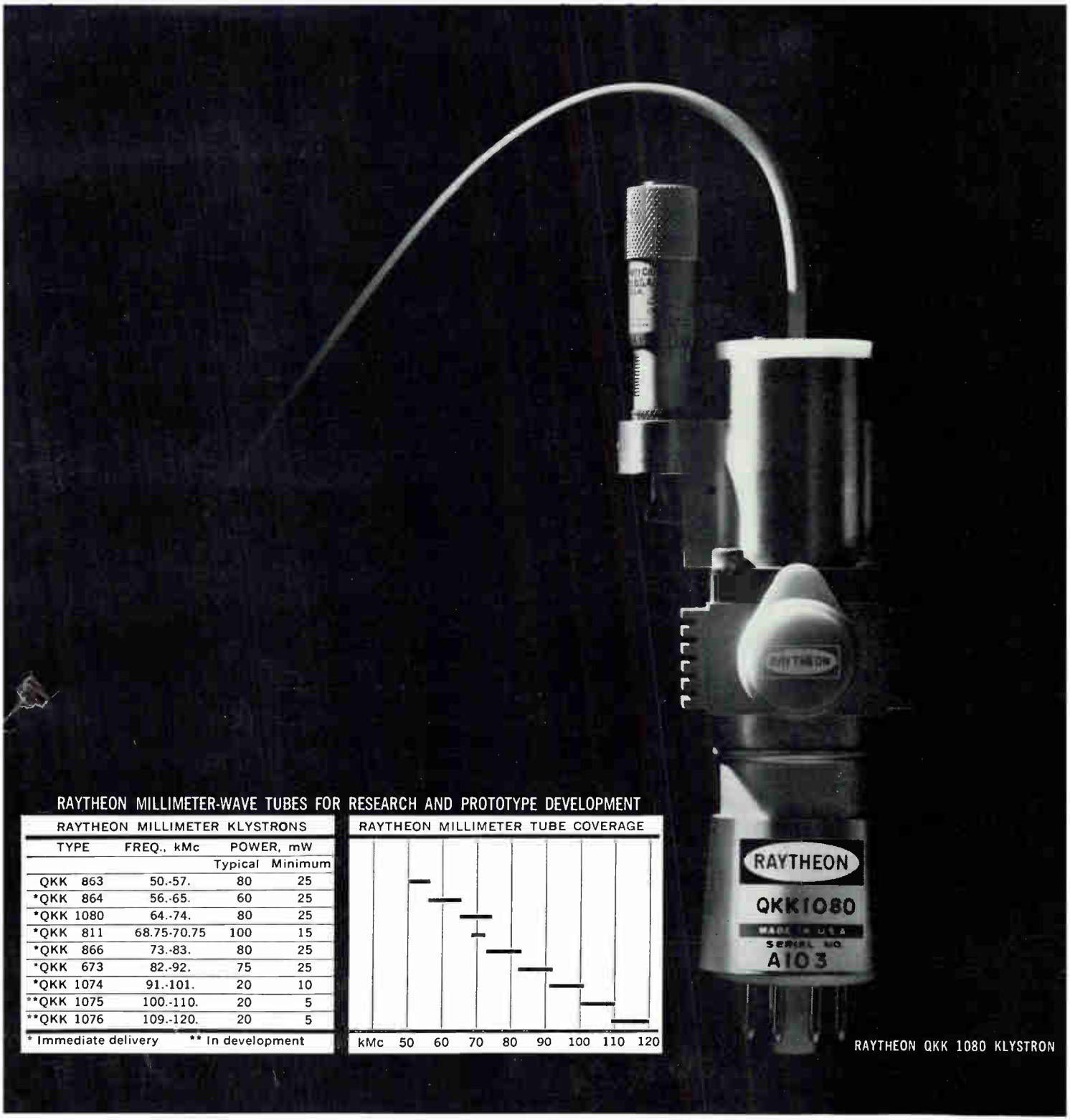
A McGraw-Hill Publication 75 Cents September 28, 1962

electronics

Coats of arms of Canada's ten provinces and two territories

SPECIAL REPORT

ELECTRONICS IN CANADA



RAYTHEON QKK 1080 KLYSTRON

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TYPE	FREQ., kMc	POWER, mW	
		Typical	Minimum
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*QKK 1080	64.-74.	80	25
*QKK 811	68.75-70.75	100	15
*QKK 866	73.-83.	80	25
*QKK 673	82.-92.	75	25
*QKK 1074	91.-101.	20	10
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**QKK 1076	109.-120.	20	5

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CIRCLE 900 READERS SERVICE CARD

RAYTHEON

September 28, 1962

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

JAMES GIRDWOOD, Publisher

Contents Continued

electronics

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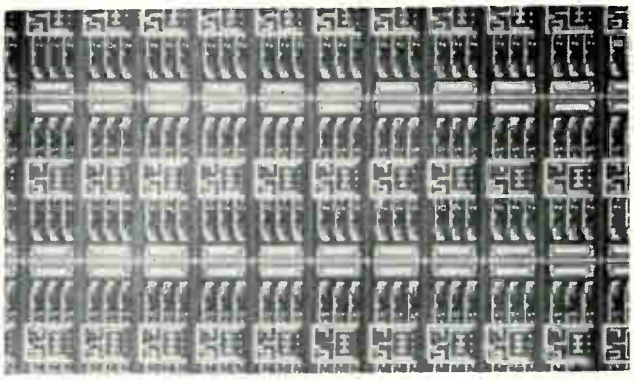
DEPARTMENTS



DO IT NOW

IN 1957, seven years after the introduction of the transistor, one of our editors attended the first session in a graduate course on pulse and digital circuits in a leading engineering school.

The instructor asked: "How many of you know little or nothing about transistors?" Fully three quarters of the class raised their hands. As a result, the instructor spent the next two sessions reviewing semiconductor fundamentals before he even started on his advertised theme.

This scene would not be repeated today, but the incident does serve to illustrate the serious time lag that often exists between the disclosure of a new technology and the widespread dissemination of fundamental knowledge and application techniques concerning it.

The reason we bring this up now is because the electronics industry is on the threshold of another major upheaval, the advent of integrated circuits in which electronic functions are created without the use of discrete components. In the last three years, much has been written about the subject. As often happens in our industry when a new concept comes along, however, public relations departments have frequently been well ahead of engineering departments in production capability.

But this situation is changing. The introduction of refinements has accelerated the pace at which complete circuit elements, particularly digital logic blocks, are becoming available for use in systems.

The impact of new techniques will be felt at all levels of our industry, and the time to prepare for it is now, not five years from now. Here are a few questions that should be preoccupying us:

Management: Eventually, integrated circuits will have to be phased into some equipment. At what rate should this be done, and when should it begin? How will it affect technical personnel? Should components be made or bought?

Engineers: The art requires more conversance with chemistry, physics and metallurgy than has been needed up to now. How to prepare for the future? How to become familiar with systems concepts rather than just isolated circuit design?

Engineering Educators: Industry will require more knowledgable engineering graduates, in the face of declining enrollments. Will young graduates be primed to design transistor circuits, only to find themselves swamped by unfamiliar circuit concepts? Will simply adding new courses do the trick, or will the whole curriculum have to be revised?

The coming year will be the biggest yet for microelectronics in all its forms. ELECTRONICS has kept ahead and abreast of this important subject from the beginning, and will continue to report on it in a sober, responsible manner, but at a faster pace.

Coming In Our October 5 Issue

NEC PREVIEW. Visitors to the National Electronics Conference in Chicago October 8 through 10 will hear some 125 papers. Some of the best of these will be previewed by Midwest Editor Wiley. Topics include ultrasonic laser modulation, infrared detection, ultrasonic image conversion, laser welding and a Hall-effect compass.

In another fringe-of-the-field article, MIT researchers describe a television transmitting system that uses infrared-generating gallium-arsenide diodes. This work was outlined on p 24 of our July 27 issue. Next week's article provides more comprehensive coverage.

Other articles next week will report on design criteria and fabrication methods for double-ridged waveguides used in broadband countermeasures systems, the design of the Project Relay communications satellite, an ultrahigh-impedance amplifier, and a reference sheet for calculating transmission-line resonant frequency.

COMMENT

Avalanche Breakdown

In his article, Avalanche Breakdown of Silicon Rectifiers (p 68, June 1), Mr. Fairchild suggests (p 70) placing voltage divider resistors in parallel if diodes are used in series.

It seems to me that if the inverse currents of diodes in series are not equal, then the diode with the lowest inverse current will be driven to its Zener point but will carry there only the inverse current of the other diodes. Since the diode with the highest inverse current will work well below its Zener point, this inverse current will be so low that it will cause no harm.

For us practical engineers it is quite important to know whether there is any advantage in using voltage-dividing networks with diodes in series.

JOSEPH C. FROMMER
Cincinnati, Ohio

Author Fairchild replies:

As a field engineer dealing with avalanche breakdown, I too am concerned with the practical aspects of this problem. I can assure you there is some advantage in using voltage-divider networks and I will cite a practical example later.

There are two sources of leakage current through a reverse-biased *p-n* junction. One is due to the ohmic resistance of the junction and varies directly with the magnitude of the biasing voltage. The other is the junction saturation current I_s. As the avalanche voltage is approached, this current is magnified by the factor $1/[1 - (V/V_a)^8]$, where V is the actual voltage applied to the junction and V_a is the avalanche voltage for the junction. Thus it can be seen that if the applied voltage is raised to $V = V_a$, then junction current would go to infinity and the junction resistance would be reduced to zero.

When two diodes are connected in series and one approaches its avalanche point due to a voltage transient, its junction resistance drops dramatically. Now the bulk of the transient voltage is applied across the *other* diode, tending to send it into an avalanche condition. At this point it would appear that, according to Kirchoff's law, both junctions should not have an avalanche voltage impressed across them at the same time, and this is quite true. Since the first diode to go into avalanche cannot recover from this condition in zero time, it is quite possible that it remains in this condition long enough to drive the other diode into avalanche. Then if the transient has sufficient current delivery capacity, both diodes will be destroyed.

I would like to give you a practical example of how voltage-divider resistors were used with good results. The Federal Aviation Agency was experiencing excessive failures in some equipment using four 1N1088 diodes in series, due to variations in inverse impedance. The Washington office ordered a modification to install a 470K resistor in parallel with each diode. Since this modification, failures have dropped to a negligible level.

The use of matched diodes or a very high safety factor of the piv rating of the power supply may eliminate the need for voltage-divider resistors. However, the diodes may not stay "matched" over long periods of time and varying ambient temperature conditions.

S. P. FAIRCHILD, JR.
Federal Aviation Agency
Tallahassee, Florida

To which reader Frommer answers:

I have a hard time seeing how the second diode can get into its avalanche condition if the first diode is in that condition and if the total voltage across the two diodes is less than the sum of the two piv voltages. Inversely, if the total voltage is more than the sum of the two piv voltages, how could the parallel resistors save the diodes? But I certainly would not argue against the empirical fact that the parallel resistors did reduce failures and I shall try such resistors from now on.

A possible explanation is that perhaps continuous exposure of the diode to smaller inverse current slowly undermines its resistance to high inverse voltages.

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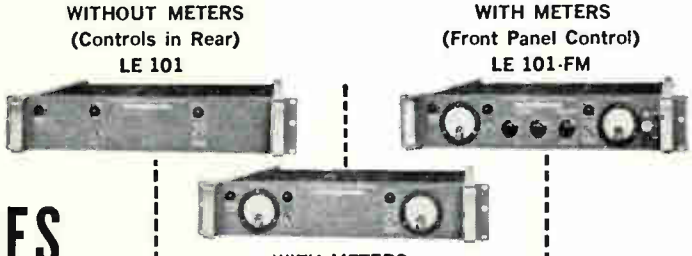

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REGULATED VOLTAGE:
Regulation
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Transient Response
(line) ..... Output voltage is constant within regulation specifications for any 15 volt line voltage change within 105-135 VAC.
(load) ..... Output voltage is constant within 25 MV for load change from 0 to full load or full load to 0 within 50 micro-seconds of application.
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Ripple and Noise ..... Less than 0.5 millivolt rms.
Temperature Coefficient .. Less than 0.015%/°C.

AC INPUT: ..... 105-135 VAC; 45-66 CPS and 320-480 CPS in two bands selected by switch.
OVERLOAD PROTECTION:
Thermal ..... Thermostat, reset by power switch, thermal overload indicator light front panel.
Electrical:
External Overload
Protection ..... Adjustable, automatic electronic current limiting.
METERS: ..... Ruggedized voltmeter and ammeter to Mil-M-10304B specifications on metered models.
PHYSICAL DATA:
Mounting ..... Standard 19" rack mounting.
Size ..... LE 101, LE 105, LE 109 3½" H x 19" W x 16" D
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LE 103 ..... 7" H x 19" W x 16½" D
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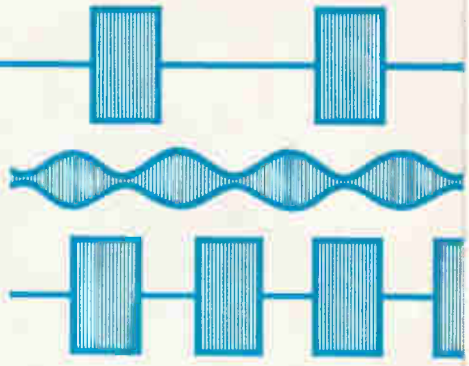

free of jitter and incidental FM

New hp 8714A Modulator delivers fast, jitter-free and FM-free pulses from any signal source or generator from 800 to 2,400 MC. A rise time of 20 nsec and fall time of 10 nsec are the result of using an absorption modulator composed of electrically controlled PIN diodes. Since the signal source, either klystron or BWO, is always operated in the cw mode, and the PIN diodes present a good match under all modulation conditions, pulses from the 8714A are free from incidental FM and jitter.

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Frequency range:	800 to 2,400 MC
RF input power:	Maximum 1 watt
SWR:	1.5 maximum at minimum attenuation, 2.0 maximum at 80 db attenuation
Impedance:	50 ohms nominal
On-off ratio:	Better than 80 db
Rise time:	20 nsec
Decay time:	10 nsec
Internal repetition rate:	Variable from 50 cps to 50 KC, 3 decade ranges
Jitter:	< 1.0 nsec
Internal pulse width:	Variable from 0.1 μsec to 100 μsec in 3 decade ranges
External sync:	0 to 1 MC depending on width/delay ratio
External AM mod:	Max. freq., 1 MC sinusoidal
External pulse mod:	Max. rep. rate, 1 MC
Dimensions:	16¾" wide x 4" high x 18⅜" deep
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ELECTRONICS NEWSLETTER

Japanese Develop High-Speed Parametron

TOKYO—Kokusai Denshin Denwa (KDD) Laboratory says it has developed a wire parametron that switches as fast as a transistor and is as reliable as a conventional ferrite-core parametron, (p 73, June 30, 1960). KDD also reports development of micromodule circuits using film parametrons.

The developer, Shintaro Oshima, of KDD, said there are now seven manufacturers making wire parametrons on an experimental basis. KDD has agreements with IBM and NCR to exchange information, Oshima added. As soon as patent approval is granted, the U. S. manufacturers will begin making it, he said.

Another company, Tokyo Radio Coil Corp., announced last week that it will start selling wire parametrons domestically in January, at prices one-third that of transistors.

KDD's wire parametron is made by plating Permalloy on copper wire. Its excitation frequency is reported to be up to 100 Mc, compared to 2 Mc for conventional parametrons, providing a 1-Mc clock frequency instead of 20 Kc. Power consumption and size are much lower than core-type parametrons.

In the film units, Permalloy is evaporated on glass and wrapped with the oscillation coil. Its excitation frequency is 2.3 Mc. Several micromodule converter units have been made in the lab.

Force-Free Fields May Avoid Magnet Breakdown

BOSTON—New approach to creation of force-free magnetic fields may help overcome internal stresses, one of two principal problems in design of megagauss magnets. The thermal problem is being tackled by liquid cooling and superconductors, but less emphasis has been given to breakdown of crystalline structure of materials.

Approach devised at Air Force Cambridge Research Laboratories was suggested by the absence of forces in magnetic fields in space and in laboratory plasmas. When fields are created by gaseous mechanism, current and field vectors are alway parallel. Goal of AFCRL program is to spread the forces over a larger area, by creating a force-free zone and bringing about gradation of force values at other parts of the field.

The problem is to determine the geometry of the conducting wire layers to result in a force-free zone in the magnetic field. Research to date by M. A. Levine and G. L. Hand has been largely mathematical, but several configurations have been fabricated.

Plug-In Circuit Modules Sealed in Tube Envelopes

NEW YORK—Sylvania is developing miniature, integrated-circuit modules consisting of thermionic devices and associated circuits built inside common vacuum tube envelopes. Resistors and capacitors are formed on ceramic substrates and encapsulated in a standard miniature tube envelope.

Module is a functional circuit that operates at temperatures between −50 C and 300 C and withstands high radiation, shock and vibration. Modular thermionic circuits are applicable to high volume production, it was reported at last week's tube technique conference, sponsored by the Advisory Group on Electron Devices. Some 500 engineers attended the conference.

Flock of Satellites Would Route Messages

MARTIN COMPANY engineer says that a network of randomly orbiting satellites would provide global military communications coverage without the necessity of coordinating satellite locations and the message paths. The system would be based on Martin's random access and correlation communications technique, Racep (p 8, March 2).

The network would consist of 57 12-channel, 250-lb satellites at an altitude of 1,000 miles, Donald L. Haas told the Air Force Association meeting in Las Vegas. Transmitter-receiver stations would weigh only 50 lb and would use omnidirectional instead of tracking antennas. System bandwidth would be 8 Mc. Up to a million users could be accommodated, Haas said.

Each ground station would be within range of several satellites. Messages would be automatically switched through the network, from satellite to satellite. Since pre-

More Noise, Better Reception

ONE WAY TO GET more messages over a voice radio band is to use the cocktail party effect (p 3, Feb. 16), thinks Maurice Rappaport, a Stanford Research Institute psychologist. Believing the effect is possibly due to a person's ability to use the stereo effect of two ears to listen selectively, Rappaport tried this experiment:

He put two headphones on a number of subjects and sent them six messages monaurally and one message binaurally. They heard 96 percent of the binaural messages. As the number of monaural messages were increased, they sounded more like indistinguishable background noise.

In this way, Rappaport found, 10 messages can be sent on five frequencies. He believes 10 frequencies can handle 45 messages. The technique, he thinks, can be used for secure communications as well as in regular voice radio systems. The enemy would have to tune simultaneously to two frequencies that could be continually varied

programmed routes would not be used, Haas said, failure or destruction by attack of specific satellites would be overcome.

Japan Spends $100 Million On New Electronic Plants

NEW YORK—The Japanese electronic industry will spend about $100 million on plant modernization, expansion and research during the fiscal year ending March 1963. This prediction was made by Fumio Iwashita, president of Tokyo Shibaura Electric Co. (Toshiba) and vice chairman of the Japan Electronic Industry Development Association. Iwashita believes that Japan's liberalizing of import restrictions on foreign trade in next month will lead to increased purchases of U. S. products by Japan's industry and consumers.

Japan Resumes Transistor Exports to Hong Kong

JAPANESE Ministry of International Trade and Industry has released 65 percent of the first six-months' exports of transistors to Hong Kong, according to a report from Tokyo. The release is good until the end of the year. MITI had banned transistor exports to Hong Kong, on May 25, but partially lifted the ban in late July. On a customs clearance basis, Japan reportedly exported 18 million transistors, or an estimated 4.1 million transistor kits, to the British colony during the first six months of this year. The wide discrepancy between this figure and transistor radio export figures reported by Hong Kong officials (see page 24) was not explained.

25-Pound Thermionic Solar Converter Output 41 Watts

LOS ANGELES—Electro-Optical Systems demonstrated this week a solar thermionic conversion system having an output of 41 watts, twice that of any previously reported system, according to a company spokesman. Using a 5-foot-diameter solar-concentrating mirror and weighing 25 pounds, the system focuses the sun's energy into a cube-shaped cavity where the elements of 5 cesium vapor thermionic converters are heated to approximately 1,700 C.

Originally designed for the Mariner class spacecraft, the system's prototype unit reportedly has been successfully tested to Atlas-Agena launch conditions. Present models have a thermal conversion efficiency of about 3 percent.

Canadian Satellite Will Probe Upper Ionosphere

NASA ANNOUNCED last week that it would launch soon Canada's ionosphere topside sounder, the Alouette as part of a broad program of ionospheric research. One of the unique features of Alouette is its long, thin antennas, one 150 feet long and the other 75 feet. The satellite is to probe daily changes in the ionosphere above the F2 layer by sending out signals swept from 1.6 Mc to 11.5 Mc. Data will be obtained at 13 ground stations. Other experiments will measure radio noise in space and in the ionosphere.

FCC Delays Action on New Educational TV Band

FCC HAS EXTENDED to October 30 the date for comment on the proposal to use the 2,500 to 2,690-Mc or 1,990 to 2,110-Mc bands for educational tv service (p 7, August 3). The extension was requested by industry and educators, but an FCC spokesman said no important resistance to the proposal is expected.

The National Association of Broadcasters is backing use of the 2,500 to 2,690-Mc band for instructional and cultural transmission, but asked that 1,990 to 2,110-Mc band be reserved for auxiliary broadcast services, including station transmission links, remote pickups and relays.

FCC said service would be classed as fixed-station, multiple address, that directional broadcasts from transmitters to receivers would avoid interference and that the use of low-power transmitters with a range of 10 to 25 miles is anticipated.

In Brief . . .

NAVY is reported to be planning a "picket line" of automatic oceanographic data-gathering stations. BuShips is expected to seek bids soon for 1,000 thermoelectric units able to provide 100 watts continuously for 9 to 12 months.

AIR FORCE plans to make the first unmanned flight with Dyna Soar (p 24, June 22) in 1964 and manned flight in 1965. Beckman Instruments has a $1.5-million Boeing contract for three analog flight-simulation computers.

ORDER for a million silicon diodes has been placed with Fairchild by Scientific Data Systems. SDS is shipping three digital computers to NASA this month, said it will be producing the SDS 900 at a rate of one a week next month.

AIR FRANCE is installing a real-time seat reservations system in Paris. Bought from Teleregister, it includes two computers and can handle 6,000 requests an hour.

ITALIAN subsidiary has been set up by Leeds & Northrup to make and sell L&N products in Italy.

DIEHL MFG. CO., has contracted to purchase Air Marine, Inc. and Motordyne Corp. from the MITE Corp.

MILITARY contracts include $7 million to Raytheon from Navy for Sparrow III missile work; $4.3 million to Western Electric for Army radios; $1.5 million to Collins Radio from Air Force for aircraft indicators.

HOWELL INSTRUMENTS is to make airborne engine analyzers for Air Force jets under a $200,000 contract. Datex is building a radio-telescope antenna data encoding systems with a recording accuracy of 5 seconds of arc, under a $63,000 NASA contract.

ANTISUBMARINE warfare contracts from Navy include $843,737 to General Dynamics/Electronics for airborne sonobuoy receivers. Loral Electronics is to develop a tactical bearing and ground speed computer for patrol planes.

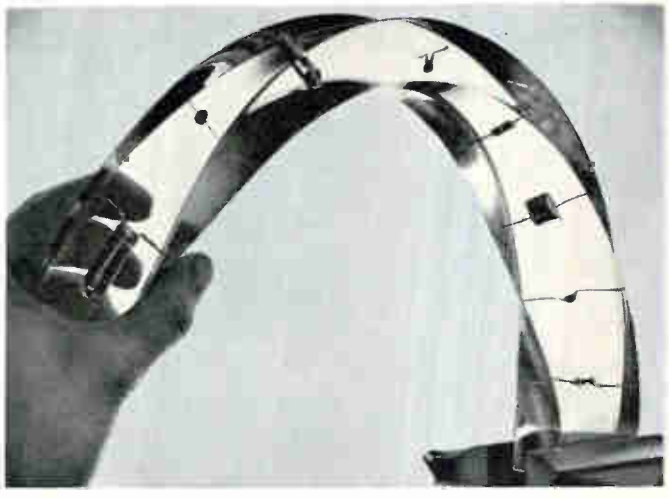
– with these silicones

See-through embedding

Supplied as an almost colorless liquid, Sylgard 182 solventless silicone resin pours easily in place; forms a tough transparent mass that provides maximum protection and complete visual inspection of components. Sylgard 182 features a cure schedule similar to that of Sylgard 183; offers equal curability in thick sections, and in confined spaces; has good dielectric properties and moisture resistance. Long service life from —65 to 200 C.

Elongation is in the range of 100%; tensile strength from 800 to 1,000 psi. Repair of embedded parts follows same procedure as for Sylgard 183.

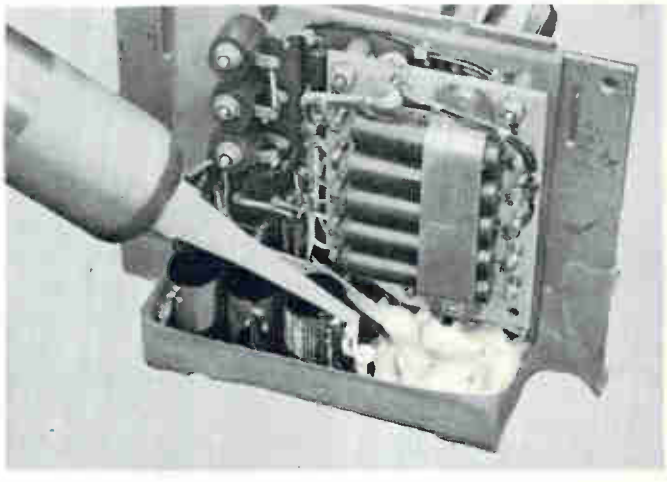
CIRCLE 290 ON READER-SERVICE CARD



Resilient encapsulating

Silastic® RTV silicone rubber cures without heat to form a tough, rubbery dielectric mass. Available in several colors and grades, it is easily applied by caulking gun or by pouring. Though higher in viscosity than Sylgard 183, it flows smoothly around delicate components without stress or pressure; forms a solid rubber jacket that protects from —55 C to about 250 C (—67 F to about 482 F); resists weathering, moisture, ozone, corona, shock and vibration. Repair of encapsulated circuits or components is easy, using a procedure similar to that detailed for Sylgard 183.

CIRCLE 291 ON READER-SERVICE CARD



Self-healing protection

This clear potting compound pours easily into assemblies; fills all voids; exerts negligible stress on components; cures to a jelly-like, transparent, resilient mass without exotherm. Curing time can be varied from 30 minutes to 48 hours; curing temperatures from 40 to 150 C. Potted parts can be quickly checked, either visually or by instrument probe. When probe is removed, Dielectric Gel reseals itself with no alteration of properties. Fully cured, it is self-healing from —60 to 200 C (usable to —100 C) has exceptionally stable dielectric properties; resists moisture; will not revert to fluid. Repair procedure is similar to that previously described.

CIRCLE 292 ON READER-SERVICE CARD

For detailed data on these silicones, contact Dow Corning Corporation, Dept. 3909, Midland, Michigan.

WASHINGTON OUTLOOK

SATELLITES ENGINEER CAN'T BID ON HARDWARE

ITT IS PROHIBITED from bidding on hardware production for military space communications systems, under a new Defense Communications Agency contract to provide "system engineering and technical advice" on development of random and synchronous military communications satellite systems. The contract, for up to $12.2 million, will run four years. At least three other electronics companies were considered, but Pentagon officials say they refused to accept the ban on hardware bidding.

A Defense Department official indicated that contractors on the Army's now-defunct Project Advent may find additional work in the new DCA-ITT program. Army and Air Force are expected to invite development and production bids shortly, with contracts to be awarded after January 1.

Prohibiting hardware production by system engineers—a long-standing question (see ELECTRONICS, p 22, Aug. 25, 1961)—will be spelled out in an upcoming administrative directive on corporate conflicts of interest. NASA policy is like that the Pentagon applied to the ITT contract. AT&T, man-in-space program communications system engineer, can't seek hardware orders in areas where its system engineering might give it a "competitive advantage." NASA and GE, technical advisor on the lunar launch vehicle checkout system, are negotiating what production contracts GE can seek.

NO BIG STEPUP IN NATO R&D

DISCOUNT ALL THE TALK about a big stepup in joint military R&D projects among NATO nations. Plans for a step-up were proclaimed officially after the recent meeting in Washington of U.S. and British defense chiefs, but serious bottlenecks are developing. Admits a top-level Pentagon official: "It's hard to avoid situations which are not disadvantageous to one or another country." Costs and information are shared, but individual countries get specific projects.

MINOW GETTING FCC MAJORITY

NEWTON H. MINOW soon will be firmly in the saddle at FCC with a dependable majority of the seven-man board to back his philosophy of tough regulation for broadcasters. E. William Henry, a 33-year-old Memphis lawyer, will replace John S. Cross, whose term expired. T. A. M. Craven, now the FCC's only engineer, reaches the mandatory retirement age of 70 on January 31. With Cross and Craven gone, Minow should have little difficulty lining up at least four votes on every issue involving closer regulation of licensees on technical and programming performance.

UHF TELEVISION BANDWAGON STARTS ROLLING

A SNOWBALLING EFFECT may benefit FCC's promotion of uhf tv broadcasting, now that mandatory production of uhf-equipped sets is the prospect for 1965 models. Major broadcasters like CBS, who couldn't make uhf go in the past because not enough people had sets, are taking a new look at prospects. Kaiser Industries with two vhf stations, has asked FCC for uhf stations in Chicago, Detroit, Philadelphia, San Francisco and Los Angeles. Why has Kaiser moved in so fast? Richard C. Block, its broadcasting manager, thinks the uhf boom will happen so quickly that broadcasters who don't get in now will risk missing the boat entirely.

The new Statham Amplibridge is a self-contained transducer and amplifier in which the transducer itself, in addition to supplying the primary signal, serves also as one of the stages in the amplifier. The system* is thus equivalent to a conventional closed loop servo system with inherent stability and accuracy. The number of electronic components is minimal, and is all contained in a case integral with the transducer itself. There are no reactive elements, no magnetic components, no semi-conductor strain gages. Size and weight are virtually unchanged from conventional strain gage transducers. The Statham Amplibridge transducer simply puts out the five volts D.C. needed for telemetry work with little increase in power drain. Statham Amplibridge transducers are now in production. Pressure transducers are available in ranges from 5 psi through 5000 psi full scale; absolute, gage, and differential. Accelerometers are available from ±1g through ±100g full range. For specifications write: Statham Instruments, Inc., Los Angeles 64.

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amplibridge 5 VOLT D.C. OUTPUT STRAIN GAGE TRANSDUCER

*PATENT APPLIED FOR

CIRCLE 13 ON READER SERVICE CARD

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Ruggedness: Designed to meet or exceed all environmental requirements of MIL-E-5272 and MIL-E-5400.

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Fast Delivery: Can begin 30 days after receipt of order.

Typical Specifications:

Carrier frequency—400 cps or 60 cps
Power source—28 ± 2VDC
Power output—up to 18.0 watts
Type of output—Push-pull
Input impedance—10K ohms. Other values available on request.
Maximum available voltage gain—4000:1 or 72 DB
Phase shift—0° ± 10°. Measured at linear portion of the output.
Gain stability over temperature range:

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Gain below 60 DB	±1.0 DB	±2.0 DB
Gain above 60 DB	±2.0 DB	±3.0 DB

Write Kollsman Motor Corporation for specifications on standard amplifiers, and information on amplifiers built to your specifications.

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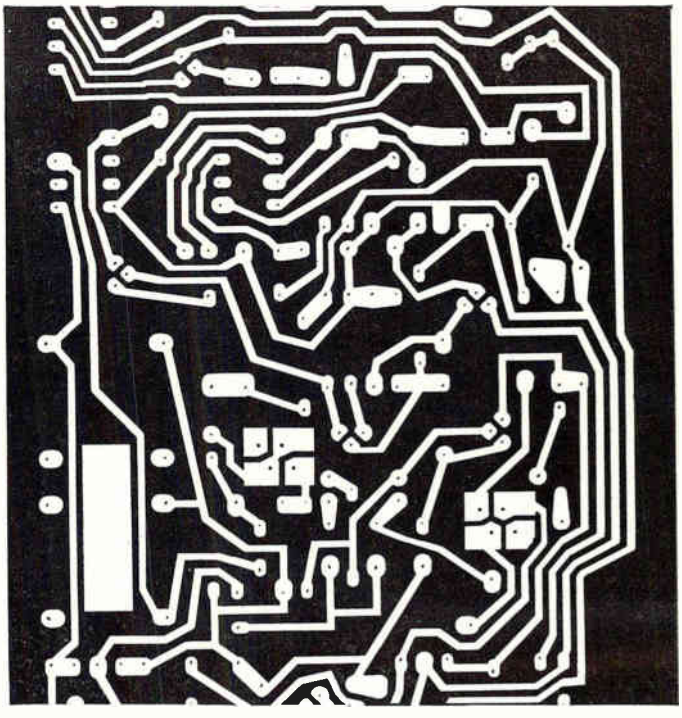
Copper-clad laminate should be WORTH the circuit printed on it



Most printed circuits require a high-quality, reliable copper-clad laminate. Synthane goes to extremes to check foil quality, adhesives and the laminate. We test peel strength at room temperature *and* at 500°F, using a newly-developed peel tester. Synthane checks blister resistance and heat resistance, and measures the thickness of the entire sheet (not merely the edges) with a new Synthane-designed instrument. Synthane prints and checks test patterns. Be sure the laminate is worth the circuit *you* print on it. Write for Copper-clad Bulletin.

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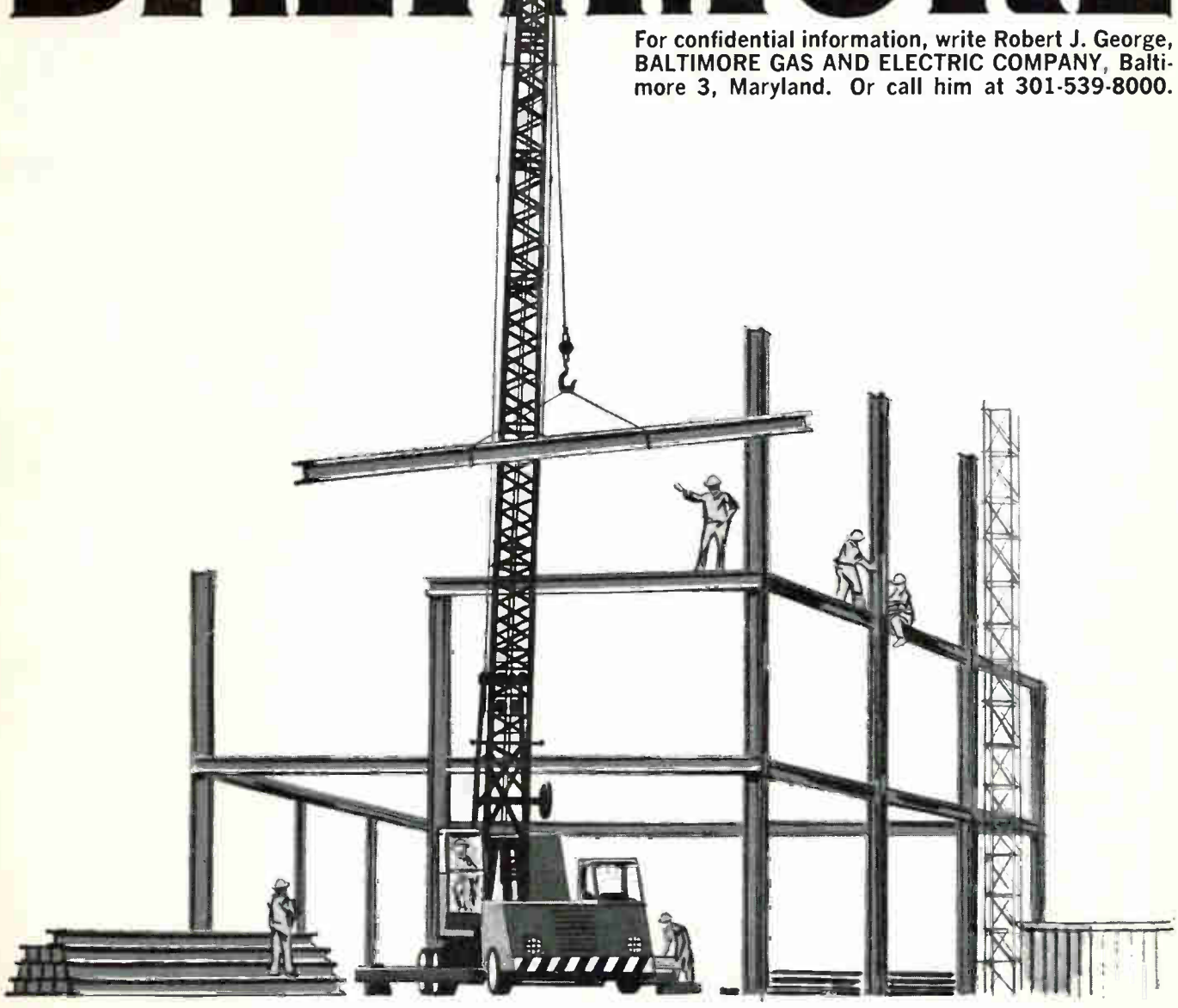

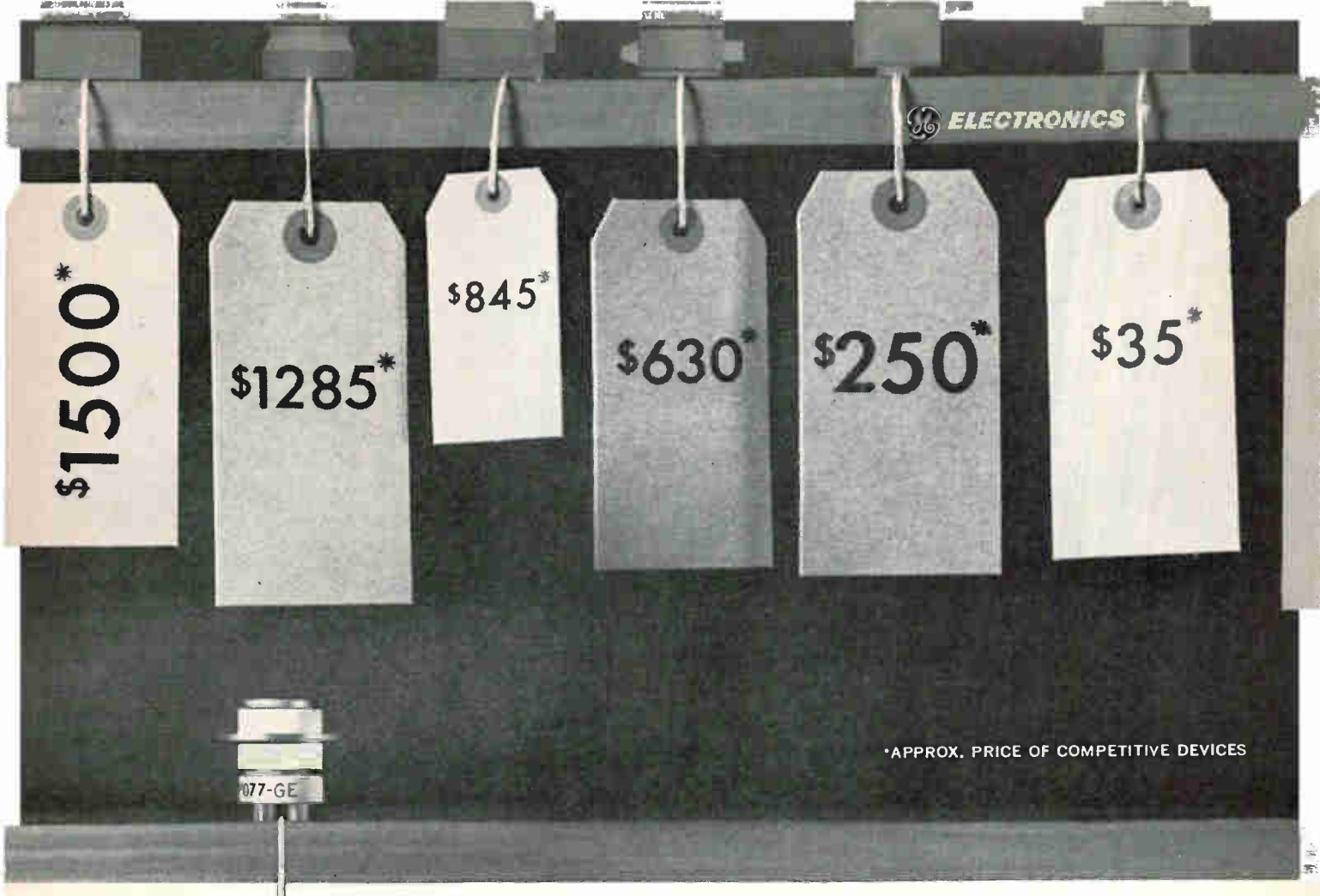

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GENERAL ELECTRIC

Detailed value-analysis chart shows how cost, size, and performance advantages can be yours. Clip coupon, or circle reader service number, for free copy.

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Most G-E ceramic tubes are on approved MIL-spec lists and are available "off-the-shelf" from your local G-E receiving tube sales representative. Send, today, for your free value-analysis chart which lists all the cost, size, and performance advantages that can be yours with G-E ceramic tubes.

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CERAMIC TUBE VALUE ANALYSIS DATA

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Company _____ *Address* _____

City _____ *Zone* _____ *State* _____

CIRCLE 17 ON READER SERVICE CAR

AIR FORCE Revamping Systems

Industry will face restrictions on proposals, more cost-consciousness

BOSTON—Air Force Systems Command's procurement policy shift away from cost-plus-fixed-fee contracts and towards fixed-cost and incentive contracts brings with it a revamping of procurement operations, Brig. Gen. O. J. Glosser, vice commander of Electronic Systems Division, told the American Management Association recently.

To implement the new emphasis AFSC is

- Expanding in-house design capability
- Limiting RFPs (Requests for Proposals) to companies that have "a realistic chance"
- Buying more off-the-shelf items to reduce systems' cost, size and complexity
- Exploring possibility of delayed costing of proposals
- Taking another look at study contracts—and already partially resuming them
- Considering a rating system based on contractors' past performance.

The move toward fixed-price is evident in two recent contracts from the Electronic Systems Division (ESD) at Hanscom Field, Bedford, Mass. Both involve the 416-L (Sage) command and control system.

A $24,450,000 award to Burroughs for Buic (ELECTRONICS, p 28, Apr. 20, 1962) is a combination fixed-price and incentive contract. The $7,754,000 award to Philco for the Alaskan Command Display System is a fixed-price contract with some provisions for value engineering.

"We must face the fact realistically that the cost-plus-fixed-fee contract is running into increasing disfavor. Its advantage of flexibility is offset by the indefiniteness of its cost features," Glosser said.

PROPOSALS—The Air Force is expanding and tapping more freely its in-house capability for system design, so that it can produce more definitive RFPs. At Bedford, this is reflected partly in substantial expansion of Mitre Corp. facilities.

Secondly, Glosser said, "We are taking a closer look at contractor capabilities, to insure that our RFPs go only to those companies which have a realistic chance of winning the competition."

The costs to industry of drawing up proposals and to the Air Force of evaluating them, "are so high that we are conscience-bound to issue RFPs to the absolute minimum of companies," he said.

For use in negotiated procurements, the AF Systems Command is exploring the possibility of delayed cost proposals. Contractors would be asked in the RFP to submit technical proposals by a specified date, but would be given another two or three weeks to submit price proposals, and might even be allowed to submit addenda to technical proposals.

AFSC, he said, is taking a long, hard look at the advisability of evaluating a company's past performance—giving it a sort of "credit rating." The idea seems to have logic on its side, said Glosser, "but the character and competence of a company are not static. Some companies get better, some get worse. Personnel come and go. A discovery in a lab can raise the standing of a company overnight."

STUDY CONTRACTS — Industry has changed its mind, said the general, about the worthwhileness of study contracts, which the AF had curtailed largely because of industry criticism that the study contractor was put in a highly preferential position to earn the implementation contract.

Now industry—by and large—is requesting resumption of study awards, according to Glosser. Under some conditions, he said, there is no logical substitute for them

Guidance Simulates Bat Sonar

LOCKHEED researchers at Palo Alto have developed a guidance device for the blind that stimulates techniques used by bats. The battery-operated device emits supersonic signals and receives echoes by a pair of pickups acting as "ears."

Two techniques are used, echo ranging with pulses and a combination of echo ranging and doppler. The first locates objects and tells how far away they are. The second provides additional information on the objects and their motion.

The wearer hears the pulse echoes as clicks and the doppler returns as a set of whistles, whines and squeeks. The second technique is believed to approximate that used by many species of bats.

Developers are A. E. Brown, D. J. Hodgson and E. R. Holland, of Lockheed. Brown said that the size of the apparatus can be reduced considerably. The experimental device is too cumbersome for practical use.

ECHOES *of supersonic signals transmitted and received by transducers in box are heard in earphones*

Procurement Operations

and they had been "invaluable to the AF in helping to choose the right design for a new weapons system."

He said industry sees these study contracts as logical in view of the move toward incentive and fixed-price contracts—which require a clear direction and specifications to be agreed on before they are signed.

"And industry," commented another Air Force officer, "does not want to see all of this study money go to the nonprofit corporations."

HIGH ROAD AND LOW ROAD TO NEW SYSTEMS?

SEATTLE—*Contracting procedure that would let the military explore novel approaches to new systems without risk to the national security was proposed at the National Advanced-Technology Management Conference this month by William B. McLean, technical director for the Navy Ordnance Test Station at China Lake, Calif.*

McLean proposed that "whenever we are forced by political pressures to start a crash program, we should select a prime contractor and start funding him at whatever level seems politically expedient." Then, anyone who thinks he can do the job using a novel approach for one-tenth the cost of the prime contract would also get a contract.

The large program will provide a "safe, scheduled and well-funded route toward the objectives" while the "more risky venture" will "try out the talents of our creative designers without forcing them to risk the political safety of the nation," McLean said

---

Stereo Preamplifier Uses 33 Transistors

MAIN PURPOSE *of using transistors in its new stereo preamplifier, reports Harmon-Kardon, is not to reduce size but to obtain better tone. The company says that frequency response is 0 to ½ db between 1 cps and 1 Mc and that harmonic distortion is unmeasurable at 2-v output from 20 cps to 20 Kc. Its seven temperature-stabilized stages yield over 200 db of forward gain with feedback removed. Price tag is $250 in kit form and $350 factory-wired*

HERE'S WHY FLUKE DC DIFFERENTIAL VOLTMETERS CHALLENGE COMPARISON

★ **ACCURACY**
±0.01%
0-500V DC

★ **DURABILITY**

★ **LOW COST**
$895.00 FOB SEATTLE

FLUKE MODEL 821A

Now—for the first time—it is possible to obtain ±0.01% accuracy with a differential voltmeter over a 0-500V DC range *regardless of source impedance!* Built-in rugged construction, plus the use of highest quality components and latest manufacturing techniques guarantee long, trouble-free operation. Through simplified circuitry and conservative design, factory selection of components is virtually eliminated insuring ease-of-maintenance . . . minimum down-time. Fluke instruments cover many applications such as: calibrating, testing, and stability measurements of regulated power supplies; DC voltmeter calibration, AC voltmeter calibration and precise AC voltage or current measurements when used with an AC/DC transfer standard. The John Fluke Mfg. Co. is the most experienced manufacturer of differential voltmeters—with over 18,000 in use today! Buy with confidence from the company that developed the *differential voltmeter!*

PARTIAL SPECIFICATIONS:

ABSOLUTE ACCURACY: ±0.01% of input voltage from 0.5 to 500V. ±0.01% of input voltage plus 10 microvolts below 0.5V.

INPUT RESISTANCE: Infinite at null from 0 to 500V

METER RESOLUTION: 5uv maximum; 1 MV full scale.

CALIBRATION: 500V working reference supply calibrated against built-in standard cell.

STANDARD CELL STABILITY: 0.003% per year.

INPUT POWER: 115/230V AC ±10%, 50-400 cps, 60 watts.

