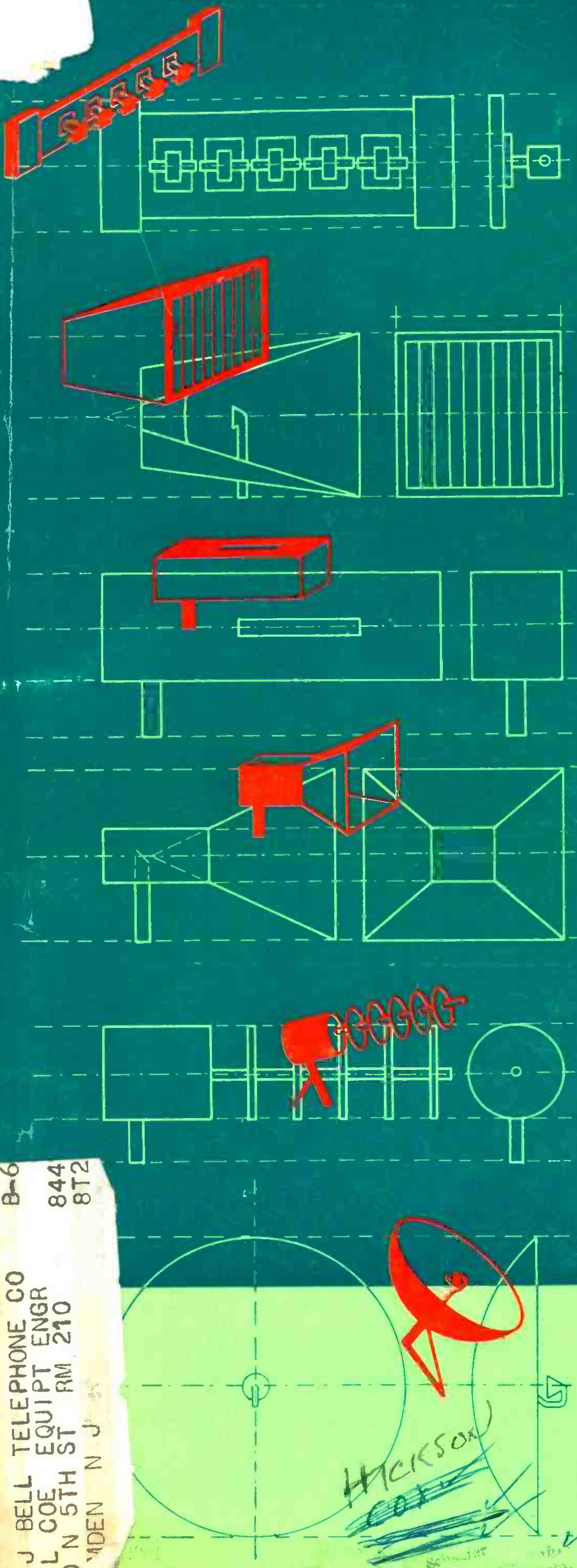
ELECTRONIC INDUSTRIES



12th ANNUAL

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UHF 10^3	SHF 10^4	EHF 10^5	

MICROWAVE ISSUE

PARALLEL T FILTERS 71

Calibrating microwave devices

Integrated video detectors

Delay lines in sequential circuits

NOVEMBER 1964

HICKSON

To Engineer Better Means to Manage Better

"MANAGEMENT" IS THE PASSWORD that Federal Government administrators and Congressmen are passing along to defense and aerospace contractors. And, defense contractors are passing along that admonition to their engineers. In a word: to engineer better means to manage better. The government is demanding more value and lower costs.

President Johnson set the tone in his first speech to Congress when he called for "frugality." Defense Secretary McNamara re-echoed that word with a major cost reduction program. "Major contractors indicate that they plan to decrease the cost of defense procurement by 5% to 10%. Much of this improvement will result from the use of more competitive and tightly controlled subcontracts—through which half of the prime contract dollar is spent."

In turn, outspoken advocates for top spending now are moderating their approach. For example, Congressman Melvin Price, head of the R&D Subcommittee of the House Armed Services and Joint Congressional Atomic Energy Committees, has outlined four points that Congress will consider in evaluating the R&D federal budget that rose from $1 billion to $15 billion from 1950 to 1964. He notes:

First, establishment of clear-cut objectives for R&D projects.

Second, a realistic cost estimate for the entire project—not just the immediate year.

Third, centralized responsibility and continuity of management.

Fourth, a plan to follow-through—to put the results of R&D to actual use.

Here, for example, the National Aeronautics and Space Administration is spurring efforts of its technology utilization speed-up program. The main idea is to hurry government-funded technology into the commercial-industrial pipelines of the nation for "The Great Society."

Such activities make sense. Western Electric Co., for example, recently reported that about 33% of its current product line (including many electronic devices) were unknown 10 years ago. After all, today's new products are tomorrow's old products—so that today's R&D must be hastened along into the pipeline of new products for new profits.

But all of this is easier said than done. However, several and varied steps are being taken to initiate improved management into engineering activities. One approach was cited before the R&D Subcommittee of the Joint Congressional Committee on Atomic Energy by Dr. Harold Brown, director of Defense Research and Engineering, Defense Department. He said, in part:

> "During this coming year (1964), one of our primary concerns will be to seek out and identify those management conditions which have in the past proven to be highly productive of militarily useful results. We then intend to initiate new policies which will make these favorable conditions more widespread than they have been in the past, in the expectation that this will result in more defense for each exploratory development dollar expended."

Quite naturally, the experience of Rear Admiral "Red" Raborn's team in developing the Polaris submarine rushes to mind. Studies of Polaris have been made and will be applied to utilize this relatively recent experience which already is a classic in government management in our time.

Sharp admonitions by Congressman Daniel Flood called the Navy to task for not doing as well with its lingering anti-submarine warfare program, during a session of the Defense Subcommittee of the House Appropriations Committee. Within a month, the Navy put Vice Admiral Charles B. Martell into the job as Director of Anti-submarine Warfare Programs to get results.

In this vein, Senator Hubert H. Humphrey recently introduced a joint resolution providing for the establishment of an agency in the Executive Office of the President to be known as the President's Advisory Staff on Scientific Information Management.

Clearly, pressure is building up from Congress and the Presidency for suppliers to manage better. As major participants in defense and aerospace programs, electronic manufacturers will feel the effects of this trend. Engineers, too, will feel the pressure for better management in all their activities.

Bernard F. Osbahr

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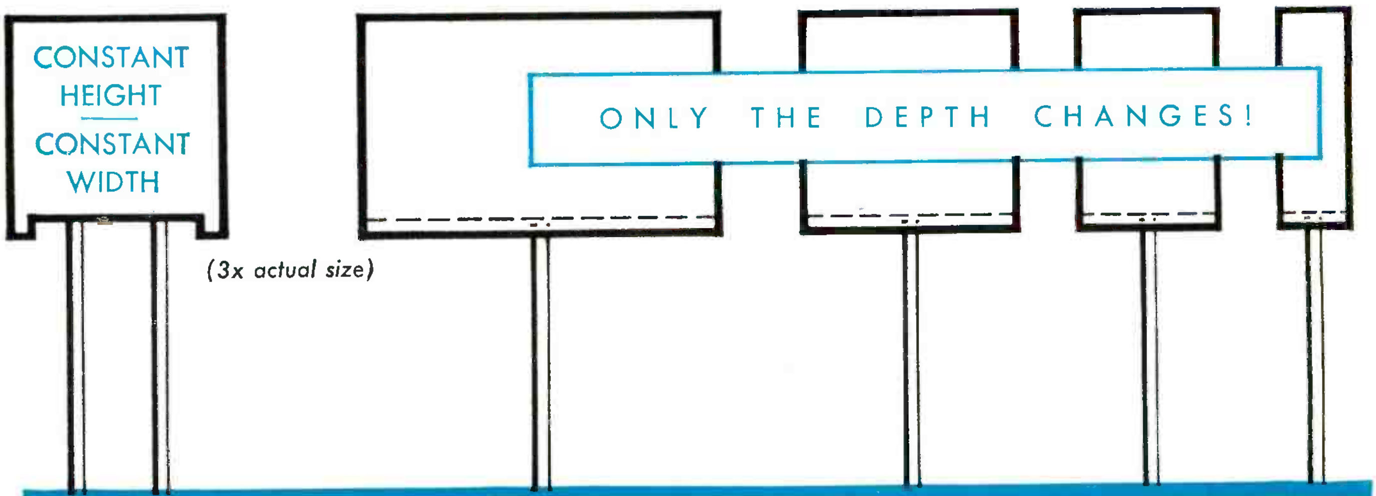

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Especially qualified for applications such as printed circuits, where board space is at a premium and must be fully utilized.

- Only the depth changes from case to case—face area remains constant, making Type 190D Capacitors extremely well-suited for automatic insertion.
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November 1964, Vol. 23, No. 11

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine
for Electronic Engineers

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COVER

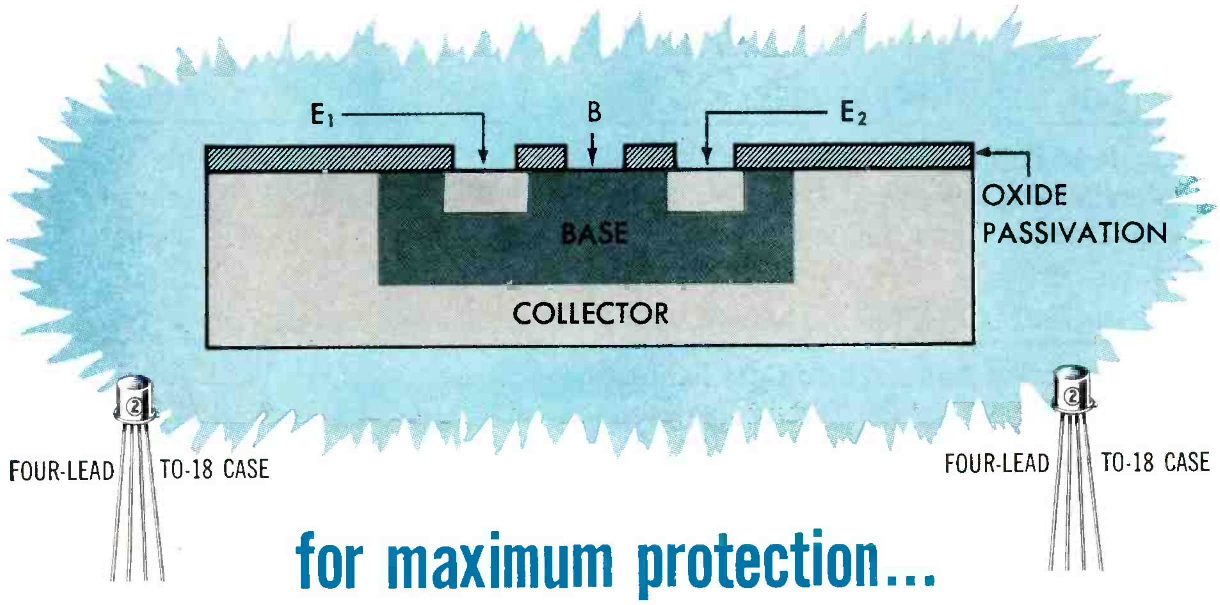
Group of typical microwave antennas sets the theme for this 12th Annual Microwave Issue of ELECTRONIC INDUSTRIES. At the same time, we spotlight that part of the frequency spectrum where the bulk of microwave activities are being carried on.

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

BPA NBP

New from Sprague!

DUET* 50-VOLT DUAL-EMITTER CHOPPER TRANSISTORS



for maximum protection...
3 times the emitter voltage previously available!

COMPARE THESE PARAMETERS WITH THOSE OF ANY OTHER DUAL-EMITTER!

Type No.	BV_{EEO}	I_{EEO}	V_O
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3N90	30V	1nA	50μV
3N91	30V	1nA	100μV
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Sprague DUET* low level dual-emitter choppers are fully passivated PNP silicon planar epitaxial transistors. They feature guaranteed emitter voltage of up to 50 volts, three times the emitter voltage previously available.

The Sprague DUET* is ideally suited for applications such as low-level chopping, multiplexing, comutating, etc., where low leakage current, low saturation resistance, and close matching are required. The DUET* is a product of Sprague's extensive research effort in silicon planar epitaxial and silicon based microcircuit technology.

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ELECTRONIC INDUSTRIES HIGHLIGHTS

A GUIDE TO FUTURE AIRBORNE RADAR ANTENNAS 34

Improved aircraft performance is accelerating the search for better antennas for airborne radar applications. Several classes of antennas, such as the leaky-wave, lens, and array antennas are being considered as a solution. The advantages and limitations of each are discussed.

UNDERSTANDING INTEGRATED VIDEO DETECTORS 42

Significant improvements in mounts and crystals are leading to wider use of crystal video detectors. This form of detection is considered a modern approach to communication systems. The information here will lead to a good understanding of integrated video detectors and indicate the present state-of-the-art.

AN ENGINEERING APPROACH TO COST ESTIMATING 52

The average engineer regards any cost estimating task as an extremely distasteful one. His attitude is that estimating is an unimportant chore. This is far from the truth, especially now when more and more contracts are being awarded on a "Fixed Price" basis. This article presents usable information to aid the engineer in this task. The method described should make the task less painful.

USING DELAY LINES IN TIME SEQUENTIAL CIRCUITS 60

This article tells how to design the circuitry used with a delay line memory. Here, Boolean input functions are simplified through the use of Vietch diagrams. Two practical examples are given to aid the designer and to prove this method's validity.

MATRIX ALGEBRA SIMPLIFIES CIRCUIT ANALYSIS 67

This method of analyzing circuits may be applied to any network whether active, passive, bilateral or unilateral. The method is particularly useful when several linear systems must be combined.

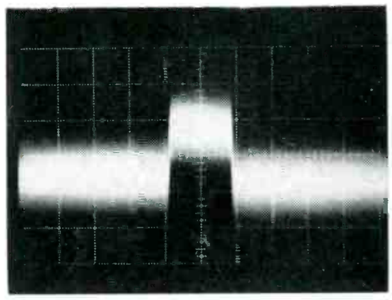
ESTABLISHING A MICROWAVE CALIBRATION LABORATORY 74

Calibration equipment normally found in the lab will not perform many needed measurement and calibration functions. This is due to the difference in measurement methods between lumped constant, low frequency circuits and distributed parameter, high frequency or microwave circuits. Equipment and methods described here enable VSWR and impedance, attenuation, power and frequency measurements to be made in the frequency range of 500 MC to 10 GC.

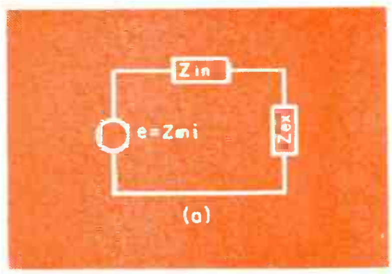
MICROWAVE GROWTH HINGES ON EXPANDING MARKETS 118

Once a booming and blooming market, microwaves now find most U. S. agencies either well equipped or low in money, buying only replacement parts. To prop up the market, microwave firms are turning to industrial, business, and consumer products—and rapidly growing exports. The market may bloom again—but not exactly tomorrow.

Airborne Radar Antennas



Integrated Video Detectors



Matrix Algebra

Calibration Laboratory

Microwave Markets

A STEP FORWARD...

...With The New "500" Series Power Controllers

At Crydom Laboratories, SCR's are made to perform a wide variety of power control functions in the new "500" Series Power Controllers — designed to afford maximum flexibility in industrial control. Outstanding features include: Three Control Windings ■ Zener Regulated Bias Supply ■ Current Limiting ■ Transient Protection ■ "Flyback" Rectifier DC Models.

Eighteen standard (18) models are available with output power ratings from 375 watts to 30 KW. Both AC and DC outputs are provided with 120 and 208 volt (suitable for 240 volt operation) inputs. Current capacity ranges from 4 to 120 amps output. All models include a current limit feature as an option. High voltage ratings on the SCR's plus thyrector transient protection assures greater reliability.

The DC units are suitable for inductive loads since a flyback rectifier is included in the output. Three low resistance high gain control windings are provided for operation from a wide variety of signal sources. A 7 volt DC 10 ma zener regulated source is also provided for biasing and reference functions.

The prices start at $162 — an unmatched combination of low cost, high reliability and performance. *Please write or call* for new Bulletin #21-5.

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ELECTRONIC INDUSTRIES

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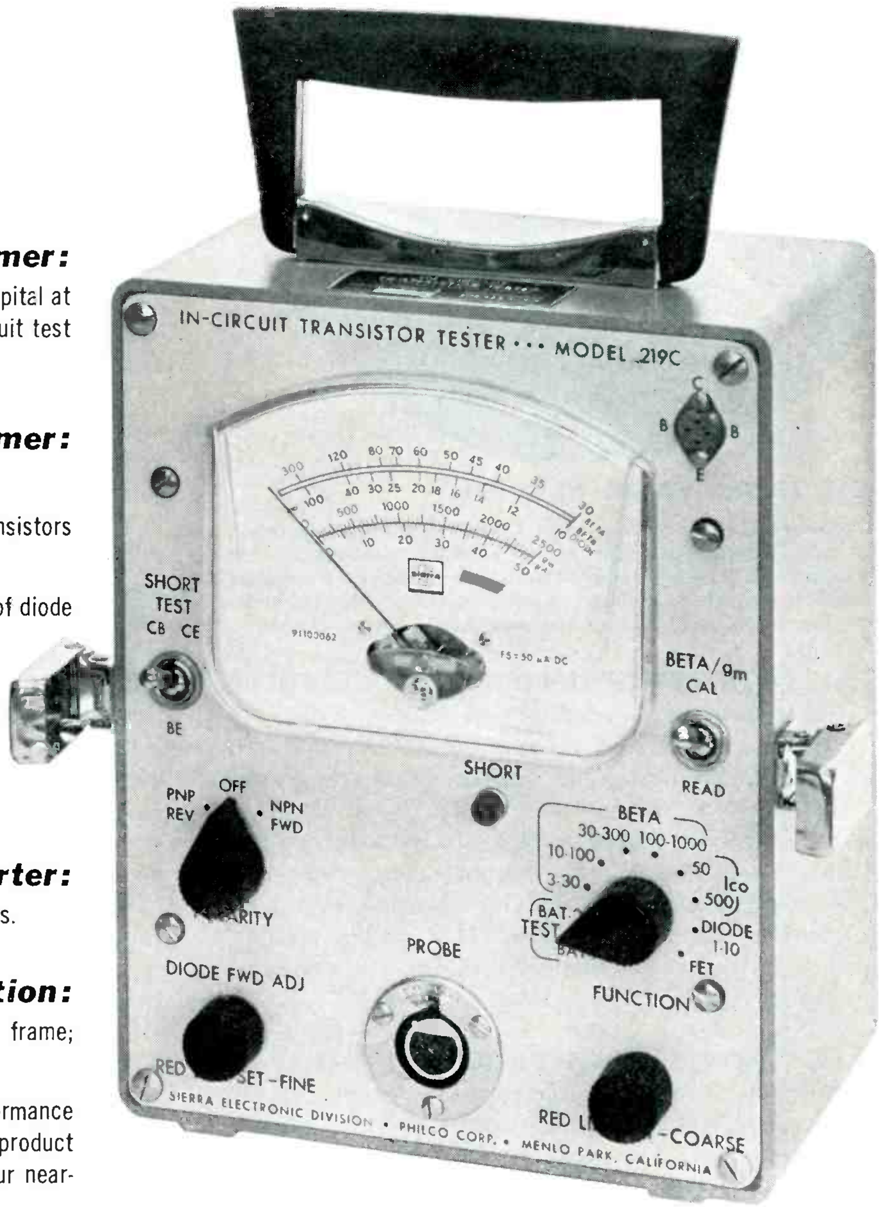
INSIDE REPORT

On a new Transistor Tester (with in-circuit test capability for Field Effect Transistors)



A capital performer:

Sierra's 219C performs better and costs less capital at a new low price of $275 (complete with in-circuit test cable and sturdy carrying case).

A versatile performer:

Performs in-circuit and out-of-circuit.

- **Beta measurements** on all standard transistors from 3–1000
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- transconductance tests of FET, 0–2500 micromhos

Performs out-of-circuit tests of leakage current (I_{co}) on 0–50 or 0–500 μa scales.

A self starter:

Powered by readily available standard batteries.

In excellent condition:

No excess poundage on this trim 7¾-pound frame; rugged, dependable all-solid-state circuitry.

A detailed report on the Sierra 219C's performance features and capabilities awaits you in the product bulletin, available now from Sierra or from your nearest Sierra sales representative.

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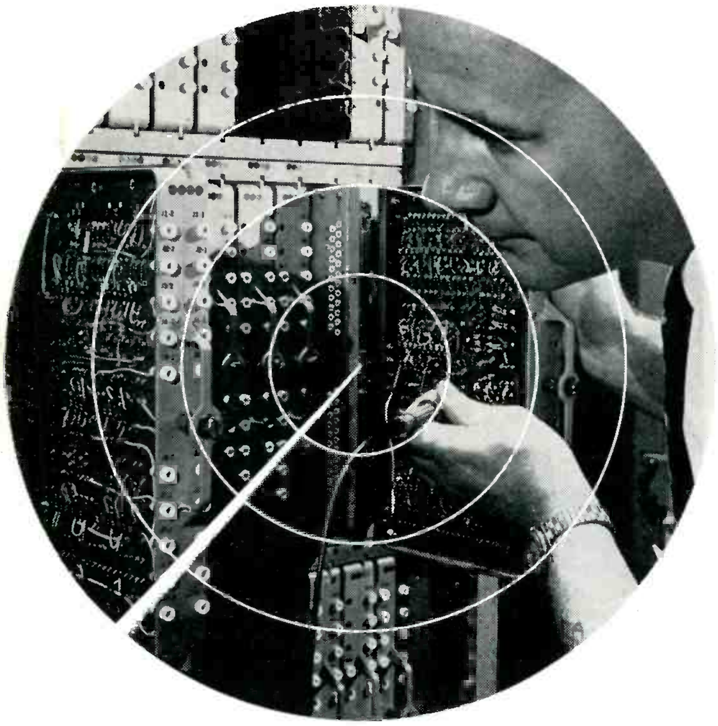
ELECTRONIC INDUSTRIES RADARSCOPE

Analyzing current developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries



ELECTRONIC RADAR WATCHER

Technician checks circuit in Sperry Gyrosco~e new video processor, a radar monitor that rivals human reliability, according to the company. All technical problems involved in replacing human scope watchers are solved, engineers report. Remaining hurdle is building human confidence. The machine uses digital computer techniques.

DO-IT-YOURSELF INTEGRATED CIRCUITS are now possible through an approach developed by Norden Division of United Aircraft Corp. Based on an Apollo design, it includes a single-crystal "Master Dice" breadboard circuit with all elements of an advanced microcircuit, but without connections. Designer can make his own circuit by bonding connections, or by giving Norden a layout. Circuit can be mounted on a TO-5 header, with 8-, 10- or 12-lead packaging, or in a flat pack. Circuit measures .065 by .085 inches.

ELECTRONIC DATA PROCESSING in banks is moving toward second generation systems, which may adapt techniques used in large-scale military command-control systems. Robert Bosch, of Auerbach Corp., said the next major advance in automated banking may be systems in which a central file of data about all customer accounts will help banks improve planning and operation. He suggested two possible systems. One is the Common-Data-Base-System, a military-type system that includes a common data pool. The other would be to simply add a central index to systems now in use.

SINGLE CRYSTAL FERRITES must be made from a solution, conclude researchers at Airtron Division of Litton Industries. They find that growth of high quality, uniform, large single crystals of high melting oxide materials is not practical from a melt. Ferrites are not stable at high temperatures, making crystal growth of ferrite-like materials very difficult. During the research for the Navy, scientists used a pressure vessel with a floating zone mechanism. Materials examined included nickel ferrite, magnetite, manganese ferrite, and nickel aluminum ferrite.

LIGHT MODULATOR, for optical transmission of signals, is reported by engineers at Harvard University for the Navy. The device, a new kind of travelling-wave-like modulator, is made up of a stack of crystals. They are so oriented that modulation increases with optical path even though the microwave field is a standing wave with no spatial variation in direction of light propagation.

LONG GAS LENSES that show promise for long-distance laser communication have been invented at Bell Telephone Labs. Lenses, which use variations in refractive indices of gases to guide light, do not reflect or absorb light nearly as much as do conventional optical components. Long gas lens, or series of lenses, can confine a laser beam to a path near the center of a pipe. Based on principle of decreasing refractive index and prisms, such a pipe could be the transmission line for long-distance laser transmission.

ULTRA-HIGH SOUND WAVES almost a million times higher than the highest sound waves ordinarilly heard by human ear have been generated by a new technique at Westinghouse Research Labs. Doing work for the Air Force, Westinghouse engineers predict the technique will eventually take sounds 100 times higher than the present 9,000 million CPS. Vibrations are made by a radical form of piezoelectric transducer, containing a "grown" thin film of crystalline cadmium sulfide built up atom by atom.

TWO-WAY DATA LINK, a long-distance, man-machine data communications system, has been developed by Information Products Corp., of South Hadley Falls, Mass. In a public test in New York, the system, called BuCom, was used with a Univac 490 located in Pittsburgh. IPC officials fired questions at the 490 and received instant visible answers on the BuCom's display screen. System includes compact, desk-top-typewriter-size interrogator-display unit, and a long-distance, high-speed Dataphone link with any computer where business data are centrally stored and processed.

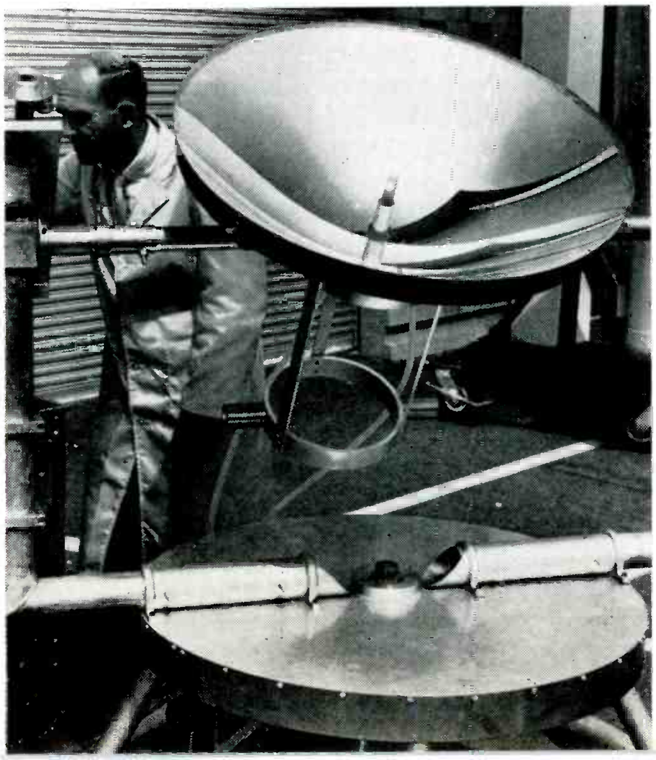
FAST-SCANNING IR MICROSCOPE that can forecast possible failure of electronic space devices without long, complex tests is being developed by Raytheon Co. for NASA. Performance analyzer, which senses minute amounts of infrared radiation, will reveal integrated circuit or semiconductor device reliability and probable life expectancy. Potential failure can be pinpointed in microcircuits and thin-film assemblies.

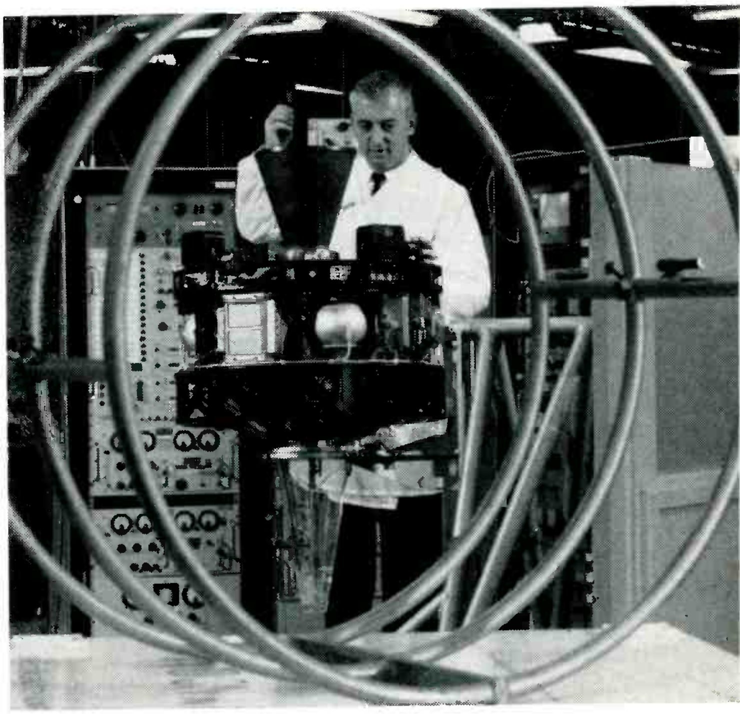
TELETYPE COMMUNICATIONS system at Armco Steel Corp. newly installed by General Telephone & Electronics Corp. transmits laboratory test data on composition of steel in production to 10 production control stations. System helps prevent costly production delays, according to Armco and GT&E. System was installed by GT&E of Kentucky to maintain precise control of continuing steel production, replacing automatic handwriting and voice-paging equipment.

NERVE CELL COMPUTER, which simulates nerve cell behavior, interconnecting fibers, and intrinsic impulse sources, has been built by cybernetics engineers at Rand Corp. Built in collaboration with neurophysiologists, the digital unit works with a continuous time parameter. Graded potentials and satisfactory root-searching add to running time for most problems, but they need only small amounts of added storage, so added realism can be incorporated in larger networks.

SUN PUMPED LASER

Parabolic concentrator provides energy for sun pumped laser developed by Electro-Optical Systems, Inc. Unit requires no electrical power, needs no cryogenics and has already produced a cw output of 25 mw at 300°K in ground level sunlight. In background is Robert J. Condon, co-developer of unit in firm's Quantum Physics Division.





READY FOR THE SHOOT

Syncom III getting last check at Hughes Aircraft by engineer William Penprase before recent launch at Cape Kennedy. The communications satellite has 3,840 silicon solar N and P cells around its surface. Transponder has 10MC i-f bandwidth for TV. Communications system is redundant, frequency-translation, active repeater system.

MONITOR OSCILLOSCOPE, solid-state, with high resolution, introduced by ITT Industrial Products Division. Designated KM702, scope is fully solid-state except for the CRT; it gives off very little heat. ITT claims exceptional stability. It is expected to have wide use in telemetry systems. It offers 7KC full-screen undistorted deflection and 100mv/cm input sensitivity.

TV ELECTRON MICROSCOPE technique, announced by RCA, increases magnification power to 2,000,000 times. C. H. Colledge, general manager of RCA Broadcast and Communications Products Division, described the new system as "the most important single advance in microscope design since perfection of the microscope itself." Conventional electron microscope is capable of direct magnification only up to 200,000 times.

PERFECT TITANIUM OXIDE becomes n-type upon slight reduction, concludes researchers at Northeastern University from tests in behalf of the Air Force. Studies included work on thermoelectric power and conductivity of TiO_2, as functions of temperature and oxygen pressure. Scientists say conduction results from excitation of electrons from donor centers into a narrow d-conduction band. Doping of single crystals of oxides like MnO and CoO by H-ion bombardment results in significant electronic property changes.

(MORE RADARSCOPE on Page 10)

ELECTRONIC INDUSTRIES

RADARSCOPE

SOLID STATE MONITOR for studying performance of electronic systems has been developed by EMCO Systems, Inc. The new performance monitor, reports EMCO, is an economic means to do jobs where the expense for computers or complex machines is not justified. The monitor is a "go/no-go" evaluation instrument for fault detection and isolation. The firm says the unit may be used with any electronic system without major modification to prime equipment.

EXPERIMENTAL COMPUTER SYSTEM to instruct students in a number of subjects is being studied by IBM. System includes standard IBM hardware and a new computer language to allow educators to feed course material into computer. Penn State University faculty is preparing several courses for use. Instructions, questions, and guidance are stored in computer and presented to students on individual typewriter consoles.

ELECTRON BEAM WELDING has been successful with materials in fabricating and assembling electron tubes, according to a report from Office of Technical Services, Department of Commerce. Materials welded include stainless steel, nickel, copper, titanium, columbium, molybdenum, rhenium, tantalum, tungsten and kovar. The process, according to United Aircraft Corp., can drill holes from 0.0005" to 0.25" in dia.

RADAR SIGNAL PROCESSOR

Producing an enhanced video display, new radar signal processor (right) generates video output on plan position indicator (PPI) for improving target detection location. The processor, developed by Cornell Aeronautical Laboratory for Navy Bureau of Ships, is designed to reduce noise, yet maintain high detection probability.

SEMICONDUCTOR FILMS, intermetallic, and of a good variety, can be made by the independent evaporation of the separate elements onto a heated substrate, according to engineers at the U. S. Naval Ordnance Lab. They also report good polycrystalline films as well as mixed crystals by this method. "Techniques and Apparatus for Evaporating Compound Semiconductors," (AD 600 676) (50¢).*

LASER SCIENTISTS at Honeywell Research Center have modulated a ruby laser beam at microwave frequencies (3×10^9cps) by applying a dc magnetic field to a ruby resonance absorber. Dr. John N. Dempsey, director, said a microwave laser system could send much more data than a conventional system.

GaAs MOS TRANSISTORS offer some advantages over silicon, especially at high frequencies, RCA engineers found during Air Force-sponsored research. Feasibility has been established and a making process developed for n-channel depletion devices. When varactor analysis is put to Gallium Arsenide-silicon dioxide system, importance of surface treatment and oxide growth condition regarding density and frequency response of interface states is apparent. "Gallium Arsenide MOS Transistors," (AD 602 440) ($4.00-Microfiche 75¢).*

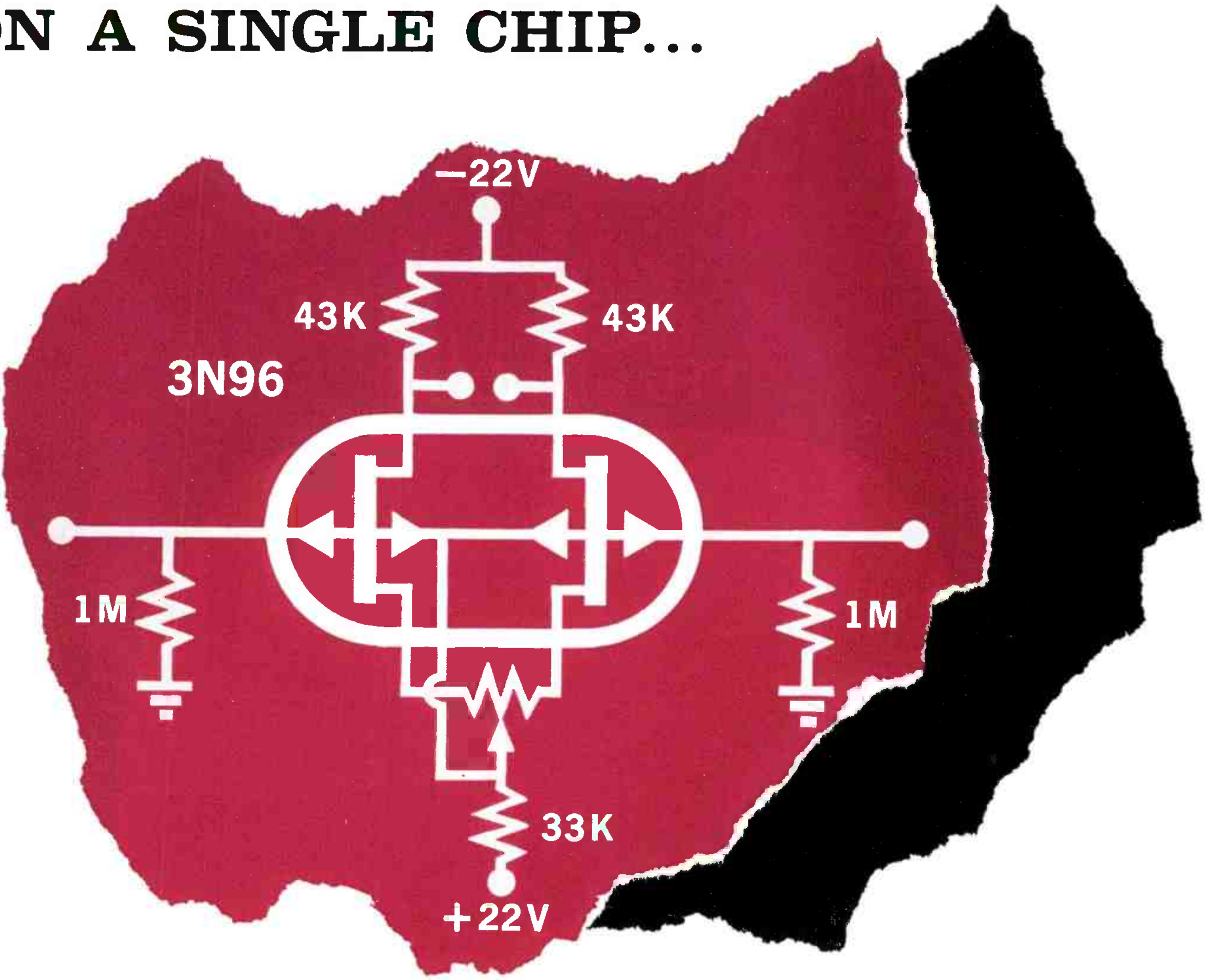
VACUUM EVAPORATION of indium antimonide films 550 to 3750 Å thick on glass substrates from a graphite crucible at 1400°C. is now possible, report scientists at Kansas State University. In tests done for the U. S. Air Force, films were deposited on substrates at room temperature. They were annealed at temperatures up to 250°C. Average stoichiometry is preserved by evaporating small pieces in toto. "Preparation and Properties of Thin Films of Semiconductors," (AD 600 725) ($2.50).*

MICROWAVE OSCILLATOR, light weight, rugged, with high efficiency developed at Harry Diamond Laboratories. Oscillator uses distributed properties of strip transmission line and h-f characteristics of ceramic planar triodes. The circuit is made with low cost printed circuitry. Peak powers up to 1000w are possible at 1200mc with up to 35% efficiency. Frequency stability is 1mc over —50° to 80°C. variation. "Low Cost, High-Efficiency Microwave Oscillators," (AD 422 900N—50c).*

(More RADARSCOPE on Page 13)

*Office of Technical Services, U. S. Department of Commerce, Washington, D. C., 20230.

A MATCHED PAIR OF FETs ON A SINGLE CHIP...



.. for differential amplifiers demanding close thermal tracking.

The newest advancement from Siliconix is a pair of tetrode FETs diffused into a single silicon chip. With the resulting tighter thermal coupling, we realized this performance in the experimental circuit shown:

> $A_V = 20$ db
> Input Voltage Drift $\leqslant$ 1 mv (25-100°C)
> Common Mode Rejection $\geqslant$ 70 db

The new 3N96-7 series is ideal for d-c differential amplifiers working from source impedances greater than 10K ohms, due to the very low differential I_G. The low input capacitance and the separate control element (gate #3) extend its application to wide band and AGC amplifiers. Here are a few typical characteristics that may stimulate your own applications thinking:

TEST CONDITIONS:

$V_{DG1} = V_{DG2} = V_{DG3} = -5v$ $I_{D1} = I_{D2} = -300\mu a$

CHARACTERISTIC		3N96/3N97 Min	Max
$\frac{\|\Delta(V_{G1S1} - V_{G2S2})\|}{\|\Delta T\|}$	$\Delta T = 25$ to 100°C $\Delta T = -50$ to $+25$°C		1/8 mv 2/8 mv
$\|I_{G1} - I_{G2}\|$	$T_A = 100$°C		1/3 na
$\frac{\|y_{fs1}\|}{\|y_{fs2}\|}$	f = 1 kc	0.99/0.95	1.0

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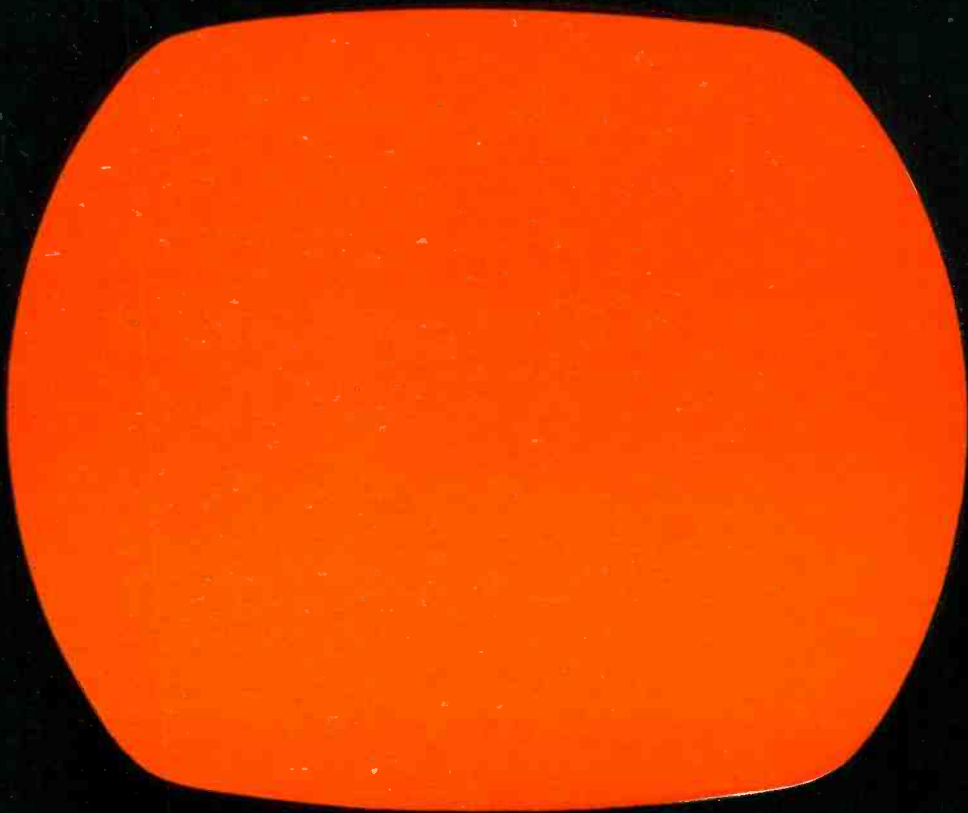
suddenly

COLOR TV HAS A NEW RED STANDARD



Sylvania's new EUROPIUM RED

New COLOR BRIGHT 85 picture tube brings more natural color to television and increases monochrome brightness 43%*

The startling news in the television industry is Sylvania's new picture tube, and its new, truer red phosphor.

The new red is a europium-activated rare-earth compound developed by GT&E Laboratories specifically for color TV application. Because the new red is brighter, the vivid full-strength properties of blue and green can now be used.

Sylvania's own screening and dusting processes bring about uniformity of true color over the entire screen, as well as a whiter screen face when the set is turned off. The unique screen coating process results in improved phosphor dots. This makes for superior registration which can simplify set-up procedures for TV-set manufacturers.

The revolutionary COLOR BRIGHT 85 picture tube is being made available to manufacturers of original equipment now. They, as well as their distributors and dealers, will share in the heightened consumer interest and increased demand that this new color tube is creating. Dealers can display color television in brightly lighted showrooms.

You can get complete information on new COLOR BRIGHT 85 picture tubes from your Sylvania sales engineer. Or write Electronic Components Group, Electronic Tube Division, Sylvania Electric Products Inc., P.O. Box 87, Buffalo, New York 14209.

*Tests show the Color Bright 85 tube is 43% brighter, on the average, than standard color picture tubes.

