims units are easy to make because of continuous process of plating the wire with magnetic Permalloy on production line.

KDD lab has also successfully experimented with film parametron in five unit code converter, telegraph regenerative repeater, automatic telegraph error correction device, and other converters. These types will be important in computer technology.

The parametron is a digital computer element which displays power gain and which can be used to form all common digital logic elements, such as flip flops, AND gates, OR gates (see ELECTRONICS, May 11, 1962, pgs. 60, 72). Small size and weight, low cost and power consumption and extremely high reliability will be used for future space-vehicle computation equipment. Several companies, both here and abroad are working on these devices.

Polyurethane Available In Sheets

PLASTIC with properties of rubber is designed for applications where elevated temperatures and high frictional abrasion are needed. Seiberling Rubber Co. has developed a process to calender the material, popularly used as foam rubber, in several thicknesses and formulations. Product may be vacuum-formed, heat-sealed and laminated using conventional equip-

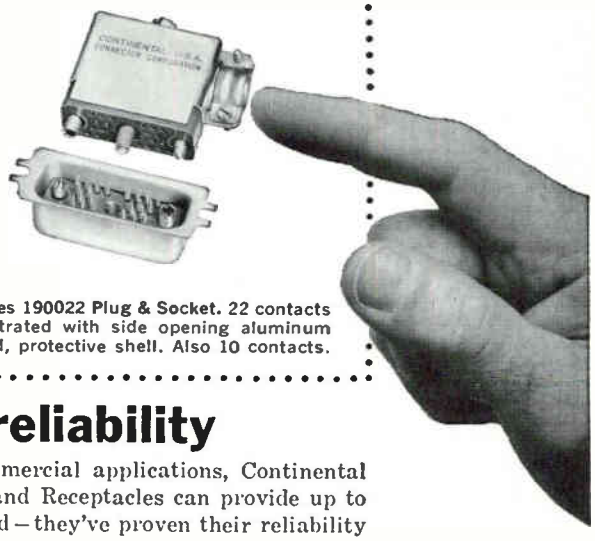


Series 190034 Plug & Socket. 34 contacts illustrated with side opening aluminum hood and protective shells.

Series 1900152 Plug & Socket. 152 contacts with wire-wrapping terminations and reinforcing stainless steel channels.

··· CENTER SCREWLOCK CONNECTORS ···

Series 190078 Plug & Socket. 78 contacts illustrated with mounting flange protective shell. Also 104 contacts.



Series 190022 Plug & Socket. 22 contacts illustrated with side opening aluminum hood, protective shell. Also 10 contacts.

small size...big reliability

Designed expressly for critical military and commercial applications, Continental Connector's Series 1900 Center Screwlock Plugs and Receptacles can provide up to 152 connections in less than 3.6 inches length! And – they've proven their reliability in hundreds of heavy duty aircraft, missile, computer and ground support installations. Features include double lead thread action center screwlocks, closed entry contacts, positive polarization, glass filled Diallyl Phthalate moldings. Standard types are available with 10 and 22 contacts for #20 wire, 34, 78 and 152 contacts for #16 wire...available with wire wrap terminals, hoods and protective shields.

DESIGNERS' DATA FILE / **Continental's Con-Dex File CSL has been compiled to help you select and specify the Center Screwlock Connectors best suited to your needs. For your copy write to: Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York**

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

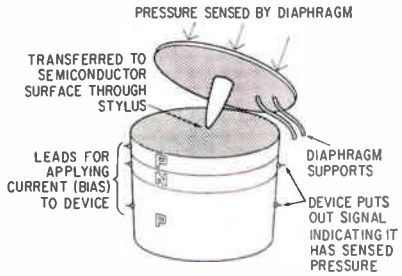
CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

ment. Eight standard gauges range from 0.005 in. to 0.06 in. thick.

Adaptable for electrical applications, formulation of Seiberling's Seilon UR completely resists ozone aging after 144-hour exposure at 120 deg F at 20 percent stretch. Sheets demonstrate dielectric strength of 760 volts per mil after 24 hours in water at 28 deg C. Insulation resistance is 3.54 megohms per 1,000 ft after one hour at 15.6 deg C. Tensile strength ranges from 6,500 to 8,000 psi and modulus at 300 percent elongation of 1,700 - 2,200 psi. Low-temperature brittleness point of −94 deg F makes it attractive for military and critical applications. Resistance to gamma radiation is excellent. Sheets are not recommended for use in acid or alkali environments.

Applications for rugged harness tape immediately come to mind for electronics. Medical electronics applications include use as valves for artificial heart.

Piezoelectricity and Semiconductor Effects



WILL *piezojunction transistor find niche in intelligence operations?*

STRAIN TRANSDUCER, based on the sensitivity of shallow p-n junctions to suitably applied anisotropic stress was recently described by W. Rindner and R. Nelson of Raytheon. Fact that it might make possible tiny, highly sensitive microphone makes one think of undercover intelligence operations.

Device could make possible nearly invisible hearing aids. Other tasks could be for pressure-sensing devices in space, medicine, industry and underseas.

Magnitude of changes in elastic strain effects exceeds those of any strain effects upon which conventional transistors are based. Stress

CANNON PLUGS FOR EXTREME ENVIRONMENTS

IMAGINATIVE ENGINEERING FOR THE SPACE ERA • For more than 40 years Cannon has been solving critical plug problems across the full spectrum of environmental extremes . . . has provided plugs for every conceivable military and industrial application. Whatever your requirement—whether a standard plug, new design or a modification—for *any* application or environment, Cannon can provide the answer. For information on how we can help you solve problems concerned with extreme environments, write to:

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.

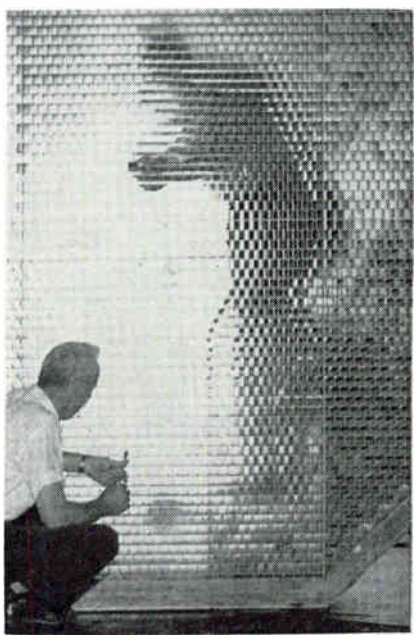
CANNON PLUGS

is applied by using a conical stylus in contact with the semiconductor surface parallel to the junction plane (see diagram). The miniature cap, resembling a tiny thumbtack, becomes a diaphragm and transmits vibrations through the point of the junction. Device responds to vibrations ranging from 0.01 cycle to 120,000 cycles per second. Pickup responds to recordings ranging up to 20,000 cycles without need for preamplifying equipment.

Sensitivity for a given electrical bias and the operational strain range of the device can be controlled by appropriate selection of junction depth and diameter of the stressed region.

NEW FAMILY—Importance of this member of a new group of solid-state devices, based on interaction of piezoelectric effect and

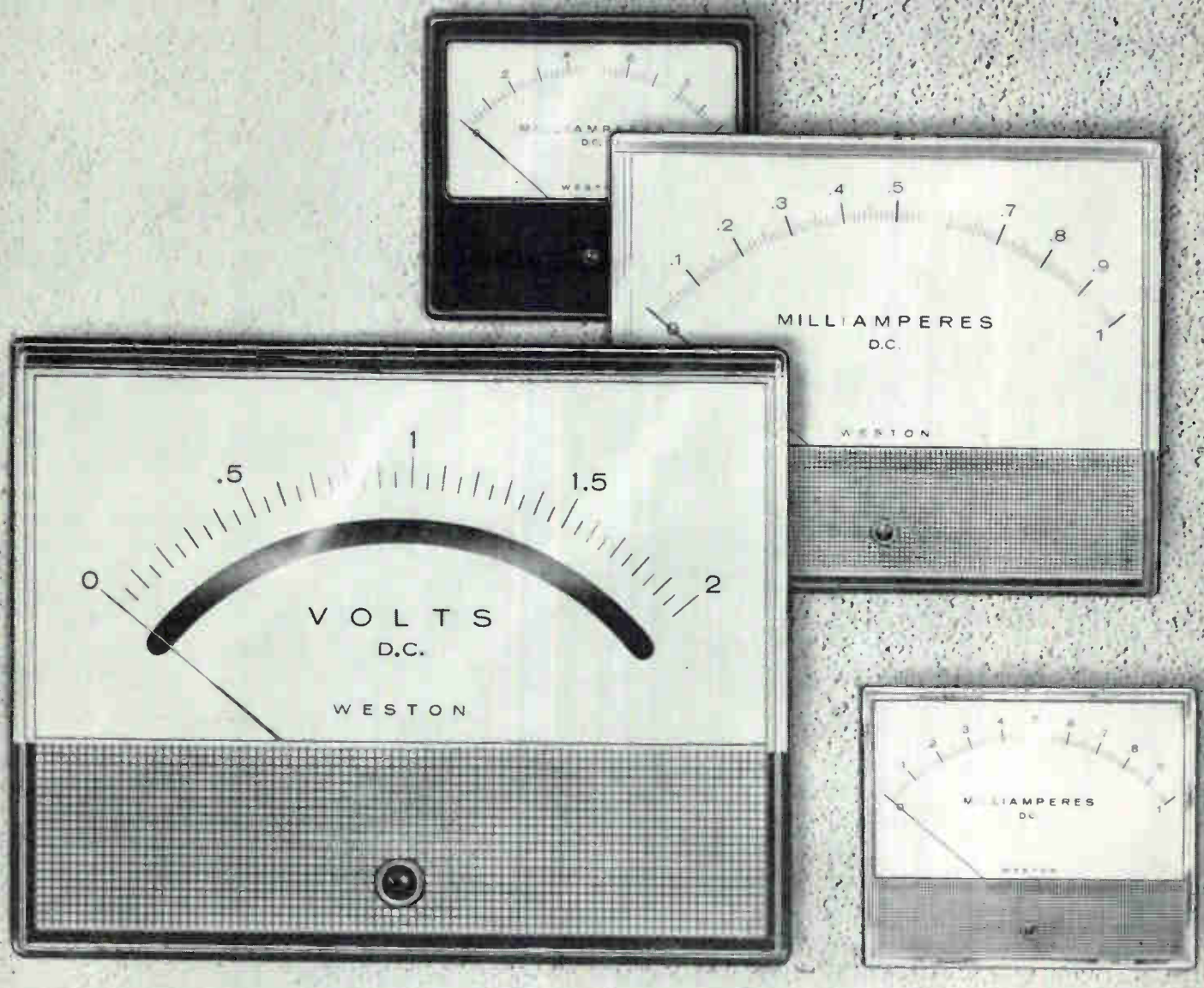
Plastic Antenna Lens



NO LOSS in physical strength and more electrical efficiency is claimed for metallized plastic antenna lens shown above. Sperry's SPG-49 radar, which is used to guide the Navy's Talos shipboard air defense missile, has plastic lens system that company says produced twice the signal gain of an earlier metal version.

Lens is molded of plastic-impregnated Fiberglas and coated with silver to make it electrically conductive. It is composed of 4,100 separate cells which focus high energy radar beams

NEW
FROM WESTON



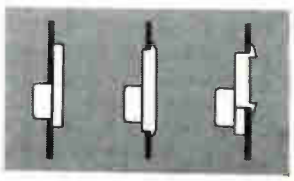
TAUT BAND

WESTON TAUT-BAND SUSPENSION SETS NEW STANDARD FOR PANEL METERS

Weston Series 1900 is the most versatile line of panel meters ever produced for general use. Instruments with taut-band mechanisms are free from friction and inertia, and offer outstanding sensitivity, reliability and uniformity from zero to full scale. 1% and 2% accuracies are standard . . . higher on special order.

Here are the facts: Weston exclusive taut band Co-planar™ suspension is the only method which assures complete control of ribbon length and tension, uniformity of torque, precise centering of moving coil, and positive protection against excessive axial and lateral motion. The instruments require extremely low driving energy, are highly resistant to vibration and shock, and may be operated in any position.

Series 1900 also sets a new standard in flexibility. Instruments with taut-band and conventional movements are completely interchangeable. They are available with Bakelite or modern, static-free plastic cases in sizes 2½" to 7½", and offer the widest choice of functions and ranges available in a single matching line. Write today for details. Dept. 103.



ANOTHER EXCLUSIVE: Only Weston Series 1900 Instruments can be mounted in three ways — conventional, flush, and recess with provision for internal illumination.

WESTON INSTRUMENTS *Division of Daystrom, Incorporated, Newark 14, New Jersey*

Aerospace Instrumentation • Bimetal Thermometers • Calibration & Test Equipment • Panel & Switchboard Meters • Photosensitive Devices • Precision Metal Film Resistors • Relays & Tachometers • Systems Design & Development

CIRCLE 95 ON READER SERVICE CARD

semiconductor properties, was pointed out last fall (see ELECTRONICS, Sept. 29, 1961, p. 9).

Clevite Corporation's P. L. DiRenzo recently pointed out that while the construction of diodes and transistor-like devices remains of distinct interest, main interest at Clevite has shifted in the last year to a study of the interaction of the piezoelectric effect and semiconductor properties as exemplified by Bell Labs sound wave amplifier. Recently, piezoelectric and elastic constant measurements were extended to the whole group of sulfides, selenides and tellurides of zinc and cadmium. Other compounds do not have as strong an effect as cadmium sulfide, but cadmium selenide is interesting because it combines a fair piezoelectric effect with higher electron mobility than available in cadmium sulfide. Measurements on the whole group of crystals provides systematic insight in the relation between chemical structure and magnitude of piezoelectric effect.

During the next year, electronics men will be hearing more about elastic deformation of materials and mechanical effects on materials: acoustoelectrics, electrostriction, magnetostriction, Joule effect, Guillemin effect and Wiedmann effect.

Nickel-Clad Wire Meets Corrosion Problems

CONCENTRIC bond of nickel on any carbon or non-chromium bearing steel alloy has electronic applications where added strength of steel core is desirable for pins, filaments and support wires. Surface properties are equivalent to solid nickel. Bonding process can also clad cuprous alloys to steel wire.