FEATURES:

• Infinite resistance at null over entire 0-500V range • Polarity switch • Taut-band suspension meter • Standard cell reference • Recorder output • In line readout with automatic lighted decimal • No zero controls

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Our point is this—your present design problem may seem just as improbable, 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.

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Barr & Stroud Rangefinders measure range of inaccessible objects . . . quickly, easily, accurately

HOW ACCURATELY? Whether the object is a few feet or several miles away, a Barr & Stroud Rangefinder is available to read the distances with better than tape-measure accuracy.

In the application shown, an 8-inch base rangefinder checks the contour of a large radar dish . . . gives ⅛-inch accuracy at 20-foot range. A simple mount with azimuth and elevation scales makes it easy to record and reproduce range measurements.

HOW EASILY? No training required. Just sight through the eyepiece . . . turn the knob until two images coincide . . . read the range directly in feet or yards.

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WHO USES THEM? Barr & Stroud Rangefinders are used in land surveys, civil engineering, construction of large tanks, and a variety of marine applications. Special types are available for short-range work, and to measure diameter and height of standing trees.

Kollmorgen Corporation, largest producer of submarine periscopes, now sells and services in the United States rangefinders and other optical equipment* made by Barr & Stroud Ltd. Write for the facts today.

**Expansometers, special industrial periscopes, infra-red glasses and components, interference filters.*

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DOWNTOWN HONG KONG *teems with activity. The city is enjoying the biggest boom in its 120-year history*

RED CHINESE *operate businesses* to acquire cash and information

Hong Kong's Transistor Radio Exports

By DAVID ROSE
McGraw-Hill World News

Colony's expanding companies now are producing components

HONG KONG — The transistor radio industry in Hong Kong has grown by leaps and bounds despite attempts to restrict production.

Three years ago this British Crown Colony depended entirely on transistor radio imports. Today, some 16 factories are assembling components imported from chiefly Japan, the United Kingdom and the United States. Smaller amounts of components come from West Germany and Italy.

The new industry practically exploded overnight. For the first three months of this year, for example, the total value of exports was more than 50 percent of the total for the whole year of 1961. Importers of Japanese transistor radios abroad began to report declining sales of the Japanese products and a rise in sales of the lower priced Hong Kong-made radios.

Official figures from the Hong Kong Commerce and Industry Department show that in 1960 a total of 4,094 units were exported, while in 1961 a total of 263,423 units were sold abroad. In the first three months of this year, some 201,692 units were exported and in the next three months, almost 300,000 more sets were exported (see table).

JAPANESE EFFORTS — Faced with these figures, the Japanese, who can supply the cheapest transistor parts, began to feel the pinch and on May 26 the International Trade and Industry Ministry of Japan (MITI) suspended the issue of licenses to exporters of transistors and diodes for Hong Kong.

This measure disrupted the Hong Kong industry to some extent but there was no significant drop in the number of sets produced because of the backlog of materials on hand.

With the hue and cry from the Hong Kong factories, MITI announced in July that it would resume issuing export permits for transistors and diodes to Hong Kong—but with a strict quantita-

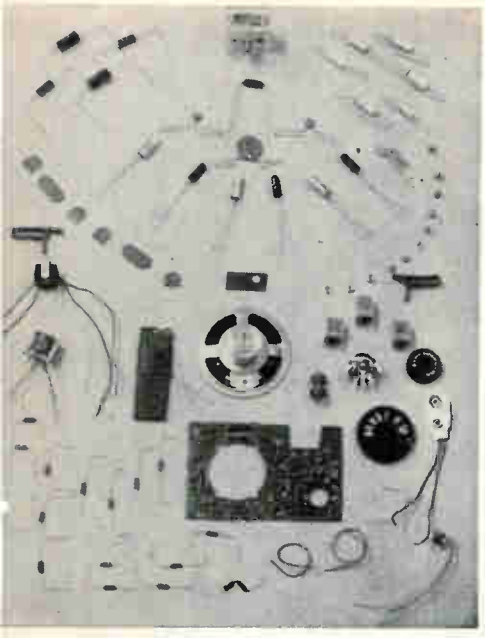
VIEW FROM JAPAN

Shortly before this report was received from Hong Kong, we asked McGraw-Hill World News in Tokyo for clarification of MITI's on-again, off-again ban on transistor exports to Hong Kong.

The answer we got was that MITI had been attempting to keep the U. S. from being flooded with cheap radios from Hong Kong, but now feels sorry it tried and is completely out of the picture.

MITI reportedly got squeezed between the Crown Colony government, which cold-shouldered MITI on export control, and the Japanese parts and components manufacturers, who were worried about their own business and put pressure on the Japanese government.

The Japan Electronics Parts Industry Association has established a seven-man branch in Hong Kong and at last report was negotiating contracts with 22 Hong Kong firms



COMPONENTS *for a radio. Many are made in Hong Kong*

TRANSISTOR RADIO EXPORTS FROM HONG KONG

Country	Value in U.S. Dollars* Jan.-June, 1962	1961	1960	Number of Radios Jan.-June, 1962	1961	1960
United States	1,811,568	445,104	—	322,902	73,868	—
United Kingdom	793,232	925,232	31,152	120,889	102,150	2,374
Panama	109,472	506,000	—	8,800	49,664	—
Italy	86,592	88,528	—	9,000	8,920	—
Canada	82,896	44,704	176	13,908	7,112	12
West Germany	52,256	12,496	—	6,508	1,421	—
Gambia	46,464	50,688	—	5,000	5,000	—
Gibraltar	14,784	98,912	—	1,200	10,000	—
Denmark	11,264	3,168	—	1,428	347	—
Central African Fed.	5,280	14,784	7,040	402	955	412
Thailand	4,048	25,168	1,056	450	2,000	100
Switzerland	2,464	2,288	—	300	300	—
Kenya	—	3,696	—	—	158	—
Argentina	—	3,168	—	—	572	—
Macao	—	176	—	—	10	—
Others	86,944	11,792	11,616	10,270	946	1,196
Total	3,103,264	2,235,904	51,040	501,057	263,423	4,094

* Based on exchange price of U.S. $0.176 equals HK$1

Soar to 100,000 a Month

tive control of $250,000 (U. S.) worth a month, which would permit the assembly of 50,000 sets a month.

Radio manufacturers in Hong Kong say that components from other countries are about 15 percent higher in price than the Japanese items and if they are required to use these in their radios, then there will be a corresponding price increase.

MAKING COMPONENTS—These export restrictions on parts made by the Japanese may in the future work to their disadvantage, because during the export freeze Hong Kong manufacturers had time to do some experimenting on their own. They sought new sources for components and are now considering the establishment of factories in Hong Kong to manufacture their own components.

At present, Hong Kong plants can manufacture their own capacitors, wind transformers and etch printed-circuit boards of their own design. Plastic cases and knobs are also made. Great strides are being made in manufacturing loud speakers and miniature earphones.

Although the industry is a young one, it also is looking to the future. Reports, which cannot be confirmed, say that there is some experimental work now going on in computer cables and allied fields. Hong Kong's labor force is largely unskilled but it has proven highly trainable and versatile.

At present, local manufacturers resitate to expand further because of the possibility of Britain entering into the European Common Market, which would deprive Hong Kong of its Commonwealth tariff preference. They feel that Hong Kong's products will not immediately reach the Japanese level in quality-for-price and would have a hard time in the beginning.

An attitude of "wait and see" has been adopted.

MARKETS—It is not difficult to find markets for these goods. The colony enjoys Commonwealth preference in the United Kingdom but at least 50 percent of the finished product must be of Commonwealth origin.

Hong Kong-made transistor radios are mainly six-transistor sets and sell extremely well in the U. S., presenting a problem to Japanese manufacturers. The quality of the products is almost as good as the Japanese-made and they are being sold slightly cheaper.

The total value of exports to the United States alone for the first three months of this year came close to HK$4.4 million (U. S. $774,400) compared to HK$2.5 million (U. S. $440,000) for 1961.

The latest information from the Hong Kong Commerce and Industry Department shows that from January to July of 1962 the total value of exports of transistor radios is HK$21.9 (U. S. $3.7 million) of which HK$12.4 (U. S. $2.2 million) was to the United States.

Trade officials say that no radios are exported to the Communist mainland because Chinese Reds are producing their own home and table radios. Transistor radios are rare and considered a nonessential item, so no importation is allowed.

HOW 30 COLLEGES USE THEIR COMPUTER FACILITIES

A sampling of 30 of the largest universities and technical institutes in the U. S. reveals that:

- *50% have central computer facilities located on campus (others have facilities in individual departments)*
- *80% give programming courses*
- *63% give theory courses*
- *87% give applications courses*
- *97% have facilities used for research by faculty and undergraduates*
- *70% allow use of facilities by undergraduate students for individual projects*
- *54% are planning to expand computer courses, services and facilities in the near future*
- *17% have purchases and upkeep of computer facilities financed in part by state government*
- *63% have facilities financed in part by grants*
- *34% have built their own computers*
- *47% use their computers to do research for local industry*

HIGH SCHOOL STUDENTS *listen as G. Thomas, Shering Corp., explains during special course given last fall (left). In the photo at right, home study explained to Pennsylvania State University student by instructor. Course is a*

More Computing Talent on the Way

By PAUL CHERECWICH, JR.
Rensselaer Polytechnic Institute
Troy, N. Y.

Colleges are expanding computer facilities, courses and services

COMPUTERS and computer technology within the academic community are receiving more emphasis than ever before, and are expected to continue making gains in the future.

A survey of major technical institutes and universities, just completed by ELECTRONICS, indicates that a majority of all such schools in the U.S. now have computer facilities on campus, and are teaching courses in computer programming, theory, and application. The survey also shows a large amount of computer time being devoted to research, including faculty, graduate and—significantly—undergraduate projects. Some 50 percent of the colleges polled have central computer facilities, while the others have facilities in individual departments.

MORE EMPHASIS—In 1955, less than 25 large digital computers were installed on U.S. campuses. In just seven years this number has been multiplied by more than five. Even more colleges are planning to expand their facilities in the near future.

"Unquestionably, increased activity in all areas (of computer activity) is anticipated on a continuing basis," said F. Hamburger, Jr., chairman of Johns Hopkins University's Department of Electrical Engineering.

One fact revealed by the survey is that slightly more than a third of the colleges polled have built their own computers, ranging from table-top analogs to large digital installations. Among the large self-built digital computers are Osage, University of Oklahoma; Illiac, University of Illinois; Caldic (now dismantled), University of California; and Mistic, Michigan State University.

A growing number of schools are offering formal courses in computer programming, theory and application. Many schools, such as North Dakota State University, are planning to add even more courses to meet student demand.

RESEARCH—Much of the available time on academic computers is devoted to research. Almost all of the colleges polled indicated active faculty and graduate student research projects requiring computer time. A number of schools—for example, Purdue University and New-

operation of Burroughs 205 computer course in computer programming is joint effort by IBM and Penn State

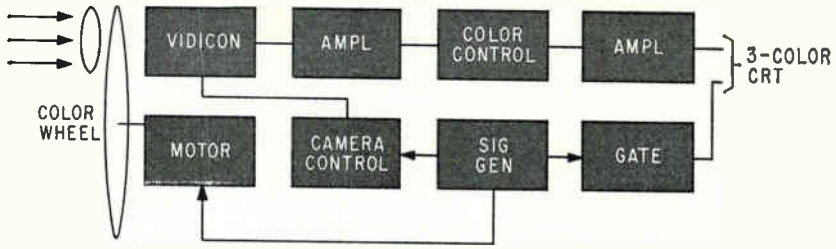
From Colleges

ark College of Engineering—allow undergraduate use of computer time for individual projects.

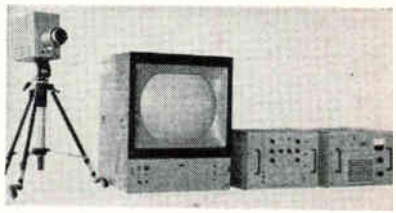
EDUCATOR OPINIONS—Reason for the rapid growth in academic computer facilities is explained in a remark by R. Ewell, vice chancellor for research at the University of Buffalo. He said a computer is "as necessary to a modern university as a microscope or test tubes."

"Knowledge of computer operation is becoming a must for every engineer and scientist," said J. H. Davis, president of Stevens Institute of Technology."

A spokesman for a large computer manufacturer said: "There is a potential explosion in use of computers at high school level for education, as well as for administrative data processing purposes. The industrial high schools will soon be teaching programming and applications courses on the computer."



COLOR WHEEL *is needed for camera only. Receiver uses conventional color tube*



COMPONENTS *of color-tv system*

New Color TV Combines Two Systems

TOKYO — Mitsubishi Electric reports development of an industrial, closed-circuit, color-tv system that uses a single vidicon with a color wheel in the camera and a three-gun color tube in the television receiver.

In conventional single-vidicon systems, both camera and receiver require synchronized color wheels. In conventional systems that use a three-gun crt in the receiver, a three-vidicon camera is required. Mitsubishi has combined these approaches to make the overall system simpler.

Operation is shown in the block diagram. A color wheel with a red, blue and green sequence passes in front of the vidicon pickup tube. The wheel and the gating circuit for a conventional three-color crt are locked by a synchronizing signal generator.

Interlaced scanning is used. A bandwidth of 10 Mc is claimed. Present price of the system is $20,000.

Overlays Speed Computer Communications

INTERCHANGEABLE overlays on control keyboards permit a new computer communications system to perform 126 different preprogrammed routines.

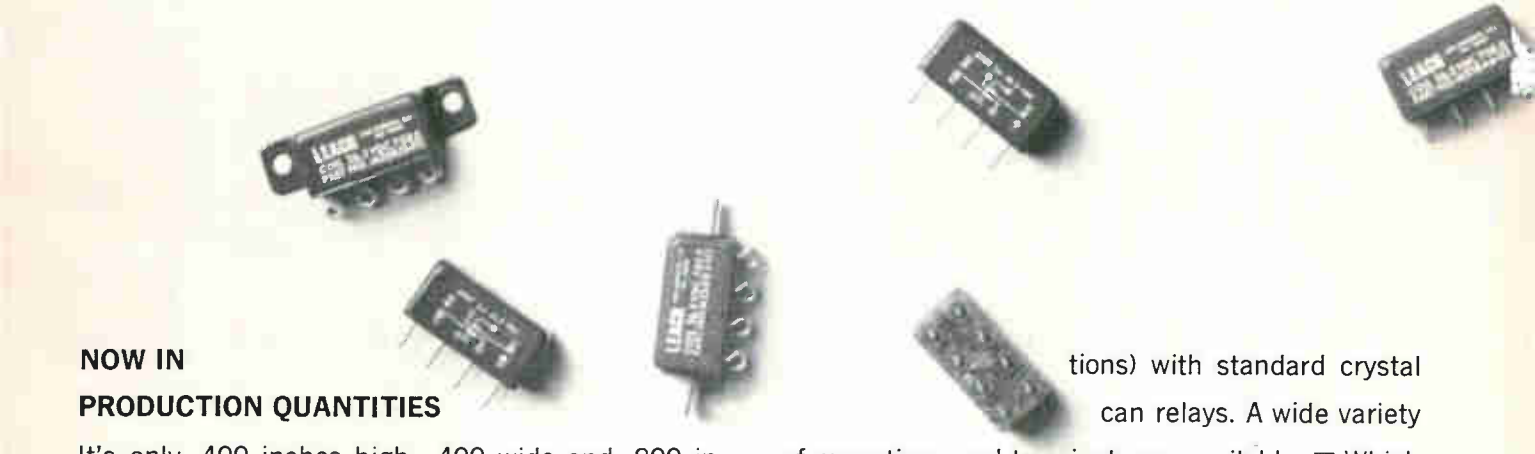
Produced for Air Force Systems Command's Electronic Systems Division by the RW Division of Thompson Ramo Wooldridge, the system includes two computer communication consoles and a display interface buffer.

English-language engraved plastic overlays for each key on the console keyboards allow variable use of an associate preprogrammed computer. According to the overlays used, unique electrical connections are made within the console circuits. Under this arrangement, the TRW system communicates with the computer at a rate of up to 100,000 words per second. Cueing lights associated with each of 30 keys on each keyboard are programmed to guide an operator through a logical sequence of operations.

Each console has a magnetic-core memory with associated read-write and selection circuits that accept computer and operator data for transmission to a crt display. Digital circuits in the buffer unit format information for the display and control elements.

A full display of 2,222 characters calling out symbols or line segments is obtained on a crt at a refresh rate of 45 or 30 cps. Call-out is one-third more at 30 cps than at 45 cps. A hand-held photoelectric pointer indexes individual points on the display so that a variety of analytical programs can be developed by the console automatically.

NEW LEACH HALF-SIZE CRYSTAL CAN RELAY



NOW IN PRODUCTION QUANTITIES

It's only .400 inches high, .400 wide and .800 in length. This smallest of the Leach relay family is also the lightest – only .25 ounces. ☐ Most important is its performance. It gives full-size results in low level to 2 amp. switching and is completely interchangeable (including internal terminal connections) with standard crystal can relays. A wide variety of mountings and terminals are available. ☐ Which reminds us, Leach has a complete line of standard size subminiature crystal can relays, too. Yes, when it comes to relays, any way you look at it, you should

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MEETINGS AHEAD

VALUE ENGINEERING & ANALYSIS CONFERENCE, EIA; Statler-Hilton Hotel, St. Louis, Mo., **Oct. 1-2.**

COMMUNICATIONS NATIONAL SYMPOSIUM, IRE-PGCS; Hotel Utica and Municipal Auditorium, Utica, N. Y., **Oct. 1-3.**

SPACE ELECTRONICS & TELEMETRY NATIONAL SYMPOSIUM, IRE; Fontainebleau Hotel, Miami Beach, Fla., **Oct. 2-4.**

ELECTRICAL ENGINEERS FALL GENERAL MEETING, AIEE; Pick-Congress Hotel, Chicago, **Oct. 7-12.**

NATIONAL ELECTRONICS CONFERENCE, IRE, AIEE, et al; Exposition Hall, Chicago, Ill., **Oct. 8-10.**

AUDIO ENGINEERING SOCIETY ANNUAL FALL CONVENTION; New York, N. Y., **Oct. 8-12.**

MAGNETOHYDRODYNAMICS CONFERENCE, Michigan State University; at the University, East Lansing, Mich., **Oct. 10-11.**

AEROSPACE ELECTRICAL ELECTRONIC EQUIPMENT & SYSTEMS DISPLAY, Aerospace Electrical Society; Pan Pacific Auditorium, Los Angeles, **Oct. 10-12.**

URSI-IRE FALL MEETING, URSI, IRE-PGAP, et al; Ottawa, Canada, **Oct. 15-17.**

SPACE PHENOMENA & MEASUREMENTS SYMPOSIUM, IRE; Statler-Hilton Hotel, Detroit, Mich., **Oct. 15-18.**

INSTRUMENT-AUTOMATION CONFERENCE AND EXHIBIT, Instrument Society of America; Coliseum, New York City, **Oct. 15-19.**

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

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

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

ADVANCE REPORT

PACIFIC COMPUTER CONFERENCE, AIEE; *California Institute of Technology, Pasadena, Calif., Mar. 15-16, 1963. Oct. 31 is the deadline for submitting four copies of a 500-word abstract to: Mr. S. Nissim, Program Chairman, Thompson Ramo Woolridge, 8433 Fallbrook, Canoga Park, Calif. Conference theme is faster information processing with emphasis on improvements in working devices and techniques as well as significant new concepts.*

Sigma Cyclonome®, a new class of motor. Delivers 5 inch-ounce torque in precise 18° steps, up to 450 steps/sec., on simple drive circuits. No stand-by power to maintain holding torque. 5.5 cubic-inch package.

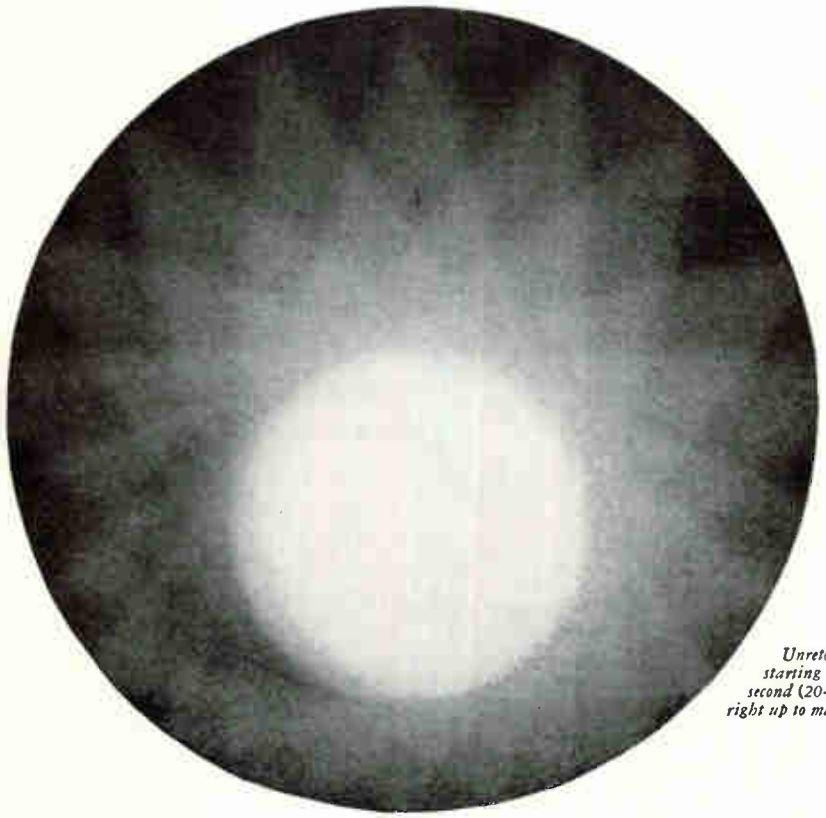
Here is a remarkable source of precisely-controllable driving torque supplied in handy 18° increments, which has so many unique advantages over conventional devices that it's a shame to call it just a "stepping motor." This high torque Cyclonome is now being used or evaluated for use in such things as punched paper and magnetic tape drives, process control instrumentation, digital to analog converters, business machines, automatic control systems, counters, computer peripheral equipment and a wide variety of rotary switching, positioning and indexing devices. Here are the main reasons it will pay you to consider a Cyclonome for your application.

The shaft starts and stops instantly on command from the input, within ±½° on each 18° step, delivering torque in exact proportion to and at the same rate as the input. Speeds up to 450 steps/second are achieved with maximum torque. Random pulses or noise of the same polarity cannot make the Cyclonome take "extra" steps or run backward; remote positioning can be done without feedback. Successive ampere-turn reversals in the stator winding are required for the motor to step. Stepping accuracy is non-cumulative and superior to that of any other motor we know of.

Drive circuitry for this unique "rotary actuator" is far less complicated and voracious than with other devices: with no changes, the same motor can be operated on either 60-cycle AC, DC drive with switches or relays, oscillators, transistor flip-flops or other means, without complex sequential switching. And because the high (7 inch-ounce) holding torque requires *no* power (*magnetic* detent), power requirements are lowered further.

Inherently long life, high reliability and noiseless operation come from the best source: very few parts and only one that moves. There are no catches, solenoids, escapements, ratchets, slip rings or brushes; principal parts are two large alnico magnets, a stator winding, and a small solid toothed rotor turning in miniature pre-loaded ball bearings. High shock and vibration immunity results from the rugged sandwich-type construction.

Present versions of this new class of motor include the High Torque Series described here, Standard Uni- and Bi-directional types and a Miniature, High Speed Series. Basic design, performance and application data on all Cyclonome motors are contained in a new and comprehensive Cyclonome Technical Bulletin. Write for your copy now.



Unretouched photo of Cyclonome starting and stopping 450 times per second (20-18° steps per revolution right up to maximum speed).

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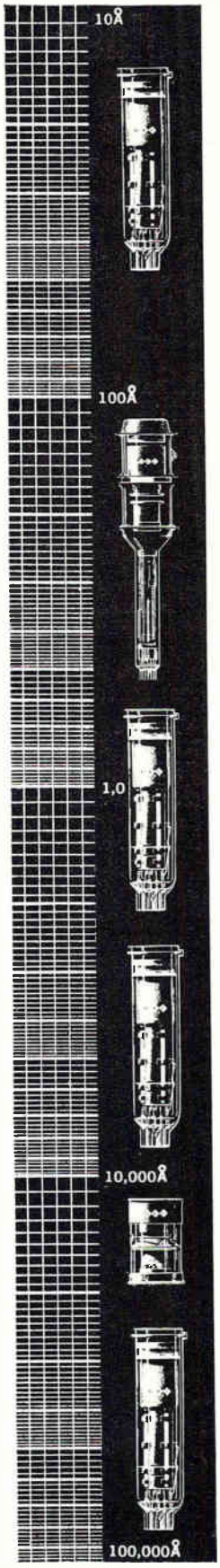

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Transistorized with printed circuit modular components, GEC Scan Conversion Units incorporate the most advanced technological developments available for controlled conversion from one scanning mode to any other.

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The make-or-buy decision in IF amplifiers is made easy by AIL's complete new line of Type 134 transistorized and hybrid strips. Good design has created a line that meets AIL's high standards of performance. (Yours, too, we bet). *And* the design has kept the price deliciously low.

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For more information circle publication number 790.

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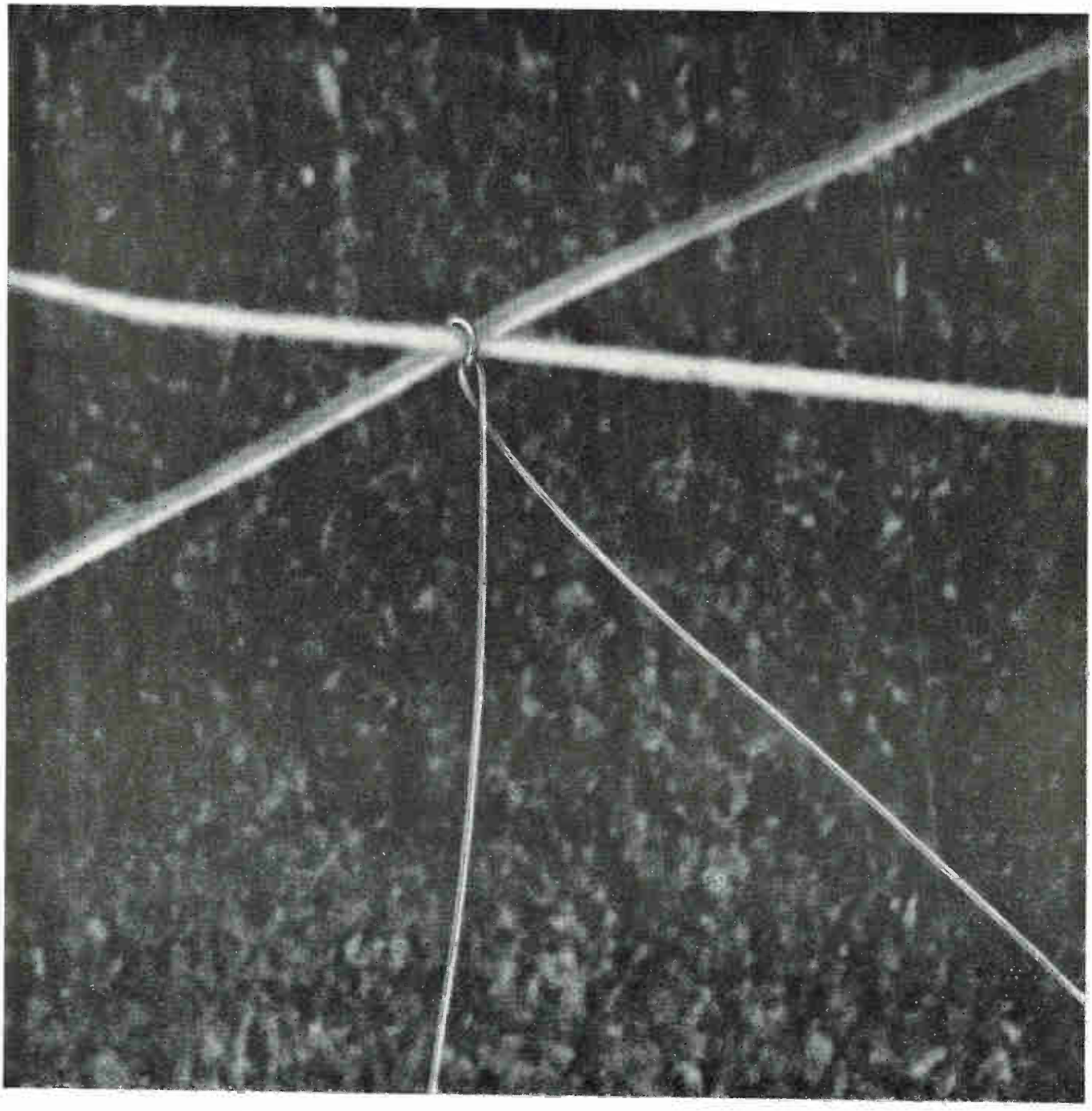

How fine can you get?

(with nickel alloy wire, ⅓ the thickness of a human hair)

The two thick bars in this magnified photograph are actually human hairs!

They're tied together with nickel alloy wire 0.0009-inch in diameter. Wire so fine that the men who make it work by touch rather than sight as they draw it through their diamond dies. Wire so fine that a pound of it would stretch more than 80 miles.

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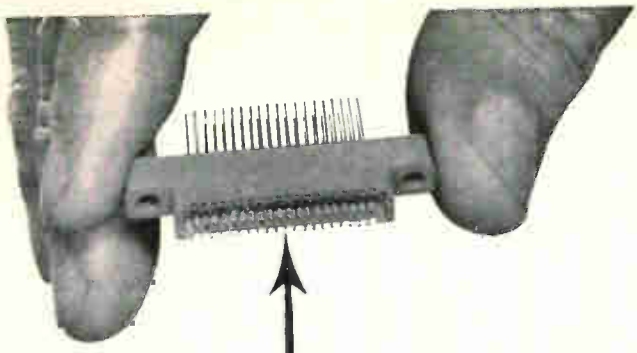
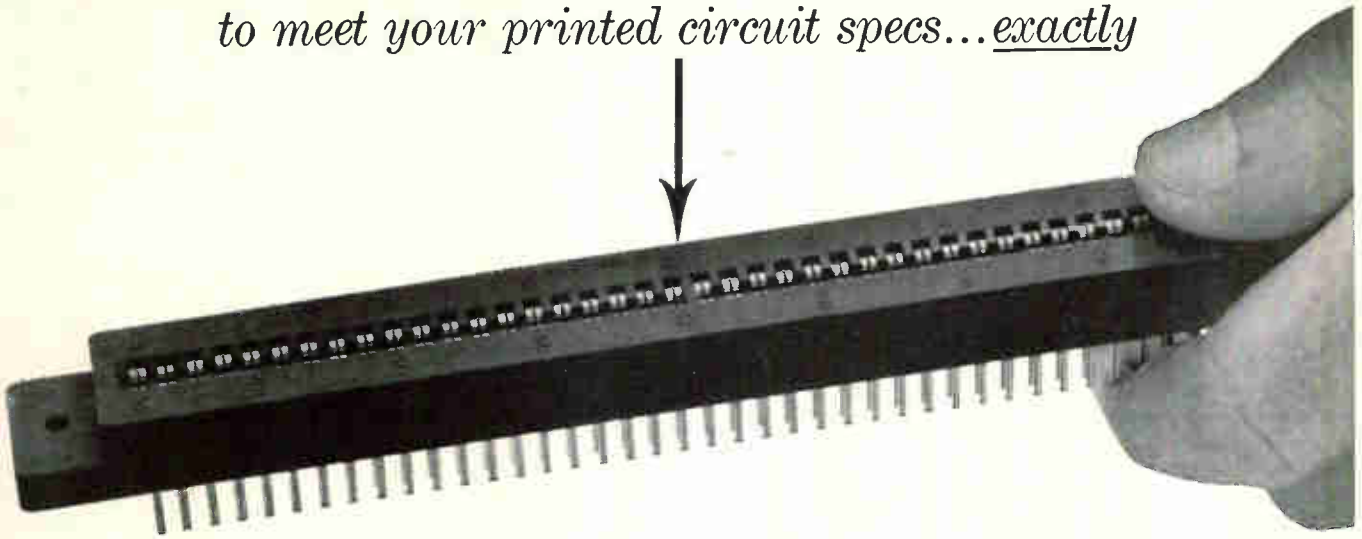


AND 67 SIZES IN BETWEEN

to meet your printed circuit specs...exactly



Continental's line of PC connectors include nearly seventy sizes and types. Name your requirement—and the chances are Continental has a standard production type that meets it *exactly*.

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New PC connector designs are constantly under development. Our Engineering Department will be pleased to assist you in solving special connector problems. Simply call or write, stating your requirements.

DESIGNERS' DATA FILE

If you're designing around printed circuits you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: **Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York, or call TW 9-4422.**

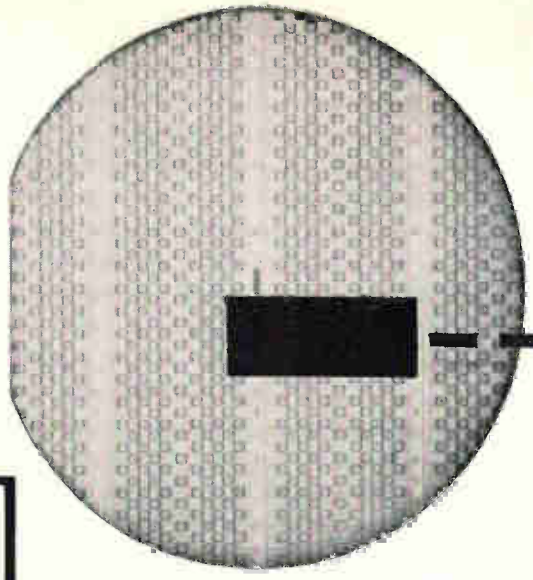
MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

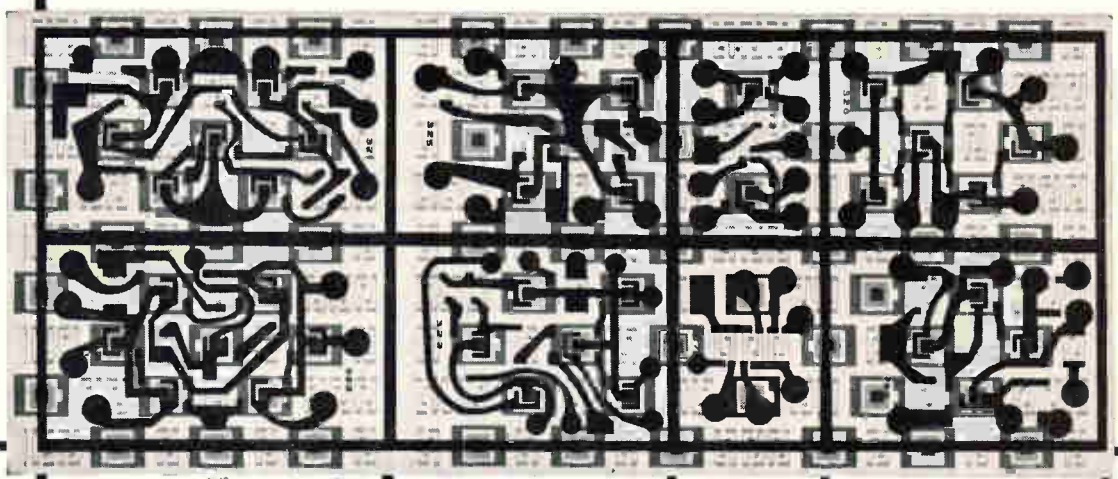
1

Silicon wafer is fabricated with a matrix of 1100 transistors and 4000 resistors . . .



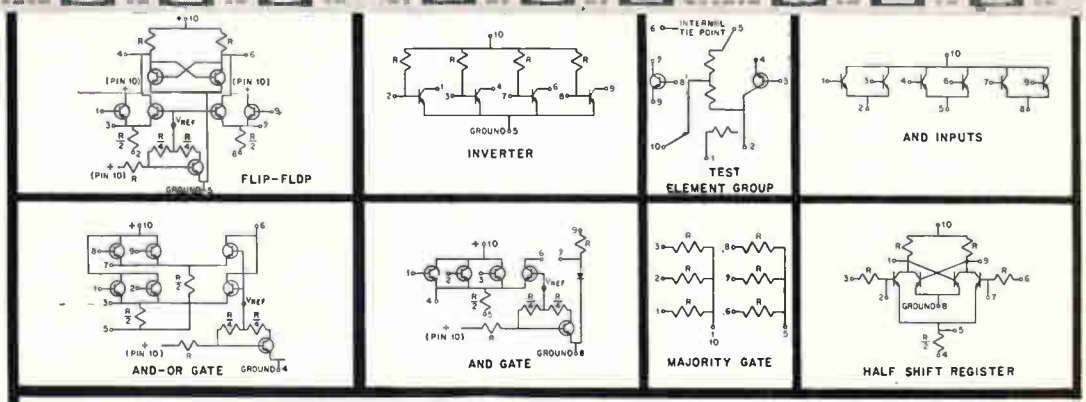
2

. . . which can be interconnected to produce a large variety of circuits as shown in this greatly enlarged section . . .



3

. . . such as these presently available ECLO circuits that feature 1) high fan-in and fan-out 2) high speed to power ratio 3) freedom from current hogging 4) low component count.



We will be pleased to send you complete data on how you can use M1 Matrix circuits in your computer applications, plus data on the now-available ECLO functional components. Please contact your General Electric Semiconductor District Sales Manager, or write Section 161140, Semiconductor Products Department, General Electric Company, Electronics Park, Syracuse, New York.

FUNCTIONAL COMPONENTS FROM GENERAL ELECTRIC

Planar Epitaxial Passivated M1 Matrix results in more flexible, reliable and efficient logic circuits. A variety of emitter-coupled logic operators are available now, with M1 Matrix circuits of your own design soon to follow.

The M1 Matrix is the practical answer to your use of miniature functional components. This is how it works:

On a silicon wafer approximately one inch in diameter are diffused 1100 transistors and 4000 resistors. Interconnections then are formed between these elements to produce over 100 different circuits. These circuits are cut and separately mounted in TO-5 headers with up to ten leads. The simplicity of the General Electric M1 Matrix results in these advantages:

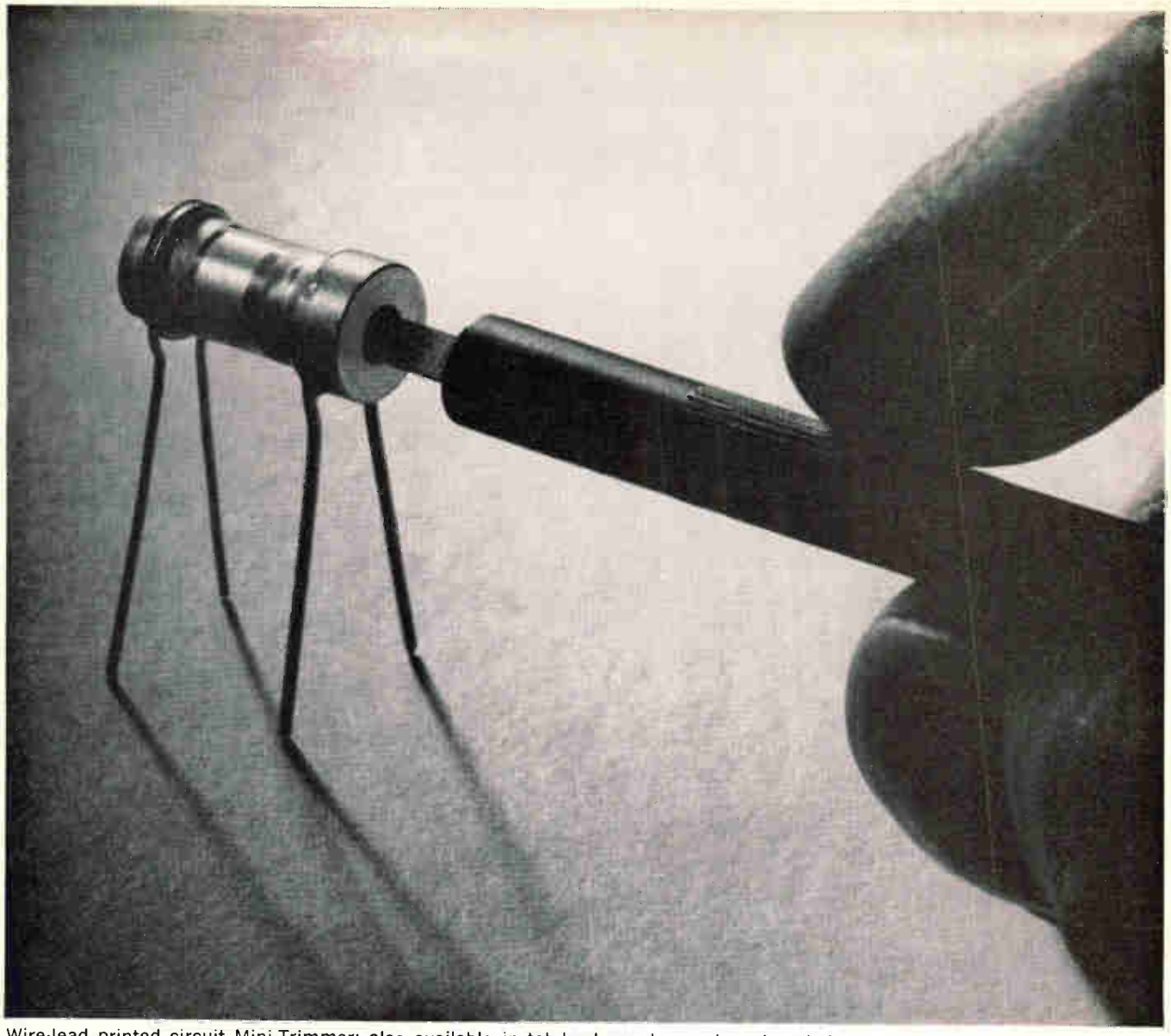
1 A tremendous variety of circuits can be obtained from a wafer. Presently available are several emitter-coupled logic operators (ECLO's) for your immediate evaluation and use. ECLO circuits feature 2 mc speed at an average of 10 mw of power, per operator, about one-sixth the power needed by direct-coupled transistor logic.

2 Lead time to produce new circuits or circuits to your own design will be inherently short.

3 Areas of the wafer can be reserved as "test elements" to determine performance characteristics and reliability of all the circuits on the wafer. All circuits will be numbered so as to maintain historical record.

4 The Planar Epitaxial Passivated diffusion process is used for its high performance, high reliability characteristics. Transistor specifications are similar to the high speed 2N914 type, with exceptionally low saturation resistance.

GENERAL ELECTRIC



Wire-lead printed circuit Mini-Trimmer; also available in tab-lead panel mount, and sealed types.

High Q—500 at 50 Mc*

and 5 other reasons Corning Mini-Trimmers give you better circuits

No tuning breakage—unique *direct traverse* design moves tuning core without rotation.

Complete linear tuning—DT motion and fine-thread screw give smooth precision, capacitance change per turn of 0.4 to 0.6 *pf*.

Shock and heat resistant—the ruggedly simple units of glass, fired-in metallizing, and special hardware can take tremendous abuse. TC is ±50 to ±100 ppm/°C.

Guaranteed: no capacitance reversals—we guarantee this within the range of the unit.

Lower contact resistance—all hardware is silver plated; this boosts circuit Q, too.

You get all this and high Q, too, in panel mount, wire- or tab-lead printed circuit, and our *new* hermetically sealed Mini-Trimmers. Four sizes in each type to give you *pf* min.-max. ranges of 1-4.5, 1-8.5, 1-12, and 1-18 at 1000 DC volts.

Dimensions: panel mount, $^{27}/_{64}$" to $1^{3}/_{32}$" behind panel, $^{1}/_{4}$" front of panel; printed circuit, $^{27}/_{64}$" to $1^{3}/_{32}$" overall.

You can get *fast* delivery on Corning Mini-Trimmers from your nearest Corning distributor. You can get more information and data sheets fast from us—Corning Glass Works, 3901 Electronics Drive, Raleigh, N. C.

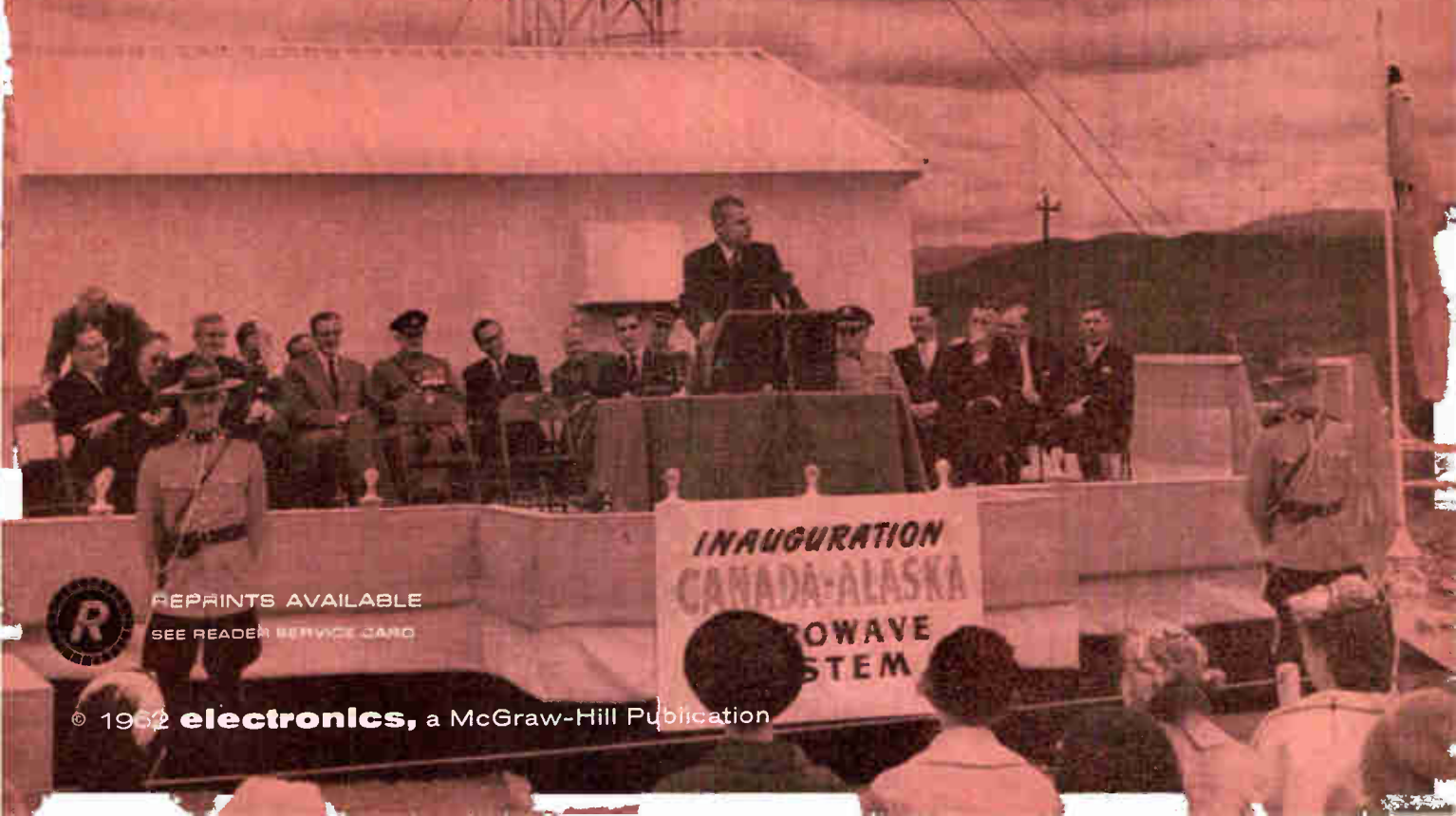
**Guaranteed*—unusual footnote, eh? The glass we put into these trimmers has a loss factor of only 0.50. Nobody else uses it. We make it ourselves, control it all the way.