SYLVANIA

SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS GT&E

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

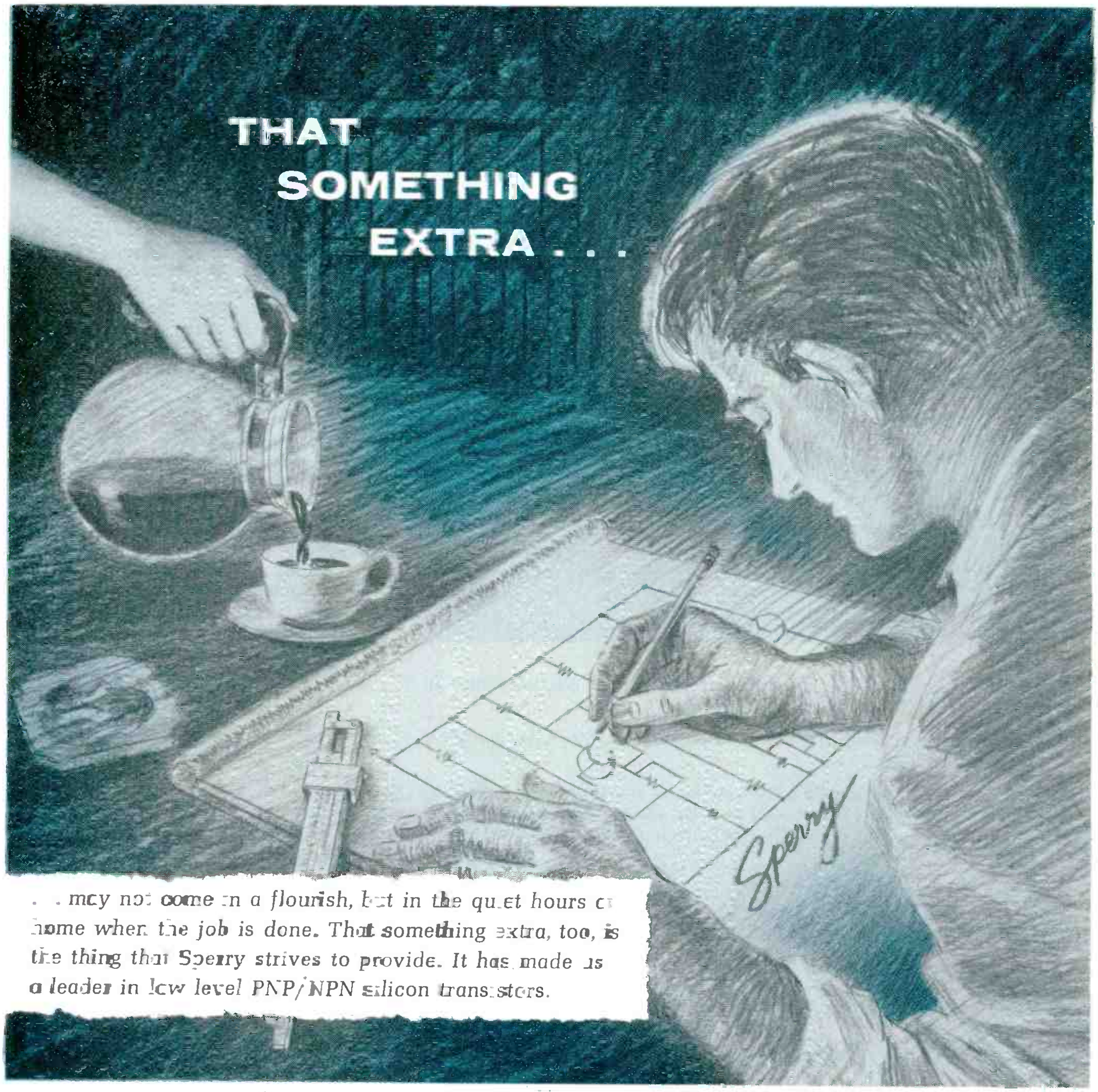
Circle 7 on Inquiry Card

RADARSCOPE

TUNABLE OSCILLATORS that offer high performance characteristics in a very small package have been developed by Microwave Products Department of Sanders Associates, Inc. The miniature solid-state oscillators cover a range of 50MC to 400MC. Designated series 60, the units operate on 16v-40ma input power. Frequency stability is better than 120 parts per million, per degree centigrade, over operating temperature range of −30°C to +60°C., engineers report.

RELIABILITY ANALYSIS method using a computer has been developed by ARINC Research. Called CRAM (Computerized Reliability Analysis Method), the method needs no new computer programming, according to Dr. D. E. Van Tijn, director of the project at ARINC. Reliability diagrams are the basic informational input to the method. They are converted to appropriate inputs to the computer program, which then turns out a reliability equation, in the usual sense. A second program uses the derived equation and additional data on subsystem or part failure probabilities to yield a numerical value for system reliability.

MASER RECEIVER, liquid-helium-cooled, has been suggested as a means to overcome major weakness of low signal power in air-to-ground communications links. Suggested as feasible links are orbiting belt of dipoles, spherical reflectors, or the moon. Based on favorable results from an analog computer simulation, performed by Air Force researchers, an air-ground digital communications system using some form of post detection signal integration is workable for an effective cross-sectional area of at least 500 sq.m.



LOW LEVEL AMPLIFIER PROBLEMS? Use a 2N2524 and its PNP complement, 2N2605. Beta of 100 @ 10 microamps — both in TO-46 package.

Circle 120 on Inquiry Card

NEED HIGH VOLTAGE? You'll get 100v collector to emitter with the 2N2600A and its NPN complement, 2N2519.

Circle 121 on Inquiry Card

DESIGNING A MICROWATT SWITCH? With the 2N3340 and 2N3341, you'll get 10 microwatts per flip-flop.

Circle 122 on Inquiry Card

PNP LOW COST, LOW LEVEL INDUSTRIAL NEEDS? Use our 2N3579-80-81 and 82 — with voltages up to 60 and beta up to a minimum of 100 @ 100 microamps.

Circle 123 on Inquiry Card

Here's something extra, for instance, popular NPN's, such as the 2N930A (typically in TO-18 cans) come to you at no extra cost in TO-46 package (2N2524). The transistors mentioned above represent a few ways to solve problems in designing circuits for military and industrial products. As a leader in low level silicon transistors, Sperry Semiconductor has developed the most complete line of PNP/NPN Complementary Silicon Planar Transistors — more ways to do the best job. ☐ For complete information on the Sperry complementary line, circle the reader-service number below. ☐ **SPERRY SEMICONDUCTOR, Norwalk, Connecticut 06852.**

SPERRY
SEMICONDUCTOR
DIVISION OF SPERRY RAND CORPORATION

Circle 124 on Inquiry Card

COMING EVENTS

NOVEMBER

Nov. 4-6: NEREM (Northeast Elec. Res. & Engineering Mtg., Reg. 1 IEEE; Commonwealth Armory & Somerset Hotel, Boston, Mass.

Nov. 9-10: Optical & Electro-optical Inf. Proc. Technology Symp., PTG-EC IEEE, ACM, OSA, ONR; Statler Hilton, Boston, Mass.

Nov. 16-18: 17th Annual Conf. on Eng'g in Medicine & Biology, IEEE-ISA, PTG-BME; Cleveland-Sheraton Hotel, Cleveland, Ohio.

Nov. 16-18: Space Simulation Testing Conf., AIAA, PTG-AS IEEE; Pasadena, Calif.

Nov. 16-19: 10th Conf. on Magnetism & Magnetic Materials, IEEE, AIP; Radisson Hotel, Minneapolis, Minn.

DECEMBER

Dec. 3-4: 15th Annual Vehicular Comm. Symp., PTG - VC IEEE; Cleveland-Sheraton, Cleveland, Ohio.

January 1965

Jan. 6-8: 13th Annual Ind. Elect. & Control Instrumentation Conf., IEEE, ASME, ISA; Phila., Pa.

Jan. 12-14: 11th Annual Symp. on Reliability and Quality Control, IEEE, ASQC; Fontainebleu Hotel, Miami Beach, Fla.

Jan. 31-Feb. 5: IEEE Winter Power Meeting, IEEE; Statler-Hilton Hotel, New York, N. Y.

'65 Highlights

IEEE Int'l Conv., Mar. 22-25; Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.

February

Feb. 3-5: 6th Winter Conv. on Military Electronics, IEEE; Ambassador Hotel, Los Angeles, Calif.

Feb. 15-17: 5th Electrical/Electronic Trade Show, ERC, ERA; Denver Auditorium Arena, Denver, Colo.

Feb. 17-19: Int'l Solid State Circuits Conf., IEEE, Univ. of Pa.; Phila., Pa.

March

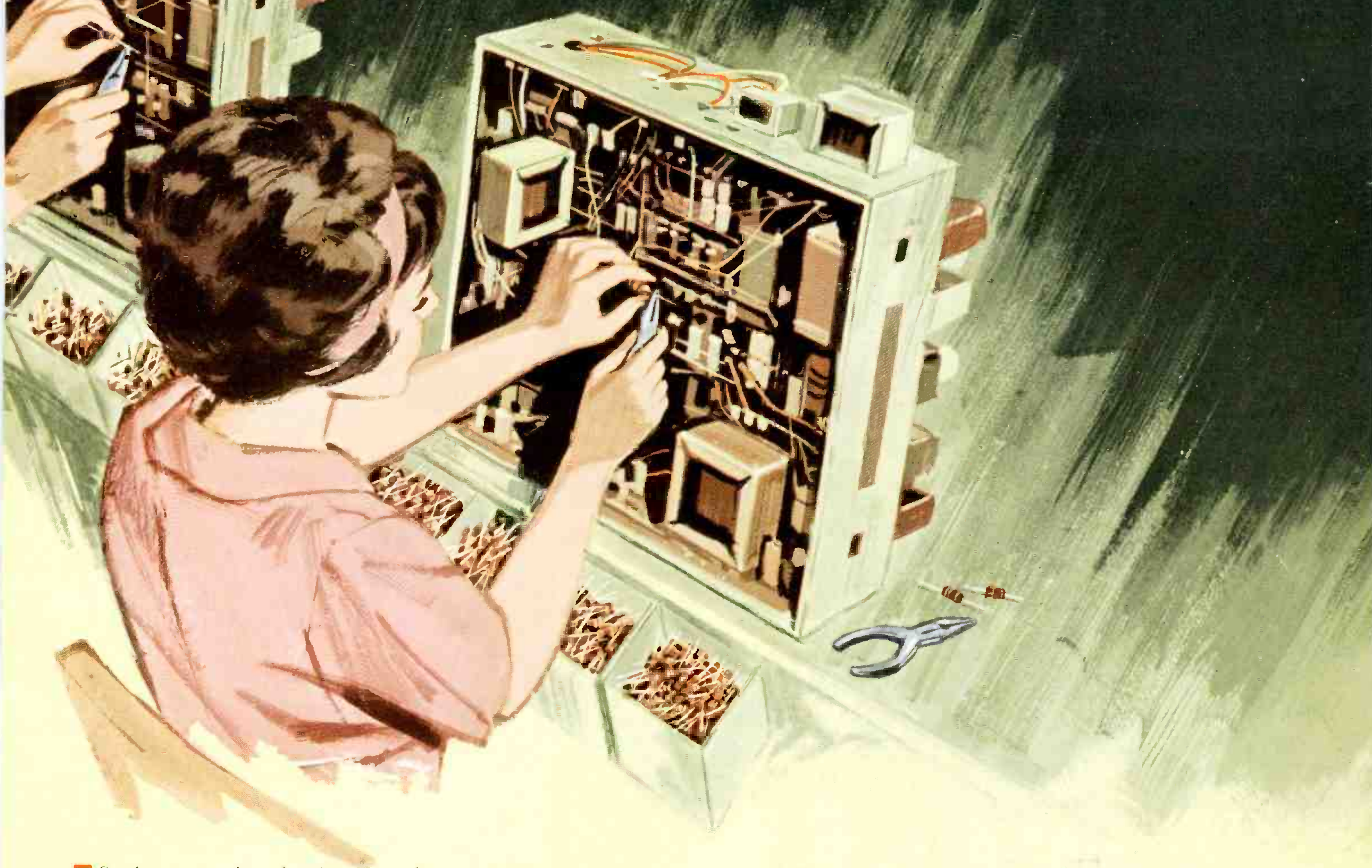
Mar. 22-25: IEEE Int'l Conv., IEEE; Coliseum & N. Y. Hilton Hotel, New York, N. Y.

Mar. 31-Apr. 4: Electronic Parts Distributors Show, EISC; N. Y. Hilton & Americana Hotels, New York, N. Y.

April

Apr. 5-6: Rubber & Plastics Industries Conf., RPI; Sheraton-Mayflower Hotel, Akron, Ohio.

trying to work with two grades of resistors is a headache—and not cheap



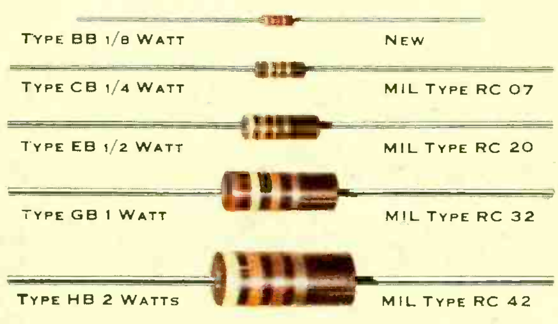
Such two grades of resistors are bound to get mixed up in production—and correcting such a mistake is expensive. It can't be expected of the assembler that he tell one grade from the other by merely looking at the resistor!

The Allen-Bradley hot molded resistors whose all-around quality has not been equaled to date—may cost a bit more, but when, for instance, RCA wired us: "The resistors furnished by you were part of the highly successful Ranger 7 mission to the moon"—doesn't this tell its own story? To satisfy top quality requirements, Allen-Bradley hot molded resistors were made available and are found in use all over the world. Now these resistors—presumably in A-1 condition—are available on the moon.

The secret of the superiority of Allen-Bradley resistors lies in craftsmanship, manufacturing know-how, and the specially designed, fully automatic production machinery. This combination produces such complete uniformity from one resistor to the next that their long term performance is accurately predictable. This has been true during the last 30 years—and will remain true for the next 30 years. Furthermore, the conservative ratings and stable characteristics of all Allen-Bradley hot molded resistors guarantee superior and reliable performance even in the most critical circuits.

For over three decades Allen-Bradley has been supplying hot molded resistors—not by the millions but by the billions—and there has never been one instance of catastrophic failure. You should not expect to obtain such standard of performance and dependability from resistors whose only "advantage" consists of a lower price. Remember, you get what you pay for!

Protect both the "name" and the "quality" of your product by standardizing on Allen-Bradley hot molded resistors. For complete specifications, please write for Technical Bulletin 5050: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



HOT MOLDED FIXED RESISTORS available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.

A-B QUALITY

ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

41-10-4E

RODGERS 36-E
CUSTOM THEATRE ORGAN

"Allen-Bradley ferrite cores have made an important contribution to our electronic organ"

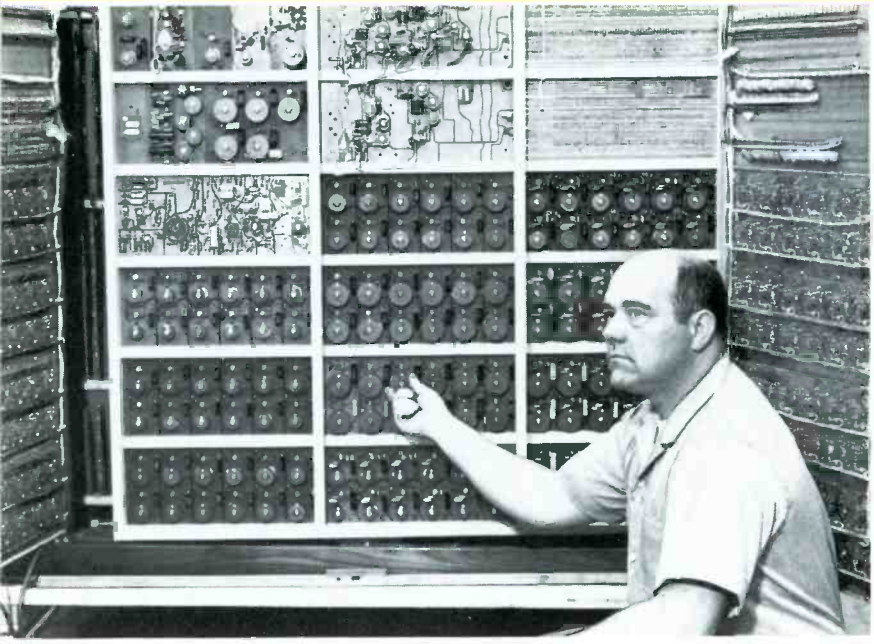
—Rodgers Organ Company

■ Since the permeability of Allen-Bradley Type W-03 ferrite material remains constant over a practical working range of flux values, this enabled the Rodgers Organ Company engineers to design stable inductors for use in a simplified tone generator that "stays on frequency"—one of the basic requirements of an electronic organ. In addition, proper grinding of the center air gap surfaces of the cup core and matching cover assembly permits the inductance and the resulting frequency to be adjusted by simply rotating the cover.

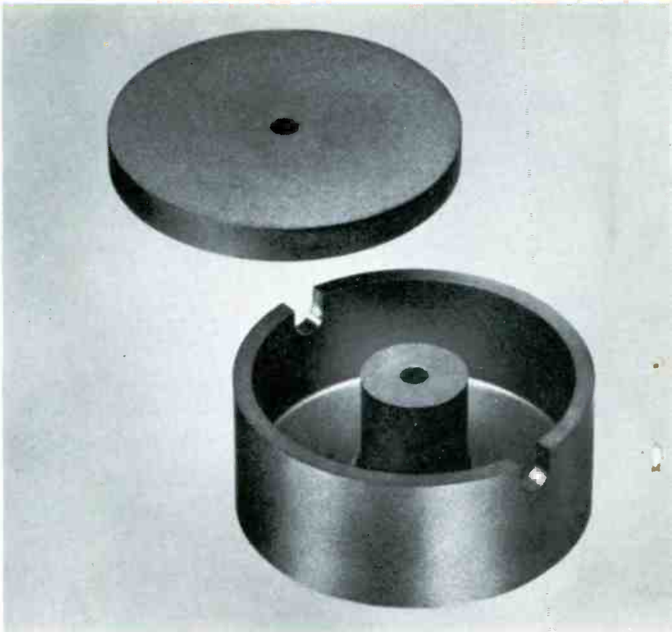
Allen-Bradley ferrite materials offer a wide choice of characteristics to meet the design requirements of such applications as:

1. TV flyback transformers
2. Broad band transformers
3. TV deflection yokes
4. Transistorized inverter power supplies
5. Pulse transformers
6. Ultrasonic frequency transformers

Allen-Bradley engineers will be pleased to work with you in the selection and application of an Allen-Bradley ferrite with the exact properties to fit your design requirements. Please let us hear from you. Write: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



Rear view of Rodgers organ with panel doors open showing extensive use of Allen-Bradley Type W-03 ferrite material in the form of cup cores and covers for tone generators.

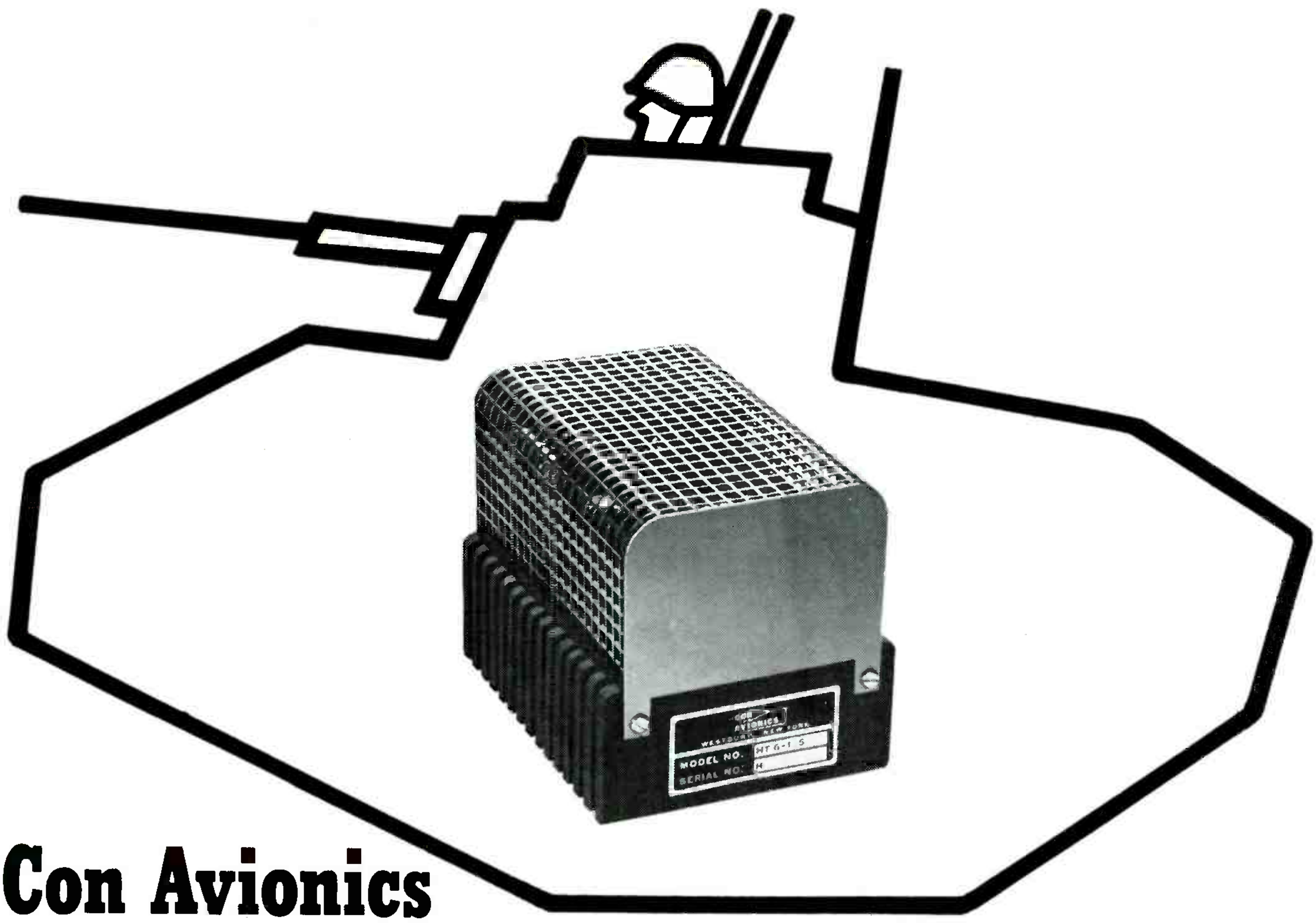


Typical Allen-Bradley ferrite cup core and cover. These are available in sizes from 0.368" to 2.400" in diameter.

42-11-4E

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS



Con Avionics
$65 power supplies meet military specs

Made With Silicon Transistors, They Are Unconditionally Guaranteed For 5 Years

These dc regulated power supplies are available in nearly 200 different voltage-current combinations. Silicon transistors are used throughout and the units operate in ambients as high as 75°C, with a small external heat sink.

The Mean Time Between Failure of the modules is 100,000 hours, calculated according to Mil Handbook 217. They are certified to meet the environmental tests of Mil-E-5272, and most of the requirements of three other mil specs. In addition, they meet the RFI requirements of Mil-I-6181.

Prices start at $65. Every time you specify one of these supplies, instead of a comparable germanium unit, you save considerable money. If you're using commercial supplies, typical savings-per-unit are about $40. For military supplies it's much more.

The fastest way to get complete technical information and prices is to write, call, TWX or wire Gerry Albers at Con Avionics.

SPECIFICATIONS

	STANDARD MODEL	"A" MODEL
Total Regulation (Line and Load)	±0.5%	±0.05%
Ripple (rms max.)	10 mv	1 mv
Temperature Coefficient	0.07%/°C	0.03%/°C

ALL MODELS

Input	105-125 v ac, 47 to 440 cps
Temperature	75°C ambient max. 90°C base plate max.
Response Time	10 microseconds
Military Specifications	Certified to meet the environmental requirements of MIL-E-5272 and the RFI requirements of MIL-I-6181

A Member of The Condec Group

CONSOLIDATED AVIONICS CORPORATION

800 SHAMES DRIVE / WESTBURY, L.I., NEW YORK / 516 ED 4-8400 TWX: 333-1097

For complete details and visit with engineering representative, circle number 40.
For product data and general information, circle number 80.

HONEYWELL CERAMICS ADVANCE

"BIG BENDER" is one of the most compact low-frequency sonar transducers ever built. Designed by Honeywell as a research sound source for the U. S. Navy Underwater Sound Laboratory, New London, Conn., this three-ton unit is made up of 90 bender bars, each of which uses 52 elements of Honeywell K-12 precision ceramics that are machined to within two-thousandths of an inch. The ceramic bender bars are able to withstand high internal stresses resulting from the large excursions necessary to produce a four-kilowatt output at 117 cycles per second. The "Big Bender" has an electroacoustic conversion efficiency of greater than 50 per cent and is capable of operating for one year at depths to 1000 feet. Similar Honeywell bender transducers operating at somewhat higher frequencies have shown efficiencies as high as 60 per cent.

SONAR TRANSDUCER TECHNOLOGY

High-efficiency ceramics extend the range and durability of sonar transducers

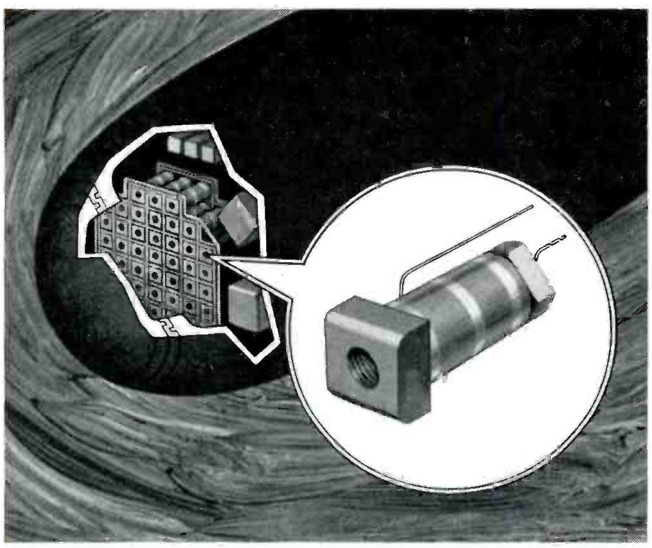
Through significant advances in underwater acoustic technology and high-efficiency ceramics, Honeywell has been able to design sonar transducers that provide lower frequencies, lower operating depths and higher power for some of the nation's most advanced underwater sound programs.

To meet these requirements, Honeywell is producing three types of ceramics that are now available to the industry:

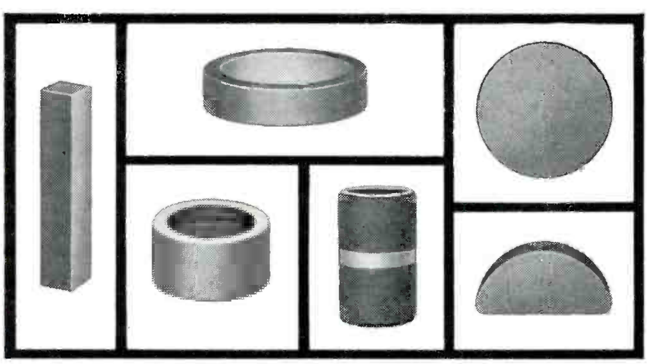
- Lead zirconate/titanate
- Modified lead zirconate/titanate
- Barium-titanate

This range of basic materials, coupled with Honeywell's unique capabilities in custom-building elements of various piezoelectric properties, provides a selection of *quality ceramics* that meets the demands of the most advanced sonar transducer designs.

Although it is common practice to test each ceramic element before it is included in a system, the quality of Honeywell ceramics is so consistently uniform that many customers use the sampling technique of testing. To achieve such quality, Honeywell maintains stringent control procedures throughout its ceramic manufacturing process. All ceramic materials meet IRE standards for electrical properties and are guaranteed to meet minimum standards. When the ceramic materials are processed, automated equipment controls and records the process. The result is uniform ceramics which permit sonar transducers to reliably meet design specifications at high power over long periods.



ADVANCED TRANSDUCERS FOR ASW VEHICLES are being developed and produced by Honeywell. The multi-element array shown is a highly directional transducer designed for use in a sonar projector-receiver system.



CERAMIC TRANSDUCERS of various shapes, sizes and characteristics have been brought to a high degree of development by Honeywell. Having a high rate of exact reproducibility of electrical and mechanical properties, these ceramic elements meet specifications for a variety of acoustic applications.

Honeywell transducers operate in all types of undersea conditions

The ultimate performance of a sonar system depends critically on its transducer, and a transducer is no more effective than its ability to meet system requirements in the prevailing acoustical conditions of a body of water.

At Honeywell, achieving the best combination for a particular application results from close cooperation between the transducer designer and the systems engineer who consider trade-offs such as bandwidth, efficiency, depth capability, and the electrical system parameters governing the performance of transmitters, receivers, and beam-forming and signal-processing networks.

During ten years of participation in the Navy's sonar programs, Honeywell has gained a thorough understanding of underwater acoustics, undersea warfare systems and sonar instrumentation. This has resulted in the design and production of a successful family of sound projectors and hydrophones including:

- Longitudinal vibrators
- Circumferential vibrators
- Flexing-disc transducers
- Flexing-beam projectors ("bender bars")
- Extensional-flexural elements and arrays
- Reference hydrophones

Each of these configurations requires ceramic materials of the highest uniformity and quality to meet the exacting demands of the particular application. As an example of the capabilities of the ceramics in its systems, Honeywell today produces transducers covering a range of frequencies from 45 cycles through several hundred kilocycles per second, acoustic power ratings of several kilowatts and operating-depth capabilities to the bottom of the deepest ocean trenches.

WE INVITE YOUR REQUEST for further information on Honeywell ceramics or sonar transducers. Please specify your interest by writing on your letterhead to Honeywell, M.S. 847, 600 Second Street North, Hopkins, Minnesota 55343.

Honeywell

Circle 14 on Inquiry Card

"EARLY BIRD" ON SCHEDULE—Communications Satellite Corp., has been keeping an eagle eye on the "Early Bird" schedules. So far, the March launch date, using a thrust-augmented Delta, is still good. Stations in U.K., France, Germany, and Italy are gearing up, and the International Consortium participating in the program is satisfied that the program will meet its deadlines.

DATA RETRIEVAL DIRECTORY — The Library of Congress has set up a National Referral Service for Science and Technology. The agency plans an initial publication of some 3000 Information Retrieval Centers this summer. Listings are expected to reach 50,000 ultimately.

BILL TO LIFT LIMIT TO 'LORAN'—Senate Committee on Commerce may amend the law that limits the Coast Guard to "loran" stations only. Revision would allow the service to develop and use other electronic navigational aids. Electronic aids to air commerce, however, would be allowed only upon a Coast Guard request to FAA. Navigational aids to serve the armed forces would be allowed on request from the Defense Secretary.

NASA EASES PATENT RULES—Following up a year-old White House order, NASA is easing patent rules to give contractors a better crack at invention rights. As of September 28, NASA is giving field officers carte blanche to waive commercial rights on a contract during its life, especially where development would help commerce. If invention is not commercialized within a set time, the waiver may be withdrawn.

NAVY'S VALUE ENGINEERING—A new Navy instruction pinpoints value engineering and fixes responsibility for effectiveness. In a policy statement, the Navy says its program must be "both Navy and contractor oriented." VE embraces all weapons, end items, equipment, installations, components and manufacturing. The new instruction advises contractors to assign qualified VE persons to oversee programs.

OCEANOGRAPHY BUDGET GROWTH — National Oceanography Plan sees an annual growth of about 10% over the next ten years. This would put Federal investment at more than $400 million by 1974. Interests of industry and some states is mounting as seen, for example, by recent seminars in Maryland and California. Major problem areas: Modern instruments, underwater engineering for fishing, mining, and recreation, weather prediction, transportation.

BUDGET SUBMISSIONS DUE—Annual DOD budget requests from military services enter crucial stages this month and next. Overall trend is expected to be down slightly. Biggest change may be in allocation of money. More specialization in almost all fields appears to be certain. Budget experts agree that, barring unforeseen emergency, defense money will show another slight decline.

DEFENSE COMMUNICATIONS SYSTEM — Secrecy-shrouded defense communications system is taking shape but little is known about its stage development. There appears to be negotiation with other countries on communication stations at various points around the globe. Indian Ocean station is getting priority in view of heavy U. S. commitments in Southeast Asia.

MARINES AID SMALL FIRMS—The Marine Corps recently agreed to buy, among other things, portable diesel-electric generators from small businesses "indefinitely hereafter." Other marine business "set aside" for small firms includes radio equipment. In one case, a price of $45,000 bid by a big house on a radio test set was severely underbid at $17,850 by a small firm.

FCC CONTROL ON CATV—Reversing a usual pattern, a segment of the television equipment industry is asking for FCC control over community antenna TV industry. Under law, FCC can regulate broadcast signals but not all-wire transmissions. FCC is delighted by the request. TV equipment manufacturers tell FCC that CATV is simply "a backdoor to pay TV—and the door is swinging wider day by day."

ENGINEER 'SHORTAGE' EXAGGERATED—A congressional committee says the "so-called shortage" of engineers and scientists is exaggerated. While it is true that the demand for engineers and scientists may outrun the supply within 10 years, the supply is adequate for now, according to the House committee on government research.

DOD STANDARDIZATION HIT — Progress in standardizing military electronic parts and hardware has been negligible, and has been kept hidden because of "gross overstatements" by services in reports to Congress, General Accounting Office Charges. In one case the Army Signal Corps lost $17 million in savings by failing to coordinate and eliminate unneeded electronic items.

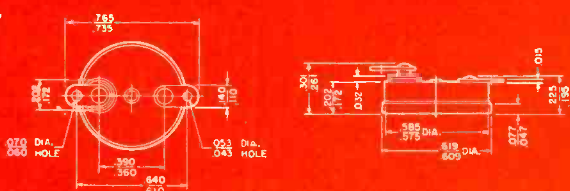
Mach 5...Mach 10...and Beyond

STEVENS *Certified* THERMOSTATS

Up where the "wild blue yonder" becomes inky black, you can't afford to gamble on precise, reliable temperature control. And that's the natural domain of Stevens Thermostats. They are compact and lightweight . . . withstand high G's . . . are utterly reliable even under wide temperature swings. For Stevens Thermostats are a product of creative engineering . . . coupled with the most stringent environmental testing and quality control programs in the industry. If space is your dimension, take the measure of Stevens Thermostats *first.*

2° to 6°F Differential Standard
1° to 4°F Differential Special

**Maximum spread of 6°F including differential and tolerance.*



* 6°F is difference between maximum open and minimum close.

STEVENS *manufacturing company, inc.*
P. O. Box 1007 • Mansfield, Ohio

STEMCO® THERMOSTATS

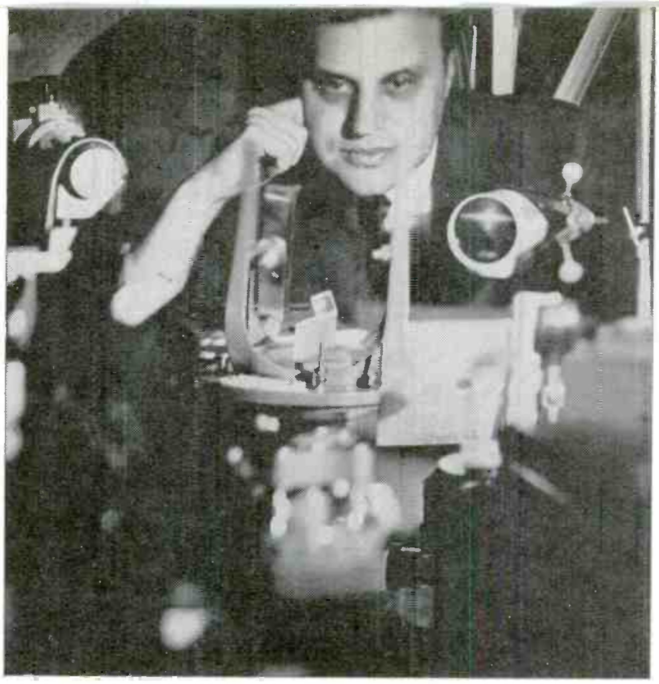
Circle 15 on Inquiry Card

ELECTRONIC SNAPSHOTS...

The Changing STATE-OF-THE-ART in the electronic industries

CRYSTAL "TREE"

Electro-optic crystals of potassium dihydrogen phosphate are examined at Clevite Corp.'s Electronic Research Division prior to being removed from the "tree" on which they were grown. The crystals will be sliced into plates and sold to laboratories throughout the country for use in various types of research, including work in laser modulation.

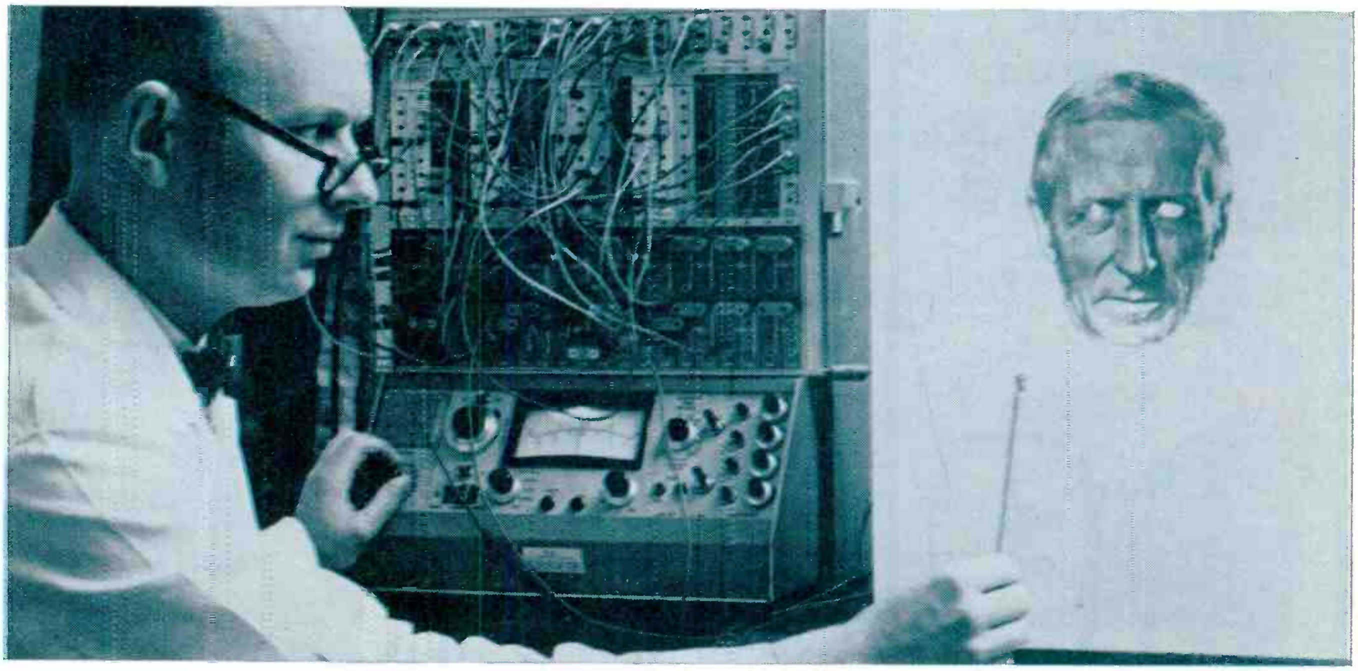


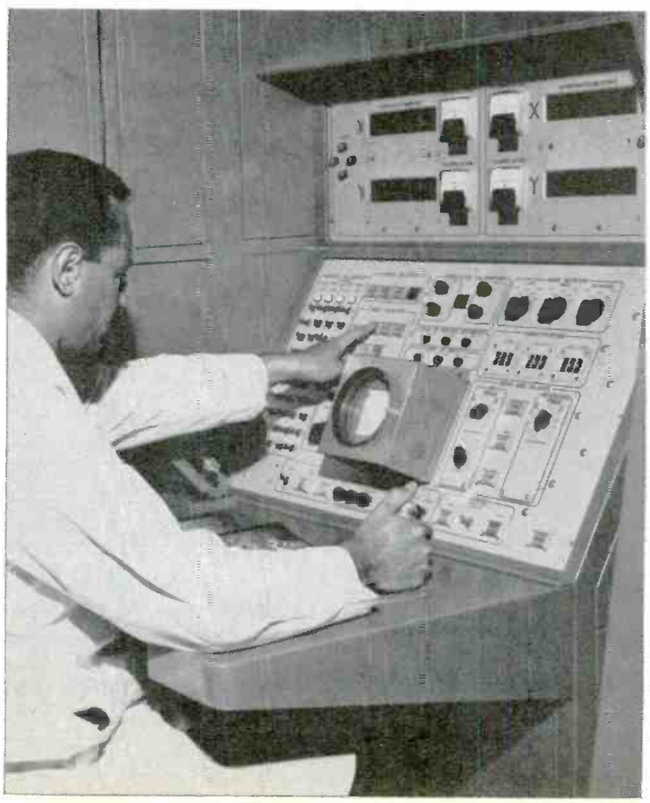
"GREEN BEAM"

Dr. Fred Johnson examines a laser system for frequency doubling at very high repetition rates. Developed by Dr. Johnson at Electro-Optical Systems, Inc., Pasadena, Calif., the unit shown here will convert a wavelength of 1.06 microns in the infrared to 0.53 microns in the visible at a repetition rate of more than 10 CPS. The new device could possibly be used in underwater signaling and other oceanographic applications where coherent radiation in the green region of the spectrum is most suitable. The system could also be used with slight modification to mix optical frequencies in coded military applications.

COMPUTER AID

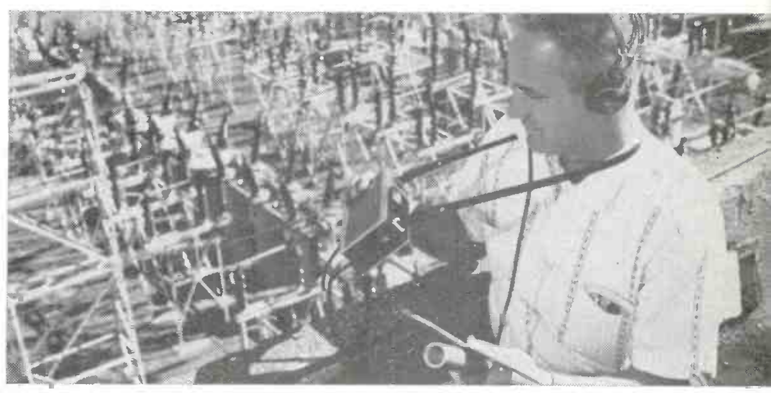
Carter C. Collins of the Presbyterian Medical Center Eye Research Institute, San Francisco, Calif., uses a TR-20 analog computer to simulate tracking and converging eye movements and some possible mechanisms of their malfunction. Researchers at PMC are using the computer (made by Electronic Associates, Inc., West Long Branch, N. J.) to simulate a series of eye disorders such as strabismus, impairment of acuity and glaucoma. The computer is a desk-top model.





MAP MAKER

Engineer operates new Automatic Point Marking, Measuring and Recording Instrument (APMMRI) made by the Link Group of General Precision, Inc., Binghamton, N. Y. The photogrammetric instrument is used in the process of making very accurate maps.



ULTRASONIC TRANSLATOR

Inspector Graydon Bailey checks for radio and TV interference at a Tacoma (Wash.) City Light Co. distribution sub-station. He is using a Delcon Corp. (Palo Alto, Calif.) Model 117 Ultrasonic Translator detector to pinpoint the source of trouble.

PROBLEM SOLVING PRECISION SWITCHES AND CONTROLS

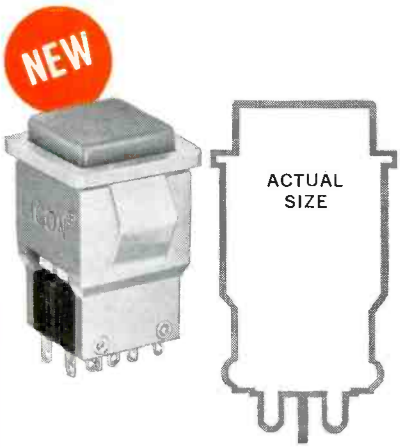
LICON

SNAPS IN PLACE!

TYPE 01 ONE-LITE

The new "Square Bezel" Type 01 LPB has an integral plastic housing that "snaps-in" from panel front without hardware or bushing. Offered in one and two pole, momentary and alternate (push-push) action. Switches rated at 10 Amps.

- Integral lite and switch.
- Selection of lens cap colors.
- ⅝" or ¾" lens cap, square or round.