Process eliminates porosity or flaking, provides protection necessary when wire contacts corrosive liquids, gases or high temperatures. Bond coat is approximately 0.0005 in. at finished wire diameter of 0.010 in. Wire can be provided in long, continuous lengths. Other applications are found in cable, braided wire, chemical filters. Trade-named MULTILAYER, clad wire is produced by Texas Instruments Metals and Controls Division, Attleboro, Mass.

1-KW/ft.^{3}

The CAPITRON* power supply packs it in . . . power to spare in minimum space—500 watts per half cubic foot . . . a kilowatt per cubic foot . . . closely regulated and reliable!

This specially designed transistorized computer power supply goes a long way toward solving packaging density problems in new, miniaturized design requirements and it's built to go for a long time.

For absolute minimum cube, close regulation to help maintain computer accuracy . . . for long life and extreme reliability . . . check these features . . . see how easily they fit your design plans:

DESIGN FEATURES: • High power in small space • Protected against short circuits • Close regulation over full load range • Integral pancake type fan cooled • Output adjustable to ±1.5 volts tolerance • Protected against input overvoltage • Easily accessible electrical connections • Fast recovery from load surges over full load range • Remote sensing to control output at the load • Output voltage and current can be varied over a range of 200% within the same size package if output power is held constant.

PERFORMANCE SPECIFICATIONS:

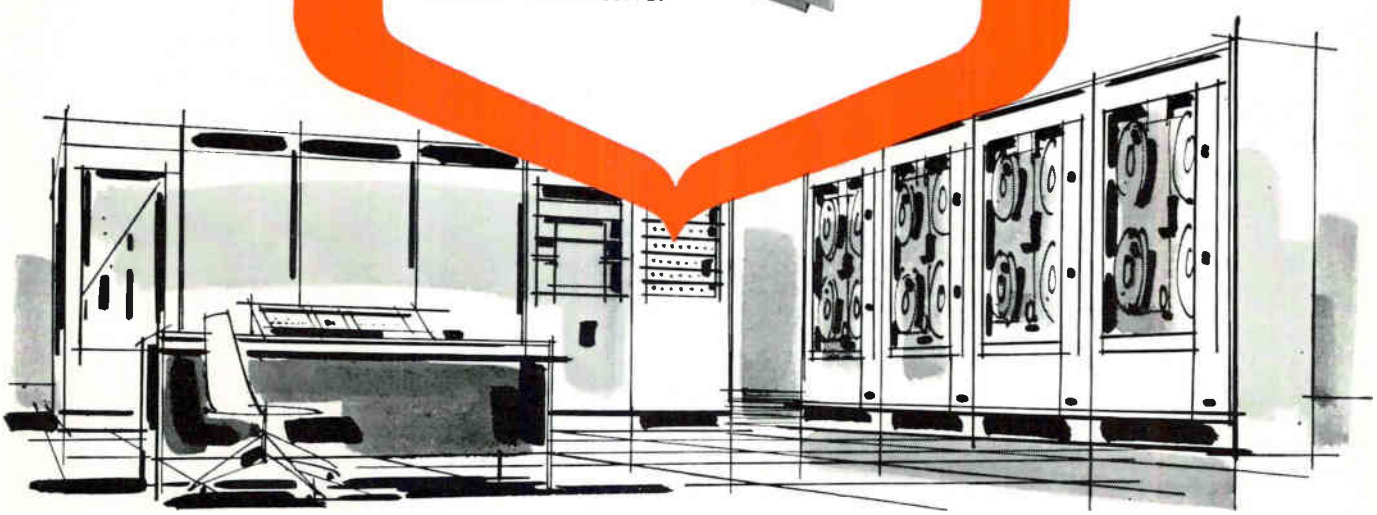
- Input—95 to 130 V AC, 1 ∅, 60 ± 3 cps
- Outputs—
  +20 V DC at 10 amperes, 1% Ripple P to P
  −20 V DC at 20 amperes, 1% Ripple P to P
  +17½ V DC at 5 amperes, 5% Ripple P to P
- Regulation—Better than 1% from 0 to 100% load variation and 95 to 130 V input • Ambient Temperature—15°C min. to 38°C max. • Size—7½" H x 7½" W x 14" L • Duty Cycle—Continuous

AMP INCORPORATED | *CAPITRON DIVISION*

155 PARK STREET, ELIZABETHTOWN, PA.

*Trademark of AMP INCORPORATED

CAPITRON* POWER SUPPLY

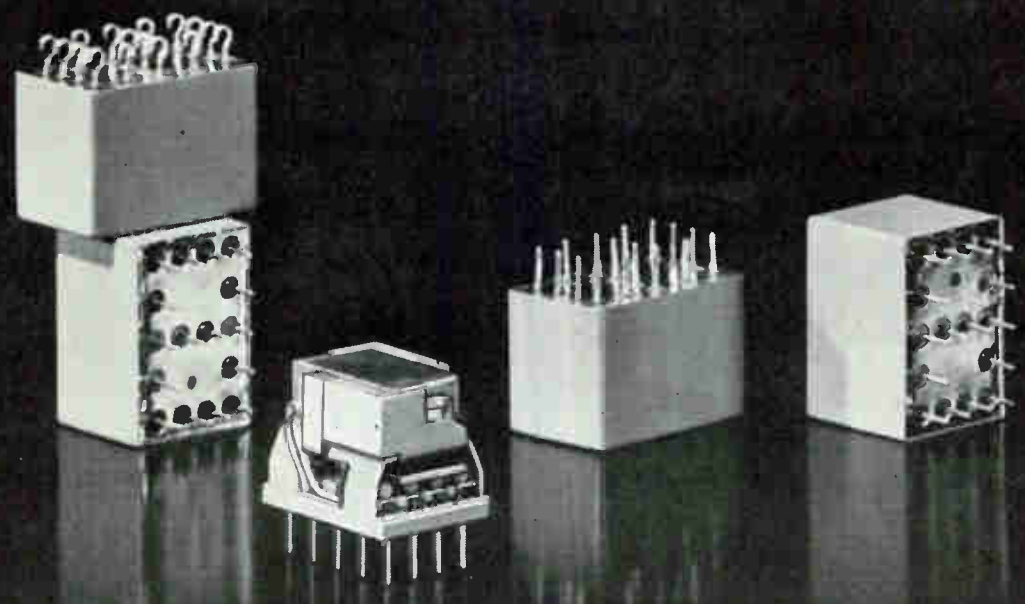


AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

New

micro-miniature

4-pole latching relay has sealed coils for greater reliability



TL SERIES This new latching relay's high inherent reliability is due to hermetically sealed coils, bifurcated gold plated silver alloy contacts and a unique magnetic structure.

Other features: Fast operate time, virtually no bounce, high shock (in excess of 100g) and vibration (30g to 2000 cps) resistance, small size (0.56 cubic inch). This relay meets or exceeds all applicable sections of MIL-R-5757D and PD-R 187.

Engineering samples are now available from Potter&Brumfield. Call your P&B representative for complete information.

TL ENGINEERING SPECIFICATIONS

Size: 1.031" long, .725" wide, .750" high max.
Weight: Approx. 1¼ ozs.
Contact Arrangement: 4PDT (bifurcated, gold plated silver alloy).
Rated: Dry circuit to 3 amps at 28 v dc res.
Life: 100,000 operations at max. rated load.
Coil Power: For two-coil relays: Approx. 1 watt (nominal at 25°C). For single coil relays: Approx. 0.5 watt (nominal at 25°C).
Operate Time: 6 milliseconds max. at nom. voltage at 25°C coil temp.
Transfer Time: 0.5 milliseconds approx. at nom. voltage at 25°C coil temp.
Temperature Range: −65°C to +125°C.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA
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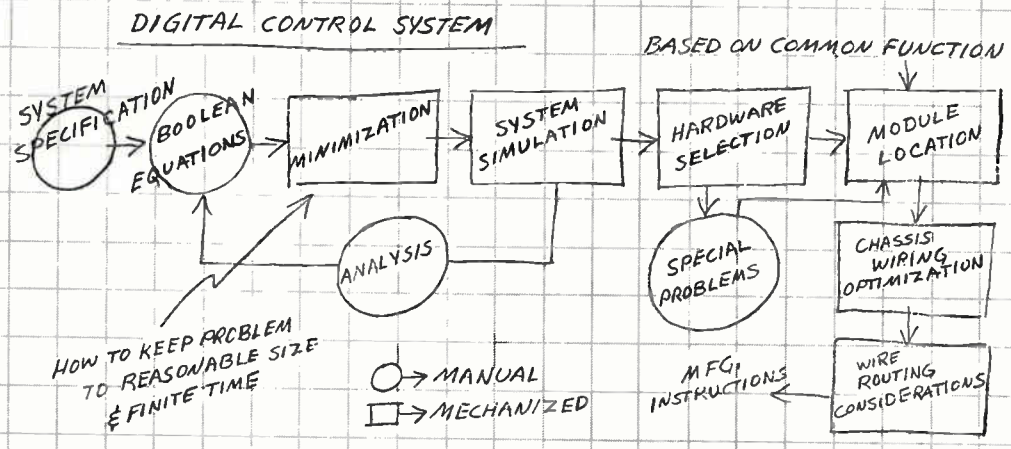
CIRCLE 99 ON READER SERVICE CARD



COMPUTER MECHANIZATION OF DESIGN PROCESSES

...one of more than 500 R&D programs under way at Douglas

This Douglas program has a dual purpose: first, to develop a network of integrated man-machine procedures for use in the design of electrical-electronic systems; second, to automate portions of the design task for greater design efficiency.

Research is going forward in such areas as logical design (i.e., Boolean equation optimization and minimization), component placement on a two dimensional plane, hardware selection, wiring change control, and automation of production tasks.

Considerable progress is being achieved through the application of such disciplines as probability and statistics, topology, linear algebra, symbolic logic and dynamic programming.

Of career interest to engineers and scientists

The demands of missile and space technology have multiplied the requirements at Douglas for computer and electronics oriented personnel at all levels of experience and educational background. Work assignments are among the most advanced and challenging in these fields.

You will participate in stimulating technological programs—many extending years into the future—relating to space exploration, defense and communications.

Send us your resume or fill out and mail the coupon. Within 15 days from the receipt of your letter, we will send you specific information on opportunities in your field at Douglas.

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Please send me full information on professional opportunities in my field at Douglas.

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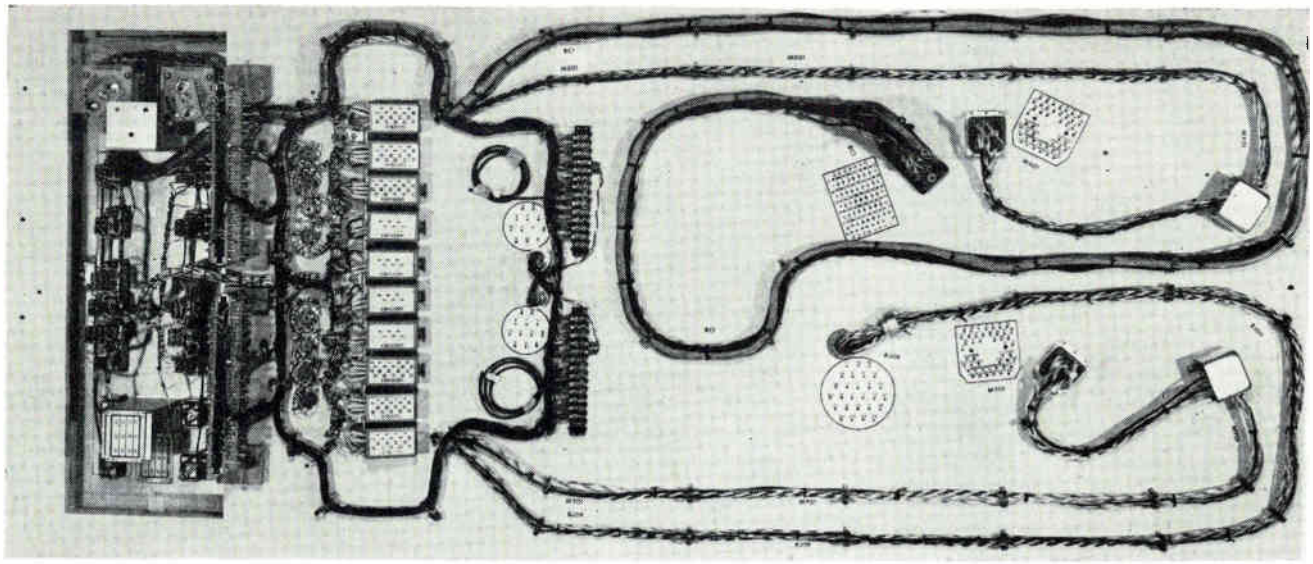

HARNESS BOARD *ready to be used in production looks like a completed harness. Shadows around cables and plugs are part of the board and are caused by overlapping flood lamps in initial photograph*

Harness Boards Use Full Scale Photos

Photo technique cuts costs and errors and increases production

By D. G. BRIANT
A. A. RANGER
General Electric Computer Dept.,
Phoenix, Arizona

HARNESS BOARDS made with photographic techniques have been developed by this division into an effective production method. The technique has proved so satisfactory that it is now used in the manufacture of computers and will be extended to many other applications.

The process uses a full scale photograph of a sample harness as a model for production harness boards. Full scale enlargements of harness photographs are made on DuPont Cronapaque film, which has been developed within the past several years.

Definite advantages result from the photographic technique. Substantial cost reductions in manufacturing have been obtained and have been confirmed by the department Cost Improvement Board. Since the pattern to which the assembler works is an exact reproduction of the desired harness, greater uniformity is obtained and there are fewer errors in wiring.

The full scale pictures of the harness have proved to be tough and long lasting. Matte surface finish cuts glare and pencil or ink markings can be added. Wire color coding is indicated by various shades of gray but color can be added to the enlargements with dyes, if desired. New boards can be produced quickly from existing negatives and record keeping is simplified.

Other advantages include less operator training, less supervision, easier inspection, improved operator attitude, and increased production.