CORNING
Electronic Components

ELECTRONICS IN CANADA

BY **S. FROUD,** ASSISTANT EDITOR

- RAISING AN INDUSTRY BY ITS BOOTSTRAPS
- TURNING IDEAS INTO HARDWARE
- NEW CANADIAN PRODUCTS
- RESEARCH AND DEVELOPMENT
- CANADA'S PROSPECTS FOR TRADE



RAISING AN INDUSTRY BY

* *Canada hopes to achieve a favorable balance of trade by overcoming her reliance on raw-materials exports and increasing her exports of manufactured products*

* *The Canadian government is supplying both cash and ideas to promote industrial research and development*

* *The electronics industry, just recovering from a recession, seems to offer the best return for the government's pump-priming dollar*

CANADA, LONG RENOWNED as a mining country and source of basic minerals and metals, now turns her attention to the more exotic elements used by the electronics industry. Many semiconductors are produced in Canada (Cominco)

CANADA (actuallly Newfoundland) was at the receiving end of the world's first transatlantic broadcast. Photograph of Marconi with his early apparatus is from Canadian Marconi Company files

CANADIAN ELECTRONICS: INCREASED EXPORTS A DOMINANT THEME

World markets for Canada's traditiona raw-material exports—timber, newsprin minerals, agricultural produce — ar roughly constant, hence increased expor to reduce Canada's trade imbalance mu come from her manufacturing industries

Canada's population is less than on tenth of America's yet it is stretche 4,000 miles between Canada's Atlantic and Pacific coasts, with most Canadian living within 100 miles of the U.S. border In a country larger than the U.S., onl about one tenth the land area is devel oped, Fig. 1.

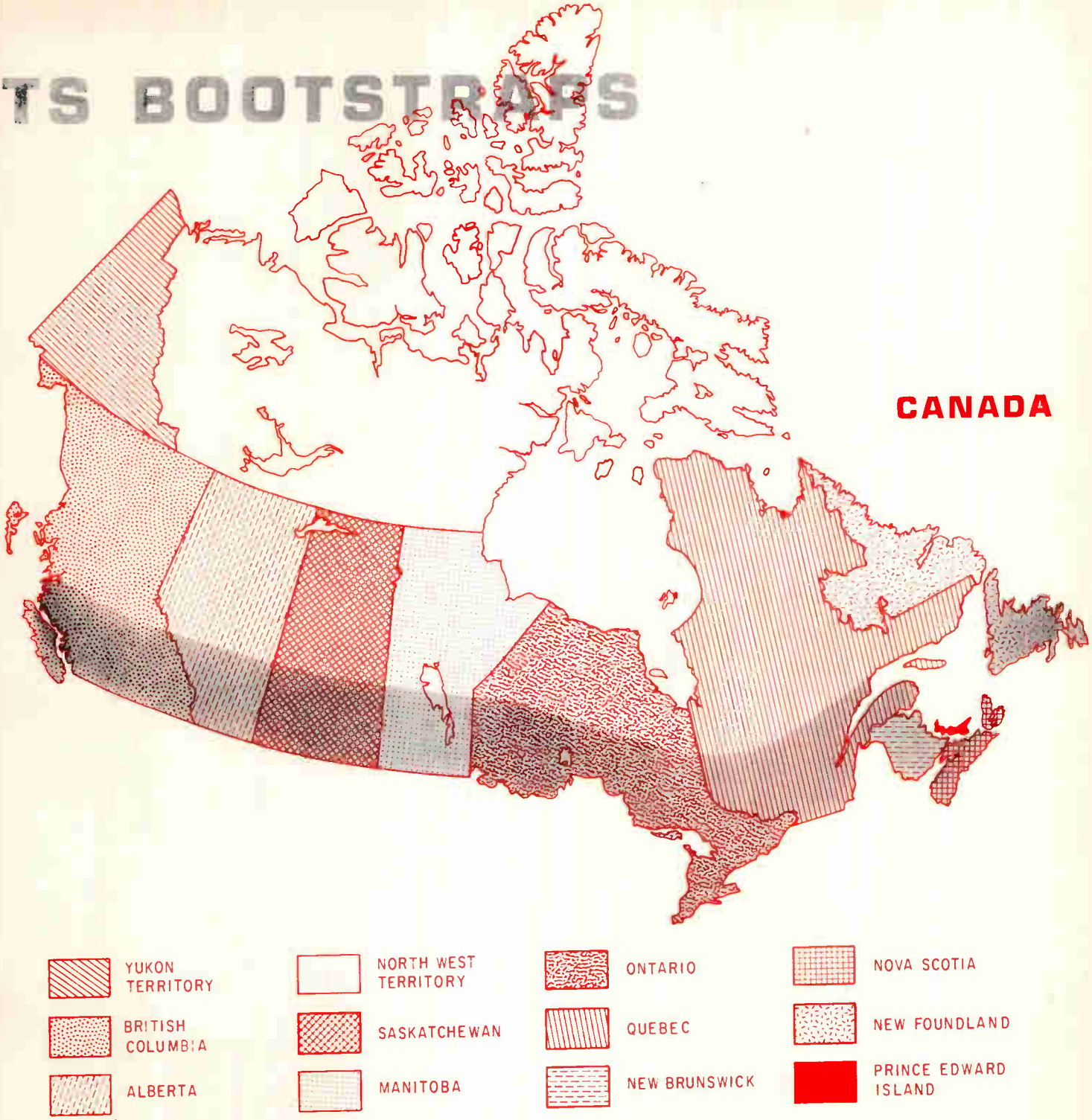
An electronics manufacturer in New York has a larger market in his imme diate vicinity than his Toronto counter part has in the whole of Canada. Althougl Canadian wages are somewhat lower tha U.S. wages, Fig. 2, this competitive ad vantage is offset by Canada's high tran portation costs and lower productivit arising from smaller sales volume.

But, low productivity and long shippin distances are not serious obstacles fo sophisticated electronics exports, and i this field Canada hopes to carve a nam for herself just as the Swiss have don in watchmaking. Electronics firms ir Canada think that by far the best returr for the Government's export and r& pump-priming dollar will be achieved b investment in the Canadian electronic industry

ELECTRONICS COVER . . .

Twelve coats of arms represent the ten self-governing Canadian Provinces, plus the Yukon and Northwest Territories which are administered directly from Ottawa

Frontispiece—Canadian Premier John Diefenbacker opens the Canada-Alaska microwave link. The $25 million system built for Canadian National Telecommunications by RCA Victor stretches 1,300 miles from Grand Prairie in Alberta to Mount Dave on the Yukon-Alaska border



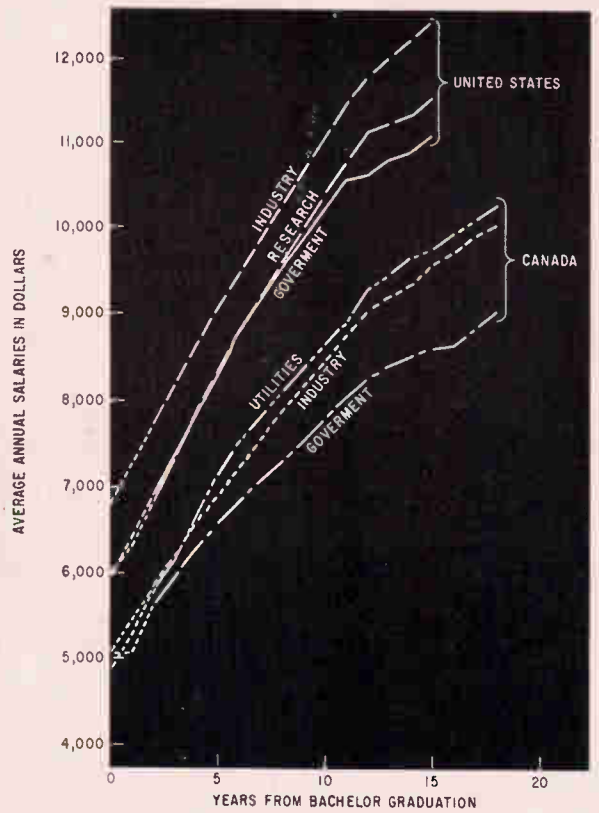
MOST CANADIANS live within 100 miles of the U.S. border, shown by gray band across map. Only about one tenth of Canadian territory is developed owing to the cold climate—Fig. 1

CANADIAN ELECTRONICS INDUSTRY can be charged with hiding its light under a bushel. Many of Canada's neighbors familiar with her raw-materials exports are only vaguely aware that Canada has any electronics industry at all.

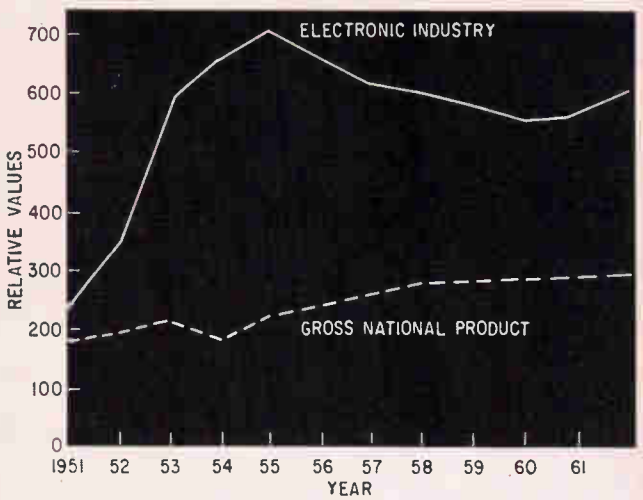
Yet a Montreal firm has built the communications package for the Project Relay satellite which will rival AT&T's Telstar. Another Canadian firm sells doppler radar to a dozen of the world's airlines, the USAF as well. A third was a major factor in parametric amplifier sales in 1961.

In rocket studies of the upper atmosphere, Canada launches the instrumentation payload from a surplus naval gun. The electronics package withstands and acceleration up to half a million g's. In research, Canada's long experience of magnetic surveying is put to use in submarine detection equipment. Ingenuity is not what Canada lacks.

The Canadian electronics industry is recovering from



CANADA has world's second highest standard of living despite lower salaries than U.S. Lower engineering wages in Canada usually means one car in the garage instead of two—Fig. 2 (NRC)



GROWTH of Canada's electronics industry is becoming evident following a recent recession.—Fig. 3 (CEE)

a depression that set in around 1956, as indicated by Fig. 3. In 1955 annual sales by the industry totaled nearly half a billion dollars. During 1962, the figure is expected to exceed $450 million after climbing back from a drop to $430 million in 1960.

There are two basic causes for this depression. A change in Canada's defense procurement policy caused major project cancellations in 1956-58. And home sales of consumer goods reached saturation following rapid growth to a 1955 peak.

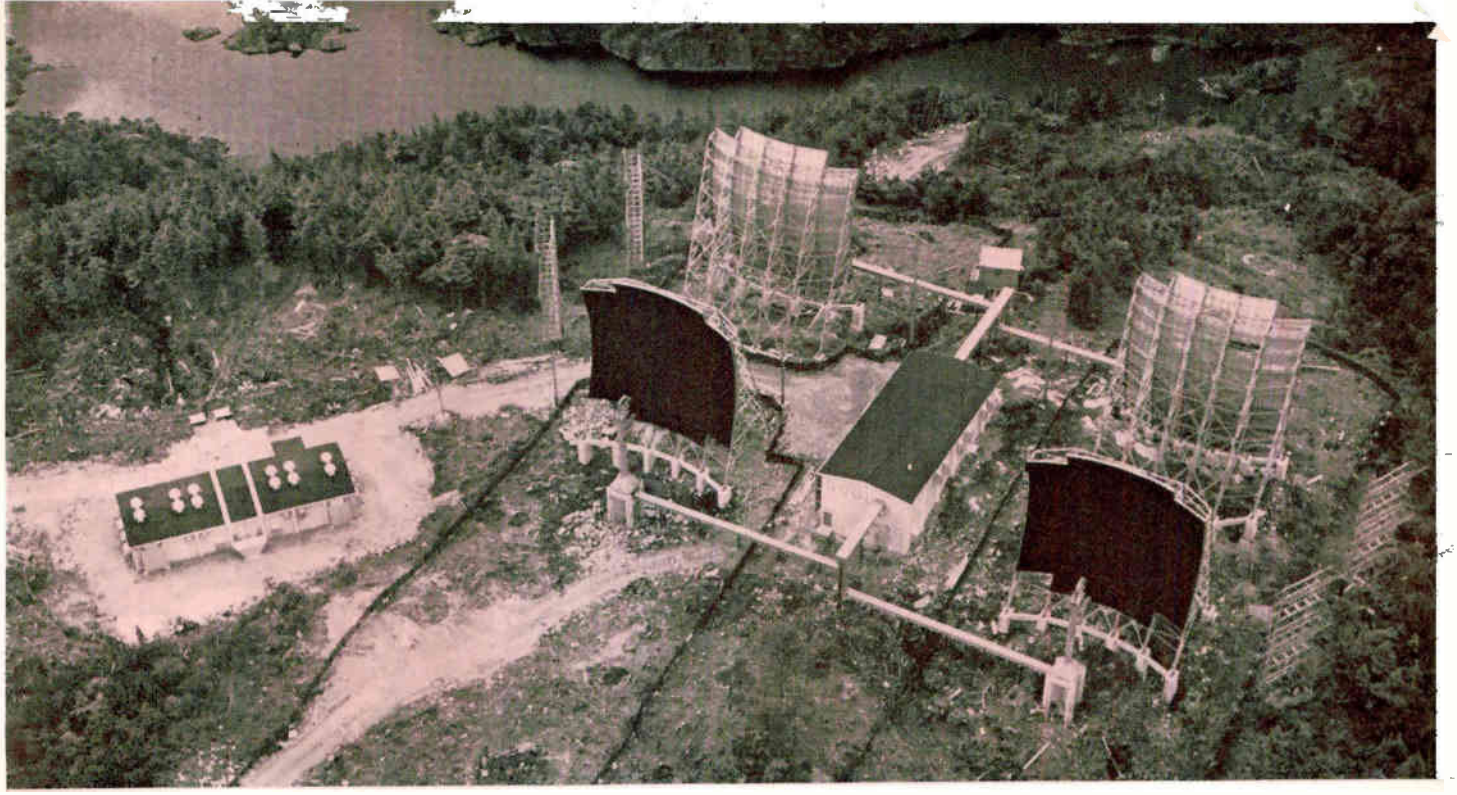
In 1958 the Canadian government switched to a new defense procurement policy of buying military hardware wherever needed equipment could be obtained most economically. Cancellation of the large Arrow fighter-plane contract as a consequence of this policy caused large-scale disruption of many industries, the electronics industry included.

One of the most serious but indirect results of the defense cancellations was the loss to Canada of much of her r&d capability. Firms with no contracts to support extensive r&d fired high-caliber engineering teams that they had so painstakingly built up. Many of the discarded engineers emigrated to the U.S., or returned disillusioned to the United Kingdom.

Only now is the electronic industry beginning to recover from its 1958 setback, and its level of r&d increase towards the NATO-recommended figure of 2.2 percent of gross national product. However, industry cannot build its hopes for expansion on the domestic market alone: it must look to exports for future gains.

A broad picture of the Canadian electronics industry, therefore, is of too many firms competing for the home sales dollar, with not enough r&d going on as yet to give them a competitive edge in the world-wide export market. On both counts the Canadian government is alert to the problems and has mustered an armory of incentives for increased r&d and for promoting a vigorous export campaign. It has also inaugurated a Canada-United States defense sharing pact to offset a one-way flow of defense spending.

SKILLS IN CANADA are as high as anywhere. This woman is a chief electronics inspector (NFB)



TROPOSPHERIC scatter communication covers distances beyond the horizon by bouncing signals off ionized atmospheric layers. Communications reliability is increased with two sets of transmitting-receiving antennas at this repeater station by Lenkurt, located on the north tip of Vancouver Island

TURNING IDEAS INTO HARDWARE

What the Canadian electronics industry is building

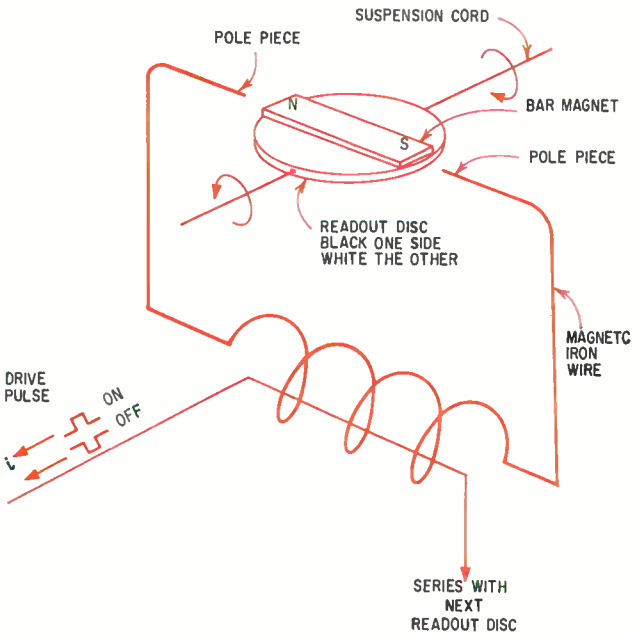
INDUSTRIAL MAKEUP—About forty percent of Canadian electronics firms are subsidiaries of foreign organizations. Since these firms are among Canada's largest employers, they account for some 80 percent of annual sales.

There are numerous advantages to operating in Canada as a division of an international organization. Among these advantages are: access to funds for expansion, flow of manufacturing and r&d knowhow, subcontracts from other divisions, and frequently, an overseas marketing network that can handle Canadian exports.

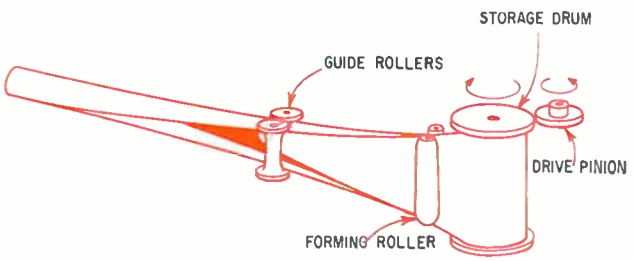
Disadvantages of being a subsidiary in Canada are related to the degree of autonomy permitted. Most subsidiaries were originally set up to supply the Canadian market; however, the market picture is constantly changing, and the electronics industry must export to expand, therefore, firms with independent Canadian r&d and manufacturing programs can cope best with the new situation. Firms that rely on the head office for design and manufacturing information generally face greater difculty in securing an export foothold.

There are conspicuous examples in Canada where a subsidiary company's independent r&d and manufacturing program has achieved millions of dollars in export business.

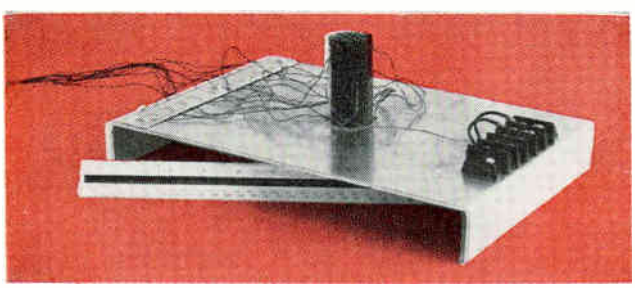
CANADA'S STRONG POINTS—Canada's vast geographical area and loosely spread population require communications equipment offering long-distance service between relatively small communities. Lenkurt in Canada has such a specialty. There are several other firms, subsidiaries like Lenkurt, that have poineered communications equipment specifically for Canadian use. Canadian Westinghouse Ltd. has developed



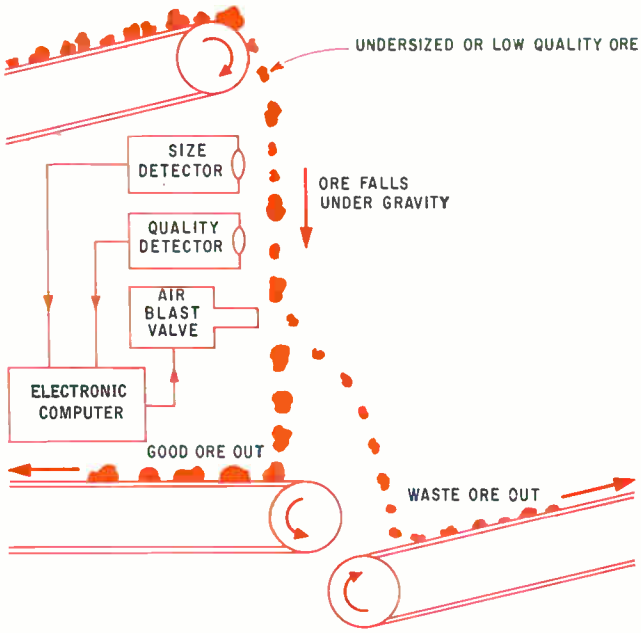
READOUT DEVICE uses an array of disks, black one side, white the other, instead of incandescent lamps. Polarity of input pulse decides whether disk shows its white or black surface. Magnet across disk face provides memory function. Ferranti-Packard



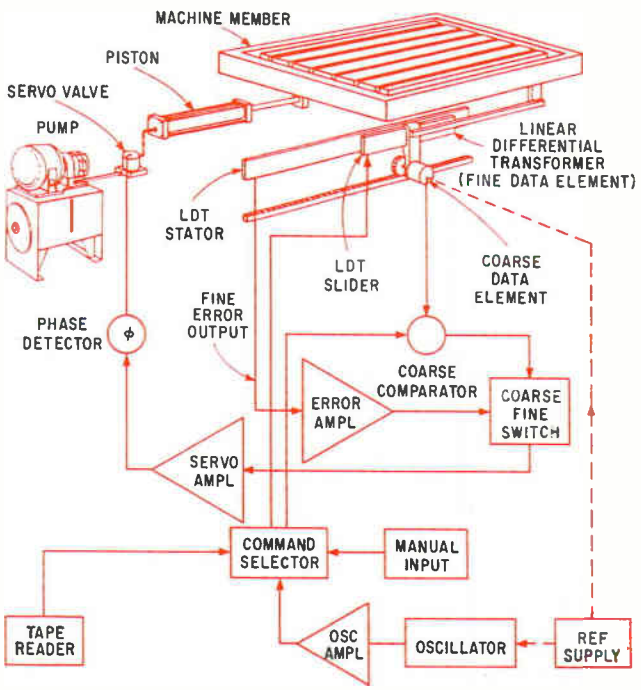
ENGINEERS have perfected this method of unwinding a steel ribbon so that it forms itself into a rigid cantilevered antenna. Lengths to 75 feet may be unreeled for satellite applications. De Havilland



NOVEL USE of thermoelectric cooling elements is in this constant temperature container for precision-oscillator crystals. The unit is being developed by Needco Frigistors Ltd, of Montreal



ORE SORTER by Electronic Associates of Toronto scans chunks of radioactive ore as they fall under gravity and rejects undersized pieces and those low in radioactivity. Nuggets are evaluated and tracked by the machine's computer, which triggers an air jet to blast rejects onto the waste conveyor



NUMERICAL machine-tool-control uses Sperry linear resolver to achieve accuracies up to 0.0005 inch even when the table travels three feet. Nine-inch resolver units are joined end-to-end to multiply travel

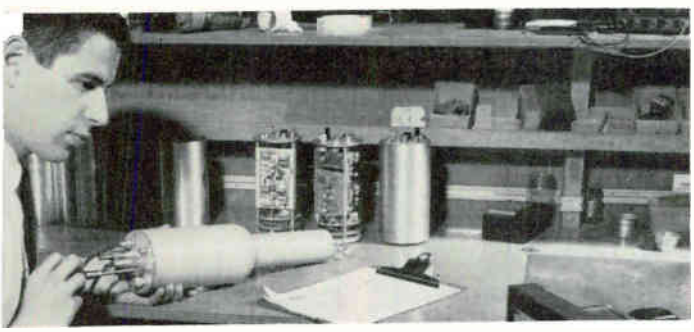
WHEN WILL CANADA'S ELECTRONICS INDUSTRY MIGRATE WEST?

Lenkurt's electronics plant in Vancouver with a total staff of 450 is about the biggest electronics employer west of the Canadian Rockies. Yet most Canadians in Vancouver feel that their province is ripe for an electronics boom such as California has experienced within the last couple of decades.

Vancouver is nearer Los Angeles than it is to Canada's own electronics center of Toronto-Montreal. The Vancouver climate is not unlike that of San Francisco.

CANADIAN antimortar radar. Raytheon Canada is producing nearly a dozen of them under government contract. National Research Council developed the equipment. The government now hopes to find extensive NATO and U.S. markets

SOUTHERNMOST TIPS of Ontario are at the level of northern California but the Canadian climate is not always as warm. This CNT microwave tower in Newfoundland beams its signals across the Cabot Strait to the mainland even in a storm



RADIATION DETECTOR differentiates between two types of nuclear particles by distinguishing between their different energy levels. It is being adjusted at the plant of Nuclear Enterprises in Winnipeg

tropospheric scatter equipment that provides over-the-horizon communications from a mobile transmitter-receiver setup.

Spilsbury and Tindall in Vancouver have experience dating before World War II in manufacturing communications equipment for fishing boats, fur trappers, mining communities and similar remote use.

In telephone communications too, the need for low channel long distance traffic follows the same pattern. Northern Electric Company, which is the manufacturing subsidiary of the Bell Telephone Company of Canada, has developed equipment specifically for Canadian use.

Another Canadian firm that has achieved considerable success in the communications field is RCA-Victor. This firm has pioneered in microwave communications, and has completed a 1300 mile 600 voice-channel microwave system through the Yukon to Alaska on behalf of Canadian National Telecommunications. The system is now used for traffic between the BMEWS base, in Clear, Alaska and the SAC headquarters in Colorado Springs. RCA-Victor has also contracted to supply $5 million of microwave communications for linking Turkey, Iran and Pakistan, and a $12-million contract with Canadian National Telegraph-Canadian Pacific Telegraph, for a 3,000 mile trans-Canada system capable of carrying data and television signals between major Canadian cities.

Besides communications equipment, Canada's extensive geography has led to the development of another Canadian speciality: electronic navigation aids. Marconi company in Montreal has sold doppler radar to a dozen of the world's airlines and also to the USAF. Aviation Electric Ltd has developed navigation equipment for military vehicles, including tanks. Computing Devices of Canada Ltd has pioneered a sophisticated array of black boxes that permit a pilot to switch-in up to 12 successive destinations—the equipment then gives him continuous information on how to get there. Sperry Company of Canada Ltd make and service gyro equipment for Canadian and NATO governments.

Further Canadian electronic specialities stem from Canada's raw-materials processing industries. Electronic devices are used extensively in monitoring newsprint production and quality, in checking moisture content of grain, in calculating the volume of logs used for woodpulp, and in various aspects of locating and processing radioactive and other Canadian ores.

Electronic Associates Ltd, of Toronto, is exporting a system that makes a continuous quality-and-size check on high volume ore flow and rejects undersized or low-grade pieces. A Winnipeg firm: Nuclear Enterprises Ltd, exports 80 percent of its radiation monitors to the U.S. and has developed commercial monitors capable of simultaneously distinguishing and measuring three different

Many Canadians retire to British Columbia. Lenkurt's John Mathers was born and raised there; it would take a lot to drag him away. Mathers can go hunting (and does) within 40 minutes from his home. He also lives about 20 minutes from downtown Vancouver.

There is no lack of skilled engineering talent in British Columbia. Many engineers move there and accept jobs beneath their capabilities because they feel the climate makes the sacrifice well worthwhile.

Professor George Walker, of the University of British Columbia, told ELECTRONICS *that he gets 40 or 50 replies to an ad seeking laboratory technicians or machine-shop men. At least half of them, according to Professor Walker, are equipped to fill his single vacancy.*

Thus, the foundation for electronics expansion in British Columbia already exists

RIVAL TRADE GROUP

Edward A. Speers, the president of Nuclear Enterprises Ltd, Winnipeg, has an extramural activity as president of a trade organization which he founded—the Association of Canadian Manufacturers. Membership is limited to firms with Canadian ownership and control.

Speers insists that his is not an anti-American organization, even though it opposes the older Canadian Manufacturers Association, whose members include U.S. subsidiaries. Speers points to his firm's exports, 80 percent of which go to the U.S., as evidence of his enthusiasm for good Canada-U.S. relations.

According to Speers, the Canadian Manufacturers Association does not "promote the growth of home industry" for which purpose it was inaugurated in 1879. Instead, Speers insists, it represents the interests of foreign sidiaries in Canada. Opponents of the ACM, and they include some all-Canadian firms, suggest that Canadian controlled companies should put their views to government through the regular CMA by ordinary democratic voting processes.

This is not possible, Speers contends, since Canadian firms are outnumbered and outvoted when trying to make such attempts

types of radiation. A Canadian Government owned organization: Atomic Energy of Canada Ltd develops and sells a range of nucleonics devices many of which are licensed to U.S. and other manufacturers.

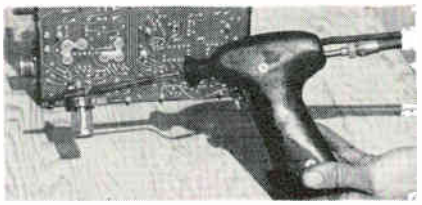
Canadian firms also originate scientific breakthroughs: RCA-Victor has achieved success with a research program on gamma detectors using semiconductor junctions. This firm has pioneered a silicon-junction-equivalent of an ionization chamber that is small enough to fit into a standard transistor can. An advantage of the new device is that the actual detecting junction is exposed to within a few microns of the incident radiation. De Havilland of Toronto has devised a novel retractable tubular antenna for satellites, while Ferranti-Packard has pioneered an ingenious readout device.

CONVENTIONAL ELECTRONICS—Besides the specialized electronic equipment that springs naturally from Canada's geographic and industrial environment, Canadian firms produce a wide variety of instruments and systems common to all advanced nations. For example, Ferranti-Packard of Toronto has supplied check-processing equipment to a number of commercial banks, including some in the U.S., and has also supplied a centralized computer reservations system to a Canadian airline. Equipment for numerical control of machine tools is manufactured in Canada by Sperry Canada Ltd; Northern Electric Company manufactures high-quality para-

NEW CANADIAN PRODUCTS

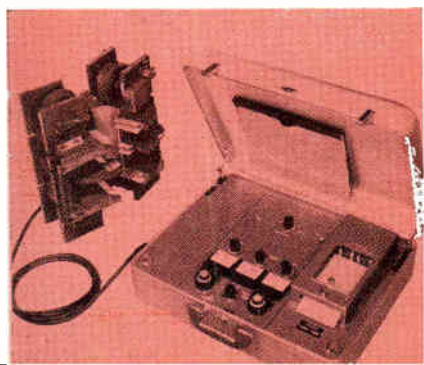
Canadian firms do not lack ingenuity, as these representative items show

RETRACTABLE ANTENNA UNIT. Antennas of this type are used in the U.S. Gemini program, and in Canada's own Topside Sounder satellite. The mechanism unreels a steel tape into a rigid tubular antenna up to 75 feet long. DeHavilland Aircraft of Canada, Ltd, Malton



SOLDERING IRON REMOVES BLOBS. Vacuu fitting sucks surplus solder away from i tricate printed-circuit wiring to avoid sho circuits. General Electric Company o Canada, Ltd, Toronto

ELECTROMAGNETIC ROPE TESTER. Tes steel cables nondestructively. Magneti inspection unit fits around elevator cable and checks for flaws in individual steel strands. Reveals dangerous flaws tha would otherwise be undetectable. McPha Engineering Ltd, Don Mills, Toronto



metric amplifiers for export, and makes its own varactors and various close-tolerance transistors and diodes.

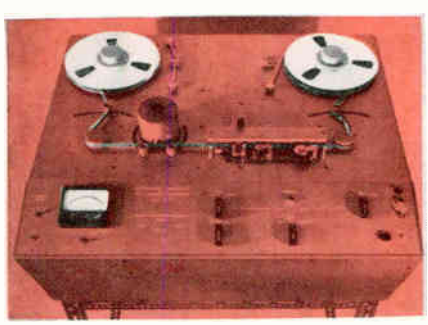
By selling million-dollar flight simulators to NATO governments, Canadian Aviation Electronics saves the customers considerably greater investment in actual F-104 fighters and in upkeep costs that additional trainer aircraft would entail.

In the broadcast equipment field, Canadian General Electric Company is one of several Canadian firms, including Northern Electric and RCA-Victor, who sell radio and tv transmitting equipment to domestic and foreign broadcasters. Canadian GE is also one of the Canadian manufacturers of closed-circuit tv for industrial applications.

CONSUMER ELECTRONICS—About 95 percent of tv receivers sold in Canada are manufactured by Canadian firms. Most of the imports are from the U.S. Canadian tv manufacturers describe the tv business in Canada as highly competitive. Aggravating the consumer business is the fractioning of the consumer manufacturing industry, with many firms producing at a quarter of the volume regarded as being economical in the U.S. According to the 1957 Royal Commission on Canada's Economic Prospects, foreign parents are more tolerant of losses in their Canadian subsidiary than would be permitted in the home plant. Consequently, many Canadian plants still produce for a largely-saturated market.

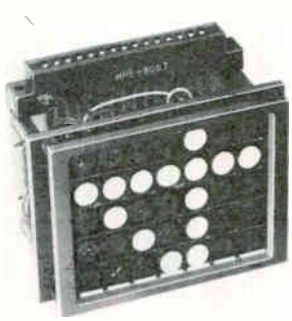
In 1955 some 21 Canadian tv manufacturers produced an average of 41,000 units each, while 45 to 50 producers in the U.S. produced an average of 164,000 units. There has been a decline in the radio receivers manufactured in Canada too. Although the total sales of radio receivers has doubled since 1955, this increase has been made up by imports, some 50 percent of them from Japan. There is much activity on the part of Canadian trade organizations to pin the blame on Japanese imports for taking over some 35 percent of the receiver sales; however, it is a moot point whether the sales upsurge would have arisen (see p 52) without low-cost imports. Certainly, tv sales have fallen since 1955 and to date there have been virtually no Japanese tv receivers entering Canada.

Canadian manufacturers specializing in consumer products have met greatest success when they have broken fresh ground and developed more specialized equipment for a particular market. Dominion Electrohome industries actually exports most of its hi-fi equipment to the U.S. Another Canadian firm, Clairtone Ltd, founded by a furniture designer and an electronic engineer, are exporting a wide range of audio and tv equipment, much of it to the U.S. Since both these firms are Canadian owned, they are able to compete in foreign markets where other Canadian subsidiary firms would be competing with a sister division of their own company. This is often not permitted.



TAPE RECORDER REPRODUCER. Operates as conventional recorder but examines waveforms of special interest with tape stationary. Rotary heads read information selected from a section of the stationary tape and present a continuous display on an oscilloscope. Can be used in seismological work to distinguish between wave patterns of nuclear explosions and earthquakes. Presentey Engineering Ltd, Ottawa

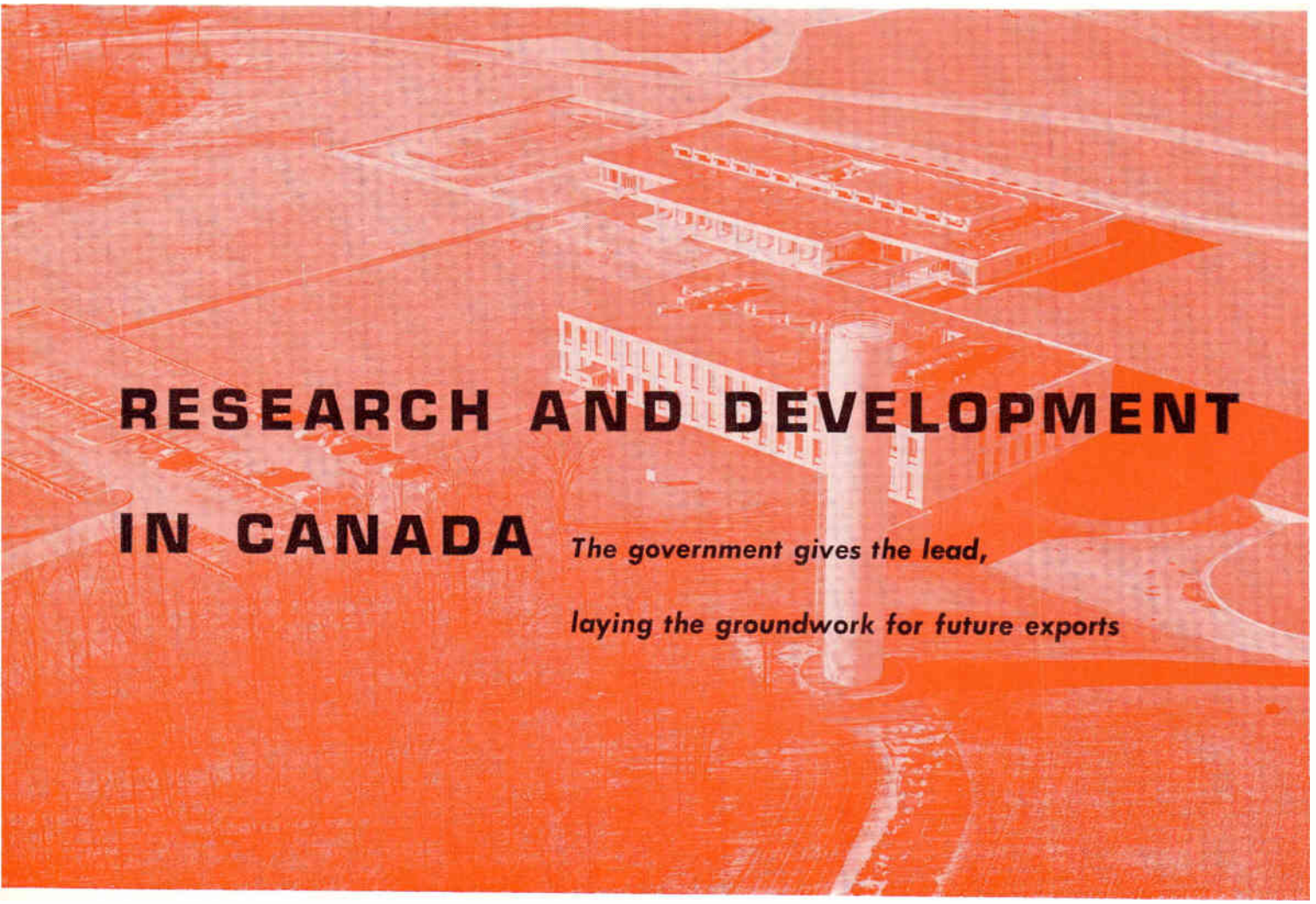
NUCLEAR PARTICLE DETECTOR. Semiconductor detectors provide a solid-state version of the traditional ionization chamber. New units range upwards from standard transistor size, are rugged and extremely sensitive. RCA-Victor Ltd, Montreal



LATCHING ALPHANUMERIC READOUT. Individually suspended disks, black on one side, white on the other, are pulsed in or out of view by the interaction of a magnetic field due to input current and the field from the bar magnet fixed across each disk's diameter. Readout needs no translating matrix of diodes: single wire threads all disks needed for a given symbol. Readout remains latched until reset by a succeeding input pulse of around 30 millisecond duration. Ferranti-Packard Ltd, Toronto

STEPPING TRANSMITTER AND RECEIVER. Uses microswitches to make a low-inertia, low-force, position transmitter. The system yields overall torque gain. Designed for a range of lightweight discrete-positioning functions. Muirhead Instruments Inc., Stratford

ELECTROSTATIC TRANSDUCER. Reproduces high-frequency audio signals from 24 by 6-inch panels only ¼ inch thick. Claimed free from vibration and operable without impedance matching transformers. Sigma Technical Associates Ltd, Longueuil, Quebec



RESEARCH AND DEVELOPMENT IN CANADA

The government gives the lead, laying the groundwork for future exports

NEW RESEARCH LABORATORY of Northern Electric just outside Ottawa will employ about 400 scientists and engineers

RESEARCH AND DEVELOPMENT GAP—Canadian r&d is noticably lagging behind the level necessary for Canada's technological capability to keep up with the rest of the Western World. A NATO report recommends that each NATO nation spend 2.2 percent of its gross national product on r&d. Canada spends less than a third of this. (Fig 1, p 48)

To encourage r&d, the Canadian government is offering industry a variety of incentives. They range from advice on problem solving, to tax incentives and direct subsidies. Under one scheme recently introduced, a Canadian r&d lab can carry out research for 22 cents on the dollar, and perhaps even for 12 cents.

GOVERNMENT ASSISTANCE WITH R&D—Three departments of the Canadian government are able to provide r&d funds for a range of industrial and military research projects.

(1) The Department of Defence Production—(DDP) provides for defense hardware development. A fund up to about $10 million is available annually for development of defense equipment. A lower-budget program provides upwards of half a million dollars annually to help firms get under way with components production.

(2) The Defence Research Board undertakes research and development work on behalf of the Department of Defence Production. Two sources of r&d funds are available from DRB.

First, the Electronic Component Research and Development Grant (ECRDC) provides funds for basic development in electronic components. To date about $2 million has been provided by this program. A high-temperature tantalum-dielectric capacitor is one result of the ECRDC program. The unit is being marketed commercially in Canada and licensed to US manufacturers.

The second industry-support program from the Defence Research Board through its Department of Industrial Research has an initial budget of $1.5 million which is allocated to a variety of industrial projects for fundamental r&d. However, there are provisions for bringing a piece of equipment to the prototype stage under a DIR plan.

(3) The National Research Council, a nonmilitary research arm of the Canadian government, has a financial support program with a budget of $1 million. Unlike the DRB's cost-sharing basis, the National Research Council offers to pay salaries for approved long term r&d programs. By doing so, it encourages the firm

SUCCESS THROUGH CANADIAN R&D

John Houlding, President of RCA Victor Ltd, Montreal, offers his formula for Canadian electronics expansion.

"During the last few years, RCA Victor Company Ltd. has progressed from a company largely dependent on our parent company, to an organization with important ideas, experience and capabilities of its own. We are not only extremely fortunate to be part of the Radio Corporation of America, but we are also proud that we are making our own contribution as a full-fledged member of the RCA family. We are standing up to international competition in specific areas and we are also called on to provide technical information and finished products from our factories and laboratories to our parent company in those areas, such as microwave communications, where we have proven capability. It is no longer necessary for our best people to leave Canada for more challenging work in the United States or elsewhere.

At RCA Victor, an organized program of research and development undertaken by Canadian scientists and engineers will maintain the position of the company as a leader in both electronic products for industry and entertainment for the home.

As RCA Victor is an integral part of the Canadian economic scene we are fully aware of the need for increased exports. By stressing research and development, we are placing ourselves in a more strategic position to develop products with export potential. This investment in the scientific brainpower of the nation is expected to bring about a steady increase in the sale of electronic apparatus at home and abroad.

As a Canadian subsidiary of an American company, we have demonstrated that through increasing technical self-sufficiency and a strong r&d program, that not only does Canada benefit, but it is also good business for the parent company as well"

to be more lavish in securing the best available researchers for the job.

TAX CONCESSIONS—Besides offering industry direct subsidies to encourage r&d, there are tax concessions that enable firms to do r&d for about 20 cents on the dollar. The plan allows Canadian firms to deduct r&d expenses at the rate of 150 percent on new projects started in the tax year. It is not clear yet whether a firm already receiving a government r&d subsidy will simultaneously be eligible to deduct its 150 percent on r&d expenditures; however, if this move were approved, a Canadian company would be able to undertake r&d for just over 12 cents on the dollar.

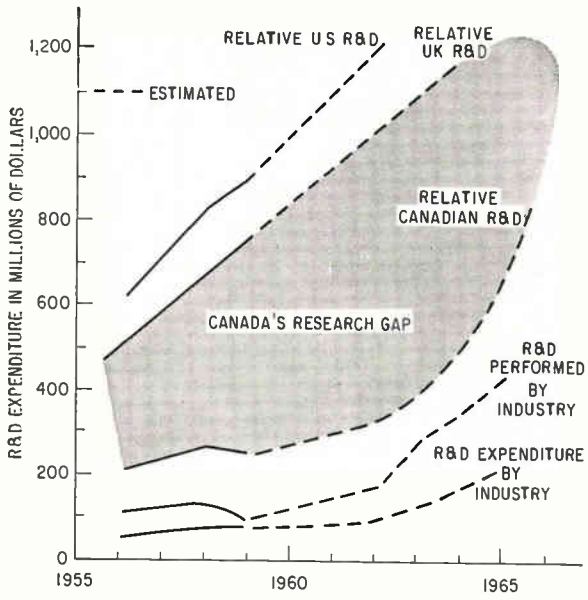
These programs are inducements to foreign firms to set up r&d facilities in Canada, and to encourage more r&d by Canadian subsidiaries.

THE ASSISTANCE GAP—Canada has an urgent need for products that can be produced with the minimum of long-term fundamental investigation. Yet the nonmilitary field is an area which government aid misses. Even tax concessions are not available to a firm with a bright idea but without funds to turn it into hardware. Some Canadians suggest that the government provide a loan pool

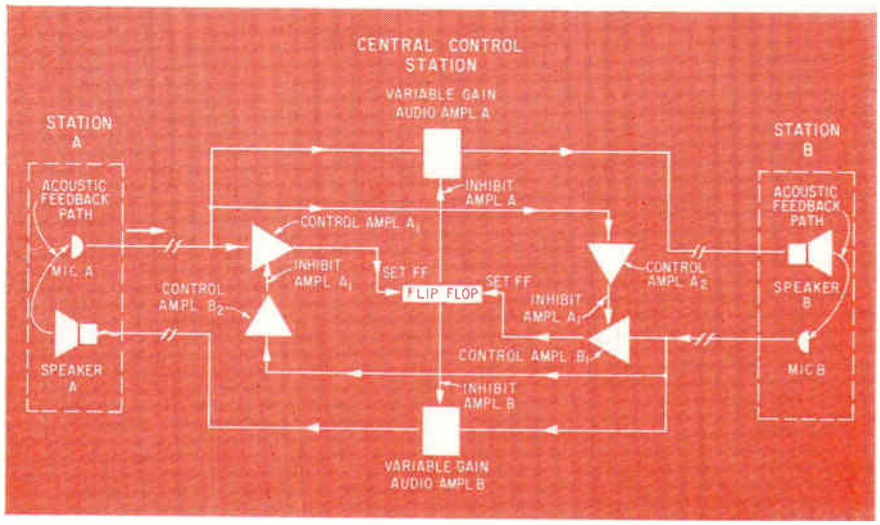
INTERNATIONAL COOPERATION—engineers from Canada, Nigeria, Hungary, Argentina and U.K. discuss transponder developed by RCA-Victor for the Project Relay satellite

GOVERNMENT BUREAUCRACY does not normally cater to the interests of individuals; however, a loophole is deliberately cultivated at the NRC Laboratories, Ottawa, for Hugh LeCaine, who is an electronic music enthusiast.

CANADA'S TOPSIDE SOUNDER SATELLITE, to be launched with NASA cooperation in the fall of 1962, is being discussed with government scientists at DRB Electronics Wing, Ottawa



RESEARCH and DEVELOPMENT expenditures normalized to show Canada's relative position. (CAE)—Fig. 1



PREVENTING SING-AROUND in loudspeaker communication. Loudest input flips bistable circuit reducing gain of opposite channel. Control amplifiers prevent resetting flip-flop until first speaker has finished (Northern Electric)

from which money can be made available at low, or zero interest for industrial development projects of the non-military kind.

SUBSIDIARY VIEWPOINTS—There are many contrasts in the attitudes of various Canadian subsidiaries to research and development. Often the annual profits are as low as 2 percent, or even lower. Some firms view this low profit level as an obvious indication that they can't afford to invest in r&d. Other firms take the similarly-low profit picture as a forcible indication that they need more r&d to survive, and should go into debt if necessary to do so. The preponderance of the latter attitude will determine the future of Canadian electronics.

At present, the government is encouraging Canadian subsidiary firms to take over a particular branch of technology, and act as the company division responsible for r&d in that chosen field. Thus, the Canadian branch of an international organization might concentrate on specialized and complex instruments where demand for such instruments overcomes all tariff barriers imposed by importing countries. As yet, few Canadian companies make sophisticated instruments although a few Canadian specialties have already emerged.