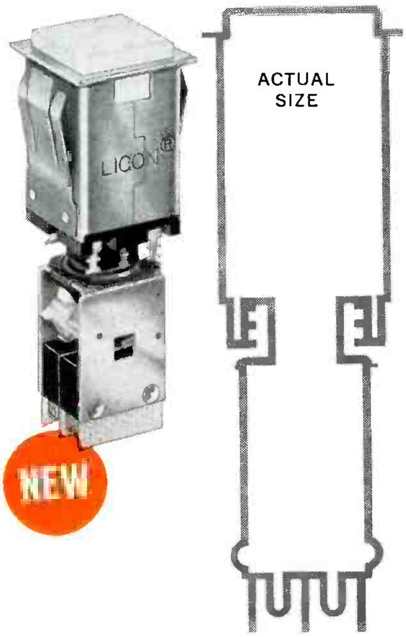


SNAP OR CLAMP!

TYPE 04 FOUR-LITE

Completely re-designed Type 04 LPB has a four-sided square bezel for dressy panel appearance. Available in no-hardware "snap-in" or two-screw "clamp-on" mountings, both applied front-of-panel. A snap-on switch module is also offered. Switches rated at 10 Amps.

- Four bulb illumination.
- Selection of panel and screen colors.
- Easy lamp servicing.



REALLY SMALL!

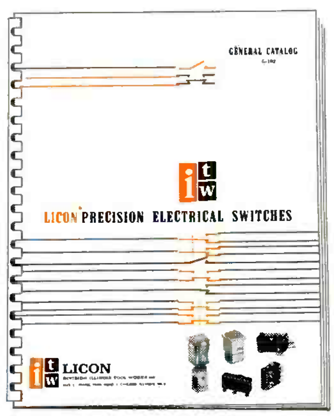
TYPE 18 DOUBLE-BREAK SUB-SUBMINIATURE

All the reliability and performance of the famous Licon® Type 16 has been packed into this new sub-subminiature switch. It offers a big switch rating and a 20 million cycle life in a package. Size: .500" x .350" x .200"!

ELECTRICAL RATING

125/250 VAC: 10 Amps
30 VDC: Form X or Y 10 Amps Res.
5 Amps Ind.
Form Z 10 Amps Res.
3 Amps Ind.

Send for new Licon full-line catalog and distributor list. Contains complete Licon switch specifications, details, dimensions.



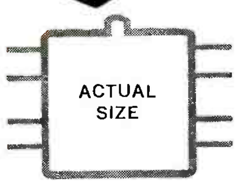
INTRODUCES
SIX NEW SWITCHES

DOUBLE-POLE MIDGET!

TYPE 26 DOUBLE-POLE, DOUBLE-BREAK SUBMINIATURE

A new-to-the-industry switch that packs double-pole performance in an absolute minimum of space; has the durability and versatility of quality switches twice its size. Simultaneous break eliminates complicated multipole actuator mechanisms. Size: 25/32" x .761" x .250"!

ELECTRICAL RATING
125/250 VAC: 10 Amps
30 VDC: Form XX or YY 15 Amps Res.
Form ZZ 10 Amps Ind.

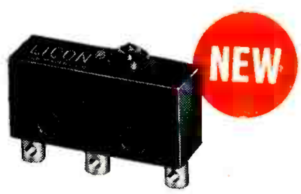


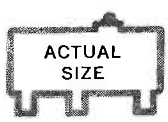
VERSATILITY PLUS!

TYPE 19 SINGLE-BREAK CRICKET T.M. SUBMINIATURE

The new Type 19 **Cricket** T.M. subminiature switch provides a long-life 5 million cycle snap-action switch enclosed in an accurately molded plastic case. Wide choice of terminals and actuators. Size: .780" x .360" x .250".

ELECTRICAL RATING
125/250 VAC: 5 Amps
28 VDC: 4 Amps Res.
2.5 Amps Ind.



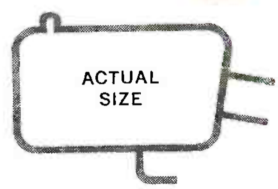


MORE RELIABLE!

TYPE 23 SINGLE-BREAK HI-CAPACITY

A competitive switch that brings Licon's well-known 20 million cycle reliability to the field for the first time. Available in a wide selection of terminals, actuators and circuitries. Size: 1.344" x .625" x .410".

ELECTRICAL RATING
125/250 VAC: 10 Amps
30 VDC: 10 Amps Res.
6 Amps Ind.
6 Amps Motor



Six different switches—all new—are now added to the Licon line of precision switches and controls. They include two completely re-designed lighted push button switches; two new-to-the-industry double-break switches with exclusive Licon® **butterfly** T.M. action, and two new competitive single-break switches. Get the cataloged facts on the complete Licon line—and see for yourself. Request sample/demonstration on your letterhead.

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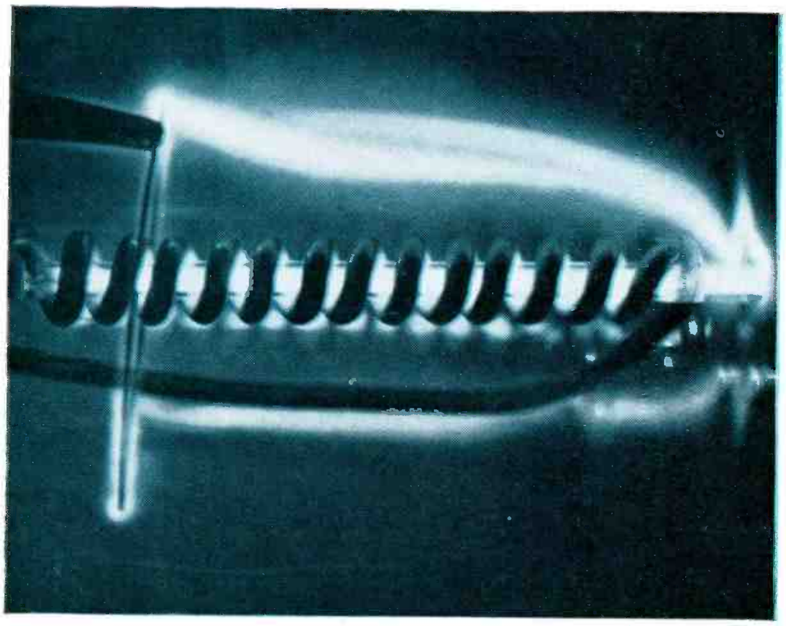
SILICONE NEWS from Dow Corning

Silastic rubber . . . no stranger to an alien environment



CIRCLE READER SERVICE CARD NO. 25

Silastic® brand silicone rubber is often the right material—if not the only elastomer—to use for rubber parts in electronic gear that must operate in harsh environments. Parts made with this rubber retain their physical and dielectric properties over the wide temperature span of −90 to 250 C and are virtually unaffected by ozone, corona or corrosive atmospheres . . . initial properties are unchanged despite rapid thermal cycling or long term storage.

Use it for O-rings, connector inserts, antenna seals, lead wire insulation . . . for anti-corona moldings on flyback transformers, gaskets. Use sponge made from Silastic rubber for vibration dampers and to isolate delicate instruments.

Write for your free selection guide to Silastic silicone rubber and a list of manufacturers who can fabricate parts to your specifications.

Silicone laminates . . . high performance, low dissipation

Laminates of Dow Corning® silicone resins assure circuit performance as designed in electronic applications because of their continued low dissipation factor and dielectric constant under widely varying conditions of frequency and temperature. In printed circuit boards, in terminal boards and strips, antenna connectors . . . wherever these laminates are used in electronic packaging, they assure greater performance and reliability.

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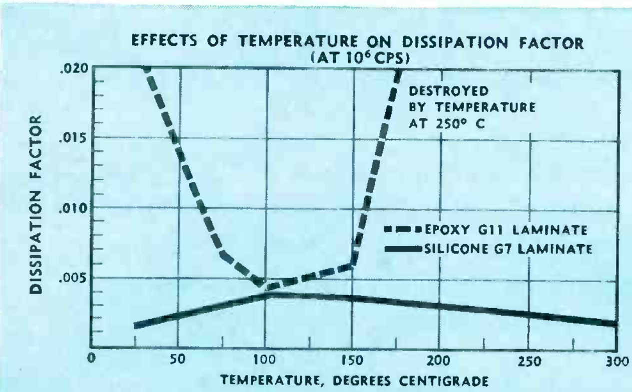
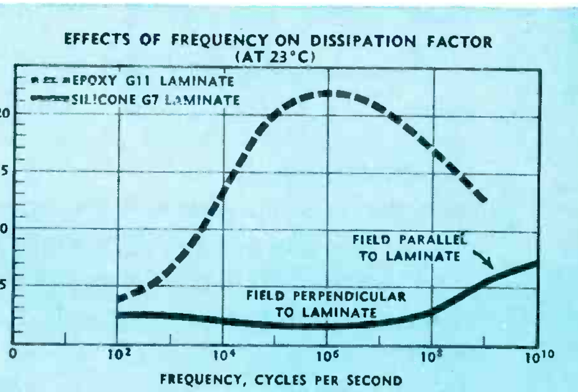
Write for additional information on silicone laminating resins and a list of silicone laminate manufacturers who can fabricate parts to meet your specifications. Address Dept. F311, Fabricating Materials Department, Dow Corning Corporation, Midland, Michigan, 48641.





CIRCLE READER SERVICE CARD NO. 26

Dow Corning

ELECTRONIC INDUSTRIES MARKETING

EXCISE CUT COULD BOOST TV SALES TO 10,000,000

Annual sales of TV sets could reach 10 million units if the proposed reduction of excise tax from 10% to 5%, at a limit of $8, is adopted, declared Mort Farr, director of the National Appliance and Radio-TV Dealers Association. Before the House Ways and Means Committee, he also said that sales could drop below the current eight million level if the reduction is not enacted.

Mr. Farr testified in support of TV manufacturers and the Electronic Industries Association. He said that TV saturation is at 93% of viewing in homes today. The market is now mainly for second and third and replacement sets. "Everyone knows that such purchases are easily postponed," he observed.

Consumers are now paying from $10 to $30 for all-channel sets. Mr. Farr stated that "we dealers are on the firing line and will have to bear the brunt of customers' complaints in buying something that most them cannot use or may not want."

CLOSED-CIRCUIT TV MAY HIT $70 MILLION BY 1968

Sales in closed-circuit television may reach $70 million by 1968, predicts Robert E. Brockway, vice president/marketing, Commercial Electronics for Sylvania's Home and Commercial Electronics Division.

Mr. Brockway made the observation during dedication for a mobile TV studio developed for the school system of Darien, Conn. The town's 10 schools are now linked by telephone lines and TV cameras. At a cost of about $23,500, the system may be the nation's first mobile studio for educational-TV.

COLOR TV SALES EXPECTED TO SHOW RECORD IN 1964

Makers of color television receivers may be enjoying technicolor dreams of prosperity. An optimistic estimate is that 1,200,000 or more color sets will be shipped out of a total of nearly 9,000,000 TV sets in 1964.

Joseph S. Wright, president of Zenith Radio Corp., observed that this year's output far exceeds the uncertain 1963 estimates of color TV sets which ranged from 500,000 to 750,000.

Mr. Wright said that no one really has any good figures on past years' color sales except RCA, and "they haven't really said, which probably means they were actually smaller than commonly reported."

As the Christmas season approaches, most firms anticipate record sales.

TO MARKET, TO MARKET

Using its own airborne trade fair, Hi-G, Inc., makers of relays and other electronic products, is touring 11 European cities in a grand-style international sales effort.

COMPUTER MARKET GROWING FAST IN WEST EUROPE

The computer field is more than 20 years old, but most computers have been sold in the last four years. Three-fourths of 19,000 EDP units now used in the U. S. and in West Europe were made since 1960, Chase Manhattan Bank estimates.

Fastest rate of growth has been in West Europe, racing to catch up with the U. S. West Europe sales skyrocketed from 25 units in 1955 to more than 3,200 units at 1963 end. European sales are expected to reach 15,000 units by 1970, Chase estimates.

Most major U. S. makers already have, or plan to have, plants in West Europe. Since 1960 U. S. firms have set up about 20 plants in West Europe, according to another estimate. Other firms have made extensive sales and license agreements with European counterparts. The six major European computer manufacturers are relatively small firms.

The European computer market is about one-fourth the size of the U. S. market. U. S. firms had about $1.24 billion in computer sales in 1963, says Electronic Industries Association. We can assume, then, that the European market is about $300 million and growing.

By comparison, an estimate indicates that of about 700 computers used in Japan today, about 60% are Japanese-made. It is somewhat generally known that the Japanese tend to be fond of and prefer their own products, until their domestic market fills up. Then they look abroad.

U. K. HAS MARKET PROSPECTS FOR U. S. GEAR, MISSION FINDS

Challenging business opportunities in the United Kingdom await U. S. vendors of advanced electronic and automatic equipment, concludes a six-man U. S. Electronic and Automation Trade Mission.

Products offering the best markets include instruments, computers, process and numerical control systems, and advanced microelectronic circuits.

Mission members warn that the United Kingdom is not a good market for "shelf" items. Standard products face severe handicaps because of duties up to 33 1/3%.

U. S. firms who sell in the United Kingdom were advised that sophisticated marketing and management help in negotiating licensing or joint-ventures.

The Mission reports that the United Kingdom produces only about 8% of the world electronic output, but is nevertheless second to the U. S. which leads the world with about 60% of production. Figures show that U. K. output in 1962 was $842.8 million.

U. S. FIRMS INVITED TO SHOW CONTROL HARDWARE IN U.K.

Of the many booming areas of the United Kingdom's electronic market, none exceeds the rate of demand for electronic control equipment—expected to triple by 1968.

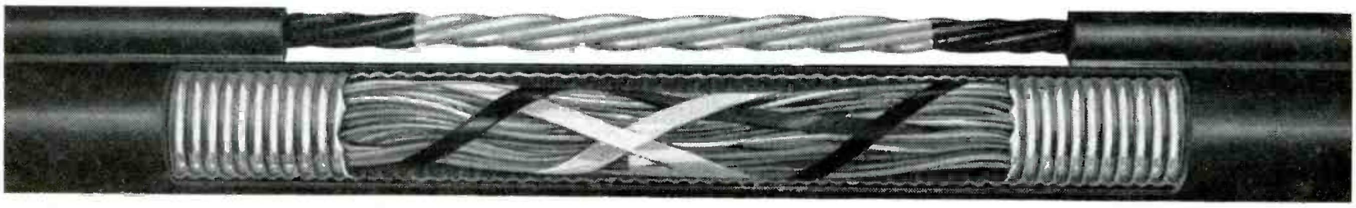
American firms are invited to show their products to this $10 million market through a show of "Electronic Controls for Industry," at the U. S. Trade Center in London, December 8 to 18, 1964, the U. S. Department of Commerce announced.

U.K. imports of electronic control devices for mechanical industrial processes climbed 475% between 1958 and 1962. The U. S. currently supplies 63% of imports, 12% over 1960.

Report from

BELL LABORATORIES

"UNDULATED" CORE MAKES SELF-SUPPORTING CABLE PRACTICAL



ABOVE: Drawing of new self-supporting cable structure shows "undulated" core of telephone wires encased in aluminum and polyethylene sheath members. Edges of corrugated aluminum sheath are butted along top of cable. Polyethylene sheath extends over steel strand on top to provide built-in cable support. BELOW: Photographs show, left to right, older-type ring-supported cable, present lashed cable, and new self-supporting cable.

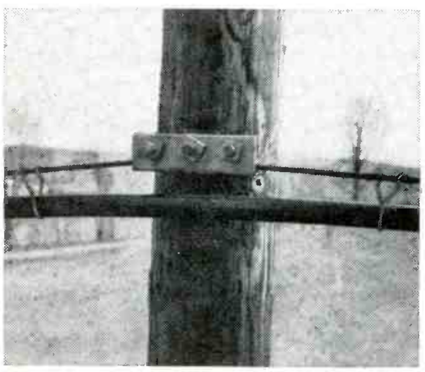
Telephone cables strung along pole lines need mechanical support. Heretofore, this support has been provided by a separate, strong steel strand from which the cable is suspended—either by wire rings or by a lashing wire wound helically around the strand and cable.

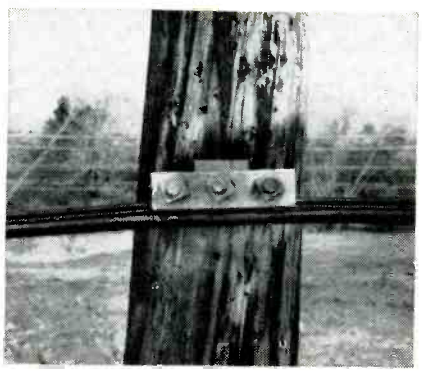
For ease of installation it is desirable to design the cable and strand into a single self-supporting structure. But in such designs the cable sheath and its core of telephone wires, as well as the strand, may be placed under tension when suspended between poles. With the wires under tension, craftsmen have no readily available slack wire, which is needed in making connections for bringing service to a customer's house.

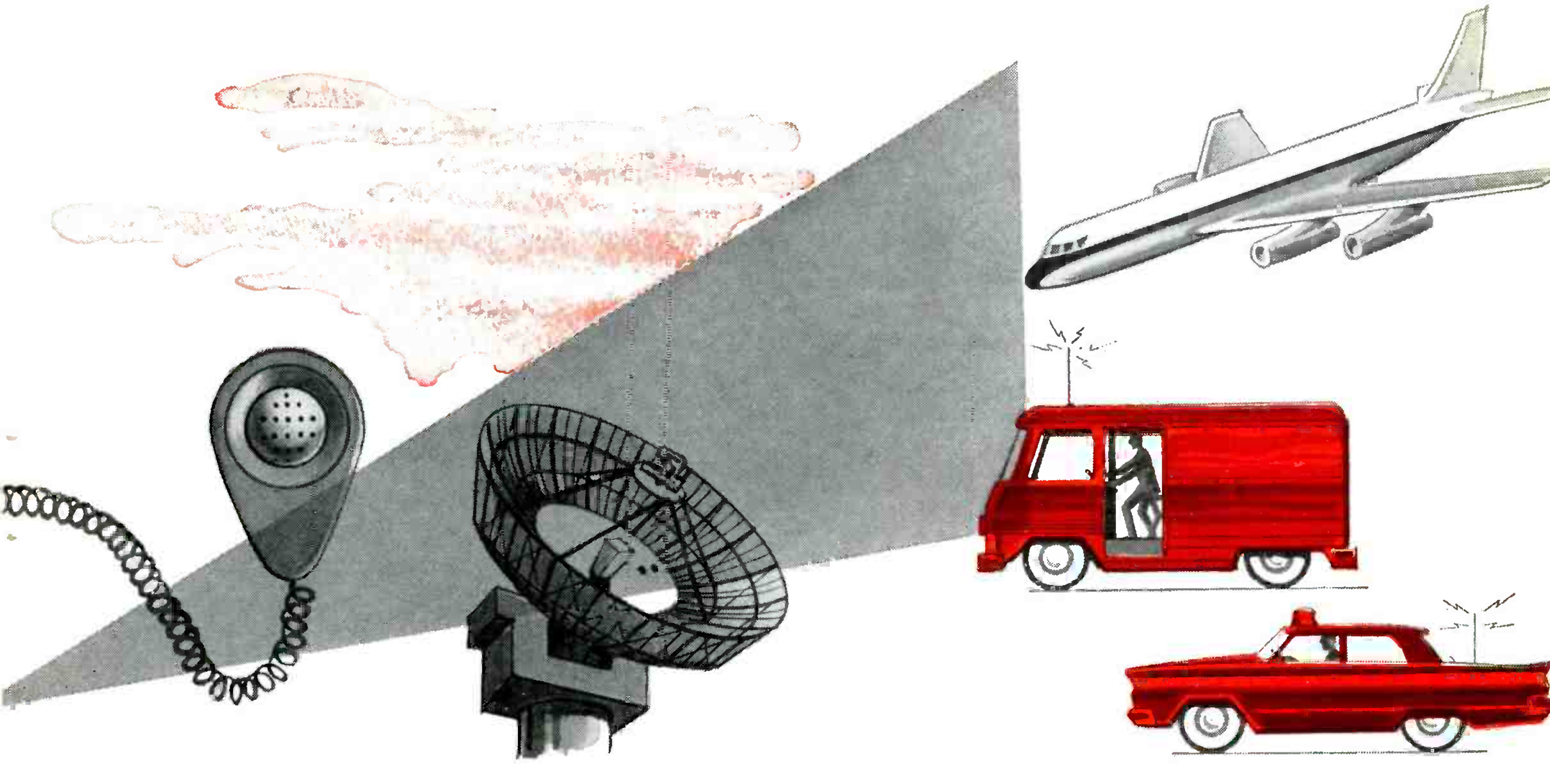
To solve this problem Bell Laboratories engineers, working in close cooperation with engineers of the Western Electric Company, manufacturing unit of the Bell System, "built the slack into the cable." The slack is provided by an undulation incorporated into the core of telephone wires. To help prevent the polyethylene cable sheath from tightening around the wires during manufacture, the longitudinal edges of a corrugated aluminum sheath member are butted up against each other, rather than overlapped as in other cables.

The new cable permits both efficient and economical construction methods. It is rapidly raised, tensioned, and clamped to poles. Craftsmen easily pull slack wire from the cable and, using plastic "ready access" terminals, make the required connections.

Bell Telephone Laboratories
Research and Development Unit of the Bell System







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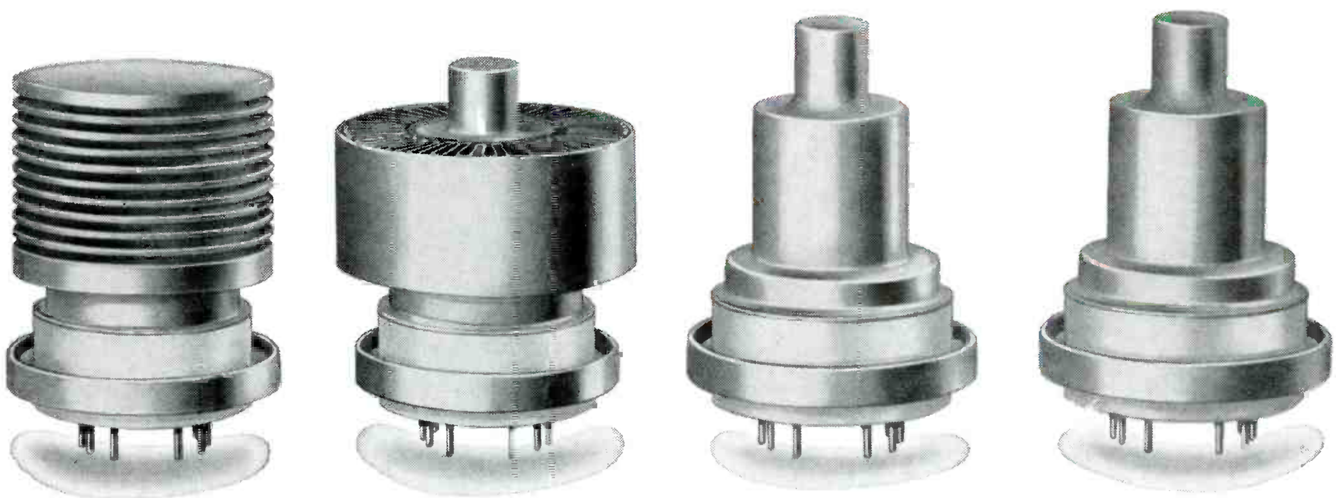

Make your choice RCA Ceramic-Metal Tubes for more RF Power in UHF Communications

Here are four members of the newest RCA family of ceramic-metal tubes... tetrodes already designed into compact, high-power equipment for airborne, fixed station, and mobile communications applications.

The four—each packing more RF power than previously available in tubes of comparable size—are designed expressly for UHF power use. Designers have specified them for use in aircraft communications systems, SSB linear amplifiers, localizer gear in GCA equipment, high-power deflection amplifiers for radar, mobile ground communications equipment and amateur radio transmitters.

RCA-8072 is conduction cooled and can be an ideal choice where space is at a premium. RCA-8462 features "quick heat" warm-up capability of less than 100 milliseconds in push-to-talk equipment. RCA-8121 and -8122 are air-cooled versions of the 8072 and offer higher power in devices of comparable size.

Special characteristics can be custom-designed to fill individual needs. For more information, see your RCA Representative. For technical data on specific types, write: Commercial Engineering, Section K-50-Q, RCA Electronic Components and Devices, Harrison, N. J.

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Typical CW Operation

Type	Cooling	Maximum Plate Dissipation (Watts)	Plate (Volts)	Frequency (Mc)	Useful Power Output (Watts)
8072	Conduction	100*	700	50 175 470	110 105 85
8121	Forced-Air	150	1500	50 470	275 235
8122	Forced-Air	400	2000	50 470	375 300
8462 (Quick-heat)	Conduction	100*	700	50 175 470	110 105 85

*May be higher, depending on heat-sink design.

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LETTERS

to the Editor

Antenna Power Gain

Editor, ELECTRONIC INDUSTRIES:

Unless there is some technical detail missing in the article "Antenna System for H-F Band," page 89, August 1964, I believe that the curves in Fig. 3 should crest at less than 3 db at about 7MC for the 64 ft antenna and about 10 MC for the 48 ft antenna.

M. L. Shapiro.
Project Engineer
Sylvania Electronic Systems
63 Second Ave.
Waltham, Mass. 02154

Editor, ELECTRONIC INDUSTRIES:

With reference to my article "An Antenna System for the Entire H-F Band," in the August 1964 issue and Mr. Shapiro's letter to you, I am happy to provide additional information in regard to the power gain data provided by Fig. 3 of the article. In addition to Mr. Shapiro's inquiry, I received several questions from other engineers, all of whom were surprised that a simple dipole antenna can provide the indicated gain.

The power gain data provided in Fig. 3 of my article was the result of computations made of the radiation patterns and radiator currents as influenced by the mutual impedance between the image radiator and the actual radiator.[1] A recheck of these computations reveals an error which resulted in the power gain shown by Fig. 3 being about 2.5 db too high in the region of 6 MC. Mutual impedance data were not available for all radiator lengths and some approximation and interpolation were required to obtain the gain by this method.

In view of the questions raised by Mr. Shapiro and others, a new determination of power gain has been made and the results are shown in Fig. 3a. The new figures are based on hemispherical integration of radiation patterns computed with a digital computer.

The radiation patterns and the power gain figures are based on a simple horizontal dipole antenna of the indicated length mounted at a height of 22.5 ft above a perfect ground plane. Simple sinusoidal current distribution was assumed with a 5% increase in effective dipole length assumed to account for finite velocity and end effects. As stated on both the original and revised Fig. 3, the power gain is expressed with reference to an isotropic radiator and dissipative losses were neglected.

Examination of Fig. 3a shows gains ranging from 7.5 to 8.5 db over the lower portion of the frequency range. The maximum power gain occurs at about 18 MC for the 64 ft antenna and 24 MC for the 48 ft antenna. At these frequencies, the effective half length of the dipole is 0.62 wavelengths which is the length that provides maximum radiation in the direction normal to the dipole orientation. The power gain in the forward direction diminishes rapidly at the higher frequencies for each length because of the loss of power occurring in the large side lobes which are evident in the highest frequency radiation patterns of Fig. 2a of my article.

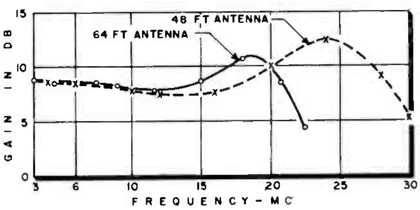

Fig. 3a: Revised h-f Antenna power gain.

Perhaps most of the questions concerning power gain arise from the confusion sometimes caused by the several different methods of rating the power gain of antennas.[2] I choose the IEEE standard of reference of power gain, which is the isotropic radiator. It is my understanding that the isotropic reference is used by most manufacturers of h-f antennas when quoting power gain figures. The power gain referred to a half-wave dipole in free space would be 2.15 db less than the figures shown. The power gain referred to a half-wave dipole at the same height above ground would be 8.15 db less, although this is not precisely true because the influence on gain of the mutual impedance from the image radiator varies with dipole length.

Stephen W. Kershner
President
Delta Electronics, Inc.
4206 Wheeler Ave.
Alexandria, Va.

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[1] See chapter 21, pps. 21-3 to 21-4, Jasik's *Antenna Engineering Handbook* for details of this method.

[2] An article on this subject by M. F. Radford appears on p. 48 of the June, 1964, issue of the Marconi publication *Point-to-Point Telecommunications.*

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- Maximum contact reliability. Hermetically sealed contacts eliminate failures due to air-borne contamination and fumes.
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only

offer, in addition,

1. Rectangular capsule arrangement (2 x n) increases efficiency by placing each switch capsule in the optimum position within the coil. This results in uniform timing for high-speed circuits.
2. "Snap-Clip" mounting springs provide fast, low-cost installation on standard panel cutouts without the use of screws.
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5. High heat dissipation capability increases coil life for continuous duty.
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8. No iron frame to promote coil corrosion under conditions of humidity.
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11 Terminals will accommodate two individual wire-wrapped connections, reducing the need for terminal blocks.

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14 No strains or fractures of the glass envelopes from bent terminals.

15 Form A and Form B contact assemblies are available in several bobbin capacities. A combination of Form A and Form B contacts may be strapped to provide transfer action.

16 There is no reduction in reliability of Form B contacts. Normally-closed contacts have pressure and resistance equal to operated normally-open contacts.

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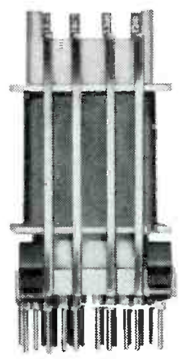

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A Guide To Future Airborne Radar Antennas

Improved aircraft performance is accelerating the search for better antennas for airborne radar applications. Several classes of antennas, such as the leaky-wave, lens, and array antennas, may hold the solution. The advantages and limitations of each are discussed.

By R. E. LAWRIE and Dr. R. C. RUDDUCK
Antenna Laboratory, Dept. of E. E.
The Ohio State University
1320 Kinnear Rd., Columbus, Ohio 43212

THE NORMAL APPROACH to designing antenna systems for airborne radar is to employ a parabolic or shaped reflector antenna. This is protected by a radome cover.

In view of the steady increase in aircraft performance and requirements imposed upon the radars, the conventional approach to airborne antenna design is limited by several factors. These factors depend, to some extent, on the function of the radar.

* * *

For bombing and navigation systems which include terrain avoidance, ground search and doppler velocity sensing radars, the conventional approach is limited by several factors:
(1) the nose cross section of the aircraft provides a small frontal area and hence, a limited aperture size for the antenna
(2) environmental and structural factors such as high temperature, high-temperature gradients, thermal shock and rain erosion, present severe problems to radome designers
(3) highly streamlined radomes create diffraction problems which are difficult to overcome.

For airborne intercept systems operating against targets such as ballistic weapons, the sector to be searched extends to extreme elevation angles, while the velocities attained by such targets require a radar data interval of not more than a few seconds for accurate target tracking. Thus, conventional airborne radar is limited by the relatively slow scan rates obtainable with scanned reflectors. Furthermore, scanned reflector antennas require a large volume in a situation where volume is at a premium.

Several classes of antennas which are capable, at least in theory, of overcoming some or all of the limitations of the reflector-radome system are leaky-wave antennas, lens antennas and array antennas. These three classes have some common features which overcome the limitations of the conventional system. All three classes of antennas may be flush or nearly flush mounted. They radiate through a fixed aperture, i.e., the radiated beam may be scanned or stabilized without any motion of the antenna itself. Finally, any radome used can be placed directly on the antenna or constructed as an integral part of the antenna.

Leaky-Wave Antennas

Leaky-wave antennas are essentially transmission lines from which energy fed at the beginning of the line radiates or leaks off as it propagates along the

A geodesic lens is flush mounted in a simulated nose cone to permit tests and design studies under operating type conditions.

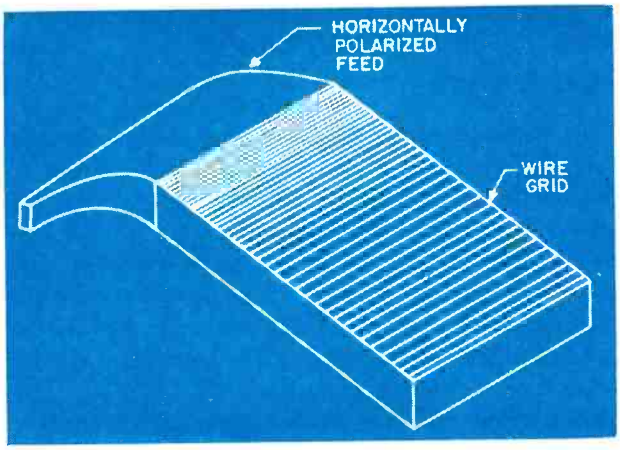


Fig. 1: The inductive-grid leaky-wave antenna consists of parallel wires supported above a metallic plate as shown.

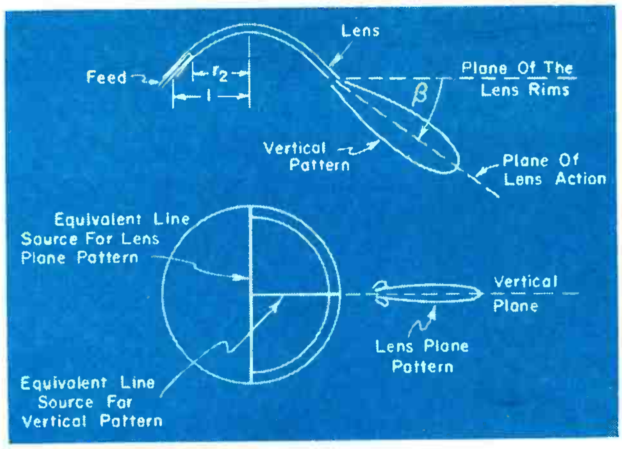


Fig. 2: The geodesic lens antenna focusses the energy by design of the lens contour.

line. A two-dimensional leaky-wave antenna may be formed by arraying a set of linear leaky-wave structures, such as slotted rectangular waveguides, or by using a two-dimensional waveguide structure formed from two parallel surfaces, usually a leaky surface supported above a conducting plate. An example is the inductive-grid structure[1] shown in Fig. 1. This consists of a grid of parallel wires supported above a metallic plate. The spacing between the wire grid and the metallic plate basically controls the phase velocity, whereas the spacing between wires basically controls the amount of leakage, although there is some interdependence between the two.

The beam position θ measured from the normal to the antenna is given by

$$\sin \theta = c/v$$

where v is the phase velocity. A pencil beam can be obtained from a parallel-surface structure by using a wide-angle sectoral horn feed or an array of waveguide feeds. Consequently, the beam is steered in one principal plane by control of phase velocity and is steered in the transverse coordinate by the feed excitation. Control of the phase velocity may be achieved by varying frequency. Non-frequency methods of beam steering involve control of spacing between the two surfaces of the leaky-wave structure or control of the dielectric constant or permeability of the medium between the two surfaces. Possible techniques are mechanical or hydraulic schemes for varying spacing, or electronic schemes using ferrite, ferroelectric or semiconductor materials.

Leaky-wave antennas are basically steered-beam structures, although multiple beams can be formed in one dimension by arraying a set of feeds with conventional array techniques. No practical methods for non-frequency beam-control have been developed to our knowledge. Leaky-wave structures can be flush-mounted and are much simpler in construction than conventional arrays.

Lens Antennas

In circularly symmetric or Luneberg lens antennas the symmetry properties can be used to advantage for electronic beam steering. There are two basic types: spherical lenses and two-dimensional lenses. Focussing in spherical lenses is achieved by variation of the index of refraction. A spherical lens structure is usually constructed from concentric shells; the index variation required by the lens design is approximated by choice of the dielectric constant for each shell.

Two-dimensional lenses are usually parallel-plate waveguide or surface-wave structures. Focussing may be achieved by variation of the index of refraction as in spherical lenses, or by design of the lens contour. The lens contour may be designed to focus energy with a uniform index of refraction throughout the lens. This type of lens is denoted a geodesic lens because the ray paths follow the geodesics of the lens surface.[2] A lens antenna is shown in Fig. 2.

A lens antenna is usually fed by waveguide or horn feeds placed at its focal radius. Since the beam position is diametrically opposite the feed, beam steering or multiple beams can be obtained by positions of feeds.

Lens antennas are basically multiple-beam structures. If beam steering is desired, it must be achieved by switching multiple beams or by feed motion. In two-dimensional lenses beam steering transverse to the plane of the lens rim may be achieved by a set of stacked lenses in which each lens gives a specific beam angle or by the technique in which the beam angle is controlled by radial feed positioning.[3] Of course, any methods suitable for controlling the phase velocity of a leaky-wave structure would probably be useful for beam steering transverse to the plane of the lens rim in two-dimensional lenses.

Current limitations on dielectric materials restrict spherical lenses to relatively low power. Spherical lenses are not flush mountable and radomes similar to those used for reflector antennas are required. Two-dimensional lenses can be flush-mounted and geodesic lenses, which employ no dielectric material, have potentially high power handling abilities. Like

Fig. 3: Diagram shows a frequency scanned linear array.

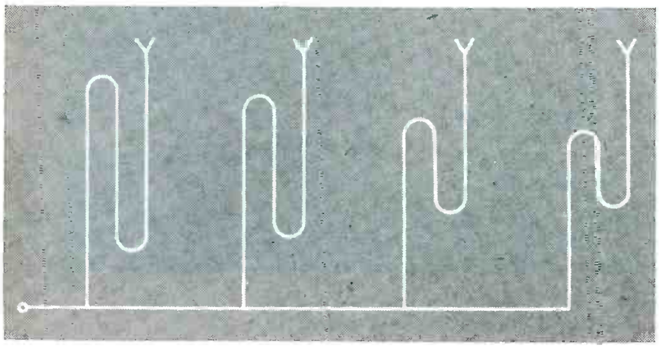


Fig. 4: One method of phase shift scanning a square array.

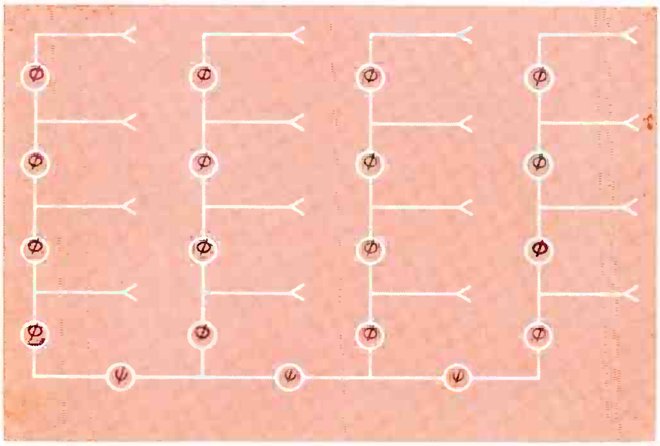
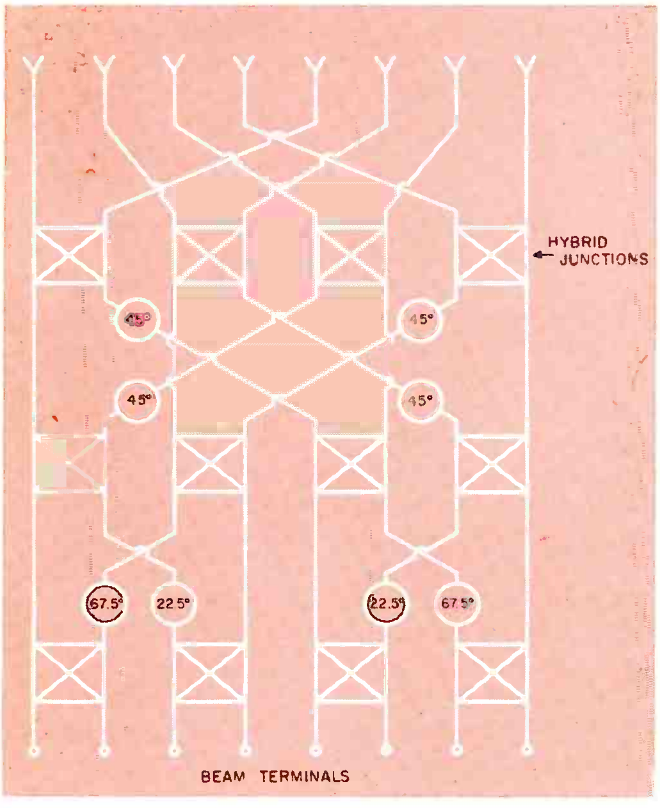


Fig. 5: Eight element multiple beam antenna uses hybrid couplers and fixed phase shifters for isolation and distribution.



leaky-wave antennas, the construction of lens antennas is much simpler than array antennas.

Array Antennas

An array antenna consists of a number of separate radiating elements properly spaced with respect to one another. The radiation pattern of an array is obtained through the combined action of all the elements. The amplitude and phase distribution over the array aperture, and therefore the shape and the direction of the radiated beam, are controlled by the relative phase and amplitude of the excitation applied to each of the radiating elements.

Array antennas are probably the most versatile antennas available. They may be operated in one of three possible modes. An array can be used to generate a single beam of variable shape which may be scanned by continually varying the relative phase of the excitation applied to each element. An array may also be used to generate simultaneous, fixed, multiple-beams which may be dispersed throughout a search sector to provide instantaneous coverage of that sector. In the third mode of operation an array can be used to generate several simultaneous beams which may be scanned individually or as a group.

Scanning of an array is done by varying the relative phase difference between the elements. The two basic methods are called frequency scanning and phase-shift scanning. Frequency scanning is done by feeding the elements of the array through unequal lengths of transmission lines. Thus, as the frequency is changed the phase shift per unit length of feed line changes. This alters the relative phase of the elements. A frequency scanned linear array is shown in Fig. 3. Phase-shift scanning is done by inserting phase-shifting devices into the transmission lines feeding the elements. Extremely fast scan rates are attainable with electronically controlled phase shifting devices. The schematic of one possible method of implementing a phase-shift scanned, square array is shown in Fig. 4.

The use of electronically controlled phase-shifting devices results in an extremely complex antenna system. For instance, a gross approximation to the number of array elements *(N)* required to produce a desired beamwidth is given by[4]

$$N \approx \frac{10^4}{\theta\,\phi}$$

where θ and ϕ are the half-power beamwidths in the principal planes of the beam, and a spacing of one-half wavelength between elements is assumed. Thus, a square array producing a 3° pencil beam requires about 1100 elements. The complexity of a scanned-beam array is apparent in the tremendous number of phase-shifting devices required and in the circuitry, components, and driving power needed to control the phase shifters. At present, a phase-shift scanned array for airborne use is not practical due to the lack of suitable phase shifting devices. Although there are many phase-shifting devices[5,6] and techniques[7,8,9] available, none can completely satisfy the requirements of size, weight, low driving power, and high power handling for airborne use.

Multiple-Beam Antennas

A multiple-beam array is achieved by using various types of coupling devices. These devices allow the elements of an array to be excited through separate isolated inputs. If the phase difference between elements is different for the different inputs, each input will produce an independent beam pointing in the direction associated with the particular phase difference. There are several techniques for interconnecting the elements in an array to generate multiple simultaneous beams.[10] One technique,[11,12] attributed to Butler, is shown in Fig. 5. This system uses hybrid couplers and fixed phase shifters. When the couplers and phase shifters are properly interconnected, an N-element array can form N overlapping beams.

Each of the electronically scanned antennas solves most or all of the typical problems encountered by mechanically scanned reflector antennas and is generally more versatile. However, as previously noted, the physical realization of these antennas for airborne radar presents other problems. The vast number of components required for array antennas and their size and weight represents a severe hardware limitation. Leaky-wave and lens antennas are better in this regard, but lack the versatility of arrays. The techniques for achieving the required versatility with these antennas will also complicate their hardware.

Electronically scanned antennas may be used in either single or multiple beam operation although some types are more adaptable to a particular mode of operation.

If a multiple-beam antenna is to be used in a duplexed system a transmitter and receiver are required for each beam. The most advantageous application appears to be in using the multiple-beam antenna as a receiving antenna while using a low gain, broad beam transmitting antenna to cover the same sector as the receiving beams. This system removes the burden of high power handling capabilities from the array components. Thus, the array network may be fabricated of passive, non-variable components. These components can be made more reliable and cheaper than the components used in scanned arrays.