FILM FOR LARGE BOARDS

Photographic enlargements of the harnesses are made from a white, opaque, polyester film that has a continuous-tone, variable-contrast emulsion. The material is said to be durable, dimensionally stable, and resistant to yellowing. Introduced about two years ago by Du Pont, it is called Cronapaque (last syllable rhymes with cake).

Cronapaque is available in sheets from 3¼ × 4¼ to 24 × 30 inches, and in rolls up to 42 inches wide by 30 ft. long. No special processing is required other than standard developer, stop, fix, and wash. When purchased in rolls, the film costs about $1 per square foot

BOARD MANUFACTURE—In applying the technique, the equipment listed in the table will normally be required. The sequence that follows has been used successfully by this division.

(1) After assembly drawings are released, the material for one unit is assembled. This will be the harness model.

(2) Wiring data lists are produced by an automated drafting system. Information is placed on punched cards, fed into a computer, and printed out. Copies are made with an offset duplicator.

(3) The first harness is con-

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—tells about new ultra-pure "Freon" solvent for precision cleaning

Free 12-page booklet gives complete specifications for new "Freon" precision cleaning agent created specially for "white-room" and critical cleaning applications. It describes in detail the analytical control and packaging procedures which insure your receipt of a cleaning agent with a purity previously thought commercially impractical.

It's free . . . no obligation . . . mail coupon or write for your copy. "Freon" Products Division, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

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FREON precision cleaning agent

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Wilmington 98, Delaware.

Please send me new booklet giving specifications, analytical control and packaging procedures for "Freon" precision cleaning agent.

Name_____

Title_____

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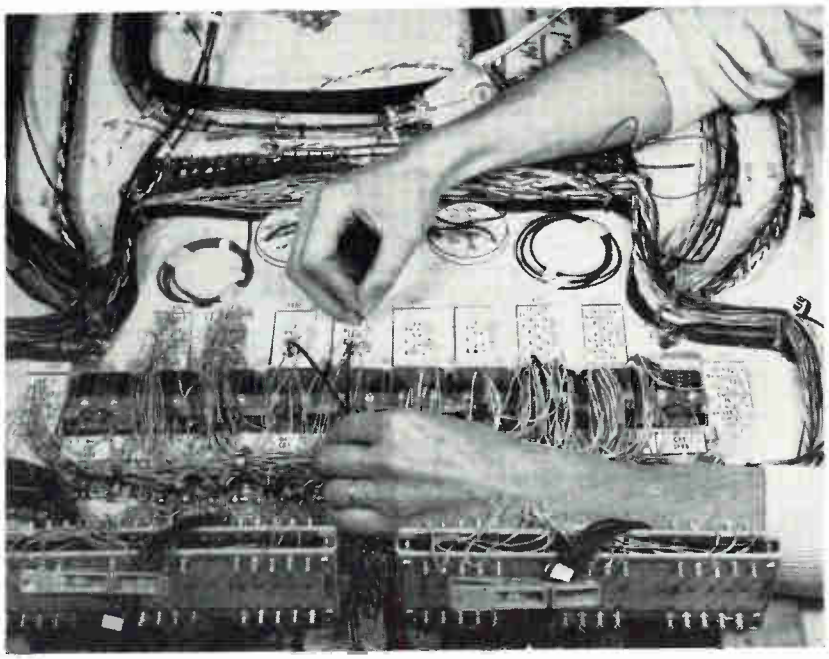
☐ Please have a technical representative call.

ONCE *the photo-harness board has been made, it is used similarly to other boards in harness production*



DRILLED *holes serve as termination points and allow checking before final connections to the plug are made*

structed. Prototype equipment may be used, providing the design is firm and a unit is available when required.

(4) The finished harness is removed from the unit and placed securely on a suitable background such as a ¾-inch plywood board painted white or covered with white cardboard or paper. Staples, harness nails, clips, etc., are used to fasten the harness. The harness should be arranged for best possible layout with regard to wiring and subsequent assembly to the unit.

(5) Identification information is placed in block form in one corner and key parts of the harness are labeled. Labels are best obtained by type setting with a standard desk model machine. Enlarged views of connectors, plugs and other components are added to the layout since the usual identification marks are too small to be read easily. Now the mock-up is ready to be photographed.

(6) The harness board is next

MATERIALS AND EQUIPMENT FOR PHOTO-HARNESS PREPARATION

1. Wire harness sample
2. Material and wiring data lists
3. Standard operator tools
4. 4 × 5 inch View Camera, tripod mount
5. Panatomic X sheet film
6. RFL #2 photo flood lamps
7. DuPont opaque polyester film ("Cronapaque")
8. Backup board (¾-inch plywood)
9. Reflective material (white cardboard or paper)
10. Hardware (harness nails, clips)
11. Identification items
12. Photo enlargements of connectors, plugs and other materials
13. Hand drill and bits, small power saw, double-faced tape

set up vertically and secured. The photograph is made with a 4 × 5 inch view camera, using two or three photo flood lamps as required by the size of the layout. A medium speed, fine grain, panchromatic film such as "Kodak Panatomic X" is recommended. As many shadows as possible should be eliminated, lighting should be even and the camera should be "square" to the subject.

(7) A camera setting of one-half second shutter speed and f-22 aperture opening is typical. For extensive enlargements, a slightly thin negative is helpful.

(8) After the negative is processed and dried, it is enlarged to the original size of the harness layout using Cronapaque. Again, care should be taken to assure a "square" image. Extra large prints can be spliced. The film allows filtering and dodging techniques and the variable contrast emulsion is an asset in printing from less than perfect negatives.

(9) Mount full size photographic prints on plywood board; 3M type 400 double-face two inch tape can be used to secure the print to the board.

(10) Make cutouts in board to accommodate plugs, connectors, etc. Buildup the board where required. Place harness nails, clips, etc.

(11) Set board up for operation, allowing continuous light at the

work surface of 100 to 150 foot-candles.

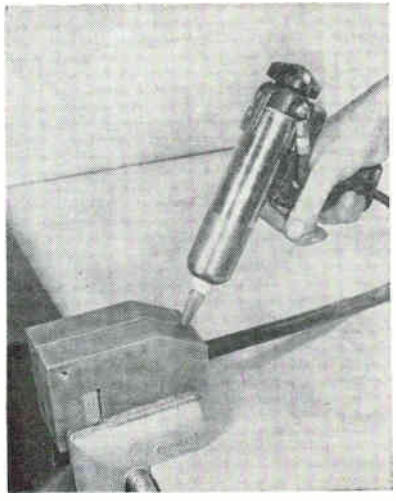
To expedite the application of the technique, a mobile harness cart is being developed to aid photographing the initial harness at its normal work station. The cart will carry white background paper, a large, adjustable, perforated aluminum alloy harness-mounting sheet, clips, harness nails, basic identification nomenclature, numerics and other supporting equipment.

Molded End Plugs Improve Cable Reliability

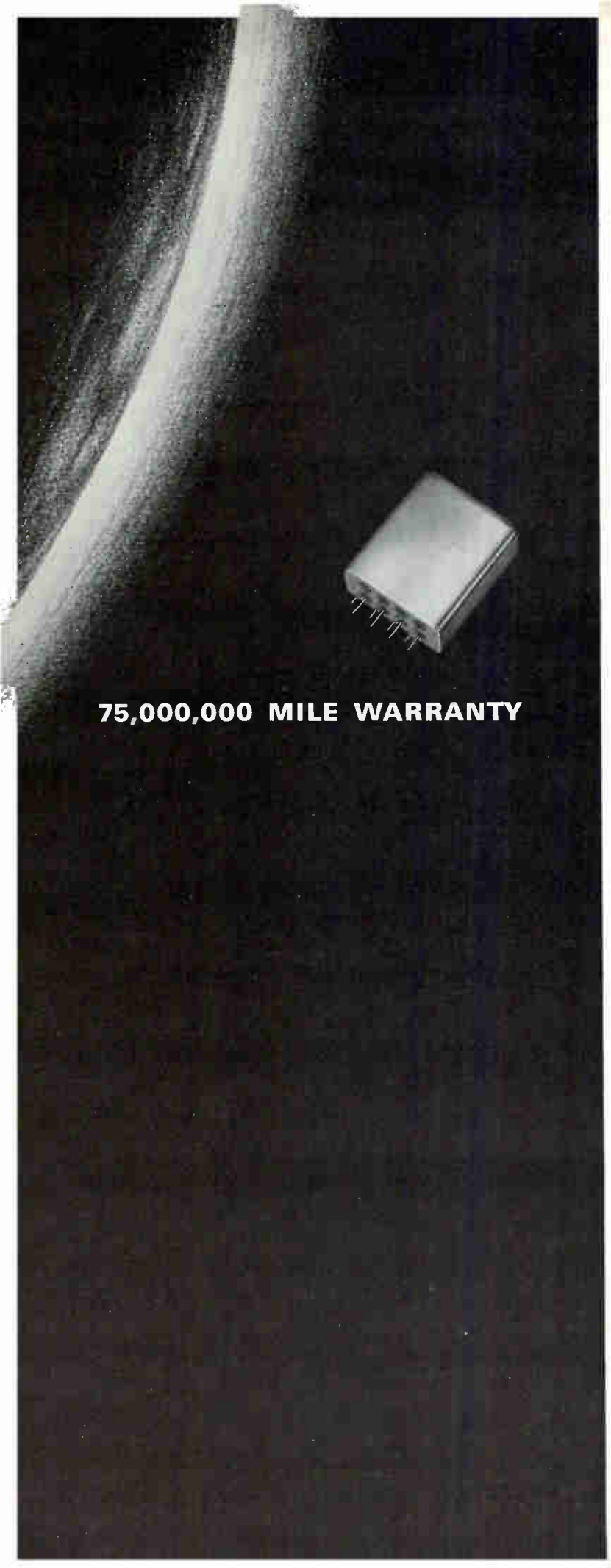
PLUGS for cable termination can often be molded directly to the cable. This type of construction provides maximum protection to the assembly against entry of foreign materials and reliability is generally increased substantially.

The technique is being applied by Cadre Industries Corp., Endicott, N. Y., to make cable for various applications. Molds are used to shape the configuration of the cable end and many types of plugs can be used.

After the molds have been designed and built, the wired cable plug is assembled in position as the photographs indicate. The potting or molding compound is applied with an extrusion gun, but in some



FILLING COMPOUND *is applied with extrusion gun in typical application*



75,000,000 MILE WARRANTY

This relay is going on a 75,000,000 mile trip. It's the BR-7 — one of many Babcock relays selected for the maiden flight of America's first active military communications satellite.

As part of the spaceborne payload, each of these subminiature relays has a vital responsibility. Some will be on 24-hour call for switching communications channels. Others will help reposition the satellite if it creeps off station. Still others will take part in carrying out attitude change commands for orienting solar paddles.

All of them will have to perform, without failure... for 15 months.

Reliability of this order requires more than just sound engineering and careful fabrication. Absolute assurance is needed that performance will match expectations. In short, a "75,000,000 mile warranty".

Babcock's "warranty" is the Failure Rate Report — a documented prediction of performance based on statistical test and evaluation techniques. The "probability of success" for the space-bound BR-7's is more than 99.9% with a confidence factor of 95%, based on 10,000 miss-free contact operations at rated load — another way of saying these relays will do their job for 15 months or 75,000,000 miles.

We'll be happy to send you our general product catalog listing all Babcock reliability-rated relays available from stock, plus information on Babcock's Reliability Program, the first and most extensive company-sponsored program of its type in the relay industry.

BR-5

MICRO/MICROMINIATURE
DRY CIRCUIT TO
1 AMP SERIES
Contact Style Rating:
SPDT/1 amp res. @ 32VDC,
.050Ω max.
Size: 0.2 x 0.4 x 0.6

BR-7

SUBMINIATURE DRY
CIRCUIT TO
POWER SWITCHING SERIES
Contact Style Rating:
SPDT, DPDT 2, 5 & 10 amp
res. @ 28VDC or 110VAC,
400 cps Size:
.515 x 1.075 x 1.300

BR-8

MICROMINIATURE CRYSTAL
CAN SERIES
Contact Style Rating:
SPDT, DPDT/2 amp res. @
32VDC or 115VAC, 400 cps;
1 amp ind. @ 32VDC
Size: .360 x .790 x .870

BR-9

SUBMINIATURE MAGNETIC
LATCHING SERIES
Contact Style Rating:
DPDT 5 & 10 amp res. @
28VDC or 110VAC, 400 cps
Size: .515 x 1.075 x 1.300

BR-12

MICROMINIATURE
ULTRASENSITIVE SERIES
Contact Style Rating:
SPDT, DPDT, 2 & 3 amp res.
@ 32VDC or 115VAC, 400
cps; 1 amp ind. @ 32VDC
Size: .400 x .795 x .890,
std.; .800 x 1.250 x .415,
printed circuit.

BR-14

SUBMINIATURE FOUR POLE,
DOUBLE THROW SERIES
Contact Style Rating:
4 PDT (4 form C)/5, 7.5 &
10 amp res. or 2, 2.5 & 3.5
amp ind. @ 28VDC or
115VAC, 400 cps
Size: 1.000 x 1.075 x 1.300

BR BABCOCK RELAYS

A Division of Babcock Electronics Corporation
3501 Harbor Boulevard, Costa Mesa, California

CIRCLE 107 ON READER SERVICE CARD

MOLDS CAN *be made for many types of plugs*

cases more extensive tooling is desirable. Materials suitable for molding include epoxies, silicons and modified rubber.

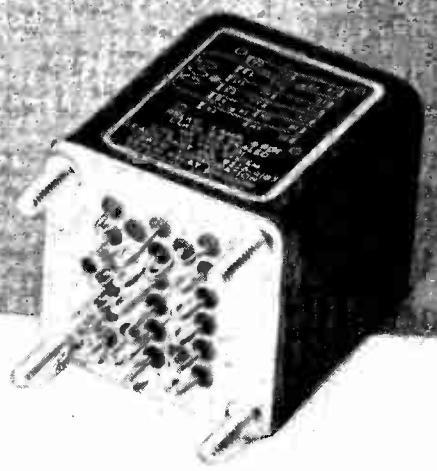
Milking Machine Pump Speeds PC Production

VACUUM PUMP from a milking machine is speeding the production of printed circuit cards at Boeing Co.'s Transport Division in Renton, Washington.