R&D PROGRAMS—Approaching the ideal of independent Canadian operation, RCA Victor in Montreal has a considerable degree of autonomy in its operations. In RCA Victor's Montreal laboratories is concentrated RCA's plasma physics research group, working on ion-propulsion projects for space vehicles.

Communications is another RCA-Victor specialty. Independent r&d in this firm's Montreal Laboratories has yielded an international reputation in the communications field; specifically: RCA-Victor is building the Project Relay Satellite's communications unit for NASA.

Most of the larger Canadian firms are undertaking some development work, even if only to make their products conform more nearly to Canadian needs. However, firms undertaking original development stand the best chances of future profit. Canadian Westinghouse is doing fundamental work with electroluminescent light sources to produce a low-voltage lamp capable of operation directly from transistors. Further fields of Westinghouse endeavor are microwaves and in investigation of anechoic test chambers for radar equipment.

A new and comprehensively equipped industrial laboratory was opened in 1962 in Ottawa, where Northern Electric Company does basic studies. Much of the r&d at the new Northern Electric Laboratory is concerned with making equipment for the communications industry. For example, NE makes transistors, diodes and varactors to the precise tolerances.

GOVERNMENT R&D—The Canadian government does more r&d than industry. Industry spokesmen contend that the government laboratories should be reduced, with the staffs either going into the universities, or being absorbed by industry. On the other hand, government spokesmen combat this view by pointing out that industry has been backward in providing facilities where advanced long-term r&d is possible.

One of the Canadian government's most sophisticated programs is the Topside Sounder satellite that is being built under engineering supervision of the Defence Research Board. Industry is providing much of the hardware, but engineering supervision comes from DRB engineers and scientists. The Topside Sounder satellite is scheduled for launching by a NASA rocket this fall.

Among the many programs sponsored and being carried out at the government labs are basic radar research, investigating Canada's upper atmosphere and the effects

ORGANIZING A RESEARCH SYMPOSIUM

Canadian Westinghouse Company flexed its r&d muscles in public June 28 by inviting members of government departments, the Universities, and other Canadian firms, to a research symposium at its Hamilton Electronics plant. The company also made sure that American representatives were present too, so that they could see the firm's r&d potentialities for themselves.

Michael McKerrow, Manager of Contracts explained that usually a company is able to present its r&d activity to the public only when some new piece of hardware is unveiled. Since the fundamental r&d being undertaken by Westinghouse may not yield saleable hardware for several years, the symposium fills the resulting gap.

Besides presenting several technical papers on their r&d projects, the firm revealed that the r&d program on electroluminescence would continue at doubled strength owing to government participation. Westinghouse is one of the first Canadian companies to receive government r&d aid on a cost-sharing basis under the Department of Industrial Research plan.

RESEARCH SYMPOSIUM sponsored by Westinghouse at Hamilton, includes discussion of electroforming process for K-band waveguides

of the aurora, medical electronics, circuits, components, materials, and fundamental investigation into lasers and low-temperature physics.

UNIVERSITY RESEARCH—Since Canada has urgent need for an expanded r&d program, and since additional funds to effect this expansion are not always available, it has been suggested that university research projects could be integrated with industry needs. For example, private companies might submit to a central clearing house a list of topics that they would like investigated. Such lists could then be circulated among students about to embark on graduate-degree projects and among university teaching staffs.

More direct collaboration between the universities and either industry or government would probably be opposed by most Canadian universities, who express varying degrees of horror at America's method of undertaking classified military research in university laboratories.

A problem facing the newly graduated engineer is where to work. If he is research minded, the opportunities in Canada for him to pursue his interests are limited in comparison with facilities in the U.S. He is often strongly tempted to emigrate. Many Canadians do so. If he marries and settles down before returning to Canada, the chances of getting him back, even with a salary and status boost, are small.

Yet Canada needs researchers and can ill afford to export her most valuable asset. On the other hand being a democracy, Canada can't detain them. Professor G. L. D'ombrain, of Ivy League McGill University summed up the situation for ELECTRONICS: "The higher the caliber of training a university provides, the more likely is Canada to lose the students it turns out." A situation that will take years and careful fostering of a Canadian r&d environment to correct.

WHAT WILL THESE STUDENTS DO WHEN THEY GRADUATE? Will they devote their efforts to increasing Canada's technology or emigrate to U.S.? Brainpower is one export that Canada can ill afford (University of Saskatchewan)

ENGINEER EXAMINES Honeywell microcircuit deposition mask produced by photographic techniques

CANADA'S PROSPECTS FOR TRADE

Home sales, exports and imports

GIVEN production runs of the same volume, Canada's assembly shops can equal the quality of anyone and better the costs of many (TMC Lt

EXPANDING EXPORTS—In a speech to the Canadian Military Electronics Symposium in Ottawa this year, W. S. Kendall, Marketing Director of Computing Devices of Canada, said that the Canadian electronic industry could only expand through increased exports, that home sales alone would not give the increased volume of electronics business necessary for expansion.

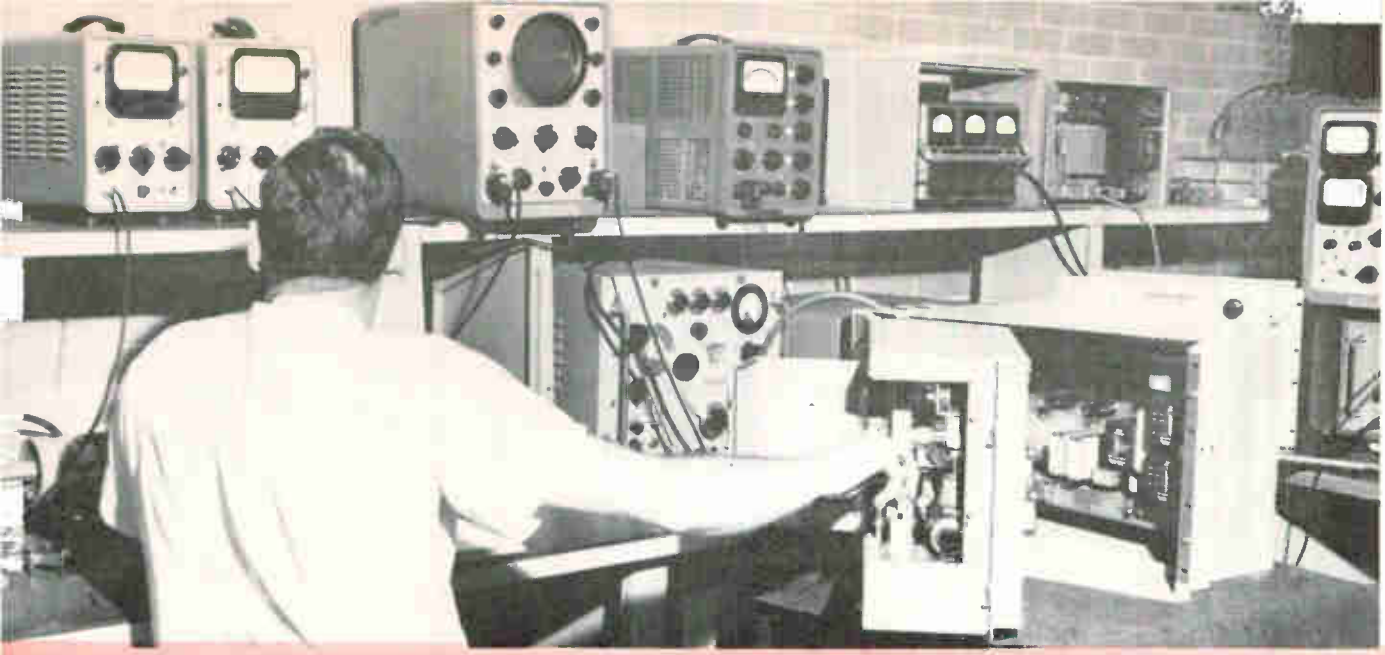
On a broader front, the Canadian economy has a trade imbalance which the government proposes to offset by exporting. Government offers several incentives to would-be exporters.

Thus, with pressure for expansion generated within the industry, plus government encouragement towards export expansion, overseas electronics sales will help shift the emphasis of Canadian exports from raw materials to manufactured goods. Currently electronics exports are about $30 million annually.

One president of a Canadian electronics firm told ELECTRONICS that he thought Canada could develop a name for herself in high quality electronics exports just as Switzerland has done with precision watches. This would come through development of sophisticated equipment where competition and small volume is less severe, he said.

Among the difficulties that Canadian electronics firms have to face is their lack of exporting experience. Light-industry exports have formed only a small proportion of Canada's total output, because many Canadian manufacturing firms were not founded to undertake export trade. There is a tendency in Canada electronics to assume that exporting cannot be done in the face of foreign tariffs, shipping costs and competition. Few Canadian firms have their own sales offices abroad, although an export channel often exists through their parent company's overseas subsidiaries. However, such overseas sales outlets generally lack salesmen with a specific interest in pushing Canadian products.

A corollary to the present relatively low volume of light-industry exports is the small scale of overseas publicity that has been undertaken by the Canadian manufacturing firms. For example, India is far more likely to be aware of Canadian wheat than it is of the



EXPORTS stem directly from investment in r&d. Northern Electric Company sold $1 million worth of parametric amplifiers in 1961, most of them exported and sold in competition with U.S. manufacturers

CANADA'S JAPANESE WHIPPING BOY

Total sales of radios have doubled in the last four years, sales of Canadian-built sets have declined from the 1957 figure by about 15 percent. While sales of Canadian radios have declined by 15 percent, imports have increased by some 700 percent over the 1957 figure.

Although the Canadian Electronic Industries Association claims that imports, largely from Japan, have deprived the Canadian manufacturers of increased sales, it is not certain that the Canadian industry could itself have built the sets at low enough cost to induce this sort of sales expansion.

Sales of television sets have declined much as radio sales have since 1957 but there have been virtually no Japanese tv imports during this period.

skills offered by Canadian manufacturers. Moreover, the Canadian electronics industry is sufficiently compact for a purchasing agent or Government official to know what most firms are doing. Consequently, advertising and public relation receive relatively less attention: certainly so on an international scale.

EXPORT ASSISTANCE—There are four main techniques used by the Canadian Government to encourage her industries to get into the export business. Besides the four main methods, a tax concession to firms showing increased sales offers a less direct but none the less useful inducement to export. To increase sales a firm will often be obliged to export.

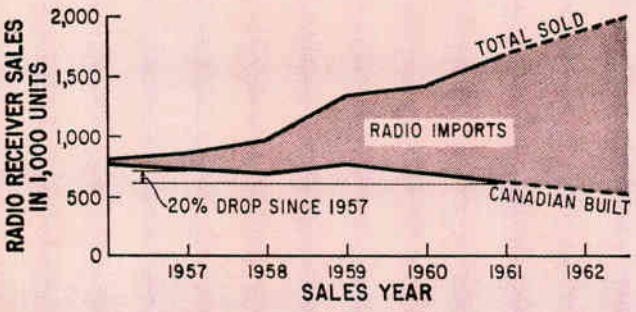
Here are some of the promotional measures offered by the Department of Trade and Commerce (DOT&C) to encourage exports:

(1) Foreign trade fairs. The DOT&C buys space in foreign trade fairs, erects sales booths, then hands them over for a token fee to Canadian firms wishing to exhibit. Besides paying most of the booth and space

BOOTH at the Chicago Design Engineering Show cost Westinghouse $100 under a government subsidy plan to encourage exports. Government also pays cost of shipping exhibits to and from trade fair

MOST OF Needco Frigistors Ltd cooling elements shown here in the inspection stage are exported to the U.S. Currently the firm is improving production efficiency by sintering the semiconductor cooling elements instead of machining them from solid

GROWTH OF RADIO RECEIVER SALES



SALES of Canadian-built radio receivers decline steadily, imports keep total sales rising

SOURCES OF RADIO IMPORTS

Country of Origin	1961 Units	1961 Percentage	1960 Units	1960 Percentage
U.S.A.	106,300	6.2	78,540	5.5
U.K.	28,450	1.6	13,856	0.97
W. Germany	53,914	3.1	56,946	3.9
Netherlands	25,458	1.5	31,122	2.1
Japan	839,696	49.5	531,022	37.1
Total Imported	1,080,605	—	731,511	—
Percent of Total Sales		63.8		51.2

JAPAN scoops almost half the import market, gets blamed for loss of assembly jobs in Canada

cost, the DOT&C will also pay for shipping the exhibitor's equipment to the fair.

(2) **Trade missions.** Groups of Canadian businessmen are shepherded by DOT&C officials on tours of prospective buying countries, with the travel costs borne by DOT&C.

(3) **Businessmen's instructions.** Selling-symposia are conducted in Canada and in Canadian Consulates abroad on how to tackle the export problems of each industry. Pamphlets and booklets are available from DOT&C officials.

(4) **Financial backing.** Once a company has landed its export orders the DOT&C will provide long term loans at low interest to finance the deal.

INVESTMENT IN CANADA—There has been some international concern that the Canadian government regards the present level of foreign investment in Canada as too high. Much foreign capital has recently been withdrawn for example, as a result of this concern. Yet the Canadian Government will actually fly groups of interested businessmen to Canadian industrial areas to show them the potentialities for investment there.

IMPORTS—During the first half of 1961, total imports of electronics equipment rose over the total for the same period in 1960. Electronics imports from the U.S. rose during this same period from approximately $62½ million to just over $68 million.

The table gives the detailed breakdown through 1960 and 1961 of Canadian radio imports. Although radio import totals have risen since 1960, by far the greatest proportion of this increase has gone to competition from Japan. In fact, Japanese imports account for nearly 35 percent of total radio receiver sales for 1961.

During 1961 Japanese exporters agreed to limit future shipments of radios to Canada to about 400,000, in response to pressure from Canadian trade associations. Similarly, imports of vacuum tubes from Japan were set at about 2½ million.

From the list of over four dozen categories of electronics imports from the U.S., no single item has shown an increase sufficient to cause anxiety within the Canadian industry, or movements towards restriction.

DISTRIBUTION—Since Canada is 4,000 miles wide, and since the total Canadian electronics market is roughly equal to the electronic sales in Michigan, say, a satisfactory solution of Canada's distributing problems is not easy. Most Canadian industrial distributors handle equipment from foreign manufacturers, notably those in the United States—they often have to stock many lines to operate profitably.

If a Canadian distributor is appointed to cover the whole of Canada his delivery costs are high. On the other hand, if several distributors divide the Canadian market between them, then their individual shares are somewhat limited.

Frequently the Canadian distributor is located further away from his customer than the American manufacturer is. A Toronto distributor working for a Californian electronics manufacturer hardly offers valuable service to a customer in Vancouver, which is nearer California than Toronto is. Even if the Canadian distributor carried substantial stocks, he might take longer to deliver them than would the U.S. manufacturer.

This communications problem is even further complicated when technical failure occurs. Does the customer ship the unit back to Toronto for the distributor to return it to California? It costs money to do so and the customer will object. On the other hand, the distributor is not too enthusiastic about his customer dealing directly with the plant. It is obviously difficult to please everyone. This is probably why there are few Canadian distributors with annual sales exceeding half a million dollars.

But the distributors are not all complaining. Bill Thompson, Sales Manager of Vancouver's distributing firm, L. A. Varah Limited, explains that his company's profits have increased during every year of its decade of existence. And this with the West Coast electronics boom hardly begun. In Montreal, Electrodesign President, Harry H. Schwartz, is very forthright about Canada's need for increased industrial autonomy. In looking for more wholly-Canadian products to sell, both in Canada and overseas, Schwartz sees broader industrial independence as a way to achieve this goal.

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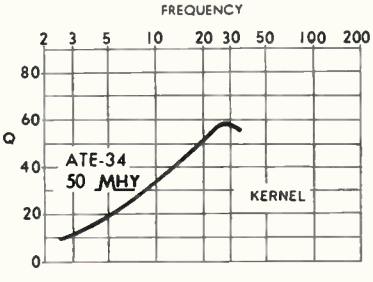

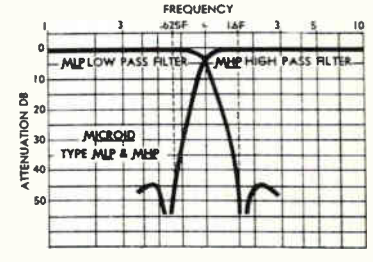

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ELECTRONIC NEWS, MONDAY, MARCH 26, 1962 110

99.997% Reliability Achieved For Minuteman Transistors

KOKOMO, Ind.—The Delco Radio division has succeeded in manufacturing power transistors for the Minuteman missile with 99.997 per cent reliability, based on tests with an assumed acceleration factor of 50. The firm is said to be the first power transistor producer to meet such requirements, according to Delco officials.

This extreme reliability was achieved in a research and development contract with Autonetics, a division of North American Aviation, Inc., associate prime contractor responsible for the inertial guidance and flight control systems for the Minuteman, developed by the Ballistic Systems division of the Air Force Systems Command.

The transistor involved is the Autonetics 251M-1. It is covered by specifications similar to those of the Delco 2N1358. More than 50,000,000 hours were accumulated testing it.

The reliability program at Delco Radio was an effort to accelerate the rate of transistor development to provide power transistors with a failure rate of 0.003 per cent/1000 hours or lower at 60 per cent confidence level.

Part of the program consisted of obtaining histories on specific lots of power transistors. The histories included absolute documentation of all environments, processes, and parts which in any way affect production of the transistors. The lot size was chosen to be the output of transistors from a single germanium crystal.

DOWNEY, Calif.—Autonetics division of North American Aviation, Inc., associate Minuteman contractor responsible for inertial guidance, flight control and aero-space ground equipment, confirmed that Delco Radio power transistors had met Minuteman reliability requirements.

A spokesman said Delco's 251M transistor, for use in Minuteman's guidance and flight control, had achieved the failure requirement of .003 per cent per 1,000 hours.

2N1358A
Germanium Transistor

TYPE	Vcbo @ Icb=4 ma	Vces @ Ices= 300 ma Sweep	H_{fe} @ Ic=5A Min.	Max.	Vce (Sat) IB=2A IC=12A	Thermal Resistance Junction to Case	Junction Temp. Max.
2N1358A	100V Min.	75V Min.	25	50	.7V	.5° C/w Max.	110° C

Write for additional information on the Delco Radio Power Transistor Reliability Story

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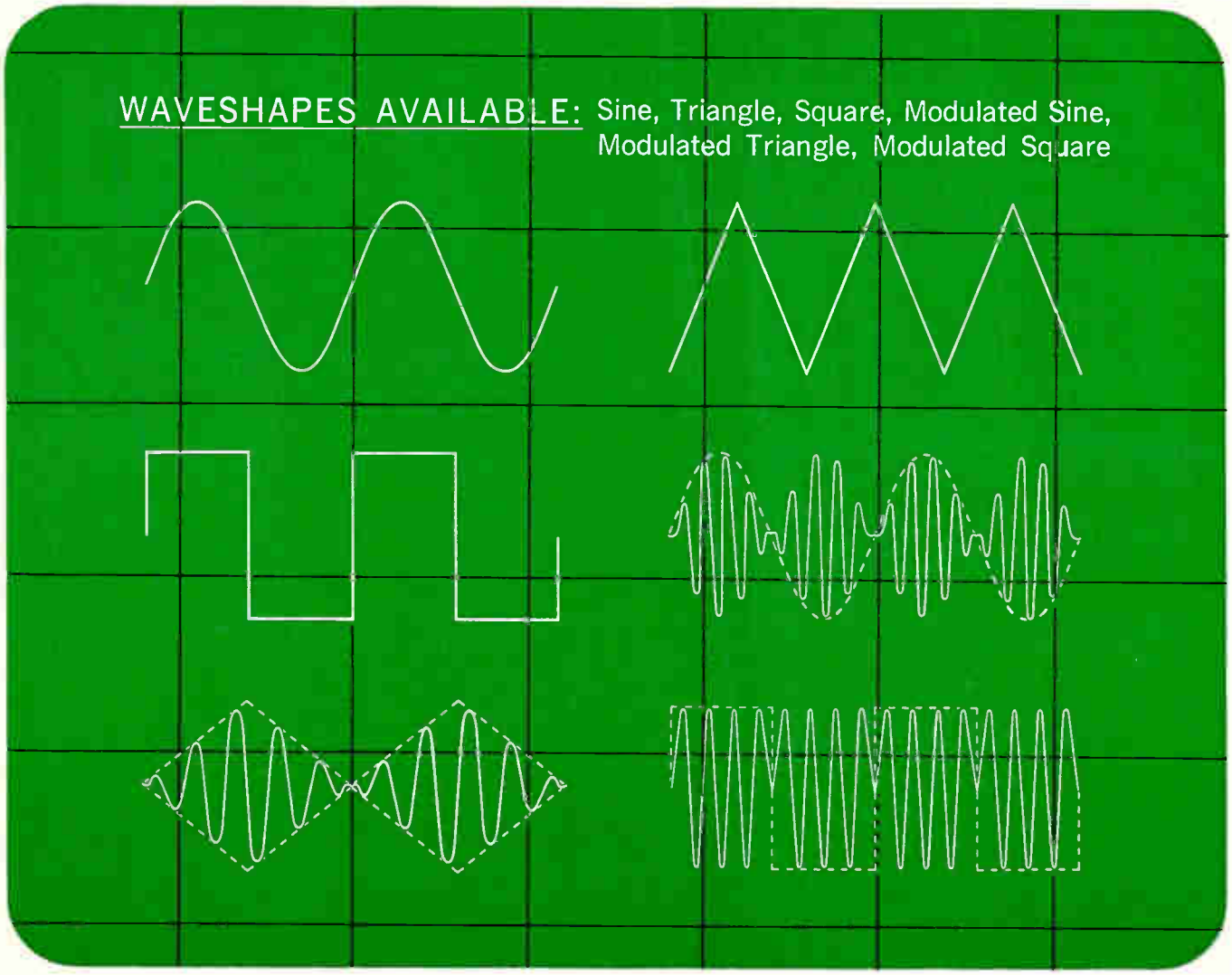

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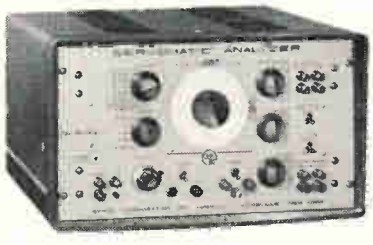

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electronics

September 28, 1962

New Tunnel-Diode Preamplifier Improves Phased-Array Radar

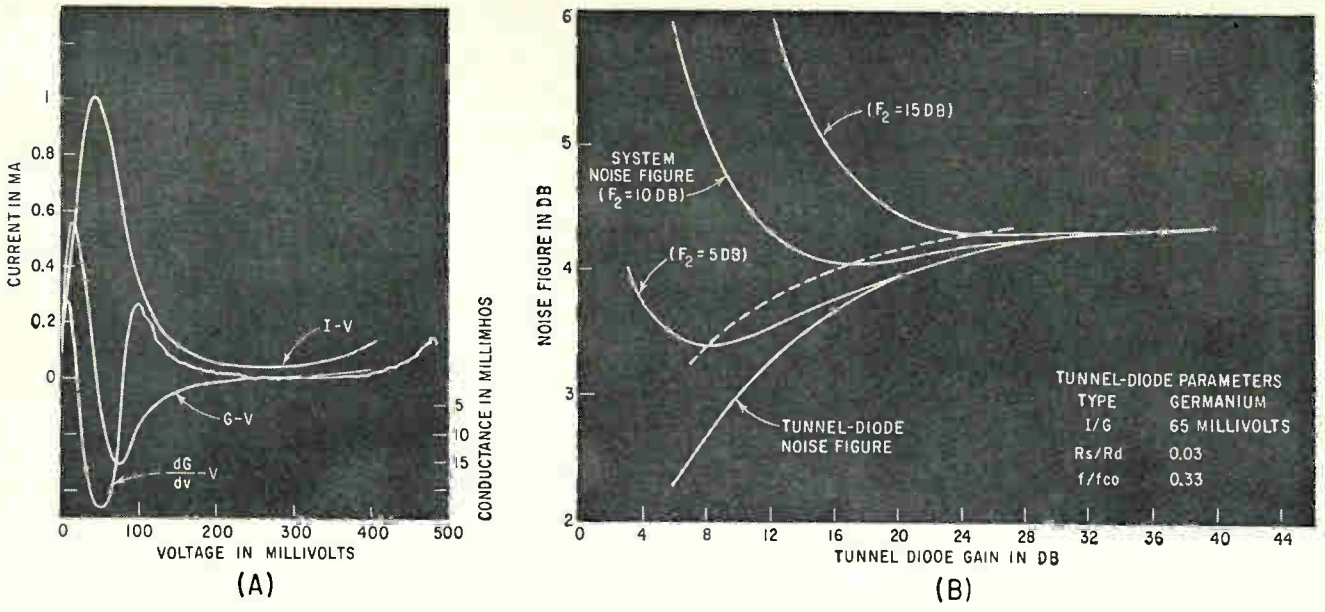
Circulator-coupled tunnel-diode amplifier enhances low-noise receiving techniques. Here are ways to achieve wide bandwidth and good stability by control of circulator impedance

By D. W. MacGLASHAN
Bendix Radio Division,
The Bendix Corp., Baltimore, Md.

CONSIDERABLE effort is now being applied to developing phased-array radars for ICBM defense. These radars consist of many small radar sets whose individual beams are electronically steered to collectively form one signal. Due to electronic steering, both search and track functions can be performed together, permitting the processing of thousands of targets in a few seconds.

To achieve long-range detection, the system uses many sensitive re-

SMALL SIZE *of tunnel diode preamplifier suits radar transmitter-receiver module*



OPERATIONAL CURVES *for tunnel diode (A) and system noise figures (B)—Fig. 1*

ceivers. The primary requirements of the receiver's preamplifier are: a change of less than 1-db gain over a 10-percent bandwidth; 3 to 5 db noise figure; 10 to 20-db gain; and ability to withstand 5 to 10-watts peak r-f power leakage. It must be able to track in phase and amplitude from channel to channel within tight tolerances and be small and light.

The circulator-coupled tunnel-diode amplifier meets these requirements. The novel feature of the amplifier is the integral mounting of the amplifier and circulator. This scheme offers advantages in both bandwidth and stability. Some performance characteristics are: center frequency 1,250 Mc; 1-db bandwidth, 200 Mc; gain 15 db; noise figure 3.5 to 3.7 db; 1-db saturation level, −35 dbm; r-f peak power capability 5 to 10 watts. The unit uses a 2.3-inch diameter circulator and an *n*-type tunnel diode.

LOW-NOISE DESIGN—It is difficult to outline any simple design procedure since many of the parameters must be considered simultaneously. The noise generated by a tunnel diode is mainly due to shot-noise, which can be expressed in terms of the diode current to conductance ratio, I/G. If curves of the diode are plotted to show this relationship, it is apparent that there is but one voltage point at which the noise figure is minimum. To locate this point accurately, curves should be plotted for each diode as in Fig. 1A. The maximum point in the negative resistance region of the dG/dv − V curve shows where the diode should be biased for minimum noise figure. The actual value for the I/G ratio is calculated from the current voltage I-V curve and the conductance G-V curve at that particular bias point. The effect of the I/G ratio on the tunnel-diode noise figure F, is found by

$$F = \frac{1 + (20\,\alpha\, I_o/G_d)}{\left(1 - \frac{R_s}{R_d}\right)\left(1 - \frac{f^2}{f_{co}^2}\right)}$$

where I_o = bias current, G_d = negative conductance $G_d = 1/R_d$, R_d = diode series resistance, f = operating frequency, f_{co} = diode resistive cutoff frequency at minimum I/G ratio point, α = gain factor and R_s = diode series resistance rise.

The I/G ratio plays a dominant role in determining diode noise figure. Gain factor α is also included in the numerator. The denominator contains two modifying ratios, R_s/R_d and f/f_{co}. Both these should be kept as small as possible. Too large a value for f_{co} can cause stability problems and therefore is usually limited to three times the operating frequency.

The fact that α enters the equation implies that there is an optimum preamplifier gain for any arbitrary second-stage noise figure. This is illustrated for a germanium tunnel diode in Fig. 1B.

GAIN—Examine the current-voltage relationship shown in Fig. 1A. The diode exhibits a negative resistance; this means that it will pump energy back into the system thereby showing a net gain. This gain is most easily expressed in diode voltage-reflection coefficient, Γ. The complete gain expression is

$$\text{Gain} = \Gamma^2 = \frac{(1+\alpha)^2 + B^2}{(1-\alpha)^2 + B^2}$$

where $\alpha = G'_d + G'_s)/G_c$; G'_d and G'_s = transformed values of tunnel-diode negative and series conductances and G_c = circulator conductances and β = total circuit susceptance. For 15-db midband gain, $\alpha = 0.7$, $\beta = 0$, which means the diode should have a negative

THE LOW-NOISE MICROWAVE TOURNEY: A NEW CONTENDER

Low-noise front ends are mandatory in uhf and microwave receiver design and are particularly important in extending the operational range of radar systems which are critical in our electronic defenses.

This article shows the application of the tunnel diode in a radar receiver preamplifier and points up the fact that this device has earned its rightful place with masers and parametric amplifiers in the ranks of low-noise amplifiers

resistance of about 72 ohms at the I/G ratio bias point when used with a 50-ohm system. Since the value for negative resistance varies from unit to unit, some scheme is necessary to vary the r-f gain without degrading the diode noise figure. This was accomplished by using the series-parallel tuning arrangement shown in Fig. 2A. The parallel stub tunes out the diode capacitance, while the series stub alters the value of negative resistance. By making the series stub inductive, the gain can be increased. When using this stub, it is better to employ a diode with 78 ohms negative resistance so that the gain can be adjusted to about the 15-db level. While a gain variation of 6 db can be realized with this technique, the added inductance cannot be allowed to exceed the value set by the stability criterion. Although gain can be varied by changing the bias, this degrades the noise figure since, in achieving the desired gain, the bias may no longer be at the minimum I/G ratio point.

The single-tuned bandwidth of the preamplifier is

$$BW = [(1-\alpha)/\alpha][1-R_s/R'_d]/2\pi R_d C_T$$

where C_T is total diode capacitance, R'_d is series equivalent of negative resistance.

With the diode selected, the 3-db bandwidth was only 180 Mc. This was considered inadequate, so double-tuned circuits seemed necessary. This approach, however, assumes that the source impedance, which is the circulator, will remain constant across the band. Since this is not true for most commercial circulators, the bandwidth can be increased by controlling the circulator impedance so that the real part is increased at the band edge. This is shown in Fig. 3A while the results of this approach are given in Fig. 3B.

CIRCULATOR—The fact that the tunnel diode is a two-terminal device immediately creates stability problems, since any external variation of impedance alters the gain drastically. A three-port circulator with $\geqq$ 20 db of isolation; $\leqq$ 0.5 db insertion loss and a vswr of $\leqq$ 1.2, was used to achieve some degree of isolation. While the three-port preamplifier design functions properly under controlled conditions, high vswr's of the second stage and antenna can cause instabilities through phasing. This problem can be resolved by using a four-port circulator-amplifier. Two less desirable alternatives are a three-port culator-amplifier.

The basic inequality that sets the conditions for stable gain is $L_T/R_dC_T < R_T < R_d$, where L_T = total circuit inductance; R_d = negative resistance; C_T = total circuit capacitance and R_T = total positive resistance. This expression holds for low frequencies and r-f. While the r-f instabilities are usually due to a poor circulator, low-frequency instabilities are a result of improper bias network design. This problem can be overcome by keeping the r-f bypass, low frequency bypass and power-supply source termination physically close to the diode. Although theory shows that the value of power supply impedance need only be less than $R_{d/\min}$, experience proves that this value should be about one third $R_{d/\min}$. The low frequency bypass selected was $2\mu f$.

The integral mounting of amplifier and circulator has advantages in bandwidth and stability. This mounting scheme permits the bandwidth to be controlled by the circulator impedance. Adding line length between the amplifier and circulator will alter the impedance presented to the tunnel diode, creating a potentially unstable condition. The amplifier must be mounted as close to the circulator as possible.

The preamplifier was required to withstand 5 to 10 watts of r-f peak power. Achieving this capability reduces the isolation requirements of the monoplexer (duplexer), thereby lowering its insertion loss and system noise figure. Tunnel diodes tested to date will withstand between 5 and 10 watts peak power without degradation.

Phased array radar preamplifier must phase and amplitude track with respect to each other within tight tolerances over the operating band. Figure 3C shows a typical set of tracking curves.

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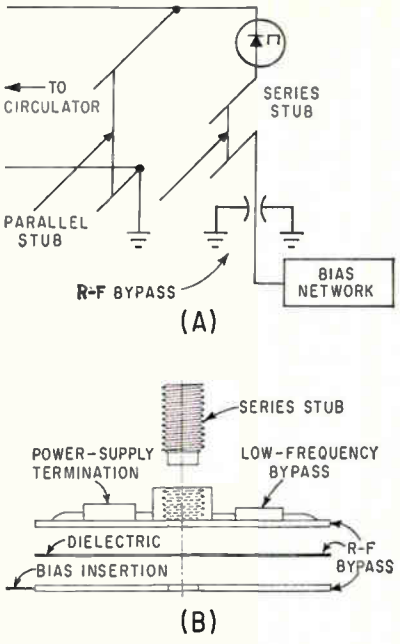
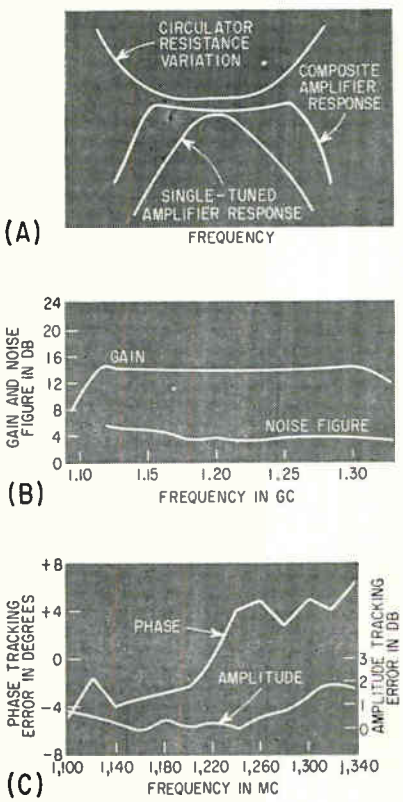
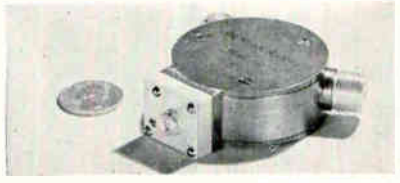


SIMPLIFIED *preamplifier (A) and physical configuration (B)—Fig. 2*



TUNNEL DIODE *bandwidth improves with circulator matching (A), curves for preamplifier gain and noise-bandwidth (B) and phase and amplitude tracking (C)—Fig. 3*



THREE PORT *circulator-coupled L-band amplifier*

Versatile Analog Storage Uses Ferrite Cores

With thick-walled ferrite cores to store analog signals, a new type of transport delay simulator is designed. Continuously variable delay can be more easily obtained than with capacitor-drum storage

By W. C. TILL* and WEN H. KO, Associate Prof., Engineering Design Center, Case Institute of Technology, Cleveland, O.

SYSTEMS INVESTIGATION by analog computers often involves simulation of transport or time delay phenomenon. In some cases, the time delay to be simulated is a fixed quantity, and in others it must be continuously variable. Present methods of introducing time delays into an analog simulation employ magnetic tape storage, capacitor storage, and operational amplifier techniques, such as the Padé approximation.

Another technique for obtaining time delay uses ferrite cores rather than capacitors to store sampled signals. This technique should compete favorably with capacitor-drum storage because electronic rather than mechanical commutation could be employed, and as a result, continuously variable delay could be more easily obtained.

A thick walled toroidal ferrite core provides a hysteresis loop (Fig. 1A) with which it is possible to store a variety of voltage levels as magnetic flux levels. Considering point 1 as a reference, a bias current is introduced such that $N_b I_b$ cause a flux level at point 2 on the hysteresis loop. A signal current is then applied such that $N_s I_s$ causes storage at point 3. When both I_s and I_b are removed, a magnetic flux θ_{s+b} will be stored at point 4. When the readout pulse $N_r I_r$ is applied, the flux level is moved to point 5 and a voltage e_o occurs across the output winding. Integration of the output voltage provides a voltage level which is proportional to θ_{s+b}:

$$\theta_{s+b} = 1/N_r \int_{t_o}^{t_1} e_o \, dt$$

When the current I_r is removed, the flux level falls to point 1.

DELAY UNIT — The principle of a ferrite core delay unit is shown in Fig. 1B. The input signal $f(t)$ is fed into the cores by sequencing switch A. Output is obtained when switch B is sequenced after the desired time delay. An output voltage e_o from a given core appears when the read current is applied after a write current. Diodes in series with the output windings insure that only the readout voltage is used. Integration and amplification of the readout voltage pulses provides the original samples, delayed in time. A low-pass filter provides a smooth output signal. Switches A and B can be replaced by decade counters with associated circuits.

With capacitor storage, it would be difficult to use electronic commutation because the impedance of the electronic circuits associated with the storage capacitors must be high to prevent leakage. In a ferrite-core delay unit, however, the input and output impedances of the storage elements are low, so that electronic commutation is feasible. Thus, continuously variable delay is more easily obtained.

To make sure that a core returns to the reference (point 1 in Fig. 1A) after each storage cycle, the read-out mmf must be at least five times as large as the mmf needed to fully switch the core. Tests were conducted using MC-125 General Ceramic cores (0.375 in o.d.). Since five ampere-turns were needed to fully switch these cores, 25 ampere-turns were used for read-out.

Since only 200 lines of flux are involved when a core is switched from (−) to (+) saturation, the determination of how accurately analog signals can be stored as flux levels is difficult. To get an accurate measurement of flux against ampere-turns in single cores, a technique was developed based on comparing the test core to a reference core. The circuit uses a mercury relay for switching currents, and two Helipots and an oscilloscope as a null detector (Fig. 2A and 2B). The mercury relay eliminates contact bounce; R-C circuits across contacts reduce arcing.

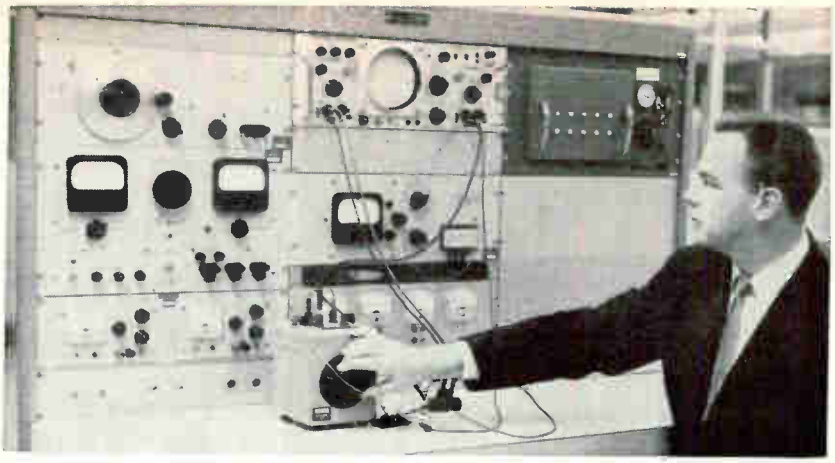
The reference core in Fig. 2A was switched continuously between (−) and (+) saturation. Test cores were switched between (−) saturation and the flux level desired. One hundred output turns were used on each core. The two outputs were integrated with matched 100,000-ohm resistors and matched 0.1-μf capacitors (Fig. 2B). The 100,000-ohm helipots were used after the integrators. The tolerance in the dial reading of the pot used with the reference core did not exceed 0.16 percent. Outputs were fed to the differential preamplifier on a Tektronix oscilloscope.

For a given level of partial switching flux in the test core, an output voltage appeared across the test core pot. The reference core pot was then adjusted until the voltages were equal and a null was observed on the oscilloscope. The 10-turn dial of the reference core

* Now with General Motors Institute, Flint, Michigan

WHERE IT CAME FROM

For those who may wonder about the fundamental approach taken by authors Till and Ko, and who may wish to know more about this work, it may be interesting to find out that the article is a part of Mr. Till's Masters thesis. Although only a ten-core unit is detailed in the article, Professor Ko reports that if a need and support arises, they would like to build a 100-core delay unit

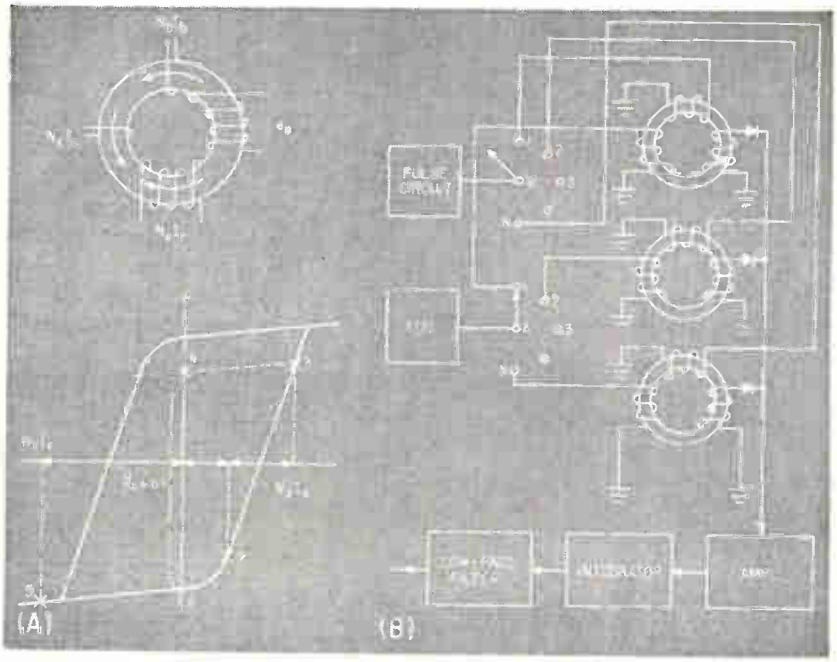


HYSTERESIS LOOP *of ferrite core is measured by co-author Till*

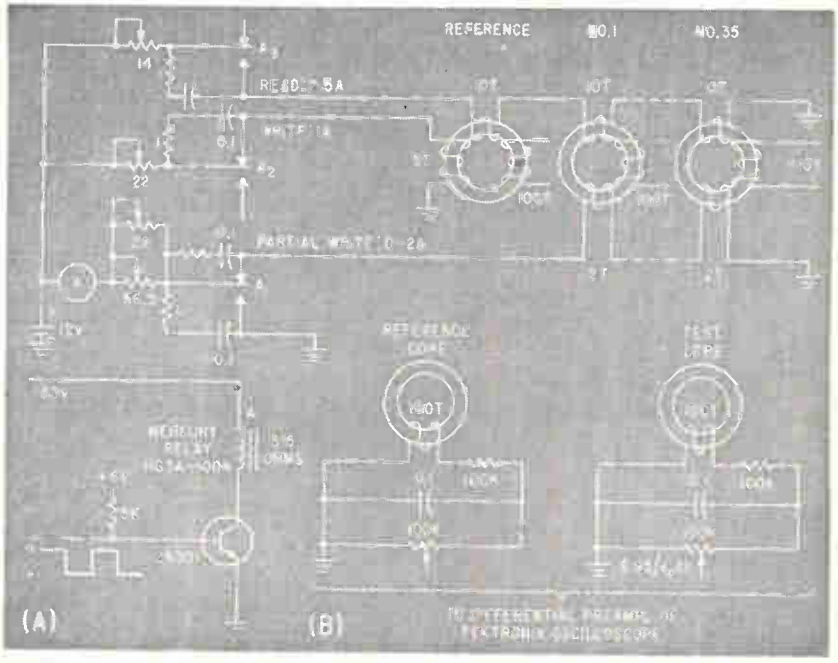
pot was then read, the dial reading giving the ratio of the partial value of flux stored in the test core to the total flux stored in the reference. Since the same reference core was used with each test core, the test cores could be compared.

Plots of flux stored against partial-write ampere turns were obtained for 35 MC-125 cores. Ten cores out of 35 stayed within ±2 percent of the full-scale flux change, and within a ±5 percent deviation from linearity.

SWITCHING TIME — To determine the pulse width necessary for partially switching an MC-125 core, switching time was measured as a function of the applied field by introducing partial write pulses into a core, then observing the core output waveform when the write pulses occurred. The core output waveform is shown in Fig. 3A. To get a measure of the switching time of the core from this waveform, T_s was defined as the length of time from the start of the core output pulse to the time at which the second peak occurred. Because of the trailing end of the core output waveform, it may take seconds for domain-wall motion to cease completely when a long pulse of write current is applied. However, it was initially assumed that domain-wall motion is completed in 10 T_s. As the applied mmf was decreased, the time T_s was observed to increase, so that the maximum time for complete switching was needed when the partial switching current was a minimum. The lowest current value for which a second peak could be observed indi-



THICK-WALLED *ferrite core and its hysteresis loop (A) are exploited in this kind of delay unit design (B)—Fig. 1*



MERCURY RELAY *test circuit (A); core output circuit (B)—Fig. 2*

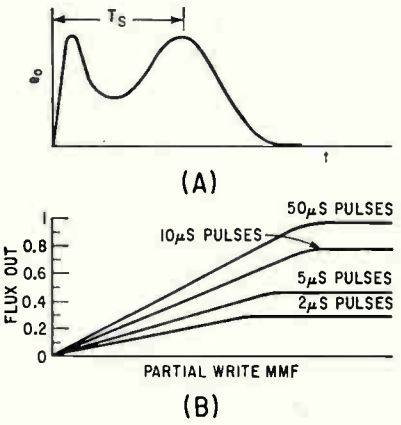
cated that T_s equaled 20 microseconds for a partial write mmf of 1.86 ampere-turns. It was assumed that for this value of mmf, domain-wall motion was completed in 200 microseconds (10 T_s). This is the minimum pulse width that could be used in an analog memory if wall motion were to be completed.

If a linear relationship could be obtained between write ampere-turns and flux when the pulse width was too short to allow wall motion to be completed, then the switching of ferrite cores in an analog memory could be achieved at a much faster rate. To determine if a linear relationship could be obtained, a transistor pulse circuit was used to provide current pulses of short duration, and a video amplifier and integrator circuit was constructed to amplify and integrate the core output pulses. Using these circuits, plots were made of flux-out against partial-write mmf for a number of partial-write pulse widths. The read-out pulse width was held constant at 10 microseconds. The plots of flux against partial-write mmf which were obtained using 2, 5, 10 and 50 microsecond partial-write pulses are shown in Fig. 3B. While an approximately linear region exists in all four cases, the linear region grows shorter as the pulse width is decreased. For the 10, 5 and 2 microsecond pulses, only a portion of the domain magnetization was being reversed. Since no difference was observed in the flux against partial-write mmf plot when the pulse width was greater than 50 μsec (2.5 T_s), it was concluded that the data taken in the mercury relay tests (where much larger pulse widths were used) is valid for pulses of 50 μsec or greater.

Since an approximately linear region exists for pulse widths as short as 2 microseconds, it is conceivable that pulses of this width could be stored in a ferrite storage unit. Before this was done, however, the percent deviation from linearity of the relation between partial write mmf and flux would have to be redetermined, since it may be considerably different than that which was previously measured for longer pulse widths.

TEN-CORE DESIGN—A block diagram of the read, write and bias circuits for a proposed 10-core transport delay unit is shown in Fig. 4A. An oscillator, whose frequency is controllable by a d-c input voltage, drives a bistable multivibrator that drives two serially connected decade counters through a count of 20. Alternate decade counter outputs are connected to read and write circuits, so that a read pulse will occur between two write pulses. So that the maximum delay time can be obtained from the unit, it is connected so that the 10th core is written into just before the first core is read out of. Thus a delay time of over 9 periods is obtained. By rearranging the sequence of the connections between counter output and the read and write circuits, delay time from 1 to 9 periods may be obtained.

Blocks one through ten in Fig. 4A indicate the read circuits driven by the decade counter. Each block consists of a monostable multivibrator, generating a 50-microsecond pulse, triggered by the leading edge of the decade counter read pulse, and a pulse amplifier which provides sufficient read-out current to drive the cores to (−) saturation. For MC-125 cores, 25 ampere-turns are required for readout. If 10 read turns were used on each core, a read current pulse of 2.5 amperes would be required from each block.