Generally, only single beam antennas have been seriously considered for airborne radar because of the number of receivers required for multi-beam operation. However, the advances taking place in microelectronics may produce extremely small and lightweight receivers. Consequently the near equivalence, in terms of the radar's performance, between single and multiple beam systems should be noted. This near equivalence may be established if it is assumed that the total transmitted power, the effective receiving aperture and the losses in the receiving antenna are the same.[13] However, the propagation time of each pulse for the two-way path from antenna to target may limit the scan rate available from a single beam antenna. On the other hand, a multiple beam system may be inefficient if only a small portion of the total sector needs to be covered at one time, for example, in tracking a few targets without a search mode.

For uses in which steered-beam and multiple-beam antennas are electrically equivalent, i.e., neither the echo delay time nor the coverage efficiency are limitations, other considerations such as those of hardware dominate. The major distinction between steered beam antennas is that many components with high power capabilities are needed for steered beam antennas, whereas multiple receivers are needed for multiple beam antennas. Not only must the transmitting components in the array proper (phase shifter, etc.) handle high power, but associated circuitry for the transmitting portion, such as control circuitry for steered-beam antennas and switches for switched multiple-beam antennas must be capable of high power.

The receiving portion of a steered beam array is much simpler in hardware terms than the transmitting portion. In essence the tradeoff between the two types of systems largely involves the comparison of high power array components against multiple receivers. Up to the present, the state-of-the-art has been heavily in favor of steered beam systems because of the volume and weight of conventional receivers. However, in view of the anticipated state-of-the-art in microelectronic circuitry it is apparent that considerable improvement will be made in receiver circuitry.

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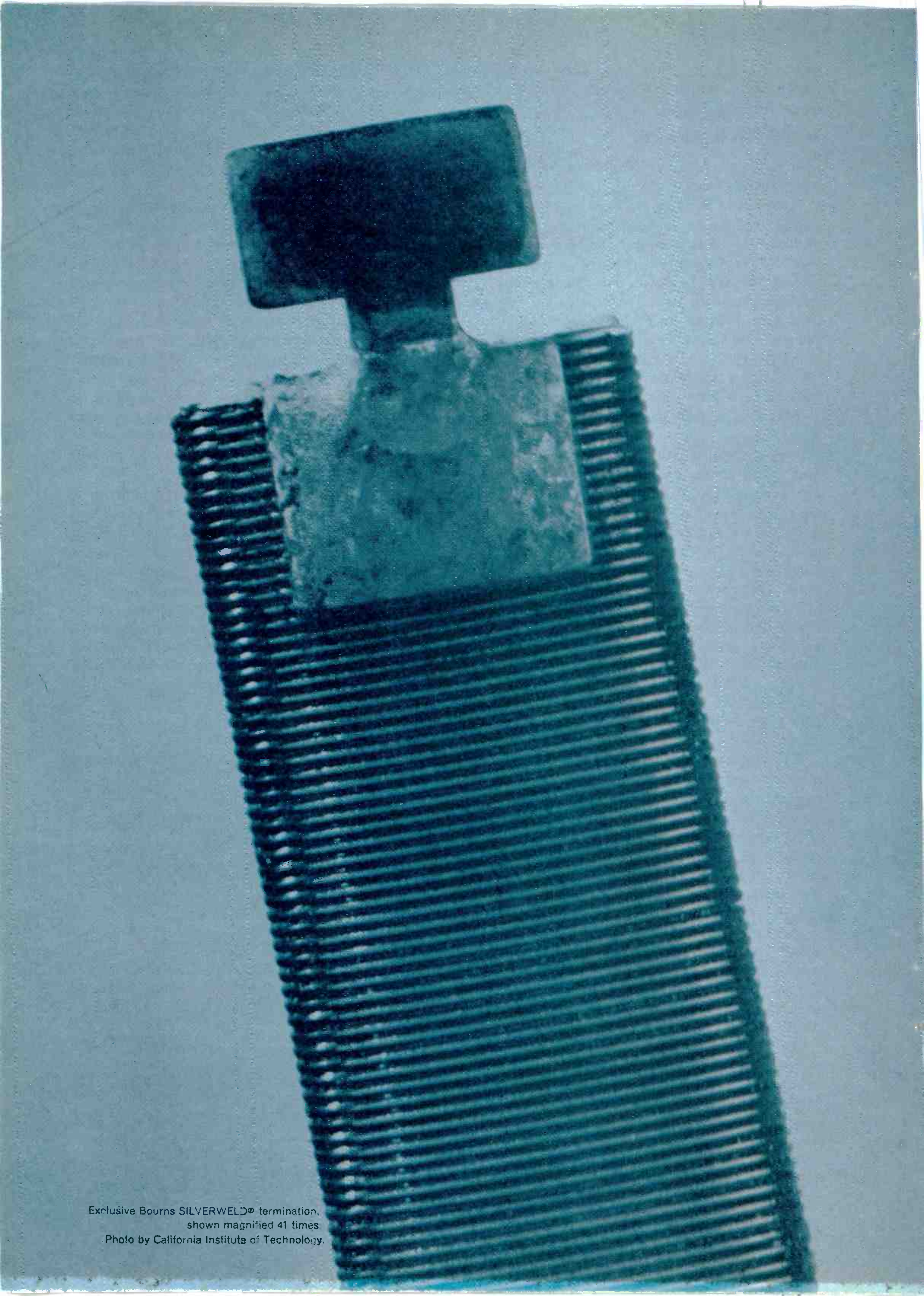

Exclusive Bourns SILVERWELD® termination,
shown magnified 41 times.
Photo by California Institute of Technology.

The termination that ended the chief cause of potentiometer failure...a typical example of

BOURNS TOTAL VALUE

Probably ninety per cent of potentiometer failures were once the result of fragile terminations. If the connection between the end of the resistance element and the terminal couldn't take the slam and shake of a missile ride or hold up reliably under years of use in industrial instrumentation, the potentiometer and its dependent functions became casualties.

With the creation of its exclusive SILVERWELD® termination in 1959, Bourns ended the fragility problem. The new termination proved virtually indestructible. To create it, Bourns fused a broad band of metal to many turns of the resistance element, and fused the external terminals to the band. A continuous electrical circuit from one external terminal to the other. *No solder, no rivets, no spot welds, no tabs, no pigtails, no weak spots, no hot spots.* The bond could not be broken without the destruction of the element itself. Used with ceramic-card elements, SILVERWELD termination has been tested to 1000°F and cycled from room temperature to 450°F without failure.

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EXCLUSIVE RELIABILITY PROGRAM

The Bourns Reliability Assurance Program is the only one of its kind in the potentiometer industry. Its primary goal is reliability! It frequently requalifies *all* standard models to insure conformance with published specifications. It also makes available free test data, saving you the time and expense of quality verification. Conducted in *addition* to quality control, it makes Bourns potentiometers the most thoroughly inspected and tested units available.

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One-fifth of all Bourns employees work in quality control or reliability monitoring. This is one of the highest personnel ratios of QC employees and inspectors in the electronics industry. In addition, all standard Bourns products undergo extensive in-process and 100% final inspection. These facts help account for the company's return rate of only 0.2% (2 units returned of each 1000 shipped!), one of the lowest on record.

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As the pioneer in adjustment potentiometers, Bourns has set the standards for an entire industry—in new products, in product improvements, in materials, in processes. Innovations such as the RESISTON® carbon and PALIRIUM® film elements and the virtually indestructible SILVERWELD® termination demonstrate that Bourns is constantly pushing the standards higher.

LARGEST SELECTION

Bourns offers the world's largest selection of potentiometers and an extensive line of precision potentiometers, relays and microcomponents. This single-source capability means less shopping around, avoidance of costly specials.

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The factory maintains a constant reserve of more than 500,000 units. In addition, more than sixty distributors across the nation carry complete stocks of Bourns adjustment potentiometers. Whatever you need in potentiometers, you can depend on Bourns for an off-the-shelf answer.

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Bourns maintains a staff of ten professional Application Engineers whose sole job is to give you technical assistance. Each of these specialists serves a specific geographic area. All are extremely able and anxious to help you cut time, corners and costs.

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Bourns—originator of the TRIMPOT® lead-screw-actuated potentiometer—has been making adjustment potentiometers longer than any other manufacturer. Bourns products have the longest reliability record, too, having performed successfully in every major U.S. missile and space program. And the record continues: in today's world-wide markets, far more adjustment potentiometers bear the Bourns label than any other.

COMPETITIVE PRICES

Depth of product line and high production efficiency allow Bourns to meet or beat the prices of competitors—despite its heavy extra expenditure for product reliability. Furthermore, Bourns "holds the line" on prices while continually upgrading its products. In those cases where a Bourns unit is slightly more expensive, you can be sure that the small extra cost means considerable extra value. It is a firm Bourns policy *never* to compromise quality for price.

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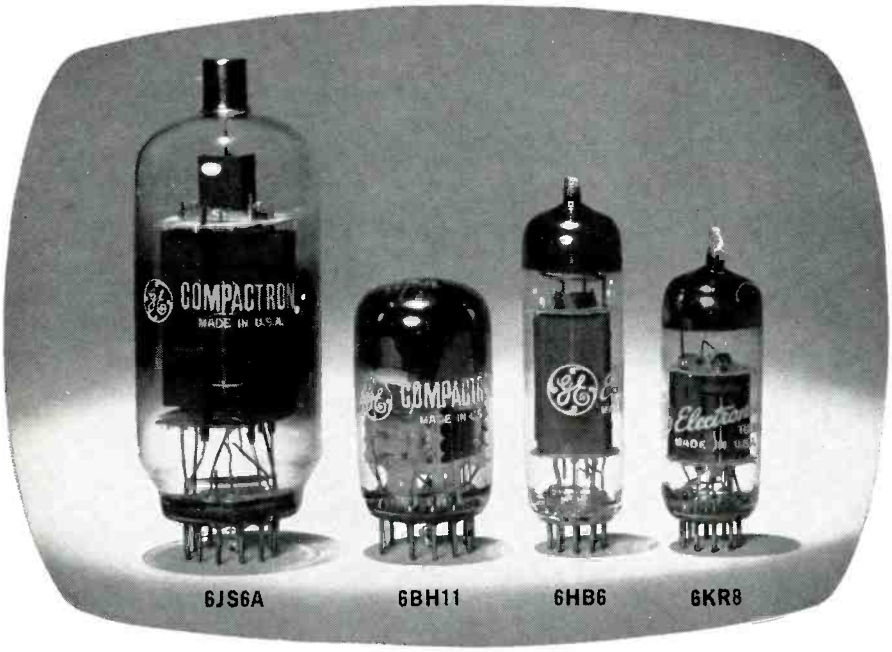
ELECTRONICS

New General Electric components



New G-E compactrons and miniature tubes provide added design flexibility for color TV sets

General Electric's new compactron and miniature tubes now offer expanded design capability for color television receivers, and other electronic applications. Four new types with added functions are available, specifically designed to meet demanding color TV needs:

6JS6A—Pentode Compactron
With improved anti-snivet control, this horizontal output amplifier can eliminate special circuitry and voltage needs. Its space-saving, low-cost design offers more usable output, expanded application possibilities in all-channel color television receivers.

6BH11—Twin-triode Pentode Compactron
This new general-purpose, twin-triode pentode combination gives you the same quality and reliability as the popular miniature type 6GH8A tube. Its pentode and triode characteristics are identical to the 6GH8A.

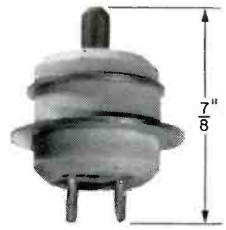
6HB6—Low-cost High-gain Pentode Miniature
Low-cost video amplifier, with special grid construction, matches the performance of its type 6KR8 companion. This general-purpose miniature with test-proved, high-gain performance is ideally suited for economical color circuitry.

6KR8—High-gain Pentode Triode
This tube will deliver 27,000 μmho in practical video circuitry. It features a high-quality, 3-strap frame grid, and general-purpose high-gain triode. Its rugged construction and high performance make it particularly suitable for color TV.

General Electric compactrons and miniature tubes lower design and manufacturing costs, increase reliability and performance. Compare for yourself the many advantages they offer. Your G-E Sales Engineer has the details and can provide application or prototype assistance.

Circle 20 on Inquiry Card

New G-E 7911 ceramic tube Size and weight reduced, Performance increased



General Electric's new 7911 miniature planar ceramic microwave triode offers advantages in size, weight and performance over previous types. Weight is slashed at least 75%, height reduced to only ⅞". You get up to 3 times greater tube gain-bandwidth product and transconductance/ma. It is ideally suited for beacons and radar altimeters, and new broadband concepts for DME-TACAN-IFF equipment.

A comparison of the 7911 with two other popular types is shown below. For specific application information, contact your G-E sales representative, or write to TIPS for more information.

Characteristic	New miniature ceramic 7911	Standard lighthouse planar types	
		6442	7815
G_m	27,000 μmhos	16,500 μmhos	25,000 μmhos
G_m/ma	1,080	470	360
Tube gain-bandwidth	2,900 mc	1,150 mc	2,000 mc
W_h	3.3 W	5.7 W	6.3 W
Cath. area	0.34 cm²	0.32 cm²	0.50 cm²
Length	⅞ in.	2⅜ in.	2⅝ in.
Max. diam.	¾ in.	13/16 in.	1¼ in.
$F_{max.}$	6,000+ mcs.	5,000 mcs.	3,000 mcs.
Eff. @ 4 Gc.	33%	25%	10%
Outline	Grounded cathode	Grounded grid	Grounded plate
C_{g-k}	5.0 pf	5.0 pf	6.3 pf
C_{g-p}	1.5 pf	2.3 pf	2.0 pf
C_{k-p}	0.05 pf	0.045 pf	0.035 pf
$T_{max.}$	250 C	175 C	250 C
Solderable	Yes	No	No
Weight	¼ oz.	1 oz.	2½ oz.
W_p	6.5 W	7.5 W	10 W
W_h/area	9.7 W	17.8 W	12.6 W
$E_{p\ max.}$	3.0 Kv	3.0 Kv	3.5 Kv
I_k	8.2 a/cm	10.8 a/cm	6.6 a/cm

Circle 21 on Inquiry Card

expand design opportunities

G.E. expands reed-switch line: Adds high-voltage and miniature types for design flexibility

When your application requirements call for *higher voltages*, check the rating of General Electric's new **type 2VR15** reed switch.

At 5,000 volts (rms), this vacuum reed switch opens new design possibilities. It requires only 113 (±20) ampere-turns for operate, 55 (±10) ampere-turns release. Maximum carrying current is 3 amps, contact rating is 15 volt-amps, and contact resistance is 0.05 ohms.

When it is *small size* you need, new G-E miniature reed switches, measuring only 2 inches over-all (glass capsule 0.78 in.), offer field-proved reliability and performance.

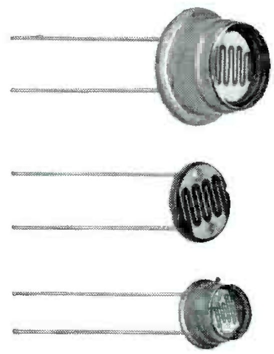
The **type 1DR04,** with diffused gold contacts, is ideally suited for either inductive or resistive loads. Full load (160 ma, 25V d-c) life is estimated to 25 million operations.

Type Y1292 miniature switches, with rhodium-plate contacts, have higher dissipation and current ratings. In life tests by one major manufacturer at 60 milliamps, 15 vdc, no failures occurred after 1.75 billion operations.

Compare for yourself the advantages and operating characteristics of General Electric vacuum reed switches. Some 20 different types are available in a variety of sizes, ratings, sensitivity and speeds. Ask your G-E sales representative for prototype samples, or write to TIPS for full details.

Circle 22 on Inquiry Card

New cadmium-selenide photoconductive cells



You can now get increased photocell performance and longer life with General Electric's new cadmium-selenide hermetically sealed or plastic-encapsulated photoconductive cells.

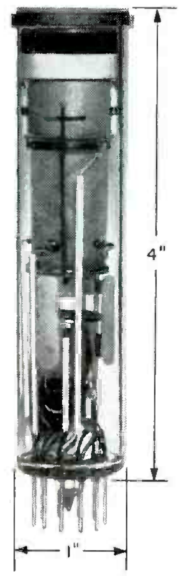
Available hermetically sealed in ½" or ⅜" diameters, with encapsulated equivalents, these new cadmium-selenide photocells are ideally suited for applications requiring fast response time and high sensitivity. They react to longer light wave lengths, matching incandescent and some other infrared light sources—even a small change in light level produces high resistance change. See table for specification details of present designs.

Response Time Approx. 1000 to 1 resistance change in 10 millisec. with 25 fc applied in darkness							
Photocell Description							
½" hermetic Type Y1206		½" plastic Type C425P1		⅜" hermetic Type Y1332		⅜" plastic custom-built	
Operating Voltage							
250 volts		250 volts		30 volts		30 volts	
Sensitivity							
darkness	2 fc	darkness	2 fc	darkness	2 fc	darkness	2 fc
2.5 megohms or more	1500 Ω	5 megohms or more	10000 Ω	2 megohms or more	1000 Ω	2 megohms or more	1000 Ω
Dissipation							
250 milliwatts (500 milliwatts with heat sink)		200 milliwatts		75 milliwatts		50 milliwatts	

See your G-E sales representative, or write to TIPS for more information. Samples for prototype work are available immediately.

Circle 23 on Inquiry Card

G-E vidicon tube offers high performance and light weight



General Electric's new type Z-7845 vidicon tube combines the high resolution performance of all-magnetic vidicons with compact size and light weight.

Operating on a new electron-optical principle, Focus Projection and Scanning (FPS), this new vidicon provides a resolution of 800 TV lines with750-volts beam acceleration.

The new Z-7845 is especially designed for applications where space and weight are critical, such as, TV missile guidance, star trackers and battlefield surveillance equipment.

General Specifications (Approx.)

Length (exclu. pins) . . . 4 in.

Diameter
- Body . . . . 1 in.
- Target ring . . . . 1⅛ in.

Weight
- Tube . . . . 80 grams
- Magnet . . . . 120 grams

Heater power . . . . 3 to 5 watts
Spectral response S-18
Focusing method . . . . . magnetic
Deflection method . . . . electrostatic
Usable target dia. . . . . . 0.84 in. max.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information, write G-E Tube Dept., Technical Information and Product Service (TIPS), Room E27002, Owensboro, Kentucky. Please specify product(s).

Circle 24 on Inquiry Card

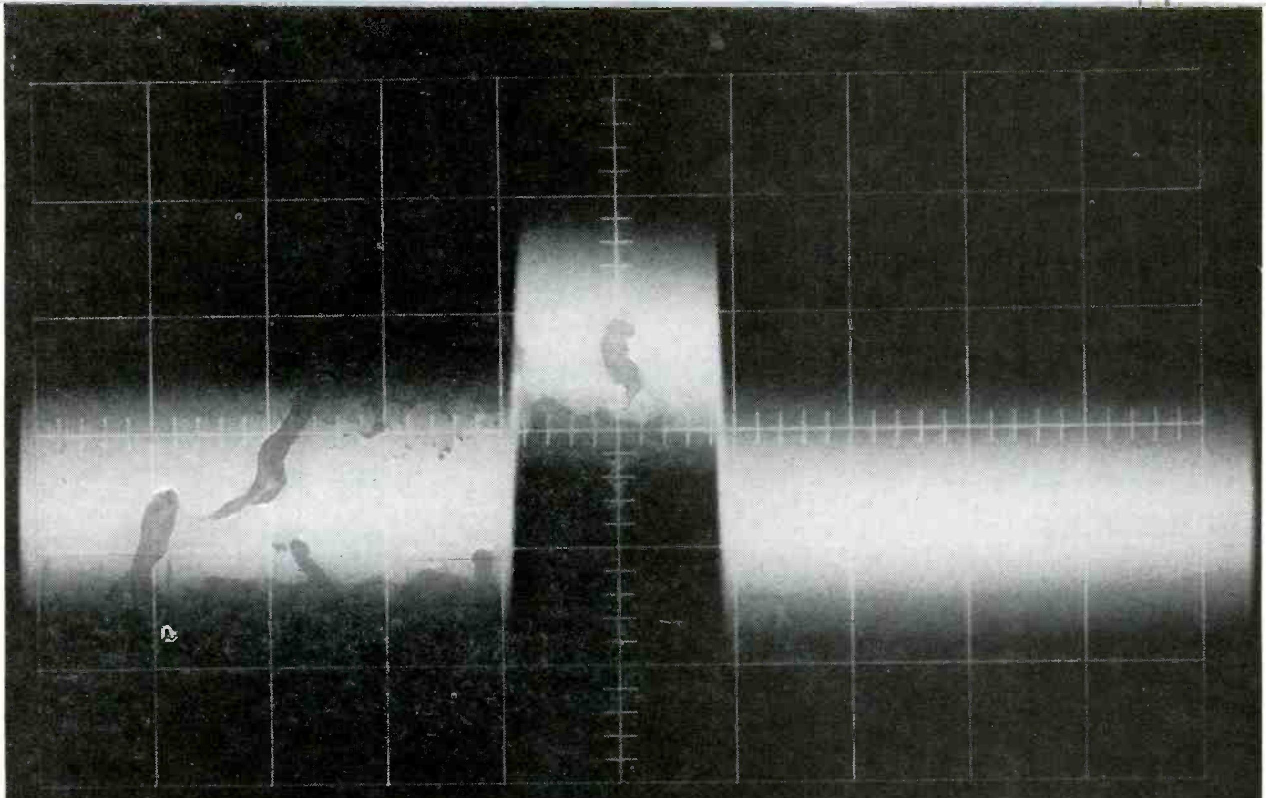


Fig. 1: Shown is an oscilloscope picture of what is normally considered the tangential sensitivity of a pulse in noise.

Understanding Integrated Video Detectors

Significant improvements in mounts and crystals are leading to wider use of crystal video detectors. This form of detection is considered a modern approach to communication systems. The information here will lead to a good understanding of integrated video detectors and indicate the present state-of-the-art.

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Staff Consultant, Equip. Div.
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Lansdale, Pa.

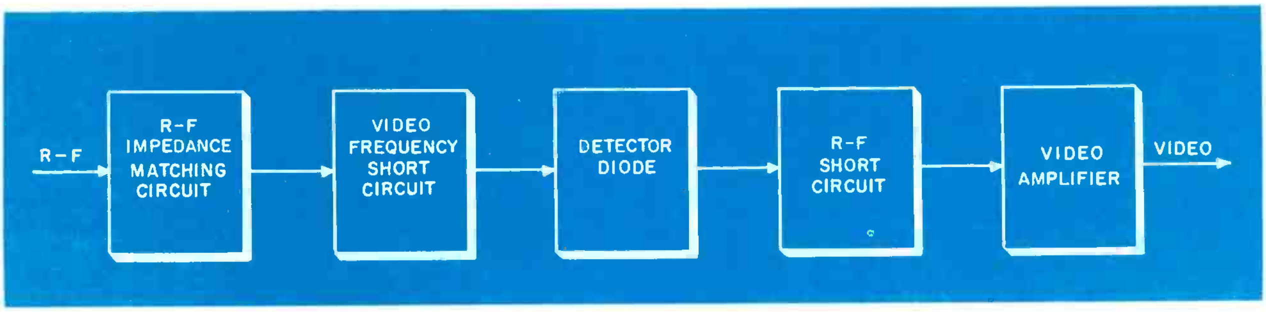
THE DEVELOPMENT OF SMALLER COMPONENTS and subsystems, together with improved reliability and operational specifications is in continually increasing demand, particularly in the communications industry. Integrated video detectors is the modern approach to improving crystal video communications systems.

* * *

According to Torrey and Whitmer,[1] "The term video crystal commonly means a crystal rectifier that is used as a low-level, square-law detector of microwave pulses. The video output voltage of the detector is amplified by a video amplifier. Such a receiver is commonly called a crystal video receiver.

"The crystal video receiver was developed somewhat later than the superheterodyne receiver to meet the need for a wide band beacon receiver that would respond to pulses over the range of frequencies encountered in interrogating transmitters. The sensitivity of the crystal-video receiver is low compared with that of a superheterodyne receiver, but this is not prohibitive in the beacon application, since the signal level for one-way transmission is high com-

Fig. 2: The block diagram is given of the integrated video detector for establishing an analytical sequence.



pared with the level of echoes at a comparable range. Wideband superheterodyne receivers have been designed for beacon reception and have been used in some beacon sets. However, such receivers are difficult to adjust and are not so light and compact as crystal video receivers—considerations which are of importance in portable beacons. The crystal video receiver has, therefore, found extensive use."

There are other uses in which crystal video receivers offer advantages over superheterodyne receivers, such as in countermeasures equipment and millimeter wave radiometry. The former takes advantage of wide input bandwidths when the exact frequency of the incoming signal is unknown, and the radiometry application avoids the difficulty of supplying superheterodyne millimeter wave local oscillator power in remote uses such as space probes.

As airborne and space communications become increasingly important, the use of crystal video receivers should increase. Particularly in view of the R&D programs presently overcoming the primary disadvantage of this type of receiver—sensitivity.

Characterization of Video Detectors

The main parts of a video detector are the crystal diode, the diode mount, and the video amplifier. Each of these is closely related in the operational characteristics of the detector. Considering the detector to have an r-f input port and a video output port, these terminal characteristics define the performance of the detector. Important operational parameters include the r-f input VSWR as a function of frequency, the detection sensitivity, normally denoted tangential sensitivity (T.S.), the video bandwidth, and the video output impedance.

The measurement of the input VSWR follows accepted slotted line techniques covering typical r-f bandwidths of 5%, octave, and up to 20:1. When the diode mount is properly designed, taking into account the effect of the diode impedance, and optimized for minimum input VSWR, typical VSWR readings are 1.5:1 for a 5% r-f bandwidth, 6:1 for an octave band and 15:1 for a 20:1 bandwidth.

The detector video bandwidth can be found by the standard techniques of measuring pulse rise time or pulse width. Typical video bandwidths cover a very wide range, such as 0.5 MC for low frequency beacons up to 100 MC for microwave computer circuits.

Video output impedance characteristics are obtained by resistance substitution methods. The magnitude of this impedance at the preamplifier output terminal is generally a design variable depending on the post amplifier signal processing input requirements and the effect on bandwidth of the output impedance along with the coupling network.

The most ambiguous of the operational characteristics is the detector sensitivity. To avoid a mathematical discussion of sensitivity, Fig. 1 shows an oscilloscope picture of what is normally considered the tangential sensitivity of a pulse in noise. For an analytical discussion, see Ref. 1.

ELECTRONIC INDUSTRIES STATE-OF-THE-ART FEATURE

Each of the components, the diodes, mounts and amplifiers, contributes to each of the terminal characteristics of the integrated detector mount. For example, the intrinsic sensitivity of the diode is the maximum achievable detector sensitivity. But, this is degraded by the diode mount according to the design of the impedance matching network coupling the r-f energy into the diode. Likewise, the video amplifier input network degrades the sensitivity as a function of its noise figure and impedance. To accurately understand the existing inter-relationships, an equivalent circuit analysis can be made.

Analysis of Integrated Video Detectors

Consider Fig. 2, a block diagram of the integrated video detector, for establishing an analytical sequence.

Since the most important operational characteristic of the video detector is its sensitivity, and this sensitivity is limited by the intrinsic sensitivity of the diode, consider this component first. The most significant diode properties are its current-voltage characteristic, given in Eq. 1 and its low frequency equivalent circuit of Fig. 3.

$$i = A\,[e^{\alpha\,(V - ir)} - 1] \tag{1}$$

where: i = current through the diode
A = log current intercept in the forward direction
α = log current slope in the forward direction
V = terminal voltage
r = spreading resistance

The circuit of Fig. 3 consists of a nonlinear barrier resistance R_B in parallel with a nonlinear barrier capacitance C_B, both of which are in series with a linear spreading resistance r.

At r-f frequencies the crystal diode can be represented by an r-f resistance R_{r-f} which includes the nonlinear barrier resistance, a resistive term resulting from the spreading resistance and the shunting effect of the barrier capacitance, assuming the reactive part of the crystal impedance is tuned out.

Then, for the purpose of analysis the diagram of Fig. 2 can be represented by Fig. 4.

The components in the circuit of Fig. 4 can be identified as follows:

R_{r-f} = crystal r − f resistance
e_{r-f} = instantaneous signal voltage
R_o = characteristic signal source impedance
Z_L = video shorting impedance
Z_c = r − f shorting impedance, including both diode mount, and amplifier input capacitance
R_L = total resistive loading at the amplifier input
R_{eq} = equivalent noise resistance of the video amplifier
A = noise free amplifier gain

When each of the circuits is performing its design objective, the complete circuit can be broken down

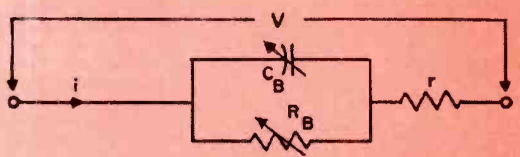


Fig. 3: Low frequency equivalent circuit for the detector diode.

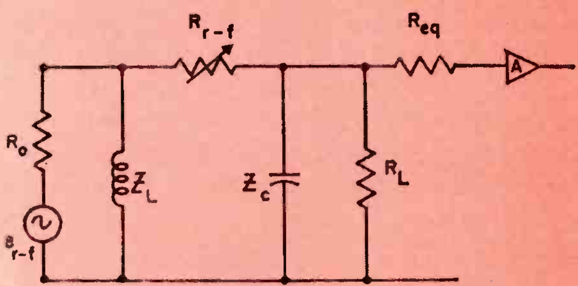


Fig. 4: For analysis, Fig. 2 can be represented by this circuit.

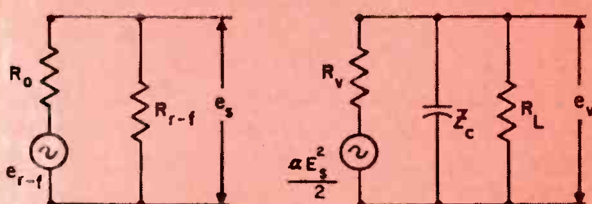


Fig. 5: The circuit in Fig. 4 can be further broken down into equivalent r-f and video circuits as shown here.

into equivalent r-f and video circuits, shown in Fig. 5, under the assumption of low level r-f.

The new terms introduced in Fig. 5 are as follows:

E_s = RMS value of e_s

R_v = diode equivalent video resistance (about R_B)

At this point it is possible to analyze the interactions involved in the integrated detector.

For maximum sensitivity, R_L should approach infinity. But, for solid state amplifiers this imposes some difficulty. Thus the sensitivity is a function of the relationship between R_L and R_B.

Considering the r-c circuit, to maximize e_s, R_{r-f} should be large. However, since R_{r-f} is a direct function of R_B, neglecting parasitic components, there is a conflict in the requirements of R_B between the r-f and video circuits. Further, the larger R_B, the more difficult to design broadband impedance matching circuits between R_o and R_{r-f} for maximum r-f power transfer from the signal source to R_{r-f}.

If R_{r-f} is made large by increasing R_B, to achieve increased sensitivity, then R becomes large and a further restriction becomes apparent in the video circuit, which is the bandwidth limit due to the combination of R_v and Z_c.

The noise sources in the circuit are a major factor in the detector sensitivity. Since the video preamplifier, in addition to the diode, contributes to this noise, and since R_L and Z_c are functions of the amplifier design, the amplifier will now be considered.

It is well known that the input stage of an amplifier is the critical one for low-noise operation. For stages in cascade, the overall noise factor, F, is given as:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \cdots$$

where: F_1, F_2, F_3, $\cdots$ are the noise factors of the individual first, second, third, etc. stages G_1, G_2, G_3, $\cdots$ individual power gains of these stages.

The equation clearly shows the importance of making the noise factor of the first stage small and its power gain large. A point sometimes overlooked pursuing the goal of reducing the noise factor of the first stage, F_1, the resultant power gain, G_1, can become low enough so that the noise factor of the second stage, F_2, cannot be ignored.

Noise sources of the active device employed in the input stage are dependent on such factors as the energizing dc current, temperature, and possibly the generator source impedance. Additionally, an optimum source impedance exists for low-noise operation of the active device.

Noise models have been developed for vacuum tubes and junction transistors. A model for transistors, based on an equivalent noise current and a noise voltage generator, was developed recently and is finding wide acceptance, since it is amenable to measurement techniques. It is convenient because of the analogy to vacuum tubes—to develop an equivalent noise resistance at the input terminals, operating in conjunction with a noiseless amplifier. The resultant expression then indicates the parameters which are important for low-noise operation.

A model using a shot noise equivalent circuit for the diode and transistor, with output shorted, is shown in Fig. 6.

To simplify the expression sought, operation is assumed in frequency regions where the capacitance and noise contribution of r_u can be disregarded. The effect at the output of all the noise sources of Fig. 6 can be replaced by a noise resistance R'_n. The contribution of the common-emitter amplifier noise resistance, R_n of silicon transistors

where:

$$\overline{e_x^2} = 4KTr_X \, \Delta f \qquad R_B = \frac{KT}{qI_D}$$

$$\overline{e_{bd}^2} = 4KTr \, \Delta f \qquad C_\pi + C_\mu = \frac{g_m}{2\pi f_T}$$

$$\overline{i_d^2} = 2qI_D \, \Delta f \qquad r_\pi = \frac{h_{feo}}{g_m}$$

$$\overline{i_b^2} = 2qI_b \, \Delta \qquad r_X = h_{ieo} - r_\pi$$

$$\overline{i_c^2} = 2qI_c \, \Delta f$$

$$g_m = \frac{qI_c}{KT} \qquad I_c = \text{collector dc current} \qquad I_D = \text{diode dc bias current.}$$

when the video impedance $(R_B + r)$ is considered fixed,[6] is:

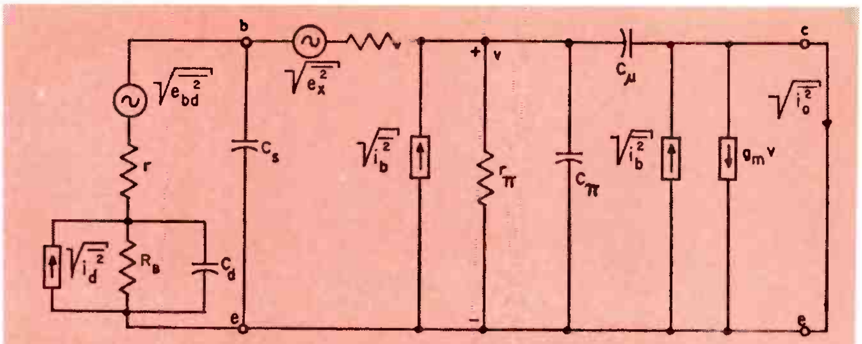


Fig. 6: A model using a shot noise equivalent circuit for diode and transistor, with output shorted is illustrated here.

TABLE 1

Integrated Detector Mount Typical Sensitivities

FOR 2 MC BANDWIDTH

Freq. Band (GC)	Tangential Sensitivity (db)
0.5–1	−60 to −62
1–2	−59 to −61
2–4	−58 to −60
4–8	−58 to −60
8–12	−58 to −60

$$R_n = r_x + \frac{q}{2KT}\left|I_B\right|(r_x + R_B + r) + \frac{q}{2KT}\left|I_c\right|\left(\frac{r_x + r_\pi + R_B + r}{g_m r_\pi}\right)^2 \qquad (2)$$

Recognizing that $r_\pi = \dfrac{h_{fe}}{g_m}$, and $R_B \gg r$, R_n can be maximized as a function of I_c to give:

$$R_n\ (\text{min.}) = r_x\left(1 + \frac{1}{\sqrt{h_{FE}}}\right) + R_B\left(\frac{1}{h_{fe}} + \frac{1}{\sqrt{h_{FE}}}\right) \qquad (3)$$

when:

$$I_c = \frac{kT}{q}\,\frac{h_{FE}}{(r_x + R_B)} \qquad (4)$$

Eqs. 3 and 4 are the final expressions we wish to discuss. First, I_c and R_n (min.) show a dependence on the video impedance of the diode. This is an important contrast to a vacuum tube, whose input equivalent noise resistance is independent of the source resistance. Second, since it is a characteristic of a detector diode that as its video impedance is increased the result is improved sensitivity. This requires lower-current operation of the transistor. As the video impedance increases, temperature stability should be given more serious consideration, that is when the operating current becomes comparable to base leakage current. The important point is that as diode technology produces more sensitive diodes, a corresponding improvement of transistor technology for low-noise amplification is required. In brief, Eqs. 3 and 4 point up the requirements of a good low-noise transistor.

(a) High f_T

(b) Small r_x

(c) High dc current gain, $h_{FE} = I_c/I_B$

(d) High ac current gain, $h_{fe} = i_c/i_b$

The optimum noise performance of a good low noise transistor, such as a 2N930, is roughly comparable to that of a vacuum tube. As an example, if R_B is 4,000 ohms, r_x is 100 ohms, and h_{FE} and h_{fe} are 100, then I_c is about 60 μa, and R_n is 550 ohms. This value of R_n is comparable to a high performance tube.

It was the intent of the above analysis to show the more important parameters for low-noise operation in crystal-video. It had been assumed that h_{FE}, h_{fe}, and r_x are independent of the emitter current, I_e, which, of course, is not quite correct. But they are relatively slow functions and so there is a good deal of validity in the calculations, particularly in view of the spread encountered in transistors of the same type. A more accurate prediction of the mean square noise voltage of the transistor can be obtained by plotting R_n contours in the $[(r + R_B + r_x), I_c]$ plane. This would be very similar in form to noise figure contours.

Where large video bandwidths are a consideration, such as in crystal video, the input coupling circuit can eventually become the limiting factor. When video impedances are around 5 or 10K ohms, the r-f by-pass, detector mount, and amplifier capacitances need to be minimized by means of special design methods to extend the input circuit video bandwidth. The low current operation of a transistor input stage yields low noise, but it also contributes to bandwidth degradation. The reduction of such characteristics as ac and dc current gains stresses the importance of measuring these characteristics carefully at low currents during the design phase.

For crystal video detection systems, and in general for any system, the trade-offs should be very carefully considered due to the wide variety of receiver designer's criteria. Such criteria are r-f and video bandwidth, signal-to-noise ratios, input-output impedances, power handling, linearity, size, weight and power needs. A critical step is finding those specifications which are important and those which can be relaxed without performance degradation.

(*Continued on page* 48)

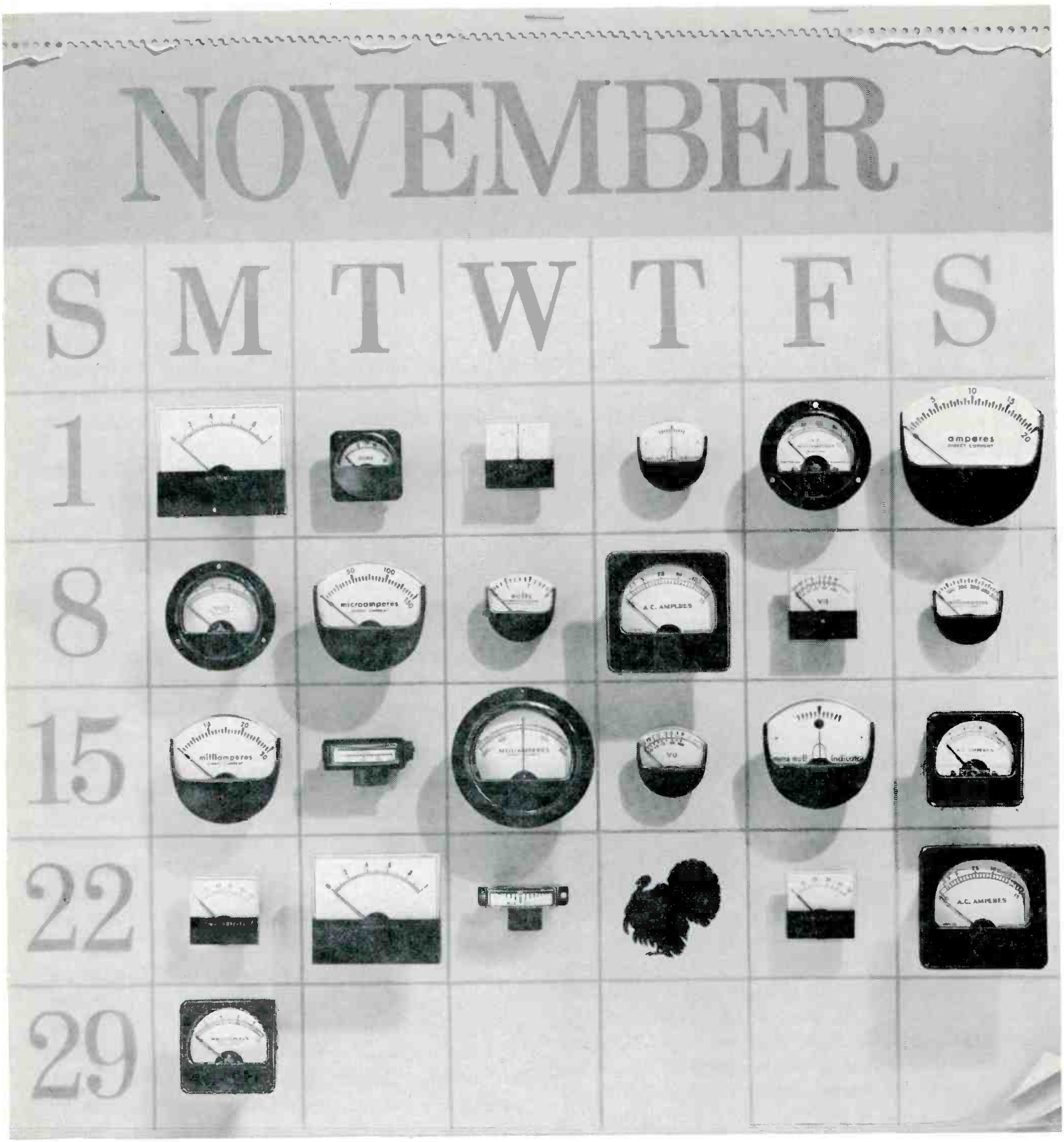
MICROWAVE COMPONENTS

Microwave components for 1963 brought in a total of about $73.1 million in factory sales.
Major product categories:

Ferrite parts, semiconductor and solid-state duplexer assemblies:	$21.915 million
Non-ferrite, non-semiconductor components:	$51.174 million

(Source: EIA)

(Another source predicts that microwave component sales may reach as much as $90 million by 1967.)



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Honeywell

How Beldfoil* reduces hum—noise

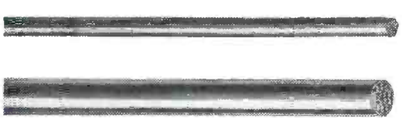
By Frank Timmons, Chief Engineer, Electronics Division, Belden Manufacturing Company

Today's sensitive electronic equipment, in most instances, cannot tolerate hum and noise resulting from pickup and interaction between conductors in cable and wire. In an effort to assist electronic engineers to meet these requirements, Belden Manufacturing Company, in 1957, introduced Beldfoil, a cable with total shielding. Frank Timmons, Chief Engineer of the Electronics Division at Belden's Richmond, Indiana plant answers a number of frequently asked questions on Beldfoil.

Q *How does a Beldfoil shielded cable differ from other types of cable?*

A Beldfoil cable is shielded with a laminated material . . . a sheet that is a combination of Mylar† and aluminum foil. The result is a high dielectric insulation that gives *total* shielding . . . 100% isolation between adjacent pairs.

Q *Are Beldfoil shield cables smaller than other types of cables?*



A Yes. Beldfoil shielding reduces the diameter of some multiconductor cables by as much as 66⅔%.

The two cables shown above have the same number of twisted pairs with identical AWG. The smaller of the two is the Beldfoil shielded cable. Beldfoil helps electronic engineers design for miniaturization. It provides extra conduit, raceway, console, and rack space.

Q *What about flexing?*

A Because Beldfoil shielding is applied spirally (as shown below) instead of longitudinally, it will flex repeatedly and maintain 100% shield coverage.

Q *What is meant by "pressure points" in a cable with braid-shields?*

A Braid-shields present a very irregular surface to the insulations under, or beside the shield. Pressures, within the cable, and as a result of crushing forces upon the cable, cause the braid to be forced into insulation at these pressure points. These conditions may be a cause of early cable failure. Beldfoil shields are smooth and do not contain these pressure points.