Available laboratory vacuum pumps failed to meet speed and load requirements in exhausting the air from a plastic bag in which the photographic negative of a circuit drawing is sealed to a sensitized copper coated fiberglass plate.

Ramon Lubovich, who lives on a farm near Renton and formerly kept a small herd of dairy cattle, suggested using the high-vacuum milking machine pump.

CIRCLE 109 ON READER SERVICE CARD→



LEACH BALANCED ARMATURE RELAYS

SERIES 9226 5 AMP. 6PDT CONTAMINANT-FREE

GENERAL CHARACTERISTICS:

CONTACT RATING: @ 28VDC or 115 VAC Single Phase

Resistive	5 amps	Motor Load	1.5 amps
Inductive	3 amps	Lamp	0.8 amps

CONTAMINANT-FREE: Meets Minimum Current test requirements of MIL-R-6106C

COIL DATA: Pull-in @ 25°C, DC

Sensitivity	940 mw	Typical Operation	@ 28VDC
Rated Duty	Continuous	Coil Resistance	180 ohms
Life	100,000 cycles (minimum)	Pull-in 18.0 volts @ 125°C	
		Pull-in 13.0 volts @ 25°C	
		Dropout over temp. range	1.5 - 7.0 volts

APPLICABLE MILITARY SPECIFICATIONS:

MIL-R-25018, MIL-R-5757C, MIL-R-6106C

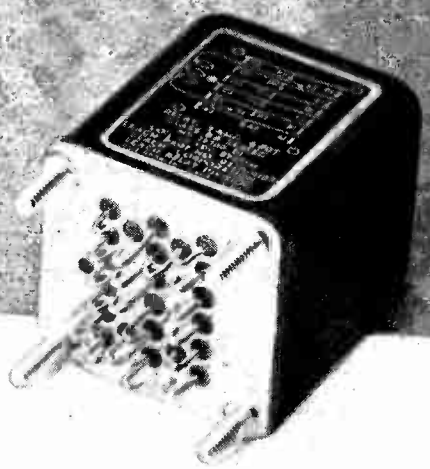
Believe everything you read

You can rely on Leach relays to meet or exceed the printed specs. What's more — Leach continues to improve performance with the ever increasing requirements of industry.

Take this old friend of many engineers — the Series 9226 balanced armature relay. It's not the same as it used to be. It's better. Constant improvement in design and production insures that it will perform with the highest reliability even in today's most critical applications. So like an old friend, engineers continue to rely on it to meet new and varied requirements.

Right now there's a Leach relay with proven reliability ready to do the job. Ask for complete specifications — you can believe what you read!

LEACH CORPORATION 18354 Susana Rd., Compton, Calif. • Export: Leach International S.A.



LEACH BALANCED ARMATURE RELAYS

SERIES 9226 5 AMP. 6PDT CONTAMINANT-FREE

GENERAL CHARACTERISTICS:

CONTACT RATING: @ 28VDC or 115 VAC Single Phase

Resistive	5 amps	Motor Load	1.5 amps
Inductive	3 amps	Lamp	0.8 amps

CONTAMINANT-FREE: Meets Minimum Current test requirements of MIL-R-6106C

COIL DATA: Pull-in @ 25°C, DC

Sensitivity	940 mw	Typical Operation	@ 28VDC
Rated Duty	Continuous	Coil Resistance	180 ohms
Life	100,000 cycles (minimum)	Pull-in 18.0 volts @ 125°C	
		Pull-in 13.0 volts @ 25°C	
		Dropout over temp. range 1.5 - 7.0 volts	

APPLICABLE MILITARY SPECIFICATIONS:

MIL R 25018, MIL R 5757C, MIL R 6106C

Believe everything you read

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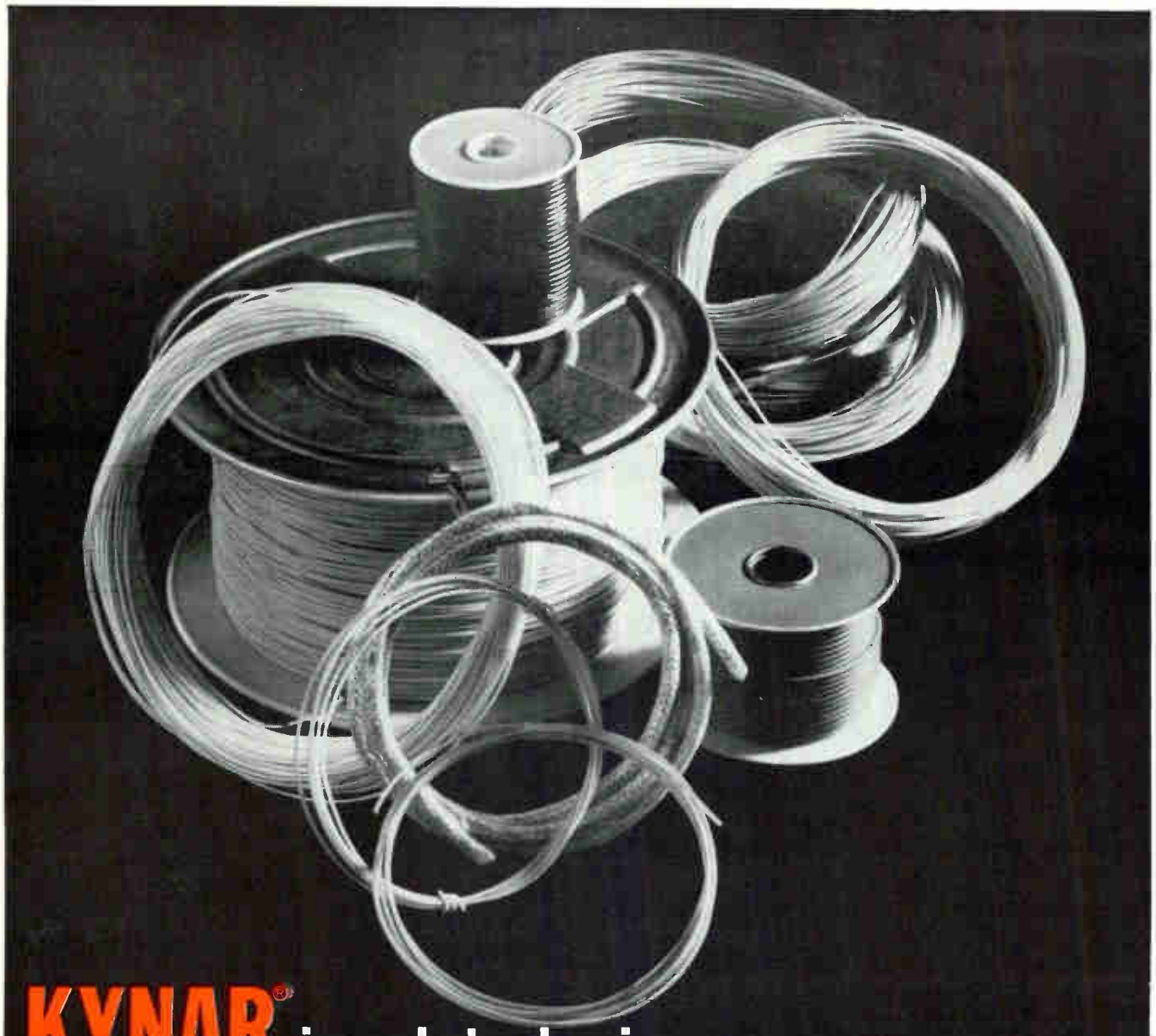

KYNAR® insulated wire . . .
new standard in performance and production

Wire and cable insulated with Kynar—the new fluorocarbon resin from Pennsalt Chemicals—delivers premium performance in your product and on your production line. Kynar-insulated hook-up wire has high dielectric strength and resistivity . . . strips cleanly, won't tear or cut-through in automatic assembly equipment. Kynar has a useful temperature range of −80° to +300°F. and Kynar-insulated wire forms strong, tight seals with epoxy-base potting compounds. As a jacketing material, Kynar offers superior resistance to abrasion, corrosion, weathering, and radiation . . . extrudes readily over single or multi-strand constructions as well as vinyls, PTFE and metallic shields. It can be pigmented and striped to identify circuits. Typical properties of 10-mil Kynar insulation extruded over AWG 24 solid soft copper conductor:

Dielectric strength, volts	10,000
Insulation Resistance, meg-ohm/M	> 1,000
Cold bend, ½" dia., 1 lb. weight at −70°F, volts	8,000
Abrasion Resistance, Janco Tester grade 400 alumina, inches of tape	50
Cut through, anvil at 90°, 350 gm. hours at 270°F.	> 500
Soldering test, flare back	None
Flammability	self extinguishing

Kynar-insulated wire is available from Surprenant Mfg. Co., Clinton, Mass.; Revere Corp. of America, Wallingford, Conn.; L. Frank Markel, Norristown, Pa.; Hitemp Wires Co., Westbury, L.I.; and Brand-Rex, Concord, Mass. Write to us for details. Plastics Department, PENNSALT CHEMICALS CORPORATION, 3 Penn Center, Phila. 2, Pa.

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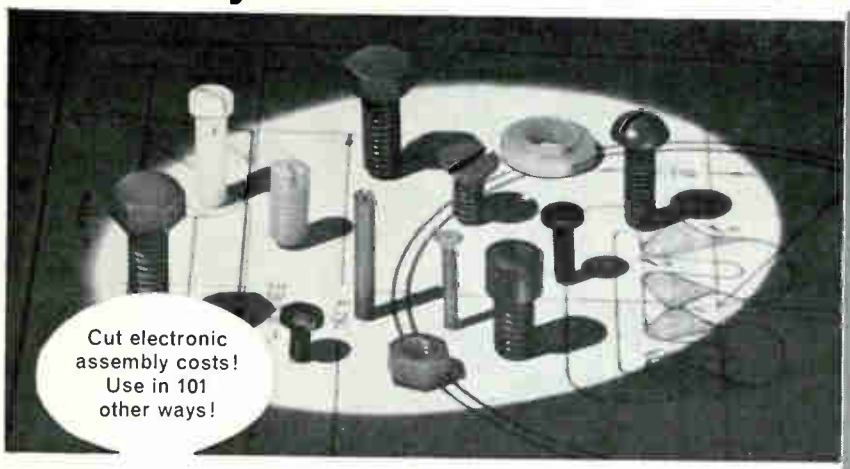

Have you investigated what NYLO-FAST® Fasteners can do for you? They're colorful, strong — yet 1/6 the weight, chemical resistant, heat resistant, elastic, resilient, and non-conducting! You'll be surprised to discover how many ways NYLO-FAST® Fasteners can serve you—BETTER! Write for complete information.

Immediate delivery from our large stocks which include Nylon, Delrin, Teflon, P.V.C., Lexan, etc. 10 different formulations! Write, wire, or telephone today for the facts!

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METAL PRODUCTS COMPANY, Inc.

CASTLETON-ON-HUDSON 10, NEW YORK

CIRCLE 207 ON READER SERVICE CARD

Designed for M *Application*

INSTRUMENTATION OSCILLOSCOPE
One Inch

Miniaturized basic packaged panel mounting Cathode Ray Oscilloscope for instrumentation use replacing "Pointer Type" meters. Panel bezel matches 2" square meter. No. 90901 uses 1CP1 tube. No. 90911 uses 1EP1 tube. Power supply No. 90202 available where application requires.

JAMES MILLEN MFG. CO., INC.

MALDEN

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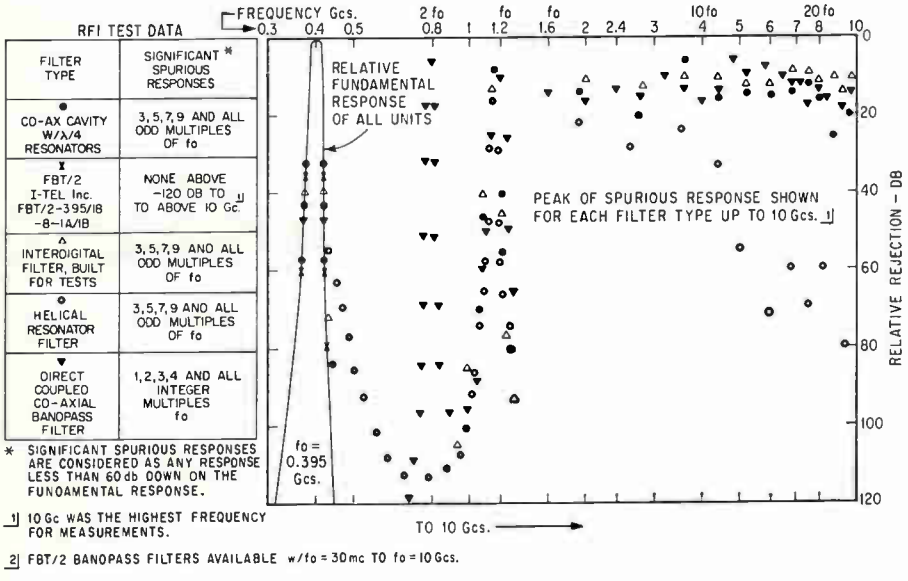
CIRCLE 113 ON READER SERVICE CARD

DESIGN AND APPLICATION



Bandpass Filters Operate at 10 Mc to 10 Gc

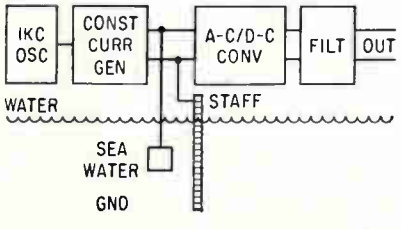
Subminiature devices have no spurious harmonic response

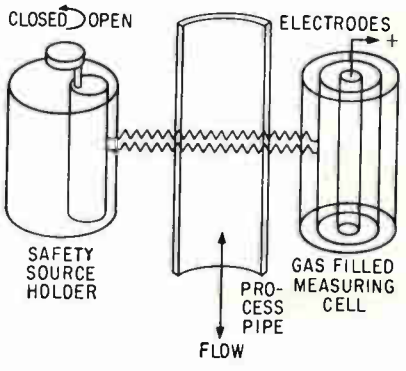
NOW in production at I-TEL, Inc., P. O. Box 641, Twinbrook Station, Rockville, Maryland, are a series of bandpass filters with the FBT-2 subminiature type available with 1 to 15 resonators in the 30 Mc to 10 Gc range with 1 db bandwidth of 1.0 to over 40 percent. A typical 8 resonator filter provides 1.75:1, 60:6 db bandwidth ratio at 0.395 Gc in less than 2 cubic inches. Insertion loss at f_o can be as low as 0.20 db with no spurious responses above −80 db to above 20 Gc. For very low loss or medium power applications (200 w), FBT-20 filters are available with 1 to 15 resonators in the 10 Mc to 1.5 Gc range with 1 db bandwidth from 0.25 to over 40 percent. Insertion loss can be as low as 0.010 db with no spurious responses above −80 db to 10 Gc thus eliminating multiple harmonic responses and attendant rfi problems.