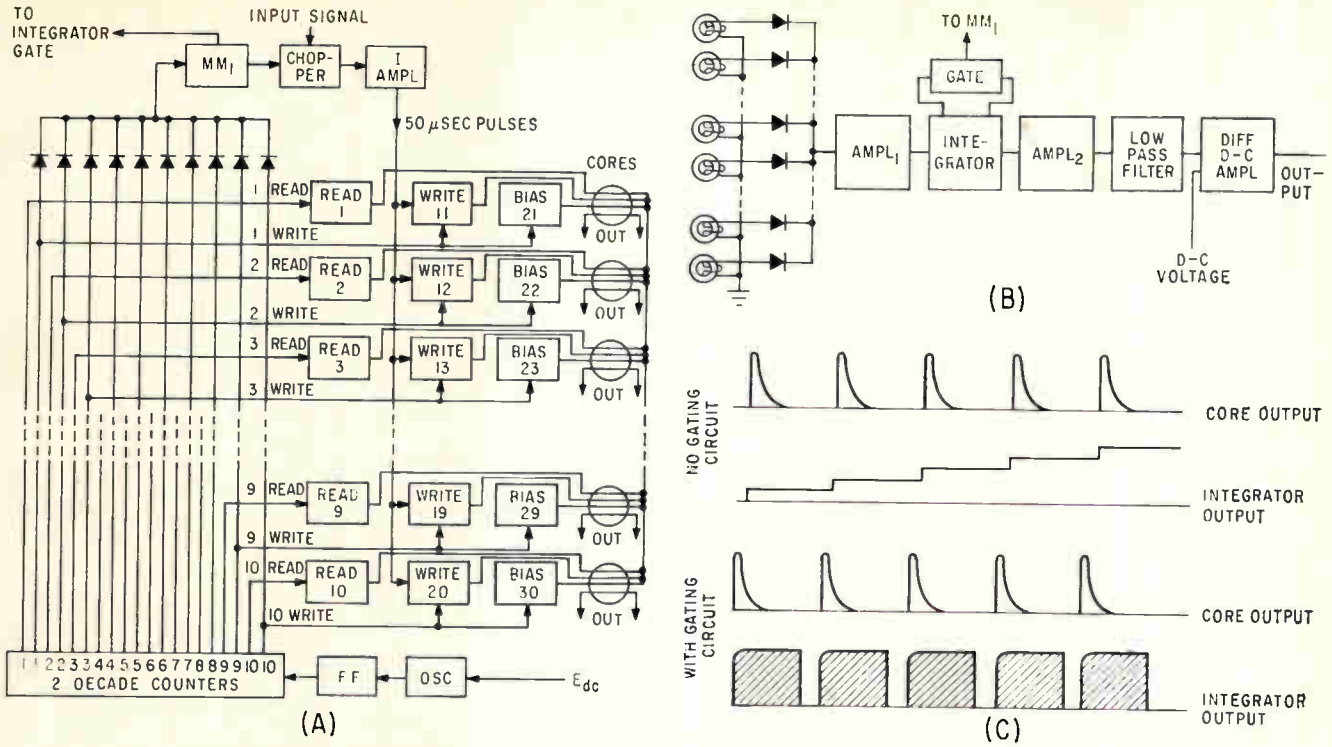
PARTIAL-WRITE *output waveform for ferrite core (A) and flux-out against partial-write mmf (B) for different pulses—Fig. 3*

Blocks 21 through 30 indicate the bias circuits used to bias the cores in the linear operating region. Each block consists of a monostable multivibrator, generating a 50-microsecond pulse, triggered by the leading edge of the decade counter write pulse and a pulse amplifier that provides the current to bias the cores in the linear region. The pulse amplifiers must be well regulated, and are separately adjustable. For MC-125 cores, 1.8 ampere turns of bias mmf are required. If two bias turns were used on each core, then a bias current pulse of 900 milliamperes would be required from each block. With more turns, the current could be made smaller, but the error in the read mmf would increase due to the counter mmf generated by the bias winding.

The ten write outputs from the decade counters are connected through diodes (for isolation). The leading edges of the 10 write decade counter outputs trigger a monostable multivibrator that generates 50-microsecond pulses. These pulses go to a chopper circuit, where they sample the input signal. The input signal must be positive, and its amplitude may vary from 0 to 4.5 volts. A signal that contained both polarities could be added to a d-c level and then stored. The d-c level could be removed at the output.

The sampled signal pulses go to a current amplifier that converts the 0 to 4.5-volt voltage pulses to 0 to 450-milliampere current pulses. The accuracy of the current amplifier must be high with respect to the ±5 percent accuracy of the storage unit. An accuracy of ±1 percent would be sufficient and could be obtained by using current feedback techniques.

Blocks 11 through 20 in Fig. 4A indicate the write gating circuits that switch the current amplifier pulses from core to core as the decade counter switches. The current amplifier is connected to all 10 of these units and one of the decade counter write outputs is connected to each of these units. When a decade counter pulse is present at a unit, the unit must switch the current amplifier pulse to a core with a small and constant attenuation. When a decade counter pulse is not present, the units must approximate open circuits. The cores will operate in a linear region over a range from 1.8 to 2.7 ampere turns. A bias mmf of 1.8 ampere-turns is provided by blocks 21 through 30. A range of 0 to 0.9 ampere-turns is



FOR TEN-CORE *delay unit, these are read, write and bias circuits (A), core output circuits (B) and core and integrator output waveforms (C)—Fig. 4*

therefore available for signal storage. Since the current amplifier provides current pulses that vary from 0 to 450 milliamperes, two write turns on each core will provide an input mmf which varies from 0 to 900 milliampere-turns.

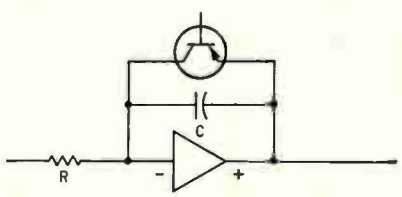
OUTPUT CIRCUITS—Figure 4B shows the core output circuits for the proposed 10 core transport delay unit. Since core outputs appear both when read and write pulses occur, the diodes block passage of the write core output. They are also used for isolation. The core output pulse is then amplified and sent to an integrator circuit. Since the voltage pulse out of the core is proportional to the first derivative of flux, integration of this pulse provides a voltage directly proportional to the flux stored in the core.

If a gating circuit were not used to short out the integrating capacitor for a period of time between core output pulses, the integrator output voltages would accumulate as in Fig. 4C (top). To prevent this voltage accumulation, a transistor switch is proposed to short out the integrating capacitor for the 50-microsecond interval while the write pulse is fed to the cores. The gating circuit is therefore triggered from MM_1, the write circuit monostable multivibrator of Fig. 4A. The core and integrator outputs are in Fig. 4C (bottom).

An operational amplifier could be used in the integrator circuit as shown in Fig. 5. The transistor switch shown across the integrating capacitor is normally biased to cutoff. It is turned on to saturation by a pulse from the write monostable multivibrator for 50 microseconds to discharge capacitor *C*.

The integrator output signals are amplified and fed to low-pass filter (Fig. 4B) which acts as a demodulator. It converts the a-m pulses into a smooth signal.

When the partial write current, into the cores, is zero, a read output will still be obtained because the bias mmf is causing a flux level to be stored in the cores. A differential amplifier is therefore used after the low pass filter to balance out the d-c level caused by the bias mmf. With zero partial write current in the cores the d-c voltage into the differential d-c amplifier is set so as to make the output zero.



INTEGRATOR *with gating circuit —Fig. 5* P

To adjust the gain of the entire unit to unity, a d-c voltage could be used as a signal input, and the gain of amplifier 2 (in Fig. 4B) adjusted until the same d-c level was observed at the output.

The MC-125 cores used were not designed for analog signal storage. The accuracy of the storage unit could be greatly increased if cores were specifically designed for analog storage. Such cores would be disk like in shape, so that a larger linear region could be obtained in the flux against ampere plot.

Although the 10-core unit has not been constructed, the approach has been tested satisfactorily with two cores and mercury relays.

The authors thank the Ford Foundation for the financial support making this work possible.

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Better Ways to Protect Transistors

Overload characteristics of zener diodes can be coordinated with those of fuses for complete protection of power transistor circuits

By OLEG BURLAK, Manager, Application Engineering, ITT Components Division, International Telephone and Telegraph Corp., Clifton, New Jersey

WHAT BLOWS FIRST?

Fuses are made to blow—diodes and transistors are not. Trying to figure out which will win the race could be a lot of fun. So collect the manufacturer's curves for the most popular fuses and keep them on file. You'll need them for the situation in which you have to stack the odds in favor of the fuse

SILICON ZENER voltage-regulator diodes are ideally suited for protecting high-power, high-voltage transistors against destructive voltage transients and overloads. Since zener diodes themselves are vulnerable to short-term overloads, the selection of a fuse to protect the entire circuit is governed by the overload characteristics.

Thermal time constant in seconds of a silicon zener diode is

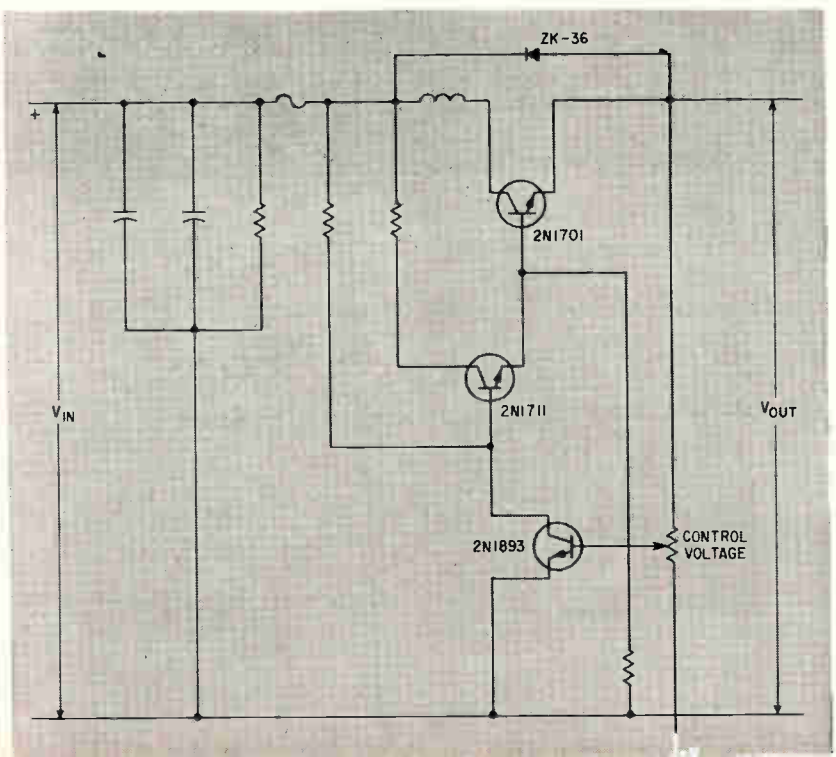
$$\gamma_t = \Theta_{JC} \cdot C_{JC}$$

seconds, where Θ_{JC} = junction-to-case thermal resistance in degrees C per watt and C_{JC} = junction-to-case thermal capacity in watt-seconds per degree C.

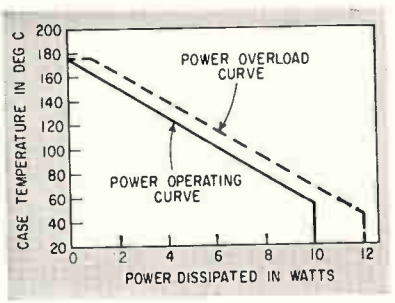
Application of power to a diode causes an exponential junction temperature increase. The time lag permits a short-time overload.

In a typical pass transistor regulator, Fig. 1, the circuit operates at a maximum ambient temperature of 55C. Protection against component failure in the event of a short-circuited load is to be provided by fuses. An ITT-ZK36 10-watt zener diode (36 volts ±10 percent) protects the transistor. Collector-to-emitter rating is 40 v.

OPERATING POINT—The zener diode, Fig. 1, does not operate in the avalanche or breakdown region under steady-state conditions. Power dissipated is limited to that generated by the reverse or leakage current. The resulting junction temperature rise is negligible and permits the assumption that case temperature is equal to ambient temperature. Stud-mounted devices are rated by case tempera-

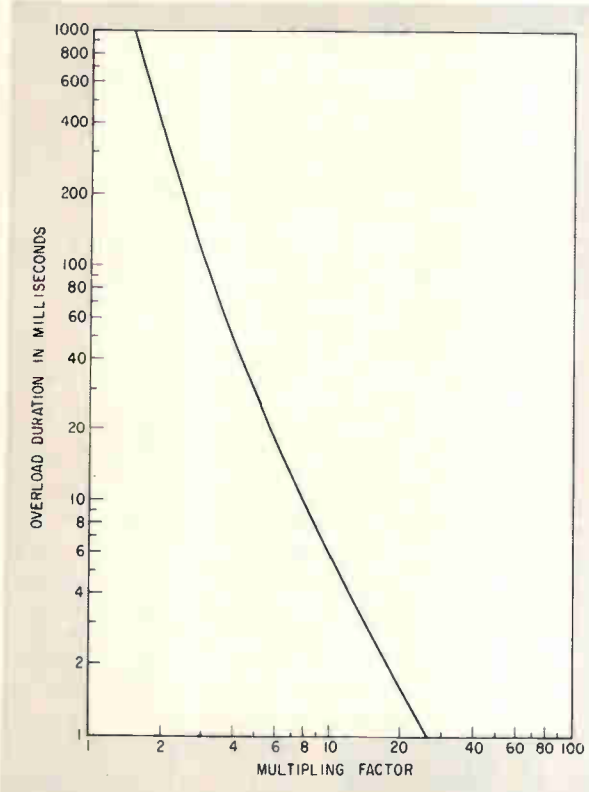


PASS TRANSISTOR *regulator is a typical example of a fuse-zener diode combination—Fig. 1*

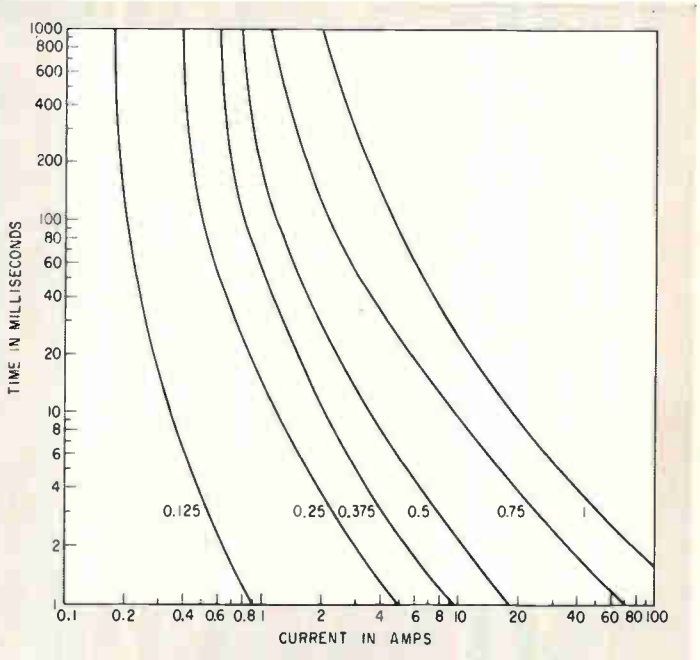


CASE TEMPERATURE *variation with power dissipation for a typical 10-watt zener diode—Fig. 2*

With Zener Diodes and Fuses



OVERLOAD CHARACTERISTIC *of the 10-watt zener diode provides the multiplying factor used to calculate maximum allowable overload current—Fig. 3*



TIME-CURRENT *curve for Littlefuse 3AG series 312 fuses is typical of the type of data necessary for proper fuse-diode coordination—Fig. 4*

ture, Fig. 2. Ambient temperature and the heat sink used must be evaluated and the diode case-temperature known before any attempt is made to establish the diode operating point from the curves.

Overload curves of the ZK.36, Fig. 2 and 3, incorporate allowances determined from the relation between junction temperature and power dissipation at time t. Thus, junction temperature rise T_J is:

$$T_J = \Theta_{JC} \cdot P \cdot [1 - \exp(t/\gamma_t)],$$

where Θ_{JC} = device junction-to-case thermal impedance in degrees C per watt, P = power dissipated in watts, t = duration of power application in seconds, and γ = thermal time constant in seconds (0.04 second for ITT 10-watt zener).

From Fig. 2, the allowable continuous overload P_o at a case temperature of 55 C is 11.2 watts. This is a measure of device's power-handling capacity for durations of 1 to 10 seconds. The derivation of all short-term overload limits proceeds from P_o as a base developed from the diode operating point.

Maximum overload current for a diode is

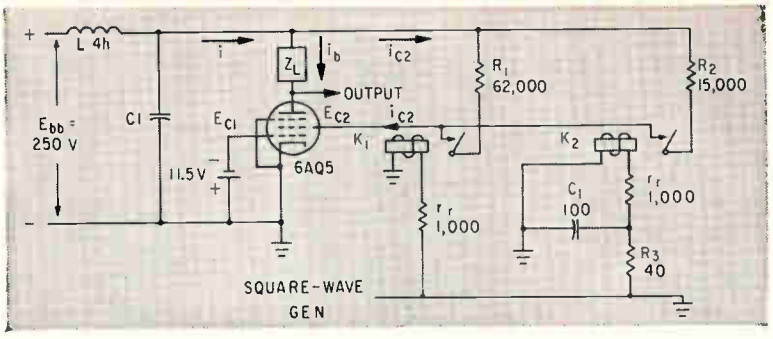
$$I_{ot} = K \cdot P_o / V_z$$

where I_{ot} = maximum allowable overload current for time t, K = overload factor (from Fig. 3), P_o = maximum continuous overload (from Fig. 2), and V_z = rated zener voltage.

A time allowance of 5 msec has been arbitrarily selected for clearing of the fuse. Fuse clearing time is inversely proportional to the square of the current carried by the fuse. Therefore, if a long clearing time is chosen, it will be necessary to add a series resistor for protection against large, short-duration current surges. Clearing time should be selected to minimize this series resistance or eliminate it completely. A desirable range of clearing time is from 1 to 10 msec. Clearing times of less than 1 msec are not obtainable, except with special fast-acting fuses.

From Fig. 3, for a 5-msec delay, K = 11. Substituting, I_{ot} = 11(11.2)/36 = 3.4 amp/5 msec. Hence, the diode will withstand an overload of 3.4 amp for 5 msec.

A 0.375 amp 3AG fuse, Fig. 4, will open in 5 msec when passing a current of 3 amp. Since this is less than the 3.4 amp that the zener diode itself can handle for the same time interval and more than the circuit drain of 0.25 amp, adequate protection of both zener diode and transistor has been achieved. Where faster fuse operation is necessary, time-current curves of other fuses may be applied.



VOLTAGE-DAMPING *control applied to voice-operated transmitter —Fig. 1*

Novel Circuit Damps Transients in

Control of power-supply transients by damping permits reaching steady-state value

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ENGINEERS are often faced with the problem of switching a load onto an oscillatory system so that the output quickly attains its steady-state value without overshoot. This action can be obtained with a technique for achieving a step-load response by timed, sequential switching of the system load.

This article shows a novel way to achieve voltage damping when a pentode is connected as a load to an LC-filtered power supply. This method has many applications to practical equipment. One such application is the voice-operated transmitter. Here, the tubes that require large amounts of quiescent power are disconnected from the high-voltage supply during standby operation. When the operator speaks into the microphone, the first syllable closes a relay; this relay connects the tubes to the supply, where they remain during the transmitting cycle. If the power supply is filtered by a low-loss LC circuit, the sudden switching may cause the plate and screen voltages to approach their steady-state values in an oscillatory manner. The output of the transmitter is then modulated at a frequency, which is usually in the audio range.

Figure 1 shows the operation of the circuit. Assuming that relays K_1 and K_2 are identical, K_2 will close after K_1. Time delay, T_n, is controlled by varying R_3 and or C_1. The effective load presented by the tube to the power supply, is determined initially by R_1, and then finally by R_n, the parallel combination of R_1 and R_2. The same effect could also be obtained by switching two series screen resistors. Thus, the effective load presented by the tube to the power supply is connected sequentially in two steps, and a controlled response is obtained by choice of R_1, R_2, R_3 and C_1.

Actual load-voltage waveforms (Fig. 2), result when the pentode is connected to the power supply. The oscillatory response that results without voltage damping is shown in Fig. 2A. Figure 2B shows the controlled response that results with damping. While the same final tube current i flows in each case, the initial undershoot, which represents the peak tube current, is reduced when voltage damping is applied.

In the circuit, the 6AQ5 pentode is the switched tube and the square-wave generator represents the microphone and associated relay circuits. For testing, the plate load Z_1 was zero. This does not effect the principles under discussion, since the plate current of a pentode is essentially independent of the plate load.

Design curves for voltage damping, shown in Fig. 3, are for normalized LC-filter elements ($L = 1$ h, $C = 1$ f). Normalized final effective tube resistance, R_n, is expressed with K_1 and K_2 activated. The normalized initial tube resistance, R_{no}, is given with only K_1 closed, and T_{dn} is the normalized delay time for only K_2.

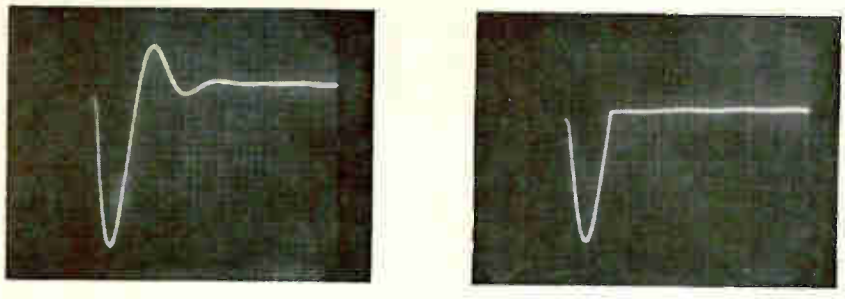
ADJUSTMENT—Because of component tolerances and engineering approximations, it is necessary to make manual final adjustments for a controlled response. This procedure is made easier because residual oscillations resulting from opposite switching errors are always mutually 180-degrees out of phase.

Now we can easily understand how the residual oscillation that occurs when the effective final tube resistance is too big is 180-degrees out of phase with the oscillation that results when the resistance is

DAMPING THAT OVERSHOOT

Power supply transients rank high among undesirable effects occurring in radio transmitters. A response of this type usually appears as unwanted audio-range modulation of the r-f output and can cause compower-supply overshoot

This voltage-damping circuit can be used to help the transmitter design engineer effectively control power-supply overshoot



(A) (B)

LOAD-VOLTAGE WAVEFORMS *without damping (A) and with damping (B)—Fig. 2*

Voice-Operated Transmitters

without overshoot, prevents modulation of transmitter output in the audio range

too small. The residual oscillation resulting from too short a delay is 180-degrees out of phase with the oscillation caused by a delay which is overly long. It is always possible to adjust the circuit for a controlled response by observing the change in sign of the transient as the proper parameter value is passed.

DESIGN EXAMPLE—The desired final total tube current i is 36.5 ma. This current is obtained with $R_s = (R_1 R_2)/(R_1 + R_2) = 12{,}000$ ohms.

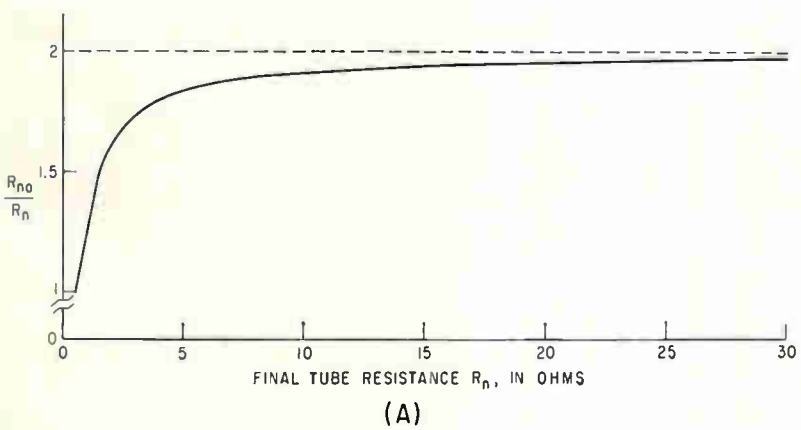
The proper screen resistor is found either experimentally, or by using the transfer characteristics in the tube manuals. Final effective tube resistance $R = E_{bb}/i = 250/36.5 = 6{,}850$ ohms; normalized final tube resistance $R_n = R\sqrt{\frac{C}{L}} = (6.85 \times 10^3)\sqrt{\frac{10^{-6}}{4}} = 3.42$ ohms.

From Fig. 3A, find the normalized initial tube resistance with $R_{no} = (R_{no}/R_n)\,R_n = (1.73)(3.42) = 5.92$ ohms. Denormalized initial tube resistance $R_o = R_{no}\sqrt{\frac{L}{C}} = (5.92)\sqrt{\frac{4}{10^{-6}}} =$ 11,820 ohms. To find R_1, using the average transfer characteristics from the tube manual, assume $i_b \approx i = E_{bb}/R_n = 250/11.82 = 21.1$ ma; from the tube tables also with $E_g = -11.5$ v, $E_{c2} \approx 175$ v; and with $E_g = -11.5$ v, $i_{c2} \approx 1.2$ ma.

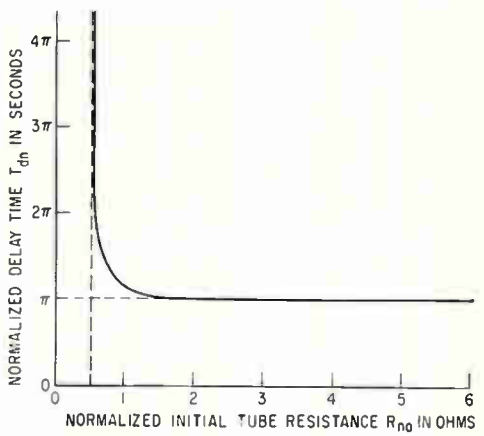
Now, to find R_1 and R_2; $R_1 = (E_{bb} - E_{c2})/i_{c2} = (250 - 175)/1.2 = 62{,}500$ ohms and $R_2 = R_1R_s/(R_1 - R_s) = (62.5)(12) \times 10^3/(62.5 - 12) = 14{,}850$ ohms. From Fig. 3B, find the normalized delay time using R_n as obtained earlier: $T_{dn} = \pi$ and denormalized delay time, $T_d = T_{dn}\sqrt{LC} = (3.14)\sqrt{4 \times 10^{-6}} = 6.28$ msec.

As a first rough approximation, $T_d \approx C_1R_p$, where $R_p = r_rR_s/r_r - R_s$ and r_r is the resistance of the relay winding. For the relays used in this circuit, $r_r = 1{,}000$ ohms. The other parameters were chosen with values $C_1 = 100\ \mu$f and $R_s =$ a 100 ohm potentiometer. These parameters yield a maximum $T_d = 9.1$ msec.

The design values are manually adjusted to produce the controlled response of Fig. 2B. Corrected values are shown in Fig. 1. Once the circuit had been constructed, it took the engineer about 45 seconds to adjust R_1, R_2 and R_3 to produce a controlled response.



(A)



(B)

DESIGN CURVES *for voltage damping—Fig. 3*

Eliminate Trial and Error

This article gives a catalog of typical impedance plots. These charts are practical, not only for simple components, but for complex components when reduced to simple ones

By GARY E. EVANS

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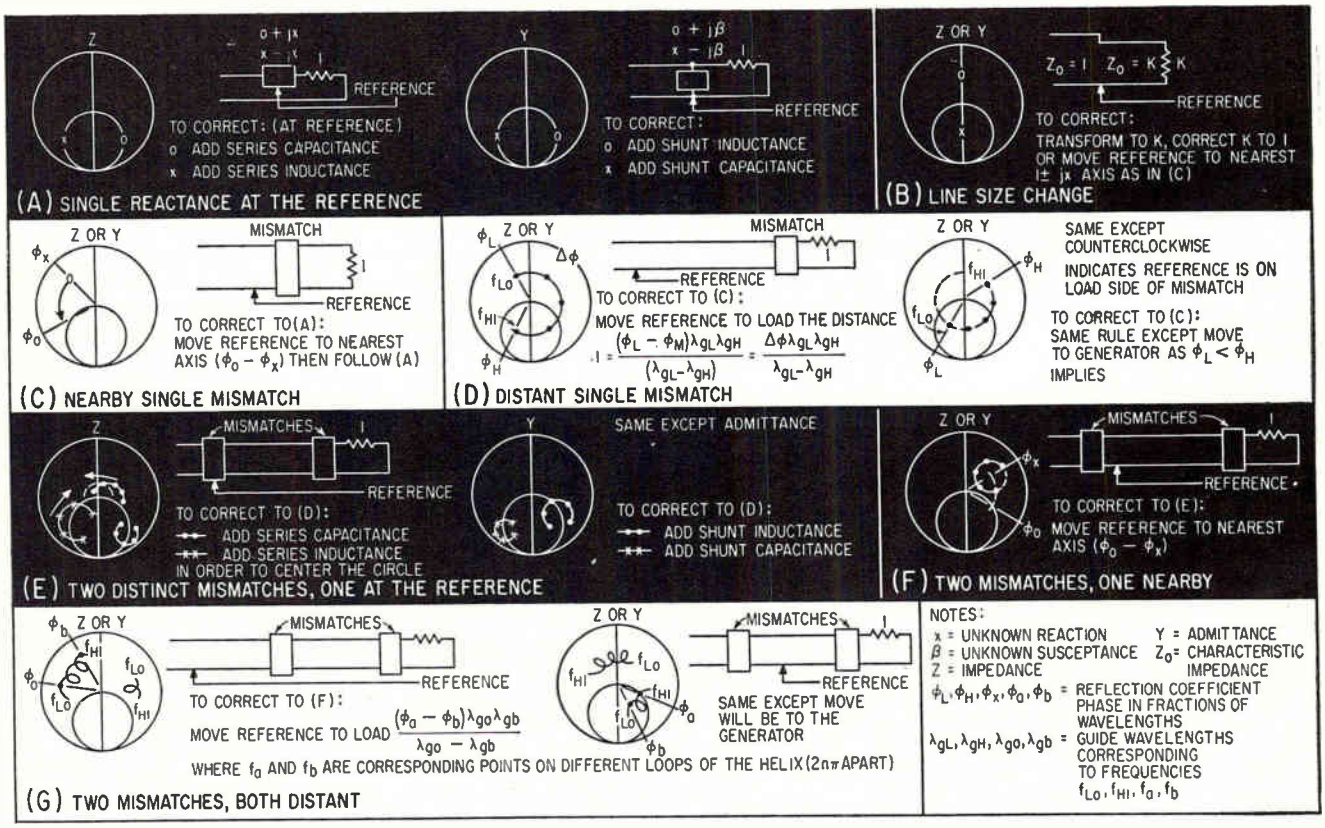
GET TO KNOW THE MISMATCHES

Maintaining a catalog of typical plots, such as that in Fig. 1, can be very practical for simple microwave components. After some experience with these, the chart will become unnecessary and the mismatches will be readily recognized. As a result, simple components can be matched quickly and complex ones reduced to simple ones and matched in about the same time. Most important, however, is that the process eliminates guesswork

REFLECTIONS occurring in microwave components result in power losses and other undesired effects. In some systems, wide frequency bands produce reflections with variable amplitude and phase. Complicated geometry makes a cut-and-try approach appear necessary to obtain a satisfactory impedance match.

A systematic approach, starting with a Smith chart plot or similar impedance graph, will provide information to locate corrections, but there is no general procedure to synthesize corrections from a set of experimental points, even for simple curves. The most useful approach is to reconstruct the probable causes of the observed plots before any correction is made. Confusing impedance plots can be clarified, and the source of the mismatch located. If the latter is not done, the corrected component may have internal standing waves and therefore reduced power handling and increased loss even though matched over the specified band.

Ordinarily, sources of mismatch are apparent from the construction or from assumptions in the design, or can be deduced from the imped-

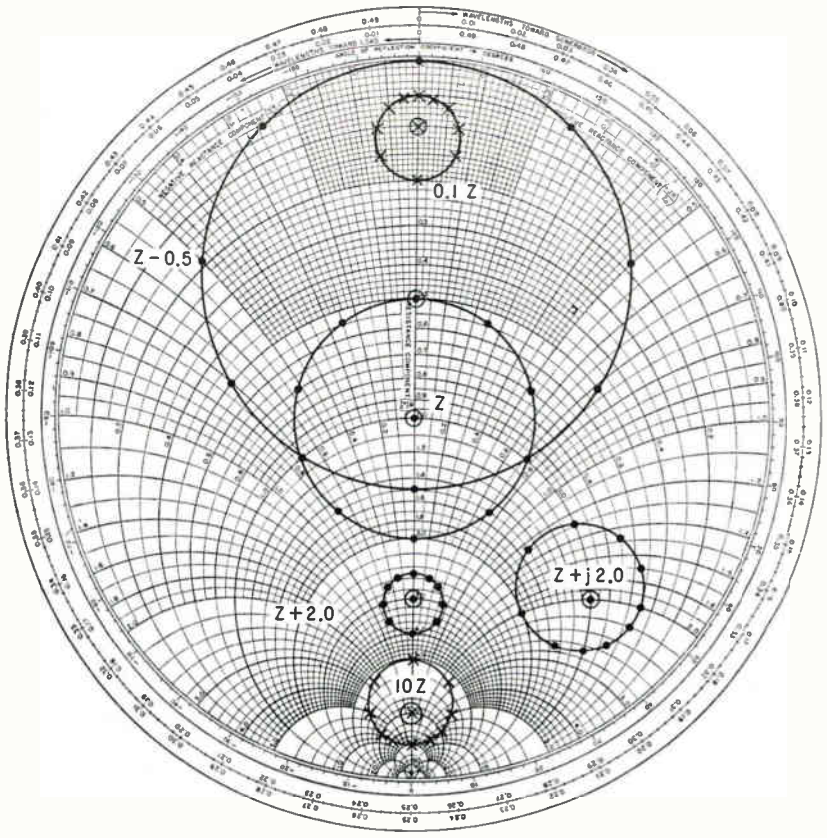


TYPICAL IMPEDANCE *loci for up to two mismatches as seen from various reference points. Each chart is a simplified Smith chart and the diagram shows relative position of mismatch and reference—Fig. 1*

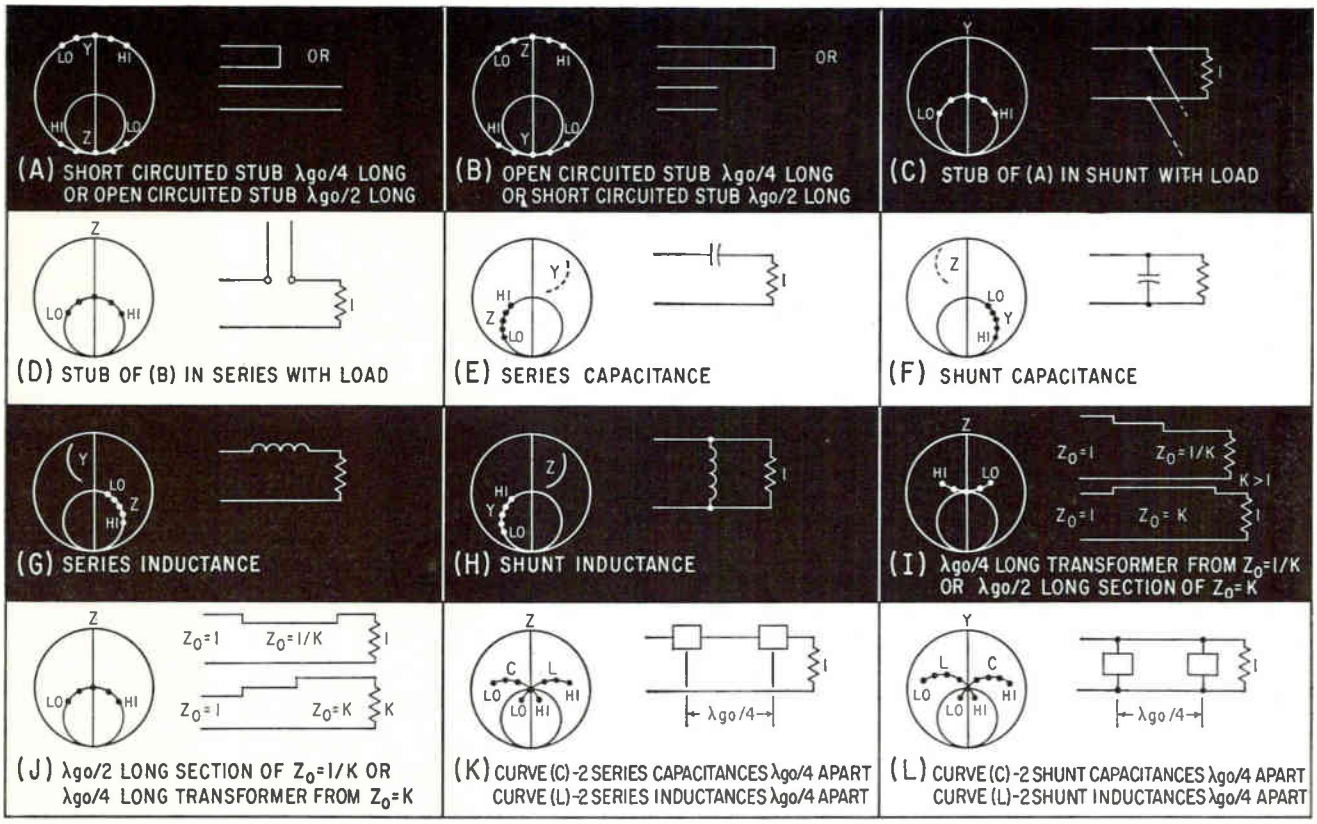
In Broadband Impedance Matching

ance plot. Any assembly requiring matching will have discontinuities such as bends or steps requiring possible correction. In addition, there may be approximations in the design, such as neglected strip thickness or an averaged dielectric constant which may indicate possible correction points. Most important, however, are impedance plot deductions.

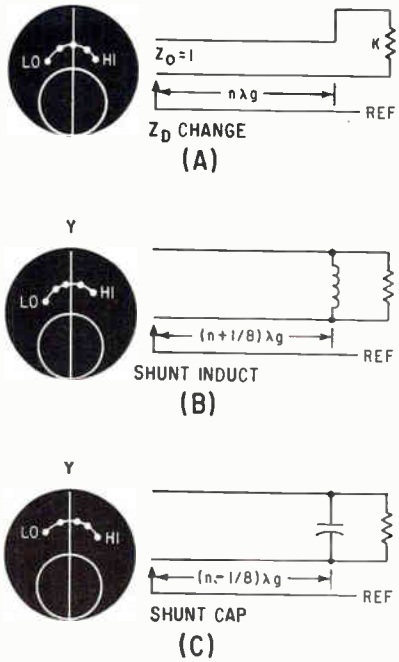
MATCHING—Matching over a narrow band is not a problem. The points are confined to a small region, and it is a simple matter to calculate the distance from the reference plane to a plane at which a particular type of correction (resistance, inductance, or capacitance, shunt or series) will match the unit over the entire band. For broader bands, the locus of impedance versus frequency may take larger and more complicated shapes. If the



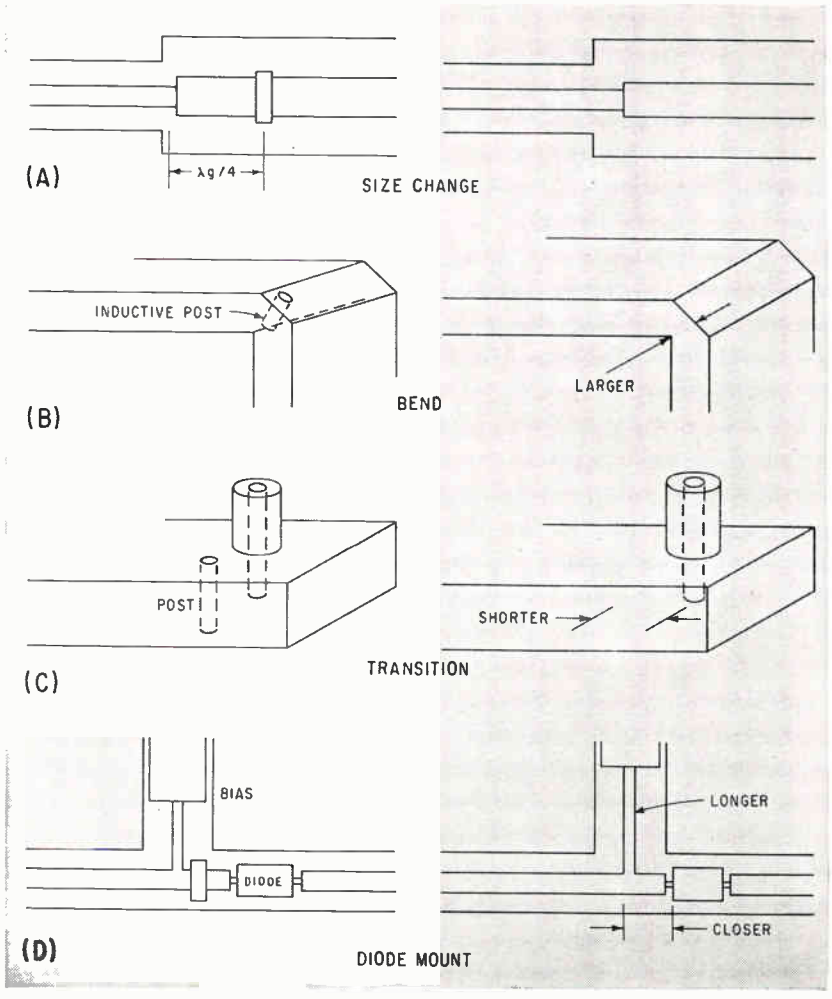
CIRCLE TRANSFORMATIONS *showing a circular locus Z and altered but still circular loci for Z with added reactance (Z+j2.0), added resistance (Z+2.0, Z−0.5), and transformed impedance (0.1Z, 10Z)—Fig. 2*



TYPICAL *frequency-sensitive elements and their loci versus frequency. These can be used or corrected for as necessary. It becomes necessary to do so when broad bands are involved—Fig. 3*



THREE TYPES *of mismatch having similar impedance loci—Fig. 4*



CORRECTING *practical devices. At the left is the breadboard design and to its right in each example, the more suitable alternative—Fig. 5*

components can be broken down into one, two or possibly three mismatches, however, the loci will have one of several characteristic shapes. These shapes are shown in Fig. 1 for up to two isolated mismatches, assuming the mismatches themselves are not exceptionally frequency sensitive. In Fig. 1, all impedance plots are normalized to the load resistance, implying that reflections are eliminated when the locus is a point at $1+j0$ (center of the Smith chart).

Starting at Fig. 1A or 1B, a single, frequency insensitive mismatch causes a single point locus displaced from the center. Since the corrections are usually shunt inductance or capacitance, points on the major axis, $1 \pm jB$, where B is the normalized susceptance, are especially important. If such a mismatch is viewed from a different, but nearby point, the locus is still small but may be at any phase (Fig. 1C). Such a small locus is typical of narrow-band problems and may be corrected by moving from the reference point to the point at which the plot is on the $1 + j$B axis and adding inductance or capacitance.

Referred to a distant point, the phase of the reflection coefficient depends on frequency although the vswr (and radius Γ) is constant, so the locus is a circle about the center (Fig. 1D). A single fixed mismatch cannot be more complicated. From such a plot, the procedure is therefore as stated in Fig. 1D, with each step selected to simplify the plot. First, the reference is moved in the direction which compresses the locus to a point. Next, the reference is moved to the nearest major axis (suitable for the type of correction to be added). A correction is added to move the point to the center.

If a second reflection exists distant from the first, it moves the locus circle off center, Fig. 1E. If this impedance is viewed from, or referred to, yet another distant plane, the phase of the points again changes proportional to frequency (actually $1/\lambda_g$, where λ_g equals actual line wavelength) so the circle is stretched into a helix, Fig. 1G. This is as complex as two fixed mismatches can get.

Further mismatches will move the spiral off center, but attempts should be made to divide the unit into smaller component parts for test. If this is impossible, it is sometimes practical to select the first reference at the most likely source of mismatch so that the helix resulting from the other two mismatches is simply displaced and not distorted. It may then be possible to recognize the shape and correct it to a type of Fig. 1G.

To correct a plot such as Fig. 1G, the locus is first restored to a circle centered on a major axis by changing reference planes. The circle is then moved to the center with a correction and only a single mismatch remains.

ERRORS—The corrections should generally end up at or within $\lambda_g/8$

of the mismatches. To keep the charts simple and usable, various assumptions and approximations have been made that may result in error. These are errors due to distortions on the Smith chart, measurement and interpretation errors, and differences or discontinuities from the assumed lumped nonfrequency sensitive type. These errors are surprisingly small.

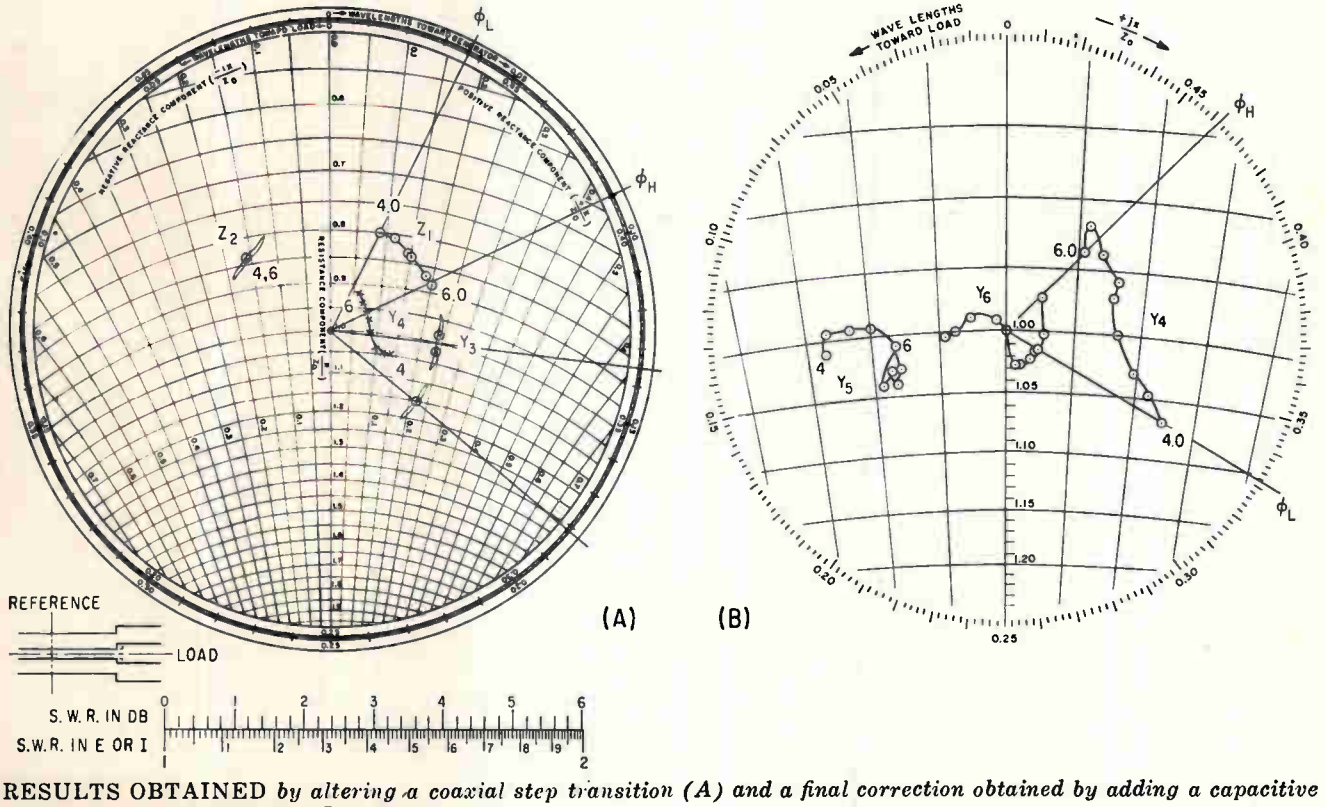
The assumed Smith chart manipulations are not in error. For passive lossless lines, a change in reference plane does develop a set of coincident points into a sector of a perfect circle. Addition of fixed resistance or reactance does preserve the perfect circularity despite the curvature of the axes, as shown in Fig. 2. Likewise, scaling characteristic impedance preserves circularity. Two lumped fixed mismatches in an otherwise uniform line will result in exactly the displaced circle described. The principal (but small) error is that the center of the circle does not remain the center and the points on the circle become correspondingly unevenly spaced. Therefore, the size of correction may be slightly in error.