Q *What about terminating Beldfoil shielded cables?*

A Every Beldfoil shield features a drainwire that contacts the aluminum portion of the shield along the full length of the cable, draining any accumulated static charges from the shield. This drainwire is a convenient ground wire with sufficient circular-mil-area so that it may be used as a conductor for relay and annunciator circuits.

Q *What are some of the applications of Beldfoil?*

A Beldfoil is effective over the entire audio and RF range (even to 1000 Mc). Typical applications include instrumentation, data processing, and telemetering equipment, as well as any information measurement circuits. Recent specific applications have been for TV audio circuits, Air Force communications systems, TV receivers, radios, phonographs, aircraft communications equipment, and mobile communications equipment.

Q *How would you summarize some of the important benefits and properties of Beldfoil?*

A Beldfoil eliminates dirty (wide-band) noise, and the problems of crosstalk. It saves space, it's easy to install, it is easy to terminate, and it has long life. And users report that it reduces end costs because of minimum maintenance or repair required of installations after they are in the field.

Q *I assume descriptive literature is available on request.*

A Yes. Requests should be directed to Belden Manufacturing Company, P.O. Box 5070-A, Chicago, Illinois 60680.

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VIDEO DETECTORS (Concluded)

To meet the needs of different communications equipment, a detector is often designed to specific requirements. However, in every case the detector is custom-matched to the diode being used, to ensure the maximum in sensitivity, as well as other specifications.

For those systems in which a standard integrated mount may be used, detectors designed to give high sensitivity in octave bands from 500 MC up to 12 GC have been realized. The sensitivities which can be achieved in these mounts, with a 2 MC video bandwidth are given in Table 1. A typical integrated detector mount, designed for X-band use is shown in Fig. 7. To show the possible trade-off of sensitivity with size, Fig. 8 shows a miniature mount designed for X-band, compared with a standard cartridge type diode.

To estimate sensitivity for other bandwidths, the approximate relationship can be used that for a 4:1 change in video bandwidth the change in sensitivity is 3 db. Where operation is desired in less than octave bandwidth, additional sensitivity is realized because the r-f input can be impedance matched more easily. A natural extension of the integrated video detector is the physical integration of a detector and band-pass filter. Operation of an integrated filter and mount has been obtained up to 25% bandwidths.

The video-preamplifier used with the diode detector mount constitutes an area of design where bandwidth, overall sensitivity, and temperature stability must be carefully considered. Operation over a wide temperature range, such as in military equipment, necessitate stiffer biasing in the amplifier with a consequent slight decrease in sensitivity. Large video bandwidth requirements can result in some trade-off with sensitivity because of the inability of the input stage to maintain high current gains at low current operation. Also, where pulse droop is unimportant in subsequent video processing, the low-frequency cut-off can be made higher to avoid the flicker noise region. This permits a further increase in overall sensitivity and improvement in amplifier recovery time under signal overload.

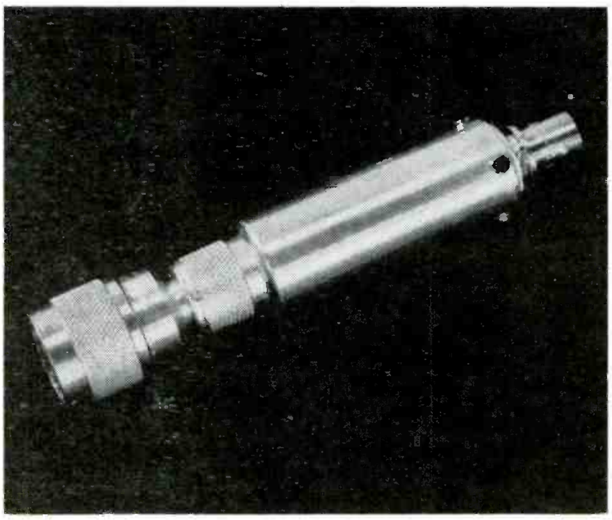

Fig. 7: A typical integrated detector mount for X-band use.

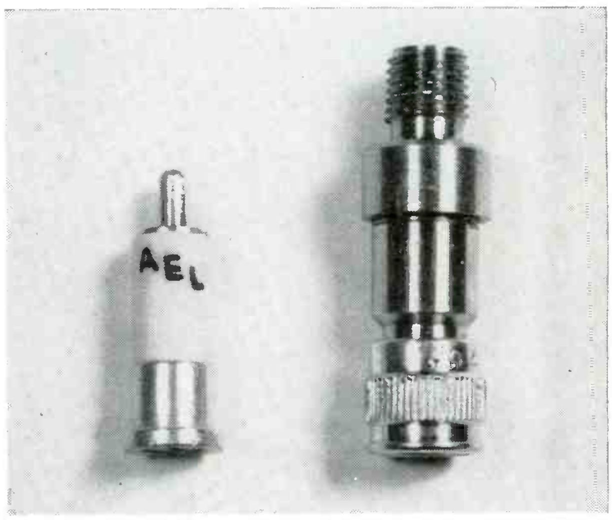

Fig. 8: Miniature integrated mount compared to standard diode.

Summary

Low-noise video preamplifiers have been built which exhibit a 20 MC bandwidth and 17 db gain, when working with a high sensitivity diode, such as an AEL-12, which has a nominal 5,000 ohms video impedance at 5 μa. bias. Such large bandwidths can be obtained by integrating the detector mount and preamplifier into a single unit. The integration of the diode and amplifier allows optimum overall sensitivity with large bandwidths. Another advantage is that the low-impedance output, typically 10 to 20 ohms, allows a long-coaxial cable to be run to a post-video amplifier for maximum physical flexibility without bandwidth deterioration.

In the light of present state-of-the-art of crystal detectors, a re-evaluation of existing systems for improved performance is now practical. Further, when new crystal video systems are being designed, integrated detectors can provide the ultimate in system performance.

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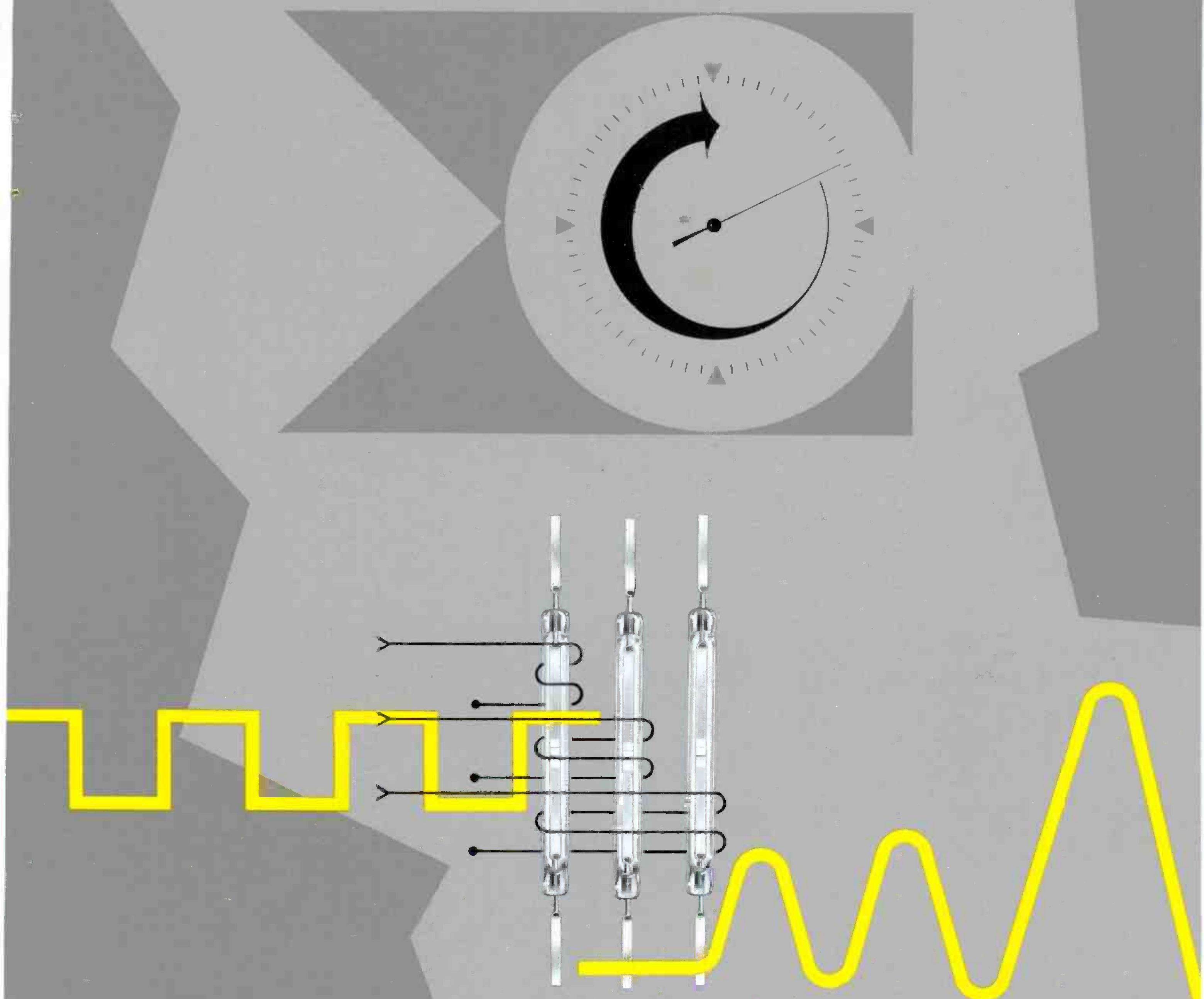

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Nominal Operating Voltage:	up to 220 vdc
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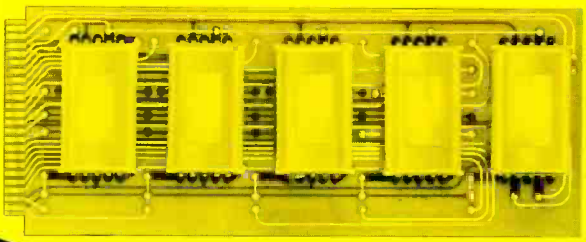

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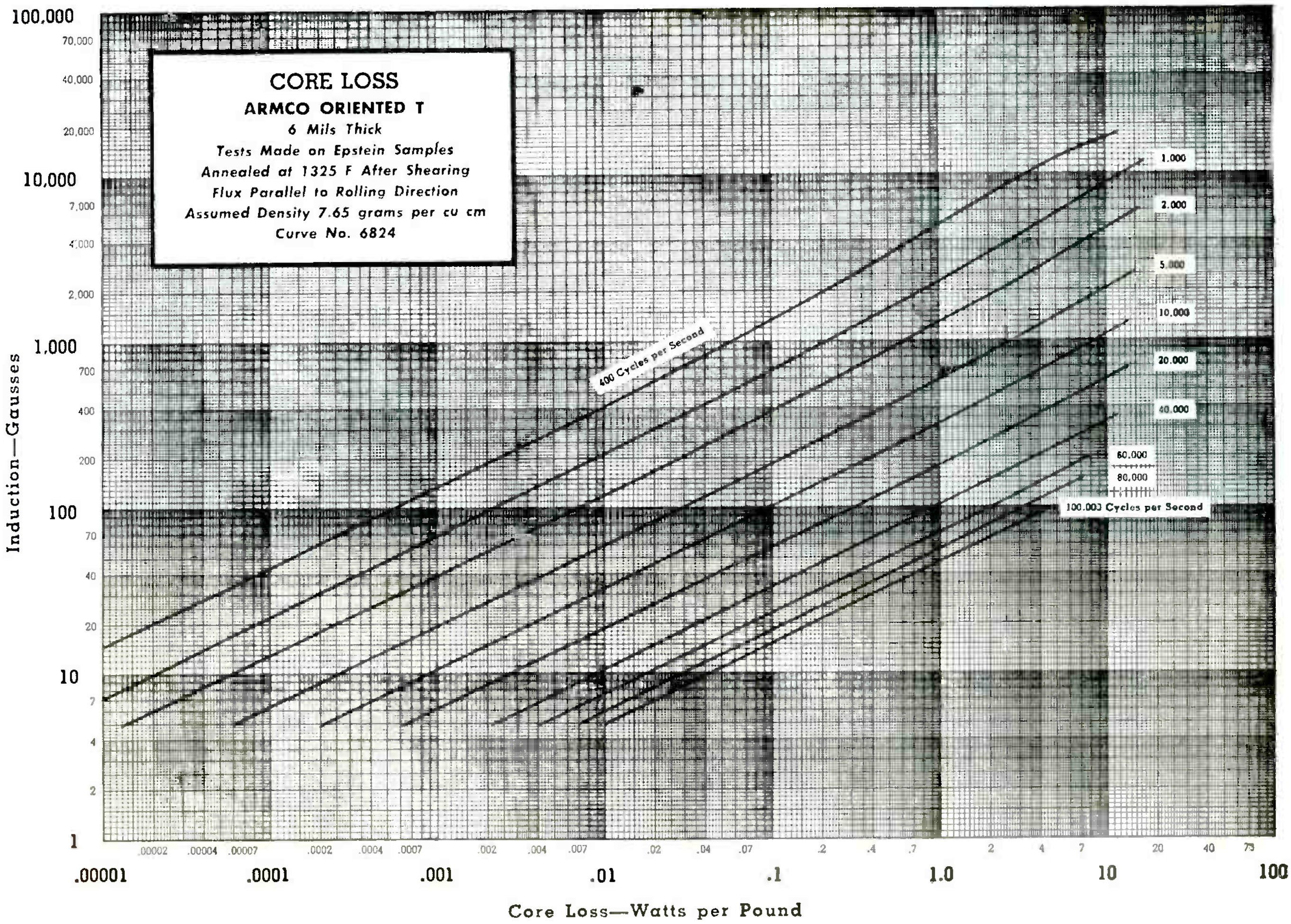

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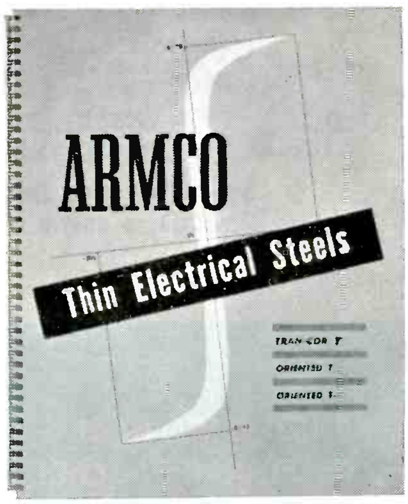

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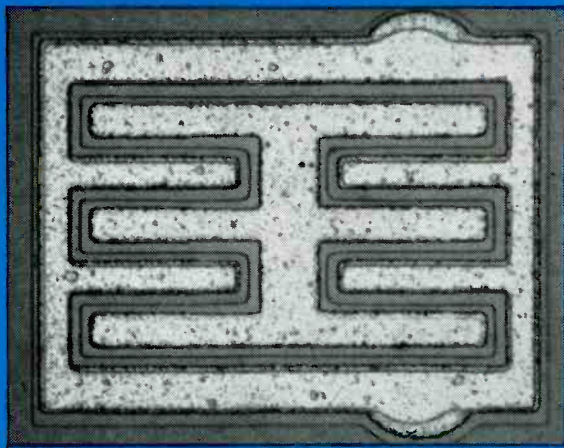

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By WILLIAM J. ATKINS,
Project Engineer,
Sylvania Electronic Systems,
Western Operation,
P. O. Box 188,
Mountain View, Calif. 94042

The average engineer regards any cost estimating task as an extremely distasteful one. His attitude is that estimating is an unimportant chore. This is far from the truth, especially now since more and more contracts are being awarded on a "Fixed Price" basis. This article presents useable information to aid the engineer in this task. The method described should make the task less painful.

An Engineering Approach to Cost Estimating

INTENSE COMPETITION FOR DEFENSE CONTRACTS, together with the trend toward fixed price contracts, has made accurate cost estimates a necessity. More than ever before the engineer must assume an important role in the preparation of cost estimates.

This article shows how engineering problem solving methods can be applied to the problem of preparing cost estimates.

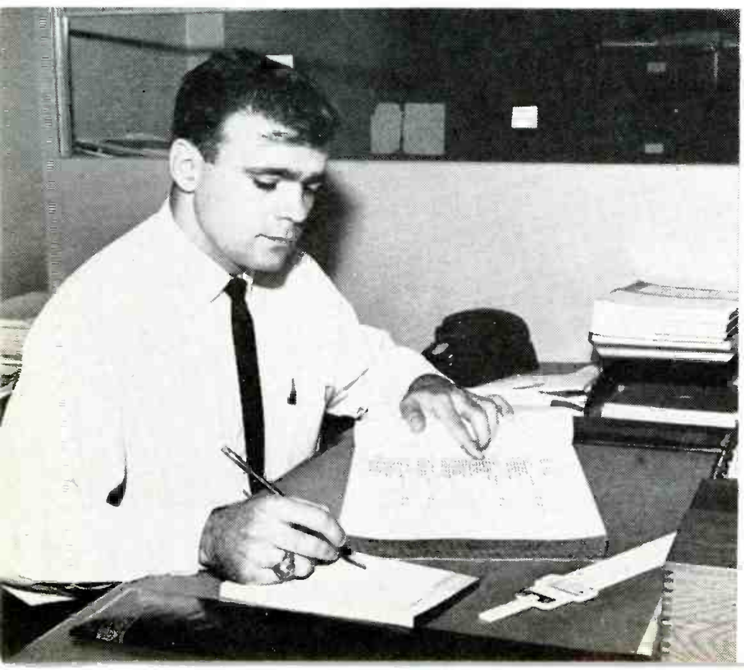
* * *

"Fixed Price Contract" used to be a term applied to production or to component manufacturers, not to R&D. Today, the Department of Defense (among others) is awarding more and more contracts on a fixed price basis for efforts previously considered as "Cost Plus." Engineering is one of the areas which is becoming fixed price. If used wisely, a fixed price contract can be an advantage to a contractor since the higher risk justifies higher profit. The object of management, then, should be to minimize the risk while maintaining the higher profit. One phase of decreasing the risk is to insure that cost estimates are complete and accurate.

An Engineering Problem

What does this mean to the engineer? For one thing, it means that he will be contributing more and more to cost estimating efforts. Not only will he have to estimate engineering time, but he will be called on to provide guidance for the bids of production and support activities. The average engineer regards activities of this type as a task to be avoided or done with minimum effort so that he can get on with design work. His attitude has likely been that estimating is an unimportant chore. "What if the bid is off by a factor of 50%; we can always get more money where that came from, can't we?" This attitude was never defensible, but with a fixed price contract it can be disastrous for the company. Obviously too many disasters of this type can jeopardize an individual's job.

Fig. 1: Estimating engineering efforts is not an easy job.



Accurate estimating and bidding is a necessity of modern business. If a contractor bids too high, he can price himself out of competition. Too low a bid can be just as bad, since it can reduce or eliminate profit.

The engineer is trained to use the scientific approach to problem solving from the very beginning of his education. It becomes second nature to him to define the problem, break it down into its smallest integral parts, find the knowns and then proceed to logically solve the problem. If estimating costs is regarded as another engineering problem, half the battle is won. No one is expected to gaze into a crystal ball and arrive at a cost figure for doing a job. What is expected is that the engineer will analyze the problem logically and then, based on his knowledge and experience, give his best estimate of the effort needed to accomplish the task.

Estimating engineering efforts is not an easy job at best. This discussion offers no substitute for experience and hard work. But, it is hoped that it will give the engineer an approach or method that will assist in making the task less painful.

An Engineering Approach

In the engineering approach to problem solving, the first step is to define the problem. In estimating an engineering task, the same procedure is used. As a first step, satisfy these questions:

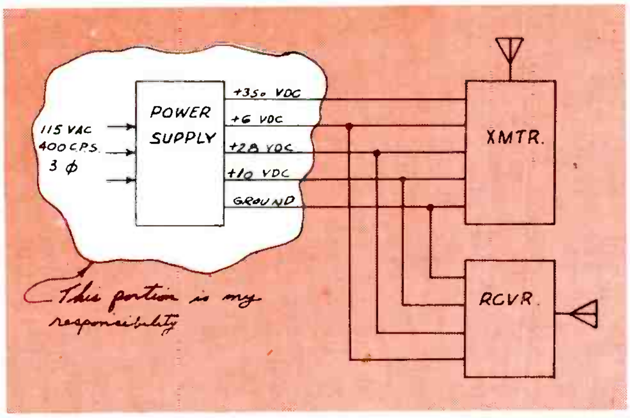
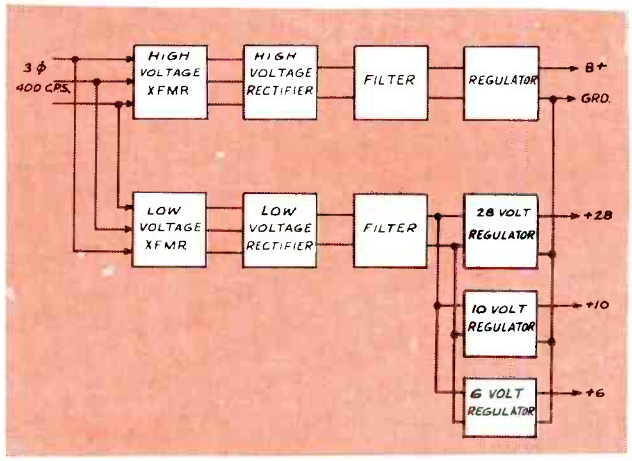


Fig. 2: This excerpt taken from the engineer's notebook illustrates the first step in preparing to estimate engineering effort.

Fig. 3: Breakdown of power supply portion for estimating purposes.



(1) Exactly what is needed?
(2) Who is going to do it?
(3) When must it be done?

The answers to these questions are found in many places and need initiative to dig them out. Some possible sources are: A statement of work, the technical proposal, a bidders briefing meeting, and the contract administrator.

We are now getting to the heart of the problem. With the above information at hand, get down to specifics. What is the equipment to be designed? Is it an adaptation of something already built? Or, is it something which is new and different? Analyze the information available. Start with a block diagram of the system and break it down into its separate entities. As an example, assume that the equipment cost to be estimated is the power supply drawer of a system. Referring to Fig. 2, it is found that:

(1) The input power shall be 400 cps, 115 vac, 3 phase.

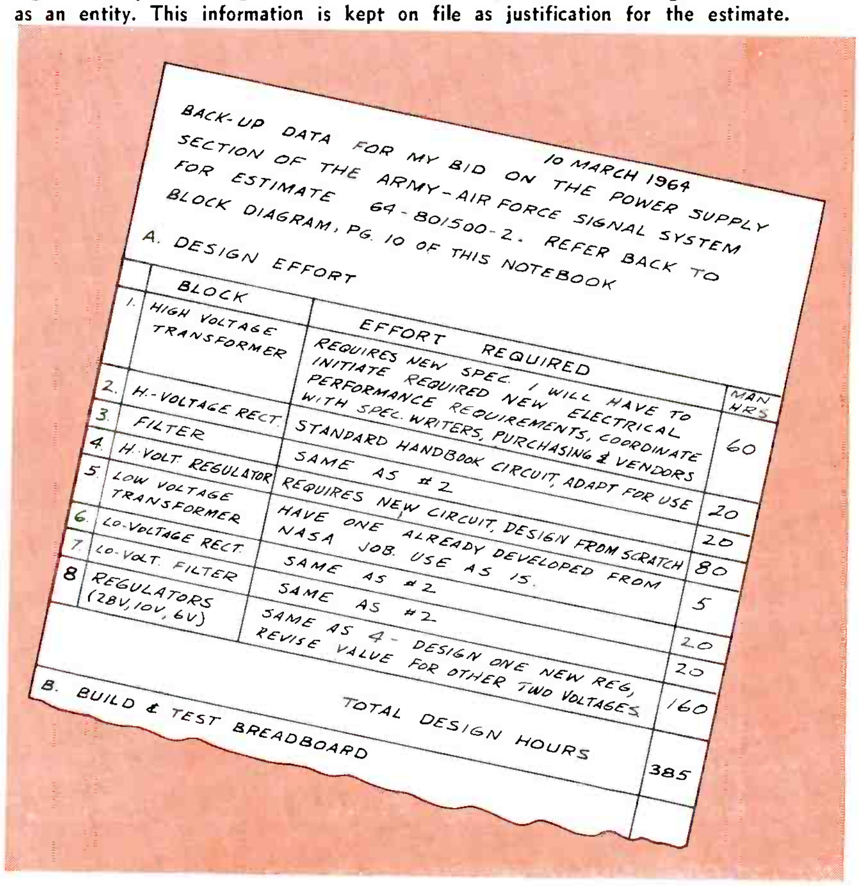
(2) The outputs must be 6.3, 10, 28 and 350 vdc, all regulated to within ±5%, with 5% ripple allowable.

Based on the technical proposal, past experience and/or other dictates, arrive at the breakdown shown in Fig. 3. This is now the basis for the estimate. Keep it in the files for reference.

For the present, forget about the overall system and concentrate on the blocks, one at a time. How about that high voltage transformer? Does one now exist of a similar design or must a vendor search be conducted? Or, will it be a special transformer, for which specs must be written? This will take time, but how much? Mark down an estimate, and go on to the next block. Do the same type of analysis on the high voltage rectifier. Has a similar circuit been used before that can be adapted for this job? Again, write down the best estimate of the design time and go on to the next. Continue this process until each block has been considered. Again, keep this information, Fig. 4.

The estimate is now in a form to "spread" the design time by manhours, manweeks, or manmonths, as needed. Total design effort is found by adding up the blocks. Taking the schedule and available manpower into consideration, this total time is spread

Fig. 4: Excerpt from engineer's notebook shows method of considering each block as an entity. This information is kept on file as justification for the estimate.



BACK-UP DATA FOR MY BID ON THE POWER SUPPLY SECTION OF THE ARMY-AIR FORCE SIGNAL SYSTEM — 10 MARCH 1964

FOR ESTIMATE 64-801500-2. REFER BACK TO BLOCK DIAGRAM, PG. 10 OF THIS NOTEBOOK

A. DESIGN EFFORT

BLOCK	EFFORT REQUIRED	MAN HRS
1. HIGH VOLTAGE TRANSFORMER	REQUIRES NEW SPEC. I WILL HAVE TO INITIATE REQUIRED NEW ELECTRICAL PERFORMANCE REQUIREMENTS, COORDINATE WITH SPEC. WRITERS, PURCHASING & VENDORS	60
2. H.-VOLTAGE RECT.	STANDARD HANDBOOK CIRCUIT, ADAPT FOR USE	20
3. FILTER	SAME AS #2	20
4. H. VOLT REGULATOR	REQUIRES NEW CIRCUIT, DESIGN FROM SCRATCH	80
5. LOW VOLTAGE TRANSFORMER	HAVE ONE ALREADY DEVELOPED FROM NASA JOB. USE AS IS.	5
6. LO-VOLTAGE RECT.	SAME AS #2	20
7. LO-VOLT. FILTER	SAME AS #2	20
8. REGULATORS (28V, 10V, 6V)	SAME AS 4 - DESIGN ONE NEW REG, REVISE VALUE FOR OTHER TWO VOLTAGES	160
	TOTAL DESIGN HOURS	385

B. BUILD & TEST BREADBOARD

COST ESTIMATING (Concluded)

out over the desired time span, Fig. 5. Generally, the engineer is only required to estimate in man-hours, not dollars.

So much for estimating design effort. There will probably be breadboard and engineering models to be built and tested. Use the same approach for these, going through piece by piece, estimating the effort for each portion. Again spread total hours over the desired time span.

COST ESTIMATE FOR PROPOSAL 64-801500-2

PREPARED BY: Ima Engineer
DATE: 11 MARCH 64

ACTIVITY	LABOR GRADE	MONTH J	F	M	A	M	J	J	A	S	O	N	D		TOTAL MAN HRS
DESIGN POWER SUPPLY SECTION	ENGINEER	173	173	39											385
BUILD & TEST OF BREADBOARD MODEL	ENGINEER	–	40	10	–										50
	TECHNICIAN	–	173	80	–										253
BUILD & TEST OF ENGINEERING MODEL	ENGINEER	–	–	10	40										50
	TECHNICIAN	–	–	90	173										263

Fig. 5: This cost estimate spread sheet shows total effort broken down by month.

Material Needs

Besides manhours, components will be needed to build the models. Check all of the work statements carefully to determine if there are any ground rules for the type of components which must be used. Remember that the engineer is the only one who knows what parts are needed. Estimate the time needed to list them, answer questions from Purchasing and insure that they will arrive when needed.

In estimating the material needs, go back to the basic block diagram and visualize what will be needed in each block. The exact parts count will probably not be known, nor will the exact type of component needed. But, the engineer knows more about that block than anyone else. He should go through each block and list his concept of the parts.

Usually the engineer will only be required to estimate the type and quantity of parts. Most companies will have experienced estimators who can supply the prices. If so, make their work easier by giving them all the information possible. Also, remember to plan on spares.

Other Considerations

When the estimate is this far along, the hardest part of the job is completed. But don't let down with an "engineering approach" yet. Many things are expected of an engineer. These are sometimes minor, but time consuming details that should be considered part of the job and estimated. Some of these details to consider are:

(1) Travel—for conferences with customer, subcontractors, the field, etc.

(2) Meetings—technical and status reviews with the customer and your own management.

(3) Reports—engineering reports, status reports, quarterly reports, final reports, both internal and for the customer.

(4) Coordination with other internal activities, not directly involved in the design. This would include handbook writers, spares people, spec writers, factory engineers and others.

(5) Design Reviews—both customer and internal. These take time for preparation.

When submitting a cost estimate, it is usually desirable for the engineer to include his own statement of work. This should tell exactly what he proposes to do, and what assumptions he has made. This serves several purposes. First, it enables a person reviewing the estimate to know exactly what effort has been bid. It will prevent duplication. Second, it protects the individual in that any effort not included in the bid is "out of scope" and should not be expected of him without additional funds. Last, it affords the engineer a chance to review exactly what he planned to do when asked to do the job which he bid.

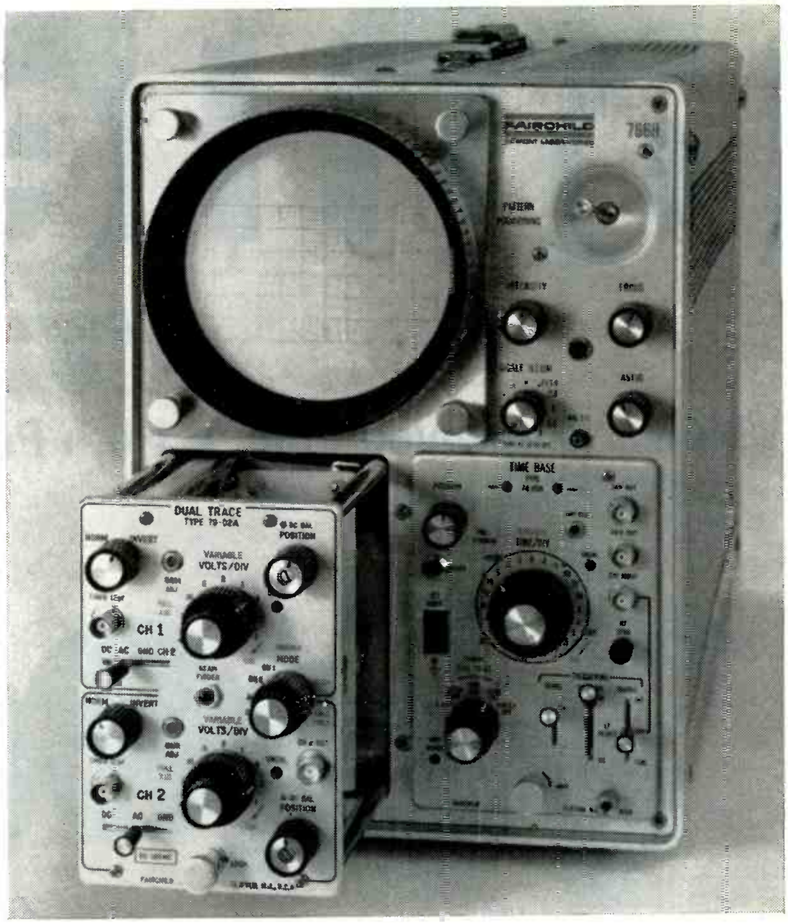
An engineering estimate should be as realistic as possible. A middle of the road approach should be observed. Estimates should not be overly pessimistic, nor should they be overly optimistic. If management feels that they need a cushion for protection, they will add it overall. Conversely, if they want to gamble in order to cut costs to insure winning the contract, they are in a better position to do it.

Think ahead to the next project while still working on the present one. Observe how long it takes to perform certain functions. How long did it take the technician to wire that chassis? How long did it take to design that amplifier circuit? How long to test it? By building up experience, each bid should be easier to estimate than the last.

If possible, when the engineer gets to work on the job which he estimated, he should compare actual costs to estimated. Where were they high? And where were they low? Why? Were any factors forgotten?

Each company has its own organizations, procedures, and forms for cost estimating. But, there is one common denominator throughout the industry. That is that the individual must provide his evaluation of what it takes to do the job. For engineering tasks, it falls upon the engineer. If it is regarded as a part of the engineer's duties and given the same approach as a design problem, everyone benefits. Bear in mind than an engineering approach is applicable to all sorts of problems, and perhaps the next time an estimate is needed it won't appear to be quite so imposing a task.

BEFORE YOU BUY ANY HIGH FREQUENCY SCOPE, KNOW HOW FAIRCHILD CAN HELP WITH YOUR TEST AND MEASUREMENT PROBLEMS



Fairchild's new Type 79-02A dual trace 100 mc plug-in for Series 765 oscilloscopes meets a need for higher speed and sensitivity in computer, radar and communications work, or for solid-state investigations. The Series 765 with its other available plug-ins is not only the most versatile of present-day scopes; its capabilities can always be updated because all functional circuitry is in the plug-ins—the main frame serves only as a power supply and indicator. While the Series 765 is in every sense a quality laboratory instrument, its transistorized circuitry, rugged construction, light weight and complete reliability make it preferred for use in the field.

Compare these features of the Type 79-02A plug-in with the capabilities of any wide band dual trace scope.

BANDWIDTH
Direct coupled: 0.1V/cm DC to 100 mc down 3 db; 0.01 V/cm DC to 90 mc down 3 db. Capacitively coupled: Down 3 db at 16 cycles. Rise time: 3.5 nanoseconds.

SENSITIVITY
Calibrated Operation Provided by frequency-compensated attenuator in 8 steps of 1, 2 and 5 sequence from 10 mv/cm to 20 v/cm when Variable Gain Control is set to CAL. Attenuator accuracy is 3%.

Uncalibrated Operation Continuously variable from 10 mv/division to 50 v/division. Variable Gain Control permits 2½ to 1 continuous sensitivity adjustments between VOLTS/DIV steps, extends the 20 v/div. range to 50 v/div.

Cascaded Amplifier Operation 1 mv/cm down 3 db at 50 mc.

Output Range Full 6 cm of vertical output scan. Overshoot and preswing each less than 3% at 4 cm scan.

INPUT DATA
Input Coupling Channel 1 has 4-position lever switch for AC, DC, Off, and Channel 2 cascaded input.
Channel 2 has 3-position lever switch for AC, DC and Off.

Polarity Inversion Provided in both channels.

Input Impedance 1 megohm shunted by 14 pf.

CALIBRATION
Attenuator includes CAL position which applies line-frequency square wave signal directly to input amplifier. Calibration is accomplished with 4 divisions of vertical deflection.

OPERATING MODES
5-position switch enables selection of following displays: (1) Channel 1 only; (2) Channel 2 only; (3) Channels 1 and 2 switched alternately; (4) Channels 1 and 2 in chopped operation. Two chopping rates are provided, selected by internal slide switch. Chopping rates are 100 Kc and 1 Mc. Switching transients on CRT are automatically blanked; (5) Channel 1 plus Channel 2. Use of polarity inversion switches give Channel 1 minus Channel 2 or Channel 2 minus Channel 1 presentation.

SIGNAL DELAY
230-nsec balanced distributed bifilar helical delay line is sufficient to view base line and leading edge of the signal triggering the time base.

INTERNAL TRIGGER SELECTION
Two-position switch provides trigger take-off after the switch stage (Ch. 1 and Ch. 2) or take-off from Channel 2 only.

CASCADED AMPLIFIER OPERATION
An internal connection from Channel 2 OUT connector to Channel 1 input connector can provide series connection of Channel 1 and Channel 2 amplifier. Channel 2 OUT BNC provides output of 0.5v.

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bulletin

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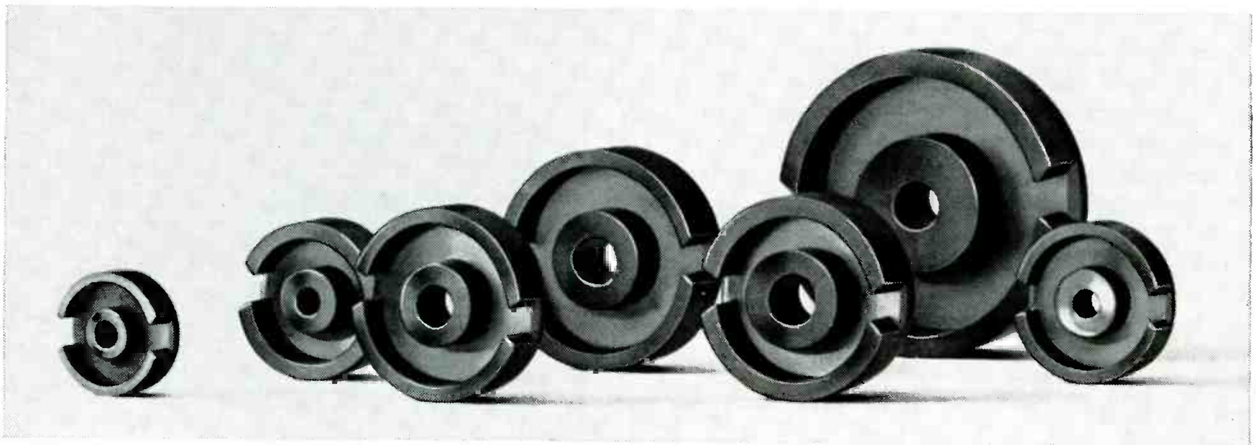
New...Improved Line of High Purity Ferrite Pot Cores!



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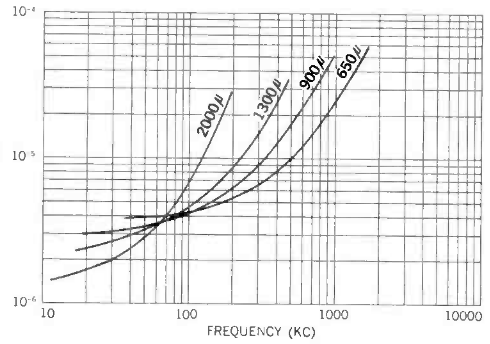

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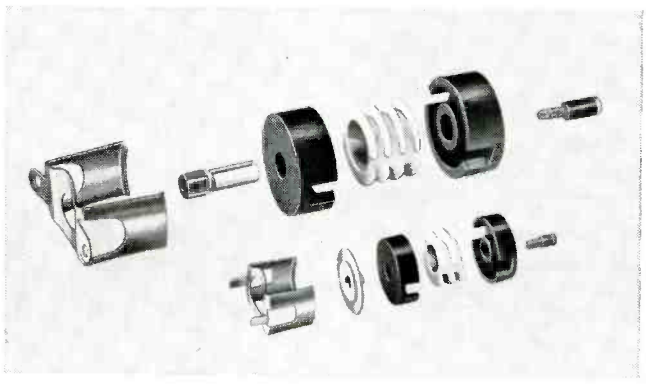

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FEATURE

Using Delay Lines In Time Sequential Circuits

This article tells how to design the circuitry used with a delay line memory. Here, Boolean input functions are simplified through the use of Vietch diagrams. Two practical examples are given to aid the designer and to prove this method's validity.

By HANN F. NAJJAR Engineer, Minneapolis-Honeywell, EDP Division, 151 Needham St., Newton Highlands 61, Mass.

A PROCEDURE IS DESCRIBED to show how sequential circuits of digital counters can be logically designed when using delay lines as memory devices. Logical characteristics of a delay line memory are used to derive the input functions pertaining to binary stages used in the design. These Boolean input functions are simplified by means of Vietch diagrams to eliminate all redundant variables. This minimizes components of decision circuits ("OR" and "AND" gates) and improves reliability of the overall circuit. Significance of this approach lies in the manner in which the subject matter is delivered. This is characterized by a rigorous mathematical treatment shown by two practical examples justifying the method's validity.

* * *

The approach is based on normal digital methods to describe the performance of sequential operations when using sonic delay lines. Time sequential operations are performed by counting circuits which are either electronic or electromechanical.

The former uses sonic delay lines to store data which, in this case, is in binary form. The concept of storing digital information in delay lines is based on the logical properties of a delay line flip-flop. These properties can be best described in tabular form (see Table 1).

Logical Properties

Q_t and Q_{t+1} represent the states of a delay line at two bit-time intervals t and $t+1$. D designates the input to the delay line, which is normally in the form of a Boolean function. Numbers in this table are regular binary 1's and 0's. "1" indicates the state that is allowed (true state) and "0" the false state (forbidden). If 1's and 0's are expressed in terms of their variables, then binary 1 is represented by "normal" variable and binary "0" by "negated" variable.

Stating the Problem

The input may be found if Q_t and Q_{t+1} are known. Thus, in all design problems, it is essential to know precise needs of the problem before thinking of the solution. The problem should specify the sequence in which the digital counter is required to count. It should also specify how far the count is to go. This will lead the designer to write the counting states in binary form, and also to find the minimum number of binary stages needed. In other words, after the problem is defined, the designer must be able to determine the complexity of the circuit he is about to design; thus knowing the amount of equipment in the design and its inherent statistical reliability. Thus, in almost all design problems of this type of digital system, two things must be clear before the problem is investigated. These are: (1) sequence of operation, and (2) value of "X" as to whether it is equal or less than 2^n; where X is the number of counts in the specified sequence and n is the number of binary stages.

Operation

The delay line memory is usually used with a driver amplifier and an output amplifier to form a standard logic module, Fig. 1. The driver supplies a constant drive to the delay line at a given pulse width. Losses in the line are made up in the output amplifier which consists of several linear amplification stages, an emitter follower, and two threshold stages used to set constant signal to noise ratio. Since the output pulse is normally narrow, it must be applied to a pulse stretcher circuit, such as that of Fig. 2. This circuit is used as a set-reset circuit by applying

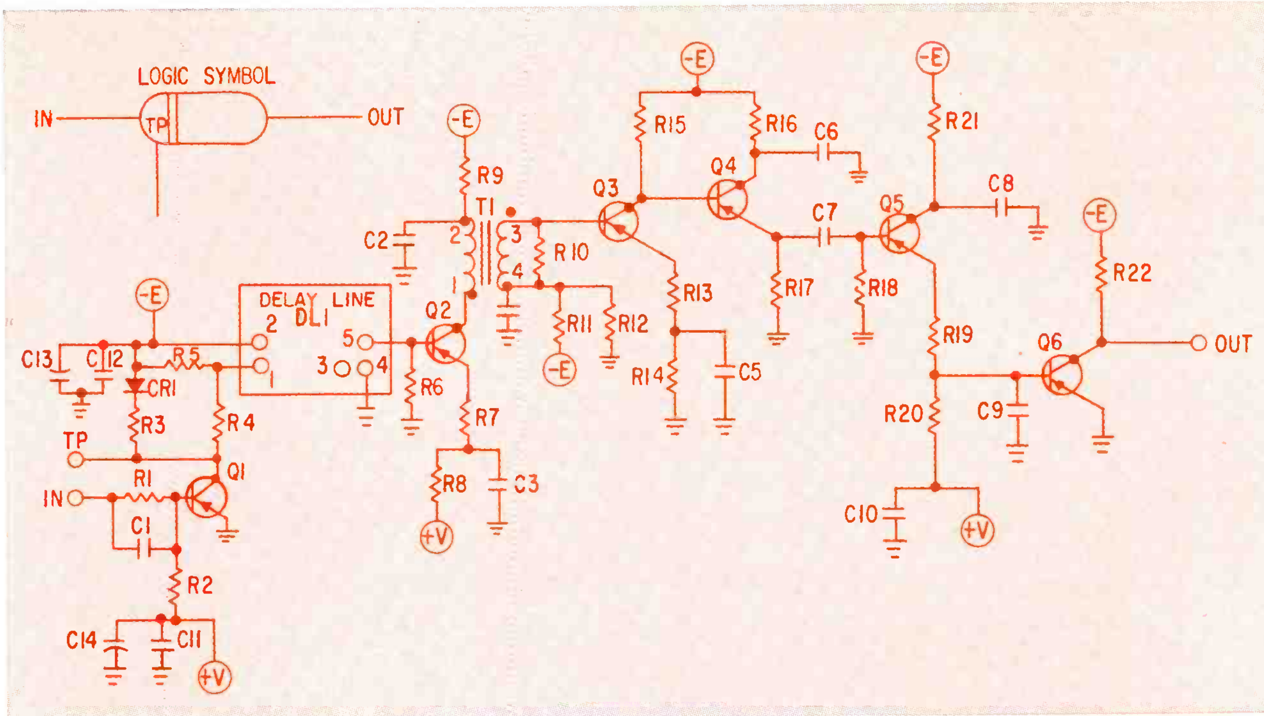


Fig. 1: Delay line circuit diagram and logic symbol.

inputs from clock pulse generator and delay line at terminals S and R respectively. Terminal R allows a dc reset to be applied. This is provided from the output terminal of the delay line circuit of Fig. 1. Logic symbol for the combination of Figs. 1 and 2 is shown in Fig. 3.