CIRCLE 301, READER SERVICE CARD

Measuring Height of Ocean Tides and Waves

MANUFACTURED by Hytech Div., G Street Pier, San Diego, California, the model 601 wave and tide monitor is a single sensor system for measurement of relative change in elevation of the surface profile of sea water over a broad frequency range. The sensor is a Nichrome alloy resistance wire applied in a continuous spiral around a polyethylene-jacketed cable. The sensor is partially embedded in the plastic reducing the tendency of water to be channeled in grooves formed by the wrap. Rate and degree of fouling is minimal due to applied a-c voltage. The d-c readout is monitored by meter and in a form suitable for telemetering. Staff lengths come to 40 ft at an impedance of 2,000 ohms nominal. Operating frequency is 1 Kc, accuracy is ±0.25 percent full scale, linearity is ±0.2 percent full scale and resolution is 0.1 percent. Response is 0.25 second and output is 0 to 5 v into a 100,000-ohm load. (302)





Nuclear Gage Solves Processing Problems

RECENTLY announced by Ohmart Corp., 4241 Allendorf Drive, Cincinnati 9, Ohio, the beta/gamma gaging systems can measure density of solids, liquids, or percent solids of slurries with a precision and repeatability of ±2 percent with ranges as narrow as 0.025 sgu available. Levels or interface position of liquids, solids or slurries in tanks can be measured to ±⅛ inch. Thickness of plastic sheet can be measured to 0.001 inch with precision of ±0.00001 inch. The gage converts beta or gamma radiation directly to electrical energy. The device is safety shielded and the radiation passes through the material to be measured. Radiation reaching detector is function of

ELECTRONICS
PROGRESS IN RECTIFIER COMPONENTS

MILITARY TYPES

NOW GENERAL ELECTRIC OFFERS
SILICON CONTROLLED RECTIFIERS
TO MEET MIL-S-19500/168 • MIL-S-19500/108 MIL-S-19500/204A

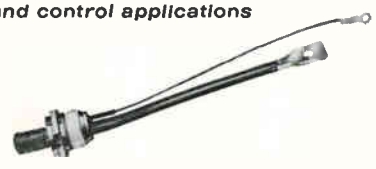
For your low power switching and control applications

Type	MIL Specification	PRV & VBO	Max. I_{DC}
USN 2N1771A	MIL-S-19500/168	50	7 A @ 115°C stud
USN 2N1772A	MIL-S-19500/168	100	7 A @ 115°C stud
USN 2N1774A	MIL-S-19500/168	200	7 A @ 115°C stud
USN 2N1776A	MIL-S-19500/168	300	7 A @ 115°C stud
USN 2N1777A	MIL-S-19500/168	400	7 A @ 115°C stud

For your medium power switching and control applications

Type	MIL Specification	PRV & VBO	Max. I_{DC}
USN 2N681	MIL-S-19500/108	25	25 A @ 57°C stud
USN 2N682	MIL-S-19500/108	50	25 A @ 57°C stud
USN 2N683	MIL-S-19500/108	100	25 A @ 57°C stud
USN 2N684	MIL-S-19500/108	150	25 A @ 57°C stud
USN 2N685	MIL-S-19500/108	200	25 A @ 57°C stud
USN 2N686	MIL-S-19500/108	250	25 A @ 57°C stud
USN 2N687	MIL-S-19500/108	300	25 A @ 57°C stud
USN 2N688	MIL-S-19500/108	400	25 A @ 57°C stud

For your high power switching and control applications



Type	MIL Specification	PRV & VBO	Max. I_{DC}
USN 2N1931W	MIL-S-19500/204A	50	110 A @ 60°C stud
USN 2N1910W	MIL-S-19500/204A	50	110 A @ 60°C stud
USN 2N1911W	MIL-S-19500/204A	100	110 A @ 60°C stud
USN 2N1912W	MIL-S-19500/204A	200	110 A @ 60°C stud
USN 2N1913W	MIL-S-19500/204A	300	110 A @ 60°C stud
USN 2N1914W	MIL-S-19500/204A	400	110 A @ 60°C stud

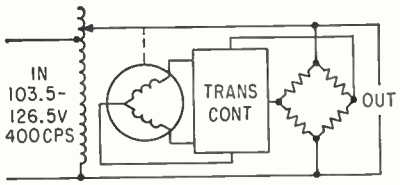
For complete details, see your G-E Semiconductor District Sales Manager. Or write Section 16J87, Rectifier Components Department, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 159 Madison Ave., N.Y. 16, N.Y.

AVAILABLE THROUGH YOUR G-E SEMICONDUCTOR DISTRIBUTOR

GENERAL ELECTRIC

density, level or thickness of intervening material. Voltage output is proportional to material density, is amplified and fed to recorder-controller.

CIRCLE 303, READER SERVICE CARD



Voltage Regulator Has Zero Waveform Distortion

MANUFACTURED by Superior Electric Co., 383 Middle St., Bristol, Connecticut, the Stabiline automatic voltage regulator is an electro-mechanical transistorized device operating from a 400-cps line with zero waveform distortion and 98-percent efficiency. In a typical unit with input variations between 103 and 126 v, 380 to 420 cps, output voltage is 115 v at 6 amperes, with a correction rate of 0.23 second per volt. The unit has an efficiency of 98 percent and performance is unaffected by position or temperature changes. Insensitive to magnitude and power factor of the load, it has no effect on system power factor. (304)

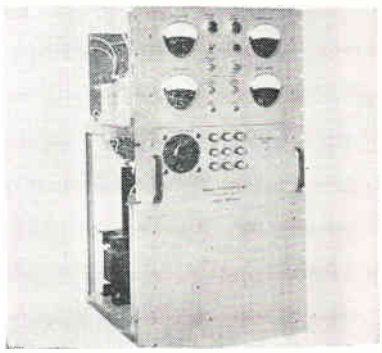
1-V Input Converter Makes 25 W at 72% Efficiency

ANNOUNCED by Lin Research Corp., 2412 Reedie Drive, Wheaton, Maryland, the model 1A-28 converter is a new approach to transistor design and application for efficient conversion of one-volt energy sources to regulated 28 v d-c at power levels up to 25 w. Immediate application is in conversion of voltages from thermoelectric devices, solar cell arrays, fuel cells and the like. Output is regulated against line and load variations and is short-circuit proof. The unit is 3 × 5 × 4 and weighs 3 lbs. (305)

Power Converter Used for Space Probe

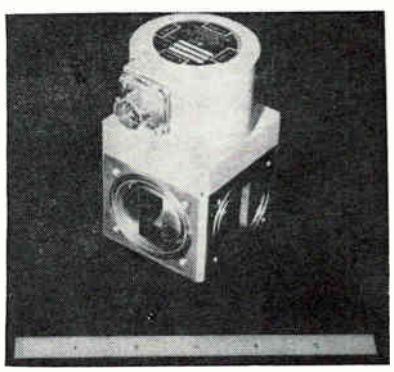
PIONEER MAGNETICS INC., 850 Pico Blvd., Santa Monica, Calif., announces a d-c/a-c half wave, variable frequency power converter which has been designed for a space

probe. It takes 28 v d-c and converts it to 350 v, square, half wave output power to serve as the power source for a telemetry transmitter. By applying half wave-square waves to transmitter, battery life of space vehicle is almost doubled since transmitter thus has a 50 per cent duty cycle. (306)



Power Source Is Custom Built

AMULEX ELECTRONICS INC., 467 Connecticut Ave., South Norwalk, Conn. Model MPS-622-R is representative of custom built regulated and unregulated power supplies available. Unit pictured is a multiple output supply which delivers a 2 Kw output power, including 350 joules of storage and is convenient for rack mounting, requiring only 19 in. by 35 in. panel space. Price is $1,475. (307)



Transfer Switch Works by Remote Control

QUANTATRON, INC., 2520 Colorado, Santa Monica, Calif. Model WS-01H11 compact waveguide transfer

CIRCLE 116 ON READER SERVICE CARD
CIRCLE 117 ON READER SERVICE CARD→

In almost any language, the words "Sweep Generator" and Telonic have become synonymous. You might find, for example, the model HD-1A, above, checking IF amplifiers in Zurich — or a PD-8 with its 4-watt output testing varactors in Palo Alto — or an SV-13 aligning TV tuners in Tokyo.

Supplying both the precision needed in the laboratory and the durability for production applications, Telonic Sweep Generators can cut hours off test and check-out time. Operating from audio to 3000 mc, there are models to select from covering narrow bandwidths or the complete frequency range.

MODELS

- HD-1A, 0.5 to 900 mc — 995.00
- HD-7, 0.1 to 75 mc — 695.00
- SM-2000, audio to 3000 mc (plug-in oscillators) — 600.00, basic unit
- PD-8, 330 to 1010 mc (high power output) — 2750.00
- SV-13, (all U. S. and foreign TV channels) — 800.00 approx.
- SH-10, 0.5 to 500 mc (oscilloscope plug-in type) — 700.00

Complete catalog on request

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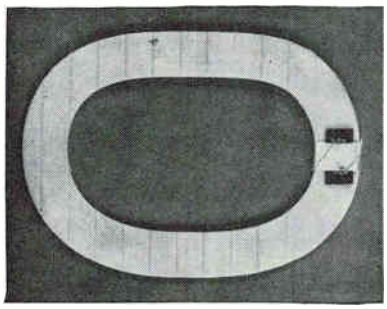
❖ SWEEP GENERATORS ❖ RF ATTENUATORS ❖ CW OSCILLATORS ❖ COAXIAL SWITCHES

switch makes it possible to switch radar and microwave power in less than 30 millisec under extremely adverse environmental conditions. The electrically-operated, 4-port unit offers excellent r-f performance over the entire 7.0 to 11.0 Gc frequency range.

CIRCLE 308, READER SERVICE CARD

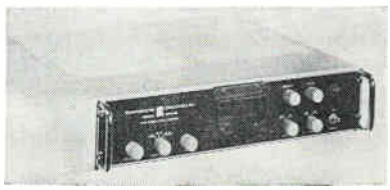


A-M Loop Antenna Made to OEM Prints

ROLLAN ELECTRIC CO., 8233 S. Princeton Ave., Chicago 20, Ill. Made of high-impact styrene, Polyloop possesses the high uniformity, electrical and stability characteristics of low distributed capacity (7.5 pf) plus a Q at 1,000 Kc of 204. It can be formed in any shape. Of strong, rigid, light-weight construction, unlimited mounting methods are possible, including self-supporting techniques. (309)

X-Y Recorder Uses Plug-In Modules

HOUSTON INSTRUMENT CORP., P. O. Box ?2234, Houston 27, Texas. The HR-95 is a 8½ by 11 in., flat bed, X-Y recorder with vacuum hold-down. Featuring interchangeable plug-in modules, the instrument is constructed for maximum convenience and ease of operation. The front recording panel swings open for easy access to the X and Y axis amplifiers which are completely independent and interchangeable. All of the plug-in modules are equipped with precision ten turn input attenuators, and automatic pen lift controls. (310)



Signal Monitor for H-F Receivers

COMMUNICATION ELECTRONICS, INC., 4900 Hampden Lane, Bethesda 14, Md. Designed for use with communication receivers having an i-f frequency of 500 Kc, the SM-8510

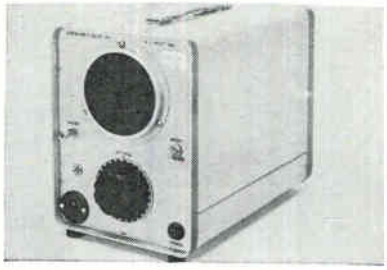
signal monitor provides a visual display of signals on a 1½ by 3 in. crt in a band around which the companion receiver is tuned. Sweep widths of 5 Kc, 20 Kc, and 50 Kc are provided and are selectable by front panel control. **(311)**

Hardness Tester

RADIO CORP. OF AMERICA, Detroit, Mich., offers a portable hardness tester that can be used as a bench unit for inspecting small metal parts or equipped with a hand grip to measure large surfaces. **(312)**

Thermistors Offer High Stability

THERMONETICS, INC., 14536 Calvert St., Van Nuys, Calif., announces thermistors featuring high stability, temperatures to 300 C with leads, lower resistance at 25 C in higher betas, and 0.050 in. diameter disks. Innumerable variations of assembly, temperature coefficient, size, geometry and resistance are producible to specifications. Designer kits ($6.95 to $9.95, two for $13.50) containing ten thermistors of select values, facilitate circuit design and testing. **(313)**



Flash Generator for Testing Semiconductors

EPIC INC., 150 Nassau St., New York 38, N. Y. Flash generator SC4 is a pulse light source unit giving a flash sequence which may be adjusted from 1 to 20 per sec. Flash duration is 0.1 μsec. Flashes are uniform as they are produced by discharge into a tube filled with Krypton and other gases. The life time of minority carrier of semiconductors is measured by exposing them to intense but extremely short flashes of light while they are connected to d-c current. An oscilloscope is required to obtain the curve showing the decay of the photoconductive current. **(314)**

Potting Machine Priced at $4,950

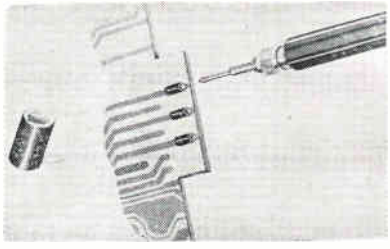
UNITED PROCESS MACHINERY CO., 1501 Colorado Ave., Santa Monica, Calif. The Wren potting and molding machine is a compact, bench unit designed for the production of small molded or potted parts with epoxies, rigid and flexible urethane foams and similar materials. Output range is from 100-600 grams per minute. Machine is housed in a cabinet approximately 24 by 24 by 12 in. high. It contains two extremely accurate rotary positive

displacement metering pumps having d-c variable speed drives with rpm indicators measuring pump speeds.