Errors in interpretation are significant when the vswr is small or the band is narrow. With small vswr, phase measurements are inaccurate and for narrow bands, the observed sectors of curves are small. In either case, it is difficult to determine the center of a circle or to distinguish a circle sector from a helix sector. Wherever they cannot be distinguished, a correction for one works for either, from the impedance standpoint.

With narrow bands and large mismatches, a correction can be misplaced by several half wavelengths with resultant internal standing waves. If peak power or loss is critical, it may be advisable to measure over a wider band than necessary to obtain a large and recognizable sector of the curve.

The largest error in the simplified approach is due to neglected frequency sensitivity of corrections. Correspondingly, this can be used for matching more complex plots. Often the error can be neglected if a few trial and error steps are permissible, since the effect decreases as the center of the chart is approached. It may be sufficient to assume R, L and C constant and to account only for the usual reactance change of such discontinuities with frequency (ωL or $1/\omega C$, ω being the angular frequency). Figure 3 shows various frequency-sensitive elements that can be used or corrected for, as necessary. It becomes necessary to do so when broad bands are involved.

A pair of equal mismatches may be present in curved bends, double mitered bends, twists, certain tapers, rotating joints, slotted sections, phase shifters and any transition in and out of a special line. The locus should be a circle (or helix) tangent to the center of the chart, since the radius of the circle is the reflection coefficient Γ of the first mismatch (scaled) and the displacement of the circle is approximately the reflection coefficient of the second mismatch, and these should be equal. At some frequency the two equal mismatches must cancel and provide a point at $1 + j0$. If they do not, it is generally wise to determine the reason first, or else the corrections will be unequal and any future attempt at reproducing one of the junctions will bring up the question of which end to reproduce. For the same reason, care should be taken to keep the two corrections



RESULTS OBTAINED *by altering a coaxial step transition (A) and a final correction obtained by adding a capacitive ring results in the curve Y_6 (B)—Fig. 6*

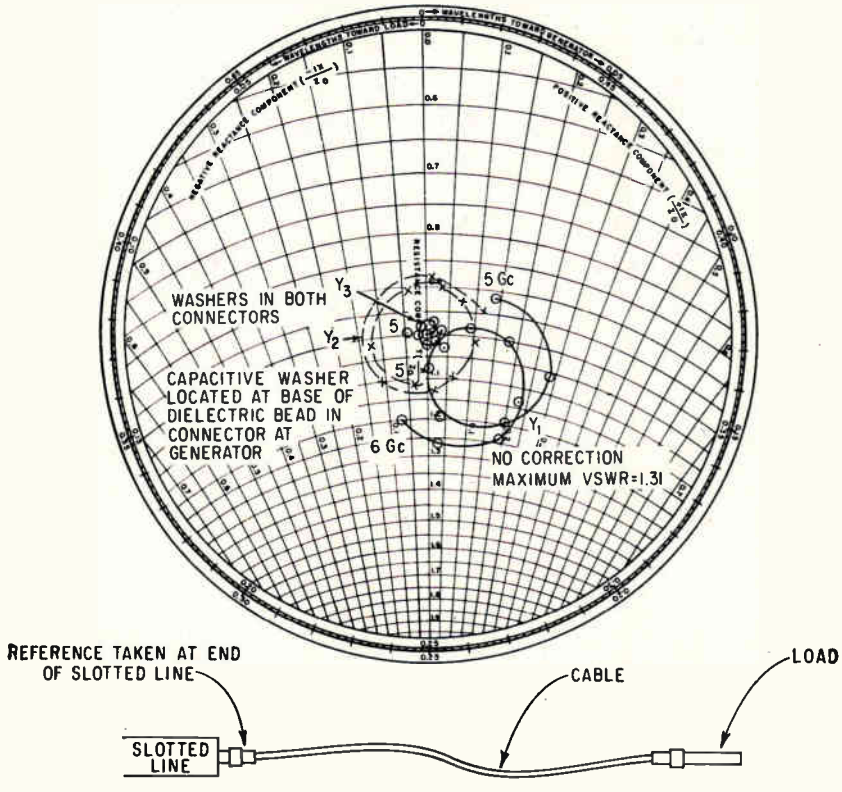
equal and separate, even if a satisfactory match can be obtained.

After the unit is matched, the location of corrections frequently points out errors in the original design and it may be desirable to replace corrections with more suitable equivalents. For example, the junction of two lines of unequal impedance may have been corrected with a capacitive or inductive iris $\lambda_g/8$ from the junction, since the plots are similar, Fig. 4. This might happen if a line of odd cross section were used and its characteristic impedance (Z_o) were approximated. Thus, it may be advisable to correct Z_o or to use a quarter-wave transformer. Many similar cases arise in which the correction can be absorbed into the design. Figure 5 shows some typical examples.

DESIGN EXAMPLES—Figures 6 and 7 show loci measured on equipment designed for use in a radar system. Figure 6 is taken from a step transition from a Type-N coaxial slotted line to a special large 50-ohm coaxial fitting. The step was first built without compensation for the step capacitance and the original locus is similar to Fig. 1D. Distance to a plane at which low and high frequency points are together $= l_1 = (0.463 - 0.410)(7.5)(5.0)/2.5 = 0.795$ cm to the load. Impedance Z_2 is plotted at that point. Since the correction is to be shunted with the line, the corresponding admittance Y_2 is plotted. The nearest $1 + j\beta$ axis is 0.276 cm further, as shown by Y_3. The total distance from reference to correction point is therefore 1.071 cm, which is at the step, as expected. The step was cut back to remove capacitance and the locus Y_4 resulted, which shows the effect of neglecting frequency sensitivity over this broad band. The distance that the points moved is approximately proportional to frequency.

Repeating the process with the new curve Y_4, $l_2 = (0.332 - 0.437)(7.5)(5.0)/2.5 = 1.575$ cm to the generator of the step. Y_5 is plotted at that point and is already on the $1\text{-}j\beta$ axis. A small capacitive ring at that point produced Y_6, the final locus. Again, the frequency sensitivity has stretched the locus.

Figure 7 is taken from a section of semirigid coaxial line with Type N cable fittings. The fittings were about 5 wavelengths apart and were in no way modified to mate with the special cable except in the brass clamp. As a result, there are two roughly equal mismatches, one of which is near the reference, and the locus Y_1 is similar to Fig. 1F but slightly distorted into a helix of Fig. 1G. The points at 5.1 and 5.8 Gc could be used to calculate a distance, about 2 cm, to the point at which the locus is a circle, but the sources of mismatch were obvious. A capacitance was placed at the base of the connector bead and adjusted to give Y_2. The distance to the second mismatch is about 25 cm or 4.5 wavelengths. The line also could be turned around. Actually, the first correction was added to the second connector with the resulting curve Y_3.



EXPERIMENTAL LOCI *for a section of semirigid coaxial line with UG-21/D fittings—Fig. 7*

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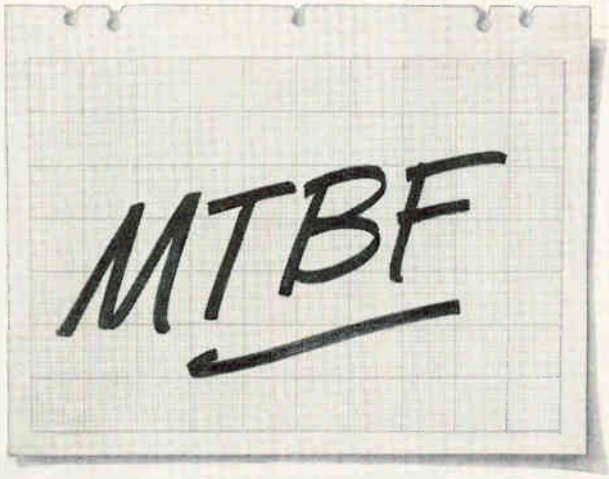

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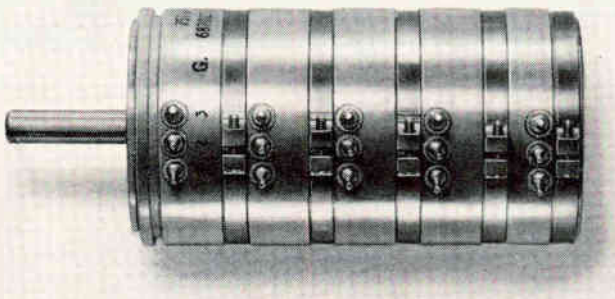

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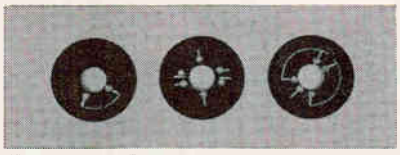

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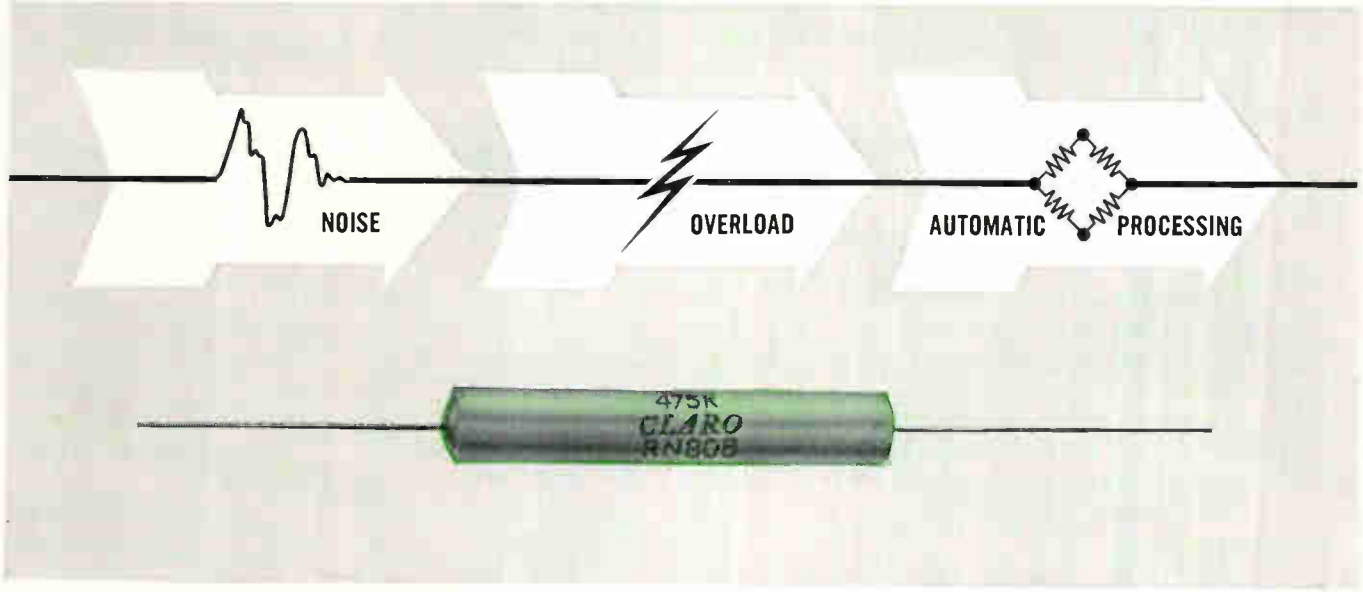

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Microwave Conversion Efficiency Reaches 70%

Wireless electric power transmission is brought closer by diode bridge

MICROWAVE energy has been converted to d-c voltage at efficiencies up to 70 percent. This performance was achieved using existing semiconductor diodes in a relatively simple full-wave bridge-type rectifier.[1]

The high-efficiency rectifier is one result of an investigation of microwave energy conversion being conducted at Purdue University School of Electrical Engineering under U. S. Air Force sponsorship. The work by Prof. E. M. Sabbagh and a team of researchers also includes studies of conversion by bulk semiconductor and by rectifier tubes. Although efforts are being made in the program to produce semiconductor diodes with more desirable characteristics, the results reported were obtained using type 1N830 diodes.

The probable higher cost of wireless transmission of electrical power would be justified in many special cases. For example, power could be provided where power line installation is difficult or impossible. Helicopters or similar vehicles could be kept aloft indefinitely to function as communications relays or radar stations. A number of functions could be performed in satellites with an adequate supply of electrical power.

DIODE RECTIFIER—Microwaves have been considered for transmitting power because the energy can be directed. Also, newer microwave generators can produce substantial amounts of power. However, efficiency in converting microwaves into d-c or low-frequency a-c power has been limited. The increased conversion efficiency obtained with the semiconductor rectifier contributes to overall efficiency of a microwave power transmission system. Conversion efficiency is shown in the table for operation at 2,440 Mc using 680 type 1N830 diodes.

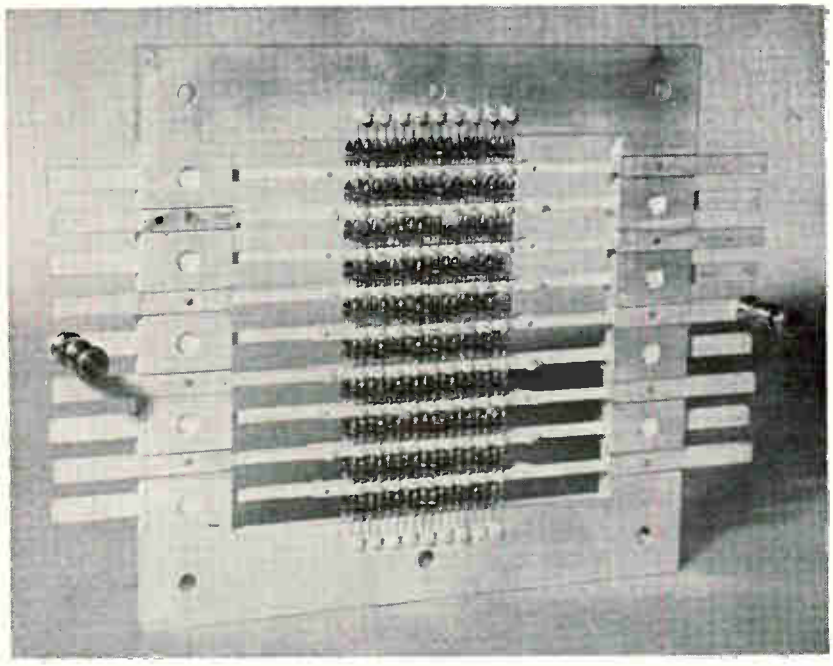
CONVERSION EFFICIENCY

Percent Efficiency	D-C Watts Output	D-C Volts Output
70	9	24
67.5	13	30
65	18.7	30
60	25.2	32
60	25.2	36
55	28.6	32
55	30.7	36
50	32.5	32
50	34	36

The microwave energy converter fabricated at Purdue includes a silver-plated brass diode mounting plate 0.25 inch thick. A hole 4.25 by 4.75 inches in the plate shown in the photograph enables 360 diodes to be mounted, while a modified plate accommodates a maximum of 760 diodes. Diode leads are clamped in slots in 0.125-inch supporting bars. The enlarged end of each supporting bar is insulated and held in a slot in the mounting plate by a nylon screw. The mounting bars extend an inch beyond the mounting plate for cooling if necessary. These ends are also convenient for measuring d-c voltage distribution and for locating faulty diodes.

In the 360-diode mounting plate, 180 diodes can be mounted on each face or 18 diodes can be connected in parallel with five parallel banks connected in series in each arm of the bridge. The circuit for a typical parallel element is shown in the figure.

TEST GEAR—In tests of efficiency and other experiments, a 100-watt, c-w magnetron was used. To permit use of available S-band test equipment, a 10-inch long tapered section was made for the transition between S-band waveguide and waveguide designed for operation at



MOUNTING *plate for 360 diodes was modified to accommodate 760 diodes in waveguide section*

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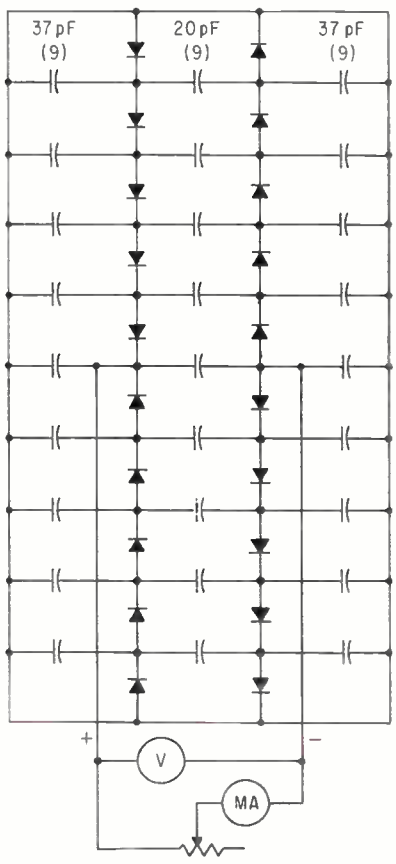
2,440 Mc having dimensions of 4.25 by 4.75 inches. The diode plate was clamped between a short section of the 2,440-Mc waveguide (containing a shorting plunger for impedance matching) and the flange of the tapered section.

EXPERIMENTS — With output constant at 30 volts, measurements were made of the effects of the numbers and arrangements of diodes on efficiency and d-c power output per diode. One conclusion from these tests is that diodes are used more effectively at higher input powers when there are fewer diodes per unit area of surface.

The 760-diode mounting plate was used to determine the effects of spreading diodes or of adding diodes on each side of the original group shown in the photograph. With the original 360 diodes mounted in alternate spaces covering twice the original area of the waveguide, efficiency was low at small power inputs but much improved at high power inputs.

When the diodes are spread out,



PARALLEL *elements like this are connected in series to form each leg of microwave bridge rectifier*

apparently heavy loading reduces field intensity near the center of the waveguide and diodes near the sides do much of the work. With lighter loading, diodes near the sides are in such a weak field that they contribute little to forward current but continue to add appreciably to reverse leakage current.

During modifications of equipment used in the experiments with 1N830 diodes, tests were made of eight HD-5000 fast-switching diodes connected with two diodes in each arm of a full-wave rectifier bridge. With the bridge mounted in S-band waveguide, efficiency was 45 percent with a 12-volt d-c load and input power of 125 mw per diode. With an 18-volt load and input power of 250 mw per diode, efficiency was 36.9 percent.

These efficiencies are by far the highest obtained with junction-type diodes. Although it is considerably less than that of 1N830 diodes, d-c voltage per diode is two or three times as great and power-handling capabilities are better. Forward resistance of the HD-5000 diodes was about three times that of 1N830 diodes.

OIL COOLING—Tests of methods for cooling the 1N830 diode bridge indicate the circulating paraffin oil around the diodes provides effective cooling with little loss in efficiency. It was also found that silver plating and polishing of inner waveguide surfaces resulted in considerable improvement in efficiency at lower power inputs but virtually none at maximum power input.

Increasing the number of diodes in the 760-diode mount beyond 680 diodes resulted in no significant increase in d-c power output. However, if a larger mount were used with appropriate tapered section, d-c power output would probably increase in proportion with the area of the mount.

In general, the tests indicate that at high input forward diode resistance is the determining factor in rectifier efficiency. At low input power, reverse leakage current determines efficiency, particularly at higher output voltages. In addition to operating efficiency, these rectifiers are compact, light and require no standby power. Higher power

outputs can probably be obtained. Disadvantages of the converter are the cost of the diodes and of assembling the rectifier.

Simple Test for Transistor Quality

By FRED W. KEAR
Lytle Corporation
Albuquerque, New Mexico

TRANSISTOR gain and leakage can be tested by quality assurance and production personnel using a simple and inexpensive tester. The tester has proved to be very satisfactory for general testing of production units, although complete test data is not provided for each unit.

Most personnel using the tester are not qualified to operate more complex testers without special instructions. In the application for which it was designed, only gain and leakage were of interest. However, different devices required testing under widely varying current loads.

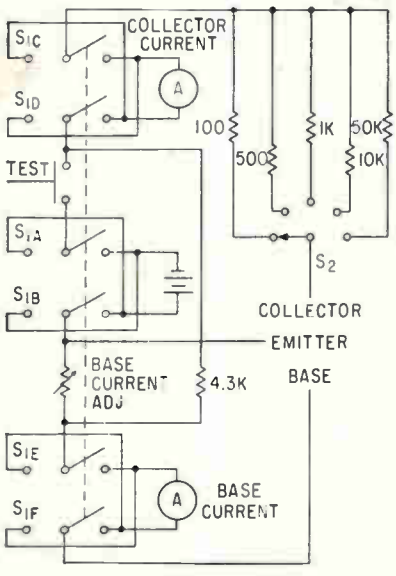
In the circuit in the figure, switch S_1 is a six-section double-throw toggle or rotary switch. It reverses the polarities of the base current meter, collector current meter and battery for testing either *npn* or *pnp* transistors. Base current is adjusted by the potentiometer in the base biasing network. This potentiometer is selected to provide a high degree of resolution in controlling base current, considering battery voltage and other factors.

The test pushbutton switch supplies current simultaneously to the base and collector circuits of the transistor under test. The collector current meter is in series with the collector load resistor with meter polarity switched to conform with battery polarity. Collector load resistance is determined by the position of switch S_2.

The base current meter is also switched so that polarity conforms with that of the battery. This circuit switching arrangement permits all transistors to be inserted into the same socket based on lead

markings, regardless of type.

Three controls must be checked or adjusted to test a particular type of transistor. Each subsequent transistor of the same type only requires checking the base current



SWITCHING *arrangement enables tester to accept all transistor types in same socket*

adjustment while the test pushbutton is pressed.

Charts are provided to operators indicating the required base current for each test with its corresponding minimum acceptable collector current value. With base current at minimum, leakage current is measured and entered into the test records.

Laser Emits Visible And Infrared Light

HELIUM-NEON gaseous laser produces outputs separately or simultaneous in the far infrared region and at visible wavelengths. Output at 3.39 microns results from direct excitation of the gas by an electrical discharge. This approach is also said to simplify operation, produce more power and provide higher gain per unit length.

The new laser was discovered inadvertently at Spectra-Physics, Inc., during experiments with the visible helium-neon laser operating

at 6,328 A. With certain combinations of the mirrors forming the optical cavity, a narrow beam of energy was emitted even when no visible light was observed. This energy was subsequently found to be at a wavelength of 3.39 microns. It was also found that with suitable mirrors, lasers could be made that emitted either visible light, light at 3.39 microns or both.

The existence of a possible transition at 3.39 microns has been known. It results from the change in energy levels of neon caused by a difference in size of the orbit of the outermost electron. It is analogous to the laser transition at 1.15 microns, but its intensity and high gain were unexpected.

Power outputs of about 10 mw have been obtained from an 8-mm discharge tube 115 cm long. Gain per unit length is said to be even more surprising. Even though reflectivity of the end mirrors in the infrared region is only about 50 percent, the lasers oscillate. Also, with losses introduced in the cavity by quartz Brewster's angle windows, gain is so high that laser operation can be obtained with a discharge much shorter than the length of the one-meter tube.

Simultaneous emission at the two wavelengths has a pronounced effect on the visible emission because the two transitions compete for the excess higher energy population. Relative reflectivities of the mirrors in the cavity determines which transition predominates. If neither gains absolute predominance, each wavelength predominates in different parts of the beam.

INTERACTION—These variations occur because energy distribution in a confocal resonator is not uniform across the beam but varies in discrete modes so that field intensity varies in different parts of the beam. When this effect occurs, visible output is present but has a highly defined structure. There are often extreme intensity fluctuations of the visible output.

Discovery of the new laser wavelength with its high gain makes possible a gaseous laser almost as short as solid state lasers. A short gaseous laser can be made rigid, and, with the spectral purity associated with gas lasers, could be used as a frequency standard.

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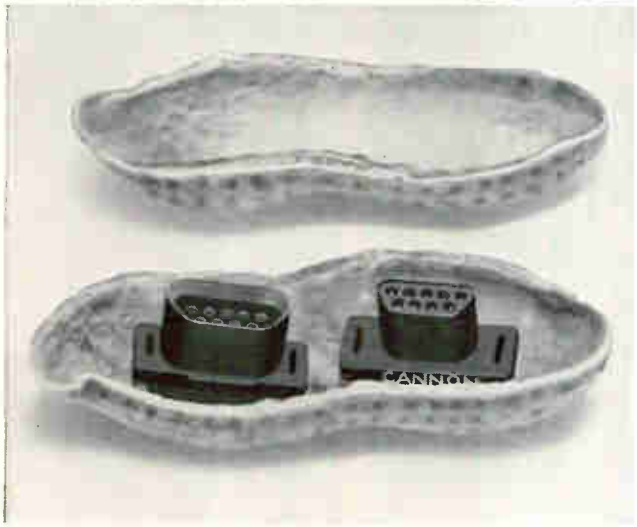

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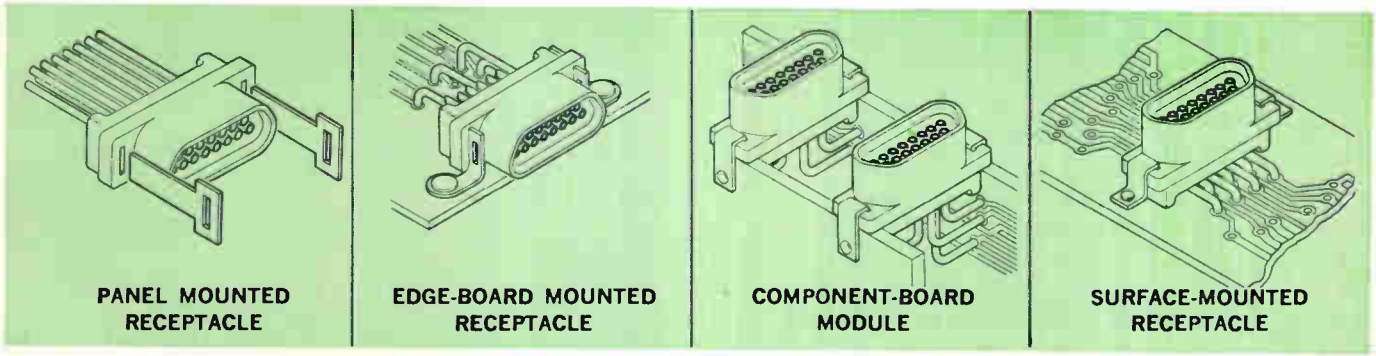

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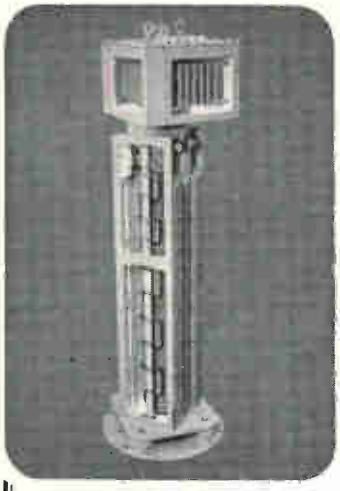

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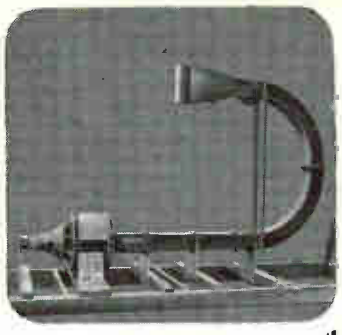
Slip Ring Assemblies—Our new concept of button type spacing eliminates moisture and dust traps, gives maximum ring capacity within minimum space requirements. Dynamic characteristics are improved because of lower torque, heat dissipation is better and capacitance is reduced. Cost is lower.

PRECISION CAST HORN
Precision Microwave Castings — We pour aluminum, magnesium and copper base alloys. Precision sand, plaster and investment castings complete with metallurgical tests are processed at our foundry.

WAVEGUIDE ASSEMBLY
Microwave Devices — Typical microwave devices ranging between L and KU Band include duplexers, switches, phase shifters, power dividers, horns, directional couplers and mixers. We test to your specifications.



CIRCULAR LINEAR POLARIZER
Antenna Assemblies — Complex assemblies in the L through KU Band frequency ranges for ground, shipboard, airborne and missile applications are available.

PRODUCTS OF PROVEN RELIABILITY

Gorham Electronics has established a reputation of supplying complex precision castings, microwave devices and slip ring assemblies of proven reliability to the country's major contractors. Completely integrated facilities covering design, precision casting, close tolerance machining and assembly, plus final electrical test — all at one location—are your assurance of a quality product, at lowest cost.

Hidden costs associated with vendor liaison, incoming inspection, divided technical responsibilities, and multiple profits are eliminated by placing a single order for timely delivery of a final tested product with an "Integrated Facility of Proven Reliability"—Gorham Electronics. Write today for our brochure.

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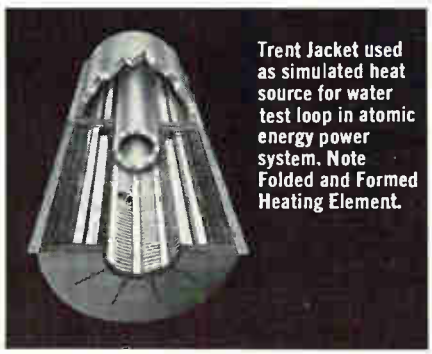

Trent Jacket used as simulated heat source for water test loop in atomic energy power system. Note Folded and Formed Heating Element.

feature TRENT FOLDED AND FORMED HEATING ELEMENT

The result? Jacket heating advantages not possible with steam or liquid heating methods! • **Temperature to 1000°C. without Pressure Equipment—Minimum Maintenance • Maximum Heat Input • Chamber Control • Heat Zone Control • Low mass element—quick control response • Maximum Element and Jacket Life** • No matter what your process heating problem—Trent can solve it. Discuss your needs with a qualified Trent Engineer, or write for Bulletin J-1.

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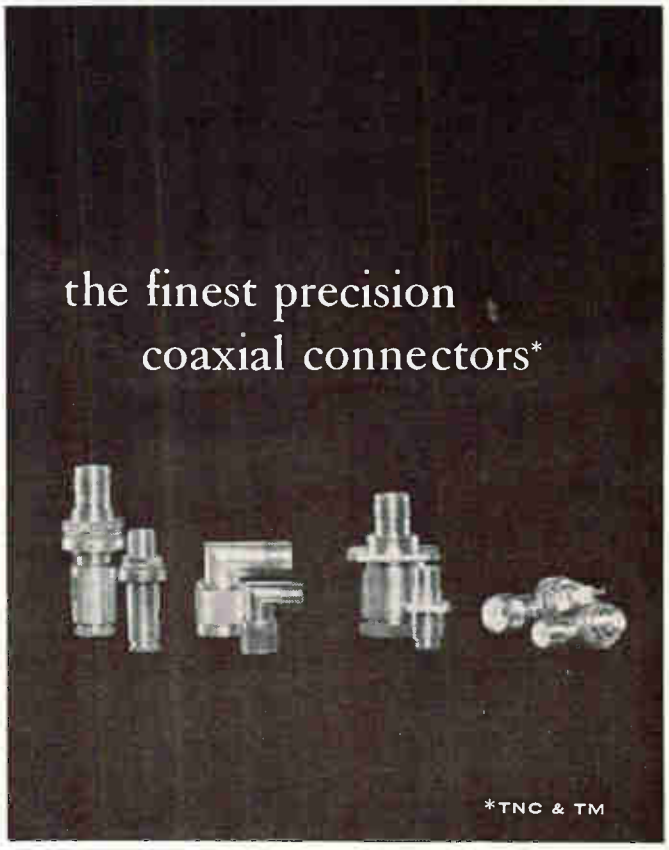

General RF Fittings, Inc.
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Telephone: 617 267-5120

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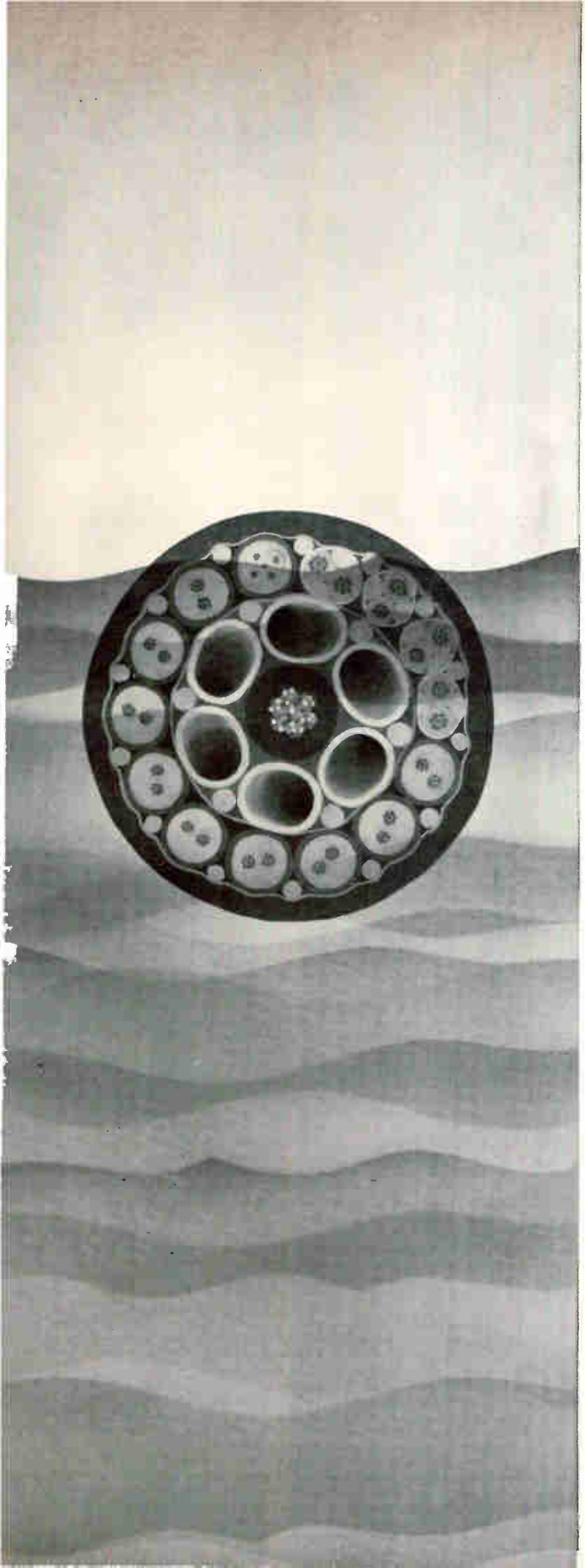

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Float at Sea
Eliminate Hosing Problems
Link Rockets to Ground Control

Many inner space projects require cable that will not sink to the ocean floor. To meet such requirements, Simplex has designed and produced special cables with built-in flotation. If desired, cables can be designed with plastic tubes to be used as gas, pneumatic or hydraulic lines.

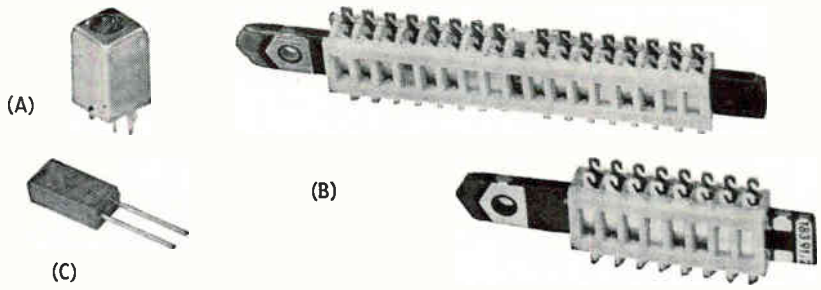
For the growing number of installations where hosing of water through a cable could cause serious trouble, Simplex offers a "non-hosing" cable construction. Cables with this construction contain a special filler compound which eliminates wicking action even if the cable jacket is damaged.

Umbilical cables manufactured by Simplex are used to connect rockets to their sites before firing. Essential characteristics of these cables include flexibility, exceptional reliability, resistance to mechanical damage and chemical attack by exotic fuels.

There's a Simplex electronic cable to meet virtually every existing application involving the transmission of power, control and communications. And Simplex has unique capabilities for solving any problems you may encounter in these areas. For further information, write Department 365, Simplex Wire & Cable Co., Cambridge, Mass.

Simplex
WIRE & CABLE CO.
EXECUTIVE OFFICES: Cambridge, Mass.
Plants at Cambridge, Mass., Portsmouth, N.H.,
Westbury, L.I., Monrovia, Calif.

CIRCLE 85 ON READER SERVICE CARD



MINIATURE *coil (A), wavelength switch (B), and resistor (C), designed as family groups whose shape and dimensions are uniformly planned for complete system. Units, actual size, plug into circuit board which is considered as a multiple female connector —Fig. 1*

Ordered Geometry for Component Design

Aim is to attain greater flexibility and increased use of mechanization

By J. RODRIGUES de MIRANDA
N. V. Philips' Gloeilampenfabrieken, Radio Apparatus Laboratory, Eindhoven, Netherlands

INTEGRATED active and passive elements will eventually be applied to consumer electronics, and to the radio and television entertainment field. Although application is for several reasons far away, a design philosophy has been suggested so that if and when modules and molelectronics replace the present spatially-distributed lumped-circuit elements, these techniques can be introduced gradually.

The aim is to stimulate an international and frank cooperation between manufacturers of electronic equipments and components to create a logically consistent system of designing components, assembly systems and assembly methods thereby taking full advantage of the possibilities offered by the properties of solid-state components.

As a radio apparatus factory, Philips designs and manufactures practically all required components. Obviously, company seeks ways and means to shorten assembly time for consumer equipment produced in large quantities, such as radio and tv sets. This goal can be reached by bringing component structure and assembling techniques in harmony with each other.

FIVE PHASES OF EQUIPMENT DESIGN

PHASE	I	II	III	IV	V
chassis	metal	circuit board e = 2.54 mm	circuit board e = 0.635 mm		
active elements	tubes	tubes (transistors)	transistors	transistors	controlled growth of solid matter
components	conventional	conventional	conventional principles	united in building blocks	
design of components	conventional	conventional adapted	coherent system h = 10 mm, small tapered tags		
assemmly	by hand	hand or cutting and bending mach. or insertion line	by hand or by insertion line		
soldering	iron	iron or dipsoldering	precision dipsoldering or small iron		
number of components per cub. inch	1–2	10	50	200	?
Introduction Philips	1925	1956	1961 "first steps"	1965–1970	2000?

FORM FACTORS—Search has been for design and assembly methods, not biased by the conventional shape of components. Components will be adopted to the requirements of the transistor circuits, to transistor dimensions, and to efficient assembly methods. Aim is for international standardization, improved reliability, better control of the manufacturing process.

Suggestions for a consistent system take the following important principles into consideration, and radio sets are now being designed to comply with these principles:

The circuit board is considered

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

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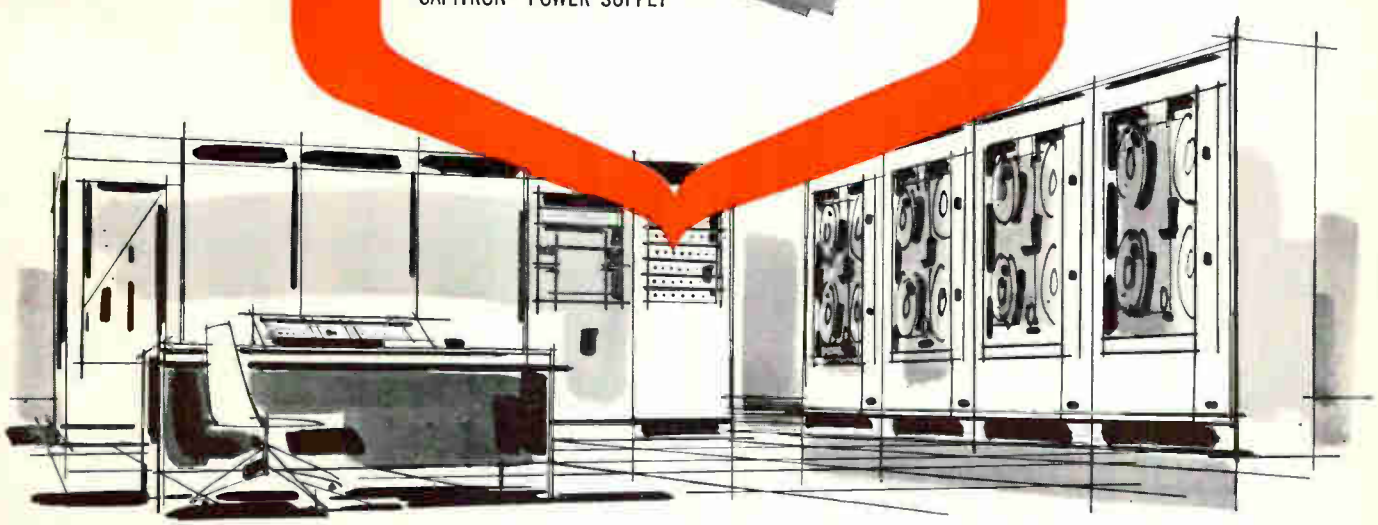

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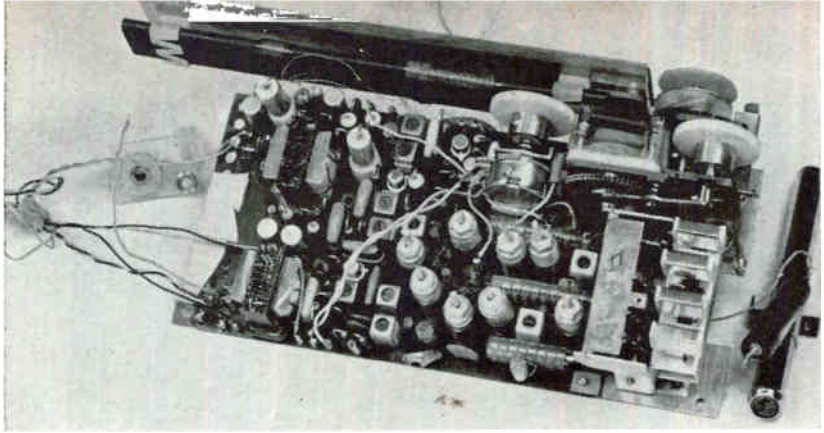

WAVE RANGE *switch system in all-transistor four-band radio set is operated by pushbuttons. Some existing components had to be used, and Philips had to decide provisionally about dimensions of new components because international agreement is not yet feasible—Fig. 2*

as a multiple female connector. Components are to be pluggable and have contact points in the shape of stiff tapered legs, fitting tightly into the holes of the printed panel. This is advantageous for mechanized insertion as well as for assembly by hand.

To provide for optimal packing density, components will have a standard height, 10 mm is proposed, with the smallest projected surface possible. Standardization of the dimensions and the shape of the legs as well as their mutual distances and of the dimensions of components in general is necessary for the interchangeability of components made by various manufacturers.

Radio sets have been designed, complying as far as possible in this stage, with the above philosophy. Coils, see Fig. 1, are conceived as a family of coils. Dimensions chosen are $6 \times 6 \times 10$ mm^3. They have five lugs, situated to fit the ϵ-grid. They can contain aerial or oscillator coils for all broadcast ranges, and i-f coils, or halfband filters for a-m or f-m. Obtainable Q is somewhere in the neighborhood of 140.

The wavelength switch used, see Fig. 1, is small and offers an enormous variety of possible applications, made possible by using two switching tracks on each side of the slider

INTERNATIONAL STANDARDS FOR COMPONENTS?

More demands are now put on the configuration of components in the development of consumer radio equipment. This observation leads to a more fundamental study of the direction consumer electronics will take based on modern design and assembly techniques. It is suggested that passive components to be used in these equipments be designed in accordance with transistor circuits, transistor dimensions, and efficient assembly methods.

Can such requirements be standardized internationally?

Electrical engineering evolved an international language of symbols for resistors, capacitors, batteries, transistors, tubes. The need for such a grammar was evident at the first international congress of electricians back in 1881. When the International Electrotechnical Commission met in Paris in 1912, it appointed a special advisory committee "to prepare a set of international graphical symbols for use in electrical diagrams and installation plans." Present committees are active to this day.

Can a similar advisory committee be formed to plan a set of international standards for the actual components?

One large firm that designs and manufactures practically all components it uses has proposed a logically consistent design system for components it uses in its own transistorized radio and tv sets aimed at the consumer market. They do not propose a plan for others, but suggest a philosophy they use for standardizing shape and dimensions of components on plug-in boards.

Now that we are at the crossroads of new directions in electronics, perhaps there will never be a better time than now to re-explore the entire subject of component standardization

and correspondingly, two lengths of contact springs. Besides this, connections between the two sides of the slider are possible. Total height of the switch is 10 mm, terminals are situated to fit the grid pattern. Plug-in components, they can be dipsoldered after all components have been assembled.

STIFF LEGS—In the future, resistors, capacitors, transistors, and combination devices will all be produced in the shape of upright standing components with stiff legs, all having standard heights with configuration fitting the circuit board grid pattern. An example of a resistor, shown in Fig. 1, was designed by another component maker, not belonging to the Philips concern.

Modules and molelectronic devices can and should be made to fit the existing grid pattern. It is quite possible that these techniques can be applied to professional and industrial equipments, and military programs.

In general, the quality of transducers such as ferrite aerial, loudspeakers and batteries depends on their size. Space saving in the electronic part can thus be transformed in better quality by using this saving for increasing the size of one or more of these transducers.

BETTER MATERIALS—An interesting aspect of miniaturization is that because it leads to a reduced consumption of raw material, it offers the possibility of using better materials which are too expensive for larger constructions. Smaller components need not be more expensive, but will probably be cheaper than "standard" components.

Techniques developed tomorrow should be the runway from which future designs, not yet developed, can take off.

The borderline crossed when passing from phase II to phase III in Table p 86 is important, because in phase III, for the first time, stringent demands are put on the mechanical configuration—shape and dimensions—of components.

Philips has designed a small radio set for long and medium wave as well as for f-m reception making use of ordered geometry techniques described. Another small radio set,

A DIRECT PLUG-IN REPLACEMENT FOR

6587A	5C22	PL174	6279
6587	HT415	9912	KU25

Extensive modifications in physical and electrical characteristics have achieved a new high in performance levels and a new unmatched low in size in this newest of a long evolutionary line of glass thyratrons. The 8253 has the capacity for critical applications which require added performance capability and reliability not obtainable from earlier designs.

Ring-disk construction cuts height and provides external (cool) anode and lower lead inductance. Rated for higher voltages with higher currents than prototype tubes. Grid connection can be made directly to the grid flange or (normally) through the base pin. Internally connected hydrogen reservoir promotes long life. Can be supplied with silastic rubber anode boot for shock cushioning or for high altitude operation in close spaces. Write for brochure on Tung-Sol hydrogen-filled tubes, including complete data on the 8253: Tung-Sol Electric Inc., Newark 4, N.J. TWX: NK193.

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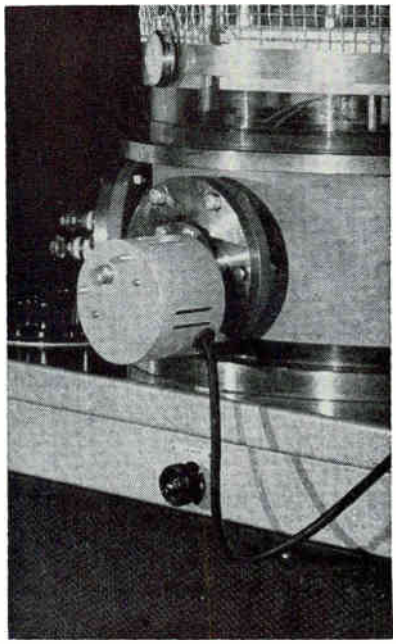
HIGHEST RATINGS— SMALLEST SIZE

TUNG-SOL 8253 HYDROGEN THYRATRON

Fig 2, designed for medium and three shortwave bands, covering 13-95 m, with push-button wave-range switch also makes use of the miniature technique.