When reference is made to delay line, refer to Fig. 3. When more than one delay line is used in a circuit, the delay lines must be assigned weights. These weights are decimal numbers 2 raised to nth order; where n is a positive integer (0, 1, 2, 3, 4, 5—etc.). For example, the first binary stage will be assigned $2^0 = 1$; the second $2^1 = 2$, the third $2^2 = 4$, and the $n + 1$ stage will be assigned 2^n. The number of binary stages determines the maximum number of counting states allowable, and vice-versa. Thus, if X designates the number of counting states specified in a design problem and n the number of binary stages, the following two cases may arise:

(1) The case when $X = 2^n$, i.e. when all the counting states are needed. This is the simplest of the two since no feedback paths exist. Thus, derivation of the input-equations becomes simple. In fact, the detailed procedure which is involved in the design, and the use of Vietch diagrams may be eliminated when such a case arises. The designer will soon find himself in a position to make certain judgements in deriving the input equations.

(2) The case when $X < 2^n$. This is the case when the feedback is to be provided from one stage to another. This occurs because certain counts are skipped, thus presenting redundant conditions which must be taken into account during design. These unused counts, or "don't-care" conditions, are used to simplify the input functions. This minimizes the equipment needed and increases inherent reliability of the overall system. The fact that redundant conditions exist makes the design procedure more involved. The difficulty presented in this type of problem is easily overcome by avoiding tedious methods and pursuing, instead, the rigorous steps which are presented later in the section on "Design Procedure and Examples."

A solution to any problem that falls under this section requires the knowledge of Vietch diagrams and their use in simplifying Boolean functions. Here is a brief account of what they are and how one can use them in logic design problems.

A *Vietch diagram* consists of a matrix of blocks. The number of these is determined by numbers of columns and rows which are each a function of the number of variables involved in a problem. The variables correspond to the binary stages. The blocks correspond to the counting states which result from raising decimal 2 to the number of binary stages. In other words, the number of blocks in a Vietch diagram is always 2^n regardless whether the problem falls under case one or case two. Each block corresponds to a number that can be expressed in terms of its variables. Thus, the idea of using these diagrams is to combine certain blocks, under certain rules, to eliminate one or more variables. This reduces the function to a minimum. The rules that govern the combination of certain blocks are:

(1) Combine adjacent blocks to eliminate one variable. (*Continued on following page*)

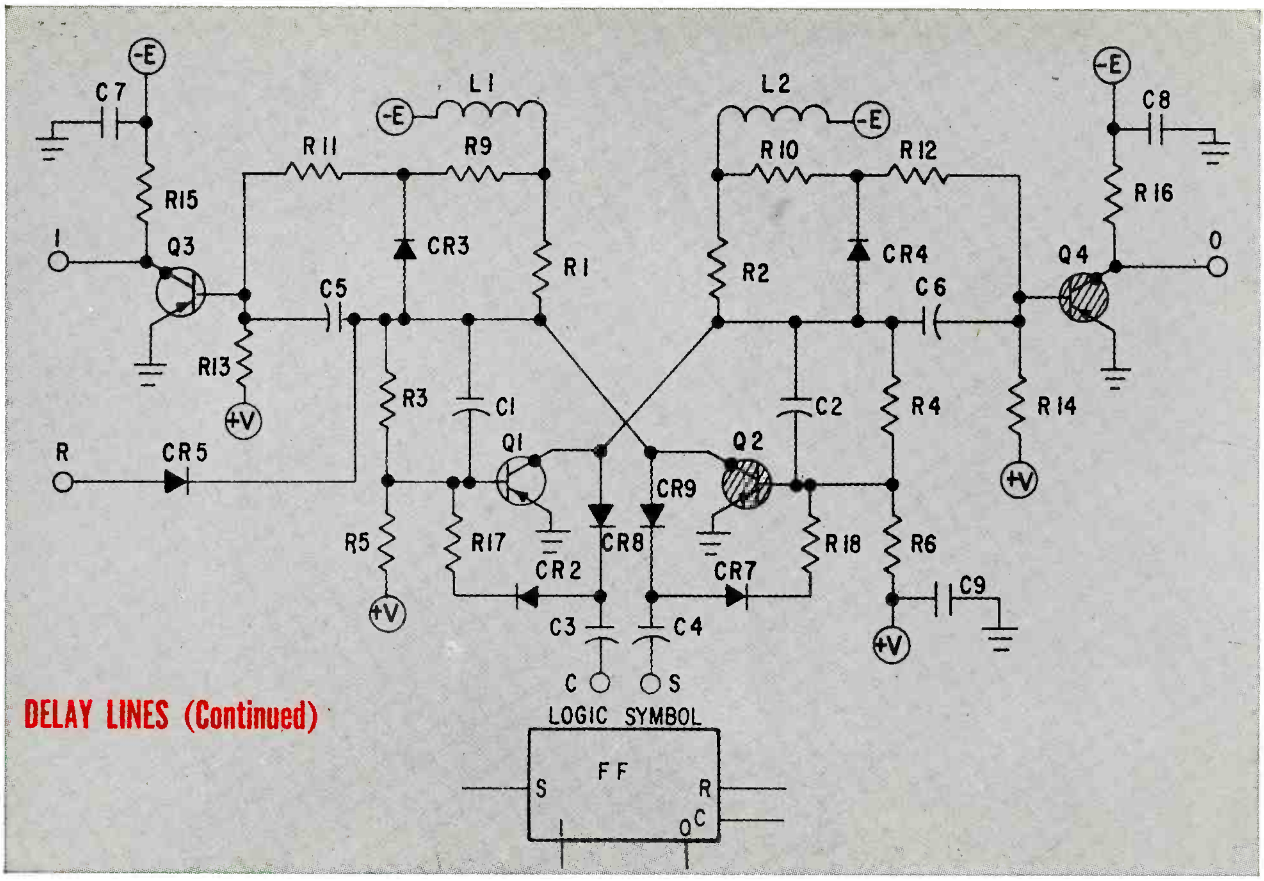


Fig. 2: High power, high speed flip-flop circuit diagram and logic symbol.

(2) To eliminate two variables.

(a) Combine adjacent blocks in a full column or row.

(b) Combine adjacent blocks in a 2 x 2 group.

(3) To eliminate three variables combine adjacent blocks in a 2 x 4 group.

(4) To eliminate four variables combine the adjacent blocks in a 4 x 4 group.

Examples in the next section show how minimization is done through Vietch diagrams.

In the sequential circuits of delay line counters one more factor has to be considered. This factor is the input pulse or sampling pulse which is normally carried from some switching circuit by an input wire *P*, designating the pulse. At each bit-time, *P* may be either binary "0" or "1." The state of delay lines in the circuit depends on whether *P* is "0" or "1." Their state changes when *P* is "1" and remains unchanged when *P* is "0." In general, therefore, if the states of the delay line memories are designated at two successive bit-times t and $t+1$ by Q_t and Q_{t+1} respectively, then the two states are equal whenever the sampling pulse is a binary signal "0," and are different whenever the sampling pulse is a binary signal "1." This important characteristic is used in the examples of the next section. It is evident that the sampling pulse *"P"* should be treated as a separate variable, and thus one would anticipate the input functions to involve *P*. Therefore, the first thing to bear in mind is the signal on *P*, as to whether it is "0" or "1."

Design Procedure and Examples

The method of performing logic design of sequential counter circuits using delay line memories is demonstrated here.

Any design problem must specify the number of counting states and their sequence. When this information is specified, the first step is to find the number of binary stages necessary to fulfill the design needs. These stages must then be assigned weights to designate the first stage by the least significant digit and the last stage by the most significant digit. For example, if the number and sequence of the counting states are "O" through "15," then as the number is "16," a four bit-delay line counter is needed to perform this operation. If these four binary stages are assigned the weights 1, 2, 4 and 8 such that the first and last stages designate least and most significant digits, then the second step is to write down the counting states and display them in tabular form over two successive bit-times t and $t + 1$. The "truth" table embracing these counts should also include the input pulse *"P,"* or the sampling pulse. Remember that the states at bit-time $t + 1$ differ from those at bit-time t only when *P* is carrying a binary signal "1." There will be no change if *P* is "0." Remember also that *P* is to be treated as a separate and independent variable. Thus, in the example under consideration the problem is treated as if there were "5" variables instead of "4."

If Q_t represents the states at time t, and Q_{t+1}

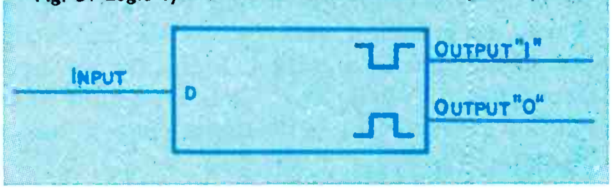
those at next bit-time $t + 1$, then truth table 2 should show how the input-pulse P is related to the counting states at the two successive bit-times.

As seen in Table 2, the states at bit-time t remain unchanged during next bit-time $t + 1$ so long as P is "O." But, as soon as P changes from "0" to "1," the states Q_t and Q_{t+1} are no longer the same. Also, for each state of Q_t there are two corresponding states of Q_{t+1}, one when $P = 0$ and the other when $P = 1$. Thus, Table 2 can be rearranged as shown in Table 3. Table 3 can also be represented pictorially, as shown in Fig. 4.

Fig. 4 shows the sequence of operation and also progress from one state to another when the state of the sampling pulse "P" is defined. The diagram is an exact equal of Table 2 and its modified version, Table 3.

The third step in design is to find the binary input

Fig. 3: Logic symbol for the combination of Figs. 1 and 2.



conditions of each stage, corresponding to all the states of Table 3. These binary input-signals are found by comparing each state of Q_t and Q_{t+1} with those in Table 1. The comparison is made on the basis of an individual delay line so that all the binary signals pertaining to $D1$, $D2$, $D4$ and $D8$ are obtained for the cases $P = 0$ and $P = 1$. Final input conditions along with Table 3 are displayed in Table 4. From Table 4, it is clear that the input binary signals are found by comparing states Q_t and Q_{t+1} of each delay line with those in Table 1. For example, in the top row, Q_t and Q_{t+1} of delay line 1 are both "0" when $P = 0$, and thus, (from Table 1) such a case occurs only when the input D is "0." But when $P = 1$, the state of this delay line at bit-time $t + 1$ is "1" and thus, the input corresponding to this case is "1." The remaining rows are compared by the same reasoning to find the remaining binary signals of $D1$ when P is "0" and "1." The process is also repeated for $D2$, $D4$ and $D8$.

Having completed all the input conditions of Table 4, the next step is to plot all the 1's pertaining to each input in the Vietch diagram. The designer is reminded again to consider the input pulse P as a separate variable, thereby increasing the number of variables to "5." Thus, two Vietch diagrams each 4 x 4 blocks, are needed; one pertaining to the case when $P = 0$ and the other when $P = 1$. The two diagrams are, in effect, one with 4 x 8 blocks. Thus, a 4 x 8 diagram is used for each input function, and the 1's pertaining to each of these inputs is plotted.

For example, $D1$, the input function to the first stage is plotted for $P = 0$ and $P = 1$ in the Vietch diagram of Fig. 7. The left half of the diagram (under $\overline{P}$) is used to plot the 1's pertaining to $D1$ when $P = 0$, and the right half (under P) is used to plot the 1's when $P = 1$.

The next step is to combine certain blocks to eliminate one or more variables; thus reducing the input function to minimum.

In this case, the first two columns are combined to yield $1 \cdot \overline{P}$, and the last two are combined to yield $\overline{1} \cdot P$. Thus, the overall input function designated by $D1$ is the sum of the two.

i.e. $$D1 = 1 \cdot \overline{P} + \overline{1} \cdot P \qquad (1)$$

The form of Eq. 1 is well known to logic designers since it expresses an "Exclusive OR" function. This function is characterized by the fact that a pulse ap-

(*Continued on following page*)

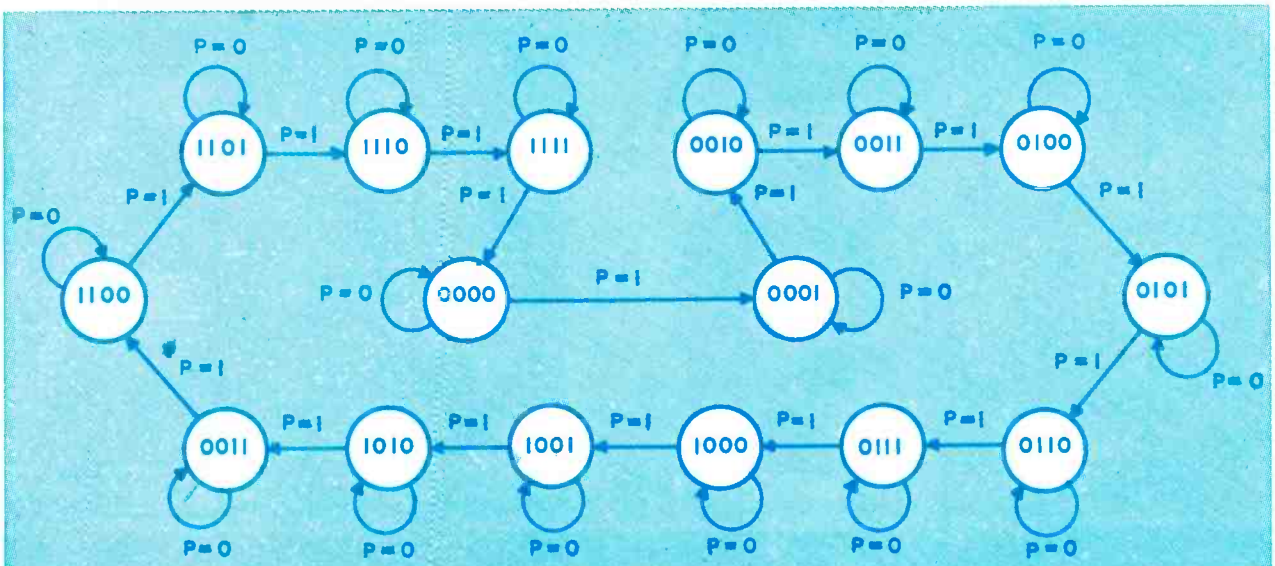


Fig. 4: Diagram is an exact equal of Table 2 and its modified version Table 3.

pears at the input $D1$ only when either of the two variables is at the binary "1" level. In other words, $D1$ is true when 1 or P are binary "1," and false when both 1 and P are either "1" or "0."

The same procedure as that described for $D1$, is applied to deriving the Boolean input function $D2$. The plotted Vietch diagram for $D2$ is shown in Fig. 8. The blocks in the first and second rows of the left half are combined to yield $2 \cdot \bar{P}$, and the four blocks occupying the bottom left corner of the right half are combined to yield $1 \cdot \bar{2} \cdot P$. Also the four blocks in the top right corner of each half are combined with each other to yield $\bar{1} \cdot 2$. Thus, the Boolean input function to the second stage designated by $D2$ is given by:

$$\begin{aligned} D2 &= 2 \cdot \bar{P} + 1 \cdot \bar{2} \cdot P + \bar{1} \cdot 2 \\ &= 2 \cdot (\bar{1} + \bar{P}) + \bar{2} \cdot 1 \cdot P \\ &= 2 \cdot \overline{1 \cdot P} + \bar{2} \cdot 1 \cdot P \qquad (2) \end{aligned}$$

Eq. 2 also has the form of an "exclusive OR" function if one looks upon the product $1 \cdot P$ (1 and P) as a new variable A, and $\overline{1 \cdot P}$ as negated variable $\bar{A}$ (not A). As for finding the input equation for the third stage, again we plot all the binary 1's pertaining to D_4 and the result of plotting these 1's appears in Fig. 9. From this diagram the input function $D4$ can be written directly as

$$D4 = 4 \cdot \bar{P} + 4 \cdot \bar{1} + 4 \cdot \bar{2} + 1 \cdot 2 \cdot \bar{4} \cdot P$$

This is obtained by combining the second and third columns to yield $4 \cdot \bar{P}$, the third and seventh to yield $4 \cdot \bar{1}$ and the eight blocks corresponding to $1\,\bar{2}\,4\,8\,\bar{P}$, $\bar{1}\,\bar{2}\,4\,8\,\bar{P}$, $1\,\bar{2}\,4\,\bar{8}\,\bar{P}$, $\bar{1}\,\bar{2}\,4\,\bar{8}\,\bar{P}$, $1\,\bar{2}\,4\,8\,P$, $\bar{1}\,\bar{2}\,4\,8\,P$, $1\,\bar{2}\,4\,\bar{8}\,P$, and $\bar{1}\,\bar{2}\,4\,\bar{8}\,P$ to yield $4 \cdot \bar{2}$. Also, the blocks corresponding to $1\,2\,\bar{4}\,\bar{8}\,P$ and $1\,2\,\bar{4}\,8\,P$ are combined to yield $1 \cdot 2 \cdot \bar{4} \cdot P$. The above input equation can be rewritten as

$$\begin{aligned} D4 &= 4 \cdot (\bar{P} + \bar{1} + \bar{2}) + \bar{4} \cdot 1 \cdot 2 \cdot P \\ &= 4 \cdot \overline{1 \cdot 2 \cdot P} + \bar{4} \cdot 1 \cdot 2 \cdot P \end{aligned}$$

Eq. 3 also represents an "Exclusive OR," since the product $1 \cdot 2 \cdot P$ could be considered as a new variable, B, and $\bar{1} \cdot \bar{2} \cdot \bar{P}$ as $\bar{B}$.

Last, but not least, the input equation to the fourth stage can be derived in much the same way as the previous three stages. The method again, is to plot in the Vietch diagram all the binary 1's of $D8$ (see Table 4). The final result appears in Fig. 10.

The middle two rows of the left half are combined to yield $8 \cdot \bar{P}$, the third row from the top is combined to yield $\bar{2} \cdot 8$, and the eight-blocks corresponding to $\bar{1}\,2\,4\,8\,\bar{P}$, $\bar{1}\,2\,\bar{4}\,8\,\bar{P}$, $\bar{1}\,\bar{2}\,4\,8\,\bar{P}$, $\bar{1}\,\bar{2}\,\bar{4}\,\bar{P}$, $\bar{1}\,2\,4\,8\,P$, $\bar{1}\,2\,\bar{4}\,8\,P$, $\bar{1}\,\bar{2}\,4\,8\,P$, and $\bar{1}\,\bar{2}\,\bar{4}\,P$ are combined to yield $\bar{1} \cdot 8$. Also, the two middle blocks of the first column are combined with those of the fourth, fifth and eighth columns to yield $\bar{4} \cdot 8$ plus the block corresponding to $1 \cdot 2 \cdot 4 \cdot \bar{8} \cdot P$. Thus, the input Boolean function corresponding to the fourth stage is given by

$$\begin{aligned} D8 &= 8 \cdot \bar{P} + \bar{2} \cdot 8 + \bar{1} \cdot 8 + \bar{4} \cdot 8 + 1 \cdot 2 \cdot 4 \cdot \bar{8} \cdot P \\ &= 8 \cdot (\bar{1} + \bar{2} + \bar{4} + \bar{P}) + \bar{8} \cdot 1 \cdot 2 \cdot 4 \cdot P \\ &= 8 \cdot \overline{1 \cdot 2 \cdot 4 \cdot P} + \bar{8} \cdot 1 \cdot 2 \cdot 4 \cdot P \qquad (4) \end{aligned}$$

This equation also represents an "exclusive OR" function if the product $1 \cdot 2 \cdot 4 \cdot P$ is considered as a new variable C and $1 \cdot 2 \cdot 4 \cdot P$ as $\bar{C}$.

If a fifth stage is used, the input equation to this stage would also be an "exclusive OR" function. Thus, in general, one can make a justified assumption

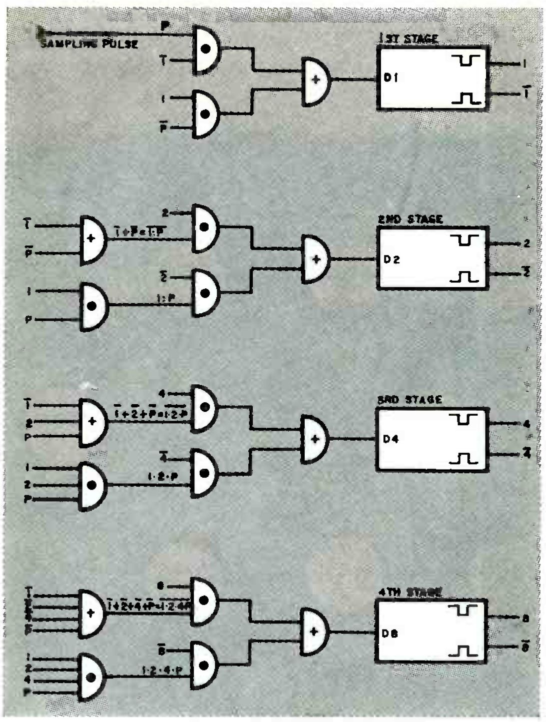


Fig. 5: Standard four-bit delay line counter.

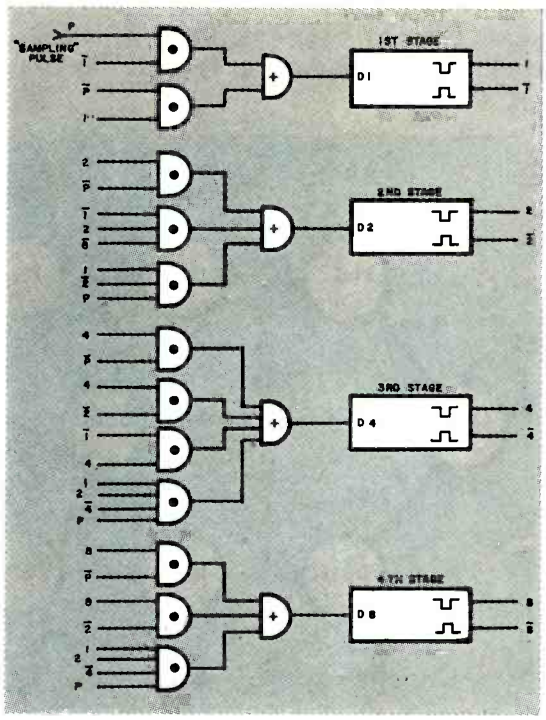


Fig. 6: Standard delay line binary decade.

by stating that if the number and sequence of the counting states follows the case $X = 2^n$, then the input function to each stage is an "exclusive OR."

The final step in the design is to find logic circuit representation of all input equations. In the example under discussion, the logic circuit representation of input Eqs. 1 through 4 is shown in Fig. 5. Interconnections are discarded for simplicity.

It can be concluded from the example that when the number and sequence of the counting states is 0, 1, 2, 3, 4, — 2^n and recycle to "0," the Boolean input function to each stage is an "exclusive OR." Thus, whenever such a case arises in the design, write down the input equations directly, thereby eliminating all the tedious steps involved in the design. But, if the number of states is less than 2^n, (i.e. certain states are to be skipped in the design) feedback paths have to be provided. These can be easily found by following the foregoing design procedure.

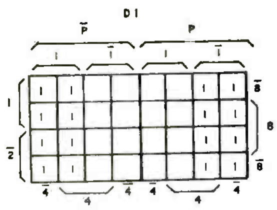
As an illustration to the case $X < 2^n$, let us consider a practical example of a decade counter using four-bit delay lines as binary stages. The counter is to count 1 through 10 and recycle to 1. Since the number of counting states is 10, four binary stages are needed to perform this operation. But since the four stages give rise to 2^4 states, six of these states have to be skipped; namely state of 0, and 11 through 15. These six states are used to simplify the input functions, thus reducing the number of components in the design to minimum. This greatly improves the inherent reliability of the sequential circuit. To show how the circuit of this type of counter can be designed, let's begin by writing the truth table for the counting sequence over two bit-time intervals t and $t + 1$. The truth table at bit-time t corresponds to two tables at bit-time $t + 1$, one for the case $P = 0$ and the other for the case $P = 1$. Also, write all the input conditions of the four stages as binary 1's and O's. The method of deriving the input conditions here is the same as that applied to Table 4. These results are shown in Table 5. The state diagram showing the first three columns in Table 5 is shown in Fig. 11.

As in the first example, the next step in the design here also is to plot all the binary 1's of each input. For the first stage, the plotted Vietch diagram pertaining to $D1$ when $P = 0$ and 1 is as shown in Fig. 12. Diagram shows that the remaining unused counts (0 and 11 thru 15) are treated as "don't-care" conditions, designated by letter X, and are plotted to simplify the input function. The input Boolean function for $D1$ can be written as:

$$D1 = 1 \cdot \overline{P} + \overline{1} \cdot P \qquad (5)$$

This is obtained, as before, by combining the first two columns to yield $1 \cdot \overline{P}$ and the last two columns to yield $\overline{1} \cdot P$.

It should be clear how the unused counts can help the designer to combine certain blocks (under given rules) to eliminate one or more variables thus simplifying the input function.



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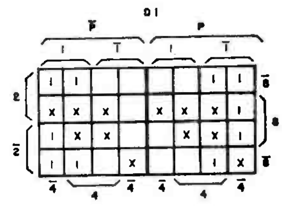

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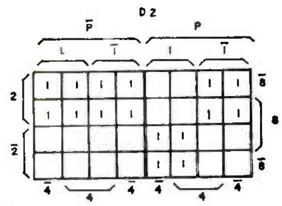

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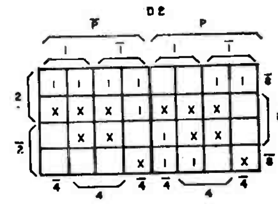

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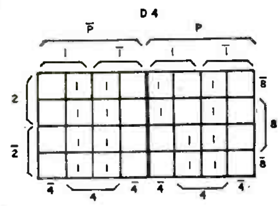

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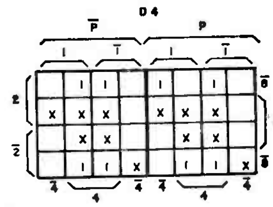

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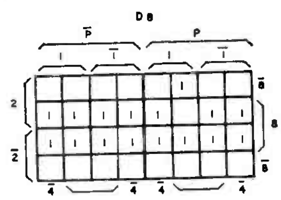

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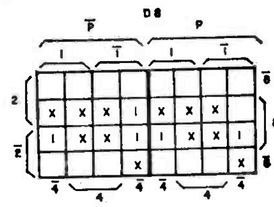

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Figs. 7-10 and 12-15: These are Vietch diagrams which are used to simplify Boolean functions. They are referred to in the text.

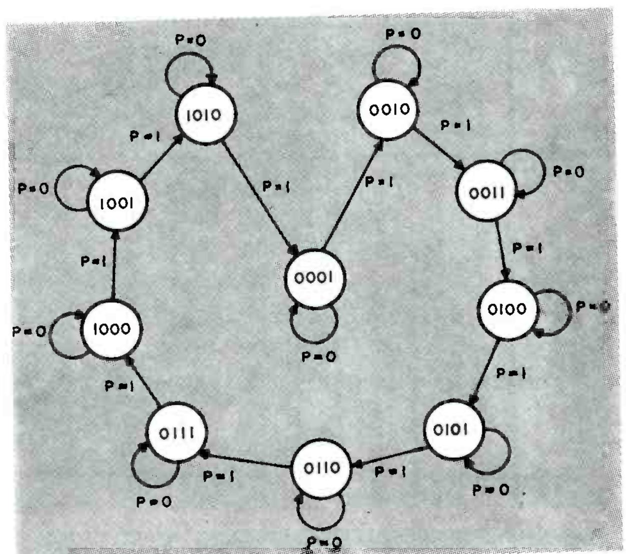

Fig. 11: State diagram shows the first three columns in Table 5.

A similar approach can be applied to the remaining three stages to obtain their input equations. Thus, to avoid repetition, it suffices to present categorically, the plotted Vietch diagrams of the remaining three stages and their pertinent input equations. These are shown in Fig. 13.

$$\begin{aligned} D2 &= 2 \cdot \overline{P} + 1 \cdot \overline{2} \cdot P + \overline{1} \cdot 2 \cdot \overline{8} \\ &= 2 \cdot (\overline{P} + \overline{1} \cdot \overline{8}) + \overline{2} \cdot 1 \cdot P \\ &= 2 \cdot \overline{P}\,(1 + 8) + \overline{2} \cdot 1 \cdot P \end{aligned} \qquad (6)$$

DELAY LINES (Concluded)

$$D4 = 4 \cdot \overline{P} + 4 \cdot \overline{2} + \overline{1} \cdot 4 + 1 \cdot 2 \cdot \overline{4} \cdot P$$

$$= 4 \cdot (\overline{P} + \overline{2} + \overline{1}) + \overline{4} \cdot 1 \cdot 2 \cdot P$$

$$= 4 \cdot \overline{1 \cdot 2 \cdot P} + 4 \cdot 1 \cdot 2 \cdot P \qquad (7)$$

$$D8 = 8 \cdot \overline{P} + 8 \cdot \overline{2} + 1 \cdot 2 \cdot \overline{4} \cdot P$$

$$= 8 \cdot (\overline{P} + \overline{2}) + 1 \cdot 2 \cdot \overline{4} \cdot P$$

$$= 8 \cdot \overline{2 \cdot P} + 1 \cdot 2 \cdot \overline{4} \cdot P$$

Throughout derivations of Eqs. 2 through 4 and 6 through 8, certain well known theorems in Boolean Algebra were used to express these equations in their final forms. The most often used is that of Demorgan. His theorem can be demonstrated in the following two examples:

(1) The complement of a sum of n variables, say

$$\overline{(A + B + C + D + \text{-----})} = \overline{A} \cdot \overline{B} \cdot \overline{C} \cdot \overline{D} \cdot \text{-----}.$$

(2) The complement of a product of n variables, say

$$\overline{(A \cdot B \cdot C \cdot D \cdot \text{-----})} = \overline{A} + \overline{B} + \overline{C} + \overline{D} + \text{-----}.$$

Going back to our design problem, we should be able to draw logic circuit equivalent to Eqs. 5 through 8. This is shown in Fig 6. Interconnections have also been eliminated in this circuit for further simplification. Note that the feedback path in this problem exists between the last and second stages (see also Eq. 6). Inputs to the remaining stages are somewhat parallel to those of the previous example.

Table 1

Q_T	Q_{T+1}	D
0	0	0
0	1	1
1	0	0
1	1	1

Table 2

Q_T	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q_{T+1}	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
	2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
	4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0
	8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 3 / **Table 4**

Q_T	Q_{T+1}	Q_{T+1}								
	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$
8 4 2 1	8 4 2 1	8 4 2 1	D1	D1	D2	D2	D4	D4	D8	D8
0 0 0 0	0 0 0 0	0 0 0 1	0	1	0	0	0	0	0	0
0 0 0 1	0 0 0 1	0 0 1 0	1	0	0	1	0	0	0	0
0 0 1 0	0 0 1 0	0 0 1 1	0	1	1	1	0	0	0	0
0 0 1 1	0 0 1 1	0 1 0 0	1	0	1	0	0	1	0	0
0 1 0 0	0 1 0 0	0 1 0 1	0	1	0	0	1	1	0	0
0 1 0 1	0 1 0 1	0 1 1 0	1	0	0	1	1	1	0	0
0 1 1 0	0 1 1 0	0 1 1 1	0	1	1	1	1	1	0	0
0 1 1 1	0 1 1 1	1 0 0 0	1	0	1	0	1	0	0	1
1 0 0 0	1 0 0 0	1 0 0 1	0	1	0	0	0	0	1	1
1 0 0 1	1 0 0 1	1 0 1 0	1	0	0	1	0	0	1	1
1 0 1 0	1 0 1 0	1 0 1 1	0	1	1	1	0	0	1	1
1 0 1 1	1 0 1 1	1 1 0 0	1	0	1	0	0	1	1	1
1 1 0 0	1 1 0 0	1 1 0 1	0	1	0	0	1	1	1	1
1 1 0 1	1 1 0 1	1 1 1 0	1	0	0	1	1	1	1	1
1 1 1 0	1 1 1 0	1 1 1 1	0	1	1	1	1	1	1	1
1 1 1 1	1 1 1 1	0 0 0 0	1	0	1	0	1	0	1	0

Table 5

Q_T	Q_{T+1}	Q_{T+1}								
	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$	$P=0$	$P=1$
8 4 2 1	8 4 2 1	8 4 2 1	D1	D1	D2	D2	D4	D4	D8	D8
0 0 0 1	0 0 0 1	0 0 1 0	1	0	0	1	0	0	0	0
0 0 1 0	0 0 1 0	0 0 1 1	0	1	1	1	0	0	0	0
0 0 1 1	0 0 1 1	0 1 0 0	1	0	1	0	0	1	0	0
0 1 0 0	0 1 0 0	0 1 0 1	0	1	0	0	1	1	0	0
0 1 0 1	0 1 0 1	0 1 1 0	1	0	0	1	1	1	0	0
0 1 1 0	0 1 1 0	0 1 1 1	0	1	1	1	1	1	0	0
0 1 1 1	0 1 1 1	1 0 0 0	1	0	1	0	1	0	0	1
1 0 0 0	1 0 0 0	1 0 0 1	0	1	0	0	0	0	1	1
1 0 0 1	1 0 0 1	1 0 1 0	1	0	0	1	0	0	1	1
1 0 1 0	1 0 1 0	0 0 0 1	0	1	1	0	0	0	1	0

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This method of analyzing circuits may be applied to any network whether active, passive, bilateral or unilateral. The method is particularly useful when several linear systems must be combined.

Matrix Algebra Simplifies Circuit Analysis

THIS ARTICLE DEMONSTRATES the use of matrix algebra in circuit analysis since the matrix notation is a condensed manner of writing systems of linear equations. Advantages of this notation are particularly great when several linear systems have to be combined.

* * *

Let us begin with some definitions and notations:

(1) A matrix is a rectangular array of scalar quantities. An (mxn) matrix is an array of mn elements consisting of m rows and n columns. This is called a square matrix if $m = n$, a rectangular matrix if $m \neq n$.

(2) Two matrices are equal if and only if all of their corresponding elements are respectively equal.

(3) The product of any two matrices, (mxn) matrix A and (nxp) matrix B, is an (mxp) matrix C and is written

$$C=AB$$

and obtained by multiplying n^{th} row elements of A by corresponding p^{th} column elements of B and adding the resulting product to get Cnp. For example:

$$AB = \begin{pmatrix} 2 & 3 \\ 1 & 4 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 1 \\ 2 & 1 & 0 \end{pmatrix} = \begin{pmatrix} 8 & 3 & 2 \\ 9 & 4 & 1 \\ 2 & 1 & 0 \end{pmatrix} = C$$

(4) The sum or difference of two (mxn) matrices A and B is another (mxn) matrix every element of which is the sum of the difference of the two elements that occupy corresponding places in A and B.

(5) Multiplication by scalar. Multiply all elements by the scalar symbolically.

$B = KA$ if and only if $Bmn = KAmn$ for all m and n.

(6) The transpose of a matrix A is that matrix A_t formed by interchanging the rows and columns of A. Symbolically $B = A_t$ if and only if $Bmn = Amn$ for all m and n. For example:

$$A = \begin{pmatrix} 5 & 4 \\ 1 & 2 \\ 4 & 6 \end{pmatrix}$$

$$A_t = \begin{pmatrix} 5 & 1 & 4 \\ 4 & 2 & 6 \end{pmatrix}$$

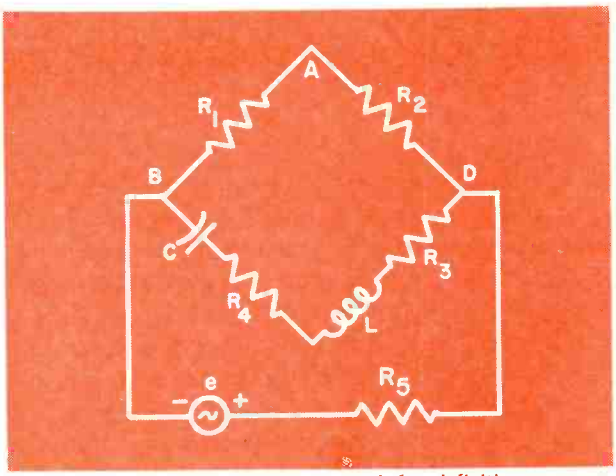

Fig. 1: This electrical network is used for definitive purposes.

(7) Row matrix—only one row.

(8) Column matrix—only one column.

(9) Null matrix—all elements zero.

(10) Unity matrix—a square matrix of any order in which the elements in the principal diagonal are 1 and all the other elements are zero and is given the symbol I. For example:

$$I = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

(11) The inverse of a square matrix A is that matrix A^{-1} which when multiplied by A gives the unit matrix I, i. e.,

$$AA^{-1} = A^{-1}A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} = I.$$

Applications to Electrical Networks

Let us consider an electrical network composed of several elements of R, L, C. In this network we define:

(1) *Node*—a terminal, it is usually common to two or several branches. Examples are Nodes, A, B, C. . . . of Fig. 1.

(2) *Branch*—one or several passive elements such

MATRIX ALGEBRA (Continued)

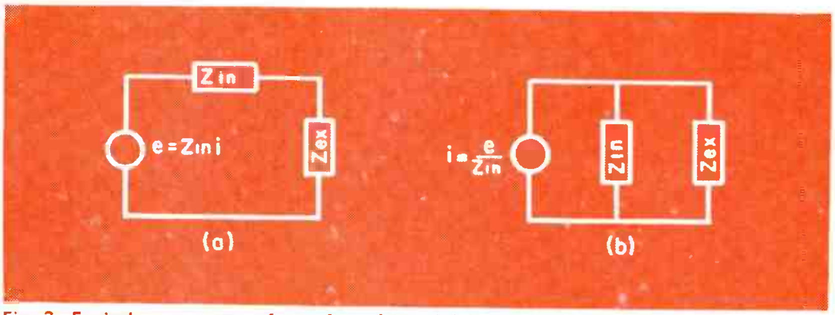

Fig. 2: Equivalent generator forms for voltage (a) and current (b) generators.

as R, L, C, connected in series between two nodes. Examples are branches AB, AD, DC . . . Fig. 1.

(3) *Mesh or Loop*—a closed contour arbitrarily drawn on a network diagram. It may consist of any number of branches in series, say contour $ABCD$, Fig. 1.

(4) *Current and voltage sources*—every driving element in our network can be considered either voltage or current source. This is true since some driving elements are more naturally considered as current sources than voltage sources. A pentode tube may be cited as an example. Actually, in a linear network, every constant-current generator has an equivalent constant-voltage generator, and vice versa. Thus, as far as conditions external to the generator are concerned, it can be considered either as a current or a voltage generator.

The equivalent generator forms are shown in Fig. 2.

In the steady state at any one frequency, it is clear that the voltage generator with its internal impedance Z_{in} in series, will deliver the same voltage and current to the external impedance Z_{ex} as will the current generator with Z_{in} in shunt, provided that

$$e = Z_{in} \cdot i$$

Here e is the strength of the voltage generator in Fig. 2a and i is the strength of the current generator in Fig. 2b. The voltage across Z_{ex} in either case is

$$\frac{Z_{ex}\, e}{Z_{ex} + Z_{in}}$$

while the current through Z_{ex} in either case is

$$\frac{Z_{in}\, i}{Z_{ex} + Z_{in}}$$

Loop or Mesh Analysis

Suppose we have a complicated network that we want to analyze. The complete solution for the current and voltages in this network can be obtained by finding the solution to the equations which we get by applying Kirchoff's Laws to the net.

Kirchoff's First Law is automatically applied by using the concept of loop current. According to this concept, the network is made up of a number of closed loops, say loops I, II, III. . . . In these closed loops, the currents i_1, i_2, i_3, . . . are all considered to be positive when flowing in the same direction, either clockwise or counterclockwise. Accordingly, in any impedance which is common to more than one loop, the current which is flowing is the algebraic sum of the circulating currents of all the loops of which it is a common member.

Kirchoff's Second Law will then be applied to the network and it is applied successively to each independent loop in the net. This gives us a number of equations equal to the number of the independent loops in the net. These equations had to be solved to obtain all the unknown variables.

Applying the matrix method we can greatly simplify the procedure. Here we had to write only three simple matrices:

(1) Voltage of the network is a one column matrix V whose components V_i are the voltages summed in the i^{th} loop.

(2) Current circulating in the loop is a one column matrix I whose component I_i is the current in the i^{th} loop.

(3) Impedance of the network is the square matrix Z, defined by

$$ZI = V$$

and looks like

$$Z = \begin{Bmatrix} Z_{11} & Z_{12} & Z_{13} & \cdots & Z_{1n} \\ Z_{21} & Z_{22} & Z_{23} & \cdots & Z_{2n} \\ Z_{31} & Z_{32} & Z_{33} & \cdots & Z_{3n} \\ \vdots & & & & \\ Z_{n1} & Z_{n2} & Z_{n3} & \cdots & Z_{nn} \end{Bmatrix}$$

where Z_{nn} is the sum of the impedance in the n^{th} loop.

Z_{in} is the common impedance between the i^{th} and the n^{th} loop. It is worth noting that the Z matrix is symmetrical across its main diagonal.

To illustrate the above method let us solve the following problem.

If C and D are short-circuited together in Fig. 3 and a unit step of voltage is applied between A and B, find the current which flows through the shorting bar $(i_1(t))$.

Assuming quiescent initial conditions and using Laplace transformation with $S = j\omega$, we can write

$$\begin{Bmatrix} R & -R & 0 \\ -R & R + \frac{1}{SC} + SL & -SL \\ 0 & -SL & +SL \end{Bmatrix} \begin{Bmatrix} i_3(s) \\ i_2(s) \\ i_1(s) \end{Bmatrix} = \begin{Bmatrix} 1/S \\ 0 \\ 0 \end{Bmatrix}$$

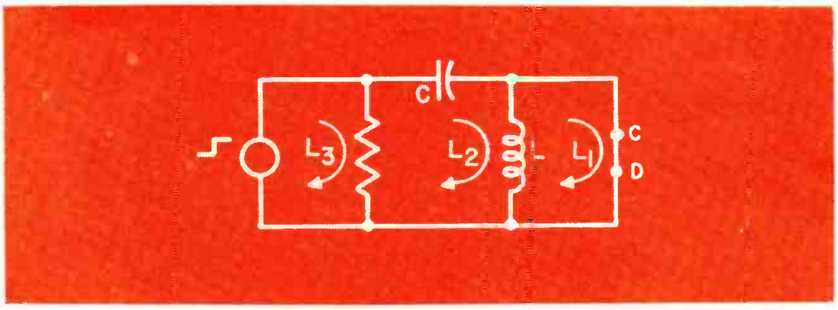

Fig. 3: Current which flows through L_1 is found by a method described in the text.

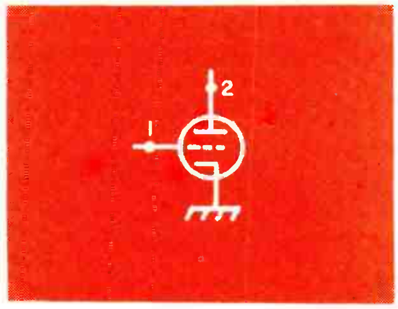

Fig. 4: G matrix for a triode is derived.