CIRCLE 315, READER SERVICE CARD

Tape Handler

OMNITRONICS, INC., 511 N. Broad St., Philadelphia 23, Pa. Model RS-210, for rewinding paper or magnetic tape from one reel to another, reduces downtime in handling by freeing reelers from rewinding duty and leaving the system free for productive work. **(316)**



Test Jack Insulated with Teflon

AUGAT INC., Perry Ave., Attleboro, Mass., offers a microminiature test jack for use in p-c applications. Jack is designed to receive 0.080 diameter test probes. It is available in a variety of colors for easy circuit identification. **(317)**

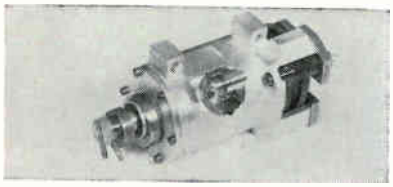
Graphic Recorder

NESCO INSTRUMENTS (Datapulse Inc.), 509 Hindry Ave., Inglewood 1, Calif. Compact transistorized graphic recorder provides full scale ranges of 10 mv to 100 v with ½ sec balance time. **(318)**

Medium Power TWT Is PPM Focused

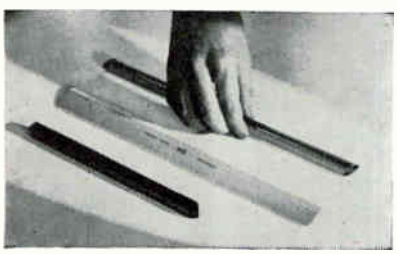
WATKINS-JOHNSON CO., Stanford Industrial Park, 3333 Hillview Ave., Palo Alto, Calif. The WJ-237

is a medium power traveling-wave tube developed for use in satellite transmitter applications where absolute reliability, small size, light weight, and maximum overall efficiency are mandatory. Unit is designed to operate from 1.70 to 2.00 Gc. The frequency range or power level can be altered either through a slight design change or a shift in operating voltages. (319)



Pulsed Oscillator Covers 5,400-5,900 Mc

ACF ELECTRONICS division, ACF Industries, Inc., 11 Park Place, Paramus, N. J., offers a miniature C-band triode pulsed oscillator designed for radar systems applications. It has a 5,400-5,900 Mc frequency, a peak power output of 1 Kw and a tuning range of 500 Mc. Temperature stability is ±30 Kc per deg C from 0 to 70 C. It is 3¾ in. long, 1½ in. in diameter and weighs 13 oz. (320)



Ruby Laser Rods of High Optical Quality

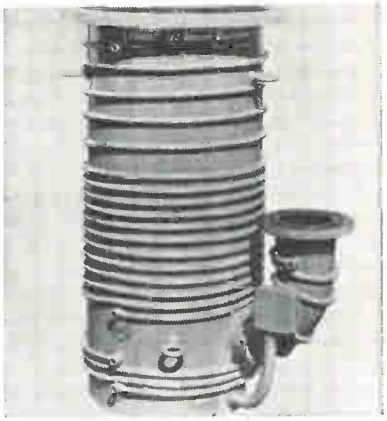
ADOLF MELLER CO., Box 6001, Providence, R. I. Ruby laser rods are a full 12 in. long with dopings of 0.02 percent and 0.04 percent chrome by weight. They are extra slow grown, extremely well annealed for minimum strain, and have diameters of approximately 0.550 in. to 0.650. The rods, 90 deg oriented, are optically corrected with all flat to 1/20th wavelength and optically parallel within 2 sec-4 sec of arc. (321)

Digital Multiplier

GENERAL DATA CORP., 1250 North Parker St., Orange, Calif., announces a digital multiplier which

multiplies an eight-bit multiplicand and an eight-bit multiplier yielding a 16-bit product plus sign within 20 μsec. A parallel circuit technique provides a built-in memory.

CIRCLE 322, READER SERVICE CARD



Diffusion Pump for High Vacuum Use

CONSOLIDATED VACUUM CORP., 1775 Mt. Read Blvd., Rochester 3, N. Y. With a speed for air of 18,000 liters per sec, the PMC-18000 is designed for use in vacuum metallizing, electron beam melting, environmental testing, and a variety of other high-vacuum applications. Pump has an insulated top nozzle which results in an extremely low backstreaming rate. Nozzle requires no coolant and hence no internal cooling connections. (323)

Matched SSB Filters Operate at 1,750 Kc

SYSTEMS INC., 2400 Diversified Way, Orlando, Fla., has introduced a matched pair of precision crystal sideband filters operating at a center frequency of 1,750 Kc. They feature a 3 db bandwidth of 2.5 Kc. Carrier rejection is 20 db with at least a 50 db rejection of undesired sideband. Ripple is less than 3 db with insertion loss less than 6 db. Source and load impedance is 10,000 ohms. Filters measure 1½ by 1½ by 4 in. high, plus a standard octal base. Cost is about $125 per unit in lots of ten. (324)

PRODUCT BRIEFS

MINIATURE METERS in 21 shapes and sizes from 1 in. to 3 in. Movements range from 100 μa to 1 ma. The Mura Corp., 777 Northern Blvd., Great Neck, L. I., N. Y. **(325)**

WAVEGUIDE HOLDER is assembled by the use of keys and slides together. This eliminates use of small bolts, nuts, and washers. Armo-Strut, 2717 Seelcco St., Dallas, Texas. **(326)**

A-C AMPLIFIER delivers 250 mw. Compact unit operates from −65 to +250 F. Taber Instrument Corp., 107 Goundry St., North Tonawanda, N. Y. **(327)**

MINIATURE TRIMMER with new edge mount. It has instant fingertip or screwdriver adjustment. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. **(328)**

ROTARY SWITCH has less than 0.004 in./oz system load. It can handle up to 100 va, at pulse rates from 0 to 4,000 per min. Disc Instruments, Inc., 3014-B South Halladay St.. Santa Ana, Calif. **(329)**

AUTOMATIC TEST SYSTEM simulates working memory conditions. Checks both coincident-current and word organized memory planes and stacks. Computer Instrumentation Corp., Route 38 & Longwood Ave., Cherry Hill, N. J. **(330)**

CRYSTAL FILTERS with center frequencies from 60 Kc to 30 Mc. Bandwidths are from 100 cps to 200.000 cps. Damon Engineering, Inc., 240 Highland Ave., Needham Heights 94, Mass. **(331)**

DISPLAY INDICATORS and pushbutton switch lights. They feature a direct-pull cap removal technique for simplified, front-end relamping. Korry Mfg. Co., 223 8th Ave., No., Seattle, 9, Wash. **(332)**

ANALOG COMPUTER in console model. It features central pushbutton control and monitoring. Applied Dynamics, Inc., 2275 Platt Road, Ann Arbor, Mich. **(333)**

AUTOMATIC SORTER features 16 bins. It extends the capability of transistor and diode tester. Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas. **(334)**

PULSE HEIGHT ANALYZER is a multichannel unit. High reliability, transistorized circuitry is used throughout. Loral Electronics Corp., 825 Bronx River Ave., New York 72, N. Y. **(335)**

TUNABLE R-F FILTER in 3 and 5-section versions. It features low insertion loss, compact packaging. Telonic Engineering Corp., 480 Mermaid St., Laguna Beach, Calif. **(336)**

SILICONE VIBRATION MOUNTINGS feature high strength. They are available in a full line of sizes and load ratings. Lord Mfg. Co., Erie, Pa. **(337)**

HIGH POWER KLYSTRON uses magnetron injection gun. Gain is 30 db, power

1 Mw peak. Raytheon Co., Foundry Ave., Waltham 54, Mass. (338)

PRECISION POTENTIOMETERS rated at 2 to 8 amp, in excess of 50,000 cycles, −65 C to +125 C. Rotoquate will perform over 500,000 switching cycles at derated loads and temperatures. Subminiature Instruments Corp., 3236 Kansas Ave., Riverside, Calif. (339)

LOW NOISE PREAMP MODULE for systems use where 40 db voltage amplification is required. Frequency response is 2 cps—1 Mc (±1 db.) H. H. Scott, 111 Powder Mill Road, Maynard, Mass. (340)

CIRCUIT BREAKER is an all solid-state device. Ratings are 6 to 28 v d-c, with currents up to 5 amp, temperature range −55 C to +125 C. Tempo Instrument Inc., East Bethpage Rd., Plainview, N. Y. (341)

A-C INDUCTOR MOTOR is a totally closed external fan over type. It meets MIL-M-7969 and MIL-E-5272. U. S. Industries, Inc., Engineered Products Div., 6312 Hollister Ave., Goleat, Calif. (342)

NARROW BAND-PASS FILTER with gain adjustable from 0.1 to 10. Filter is suited for separation of closely spaced frequency components. Dytronics Co., Inc., 5485 North High St., Columbus 14, O. (343)

MICROMINIATURE RELAY with welded header construction. It employs a Vycor activated getter. Babcock Relays, a division of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif. (344)

TRANSISTORIZED METER RELAY features photoelectric contacting. It operates from −20 C to +50 C. Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J. (345)

PORTABLE GALVANOMETER has current sensitivity as low as 1 na per mm at 1,000 ohm input resistance. It features an amplifier using silicon transistors. Industrial Control Products, Inc., Caldwell Township, N. J. (346)

MICROWAVE EQUIPMENT in the 12 Gc band. It is designed for use in c-c tv systems, message communications, and control. Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa. (347)

CURRENT REGULATORS used in industrial temperature control. Basic regulator price is $150. Norbatrol Electronics Corp., 356 Collins Ave., Pittsburgh 6, Pa. (348)

DISK-SHAPED TANTALUM CAPACITOR has high volumetric efficiency. It is designed for use in micro-module electronic equipment. Tansitor Electronics, Inc., West Road, Bennington, Vt. (349)

ETCHED CIRCUIT KIT eliminates fancy art work, negatives and long waiting. Price is $5.95. Vector Electronic Co., Inc., 1100 Flower St., Glendale 1, Calif. (350)

Literature of the Week

CONTAMINATION CONTROL Dexon, Inc., 3517 Raleigh Ave., Minneapolis 16, Minn., announces the availability of Techni-Topics, a newsletter on contamination control. (351)

SPEAKER MAGNETS Indiana General Corp., Valparaiso, Ind. Bulletin 381 is entitled "Indox V Speaker Magnets, A Guide to Reduce Costs and Improve Designs." (352)

POWER SUPPLIES Kepco Inc., 131-38 Sanford Ave., Flushing 52, N. Y. A reference handbook on applications of regulated power supplies for systems use is available by request on company letterhead.

TUNNEL DIODE AMPLIFIERS Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J., has published a brochure entitled "Low Noise Tunnel Diode Amplifiers and Microwave Solid State Components." (353)

BIAS TRANSFORMERS Tektran Inc., 2905 N. Leithgow St., Philadelphia 33, Pa. Bulletin PT2027A describes silicon rectifier bias and power transformers. (354)

COMPONENT RETAINER Litton Industries, U. S. Engineering Co. division, 13536 Saticoy St., Van Nuys, Calif. Brochure contains complete information on Top Hat retainers for plug-in components. (355)

DATA-TRANSMISSION CONTROLLER General Electric Co., Phoenix, Ariz. Brochure CPB-226P covers the Datanet-15, a data-transmission controller for use with the GE-225 general-purpose computer. (356)

CERAMIC CAPACITORS Erie Resistor Corp., 644 W. 12th St., Erie, Pa. Bulletin NP-120-2 describes Transcap, a line of ceramic capacitors offering a very high capacitance per unit volume ratio. (357)

SILICON DIGITAL MODULES Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. Catalog covers digital logic modules. (358)

FORCE MEASURING TRANSDUCER Microdot Inc., 220 Pasadena Ave., S. Pasadena, Calif. Catalog sheet describes the operation and typical application of a force measuring transducer, or load ring. (359)

TIME CODE GENERATORS Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. The 811 and 812 time code generators are illustrated and described in a brochure. (360)

VIBRATION CONTROL MOUNTINGS Lord Mfg. Co., Erie, Pa. Bulletin 907 describes a variety of miniature elastomeric mountings. (361)

SNAP-ACTION SWITCHES Cherry Electrical Products Corp., P.O. Box 439-

11, Highland Park, Ill. A 32-page catalog contains diagrams and technical data on a line of snap-action switches. (362)

ZENER DIODE LOCATOR International Rectifier Corp., 233 Kansas St., El Segundo, Calif. A 24-page guidebook lists all known Zener devices by JEDEC (EIA) and manufacturers part numbers. (363)

COUNTER-TIMER Systron-Donner Corp., Systron Division, 888 Galindo St., Concord, Calif. A technical bulletin illustrates and describes model 1032, a 2.5 Mc counter-timer. (364)

VARIABLE FILTER Consolidated Electrodynamics Corp, 360 Sierra Madre Villa, Pasadena, Calif Bulletin 1159 discusses features of type 1-159 solid-state variable filter. (365)

D/A CONVERTER General Automation, Inc., 8 East Butler Ave., Ambler, Pa., has published a bulletin illustrating and describing the DA2-13C digital to analog converter. (366)

D-C AMPLITIER MODULE Trio Laboratories, Inc., Dupont St., Plainview, L. I., N. Y. Bulletin describes a solid-state d-c amplifier module for close-differential comparison and deviation-detector applications. It is available on company letterhead request.