Motor Controls Vacuum Deposition Processes



MOTOR *locates geartrain inside vacuum, has no rotary feedthoughs*

MANUFACTURE of microcircuits and thin-film computer elements requires ability to change heating sources or to rotate masks for deposition of semiconductors within same vacuum system and pump-down.

When this is done by using feedthoughs or shafts guided with rubber gaskets that are powered by motors located outside vacuum system, leakage may occur after usage. System may be contaminated, and motor may impose high speed and friction restrictions.

High-vacuum motor, developed by Photonetics, locates brushless motor with gearhead assembly within vacuum system, keeps driving coils outside. Magnetic field needed to operate motor is concentrated around rotor and no stray field results, so that deposition of magnetic materials is achieved without interference from motor itself.

In molecular beam selection, use

Be practical

When the soldering gets tough, crimp. Because sometimes it just isn't practical to terminate connectors by soldering them.

Take connectors used in aircraft, for example. After a jet fighter is assembled to the point where connectors are ready to be terminated, working space has practically vanished. Under these conditions, soldered-on-the-job terminations are expensive and impractical.

That's probably why many airframe manufacturers and subcontractors have standardized on Amphenol "Poke R"* connectors, especially when a MIL-C-5015 type connector is needed. "Poke R's" have removable, crimpable Poke-Home® contacts. Instead of soldering to contacts in a connector, Poke-Home contacts are crimped to wires *then* inserted into their proper connector location.

Besides conserving valuable assembly time, the Poke-Home method consistently produces more rugged, more reliable terminations.

Amphenol "Poke R" connectors are also widely used in land-based applications. An eastern computer manufacturer, for example, uses "Poke R" connectors not only because they work better and are available with shielded contacts, but also because circuit changes can be easily made *after* connectors are installed. Anyone who has ever been forced to make circuit changes involving soldered terminations will recognize the value of removable contacts.

Complete technical data, including "Poke R" environmental resistance characteristics, is available from any Amphenol Sales Engineer. If you prefer, write Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 S. 54th Ave., Chicago 50, Illinois.

*T.M. Amphenol-Borg Electronics Corp.

AMPHENOL **Connector Division** / Amphenol-Borg Electronics Corporation

of high-vacuum motor mechanism controls vacuum deposition rates, and operates shutters of optical rotary prisms to measure thickness of deposition. Applications also exist in areas of differential pumping, formation of crystalline structures of preferred orientation, and space chambers. Motors supply 1/20th horsepower at 3,200 rpm, high running torques to one pound per inch, starting torques to 0.6 pound per inch. Gearheads operate under pressures as low at 10-11 mm of mercury or lower. Ratings up to one horsepower are available for special usage.

High Temperature Coat Applied by Spraying

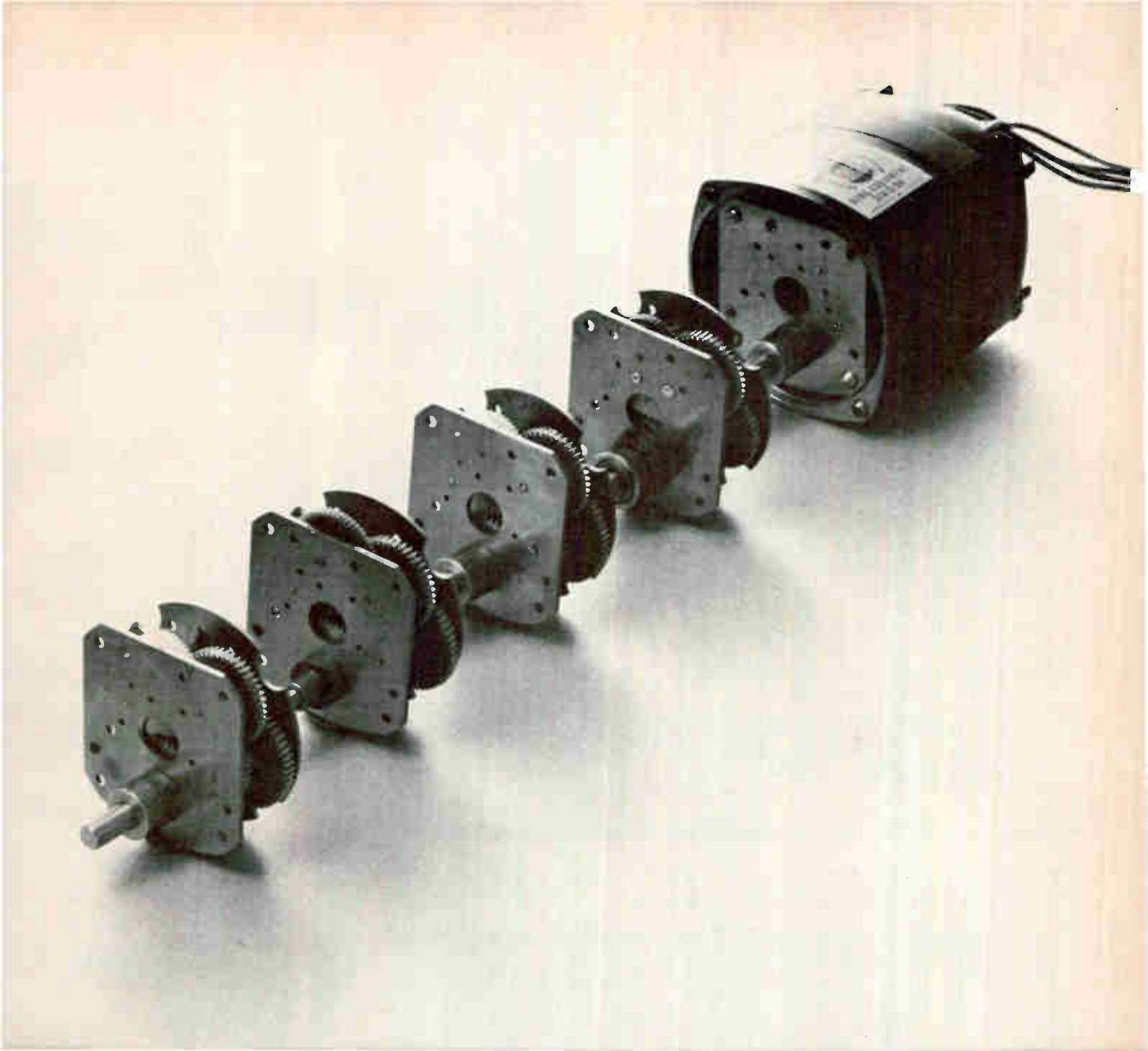
HEAT AND BLAST resistant coating holds interior temperatures of Atlas launch equipment exposed to 5,000 deg F blast of burning propellants to around 130 deg F.

Key to Dyna-therm Chemical's coating is its property of intumescence, it foams and bubbles to about twice its original thickness when exposed to heat. The material has withstood temperatures of 23,000 deg F during recent tests. One application of D-65 coating costs approximately $27,000, but General Dynamics/Astronautics says use of D-65 has resulted in net savings to equipment of over $12 million during 36 recent Atlas firings.

Low Failure Rates Goal For Star Planar Transistor

AIM for silicon epitaxial Star planar transistor is to meet a failure rate of 0.001 percent per 1,000 hours at a 90 percent confidence level at 25 C. U. S. Army Signal Supply Agency will spend over $150,000 for this investigation.

Symmetrical, four-point pattern of transistor geometry gives a high combined current-frequency performance capability useful for information handling capability of high-speed computers. Contract with Motorola calls for production engineering on epitaxial materials, surface preparation, geometry definition, metalizing, wire bonding and diffusion processing phases.



Why Borg motors let you shift gears

Because you can save money by stocking fewer motors.

Take the new sub-fhp 1060 series*, for example. You stock one model and several interchangeable gear trains. As the torque requirements of your equipment change, you simply select the appropriate gear train to vary the output speed, gaining the needed torque rating. By stocking spare gear trains—instead of extra motors—you use less shelf space, you save on inventory.

There's more to Borg motors than gear-train versatility and economy. Synchronous, induction, and low-inertia types are available. Their torque speed relationships meet the exacting requirements of instrument and control applications. And you can depend on a Borg motor to outlast any other—it's designed and built for maximum severity service.

Anticipating the problematical, Borg motors offer minimum temperature rise to counter heat dissipation problems, optional high-speed shaft extensions, special outboard bushings, special length and diameter shafts for gear boxes—and even special paint colors to match your equipment.

If you are snagged by a sub-fhp motor problem, the man to see is your nearby Borg technical representative or Amphenol-Borg Industrial Distributor. Or, if you prefer, write R. K. Johnson, Sales Manager:

**The new Borg 1060 series are sub-fhp, four-pole, induction type control motors featuring low-inertia, high-resistance, squirrel-cage rotors.*

BORG

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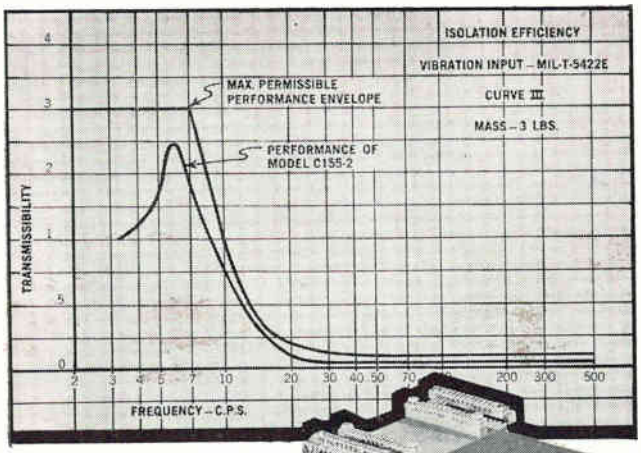

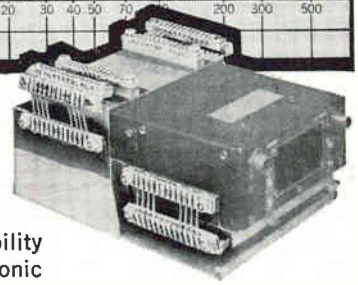

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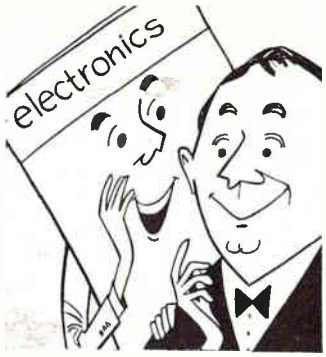

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Split Electrode Spot-Welds Microcircuits

Thin film and other welds made on 0.001 inch center

NEW APPROACH to a-c resistance welding for microminiaturized circuits is single point welding, which has been developed by Aerojet General, Astrionics Div., Azusa, Calif.

In the photograph on p 100 the operator has placed the circuit to be welded in place and the welding head has been brought down into position. The welding head is actually a split electrode with a layer of insulation between the two current carrying elements. When the two elements are touching the top piece of the weldment, a meter shows the resistance of the weld circuit and tells the operator when set-up conditions for welding are correct. Pressing a button then sends a controlled pulse through the weldment-electrode circuit.

The microwelder shown was designed for use in microminiature electronic packaging and is primarily directed towards the semiconductor, thin film, and solid state circuit problems of today. Indications are that the technique will also be compatible to the molecular circuits of the future.

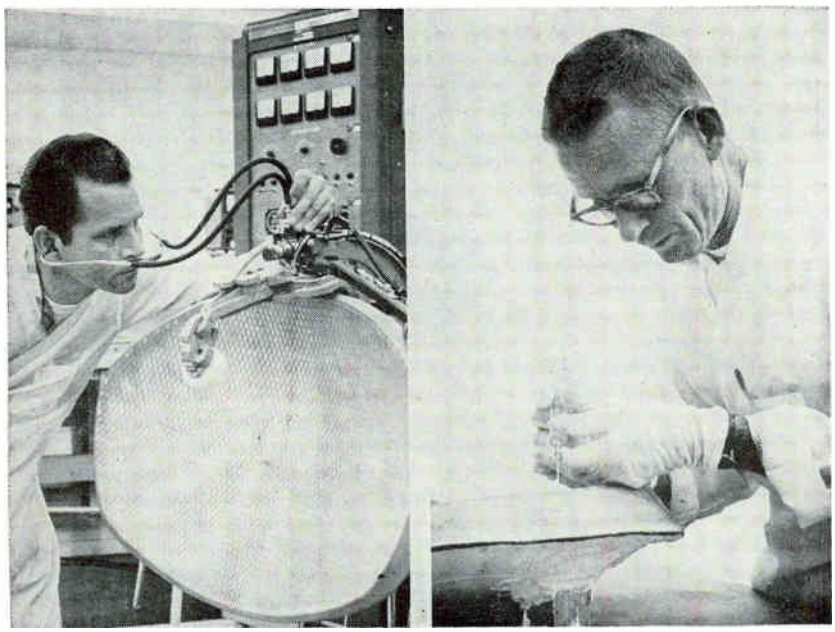
True resistance welding is obtained for the materials and combinations of materials used today for interconnections. The technique has been used satisfactorily for applications heretofore identified with techniques such as thermal-compression bonding, ultrasonic welding, and electron beam welding. Interconnecting materials under 0.010 mils thickness and 0.100 mils wide was the first objective. High reliability has also been obtained connecting 0.00025 inch leads to 250 angstrom films and welding 0.0005 inch leads on 0.001 inch centers.

WELDABLE MATERIALS — Materials that can be joined include ribbon and wire configurations of gold, silver, copper, aluminum, platinum, nickel alloys, iron-nickel alloys, kovar and other patent alloys and various combinations of these and their alloys to each other and to deposits on various substrate materials now available to industry. Metals can also be welded directly to glass and to semiconductors.

All investigations of mechanical properties of the joint have been by use of a peel test made at 90 degrees to the interface joint of the weld. In all tests the lead material breaks adjacent to the weld at pull requirements that indicate an optimum retention of the unwelded physical properties of the lead material. In some cases of application to thin films, the welded joint was of sufficient tenacity to pull off the thin film and some substrate material without destroying the bond.

As yet, there have been no problems encountered with the electrode. Thorough investigation of tip sizes from 0.030 to 0.001 inch tip diameter have satisfied all applications to date. There are indications that

Doctoring Leaky Radar Antennas



A KEY PROBLEM in manufacturing airborne radar antennas is to detect and seal air leaks around the edge of the antenna's vacuum chamber.

A medical stethoscope to isolate the sound of air entering the vacuum chamber between the front and back reflectors is now being used by General Dynamics/Electronics, San Diego. After the leak is precisely located, another hospital instrument—the hypodermic needle—is used to inject resin along the edge of the plastic radar dish to seal any pin-holes in the coating of polyurethane which has been applied to the reflectors. Small delaminations in the fiber glass covering of the dish are also sealed by this method.

A stethoscope has also proved useful in locating noisy gears and bearings in actuators and motors before the components are assembled into the radar system.

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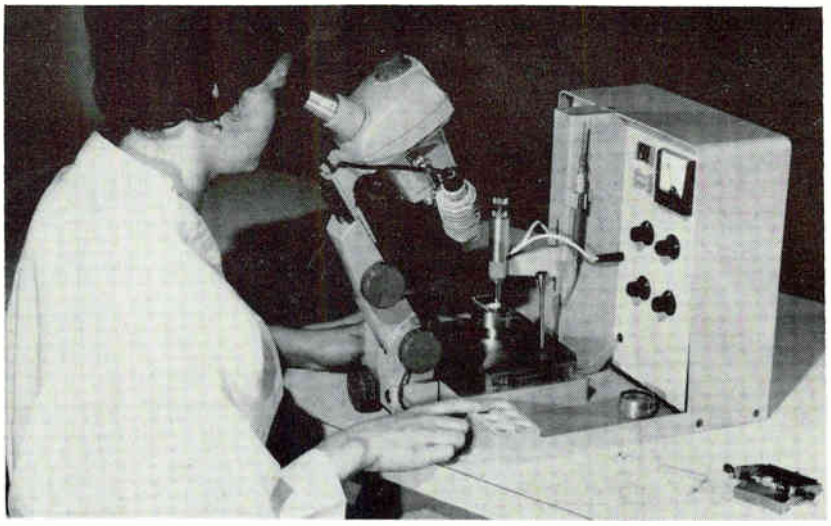


METER READING *of welding circuit resistance lets operator know when welding conditions are satisfactory. Split electrode then spot-welds the connection: metal to metal, to glass, to semiconductors, or to metalic deposits on ceramic*

some simple weld problems could be met equally well with less expensive tip materials and this is being studied.

More power and larger welding heads would make the technique applicable to many other welding problems. For example, investigations are now underway for continuous seam welding and stitch welding.

Although the technique uses the principles of a-c resistance welding, there are indications that the process could be more accurately described as impedance welding. Indications at present are that the electric field set up the welding pulse may be playing just as important a part in the fusion of top and bottom piece as the heat generated by the electric current.

TWO WIRES, *each ½ mil thick, have been welded to terminal posts and to a 1-mil wide metallic deposit*

Spray-Rinse Machine For Printed Circuits

AN ETCHING and neutralization rinsing machine that helps assure reliability of printed circuits has been developed by Sonex, Inc., Philadelphia. A fault of many present etching operations is that etching acids have a tendency to go back to their salt rapidly upon contact with air after the etching has been completed and the acids are no longer circulating on the copper paths.

The resulting crystallized acids will continue to etch slowly and they are extremely difficult to detect and remove. As a result, reliability is reduced.

To prevent crystallization and to keep the copper paths clean, the etching and rinsing machine was developed.

The etching acid is applied by spraying as the boards are drawn through a tunnel. Special spray nozzles emit a spray much finer than the usual conical-shaped spray provided by standard nozzles. The

thin, fine spray also mixes in a maximum amount of air, and thus speeds the process. Also, undercutting of the copper is reduced. Reliability is materially increased by this reduction in undercutting.

Immediately after the etched boards leave the etching spray they enter a neutralizing rinse tunnel, where either water or an alkaline solution is applied. The etching acids do not have time to crystallize during the brief transition stage.

The technique is particularly useful for two-sided printed circuit boards when through plating is required. There is no problem of crystallization of the acids within the holes, even when very small through-plated holes are produced.

Measuring Plating Area Photoelectrically

By LESLIE S. F. CHIN
Westinghouse Air Arm Div.,
Baltimore, Md.

AFTER a printed circuit card or board has been etched and the desired copper circuit is formed, it is often necessary to apply a protective plating of gold or tin on the copper runs to prevent oxidation. Plating is particularly desirable for high reliability circuits.

Calculation of plating amperage and time has been improved at this division by using a photoelectric technique to determine the total area that must be plated. Industry practice has been to calculate the area of circuits, fillets, pads etc. to be plated, or else rely on trial and error by an experienced operator who monitors the plating and establishes the plating parameters.

AREA MEASUREMENT — The photoelectric area measuring process uses a transparency of the circuit, a light source and a measuring circuit. A photoelectric cell converts the light that passes through the transparency into electrical energy, and this in turn is indicated on a meter. The meter reading is thus an analog measurement of plating area, and the meter can be calibrated in terms of square inches of plating area.

If the transparency is a negative,

LIGHT SOURCE *and photoelectric cell are used to measure amount of light passing through transparency of circuit board, thus determining plating area*

the plating area is the read out directly; if the transparency is a positive, the total area of the transparency is measured or calculated and the area read on the meter is subtracted from it to obtain plating area. Plating area is then indicated on the margin of each transparency by scribing the negative or inking the positive.

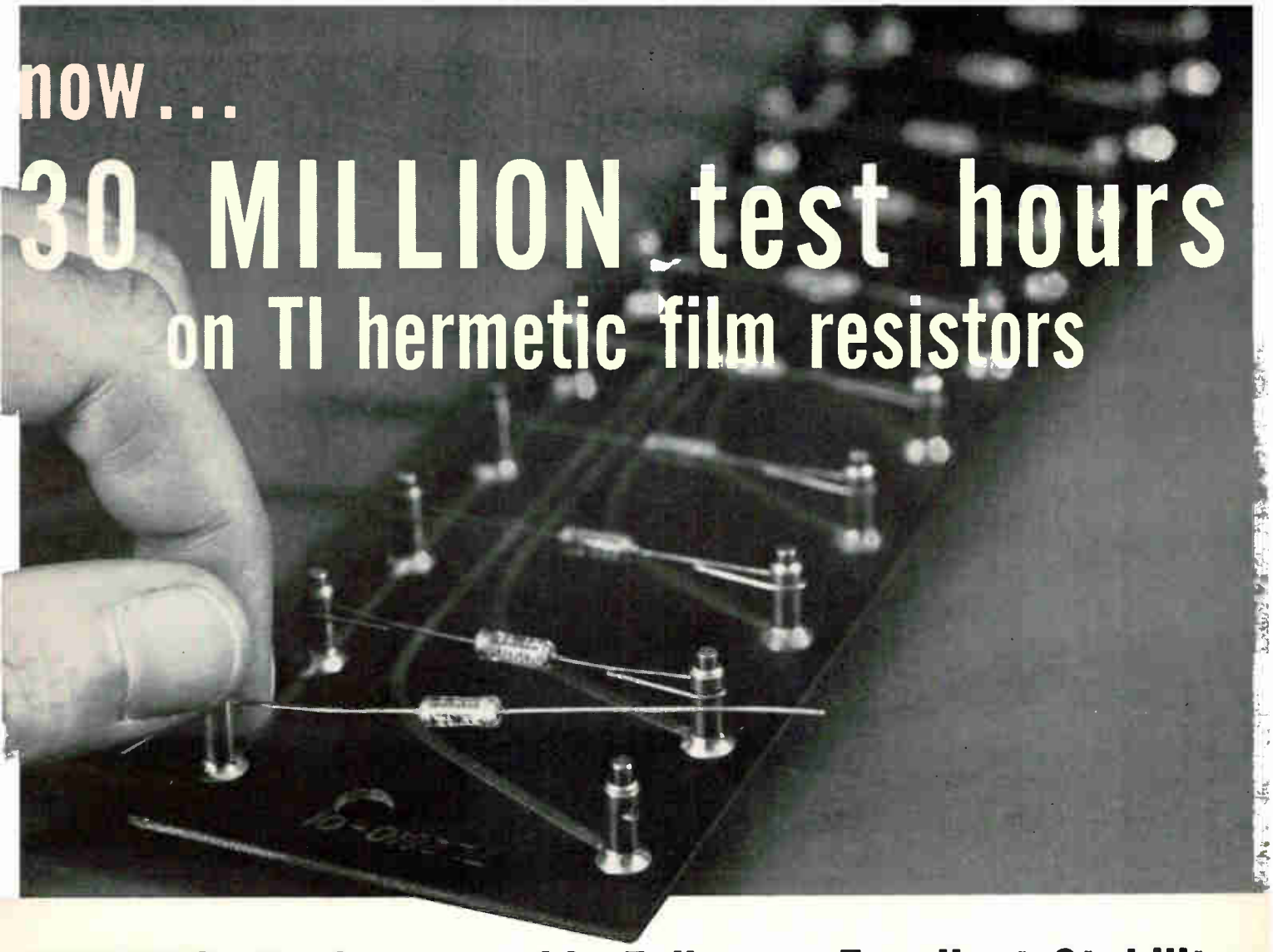
The readout meter is calibrated by a standard transparency with a known transparent area made from the normal transparency material. All transparent area not wanted is masked by two right-angle masks.

Inexpensive standard materials were used to construct the light box. Standard fluorescent lamps cooled by a blower were mounted under frosted glass to give a uniform illumination of 100 candles per square foot. The hood is black lined to eliminate light reflections and the photoelectric cell is mounted at the apex of the hood.

The plating measuring technique has now been integrated into printed circuit production and has been found to work well.

Besides a better yield, a major cost reduction resulted because precise amperage calculation allowed using a lead-tin plating process which required only 17 percent of the former tin plating process time. Related costs such as trial and error plating sequences, area calculations, and plating touch-up or repair, were reduced or eliminated.

Quality was improved in several respects: plating edge buildup was eliminated: better plating granular structure with a uniform chemically balanced lead-tin composition was obtained; thin plating, which creates soldering diffi-



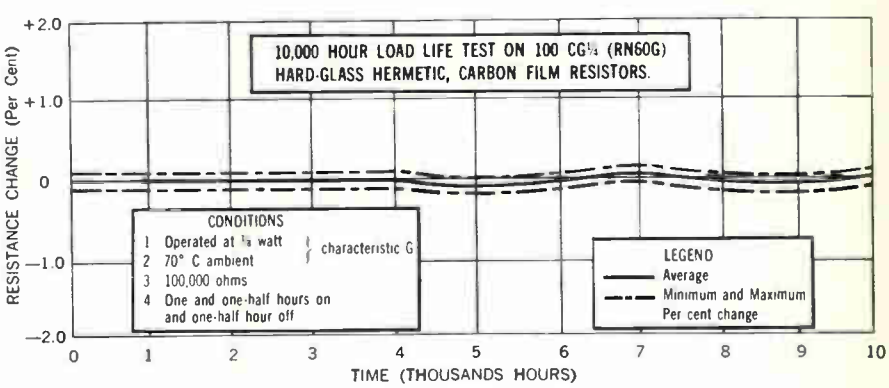
RESULTS: No Catastrophic Failures—Excellent Stability

More than 30 million unit hours of extended load life have been run on Texas Instruments CG series hard-glass, hermetic resistors. Not a single catastrophic failure has occurred during these tests, for a remarkably low failure rate of 0.003% per thousand hours (60% confidence level). In addition to this impressive evidence of built-in resistor reliability, TI has accumulated a "library" of test data on resistor stability.

Test Conditions: Over the past two years, more than 60 standard production lots of CG1/4 and CG1/8 resistors have been subjected to long-term load life tests, up to 10,000 hours per lot. These tests include: five ambient temperatures — from 25° C to 175° C; seven wattage levels — 0, 1/64, 1/32, 1/16, 1/8, 1/4, 1/2 w; three maximum voltages — 250, 300, 350 v; and 35 ohmic values — 24.9 ohms to 1 megohm.

Stability Proof: The graph at right shows one test, typical of the series. Notice the exceptional stability indicated by the drift curve, even under conditions of maximum power and maximum continuous working voltage.

You may be surprised to learn how economically you can buy TI hermetic resistors which provide all of the superior performance indicated by the test data. Ask your Texas Instruments sales engineer for more detailed information. Or write for the appropriate resistor life test data, stating your specific application requirements.



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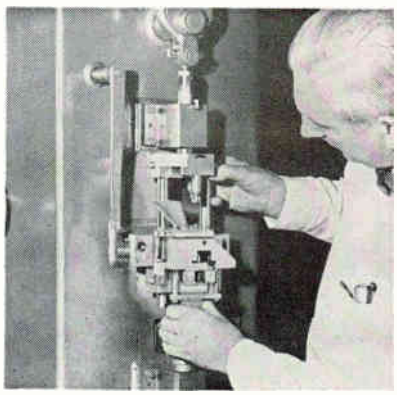
culties, was eliminated; better wetting in soldering due to lower temperature reflow was obtained.

Reliability was increased because the uniform plating resulted in better joints and less solder joint voids.

The photoelectric process requires less than one minute to determine accurately the plating area on any printed circuit. The process can be used in other applications where similar area measurements are desired.

High Accuracy for Pressed Parts



TO MEET the increasing demand for extremely high dimensional accuracy in compacted ceramics, powdered metals and ferrites, F. J. Stokes Corp., Phila., Pa., has developed a series of die-set presses with capacities from ½ ton up.

Dimensional accuracy is supplied by the die-set tooling; the press proper merely supports, actuates and guides the tooling. As a result, clearances between punch and die as fine as 0.0001 inch can be used successfully.

The die-set construction makes set up and adjustment easy and the complete die-set can be removed from the press for changes and adjustments.

In operation, pressure is applied to the material being compacted from above and below simultaneously, giving uniform density throughout the material.

The smallest press in the series, with ½-ton capacity, can be used for pieces up to ¼ inch in diameter and with up to 7/16 inch depth of fill; production rates are from 52 to 140 pieces per minute.

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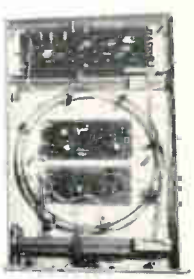

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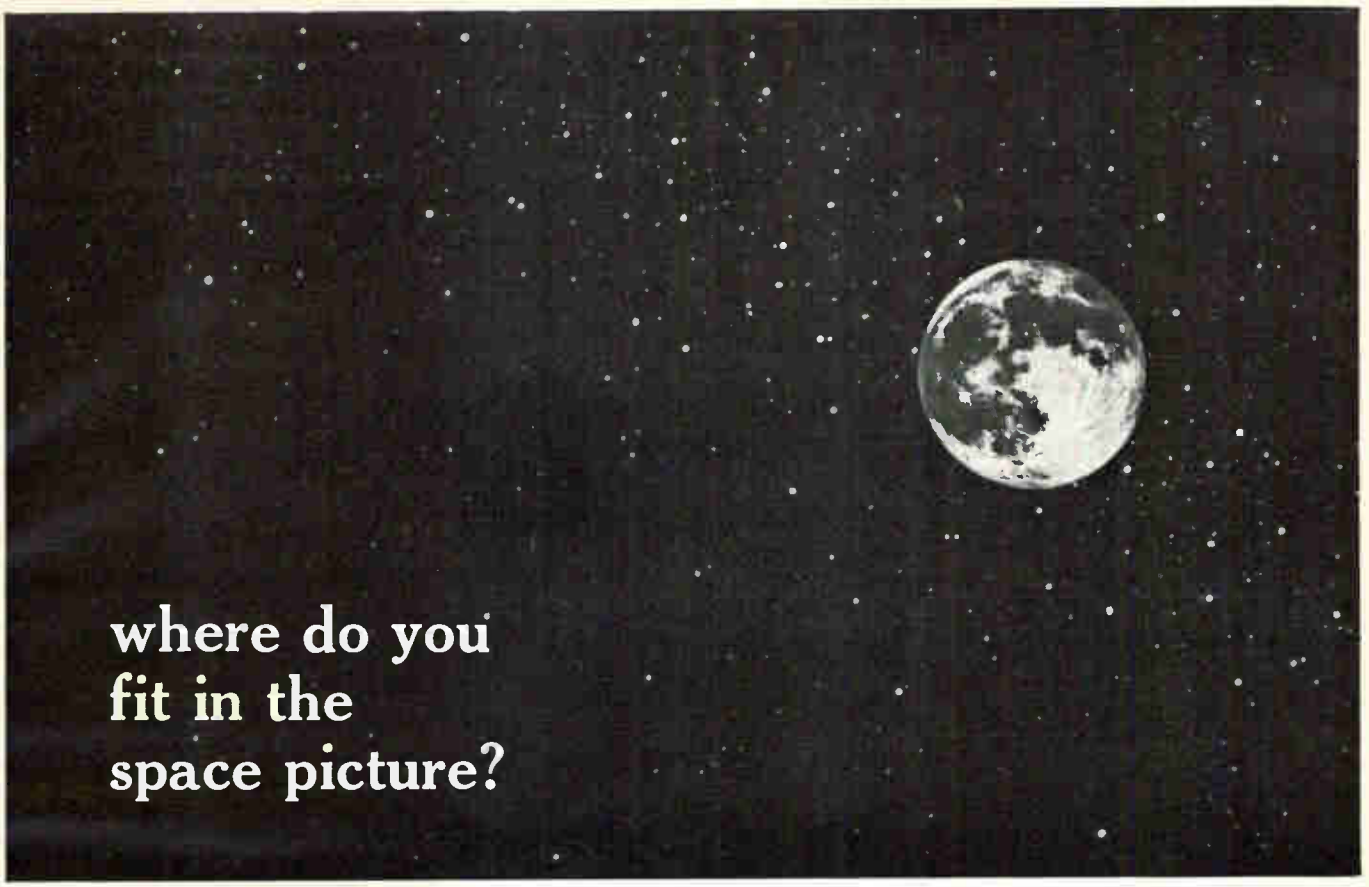

Today, the design and development of space systems, vehicles and weapon systems is achieving an even greater degree of importance than before. Expenditures are increasing. The pace is being stepped up.

Hughes Aerospace Divisions are expanding with each of these progressions. Important projects such as SURVEYOR, SYNCOM, advanced POLARIS guidance and Anti-ballistic Missile Defense (boost-intercept, mid-course, terminal) are now underway. Others will begin soon. This expansion is producing new, challenging assignments which never existed before. You can now be a part of, and benefit from, Hughes further expansion into the space age.

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Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

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To consider such basic problems as the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

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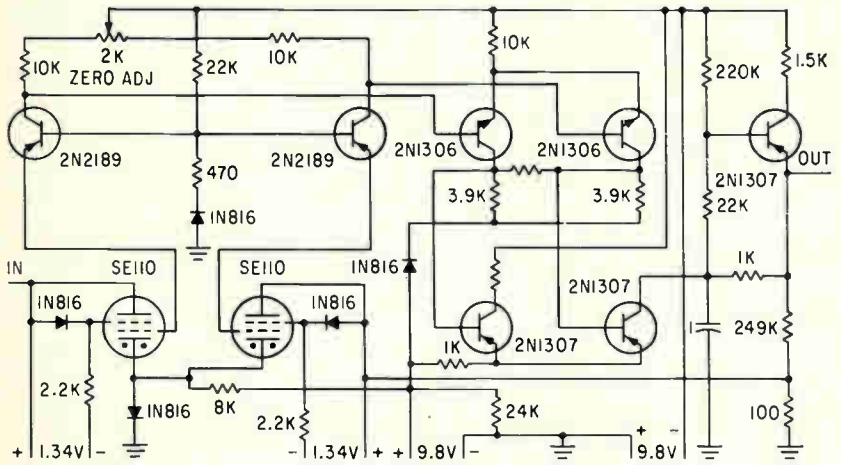

D-C Amplifier Uses Solion Tetrodes

Battery-powered d-c unit has high gain, low noise and low drift

DEVELOPED by Texas Research and Electronic Corp., 6612 Denton Drive, Dallas 35, Texas, the SA-112 d-c amplifier has a voltage gain available to 10,000, output risetime for a step input of 0.5 sec. maximum (frequency response 0.1 cps), less than 10 μv per day equivalent input zero drift, a temperature coefficient of input zero of 1 μv/degree C (typical) and an equivalent input noise of 3 μv rms (typical). Spurious input current is approximately 10^{-9} amperes and output capability is ± 1 ma into a 2,000-ohm load not damaged by a short circuit. Input impedance varies from several megohms at zero frequency to a few thousand ohms at 3 cps. Power consumption is 60 mw and the device is relatively insensitive to battery voltage changes. Sensitivity to submillivolt d-c signals is due to establishment of precise electrochemical equilibrium in the solion devices. Once attained, the equilibrium is highly stable and may be maintained as long as desired by furnishing a small continuous power to the device. The device was designed for use with thermocouples, strain gages, pyrheliometers and other low level, low-impedance sources. These signals can be recorded at 1 mv full scale on galvanometer recorders.

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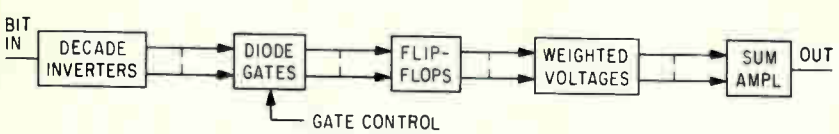
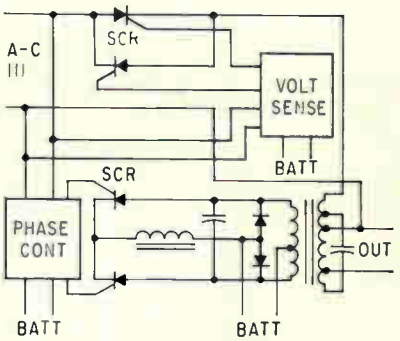


Digital to Analog Converter Has Modular Form

RECENTLY announced by Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J., the model CG-12-1 digital-to-analog converter consists of digital logic blocks, digital registers, weighted voltage sources and a d-c summing amplifier stabilized against d-c drift by a solid-state chopper. Input is either series or parallel digital codes, either 12 bit binary or 16 bit BCD. The unit makes up to 4,500 conversions per second with each conversion taking 20 μsecs. Output impedance is less than 0.1 ohm at voltages between 0 and 10.24 v. Accuracy is 0.05 percent for a 12 bit binary code. The incoming digital number is stored in a register whose outputs drive weighted voltage sources. These voltages are summed by a chopper-stabilized operational amplifier having very low output impedance. It can drive XY plotters, crt displays, meters, oscilloscopes analog computers and for controlling industrial equipment. (302)



Solid State Emergency A-C Power Source

ANNOUNCED by Electro-Seal Corp., 938 North Avenue, Des Plaines, Illinois, the Electro-Pac standby a-c power supplies can deliver up to 7.5 kva at 60 cps continuous duty with a switchless transfer in the event of main power source failure. Frequency of the emergency power source is exactly the same as the incoming line. When the power line is operating normally, the stand-by source acts as a ± 3-percent voltage regulator. A sine wave voltage is continuously generated and locked in phase to the a-c line. As long as the a-c line voltage remains above a preset level, the unit draws no current from the d-c source. When the a-c drops, the internal power supply takes over the load with no inter-

JFD Trimmers and LC tuners help keep Transit Satellite transmitters on exact frequencies

Transit, the Bureau of Naval Weapon's all-weather global navigation system, is scheduled for operational use in 1962. Transit will provide ships, submarines and aircraft with the most precise method ever devised for fixing their positions.

The highly critical nature of the system's measurement functions demanded highest reliability, stability and exactness in the performance of its two frequency sources. JFD VC42GW trimmer capacitors were specified for each of the two crystal-controlled oscillators to help assure frequency stability of 2 to 4 parts in 10^{9}. JFD trimmers were used also in the frequency multiplier circuit to maintain required oscillator frequency outputs.

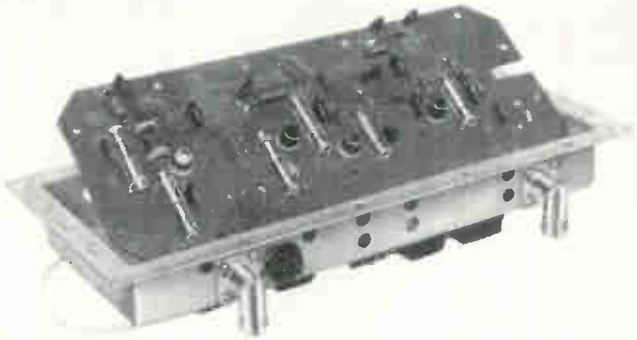
JFD LC tuners as well as trimmers were called for in both the B-system and C-system power amplifiers of the transmitter circuits and in the Transit diplexing antenna system to provide highest possible operating stability.

This is another example of how JFD precision electronic components satisfy space-challenging demands of tuning accuracy and stability under severe shock and vibration. Fewer parts, precise tolerances, patented telescoping anti-backlash adjustment are a few of the reasons why more engineers specify JFD

For complete information, contact your local JFD Field office or your local JFD franchised Industrial Distributor.

Applied Physics Laboratory of the Johns Hopkins University specified JFD Trimmer Capacitors and Tuners in the Transit 2-A Satellite.

JFD LC Tuners and Trimmers in Transit frequency multipliers and power multiplier amplifier circuits provide maximum tuning range in minimum space ... high reliability and ruggedness.



JFD VC42GW actual size
Variable Trimmer Piston Capacitor
1.0 mmf. to 21.0 mmf.

JFD LC326 LC Tuner actual size
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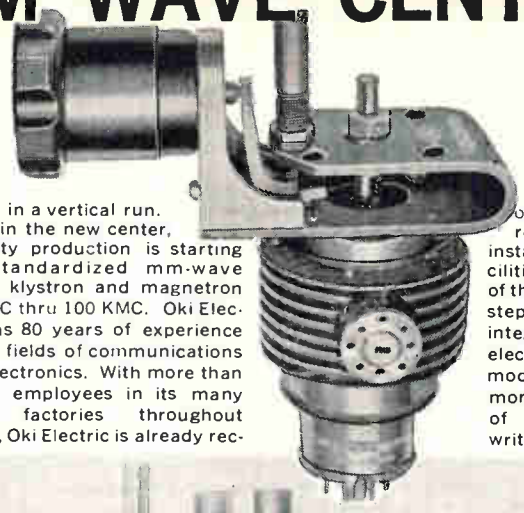

Oki's new millimeter wave center was completed this July. This mm-wave center is equipped with complete facilities for up-to-date research, development and manufacturing in the complex field of mm-wave generators and components. All the complex process of production, beginning with precision machining of cavity piece and ending by 24 hour final inspection test, are now operated in a vertical run. Here, in the new center, quantity production is starting for standardized mm-wave tubes; klystron and magnetron 20 KMC thru 100 KMC. Oki Electric has 80 years of experience in the fields of communications and electronics. With more than 10,000 employees in its many other factories throughout Japan, Oki Electric is already recognized for its complete research, manufacturing, installation and service facilities. The establishment of this new center is another step by Oki Electric as an integrated manufacturer of electronics equipment in modernization. To learn more about the Oki systems of electronics equipment, write to the address below.

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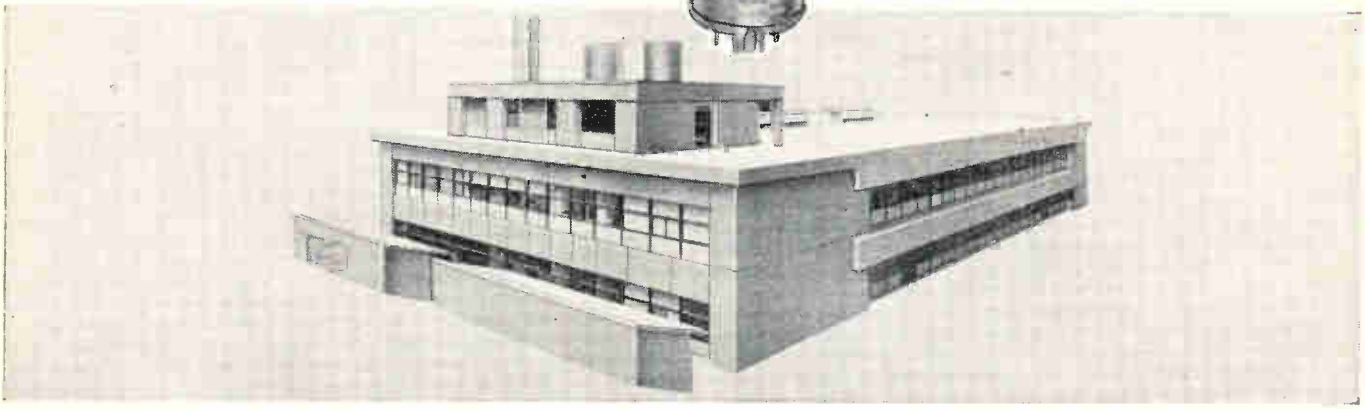

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CURTISS-WRIGHT ELECTRONICS...

adding a new dimension to the capability of man

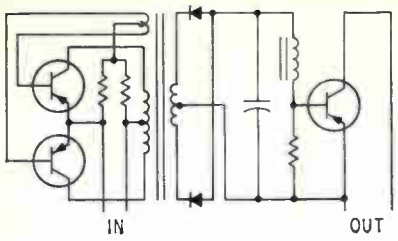
B-58 BOMB NAV SIMULATOR, designated AN/ASQ-T2, uses hemispherical recorders to trace "flight." Precise position is determined by celestial navigation using six stars and the sun together with position verification from a land-mass radar system. The Curtiss-Wright simulator provides stored radar data for four million sq. miles of area with sufficient resolution to detect landmarks as small as 200 feet.

ruption of voltage or frequency sequence. When a-c voltage returns, the unit phase locks on the line waveform and then transfers the load. As shown in the sketch, scr's are used to control the system and as d-c to a-c inverters. The voltage sensing circuit determines level of input a-c and keeps the scr's on. The voltage is regulated by ferroresonant transformer action. The inverter source is kept in line synchronism by the phase control and since the a-c voltage induced in the stabilizer transformer is the same magnitude and polarity as the inverter, the latter delivers and absorbs negligible power from the line, and draws no current from the batteries. When line voltage fails, the system opens the scr gate and the inverter takes over.

CIRCLE 303, READER SERVICE CARD

Power Supply

ASTRONETIC RESEARCH, INC., Nashua, N. H. Model 114-A small-size lightweight power supply delivers 400 v d-c at 100 w with a stability of ± 2 percent over the input range of + 23.5 to + 33.5 v d-c. **(304)**

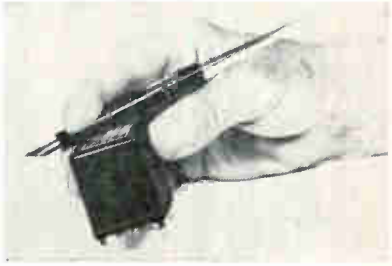


Solid-State, High-Speed Relay Has Long Life

MANUFACTURED by Sparton Corp., Jackson, Michigan, the solid state spst relay accepts an input of 6 v d-c or square wave at 400 ma and has a current rating between 1 and 5 amperes at 24 v d-c according to the duty cycle. Off resistance is 50,000 ohms and on resistance is 0.05 ohms. Temperature range is −55 to +55 C, shock is 150 g, vibration is 25+g at 2 Kc, acceleration is 500 g and expected life is over 100 million operations. Weight is 250 grams. The unit is basically a rectified chopper output driving a power switching device. Activation voltage is 6 v d-c with input impedance of 15 ohms. The switcher can be either a npn or pnp device, depending on application. Average contact resistance is 0.05 ohm. Voltage and current rating can be tailored to match special applications. **(305)**

X-Band Isolator

RAYTHEON CO., Foundry Ave., Waltham 54, Mass. Model IXM10 X-band isolator is capable of handling 50 w of average power across a band of 7100-7800 Mc with a minimum of 60 db isolation. **(306)**

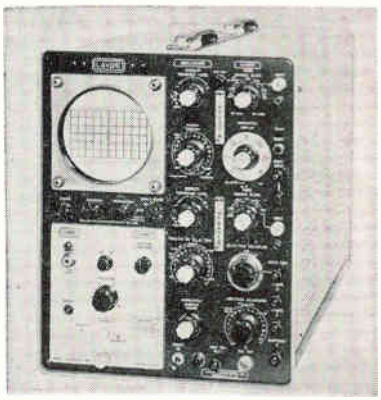


Miniature Flasher Excited by 28 V D-C

ADC ELECTRONICS CORP., 1205 South Santa Fe, Compton, Calif. Miniature flasher begins flashing cycle when excited by 28 v d-c, ± 10 per-

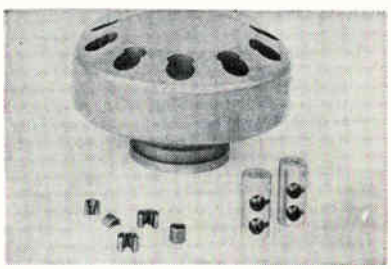
cent. Nominal flashing rate is 100 ± 10 cpm, but virtually any rate and on-time to off-time ratio can be supplied on request. All components and materials are chosen to exceed requirements of Mil-E-5272.