From here $i_1(s)$ can be obtained directly.

$$i_1(s) = \frac{\begin{vmatrix} R & -R & 1/S \\ -R & R + \frac{1}{SC} + SL & 0 \\ 0 & -SL & 0 \end{vmatrix}}{\begin{vmatrix} R & -R & 0 \\ -R & R + \frac{1}{SC} + SL & -SL \\ 0 & -SL & SL \end{vmatrix}}$$

$$i_1(s) = C$$

$$i_1(t) = C\,\delta\,(t)$$

Node Analysis

The method of loop analysis is not always the best method for solving network problems. It is sometimes preferable to use the complementary method known as node analysis. In node analysis the potentials of the various nodes with respect to some reference node take the place of the loop currents used in loop analysis. Current generators are used instead of voltage generators and admittances reciprocal of impedances are used. Finally, the network equations are the expressions of Kirchoff's First Law, namely the equality of currents going into and out of each node.

Matrix method is very powerful using this method. Here the three matrices are:

(1) Current entering a network is a one column matrix I whose components I_i are the currents into the i^{th} terminal.

(2) Voltage of the network is a one column matrix V whose components V_i are the voltages between the i^{th} terminal and an arbitrary reference terminal.

(3) Admittance of the network is the square matrix G, defined by

$$I = GV$$

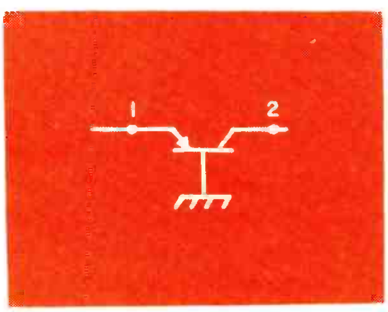

Fig. 5: The G matrix for a transistor is derived in the text.

where G is exactly as the Z matrix except instead of impedances we use admittances.

Before illustrating the method let us derive the G matrix for a triode and a transistor.

For the triode in Fig. 4 the matrix is

$$G = \begin{pmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{pmatrix} = \begin{pmatrix} \frac{\partial ig}{\partial eg} & \frac{\partial ig}{\partial ea} \\ \frac{\partial ia}{\partial eg} & \frac{\partial ia}{\partial ea} \end{pmatrix}$$

$$G = \begin{pmatrix} 0 & 0 \\ gm & \frac{1}{rp} \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ gm & gp \end{pmatrix}$$

where gm is the transconductance of the triode and gp is the plate conductance.

The indefinite admittance matrix of the triode is obtained by adding a third row and a third column to make the sum of every row and column equal to zero.

$$G = \begin{pmatrix} 0 & 0 & 0 \\ gm & gp & -gm-gp \\ -gm & -gp & gm+gp \end{pmatrix}$$

For a transistor the matrix is (see Fig. 5)

$$G = \begin{pmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{pmatrix}$$

Where 1 denotes the emitter terminal and 2 the collector terminal and the base is grounded.

(*Continued on page 70*)

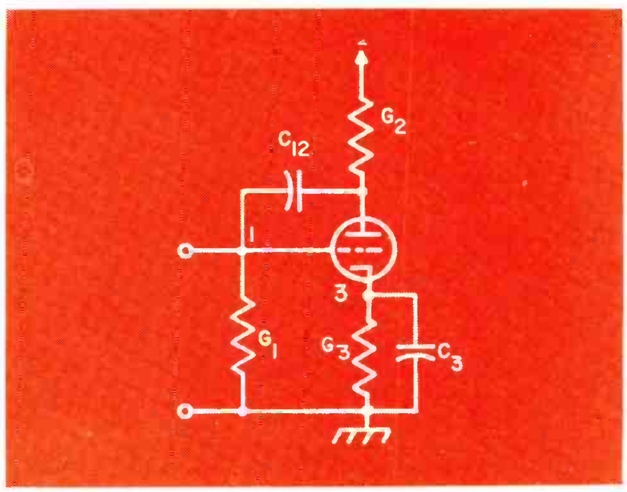

Fig. 6: The circuit at the right is used to illustrate the node matrix method.

MATRIX ALGEBRA (Concluded)

The Y's values are obtained by measurements of a certain operating point.

To illustrate the node matrix method let us analyze the circuit shown in Fig. 6.

The admittance matrix is given by

$$G = \begin{pmatrix} G_1+j\omega C_{12} & -j\omega C_{12} & 0 \\ -j\omega C_{12}+gm & G_2+j\omega C_{12}+gp & -gm-gp \\ -gm & -gp & G_3+j\omega C_3+gm+gp \end{pmatrix}$$

Gain of the circuit is given by

$$H_{12} = \frac{e_2}{e_1} = \frac{G^{12}}{G^{11}}$$

where G^{12} and G^{11} are the cofactors of G.

$$\text{So}\quad H_{12} = \frac{\begin{vmatrix} -j\omega C_{12}+gm & -gm-gp \\ -gm & G_3+j\omega C_3+gm+gp \end{vmatrix}}{\begin{vmatrix} G_2+j\omega C_{12}+gp & -gm-gp \\ -gp & G_3+j\omega C_3+gm+gp \end{vmatrix}}$$

The input impedance is given by

$$Z_{11} = (G^{-1})_{11} = \frac{G^{11}}{G}$$

and hence

$$Z_{11} = \frac{\begin{vmatrix} G_2+j\omega C_{12}+gp & -gm-gp \\ -gp & G_3+j\omega C_3+gm+gp \end{vmatrix}}{\begin{vmatrix} G_1+j\omega C_{12} & -j\omega C_{12} & 0 \\ -j\omega C_{12}+gm & G_2+j\omega C_{12}+gp & -gm-gp \\ -gm & -gp & G_3+j\omega C_3+gm+gp \end{vmatrix}}$$

The output impedance is given by

$$Z_{22} = (G^{-1})_{22} = \frac{G^{22}}{G}$$

and hence

$$Z_{22} = \frac{\begin{vmatrix} G_1+j\omega C_1 & 0 \\ -gm & G_3+j\omega C_3+gm+gp \end{vmatrix}}{\begin{vmatrix} G_1+j\omega C_{12} & -j\omega C_{12} & 0 \\ -j\omega C_{12}+gm & G_2+j\omega C_{12}+gp & -gm-gp \\ -gm & -gp & G_3+j\omega C_3+gm+gp \end{vmatrix}}$$

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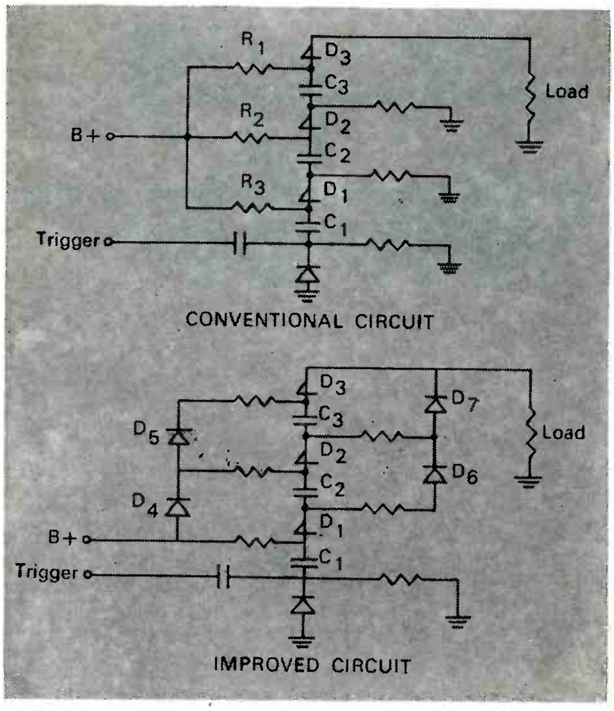
CIRCUIT-WISE

HV PULSE MODULATOR

An efficient parallel-charging, high-voltage pulse modulator, where low-voltage rating of components is an advantage, was needed. Conventional circuits for producing high-voltage output pulses dissipate a portion of their theoretical output power across the charging resistors. A modified circuit was designed using diodes that effectively disconnect the charging resistors from the circuit during the discharge cycle.



NASA TECH BRIEF No. 64-10024.

For further information contact: Technology Utilization Officer, Manned Spacecraft Center, P.O. Box 1537, Houston, Tex. 77001.

The diagrams of a conventional circuit and the improved circuit show three parallel stages for charging and a single stage for discharging the capacitors C_1, C_2, and C_3 in series through the load. Either of the circuits can theoretically use as many stages as needed to produce an output voltage of the desired magnitude.

In the conventional circuit shown, C_1, C_2, and C_3 are charged to the B+ voltage through charging resistors R_1, R_2, and R_3. A trigger pulse applied to C_1 biases the four-layer diode D_1 to a low-impedance state, opening a series conductive path from C_1 through D_3 to impress the sum of the voltages across the 3 capacitors onto the load. The output pulse, however, also appears across the charging resistors, where I^2R losses occur. Since the maximum voltage drop occurs in R_1, this resistor cannot be a low-voltage component, and the effect of voltage gradients must be considered. Currents larger than the diode holding current will flow through the charging resistor, making it difficult to turn the circuit off before the capacitors are completely discharged.

In the improved circuit, the diodes D_4, D_5, D_6, and D_7 effectively disconnect the charging resistors from the circuit during the discharge cycle. This circuit thus allows the use of low-voltage charging resistors and eliminates power loss through these resistors, as well as the problems of voltage gradients and power turnoff associated with the conventional circuit.

ELECTRON MICROSCOPE TV SYSTEM

A PRACTICAL SYSTEM WHICH APPLIES TV METHODS to the electron microscope has been announced by RCA. The new system can boost the instrument's visible magnification power ten-fold to 2,000,000 times.

The new TV system intensifies and displays on standard TV monitors the images formed when specimens are examined in the microscope. It was recently demonstrated at RCA's laboratories in Camden, N. J.

The normal electron microscope is capable of direct magnification of 200,000 times. Addition of TV increases this potential to 200,000,000 times. But it should be noted that most observations in electron microscopy are made at magnifications well below theoretical limits.

Major advantages of the system are:

(1) Radiation-sensitive materials, which until now were destroyed or altered by the instrument's electron beam, can now be examined. This is done by directing a relatively weak beam at the specimen and by electronically intensifying the correspondingly weak image until it is visible.

(2) Changes which occur in specimens as their temperature is raised or lowered, as they are stretched, or as a magnetic field is applied, can now be viewed and simultaneously recorded on TV tape for playback immediately or at any future time. Thus, events that happen only once or whose exact time of occurrence cannot be predicted can now be studied.

(3) With image intensification, still photos now can be be snapped in a fraction of a second. The normal method of exposing film directly to the electron image requires several seconds per picture

(4) TV display, using multiple viewing monitors, allows students to share the microscopist's view of the specimen. And, histories can be recorded on TV tape for classroom showings.

The TV system enhances the usefulness of the microscope image by providing a greater degree of picture contrast. Specimens that are inherently difficult to distinguish because of poor contrast can be made to project "good pictures" that are meaningful.

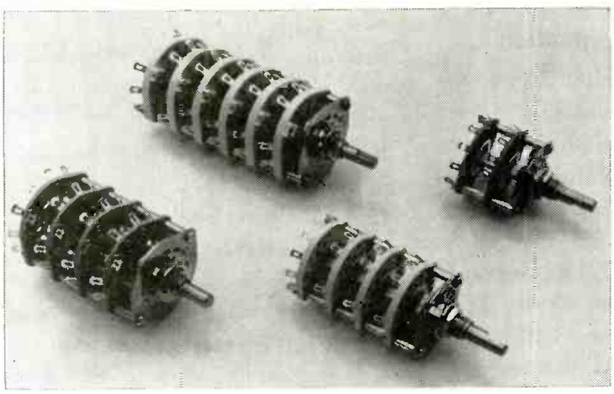
The TV system uses an all-transistorized TV camera with a 3-in. image orthicon for pickup. The system can be used with any RCA microscope in the EMU-3 series which includes all instruments delivered since 1954.

Specimen images appearing on the electron microscope's screen are brightened by an image intensifier and the resulting brighter image is picked up by a sensitive TV camera. The TV pictures can be shown on a TV monitor—as in this study of an oat leaf structure.

NEW CONCEPT IN SWITCH DESIGN

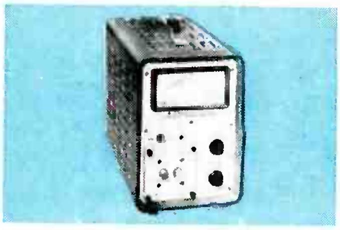
"MODULINE" IS A NEW CONCEPT in rotary switch design and fabrication by Oak Mfg. Co. that makes available more than 2 million variations of semi-custom rotary switches which can be assembled and shipped seven days after receipt of order. This compares with a normal lead time of four to seven weeks.

Switches are quickly designed by the OEM engineer using a unique catalog and easy-to-use order card. Engineering drawings are eliminated since the design characteristics of a switch are designated by a series of eight numbers (16 digits), which are selected from the catalog and written on the order card.



The first number entered in the order card designates the basic switch size and detent angle and the engineer can select from eight sizes, numbers "01" through "08." The second number entered in the order card designates the sections, contacts and switching configurations — 104 choices. The third number indicates the number of rotational stops required.

When all numbers have been filled in on the order card, it is completed by including the name of the company, quantity of switches required, delivery date, and other details. The order is completed and shipped back to the customer within seven days after receipt of the order. Oak Mfg. Co., Div. of Oak Electro/Netics Corp., Crystal Lake, Ill.



Establishing a Microwave Calibration Laboratory

Calibration equipment normally found in the lab will not perform many needed measurement and calibration functions. This is due to the difference in measurement methods between lumped constant, low frequency circuits and distributed parameter, high frequency or microwave circuits.

By PAT TUCCIARONE, Sr. Applications Engineer, PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

THIS ARTICLE PROVIDES TECHNICAL INFORMATION relative to the organization and establishment of a microwave secondary standards laboratory for the calibration of coaxial equipment in the frequency range 500 MC to 10 GC. The methods for making Voltage Standing Wave Ratio (VSWR) and Impedance, Attenuation, Power and Frequency measurements are outlined and accompanied by block diagrams.

* * *

Accuracies attainable using the equipments and methods shown are:

Attenuation: Direct Method: ±0.1 db/10 db step with a maximum cumulative error of ±0.2 db over a 40 db range. If Substitution Method: ±.05 to ±0.2 db/10 db step; over a 100 db range, ±0.5 db maximum error.

Power: A maximum RMS error of ±4% over a power range of 30 μw to 1 w.

VSWR: For a VSWR of less than 10:1, ±0.02; for a VSWR greater than 10:1, ±1%.

Frequency: Accuracy is ±0.002% at 5 MC checkpoints; ±0.03% between 5 MC checkpoints.

These accuracies apply to any measurement in the frequency range of 500 MC to 10.0 GC.

Much of the equipment specified will also be usable in making measurements in waveguide systems at the frequencies indicated as well as at higher bands. Also, much of the instrumentation is used in more than one setup.

Measurement of Attenuation

Measurement of attenuation requires that the attenuating device be inserted into a matched system. Fig. 1 shows the voltmeter-bolometer or direct method of calibrating attenuators. This method is simple, fast, universal, and accurate over a range of about 40 db. It is used in many microwave calibration labs to calibrate precision variable attenuators.

The tuner is adjusted for a minimum VSWR to insure that the load impedance, as seen by the unknown, is a match. After the matched condition is obtained a reference level is established on the output indicator (VSWR amplifier connected to the square law detector). The unknown is then inserted into the transmission line and the value of the inserted attenuation is read directly from the output indicator in db.

Fig. 2 shows attenuation calibration using the i-f substitution method. In this method, the r-f signal is heterodyned with a local oscillator (LO) signal in a linear mixer. After mixing, the resulting i-f frequency (30 MC) passes through an i-f standard attenuator so that a null is established on the front panel null meter of the receiver. The unknown is then inserted into the line, and the i-f attenuator is adjusted to restore the null. The change in the setting of the i-f attenuator is equal to the attenuation introduced into the system by the unknown. This method is most valuable for making attenuation measurements up to 100 db where signal levels are low thereby needing amplification. The accuracies using the methods above are 0.1 db/10 db step (maximum cumulative error 0.2 db) to 40 db using the direct method, and 0.05 to 0.20 db/10 db step (depending upon input signal magnitude) for the i-f substitution method. However, the maximum error for a 100 db measurement in one step is 0.5 db.

Measurement of Power

The dry calorimetric method of measuring power is one of the most accurate methods known today.

The dry calorimeter is essentially a block of aluminum into which two r-f transmission lines have been machined. Each of the lines is terminated in a low reflection r-f load. A thermopile, evaporated on a thin

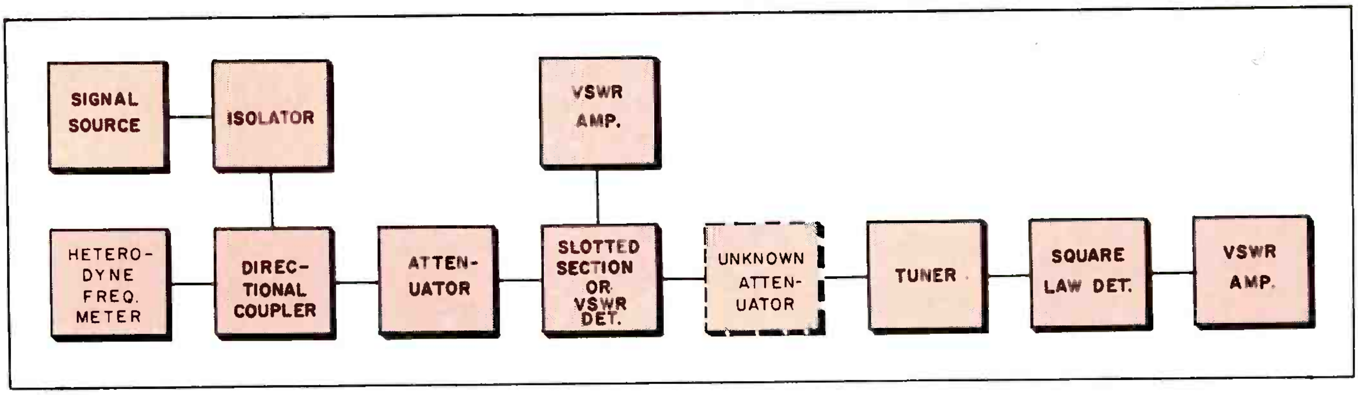


Fig. 1: Voltmeter-bolometer or direct method of calibrating attenuators is simple, fast and accurate over a range of about 40 db.

mylar sheet, is positioned close to the two r-f loads. Orientation of the thermopile is such that it measures the temperature difference of the air spaces surrounding the r-f loads. When r-f power is fed into the active line, the air space near its load gets warm with respect to the air space close to the dummy or reference load which terminates the other r-f line. This temperature difference causes a dc voltage output from the thermopile. Calibration data which is obtained using accurately monitored dc power relates the dc voltage output to the r-f input power.

The setup used for average power measurements is shown in Fig. 3. Of the several sources of error that exist, some can be compensated for, while others can only be estimated. Some of the compensable errors are those due to mismatch (VSWR) and loss (attenuation) of power between input and load. When a measurement is made, the VSWR in the line should be accurately known so that a correction for this source of error can be made. Thus, if the generator VSWR is unity (generator impedance, Z_g, is equal to the characteristic impedance, Z_o, of the transmission line) the power indicated on the power meter, P_m, will be less than the available power, P_a, being transmitted by the generator. Available or incident power, P_a, can be found from the equation

$$P_a = P_m \frac{(s + 1)^2}{4s}$$

where s is the VSWR looking into the power meter.

The loss error results from dissipation of power as it is being transmitted from the input port to the resistive load. This error can be compensated for by adding to the measured r-f power the calculated power dissipated in the line. This correction factor is supplied in the form of a graph of power correction as a function of frequency.

The estimated errors are the substitution, calibration, and instrumentation errors. The substitution error arises from the minute non-equivalence of the heating effect due to r-f versus dc. The substitution error must be kept small because the calorimeter is calibrated at dc. The calibration error is due to small inaccuracies in the calibration of the calorimeter. The instrumentation error is the error introduced by the dc amplifier which provides the direct readout of power on the power meter. The *maximum* errors to be encountered are substitution (±0.3%), calibration (±1.0%), instrumentation (±2.0% full scale).

The instrumentation error may be reduced to the order of tenths of a percent by using a precision potentiometer or differential voltmeter instead of the dc amplifier. The total errors involved should result in a maximum RMS error of ±4% over a power range of 30 μw to 1 w.

VSWR and Impedance

Fig. 4 shows the measurement setup using a coaxial slotted section for the determination of the impedance of a one port device over the frequency range of 2.0-10.0 GC. From 0.5-2.0 GC, the slotted section is replaced by a Rotary Standing Wave Detector such as the PRD 219.

Essentially, the determination of impedance requires that both VSWR and reflection coefficient angle be

(*Continued on page 77*)

Fig. 2: Measurement of attenuation using the i-f substitution method is shown at left.

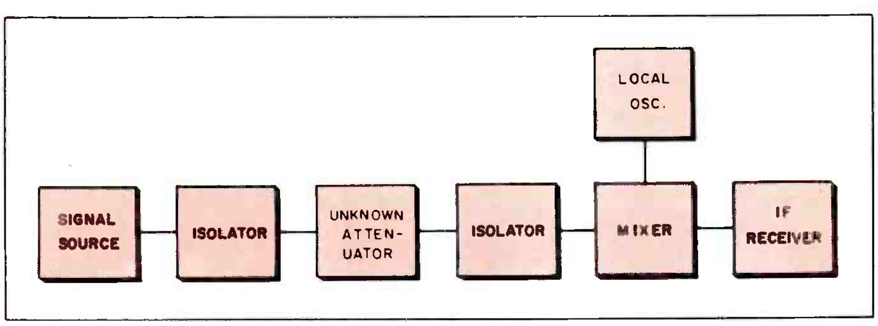
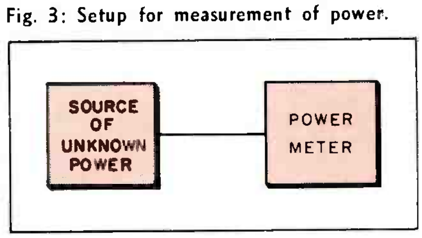
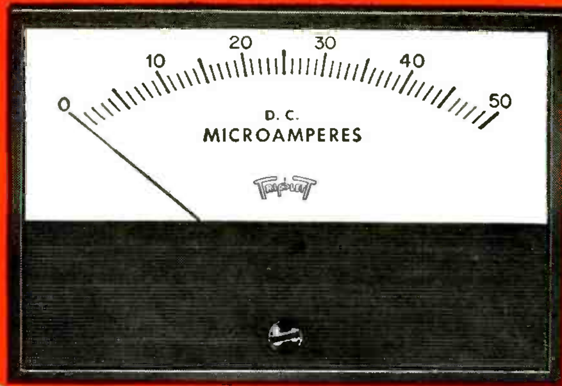


Fig. 3: Setup for measurement of power.





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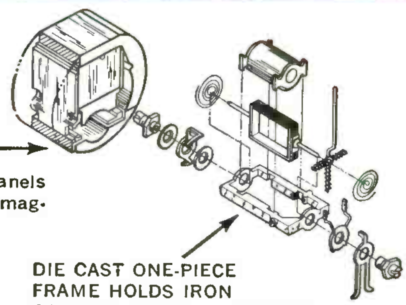

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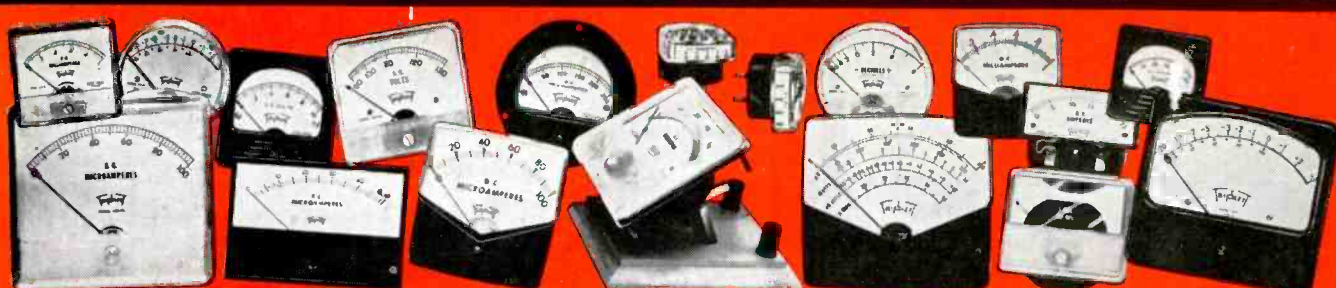

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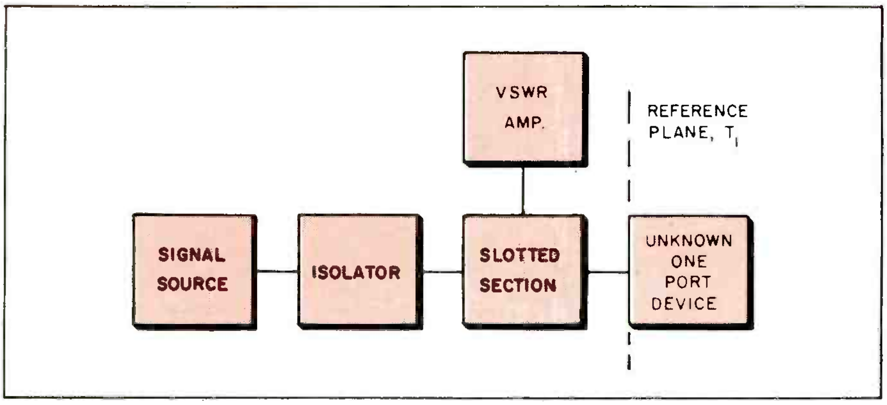
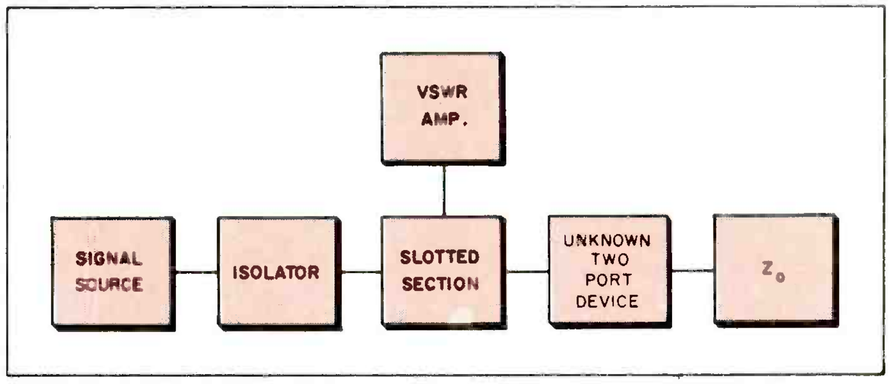


Fig. 4: Setup for measurement of VSWR and Impedance (over the range of 2-10 GC) of a one port device using a slotted section.

Fig. 5: Equipment setup for the measurement of VSWR and Impedance of a two port device.



CALIBRATION LAB (Continued)

known at the reference plane. With the unknown load Z_x connected, and with the signal source in operation (square wave modulated at 1 KC), a maximum deflection is obtained on the meter of the VSWR amplifier by adjusting the modulation frequency control of the signal source, and by tuning the probe mounted on the slotted section. The probe is moved along the slotted section to a voltage maximum position; the gain control of the VSWR amplifier is adjusted for full scale. The probe is then moved to a voltage minimum point; the VSWR is read directly from the meter. The unknown is removed and a short circuit is placed at the reference plane. The VSWR pattern, in addition to increasing in amplitude, will also shift in phase. It is this shift which relates to the reflection coefficient angle, Θ. The expression which follows allows us to calculate Θ:

$$\Theta = \frac{4\pi}{\lambda g}(D - D_r) \pm \pi \text{ (radians)}$$

MICROWAVE TEST EQUIPMENT

Test and calibrating equipment for microwave electronics accounted for an estimated $27 million in factory sales during 1963. Even though the general microwave market has levelled off, sales of test equipment may remain somewhat stable for a while since microwave equipment now in use around the world must be serviced.

Estimated totals for successive years:

1963	$27,000,000
1964	$29,000,000
1965	$33,000,000

Where D = arbitrary location of voltage minimum as indicated on slotted section carriage

D_r = location of voltage minimum with short placed at reference plane. D-D_r is, therefore, the shift in the minimum voltage of the VSWR pattern.

To find Θ, use $+\pi$ if the shift of the minimum (when the short replaces the load) is toward the generator; use $-\pi$ if the shift of the minimum is toward the load.

To find the unknown impedance Z_x, the complex reflection coefficient must be calculated. Thus,

$$\Gamma = \left[\frac{VSWR - 1}{VSWR + 1}\right] E^{j\Theta} \quad \text{or}$$

$$\Gamma = \left[\frac{VSWR - 1}{VSWR + 1}\right] [\cos\Theta + j\sin\Theta]$$

$$\text{Then,} \quad \frac{Z_x}{Z_o} = \left(\frac{1+\Gamma}{1-\Gamma}\right)$$

where Z_o is the characteristic impedance of the line. To obviate these calculations which are time consuming, the unknown impedance can be obtained through use of the Smith Chart once the VSWR ad reflection coefficient angle have been found.

Fig. 5 shows the equipment setup for the measurement of the impedance of a two port device. Note that the output port is connected to a termination which is matched to the Z_o of the line. A detailed discussion is included in the PRD Report, Vol. 2, No. 3, "Precision Measurements with Slotted Sections."

Measurement of Frequency

Fig. 6 shows the frequency measurement of an active signal source using a heterodyne frequency meter.

The PRD 504, which is an instrument of this type, is in use in many standards labs and has an accuracy of 0.002% for any frequency divisible by 5. In other words, this accuracy is attainable in 5 MC increments. *(Continued on page 78)*

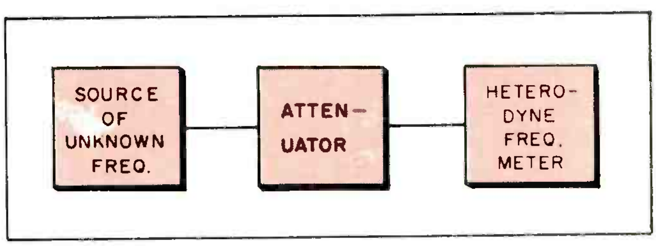


Fig. 6: Measurement of frequency of an active source using a heterodyne frequency meter.

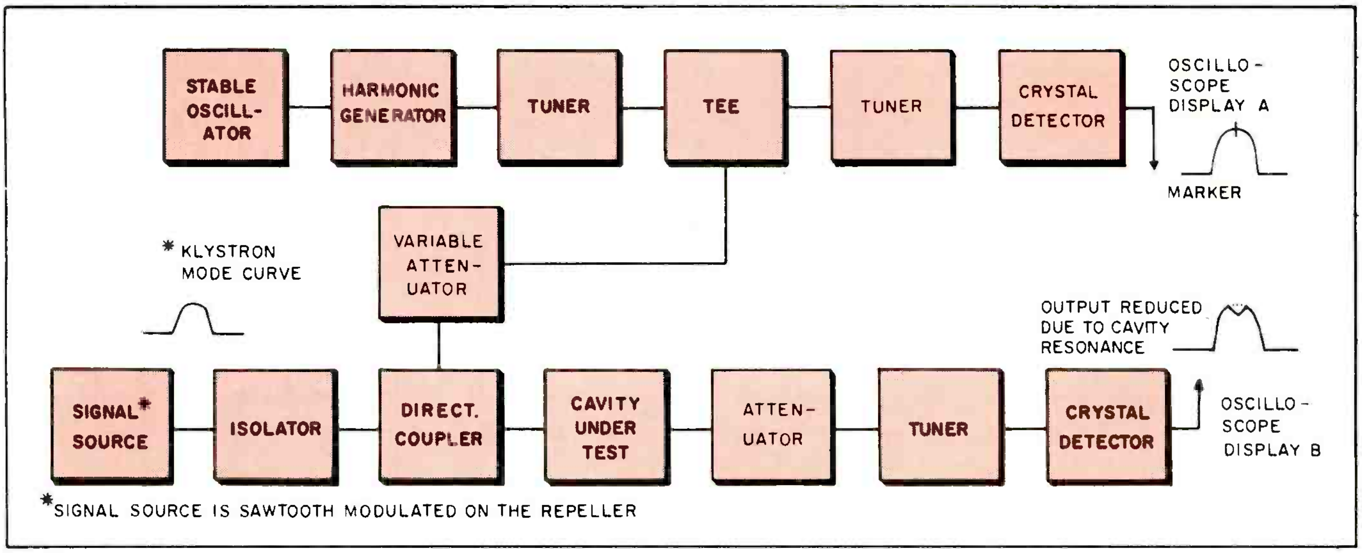


Fig. 7: Diagram for the calibration of a cavity type frequency meter is shown above.

CALIBRATION LAB (Concluded)

Fig. 7 shows a diagram for the calibration of a passive device such as a cavity frequency meter. Essentially, a highly stable marker whose frequency is accurately known is displayed on one trace of a dual trace oscilloscope. The effect of the passive device being investigated is seen on the mode curve of the other trace. In this case, the reaction on the mode curve due to cavity resonance is displayed and the frequency and bandwidth of this reaction can be measured by superimposing the two traces. This scheme is widely used and is described in detail in the PRD Report, Vol. 2, No. 2, "Frequency Measurement Devices."

Conclusion

A basic lab has been outlined that will provide a secondary standards facility for the calibration of coaxial components in the frequency range of 0.5-10.0 GC. The equipment discussed forms a basic building block which can be implemented to cover waveguide measurements as well. Also, much of the instrumentation can be used in more than one measurement. Thus, the addition of the instruments discussed can enlarge the scope of any calibration lab not presently equipped to calibrate microwave systems and components.

CIRCUIT-WISE

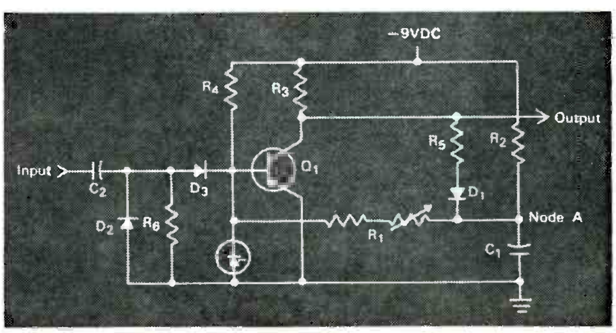
IMPROVED MONOSTABLE CIRCUIT

A MONOSTABLE MULTIVIBRATOR uses a tunnel diode to improve risetime, gives more constant quasi-stable time, and up to 95% duty cycle time.

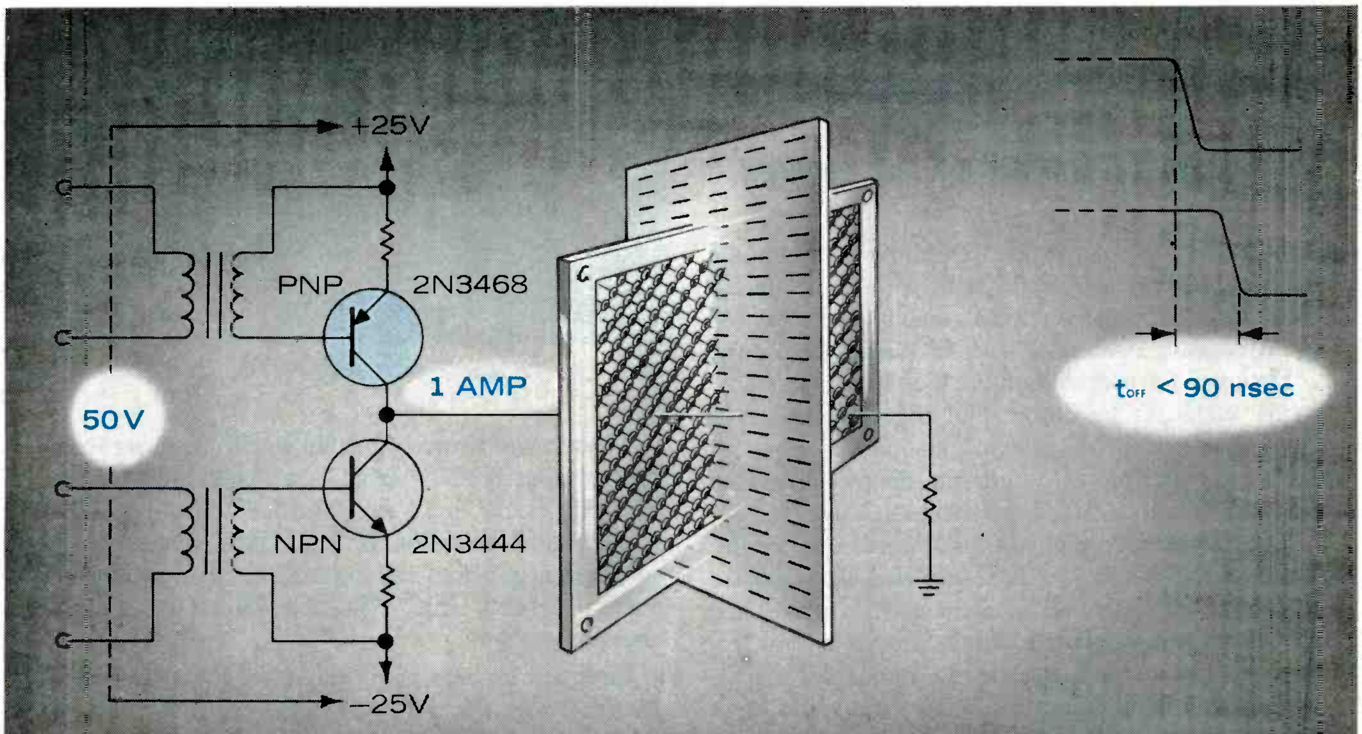
The MSMV circuit shown is typical of binary circuits in that it maintains a steady state until a triggering signal is applied to the input, causing a shift to a quasi-stable state for a fixed period of time.

When the circuit is in its stable state, the tunnel diode conducts and the transistor Q_1 is saturated. If positive trigger pulse is fed into the input, it will cause the tunnel diode to switch to a low-voltage state and to switch off. This initiates a quasi-stable state, the duration of which is controlled by the variable resistor and the choice of capacitor.

With D_1 back-biased and exhibiting a high impedance to node A, C_1 will begin to seek the steady state voltage where the low voltage resistance of the tunnel diode is about 50Ω. Node A can be considered a changing voltage source for the supply of current to the tunnel diode. Current through R_4 is insufficient to supply the necessary switching current to the tunnel diode. When the sum of the two currents from node A and R_4 peaks, diode tunnelling process is initiated and the tunnel diode switches to the on-state. Voltage across the tunnel diode is impressed across the base-to-emitter of Q_1 causing it to switch to its saturated site, thus terminating the quasi-stable state of the multivibrator. Capacitor C_1 will then discharge through the low impedance of the now forward-biased diode D_1 and saturated Q_1, completing the transition back to the steady-state condition necessary before a new quasi-stable period can be initiated.

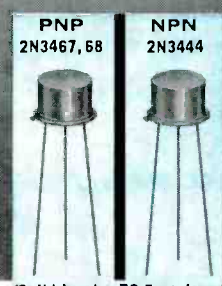


From *NASA, Tech Brief 63-10603.*



Announcing . . .

THE FIRST LOW-STORAGE, HIGH-VOLTAGE PNP / NPN SILICON TRANSISTOR PAIR !



(Solid-header TO-5 package)

High-Speed Complementary Core Driver Circuit Designs . . . a Result of Motorola's PNP Process Breakthrough

A BREAKTHROUGH in transistor process technology now extends the design simplification of complementary transistor circuits to magnetic memory driver circuits . . . meeting the combined requirements of *high speed* (for advanced thin-film and core memories) and *high voltage* (for increasing the number of series-driven magnetic elements).

The breakthrough is the result of an exclusive Motorola process which, for the first time, permits the production of gold-diffused (low-storage-time), high-voltage silicon PNP transistors.

The new devices, types 2N3467 and 2N3468, have storage times on the order of 35 nsec, BV_{CEO} up to 50 volts, and a specified *minimum current gain of 40 at one ampere* . . . characteristics that closely match the most advanced NPN transistors in the industry! *See table below.*

Because these new low-storage devices retain their valuable high current-gain characteristics, they offer a solution to the speed/voltage/current "trade offs" encountered in earlier complementary core driving circuits.

		BV_{CEO}	h_{FE}			T_{off}	$V_{CE(sat)}$	f_T
		$I_C = 10$ mA	@ 500 mA 1 volt V_{CE}		@ 1 amp 5 volts	$I_C = 500$ mA $I_{B1} = I_{B2} = 50$ mA	$I_C = 500$ mA $I_B = 50$ mA	$I_C = 50$ mA $V_{CE} = 10$ volts
		min	min	max	min	max	max	min
PNP types	2N3467	40 V	40	120	40	90 nsec	0.5 V	175 mc
	2N3468	50 V	25	75	25	90 nsec	0.6 V	150 mc
NPN types	2N3252	30 V	30	90	25	70 nsec	0.5 V	200 mc
	2N3253	40 V	25	75	20	70 nsec	0.6 V	175 mc
	2N3444	50 V	20	60	15	70 nsec	0.6 V	175 mc

Units are available now for your immediate evaluation. Call your local Motorola Semiconductor Distributor or District Office today for your particular requirements. For complete technical information write: Motorola Semiconductor Products Inc., Technical Information Center, Box 955, Phoenix, Arizona 85001.

MOTOROLA Semiconductor Products Inc.
BOX 955 • PHOENIX, ARIZONA 85001 • A SUBSIDIARY OF MOTOROLA INC.
6-38EI-11

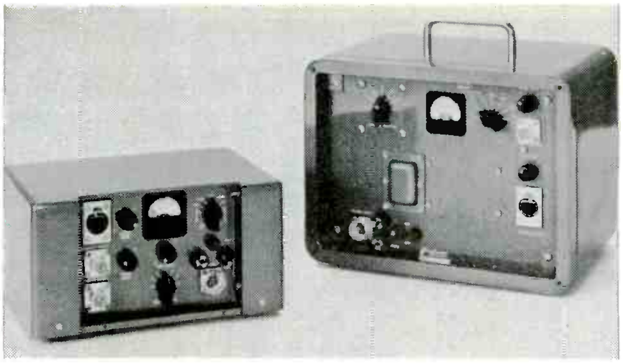
WHAT'S NEW

Solid State TV Transmitter and Receiver

BELIEVED TO BE THE FIRST OF THEIR KIND in the industry, a completely solid state portable TV relay transmitter and receiver were recently demonstrated by Microwave Associates, Inc. of Burlington, Mass.

Designed for operation in the 2 GC band, the transmitter produces 1w output and the receiver has a noise figure of 10 db nominal and video output of 1.5 v p-p max. into a 75 ohm impedance. The video response is within 0.5 db, 50 CPS to 4.3 MC.

The transmitter weighs 14 lbs., the receiver, 23 lbs. Heart of the transmitter is a stabilized UHF 500 MC transistor oscillator. The frequency is multiplied four times in a varactor multiplier to the output frequency. The transmitter accepts a standard 1 v composite video input signal and a low level audio input signal and multiplexes the two together. Operation is from a 28 v dc supply source delivering 30 w.



Solid state TV relay 2 GC transmitter (l), and receiver (r).

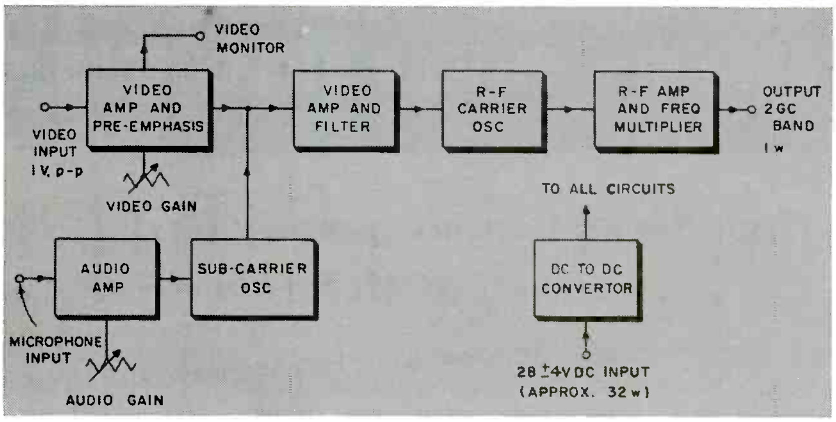
The receiver uses a regulated stabilizer power unit. Power input is 28 v dc at 1 a. Audio response is ± 1 db, 30 CPS to 10 KC. The I-F frequency is 70 MC; nominal deviation is 8 MC p-p; tuning is by switched crystals to separate channels. Audio output is ± 18 dbm max., adjustable, into 150 ohms balanced load.