SINGLE CRYSTALS Airtron, a division of Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J. Single crystal ferromagnetic, piezoelectric, and laser materials are described in bulletin 362. (367)

MICROWAVE COMPONENTS Microlab, Livingston, N. J., has prepared a catalog covering over 10,500 microwave components. (368)

PUSH-BUTTON SWITCH Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill. A 6-page, 2-color catalog introduces the Tiny-Frame push-button switch. (369)

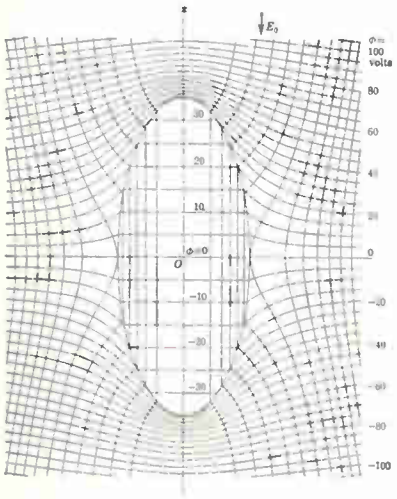
POWER TRANSISTOR Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J., has released a technical product bulletin on a 15 amp germanium power transistor. (370)

CARBON FILM RESISTORS Aerovox Corp., Hi-Q Division, Olean, N. Y. Data sheet gives technical specifications on a complete line of carbon film resistors. (371)

INDUCTION HEATING GENERATORS Lepel High Frequency Laboratories, Inc., 55th St. and 37th Ave., Woodside 77, N. Y., announces a 12-page illustrated catalog of megacycle frequency induction heating generators. (372)

SHIELDING ENCLOSURE Magnetic Shield Division Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill., offers a multiple purpose shielding enclosure design data sheet. (373)

UHF TRANSMISSION LINE Surface Conduction, Inc., 1501 Broadway, New York 36, N. Y., offers a leaflet on a new uhf transmission line that permits dispensing with the usual booster. (374)



ELECTRIC *field for a dielectric spheroid introduced into a uniform field.*

Field Theory for Engineers

By PARRY MOON
DOMINA E. SPENCER
D. Van Nostrand Company, Inc., Princeton, N. J., 530 *p*, $12.75

This volume deals with field theory in its different aspects—electromagnetic, thermal, acoustic, gravitational—with a single mathematical approach. Practical solutions of engineering field problems are dealt with, as well as the more elegant but often unobtainable mathematical solutions. All approaches to solving field equations are described at some length; separation of variables, as the most powerful technique, is treated in detail. After a detailed consideration of coordinate systems, the customary field equations are described at length in the more usual sets of coordinates: Laplace's, Poisson's, Maxwell's and others.—G.V.N.

Synthesis of Optimum Nonlinear Control Systems

By H. L. VAN TREES
The M.I.T. Press, Cambridge, Massachusetts, 1962, 102 *p*, $4

This monograph should be very useful to practicing engineers in the field of nonlinear control. The technical level is high and the au-

thor presupposes familiarity with theory of nonlinear control and a strong mathematical background.

An analogy is drawn between a communications system and a control system. The characterization of nonlinear systems is analyzed, including a study of multidimensional transform theory.

Functional solutions to the compensation problem by series and feedback compensation are given. The Volterra functional expansion and the Wiener filters are reviewed, and their equivalence demonstrated.

There are numerous references of nonlinear control and mathematical analysis. A short critique of the monograph and its extension is given in the last chapter.—M.A.M.

Computer Handbook

Edited by H. D. HUSKEY and G. A. KORN

McGraw-Hill Book Company, Inc, New York, 1962, 1251 *p*, $25

This handbook, divided equally between analog and digital computers, was prepared by experts representing computer manufacturers, universities, and computer users.

The 1,099 illustrations provide excellent examples of design principles, and there are short sections on computer system design in both halves of the book.

This book might have been of greater utility to some engineers if the two halves were available separately.—S.B.G.

Biological Prototypes and Synthetic Systems—Volume 1

Edited by EUGENE E. BERNARD MORLEY R. KARE

Plenum Press, New York, 1962, 400 *p*, $12.50

Many of our readers may not be interested in "Prey Location in Owls", but here it is along with many articles of direct interest on bio-logic, electronic, theoretic, and other models of biological functions, such as hearing, vision, adaption and self-repair. Volume con-

tains the 48 papers (8 are abstracts only, however) of the 2nd bionics symposium, and those involved in bionics will want this book, especially for its overview of actual biological work germane to engineering interests. W. S. McCulloch's paper on Biomimesis is particularly good: in a few pages, it "places" bionics, lays out a direction and a method, and thrusts a harpoon at the fourflushers "who always move in (on a new movement) as fast as they can".—N.L.

Computer Programming Handbook: A Guide For Beginners

By ROBERT NATHAN
ELIZABETH HAINES

Prentice-Hall, Inc., Englewood Cliffs, N. J., 224 *p*, $7.65

The most interesting feature of this well-designed handbook is that four computers are described in detail: the IBM 650 and 704, the Burroughs 220, and the Univac 1103 Scientific. As each new point is taken up, it is first covered generally, and then described specifically for each of the four computers. If desired, the reader can study the operation of any one computer independently of the others.

The four-computer approach, the clear language and well-chosen illustrations make this one of the best programming books for beginners.—S.B.G.

Systems Engineering Mathematics

By J. E. ALEXANDER
J. M. BAILEY

Prentice-Hall Inc., Englewood Cliffs, N. J., 1962, 394 *p*, $13

This text can be used for a one- or two-semester course in systems engineering, at the undergraduate level.

The text starts by an introduction to differential equations representing physical systems, and their solution by classical methods. The Laplace transform method of solution of linear differential equations is presented in chapter two.

The following chapters show the

mathematical representation of various dynamic systems: electrical, mechanical (rectilinear and rotational), hydraulic, pneumatic, and thermodynamic. A useful fold-out table contains all the above systems, their basic equations, and the equivalence of their parameters. The principle of storage elements is used.

The problem of stability, linearization, and methods of attack using Fourier series analysis is also given. The book concludes with an example of a system for an automatic tracking radar antenna.—M.A.M.

Network Analysis and Synthesis

By L. WEINBERG
McGraw-Hill Book Company, Inc., New York, 1962, 692 *p*, $19.50

A comprehensive graduate-level text that starts with classical network theory and carries its approach to include modern circuit techniques: linear graph theory, function theory and realization of driving-point functions. The book will be useful to the practicing engineer who has a need to bring his training up to date as well as to the graduate student. The last chapter is a handbook-type presentation of element values for three classes of useful network characteristics. This section alone makes this book a worthwhile addition to the designer's bookcase.—G.V.N.

Microminiaturization (Proceedings of the AGARD Conference, Oslo, July 1961)

Edited by G. W. A. DUMMER
Pergamon Press, New York, 1962, 368 *p*, $15

Symposium papers tend to be repetitive, and inasmuch as this NATO-sponsored conference was held last summer, the microminiaturization cognoscenti should not expect to find information here that is particularly newsy or startling. However, this volume does have many virtues.

It contains about 25 papers, all

of uniformly high quality and readability, covering all phases of microminiaturization—micromodules, microcircuits and solid circuits. All major U.S. and U.K. approaches are represented. Six of the papers are surveys, and are particularly good in providing a history of microminiaturization efforts in Britain, France and America, going as well into considerable detail on techniques and methods. The discussions that follow each paper are most interesting for the controversial points they illuminate and for pinpointing difficult technical problems involved with inductances, interconnections, heating effects, thin-film active devices, standardization, etc.—N.L.

Radio Wave Propagation in the Troposphere

By J. A. SAXTON

American Elsevier Publishing Co., New York, 1962, 199 *p*, $8.75

A bilingual (French and English) collection of technical papers from the 13th General Assembly of the URSI in London. Experimental data on tropospheric propagation, radio meteorology and climatology as well as the physical characteristics of the troposphere.

This text assumes a good technical background in the field and will appeal primarily to those actively engaged in propagation studies.—B.A.B.

Meteor Science and Engineering

By D. W. R. McKINLEY

McGraw-Hill Book Company, Inc., New York, 1961, 309 *p*, $12.50

A summary of major observational and theoretical developments in meteor science and spatial history of meteor particles and the effects they create in the upper atmosphere.

The text is written primarily for scientists and astronomers and includes a great deal of material emphasizing radio techniques without ignoring optical considerations.

One excellent section deals with scatter phenomena.—B.A.B.

CIRCLE 133 ON READER SERVICE CARD→

SCIENTISTS AND ENGINEERS: Today, Motorola digital systems and equipment are providing fresh and forceful solutions to problems of communications, comma and control for... the Air Force data acquisition and relaying system at the Edwards AFB high speed flight corridor... the NASA/JPL Mariner and NASA/McDonnell Gemini spacecr digital command systems... and the Navy/Gyrodyne DASH drone helicopter control system Current studies also encompass random access digital communications, digital-to-voice translation, and ACCESS, a combined digital/voice approach to air-ground-air communicati

If you are interested in shaping the future on these or other challenging programs, write today describing in detail your experience in the following areas:

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shaping the future in **DIGITAL COMMUNICATIONS SYSTEMS**

Systems Design • statistical communication techniques, coding theory and logic organization conce

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Research • advanced display techniques, oceanographic instrumentation, underwater sound engineer

Familiarity with State-of-the-Art • coding and decoding methods, modulation techniques, sensors, transmitters, receivers and displays, integrated circuit applications and ultra-reliability techni

We are particularly interested in programs on which this experience was obtained, and the extent of yo technical responsibility. Address information to our Manager of Engineering at the location of your cho

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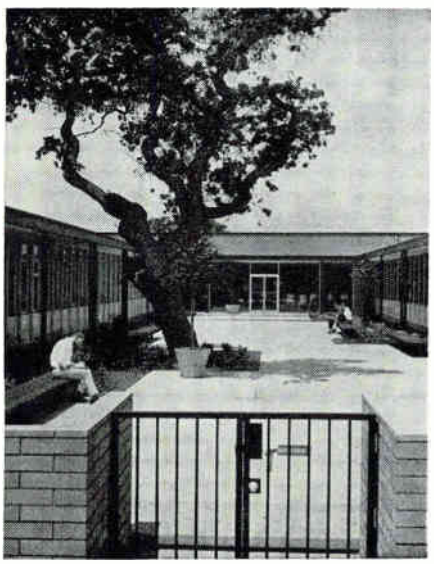
CHICAGO 51, Illinois, 1450 N. Cicero Ave. / SCOTTSDALE, Arizona, 8201 E. McDowell Road / RIVERSIDE, California, 8330 Indiana Av

Fairchild Semiconductor Opens R&D Center

FAIRCHILD SEMICONDUCTOR recently dedicated its new $2.5-million, 65,000-square-foot Research and Development Center on a nine acre site in Stanford Industrial Park, Palo Alto, Calif.

Gordon E. Moore, director of R&D, and one of the founders of Fairchild Semiconductor, said the new H-shaped building provides nearly triple the space of the previous R&D facilities, and is fully air-conditioned.

He added that 275 employees, all engaged in research and development activities, have moved into the new center, and that the force continues to expand. No manufacturing will be done in the new plant, Moore emphasized.



Fairchild Semiconductor today has a staff of 2,800 in five major U.S. locations, plus a European affiliate, and has become a leading U.S. manufacturer of high-performance silicon transistors, diodes and integrated electronic circuits.

Fairchild's original plant in Palo Alto is now occupied by its Instrumentation department. A new headquarters and transistor manufacturing plant was constructed in Mountain View in 1959. Two years later it was necessary to enlarge that plant by the addition of 40,000 square feet. Meanwhile, a third major plant, for the manufacture of diodes, was constructed in San Rafael in 1960. The fourth major expansion, a transistor assembly plant, was acquired in South Portland, Me., earlier this year.

Fairchild Semiconductor is a division of Fairchild Camera and Instrument Corp., Syosset, N.Y.

Sutcliffe Assumes New Philco Post

APPOINTMENT of C. H. Sutcliffe as director of engineering for Philco Corporation's Lansdale division has been announced. He succeeds H. K. Ishler who has resigned.

In his new position Sutcliffe will be responsible for research, development, application and pre-production engineering of Philco's semiconductor, tube and microelectronic devices. He will also direct the integration of the planar and micrologic technologies in accordance with the license agreement between Fairchild Camera and Instrument Corp. and Philco.

In addition to his new assignment, Sutcliffe will continue to direct the Lansdale division's Special Products Operation for an interim period.

STL Appoints Mueller Vice President for R&D

GEORGE E. MUELLER has been appointed to the newly-established general management position of vice president for research and development at TRW's Space Technology Laboratories, Inc., Redondo Beach, Calif. He had been vice president for space systems program management.

In his new post, Mueller will be responsible for the general management of STL's R&D activities, with particular emphasis on assuring the adequacy of the company's technical performance and technical capabilities.

Maxson Names Martinez Group Vice President

J. MARTINEZ has been named group vice president of Maxson Electronics Corp., New York City, responsible for direction of four operating units.

Maxson activities reporting to Martinez include Unimax Switch division, Wallingford, Conn.; Hopkins Engineering Co., San Fern-

Put STABILITY into your F-M System

Test Midland's Type AB-1 Discriminator in your New Equipment and Check the Results

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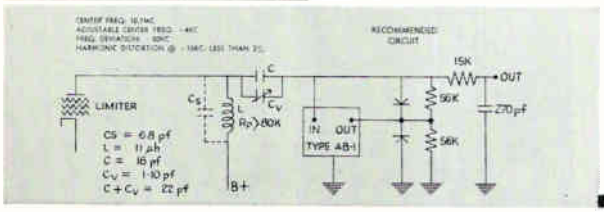
The Type AB-1 is a single-component discriminator, solder-sealed in a 1⅛L x 1⅛W x ¾H metal case with a center frequency adjustment screw, bottom-center, for F_O peaking after final equipment assembly. The Type AB-1 provides for a center frequency adjustment of ±4KC and features a voltage output essentially linear from F_O to ±15KC with less than 3% harmonic distortion. For complete technical information, write to Midland Manufacturing Company requesting literature.



Midland MANUFACTURING COMPANY
3155 FIBERGLAS ROAD • KANSAS CITY 15, KANSAS
world's largest producer of quartz crystals / division of Pacific Industries, Inc.

CIRCLE 214 ON READER SERVICE CARD

old Japan was known for these . . .

new Japan is known for these !