CIRCLE 307, READER SERVICE CARD



Oscilloscope Features H-F Sync Lock

LAVOIE LABORATORIES, INC., Morganville, N.J. Model LA-275C features a special h-f sync lock to provide stable synchronization of signals over 100 Mc. This coupled with its bandwidth and fast main vertical rise time of 4.0 nsec, make it valuable for a wide variety of applications. Usable at frequencies greater than 100 Mc, the main vertical amplifier has a 3 db response from d-c to 85 Mc. **(308)**



Centrifuge Rotors Test Semiconductors

SPINCO DIV. of Beckman Instruments, Inc., Palo Alto, Calif. Transistors and diodes can be tested up to 218,000 times gravity in new centrifuge rotors. Five types are available. The 10-hole transistor test rotor illustrated accepts 20 transistors in special holders; at top rated speed of 40,000 rpm it generates 129,000 g. Three others with four or six holes, generate from 140,000 to 218,000 g. The fifth

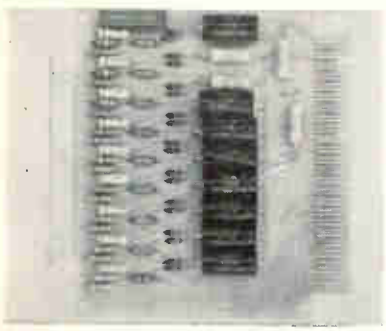
is shaped like a hollow bowl; it can subject 100 to 150 diodes at a time to forces up to 100,000 times gravity. (309)

Power Resistors Offer High Density

OMTRONICS MFG., INC., P.O. Box 1419-Peony Park Station, Omaha 14, Neb., announces a series of miniature precision power resistors incorporating high stability over a broad temperature range (through 350 C). Housed in an anodized aluminum housing, series HT are available in three sizes: 10, 25 and 50 w, with resistance ranges from 0.05 ohm through 275,000 ohms and standard tolerance of ±1 percent, with other tolerances available. (310)

Power Supply Delivers 26 to 30 V

GATES ELECTRONICS CO., 2243 White Plains Road, New York, N.Y. Model GX 30-5 power supply delivers 26, 28 and 30 v d-c from appropriate taps at 5 amp. Design features fuses, three wire line cords, and perforated metal housing. Price is $75. (311)



D-A Converters Have High Accuracy

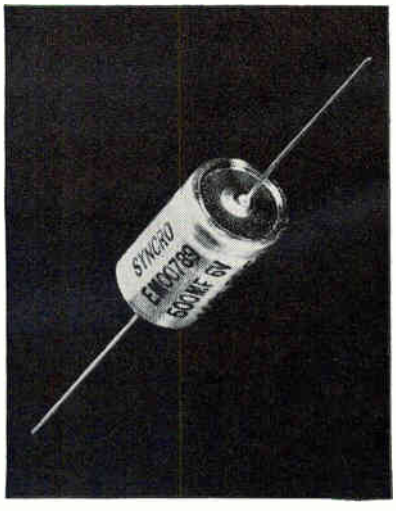
SCIENTIFIC DATA SYSTEMS, INC., 1542 Fifteenth St., Santa Monica, Calif. Series of digital to analog converters utilizes silicon semiconductors to achieve high reliability at operating temperatures from 0

to + 100 C. Available in capacities to 250,000 conversions per sec, they have accuracies to 0.01 percent. Both binary and BCD models are available. Price for 8 bits plus sign model (SX10) is $390.

CIRCLE 312, READER SERVICE CARD

Noise Generator Reads Figure in DB

RICHCRAFT ELECTRONIC ENGINEERING CO., Broad Run Drive, Sterling, Va. Model RMR is a self-powered portable noise generator. It reads noise figure in db, regardless of frequency or bandwith. Calibration accuracy is 2 db; output level, 0 to more than 30 db; useful range, 10 to over 400 Mc; size, 6¼ by 3¾ by 2 in.; weight, 20 oz. (313)



Electrolytics Have Welded Connections

SYNCRO CORP., Hicksville, O. Type EMW axial lead electrolytic capacitors feature all internal and external connections welded for greater reliability. Design is suited for use with transistorized cir-

cuitry and similar applications which require reliable low resistance connections. Capacitors are encased in an aluminum can in diamters of ¼ in., ⅝ in., ¾ in., ⅞ in. and 1 in., with or without insulating sleeving. **(314)**

Motor Blowers Save Space

RIFLEY CO., INC., Middletown, Conn., has available a line of compact motor blowers with air deliveries ranging from 5 to 19 cfm free air output. The precision-bearing, Power Pac motor with permanent sealed-in lubrication requires no oiling and operates at an extremely low noise level. The low input wattage required is a cost saving factor of advantage in multiple installations. **(315)**

Silicon Rectifiers Withstand 300 C

DIODES, INC., 7303 Canoga Ave., Canoga Park, Calif. Miniature (0.312 in. by 0.110 in.) ½ amp silicon rectifiers are designed to withstand dip-solder range temperature conditions as high as 300 C. They are rated at 200 to 1,000 peak inverse volts and are hermetically sealed in a ceramic tube. Two extra large (0.040 in. diameter) pure silver leads are provided. **(316)**

Q-Band Noise Source Delivers 18.0 DB

TUCOR, INC., 59 Danbury Road, Wilton, Conn. The T44Q1B is a Q-band noise source capable of delivering 18.0 db noise output at a nominal operating voltage of 140 v. It features a minimum firing design and

radioactive priming to stabilize the firing voltage level. Tube operates over a frequency range of 26.5 to 40.0 Gc, at a current of 40 ma. Striking voltage is 2,500 v. Built-in protective elements enable it to be used close to high lines in the system, when necessary.

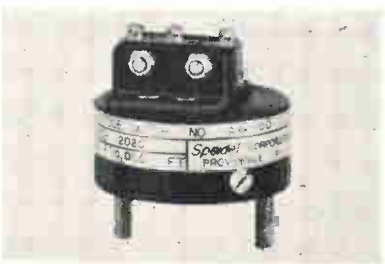
CIRCLE 317, READER SERVICE CARD

Coaxial Switch Spans D-C to 500 Mc

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N.J. The Mega Switch KMC 255-A is a fast, accurate, electronically controlled coaxial switch that simultaneously displays two related waveshapes on an oscilloscope. Providing true switch action, it provides leakage across input and output down to 70 db and more. Switching rate is continuously variable from 0.2 to 100 cps and can be synchronized externally or internally. (318)

IR Signal Generator

TELEWAVE LABORATORIES, INC., 43-20 34th St., L. I. C., N. Y. Model 501 portable calibrated infrared signal generator provides a tunable infrared source of variable wavelength to 14 microns. (319)



Altitude Switch Actuates AGC

SPEIDEL CORP., Warwick, R. I. Model AA-100 miniature ambient sensing

altitude switch weighs 2 oz and has a set range of 2,000/50,000 ft. It is suitable for such things as releasing recovery chutes, actuating cabin-pressurization systems and actuating automatic gain control. (320)

Variable Attenuator Handles 2W Average

CASCADE RESEARCH, 5245 San Fernando Road West, Los Angeles 39, Calif. Model X-22-17 is designed to switch from minimum to maximum attenuation in less than 20 μsec and provides an attenuation range greater than 30 db over a frequency range of 10, 250 to 10,500 Mc. Insertion loss (minimum attenuation) is 1.0 db max; input vswr, 1.15 max; power handling capability, 2 w average; operating temperature, 30 C to 65 C. (321)

TWT Amplifier

HUGGINS LABORATORIES INC., 999 E. Arques Ave., Sunnyvale, Calif. Model 512-S portable twt amplifier covers 2.0 to 4.0 Gc with a power output of 1 w, and has small-signal gain of 30 db. (322)

Glass Reed Relay Aids Circuit Designer

WHEELOCK SIGNALS, INC., Long Branch, N.J. Series 260 relay offers the circuit designer a 1 millisec switching device capable of billions of operations. Designed for p-c application, the precisely pre-sized, pre-positioned leads mean fast, easy mounting. Costly reed breakage is practically eliminated through the use of a patented protective resilient molded frame that absorbs mounting shocks. (323)

PRODUCT BRIEFS

MYLAR TUBLAR CAPACITOR meets Air Force requirements. Applications include coupling, by-pass and timing circuits. Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 50 Paris St., Newark, N.J. CIRCLE 324, READER SERVICE CARD

ELECTRO-BORE DRILLING MACHINE for high speed production. It has an obsolute and constant spindle speed and feed control. Drake Mfg. Corp., 11252 Nine Mile Road, Warren, Mich. (325)

MAGNETOSTRICTIVE DELAY LINE can store up to 6,000 bits at a digit rate of 2 Mc in a NRZ mode. Cost-per-bit is 2¢ for the line itself. Sonic Memory Corp., 494 Oak St., Copiague, N.Y. (326)

PRIMARY STANDARD POTENTIOMETER measures 0 to 1,000 v. Accuracy is 0.0005 percent. Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N.Y. (327)

LOGIC TRANSISTORS are rugged, inexpensive. They feature max switching times of 150 μsec and $V_{CE(sat)}$ of 0.2 v, max, at 10 ma. Texas Instruments Inc., P.O. Box 5012, Dallas 22, Texas. (328)

SEMICONDUCTOR TEST SET measures slice thickness and resistivity. Thickness is presented visually on a zero-centered gage. Semimetals, Inc., Westbury, L.I., N.Y. (329)

SINE WAVE PROGRAMMER for vibration test systems. It provides five control segments. Ling-Temco-Vought, Inc., 1515 So. Manchester Ave., Anaheim, Calif. (330)

LOW-HIGH TEMPERATURE TEST CHAMBER for testing components and small assemblies. They have 1 cu ft capacity. Associated Testing Laboratories, Inc., Route 46, Wayne, N.J. (331)

DUAL MODE TRANSDUCERS in EIA waveguide sizes WR90 and WR137. Each has a vswr of 1.10 max and an isolation of 40 db minimum. Microwave Development Labs. Inc., 15 Strathmore Road, Natick, Mass. (332)

VOLTAGE-TO-DIGITAL CONVERTER has 8 binary bits including sign. Conversion speed is 0.3 μsec per bit. General Data Co., 1250 North Parker St., Orange, Calif. (333)

L-F LOW PASS FILTER has a loss of less than 3 db at 10 cps. Attenuation is more than 40 db at 20 cps and higher. United Transformer Corp., 150 Varick St., N.Y. 13, N.Y. (334)

FIXED PAD ATTENUATOR with 1.15 vswr max. Frequency is 0-4 Gc with precision metal film resistors. Astrolab Inc., 120 Morris Ave., Box 212, Springfield, N.J. (335)

MODULAR RECEIVER provides multiple demodulation of any signal from 30 to 1,000 Mc. It consists of a signal

processor with accompanying r-f tuners. Viero Electronics, 919 Jesup-Blair Dr., Silver Spring, Md. (336)

SSB QUARTZ CRYSTAL FILTER is available in four models. Operating temperature range is 0 C to 70 C. Connolly & Co., Inc., P.O. Box 295, Menlo Park, Calif. (337)

PRECISION POWER RESISTORS with operating temperatures to 600 F. They are rated at a max 12 w power consumption. Consolidated Ohmic Devices, New Hyde Park, N. Y. (338)

IMPEDANCE MATCHING NETWORKS are high power attenuators. Models are available at 50, 100 and 500 w. Electro Impulse Laboratory, Inc., 208 River St., Red Bank, N.J. (339)

SIZE 10 MOTOR GENERATOR with 1,000 to 1 output voltage range. It has a no load speed of 20,000 rpm. Sangamo Electric Co., 1301 N. Eleventh St., Springfield, Ill. (340)

WELDED ATTENUATOR PADS feature high reliability. Temperature operating range is 40 to 150 C for silicon types. Micromodular Components, Inc., 1859 S. Manchester Ave., Anaheim, Calif. (341)

C-BAND RADAR TRANSPONDER weighs 2.8 lb. Modular construction simplifies servicing. Aero Geo Astro, Alexandria, Va. (342)

APPLICATOR AND DISPENSER for external retaining rings. They provide easier handling of rings, faster assembly, and elimination of overspreading. Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y. (343)

SINE-COSINE FUNCTION WIREWOUND POT is $1\frac{1}{8}$ in. in diameter. Function angle is 360 deg. New England Instrument Co., 39 Green St., Waltham 54, Mass. (344)

WIDEBAND DIFFERENTIAL AMPLIFIER employs silicon semiconductors. It features floating input. Packard Bell Computer, 1905 Armacost Ave., Los Angeles 25, Calif. (345)

SILICON RECTIFIERS with 25 amp forward current. They are mounted in an economy press-fit case. Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N.J. (346)

UNIVERSAL COUNTER-TIMER is a solid state unit. Heterodyning techniques are not used. Computer Measurements Co., 12970 Bradley Ave., San Fernando, Calif. (347)

TEMPERATURE COMPENSATOR DIODES for transistor circuits. Seven types cover an operating current span from 0.5 to 70 ma. Hoffman Electronics, El Monte, Calif. (348)

LOW COST MULTIMETER designed for fast readout. It contains a voltmeter, ratiometer and a direct reading ohmmeter. Cubic Corp., San Diego, Calif. (349)

MYLAR FILM CAPACITORS are miniaturized. They cover from 10 through 1,000 pf. General Electric Co., Hudson Falls, N.Y. (350)

Literature

REED RELAYS AND CHOPPERS Wintronics, Inc., 1132 S. Prairie Ave., Hawthorne, Calif. A brochure describes a standard and special series of reed relays and choppers.
CIRCLE 351, READER SERVICE CARD

PRECISION POWER RESISTORS Ohmite Mfg. Co., 3627 Howard St., Skokie, Ill. Bulletin 153 E lists as stock, 505 values of 1 percent tolerance, molded wirewound resistors. (352)

TECHNICAL INFORMATION BULLETIN Burroughs Corp., Detroit 32, Mich., has available a technical information bulletin entitled "A Computer For Direct Execution of Algorithmic Languages." (353)

STATIC FREQUENCY CHANGES Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N.J., has available a 5-page technical bulletin on the MOPA line of Transpac static frequency changers. (354)

SCR TESTER Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N.J., offers a technical bulletin on the model SCR100 silicon controlled rectifier test set. (355)

INFRARED DETECTORS Servo Corp. of America, 111 New South Road, Hicksville, L.I., N.Y., has published a two-page "Glossary of Infrared Detector Terminology." (356)

SILICON PLANAR TRANSISTORS Sperry Semiconductor, division of Sperry Rand Corp., Norwalk, Conn., has available a preliminary spec sheet describing small signal *npn* silicon planar transistors. (357)

ELECTRON ACCELERATOR SYSTEM High Voltage Engineering Corp., Burlington, Mass. An eight-page illustrated booklet explains a multi-beam electron accelerator system. (358)

LVDT's Columbia Research Laboratories, MacDade Blvd. & Bullens Lane, Woodlyn, Pa. Technical data sheet describes a line of linear variable differential transformers that measure up to a six-in. stroke. (359)

VACUUM SYSTEM CONTROLLER Mikros, Inc., 7634 S.W. Capitol Highway, Portland 19, Ore. Catalog sheet C-21 describes a pressure-oriented automatic controller for 2-in. vacuum systems. (360)

SILICON RECTIFIER MODULAR ASSEMBLIES Tung-Sol Electric Inc., One Summer Ave., Newark, N.J. Technical brochure covers silicon rectifier modular assemblies having outputs up to 75 amp. (361)

ENVIRONMENTAL TESTING General Time Corp., Progress Drive, Stamford, Conn., has published an illustrated bulletin describing the facilities of its recently opened environmental test laboratory. (362)

D-C AMPLIFIER Elcor, Inc., 1225 W. Broad St., Falls Church, Va. Complete specifications for the DCA-

of the Week

50C wide-band d-c amplifier are given in bulletin 43-562. (363)

ELECTRICAL CONNECTORS The Superior Electric Co., Bristol, Conn., Bulletin C262 is a 16-page booklet giving complete details on an entire line of electrical connectors. (364)

REMOVABLE CONTACTS Winchester Electronics, Inc., 19 Willard Road, Norwalk, Conn. Series 100 brochure covers new crimp and solder type removable contacts. (365)

ELECTRONIC TACHOMETER Airpax Electronics Inc., Fort Lauderdale, Fla. Bulletin F-111 describes the Tach-Pak which is used in a multitude of applications as a control and/or indicating device. (366)

SUBMINIATURE SWITCH Sparton Electronics, Jackson, Mich. Product data sheet contains a schematic and characteristics of a new subminiature switch. (367)

PAPER CAPACITORS Sprague Electric Co., Marshall St., North Adams, Mass. Engineering bulletin 2902 covers the Hyrel PQ series of subminiature 50 v paper capacitors. It is available upon letterhead request.

R-F INSTRUMENTS AND COMPONENTS Alford Mfg. Co., 299 Atlantic Ave., Boston, Mass. Catalog SK describes in detail many of the products manufactured. (368)

PRECISION PHASE SHIFTERS The Diehl Mfg. Co., Somerville, N.J. Application Bulletin 608 describes the principles of operation of precision phase shifters. (369)

LOG-VOLTMETER-CONVERTER Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Texas. An 8-page brochure contains description, specifications and application of the HLVC-150 converter. (370)

SWITCHES Licon Division, Illinois Tool Works Inc., 6615 W. Irving Park Road, Chicago 34, Ill., offers a 20-page catalog covering miniature and subminiature switches. (371)

DECADE-SWITCHED OSCILLATOR Decade Instrument Co., Box 153, Caldwell, N. J. Pamphlet describes the model B Decalator, a decade-switched ultrasonic c-w oscillator for laboratory use. (372)

CONVERTER TRANSFORMERS Polyphase Instrument Co., E. Fourth St., Bridgeport, Pa., offers a 4-page, 2-color bulletin on d-c/d-c and d-c/a-c converter transformers. (373)

FORCED AIR COOLING Rotron Mfg. Co., Inc., Woodstock, N. Y., has available a technical report entitled "How Altitude Affects Forced Air Cooling Requirements of Electronic Equipment." (374)

SPDT RELAY Bourns, Inc., 1200 Columbia Ave., Riverside, Calif. Bulletin covers the series 3100 subminiature 1 amp Trimpot relay. (375)

LAYING *plans for dedication of the Warnecke Electron Tube, Inc. plant are William J. Halligan (left) and George Rappaport*

Warnecke Plant Opening

GEORGE RAPPAPORT, president of Warnecke Electron Tubes, Inc., and William J. Halligan, Warnecke director and board chairman of The Hallicrafters Co., have announced that formal dedication of Warnecke development and manufacturing facilities (approximately 21,000 sq ft) in Des Plaines, Ill., will take place October 30th. The new firm will produce high-power microwave tubes and related vacuum devices for both aerospace and commercial markets.

Warnecke Electron Tubes, Inc., is a joint financial and scientific venture sponsored by Hallicrafters and CSF (Compagnie Generale de Telegraphie Sans Fil) of Paris, France. CSF is considered a pioneer in microwave tube research and development.

Maurice Ponte, chairman of the board of CSF and a scientific advisor to President DeGaulle, and Robert Warnecke (for whom the company is named) director of CSF's Electron Tube division, are expected to attend the dedication.

In commenting on the dedication plans Halligan said, "Warnecke Electron Tubes, Inc. is the first tangible result of our concerted civic and industry program to make the Midwest a more dynamic factor in defense oriented electronics contracts. As you know, I have been actively engaged with other industry representatives, the Mayor of Chicago, and state officials in presenting the picture of the Midwest's capabilities to key executives in the DOD, AEC, and NASA. We are first, as an area, in consumer electronics production. Our intent is to continue the improvement of our defense electronics stature."

Elgin National Watch Names M. W. Joseph

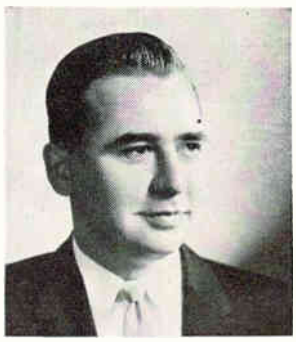
MARTIN W. JOSEPH has been named reliability manager for the Industrial Group, Elgin National Watch Co., Elgin, Ill. He is responsible for setting and implementing policy regarding reliability standards and techniques for the six divisions in Elgin's Industrial Group. He is involved, also, in the development of specialized test equipment oriented towards high speed testing of semiconductor devices and other components in connection with reliability evaluations.

Joseph was formerly reliability manager of International Telephone and Telegraph, and, previously, senior reliability engineer for Hughes Aircraft.

Hoffman Appoints Warren Eriksen

WARREN T. ERIKSEN, formerly manager of advanced engineering for the Semiconductor division of Raytheon Co., has been appointed technical director of the Semiconductor division of Hoffman Electronics Corp., El Monte, Calif.

Eriksen succeeds Paul N. Russell, who has been acting as technical director and who is returning to the staff of the Hoffman Science Center at Santa Barbara, Calif.



Gould Assumes Higher Position

MICROWAVE ASSOCIATES, INC., Burlington, Mass., recently appointed Lawrence Gould as executive vice president and general manager.

A vice president of the company since 1959, Gould had also held the position of manager of the Electron Tube and Device division, which accounted for a major portion of the company's total sales volume. He also had held the position of technical director of the company.

General Time Revamps Top Management

GENERAL TIME CORP., New York City, has realigned its top management team, electing Donald J. Hawthorne chairman and chief executive officer, B. K. Wickstrum president, and Don G. Mitchell exexutive committee chairman.

Hawthorne, with the company

MNEW FROM MNEMOTRON!*

We are silent about the "M" in Mnemotron but not about our new 700 Series Data Recorder. With good reason. For one, it brings the size and cost of data recording systems down to sensible proportions if your data is analog voltage from DC to 5000 cycles per second. And its features would not embarrass even the costliest instrumentation recorder. Here are a few·

COMPACTNESS. A complete 7 channel record/reproduce system uses less than two feet of rack space. A 14 channel system adds less than seven inches more.

ACCURACY. Input-output characteristic is linear within 0.2 per cent with Mnemotron unique Pulse Frequency Modulation (PFM) data conversion technique.

FLEXIBILITY. As many data channels as you need with a choice of channel format. For greatest operating economy, choose up to 7 channels on ¼ inch magnetic tape, 14 channels on ½ inch tape, standard IRIG spacing and track width of 7 channels on ½ inch tape.

INTEGRATED RECORD/REPRODUCE MODULES. A single solid-state PFM Data Converter has all the record/reproduce electronics for each channel. Simple rotary switching lets you select data conversion for 3 tape speeds. No additional plug-ins needed.

ISOLATED INPUT CIRCUITS. Input terminals of each channel are isolated from all the others to readily accept data from floating, unbalanced or differential sources.

VERSATILITY. 700 Series plug-in accessories expand instrumentation capability. Typical: Electrocardiogram preamplifiers for recording directly from electrodes. Pulse Record unit for recording trigger pulses, time markers, or stimulus pulses in medical research . . .

PRICE. 7 Channel System from $6,495

COMPLETE SPECIFICATIONS. Send for your copy today.

*To answer the many inquiries, Mnemotron comes from Mnemosyne, Greek Goddess of Memory.

MNEMOTRON CORPORATION

45 South Main St., Pearl River, New York, 914 PEarl River 5-4015, Cables: Mnemotron, TWX: H99

Subsidiary of Technical Measurement Corporation, North Haven, Conn.

SAUL FAST has been named vice president and technical advisor to

IN THE EXPANDING FIELD OF

PHOTOGRAPHY

since 1925, had been president since 1953.

Wickstrum is a director and prior to joining the firm in 1960 was a

Labac,

the president of National Co., Inc., Malden, Mass.

National is engaged in the research, development and production of primary frequency standards, troposcatter communications systems, ssb receivers, and other military and industrial electronic systems.

Starting with the company as chief engineer of the communications systems department in 1955, Fast advanced to the post of director of technical liaison. In 1960, he was appointed technical assistant to the president.

Motorola Appoints G. W. Soderquist

GEORGE W. SODERQUIST has been appointed program manager on the program planning staff at Motorola's Military Electronics division/ Western Center, Scottsdale, Ariz.

Soderquist joins Motorola after 10 years of engineering, management and marketing experience gathered at Cape Canaveral, Fla., where most recently he held the position of regional sales manager for the Hallicrafters Corp.

Ortronix Incorporated Promotes Bowers

RICHARD S. BOWERS has been named executive vice president at Ortronix, Inc., Orlando, Fla. He was

the president of National Co., Inc., Malden, Mass.

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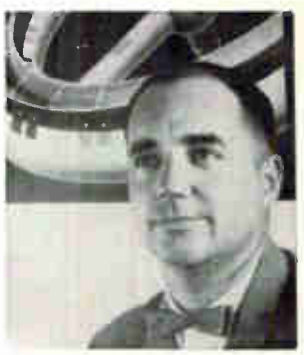

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Co. He is presently a member of the board of directors of the Electronics Industries Association and is chairman of the Military Products division.

CTS Corporation Adds to R&D Staff

CTS CORPORATION, Elkhart, Inc., has named Edwin H. Layer as manager of solid state research. He will be responsible for research on solid state devices with emphasis on thin film technology.

Layer was previously an assistant chief of the Solid State Devices division at Battelle Memorial Institute, Columbus, O.

Washington Scientist Joins Geotech

THE GEOTECHNICAL CORPORATION, Garland, Texas, announces the addition to its technical staff of Robert F. Brown, Jr., formerly a scientist with the National Bureau of Standards, Washington, D. C.

In his new post, Brown will serve as a senior physicist in research and development on electronics, acoustics, and magnetic recording.

National Company Names Saul Fast

SAUL FAST has been named vice president and technical advisor to

since 1925, had been president since 1953.

Wickstrum is a director and prior to joining the firm in 1960 was a senior vice president of the Sylvania Electric Products subsidiary of General Telephone & Electronics Corp.

Mitchell, a director of General Time since 1950, is a former president of General Telephone.

Hycon Appoints Duane Gaskell

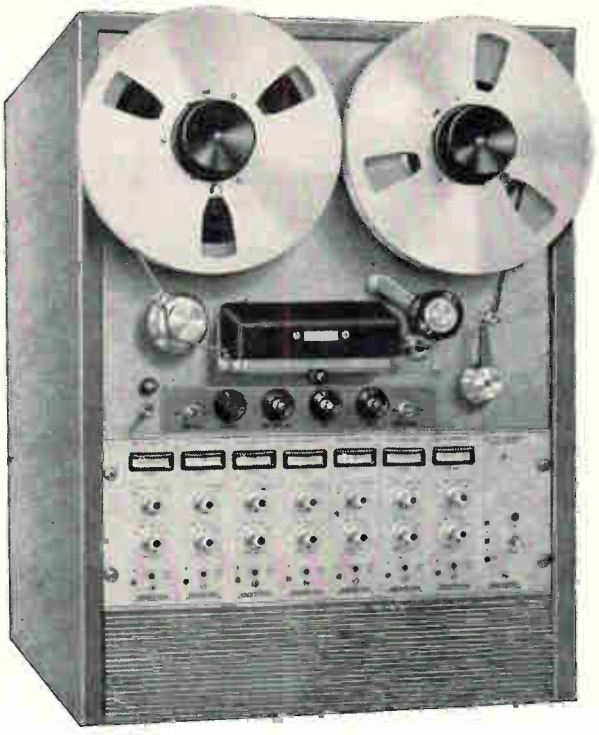
NEW DIRECTOR of the microwave systems department of Hycon Mfg. Co., Monrovia, Calif., is Duane Gaskell. He was formerly staff engineer for the General Telephone and Electronics West Coast Laboratories.

Gaskell's responsibilities at Hycon will be to direct the development of a product line of strip transmission line components and expand the company's microwave system capability.

Pickard & Burns Elects Farrar

ASHLEY A. FARRAR has been elected vice president and general manager of Pickard & Burns, Inc. of Waltham, Mass., electronics research and development subsidiary of Gorham Corp.

For the past 20 years Farrar had been associated with the Raytheon



MNEW FROM MNEMOTRON!*

We are silent about the "M" in Mnemotron but not about our new 700 Series Data Recorder. With good reason. For one, it brings the size and cost of data recording systems down to sensible proportions if your data is analog voltage from DC to 5000 cycles per second. And its features would not embarrass even the costliest instrumentation recorder. Here are a few·

COMPACTNESS. A complete 7 channel record/reproduce system uses less than two feet of rack space. A 14 channel system adds less than seven inches more.

ACCURACY. Input-output characteristic is linear within 0.2 per cent with Mnemotron unique Pulse Frequency Modulation (PFM) data conversion technique.

FLEXIBILITY. As many data channels as you need with a choice of channel format. For greatest operating economy, choose up to 7 channels on ¼ inch magnetic tape, 14 channels on ½ inch tape, standard IRIG spacing and track width of 7 channels on ½ inch tape.

INTEGRATED RECORD/REPRODUCE MODULES. A single solid-state PFM Data Converter has all the record/reproduce electronics for each channel. Simple rotary switching lets you select data conversion for 3 tape speeds. No additional plug-ins needed.

ISOLATED INPUT CIRCUITS. Input terminals of each channel are isolated from all the others to readily accept data from floating, unbalanced or differential sources.

VERSATILITY. 700 Series plug-in accessories expand instrumentation capability. Typical: Electrocardiogram preamplifiers for recording directly from electrodes. Pulse Record unit for recording trigger pulses, time markers, or stimulus pulses in medical research . . .

PRICE. 7 Channel System from $6,495

COMPLETE SPECIFICATIONS. Send for your copy today.

* To answer the many inquiries, Mnemotron comes from Mnemosyne, Greek Goddess of Memory.

MNEMOTRON CORPORATION

45 South Main St., Pearl River, New York, 914 PEarl River 5-4015, Cables: Mnemotron, TWX: H99

Subsidiary of Technical Measurement Corporation, North Haven, Conn.

mō·dĕm

mo-dem (mō′dĕm) *n.* [E. fr. contr. and comb. of *modulator* and *demodulator*.] 1. A device used in electronic data communication for the transmission and reception of data. 2. a transceiver. —**Syn.** SEBIT; see RIXON.

The modem shown is a basic low-speed data communications terminal. By adding other Rixon **DD** modules, a system which meets almost any requirements (simplex, half- or full-duplex, data rates from 600 to 4800 bps) can be easily custom-tailored. No wonder Rixon is synonymous with data communication. For solutions, engineering, or hardware for your data communications problems, contact our Marketing Department.

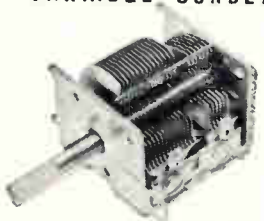
RIXON ELECTRONICS, INC.

2121 INDUSTRIAL PARKWAY—MONTGOMERY INDUSTRIAL PARK—SILVER SPRING, MARYLAND
TELEPHONE: 622-2121 TWX: 301 622-2292

Visit us at the Eighth National Communications Symposium, Utica, N. Y., October 1-3, Booths 13 & 14.
Also at the National Electronics Conference in Chicago, October 8-10, Booth 726.

CIRCLE 215 ON READER SERVICE CARD

VARIABLE CONDENSER



3 types; AM, AM-FM, FM.
2 gang, 3 gang, 4 gang.

PLASTIC INSULATED VARIABLE CONDENSER

Square Sizes:
15mm., 17mm.,
20mm., 21mm.,
24mm.,
Single band,
2 band, 3 band
and for FM only.

SANKAISHA CO., LTD.

Cable address; SANESHARICON TOKYO
1425, 4-chome, Higashinakanobu,
Shinagawa-Ku, Tokyo, Japan.

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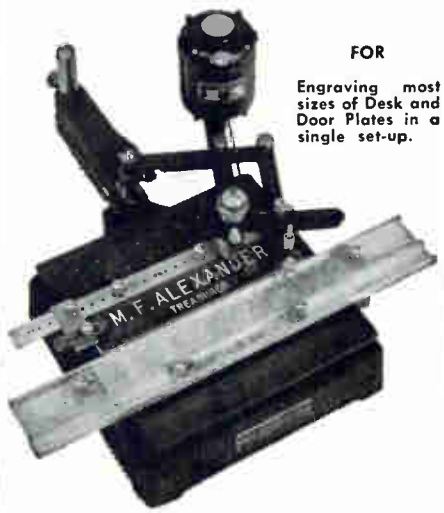
MICO

DESK AND DOOR PLATE ENGRAVER



FOR

Engraving most sizes of Desk and Door Plates in a single set-up.

FEATURES

1. Six pantograph ratios—from 1.5:1 to 4:1.
2. Spindle has integral micrometer depth control of .250".
3. Uses standard tapered-shank engraving cutters.
4. New 19" Copy carriers hold 17" of master copy; Permits engraving about 11" line of characters in one set-up at the 1.5:1 ratio.
5. Three sizes of copy carriers available. Each positioned separately.
6. Work-holding fence speeds set-up and engraving time.

Send for illustrated Catalog

MICO INSTRUMENT CO.

77 Trowbridge St. Cambridge 38, Mass.

CIRCLE 217 ON READER SERVICE CARD

SARATOGA INDUSTRIES REPORT

A breakthrough in Radar Modulator Design:

The **SI-7K1-U** is 40% more efficient with no change in input potential.

custom designed, engineered and produced to customer's exact specifications.

FEATURES — Exclusive fast rise technique in the PFN. Completely revised, regulated filament supply system. Gas filled to provide good dielectric strength over operating temperature range (—55° C to +100°C). Accepts short circuits and open circuits without blocking.

SPECIFICATIONS — B+1500 volts: trigger input — 200 volt peak; variable from 200 pps to 3300 pps; recovery time, 100 Microseconds; output pulse, 3½ Microseconds wide; Amplitude 7.5 KV at 1.2 Amps. with rise time less than 0.3 Microseconds.

For full information about Saratoga Industries complete design, engineering and production facilities, write

SARATOGA INDUSTRIES
A Division of Espey Mfg & Electronics Corp.
Saratoga Springs, N. Y. • Telephone 4100

CIRCLE 127 ON READER SERVICE CARD

formerly vice president of engineering.

Bowers will now be responsible for overall operation of the company's three divisions which include: the Engineering division, Electronic Production division, and Shelter division.

PEOPLE IN BRIEF

Reuel Bright of Sylvania Electronic Systems named supervisor of quality control at its Santa Cruz mfg. plant. **James Allegri,** Allegri-Tech, Inc., v-p, will head up the new Special Products div. **Jerald A. Weiss** of the Worcester Polytech staff appointed a consultant to the Solid State Materials Corp. **Orlien N. Becker,** formerly with Minneapolis-Honeywell, named engineering mgr. of the John Fluke Mfg. Co., Inc. **Thomas J. Richardson** moves up to manufacturing mgr. at Assembly Products, Inc. **Clifton E. Sadler** leaves Link div. of GPI to join Electronic Systems div. of Telecomputing Corp. as special projects mgr. **Onnig Shahan,** ex-Hycon Mfg. Co., now head of the stripline systems section at Micro-Radionics, Inc. **Rubie Saranik** promoted to mgr.-selenium operations of the General Instrument Corp. Rectifier div. Marconi Instruments advances **William A. (Bill) Buck** to mgr. **Robert F. Frost,** previously with the Joint Staff and Tactical Air Command, appointed director of engineering at Welex Electronics Corp. **John Carl Day** from Texas Instruments, Inc., to American Micro Devices, Inc., as a project engineer. **Charles A. Wolf** and **Henry M. Watts,** formerly with North American Aviation and Hughes Aircraft, respectively, are appointed mgr., operations, and mgr. of systems engineering, respectively, of RCA's Data Systems div. **Robert L. Gibbs,** ex-Douglas Aircraft Co., joins Burrite Engineering & Mfg. Co. as v-p. **E. T. Ferraro,** v-p, logistics, for General Precision Aerospace, also named director of logistics for General Precision Equipment Corp.

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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ATOMIC PERSONNEL INC. Philadelphia, Pennsylvania	130	2
BENDIX CORP. Field Engineering Div. Owings Mills, Maryland	130	3
DOUGLAS AIRCRAFT CO. Missile & Space Systems Division Santa Monica, Calif.	79*	4
ESQUIRE PERSONNEL Chicago, Illinois	130	5
JET PROPULSION LABORATORY Pasadena, California	130	6
LINK DIVISION General Precision Inc. Binghamton, New York	118	7
MARTIN MARIETTA Orlando Div. Orlando, Florida	130	8
MICROWAVE SERVICES INTERNATIONAL, INC. Denville, New Jersey	95*	9
MOLONEY ELECTRIC CO. St. Louis 20, Missouri	95*	10
REPUBLIC AVIATION CORPORATION Farmingdale, L.I., N.Y.	95*	11
SPACE TECHNOLOGY LABORATORIES, INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	10*	12
TROXLER ELECTRON LABORATORIES, INC. Raleigh, N. Carolina	95*	13
P-9645	95*	14

*These advertisements appeared in the Sept. 21, issue.

(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)

92862

- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other .....
- ☐ .....
- ☐ .....
- ☐ .....

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

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
Positions Wanted
Part Time Work
Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered
Employment Agencies
Employment Services
Labor Bureaus

Seven major contracts mean growth opportunities with the Martin Company in Florida

As prime contractor for missile, electronic and communications systems plus extensive research and development work, the Martin Company offers highly attractive openings for qualified engineers and scientists. Among our immediate senior level requirements are:

- **Thin Films**
- **Command and Control Systems**
- **Guidance and Control Systems**
- **Display Systems**
- **Theoretical Fluid Dynamics**
- **Missile and Electronic Systems Concepts**
- **Electro-magnetics**

Work with the team who developed Pershing, Bullpup, GAM-83, Lacrosse, Racep, Missile Master and BIRDiE. Investigate these opportunities by sending your resume, in confidence, to Mr. P. A. Miller, Martin Company, Orlando Division, Sec. 537, Orlando, Florida. (An equal opportunity employer.)

MARTIN — MARTIN MARIETTA

ORLANDO DIVISION

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"

CHIEF ENGINEER

To $22,500 Per Year

BSEE. however a MS or PHD is preferred. Experience at the department or program level, where groups of engineering and support personnel were supervised. Knowledge of Digital Systems and Solid State Devices required. Company client assumes all expenses.

ESQUIRE PERSONNEL SERVICE INC.
202 S. State St. Chicago 4, Ill.

E. E.'s

for FEE-PAID Positions
WRITE US FIRST!

Use our confidential application for professional, individualized service . . . a complete national technical employment agency.

ATOMIC PERSONNEL, INC.
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Bendix has immediate requirement in

COMMUNICATIONS FACILITIES (FAX) CONTROL
TROPOSPHERIC SCATTER COMMUNICATIONS
GROUND NAVIGATIONAL AIDS
SINGLE SIDEBAND COMMUNICATIONS

Candidates with two to ten years or more related experience. Some assignments are domestic; others are overseas.

Please write to
Mr. J. A. Runser, Dept. 92

BENDIX FIELD ENGINEERING CORPORATION

Subsidiary of the Bendix Corporation
Owings Mills, Md.

An Equal Opportunity Employer

THE Bendix CORPORATION

SEARCHLIGHT SECTION

(Classified Advertising)

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FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons. IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.
PRICES AT A FRACTION OF ORIGINAL COST!

COMMUNICATIONS EQUIP CO.
343 CANAL ST., N. Y. 13, WO 6-4045
CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 950 ON READER SERVICE CARD

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
X & S SCR.584 & M 33 AUTOTRACK RADAR.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32GCA. AN/APS10 NAVIG. & WEATHER.
AN/APS-15 B. AN/APS-23 & 31 SEARCH.
S & X BEACONS. VA 800 KLY. CARCINOTRONS.
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MICROWAVEPLUMBING—TEST EQUIP.
LARGEST RADAR STOCK IN U.S.A.
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RADAR SYSTEMS & COMPONENTS / IMMEDIATE DELIVERY

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OVER 2,000,000

RELAYS

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CIRCLE 951 ON READER SERVICE CARD

LOOKING FOR

USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of September 14th issue.

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F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

electronics

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500 Fifth Avenue, LO-4-3000 (area code 212)

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6 Penn Center Plaza, LOcust 8-4330 (area code 215)

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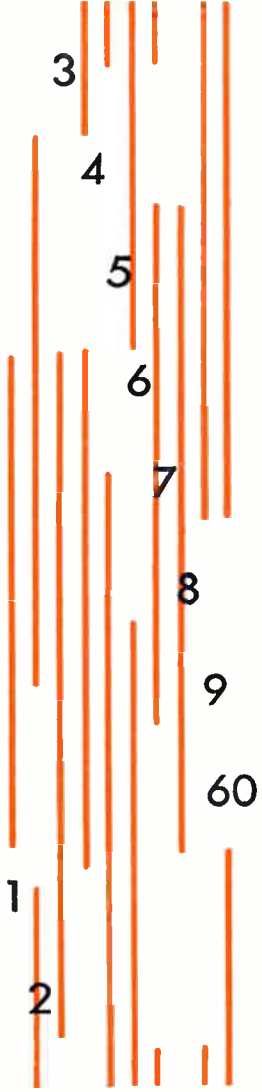
verify events permanently in milliseconds



Brush Operations Monitors' response to signals is virtually instantaneous—less than 4 milliseconds. Multiple high-speed events are clearly defined from start to stop, on a common time base—and at rates up to 500 per second. Portable 30 channel or rack-mounting 100 channel models record sharp reproducible traces with fixed-stylus electric writing that provides the utmost in reliability. "Built-in" transistor switching to eliminate relays is optional. No direct writing recording system can match the capabilities of Brush Operations Monitors for industrial and military analysis and control. Write for complete specifications and application data.

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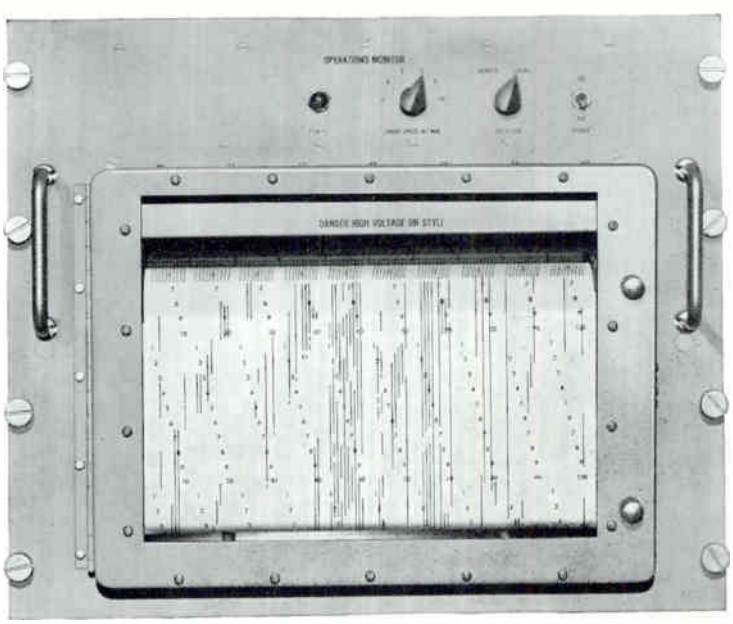
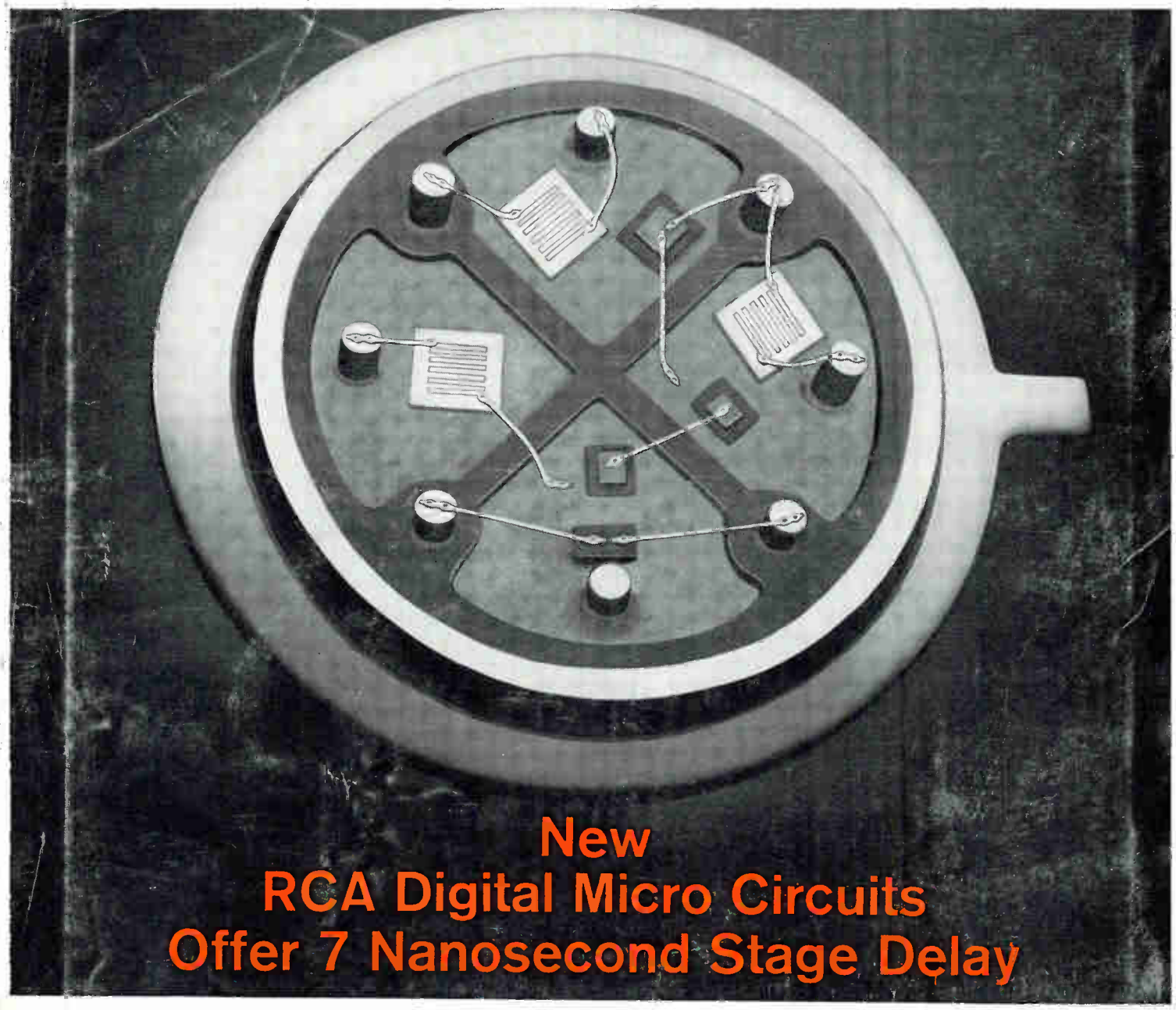
DIVISION OF
CLEVITE CORPORATION
37TH AND PERKINS — CLEVELAND 14, OHIO



CIRCLE 901 READERS SERVICE CARD



New RCA Digital Micro Circuits Offer 7 Nanosecond Stage Delay

RCA announces the DMC 100 package—First in a series of compact logic-circuits with advanced active and passive elements for ultra-high-speed and new design flexibility.

ACTUAL SIZE

RCA's new low-cost Digital Micro Circuits bring faster switching speeds, better reliability and greater compactness to computer logic circuits. Here's why:

Faster Switching—New ultra-high-speed silicon switching devices provide extra-fast switching because stray capacities and lead lengths are reduced to a minimum in RCA's exclusive DMC package design.

Better Reliability—Overall circuit reliability is increased in the RCA DMC because all internal connections are either diffused paths or thermal compression bonds.

Greater Compactness—The ultra-compact, low-profile, ceramic-to-metal, DMC package is made possible by RCA's exclusive ceramic header, already reliability-proved in millions of RCA devices.

Here are some of the outstanding features of the DMC 100, a positive NAND circuit version of RCA's new Digital Micro Circuits:

- Excellent noise immunity...±50% of signal
- High speed...7 nanoseconds typical stage delay
- Low circuit dissipation...14 mw typical
- Wide operating temperature range...−55 to +125°C
- Max. Fan-Out of 5
- Broad Application...RCA DMC 100 is designed for use as an Inverter, Amplifier, Logic Gate (positive NAND or negative NOR), Flip-Flop, and Shift Register
- Immediate Availability . . . in production quantities
- RCA's unique, 8-lead, 100-mil high, "TO-5 type" package

New Flexibility in Customer-Specified Circuits... RCA is ready to combine silicon planar transistors and silicon switching diodes—in your circuit designs—with a wide variety of high-temperature, precision, passive components into Digital Micro Circuit form. And, these are available to you without costly tooling charges. Circuit changes can be made quickly and easily, at any time, eliminating costly delays.

Call your RCA Representative today for complete price and delivery information. For further technical data, write RCA Semiconductor and Materials Division, Commercial Engineering, Section CN 9-4, Somerville, N.J.

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RCA® **The Most Trusted Name in Electronics**

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CIRCLE 902 ON READER SERVICE CARD