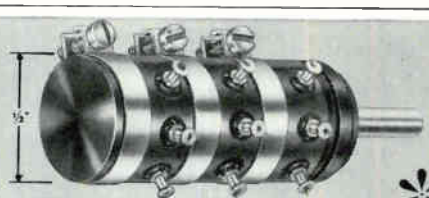
Ornate fans formed a part of every girl's wardrobe in old Japan. Today, Japan is known for tiny precision parts like these capacitors made by Nichicon. Nichicon has a complete line of capacitors designed to fit every need and backed by Nichicon quality and experience.

MAIN PRODUCTS: Oil Paper Capacitor, Electrolytic Capacitor, Tantalum Capacitor, Metallized Paper Capacitor, Ceramic Capacitor, Mica Capacitor and Mylar Capacitor, etc.

nichicon **Nichicon Capacitor Ltd.**

Head Office: Uehara Bldg., Oikedori, Karasumahigashi-iru, Nakagyo-ku. Kyoto, Japan
Cable Address: CAPACITOR KYOTO
Branch Offices: Tokyo, Osaka, Nagoya, Fukuoka.

CIRCLE 215 ON READER SERVICE CARD



A ½" diameter multi-gang "pot"?

yes*

To meet a customer's special requirements, Gamewell made a miniature, multi-ganged, precision potentiometer with linearity better than ±0.3%, depending on resolution. This metal-housed pot is conveniently phased by means of clamping rings, weighs less than 12 grams (3-gang) and meets applicable MIL specs. ■ This is one more example of how Gamewell's YES service — *your engineered specials service — is continuously meeting special "pot" and rotary switch needs. Chances are we can help with *your* special requirements, too. Write for details.

BLISS Gamewell®

The Gamewell Company, Electronics Division
1621 Chestnut Street, Newton Upper Falls 64, Mass.
A Subsidiary of E. W. Bliss Company

Please send brochure on Precision Potentiometers, including design requirements data form.

Name.....Title.....
Company.....
Street.....
City.....Zone.....State.....

CIRCLE 135 ON READER SERVICE CARD

ando, Calif., a wholly owned subsidiary; Electronics Designs division, Dallas, Texas; and a new unnamed division specializing in inertial and sensing devices such as acceleration sensitive switches and accelerometers. The new division, presently located in New York, will be housed in the new Maxson plant nearing completion at Great River, Long Island.

Martinez was formerly vice president, contracts, for the Maxson Electronics division.

General Instrument Names Divisional V-P

APPOINTMENT of Julius R. Pascuzzo as vice president and general manager of General Instrument Corporation's Radio Receptor division has been announced. He was formerly vice president of the Curtiss-Wright Corp. and general manager of that company's Electronics division.

The Radio Receptor division which Pascuzzo now heads is the largest unit in the General Instrument Defense and Engineering Products Group, with headquarters plant at Hicksville, N.Y.

Motorola Semiconductor Promotes Tallent

GEORGE R. TALLENT has been promoted to director of reliability and quality control for Motorola Semi-

conductor Products Inc. He reports directly to vice president C. Lester Hogan, and his headquarters are in the semiconductor plant in Phoenix.

Prior to this appointment, Tallent was manager of transistor production and was responsible for fabrication and assembly of all transistors manufactured at Motorola Semiconductor.

Beckman Instruments Advances Halvorsen

KENNETH G. HALVORSEN has been named technical director of Beckman Instruments, Inc., with responsibility for coordinating research and engineering programs for the Fullerton, Calif., firm's seven domestic divisions. He formerly was engineering manager of Beckman's Scientific and Process Instruments division.

The company manufactures electronic instrumentation for scientific, industrial, medical and space-defense applications.

Norden Division Promotes Nuzzo

DANIEL R. NUZZO has been promoted to senior project engineer at United Aircraft Corporation's Norden division. In this position, he will direct Norden projects in the aerospace ground equipment field.

Nuzzo has been with Norden

since 1952. Most recently, he has been a project engineer on a program for the design, development and fabrication of ground support equipment for the automatic checkout of a radar subsystem.

Roanwell Appoints Mark Harwood

ROANWELL CORPORATION, New York City, has announced the appointment of Mark H. Harwood as product manager of the Elcom department. His responsibilities include the design, development and production of a new line of precision piston trimmer capacitors.

Previous to joining Roanwell, Harwood was chief engineer for the Nucleonic Corp. of America.

Paul Breen Assumes New Adler Post

PAUL R. BREEN has been appointed manager of the Radio Development department of the Government Products division, Adler Electronics, Inc., New Rochelle, N. Y. He was formerly manager of product planning.

Acheson Colloids Names Van Voorhees

ACHESON COLLOIDS CO., Port Huron, Mich., announces the appointment

of Alexander J. Van Voorhees in the capacity of applications development engineer. He will specialize in the application of Acheson "dag" dispersions particularly in conductive coatings.

Van Voorhees was formerly with North Electric Co.

PEOPLE IN BRIEF

Gerald E. LaRochelle, formerly with Sylvania Electric Products, Inc., now manufacturing mgr. of Sperry Electro Devices Laboratory. **Richard S. Beverly** and **Edwin H. Spoehel,** previously with ITT-Kellogg and Douglas Aircraft, respectively, join Planning Research Corp. as technical staff associates in the systems engineering div. **Patrick N. McDuffie,** ex-General Precision, Inc., named mgr. of the southeastern regional office of Ford Motor Co.'s Aeronutronic div. **Neil N. Saldinger** leaves Giannini Controls Corp. to become v-p of engineering of Curvin Development Co. **Emil Misisco,** from Bulova R&D Laboratories to Philips Space Development as program mgr. GE ups **William J. Miller** to mgr. of the Lynchburg, Va., operation of the Rectifier Components dept. Webcor, Inc., advances **Valentine Hechler** to v-p and g-m of the recorder div. Collins Radio Co. elevates **John H. Boyle** to v-p and g-m of the Communication and Data Systems division, and elects v-p **W. W. Roodhouse** to fill an unexpired term on the board. Perkin-Elmer Corp. promotes **Joseph L. Borden** to director of engineering of the Vernistat div. **Dale Barger,** formerly with Hewlett-Packard Corp., joins Alfred Electronics as asst. production mgr. **H. Victor Bray,** previously with Beckman Instruments, named chief of applications engineering in the Systems Support dept. of Northrop Nortronics. **Donald L. Putt,** president of United Technology Corp., elected a director of Granger Associates. **Walter Faust** moves up to g-m of Celco's Miami facilities.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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AFSC-AFLC Joint Professional Placement Office New York, New York	106*	1
ALLEGANY BALLISTICS LAB. Operated by Hercules Powder Co. Cumberland, Maryland	143	2
ATOMIC PERSONNEL INC. Philadelphia, Pa.	106*	3
DELCO RADIO Div. of General Motors Corp. Kokomo, Indiana	86	4
DOUGLAS AIRCRAFT CO. Missile and Space Systems Division Santa Monica, California	101	5
ESQUIRE PERSONNEL SERVICE INC. Chicago, Illinois	106*	6
JET PROPULSION LABORATORY Pasadena, California	142	7
LOCKHEED CALIFORNIA CO. A Div. of Lockheed Aircraft Corp. Burbank, California	58*	8
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NORTHROP CORPORATION Beverly Hills, California	73*	12
NORTHROP CORPORATION Norair Div. Hawthorne, California	75*	13
PERKIN ELMER CORP. Commercial Div. Norwalk, Connecticut	142	14

(CONTINUED ON FOLLOWING PAGE)

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME .....
HOME ADDRESS .....
CITY ..... ZONE ..... STATE .....
HOME TELEPHONE .....

Education

PROFESSIONAL DEGREE(S) .....
MAJOR(S) .....
UNIVERSITY .....
DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

101962

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other .....
☐ ECM	☐ Operations Research	☐ .....
☐ Electron Tubes	☐ Optics	☐ .....
☐ Engineering Writing	☐ Packaging	☐ .....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	.....	.....
RESEARCH (Applied)	.....	.....
SYSTEMS (New Concepts)	.....	.....
DEVELOPMENT (Model)	.....	.....
DESIGN (Product)	.....	.....
MANUFACTURING (Product)	.....	.....
FIELD (Service)	.....	.....
SALES (Proposals & Products)	.....	.....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

ELECTRONIC ENGINEERS

assignments in engineering ingenuity

If you prefer problems to policy, challenges to conformity, there's growth ahead for you at Republic. Assignments are varied — many on advanced manned aircraft, some on next-generation vehicles. All are an open door to participation in Republic's growing role in aerospace. And to further accelerate personal growth, graduate study with generous company support is available right next door. Brooklyn Polytechnic's Graduate School adjoins Republic's facilities.

IMMEDIATE OPENINGS IN THESE AREAS:

FIRE CONTROL — 3 yrs. exp. Development, design and/or testing of radar and fire control systems.

ELECTRONIC SYSTEMS — 3 yrs. exp. Development, design and/or testing of air data computer, gyro reference table, integrated instrument systems.

DOPPLER SYSTEMS — 3 yrs. exp. Development, design and/or testing of Doppler navigation systems. Analog or digital exp.

COMMUNICATION SYSTEMS — 3 yrs. exp. Development, design of modern airborne communications systems. Troubleshooting exp. desired.

NAVIGATION SYSTEMS — 3 yrs. exp. Development and design of Doppler, inertial guidance and radio systems for airborne applications.

AEROSPACE GROUND SUPPORT — 3 yrs. exp. Design and development of electronic test equipment for airborne vehicles.

ELECTRONIC WEAPONS SYSTEMS — 10 yrs. combined exp. in radar, navigation, automatic flight controls, aircraft power systems, aircraft instruments.

SYSTEMS INTEGRATION — 3 yrs. exp. Aircraft or missile electrical or electronic systems analysis, performance and/or subsystem integration.

ELECTRONIC FIELD ENGINEERS — 3 yrs. exp. installation, test and automatic checkout of electrical or electronic systems. Assignments to East or West Coast and overseas.

ANTENNAE AND RADOME — 3 yrs. exp. Development, design and/or testing of radar antennae and radomes.

ELECTRONIC INSTRUMENTATION — 3 yrs. exp. in design and test using oscillograph, strain gauge, temperature, pressure, potentiometer and synchro techniques.

ELECTRONIC TEST — 3 yrs. exp. Analysis and test of advanced electronic systems: radar, communications, navigation and identification.

CIRCUIT DESIGN — 3 yrs. exp. Aircraft systems interconnections, power generation, distribution, communication, navigation, fire control, autopilot. Must know HIAD requirements and MIL specs.

INSTRUMENTATION — Exp. airborne oscillographic, photorecording, tape-recording, telemetering systems, ground reception, data handling and conversion systems.

Write, including salary requirements, to
Mr. James Hunter
Professional Employment, Dept. 11K-3

REPUBLIC
AVIATION CORPORATION

FARMINGDALE, LONG ISLAND, NEW YORK
An Equal Opportunity Employer

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

DISPLAYED ——RATES—— **UNDISPLAYED**

The advertising rate is $40.17 per inch for all advertising appearing in other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

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Send NEW ADS to CLASSIFIED ADV. DIV. of ELECTRONICS, P.O. Box 12, N. Y. 36, N. Y.

jpl needs

SCIENTISTS AND ENGINEERS

for

JPL's Lunar and Planetary Programs

with experience in any of the following areas:

- Celestial Mechanics
- Orbit Determination
- Space Navigation Theory
- Trajectory Studies
- Systems Analysis

Openings are now available in both theoretical and project positions.

Send complete resume to
PERSONNEL DEPT.

JET PROPULSION LABORATORY

Operated by California Institute of Technology for the National Aeronautics & Space Administration

4814 OAK GROVE DR. • PASADENA, CALIF.

"An equal opportunity employer"

Opportunity with Perkin-Elmer . . .

Project Engineer

To design, build and test complex electro-optical scientific laboratory instruments. Requires Bachelors degree in EE or Physics; advanced degree preferred. Plus 5 years designing and building electro-optical scientific laboratory instruments.

Associate Engineer

Develop electronic sub-assemblies from specifications with minimum supervision; troubleshoot new circuit and systems design; devise and conduct sub-assembly and instrument tests, contribute generally to Spectroscopy product development programs. Requires 2 years electronic engineering — strength in math and experience with transistors desirable but not essential.

Send resume to Mr. Howard M. Moran, Perkin-Elmer Corporation, Main Ave., Norwalk, Conn. An equal opportunity employer.

PERKIN-ELMER

MICROWAVE COMMUNICATIONS ENGINEERS

Overseas Opening

Supervise installation, operation and maintenance of microwave systems. Must know RF equipment, and familiar with antennas, towers, and microwave paths. Company responsible for longest link ever built.

Families may accompany to assignment. Per diem and living allowances included.

Immediate interview. Send resume to:

P-9758, Electronics
645 N. Michigan Ave., Chicago 11, Ill.

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from preceding page)

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• These advertisements appeared in the October 12th issue

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SEARCHLIGHT EQUIPMENT LOCATING SERVICE

No Cost or Obligation

This service is designed to help you, the reader of SEARCHLIGHT SECTION, to locate used or rebuilt equipment not currently advertised.

HOW TO USE: Check the ads in this SEARCHLIGHT SECTION to see if what you want is advertised. If not, print clearly the specifications of the equipment and/or components wanted on the coupon below, or on your own letterhead.

THIS IS A SERVICE TO OUR READERS. THIS PUBLICATION DOES NOT BUY, SELL OR STOCK EQUIPMENT OR MATERIALS OF ANY TYPE. Your requirements will be brought promptly to the attention of the used equipment dealers advertising in this section. You will receive replies directly from them.

Obviously, the list of such advertisers is limited by comparison with the over 56,600 subscribers to ELECTRONICS, all directly engaged in the electronics industry. A small 'EQUIPMENT WANTED' advertisement in the SEARCHLIGHT SECTION will bring your needs to the attention of ALL who read ELECTRONICS. The cost is low . . . just $27.25 per advertising inch—⅞" x 2-3/16"

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
CLASSIFIED ADVERTISING
c/o Electronics
P. O. Box 12, New York 36, N. Y.

Please help us to locate the following used equipment:

.....

.....

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY .....ZONE ....

STATE 10/19

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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