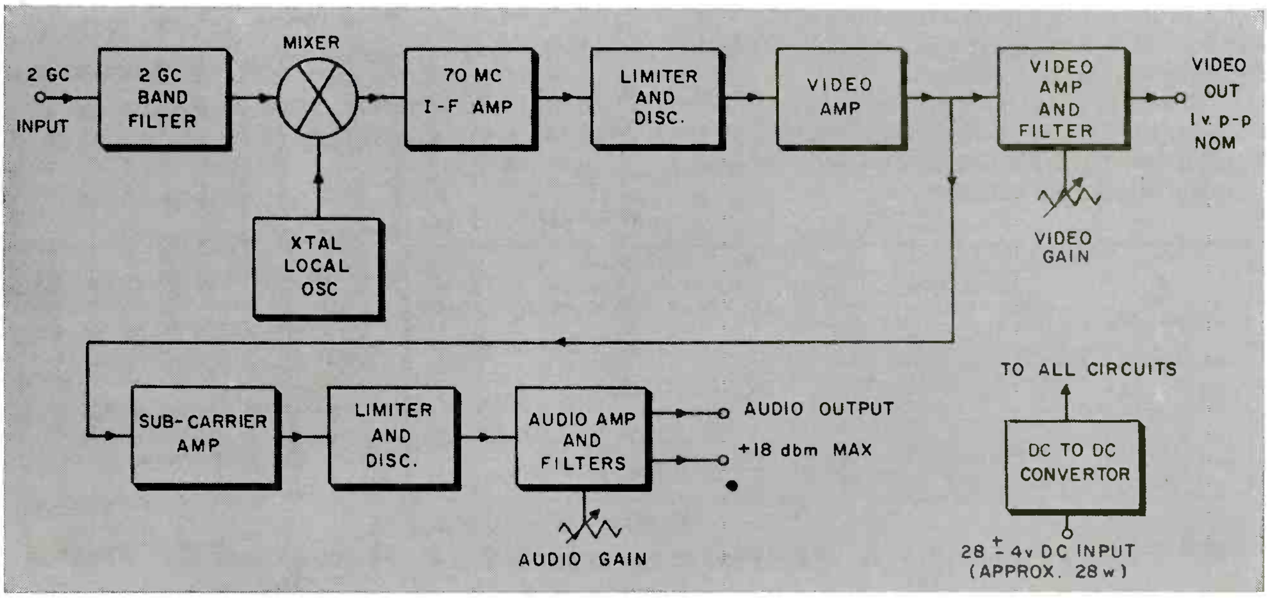
First use for this new equipment is by American Broadcasting Co. for convention and tournament coverage, including the political conventions in San Francisco and Atlantic City.

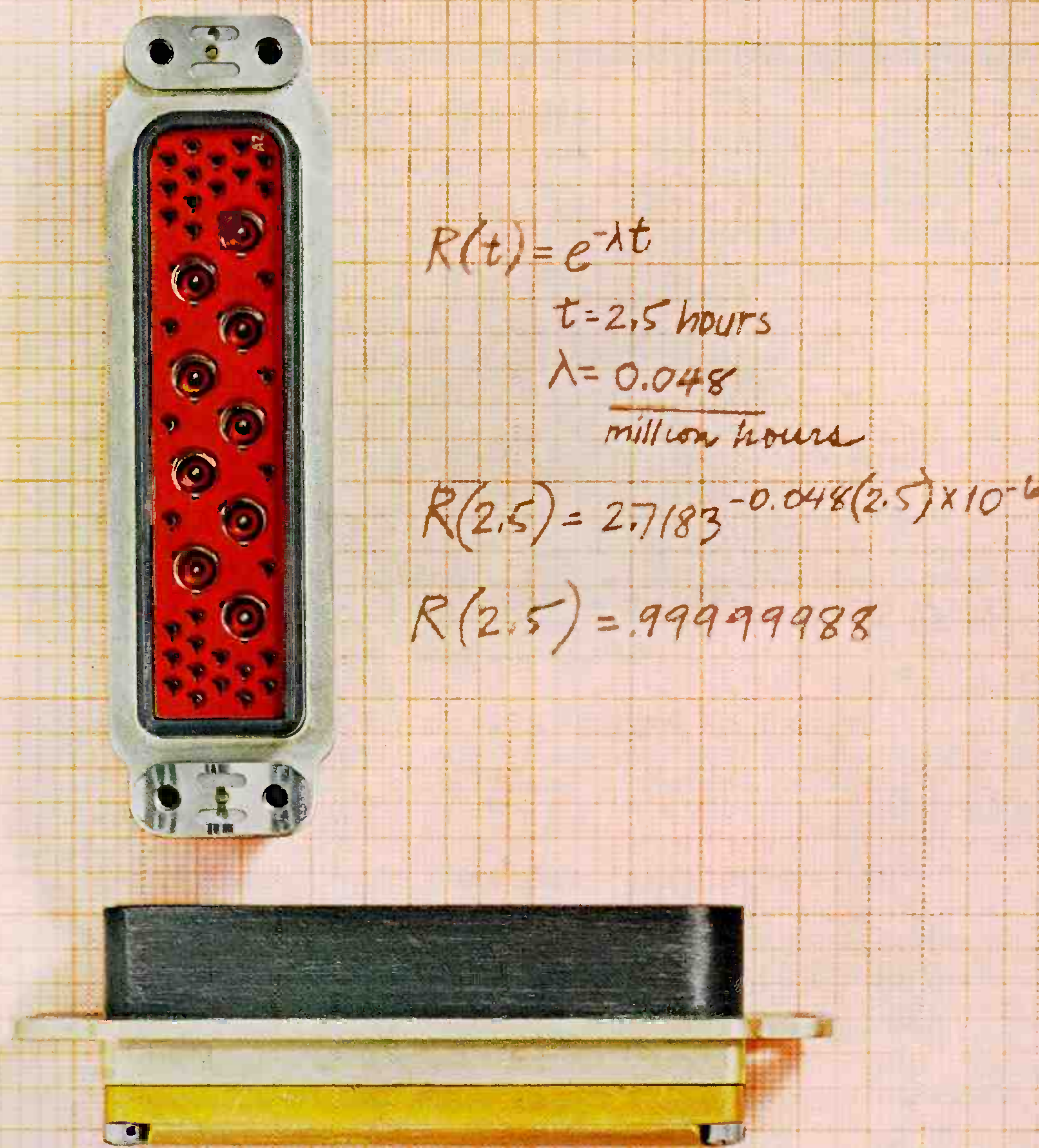
2 GC TV Relay Transmitter (right).

More What's New
on page 82

2 GC TV Relay Receiver (below).







As reliable as $R(t) = e^{-\lambda t}$

. . . and that's pretty reliable.

Our new 217 Series rack-and-panel connector meets the requirements of MIL-C-26518b (USAF), the R&P equivalent of MIL-C-26500. Connectors made to this companion specification have already put in millions of operating hours (in the Minuteman program, as well as on the Boeing 707 and 720) with a failure rate of only 0.048 per million operating hours . . . far below that of any other commercially available connector.

Fully sealed, the Amphenol 217 completely resists environmental contamination. It performs in ambients ranging from −67 to +500 F, and at ultra-high altitudes. Splash it with salt water, hot lube oil, hydraulic fluid, UDMH, or nitrogen tetroxide. The 217 Series connector will keep right on going . . . and going . . . and going.

Beveled entryways in the hard dielectric sockets guide contacts (either power or RF) surely and positively into position . . . very important in the "blind" mating conditions so common in rack-and-panel applications.

Ask your Amphenol Sales Engineer about the 217 Series. Or write: Ned Spangler, Vice President-Marketing, Amphenol, 1830 S. 54th Avenue, Chicago 50, Illinois.

Amphenol®

A DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION

Circle 36 on Inquiry Card

WHAT'S NEW

LARGE AREA COLOR TV TUBE

RCA's LANCASTER TUBE DIV., HAS DEVELOPED a 25-in., 90° rectangular color TV tube. The tube, which will be available during the last quarter of 1964, has the following dimensions: screen area, 300 sq. in.; picture height, 15½ in.; picture width, 19 27/32 in.; picture diagonal, 23 1/6 in.; and tube length, 20 7/8 in.

The tube uses the three-gun, shadow-mask principle. The curvature of the faceplate has been flattened compared to the 70° type, in keeping with the larger size of the screen and viewing. However, the new faceplate is consistent with the requirements for convergence and proper correction of raster distortion. The aspect ratio on the screen has been adjusted to be more consistent with the standards of transmitter signals, giving a ratio of 3.12 to 4.0

The company also expects to use a rare-earth phosphor on the new tube. The material has the capability of producing further light output improvements.

Rectangular color tube uses a rare-earth phosphor.

CAMERA SPEEDS PROTOTYPE PRODUCTION OF CIRCUIT MASKS

A NEW CAMERA developed by IBM provides semiconductor device and circuit designers with a low-cost means for rapidly producing and evaluating various semiconductor devices and circuit designs. It is a unique multiple lens camera designed for efficient, accurate, and fast production of photographic masks.

Heart of the camera is a special plastic lens of 1.25 in. dia. upon which up to 1,250 precision lenses are compression-formed by a molding process. The basic camera consists of a timer, a light source, an object holder, the fly's eye multiple lens assembly, and a plate holder.

In operation, the camera utilizes conventional photographic techniques to accurately and rapidly produce sets of masks in a small fraction of the time now required to provide masks by conventional "step-and-repeat" processes.

In use, a single semiconductor pattern can be a photographic negative or cut, in silhouette form in a semi-opaque plastic sheet. This step can be performed satisfactorily by hand or with a coordinatograph where ultra-precision is required. This pattern, typically 500 times larger than a single image on the finished mask, is then aligned in place on the object light source frame and a photographic plate is exposed. This plate, when developed, becomes the desired mask, and contains up to 1,250 separate patterns. The mask is then used in conventional photo engraving processes to produce devices and circuits on semiconductor wafers. Various techniques can then be used to slice the wafers into single separate semiconductor devices and circuits.

Called the Fly's Eye Camera SE 401, resolution on the optical axes of the individual lenses is over 400 lines/mm. Resolution drops toward the edge of each lens, but this does not affect the most critical dimensions of the individual configurations. Price of the camera is $16,000.

(More What's New on Page 130)

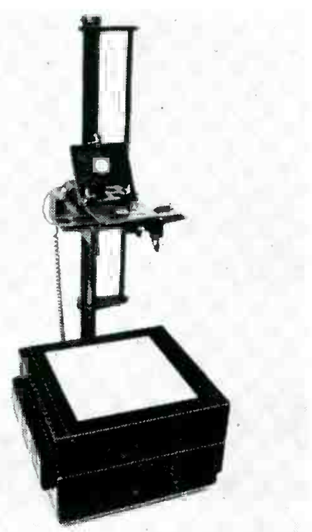


Fig. 1: IBM Fly's Eye Camera SE 401, which produces photographic masks for use in research and development studies of semiconductor devices and circuits.

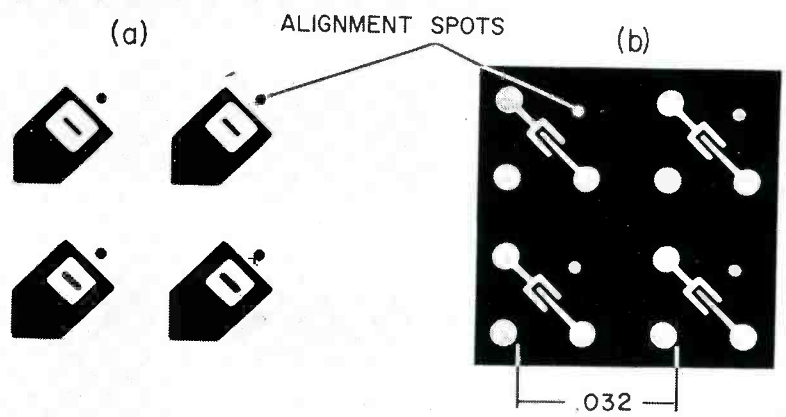
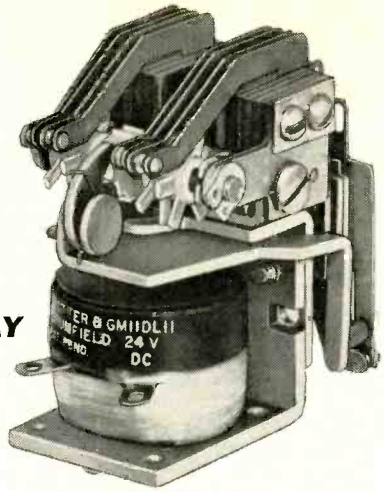


Fig. 2: Typical photographic masks produced by the Fly's Eye Camera. The portion of the mask shown at the left is a positive mask used to produce emitter diffusion semiconductors. That at the right is used for subtractive etch of contacts.



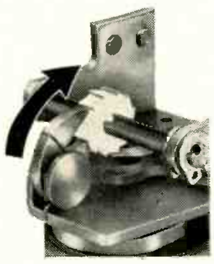
A REMARKABLE NEW RELAY FROM POTTER & BRUMFIELD

Versatile P&B relay can be made to step, count, sequence, home, switch, read-out . . .

all with singular reliability

INHERENT RELIABILITY DUE TO RELAY'S INDIRECT ACTION

The GM is a reliable, low cost, impulse/sequencing relay providing a choice of switching elements which make it practical for an extremely wide range of applications.



Contact action, except in the case of auxiliary contacts, takes place during the *drop-out* of the armature. The motive power is the armature's return spring, a constant force providing smooth, dependable results.

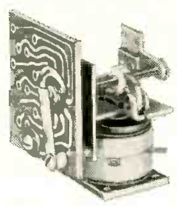
As drop-out occurs, a pawl engages a 10 or 12-step ratchet, advancing it one position. This action turns a shaft which results in contacts being opened or closed and/or results in advancing the movable contact arm of a printed circuit board switch.

PRINTED CIRCUIT BOARD CAN BE USED FOR 10 OR 12-STEP SWITCHING

A uni-directional printed circuit board with either 10 or 12 stations can be attached to the basic GM structure. Contacts are rated to 250 milliamps. The movable arm advances one position each time the armature *drops out.*

A pulse of only 20 milliseconds will effect switching.

If sufficient coil power is available, two sets of regular contact arms and two sets of auxiliary contacts may be used in conjunction with the printed circuit board.



Regular cam-activated contacts as well as auxiliary contacts are rated to 3 amperes, 115 volts ac, 60 cycles non-inductive. GM coils may be either ac or dc powered.

LET US HELP YOU WITH YOUR SEQUENCE SWITCHING PROBLEMS

GM relays have been field tested for more than a year in a number of applications, most notably in automatic vending equipment. They are readily adaptable to remote television set controls, self-interrupting and homing circuits and many others.

Perhaps this relay will prove to be a reliable, inexpensive solution to your switching problems. Please call us, or get in touch with the P&B representative in your area.

ENGINEERING DATA

GENERAL:

Description: Impulse/sequencing relays. GM = 2 Form C contacts. GM with auxiliary contacts = 4 Form C contacts.

Expected Life: 500,000 mechanical operations.

Breakdown Voltage: 1000 volts rms between all elements and ground.

Temperature Range: AC: —45°C to +45°C (intermittent duty only). DC: —45°C to +75°C.

Operate: AC: 78% or less of nominal voltage @ +25°C. DC: 75% or less of nominal voltage @ +25°C.

CONTACTS:

Arrangements: GM: Two Form C (ratchet operated). GM with auxiliary contacts: Two Form C (auxiliary), and two Form C (ratchet operated). Special: Modification of GM with 10 or 12-position uni-directional printed circuit stepping switch.

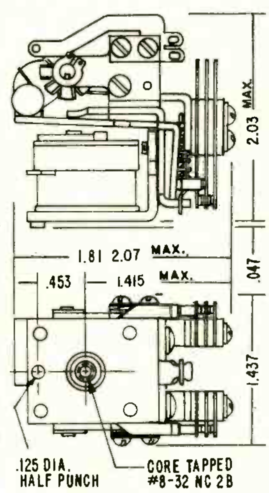
Ratings: GM: to 3 amps 115 volts AC 60 cycle (non-inductive). GM with auxiliary contacts: to 3 amps 115 volts AC 60 cycle (non-inductive). GM with 10 or 12-position printed circuit stepping switch: 250 MA.

COILS:

Voltage: AC: to 230 volts, 60 cps. DC: to 110 volts.

Power: AC: 9 voltamps maximum. DC: 2.5 watts minimum, 4 watts maximum.

Duty: AC: 50% coil duty cycle—5 minutes maximum on, 5 minutes minimum off. DC: Continuous @ 4 watts at 25°C.



Now available at leading electronic parts distributors.

POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana
In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.

Circle 37 on Inquiry Card

ELECTRONIC INDUSTRIES NEW TECH DATA

"... STATE-OF-THE-ART information on Components and Equipment."

Microwave Amplifier

Data is available on a new medium-power microwave amplifier with an integral leveling circuit. Major feature of the Model 373 is the high degree of leveling obtained by a unique feedback circuit. Spurious amplitude and phase modulation are minimized by a well regulated power supply. The TWT operates at 7 to 11GC and provides 1w. CW min. Data available from Litton Industries Electron Tube Div., San Carlos, Calif.

Circle 125 on Inquiry Card

Ferrite Components

This 16-page catalog describes ferrite components for use between 30MC and 72GC. Included are specs. and photos. Many of the units are supplied at customer-designated center freq. without any premium charge. Melabs, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Circle 126 on Inquiry Card

TWT Data Sheet

This data sheet contains 21 pertinent factors (freq. range, max. noise factor) associated with TWTs. Tubes operating in the S, C, X, C/X, and Ku bands are described. General Electric Co., 601 California Ave., Palo Alto, Calif.

Circle 127 on Inquiry Card

Computer Brochure

Brochure CPB-348AP, 12 pages, describes 5 Compatibles-400 medium-to-large-scale computers. Publication explains design features of the GE-415, 425, 435, 455 and 465 which permit hardware, software and operating system to work together to perform the major functions of a business data processor. Operating features and benefits for faster load-add-store are described. Computer Dept., General Electric Co., Phoenix, Ariz.

Circle 128 on Inquiry Card

Logic Module Catalog

A 118 page catalog #102 describes a series of silicon and germanium high-speed logic modules. Speeds up to 10MC, good noise rejection, clamped circuit outputs and high fanout capability are outstanding module features. Abacus Inc., 1718 21st St., Santa Monica, Calif.

Circle 129 on Inquiry Card

Circuit Modules

This 37-page catalog describes a completely compatible line of off-the-shelf germanium digital modules in the 200KC, 1MC, and 5MC freq. ranges. They may be used in computers and logic control systems. The data contains photos, schematics, and logic diagrams. Packard Bell Computer, 2700 S. Fairview St., Santa Ana, Calif.

Circle 130 on Inquiry Card

A-D Converter

This data describes the Model ADC 6001, an 11 cu. in. converter with 11-bit accuracy, requiring 0.75w. The converter operates from $-55°C$ to $+125°C$. Accuracy is $\pm\frac{1}{2}$ LSB with conversion speeds up to 2μsec./bit. General Microelectronics Inc., 2930 San Ysidro Way, Santa Clara, Calif.

Circle 131 on Inquiry Card

Telemetry Bulletins

Literature describing a new line of telemetry equipment is now available. Units described include: telemetry ground system; PCM bit synchronizer; and universal system tester. Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 132 on Inquiry Card

Antennas

Data is available on 2 conical log-spiral antennas designed for use with RFI measurements in the 200MC to 10GC range. These lightweight 50Ω antennas are of a broadband type with no tuning adjustments required, thereby saving measurement time. Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood, Calif.

Circle 133 on Inquiry Card

High-Power BWOs

The SBE-4022 and SBM-4212 BWOs weigh 7 lbs. including magnet, and pack up to 40 and 50mw respectively. Current life tests have surpassed 200 hrs. Freq. power data, and photos available from Sperry, Electronic Tube Div., Gainesville, Fla.

Circle 134 on Inquiry Card

Integrated Circuit

Type D-13001 differential-amplifier monolithic integrated circuit has common mode rejection of 100db. Temp. stability is better than 3μv/°C, and drift time is less than 5μv/day. Performance exceeds that obtained from an amplifier made from discrete components. Data is available from Amelco Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif.

Circle 135 on Inquiry Card

Core-Driver Transistor

The 2N3512 double-diffused epitaxial planar transistor was developed specifically for core-driver and line-driver service in high-performance data-processing equipment. The silicon NPN high-voltage unit has high-breakdown and low-saturation voltages, high power-handling capability and high switching speed over a wide range of collector currents. Complete details available from RCA Electronic Components and Devices, Harrison, N. J.

Circle 136 on Inquiry Card

Microwave System

The Type 75A Heterodyne Repeater System is all solid-state except for the traveling tube amplifier. It accommodates 960 voice channels or color TV, and can be arranged to allow the dropping or insertion of order wire and small numbers of channels at intermediate repeater stations. Performance exceeds CCIR requirements. More data available from Lenkurt Electric Co., Inc., 1105 County Rd., San Carlos, Calif.

Circle 137 on Inquiry Card

Spectrum Analysis Report

Application Note #63, "Spectrum Analysis," contains an introductory history, a section of spectral display which explains analysis in the freq. domain; a section on spectrum analyzer design considerations; a long section on specific applications; and mathematical appendices on Fourier waveform analysis and useful transforms. The 41-page report is available from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 138 on Inquiry Card

Tubes and Components Catalog

This condensed microwave tubes and components catalog contains full listings and basic specs. for an entire line of microwave triodes, TWTs, UHF high-power klystrons, (up to 150GC), and magnetrons. Also included is a full range of components designed to match tubes in the following specific bands: 25, 17, 10, 7.5, 6, 5, 4.5, 3.5, and 3Cm, and 2, 4, and 8Mm. Applications assistance and data on how to use this equipment to best advantage is available. Amperex Electronic Corp., Hicksville, L. I., N. Y.

Circle 139 on Inquiry Card

Microcircuit Welder

Bulletin MCW/EL describes a blow-out-proof welder for welding leads of microcircuit packages and other small parts. Capability for high-reliability, blow-out-proof welding on both thin-films and ordinary PCB is explained. Hughes Welders, 2020 Oceanside Blvd., Oceanside, Calif.

Circle 140 on Inquiry Card

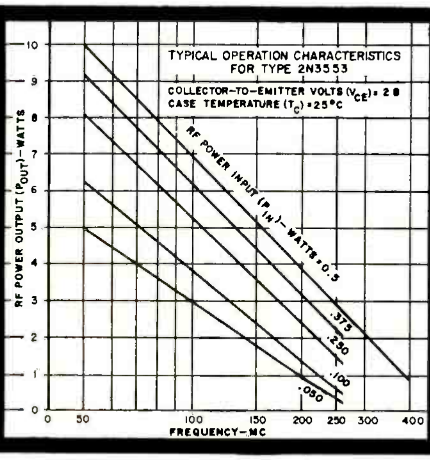
Core Catalog

Catalog SC-128-A covers a series of economical Silectron cores using the distributed gap design. The series are designed for use in power transformers, distribution transformers, magnetic regulators, and reactors. The catalog gives part numbers, weight, dimensions, and relative power-handling capacity for 21 cores with large window design and 15 small window cores. In addition, there are 16 sizes designed for distribution transformers usage rated at 5 kva to 75 kva. Arnold Engineering Co., Dept. DGSC, Marengo, Ill.

Circle 141 on Inquiry Card

VHF/UHF POWER GOES ECONOMY

HIGH GAIN 27 TO 260 MC



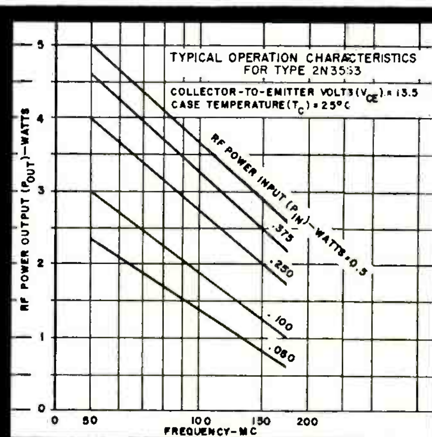
RCA 2N3553

TO-39 PACKAGE

I_C max.—1.0 A

f_T—500 Mc (typ)

V_{CEV}—65V



RCA 2N3553 offers the big VHF/UHF performance of overlay construction at low-cost

RCA introduces the new 2N3553, VHF/UHF silicon overlay transistor—general purpose economy version of RCA 2N3375. This epitaxial planar NPN unit offers today's biggest value in RF performance per dollar.

COMPARE 2N3553 FOR PERFORMANCE AND PRICE	
50 Mc	P_{out} (typ)*—5 watts, 20 db gain
175 Mc	P_{out} (min)*—2.5 watts, 10 db gain
260 Mc	P_{out} (typ)*—2.5 watts, 7.5 db gain

*Unneutralized common-emitter Class C amplifier with V_{CE}=28 volts

RCA 2N3553 offers: overlay performance • low price • up to 500 Mc straight-through • up to 2 KMc as a multiplier

Applications: pre-driver, driver, output, multiplier, video amplifier in mobile, portable equipment, aircraft systems, sonobuoy, telemetry.

For Critical Applications RCA 2N3375
P_{out}—3 Watts Min @ 400 Mc;
7.5 Watts Min @ 100 Mc

- RF Stud Package
- All Elements Isolated
- Not Second Breakdown Limited
- Available In Quantity

For complete price and delivery information, see your RCA Representative today. For technical data on specific types—write: Commercial Engineering, Section I-J-11, RCA Electronic Components and Devices, Harrison, N. J.

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

RCA ELECTRONIC COMPONENTS AND DEVICES

The Most Trusted Name in Electronics

Circle 38 on Inquiry Card

NEW TECH DATA

Signal Generator

This 2-color technical bulletin describes Model 350A Tracking Signal Generator. The unit features fast, direct freq. response runs with tunable voltmeters over the range of 5 to 1620KC. The bulletin presents operating features and a section devoted to applications. Sierra Electronic Div. of Philco, 3885 Bohannon Dr., Menlo Park, Calif.

Circle 142 on Inquiry Card

Connector Wall Chart

This 45 x 34 in. connector selector provides an immediate visual method for determining specs. on the DM, DS, MDS, DD, MDR, DA, DTK, BTK and hermetic connectors. It presents data on connector shell sizes from 3 to 61 with applicable contact patterns. The chart also details the mating receptacle and plug combination for each connector series. It suggests the use for which the various connectors are suited, and presents detailed specs. on insert material and construction. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 143 on Inquiry Card

Diode Classifier

Data is available on a digitally programmed diode classifier that permits programming of either forward or reverse tests at any testing position on the instrument. The D206 digitally programmed diode test instrument may be programmed by wheel-type selector knobs. It uses remote programming, and can be set up by unskilled operators for either forward voltage or reverse current tests in any position. Teradyne, Inc., 87 Summer St., Boston, Mass.

Circle 144 on Inquiry Card

Vibrator Monitoring

Bulletin 1650 describes an airborne vibration monitoring system for use by commercial air lines, military aviation units, and aircraft manufacturers. The unit provides visual indications of aircraft turbine engine vibration levels. Any deviation from the customary vibration pattern can be noted and adjustments made to reduce maintenance. Consolidated Electrodynamics Corp., subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 145 on Inquiry Card

Capacitor Catalog

A complete line of military and high grade commercial capacitors is described in a new condensed catalog. Metallized paper, metallized Mylar, metallized polycarbonate, Mylar and foil, kraft-Mylar, and polystyrene film capacitors are offered. Standard catalog styles include rectangular hermetically sealed, round tubular hermetically sealed, wrap-and-fill, and epoxy case. Electron Products, 1960 Walker Ave., Monrovia, Calif.

Circle 146 on Inquiry Card

X-ray Generator

Model 846 field emitter is a practical electron source which has several of the advantages of transistors: microscopic size, no heat and high current density. A cold-cathode field emission X-ray tube provides a dose rate of 10^7 r/sec. at the tube face and therefore a significant X-ray exposure in a correspondingly short time 50nsec. A current of 2000a. is drawn from cold tungsten needles. Complete details available from Field Emission Corp., Melrose Ave. at Linke St., McMinnville, Ore.

Circle 147 on Inquiry Card

Troubleshooting Wall Chart

This wall chart covers power supply troubleshooting hints and first aid procedures for plating accidents. One side of the chart lists common power supply troubles; the other side of the chart lists the first aid procedures that should be followed when electroplating chemicals are swallowed or contacted. Ramm Rectifier Co., Inc., 449 Wales Ave., Bronx, N. Y.

Circle 148 on Inquiry Card

Delay Relays Catalog

Catalog CD, 12 pages, gives detailed data on a number of types of solid-state time-delay relays. Some units use both the solid-state circuitry and a standard relay in a single enclosure. Complete engineering specs., wiring diagrams, outline dimensions and other pertinent data are given. Potter & Brumfield, Princeton, Ind.

Circle 149 on Inquiry Card

Cable Accessories

Bulletin A-C, Issue 2, is a 12-page catalog covering a line of supporting hardware, associated accessories, and installation tools for a line of coaxial cables. Fully illustrated, the catalog offers brief descriptions of each item, accompanied by part numbers. A numerical index is also provided. Phelps Dodge Electronic Products Corp., P. O. Box 187, 60 Dodge Ave., North Haven, Conn.

Circle 150 on Inquiry Card

Reducing Resistance Variation

Detailed analyses of circuits in which variation of a potentiometer's total resistance may have an undesirable effect on system performance, and methods for minimizing or eliminating these effects, are contained in Technical Data Bulletin TD-112. Typical circuits are shown and analyzed to demonstrate the effects, and how these effects can be reduced or eliminated. Markite Corp., 155 Waverly Place, New York, N. Y.

Circle 151 on Inquiry Card

Decimal Equivalent Chart

This 16 x 10½ in. wall chart converts frequently used fractions into their decimal equivalents. It is intended as a mathematical aid. Decimals are carried to 6 places for greatest accuracy. Inmanco Inc., 3800 W. 42nd St., Chicago, Ill.

Circle 152 on Inquiry Card

VHF Power Transistor

This VHF power transistor is suited for grounded emitter Class B and C communications amplifiers. The 3TE240 is designed for r-f amplifiers operating in the 100 to 250MC range. It provides up to 15w. of power with greater than 11db gain at 150MC and greater than 10w. with 8db gain at 250MC using 40v. inputs in both cases. For further information and data sheet, write Clevite Semiconductor, 1801 Page Mill Rd., Palo Alto, Calif.

Circle 153 on Inquiry Card

Miniature Relay

Data is available on a miniature, transistor-can sized SPDT relay. Weighing 1/10 oz. and occupying less than 1/20 cu. in., this device will switch dry circuit to 1a. loads with the same sensitivity as SPDT relays many times larger. Its effective load-carrying capacity results from a specially designed magnetic circuit which affords low pull-in power with max. contact pressures. Babcock Relays, a div. of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif.

Circle 154 on Inquiry Card

Sweep Oscillators

The 720 series of sweep oscillators are described in this data sheet. Design features and specs. given including freq. range, power output, remote programming, dimensions, sweep modes, etc. PRD Electronics, Inc., subs. of Harris-Intertype Corp., 202 Tillary St., Brooklyn. N. Y.

Circle 155 on Inquiry Card

Dielectrometer

This brochure describes special-purpose dielectrometers, which determine the dielectric constant and loss tangent of materials at microwave freqs. and variable temps. as high as 3000°F. The unit operates in the X, K, and R bands. Complete operating specs. are given. Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.

Circle 156 on Inquiry Card

NEW TECH DATA

Power Transformers

Data is available on 6 new power transformers for use with solid-state rectifiers. The R-200A series transformers provide dc output voltages from 25v. to 1kv. Secondary voltage range meets requirements of many vacuum tube and low-voltage transistor circuits. The transformers may be used in full-wave center tap, full-wave bridge or voltage doublet circuits. Triad Distributor Div., 305 N. Briant St., Huntington, Ind.

Circle 157 on Inquiry Card

Instruments Stock List

Instruments available for quick delivery from stock are listed in Bulletin 39. The inventory includes the most popular sizes and sensitivities of panel meters, meter-relays, indicating and controlling pyrometers, recorders, temp. controls and auxiliary components. The Bulletin includes part numbers and prices. Assembly Products, Inc., Chesterland, Ohio.

Circle 158 on Inquiry Card

Master Catalog

Catalog No. 77, 584 pages, features over 20,000 precision mechanical components. It includes a complete line of precision gears, magnetic clutches, clutch brakes, differentials, limit stops, speed reducers, gearheads, couplings, instrument clamps, in-line slip clutches, over-running clutches, precision shafting and electronic hardware available. All items are illustrated by isometric drawings. Sterling Instruments, div. of Designatronics Inc., 76 E. 2nd St., Mineola, N. Y.

Circle 159 on Inquiry Card

Catalog & Manual

Catalog 64B, 65 pages, lists a complete line of dc power supplies and provides application data for them. The data contains photos, schematics and specs. The applications section covers power-supply circuit principles, special application problems, operational features, and power supply specs. Schematics, curves, and equations are given. Harrison Laboratories, div. of Hewlett Packard Co.. 100 Locust Ave., Berkeley Heights, N. J.

Circle 160 on Inquiry Card

Relays

A line of standard subminiature crystal can relays and standard balanced armature relays are pictured and described in this brochure. Operating and environmental characteristics are given. Leach Corp., Controls Div., 717 N. Coney Ave., Azusa, Calif.

Circle 161 on Inquiry Card

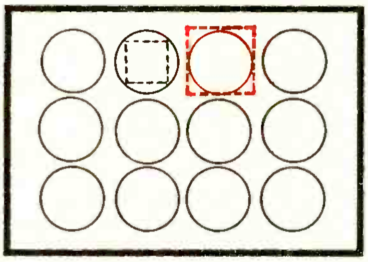
Laser Interferometer

Data is available on a new interferometer which uses a laser source. The bulletin contains data on applied fields of use and construction, and gives operating specs. and photos. Japan Electron Optics Laboratory Co., Ltd., 1418 Nakagami, Akishima, Tokyo, Japan.

Circle 162 on Inquiry Card

WHY A SQUARE THAT'S OUT IS "IN"

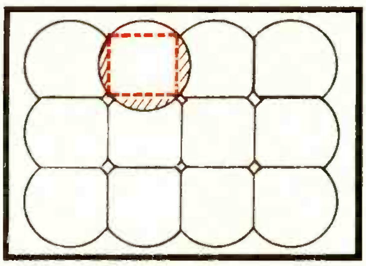
HOW IEE SQUARED THE CIRCLE TO GET 4-TIMES BRIGHTNESS FROM A REAR-PROJECTION READOUT



We're real big in squares and circles this year. Bigger yet in getting our popular Series 10 rear-projection readouts to develop 4-times greater character brightness than ever before (this with conventional MS or commercial lamps operated strictly at rated voltage!). The trick is in the lens.

Above is a horizontal view (actual size) of the old 12-position lens. The dotted square *inside* the circular lens represents the actual usable area that formerly averaged about 20 foot-lamberts with 6.3 v lamps (as bright or brighter than competitive devices). To get even greater brightness while using the same lamps at rated voltage, usable lens area had to be increased. Our problem was limited space. So we put our theoretical square *outside* the circle (shown in red above).

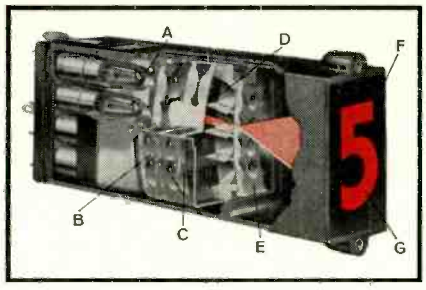
Next, we made the individual lenses larger to encircle the larger square. Now we had an overlap problem. This we solved by squaring the circles to leave off the unused portions, shown below. It's a bit unconventional, or so our lens-maker tells us. The results, however, are most rewarding.



The new Series 10 readout now averages over 75 foot-lamberts of character brightness when used with 6.3 v lamps *at rated voltage*. The increased brightness means visual clarity at wider angles and longer distances, excellent readability even under adverse high ambient light conditions.

And, there's an extra benefit if you're not overly concerned with all this brightness: operate the IEE readout at reduced voltage and you'll get *double brightness plus 10 times the lamp life* (up to 30,000 hours from 6.3 v lamps operated at 5.3 v).

CUT-AWAY SHOWS HOW NEW SERIES 10 READOUT OPERATES:



A. STANDARD MS OR COMMERCIAL LAMP
B. SQUARE LIGHT-COLLECTING LENS UTILIZES APPROX. 100% MORE LIGHT THAN OLD SYSTEM; TRANSMITS DOUBLE-SIZE CONE TO CONDENSING LENS
C. DUAL SQUARE-LENS CONDENSERS PROVIDE GREATER COVERAGE AT LOWER MAGNIFICATION
D. FILM CONTAINING DISPLAY SYMBOL (NUMBERS, LETTERS, WORDS, SYMBOLS, COLORS)
E. PROJECTION LENS
F. NON-GLARE VIEWING SCREEN
G. 4-TIMES BRIGHTER CHARACTER 1-1/16" HIGH (MAX.)

Of the four 12-position lenses used in the new readouts, three are of the new square-lens type (Pat. Pend.). The increased usable area permits each lens to collect twice the light and to project the message indication with half the magnification formerly required. These factors produce 4-times the brightness of older units.

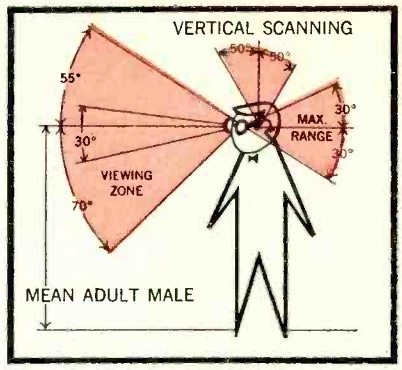
DIGITAL INSTRUMENTS BY ELECTRONIC ASSOCIATES, Inc... VISUAL TRANSLATION BY IEE

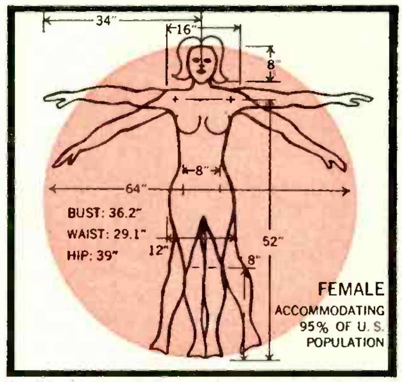
For visual translations, EAI relies on IEE. That's why so many EAI digital instruments are equipped with our rear-projection readouts. Where else can you get such an impressive array of important advantages? Visual clarity, wide-angle readability, single-plane display for crispness (instead of visual hash). Not to mention display versatility that permits you to indicate *anything*. (We mean that quite literally. Anything you can put on film, colors included, can be displayed on an IEE readout.) And, you get 12 message positions that may be displayed individually or in combination.

If you're in the market for a really good Remote Visual Display or an exceptional solid-state DVOM, we hope you look at the EAI units shown here. While you're at it, we hope you'll notice the excellent visual translations, too!

EAI SERIES 5620 REMOTE VISUAL DISPLAY

EAI SERIES 5100 DIGITAL VOLT-OHMMETER





HUMAN FACTORS:

The scanning male & standing female

As builders of display devices for a variety of applications, we are extremely interested in human engineering studies. The July/August, 1963, issue of *Vending Engineer* contained drawings by Walter Koch, Industrial Designer, on which the above illustrations are based (with permission).

The drawings show one of the basic limitations imposed on vertical display areas by physical size of people. Studies show that the effective viewing area of most people is only about 30% of the total of most floor-standing vertical displays. We suspect this data is of interest to readers outside the vending machine industry since human engineering deals in one universal factor: people.

HOW TO INDICATE STATUS CONVINCINGLY & IN LESS THAN 5 SQ. IN.

This little box isn't quite 2½" x 2" yet it replaces 12 indicator lights! With it, you can display the status of just about anything with just about any combination of colors, symbols, numbers, letters, words; up to 12 individual messages all in a single plane and for as low as 80¢ per indication. If you're interested, it's called "Status Indicator"® and we supply it ready-to-use with message configurations custom-designed to your requirements.

Your inquiry will bring the comprehensive new "Readout Display Selector Guide" which includes specifications and other technical information on the entire IEE line of readout devices.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

7720 Lemona Ave., Van Nuys, Calif. • Phone: (213) 787-0311 • TWX: (213) 781-8155

Representatives in Principal Cities

NEW TECH DATA

High Voltage Equipment

This folder contains descriptions and technical data on power supplies, volt boxes, zener regulators, insulation test sets, kilovoltmeters, connectors, and switches. Application information and operating specs. accompany photos of the unit. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle 163 on Inquiry Card

Dielectric Plastic

Technical bulletin BR-20 describes Z-tron dielectric materials. It contains property and availability data on the new thermoplastic developed for strip transmission lines and microwave freq. uses. The Polymer Corp., Reading, Pa.

Circle 164 on Inquiry Card

Sweep Generators

Catalog 63-S describes a line of sweep generators, r-f attenuators, r-f detectors, and coaxial switches. It includes a discussion of sweep generator techniques, physical descriptions, electrical specs. and uses. The catalog is available in English or French from Telonic Industries, Inc., 60 N. First Ave., Beech Grove, Ind.

Circle 165 on Inquiry Card

Trimming Potentiometers

Catalog sheet 641208 describes a complete line of cermet trimming potentiometers. Electrical, mechanical and environmental specs. are presented on both lead and pin versions of Helitrim® Model 50 and 55 trimmers. Helipot Div. of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 166 on Inquiry Card

Silicon Transistors

This 8-page brochure describes the series 2N3232 through 2N3240 silicon power transistors. It illustrates and includes technical drawings and graphs indicating electrical characteristics and absolute max. ratings. Silicon Transistor Corp., Carle Place, N. Y.

Circle 167 on Inquiry Card

Converter

Data is available on a solid-state freq.-sensitive converter which converts any appropriately scaled dc microammeter to an expanded-scale freq. meter. Models are available in ranges to 5KC. Aero Instrument Facility of Ventura Div. of Northrop Corp., Northrop Bldg., Beverly Hills, Calif.

Circle 168 on Inquiry Card

Cooling Cells

This technical bulletin describes 3 unique frame designs which are available with removable honeycomb cooling cells. Construction drawings and technical specs. are included. Metex Electronics Corp., Walnut Ave., Clark, N. J.

Circle 169 on Inquiry Card

NEW TECH DATA

Crystal Filters

Brochure MQ/108, 48 pages, describes 22 types of h-f crystal filters specially designed for use in mobile radio equipment. The characteristics of each device are given in tabular and graphic form. Filters are listed for 12.5, 20, 25 and 50KC channel spacing. STC Quartz Crystal Div., Edinburg Way, Harlow, Essex, England.

Circle 246 on Inquiry Card

Conductive Coating

An effective conductive coating with good specific adhesion to metal, glass, most plastics, and most porous materials is described in this data. Rez-N-Glue No. 159 is recommended where a tightly adherent coating is needed that will conduct a charge. Schwartz Chemical Co., Inc., 50-01 Second St., Long Island City, N. Y.

Circle 247 on Inquiry Card

Reed Relays

Bulletin No. 900A describes 4 basic types of sealed-contact reed relays. Electrical characteristics are outlined. Summaries on relays for integrated PC board assemblies and control modules for counting, selection, and logic functions are also included. C. P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill.

Circle 248 on Inquiry Card

Frequency Control Meters

This spec. sheet describes a 400-cycle edgewise, freq. control meter for use on variable freq. power systems. The standard model operates from 380 to 420 CPS, is accurate within 1 cycle, and is available with high and/or low limit control arms. AMF Instrument Div., American Machine & Foundry Co., P. O. Box 929, Alexandria, Va.

Circle 249 on Inquiry Card

Controls Catalog

This 64-page catalog features automatic transfer switches, contactors, relay controls, program clocks and timing controls. Divided into 5 indexed sections, this 2-color catalog contains full specs., uses, operating data, wiring diagrams and product illustrations. Zenith Electric Co., 160 W. Walton St., Chicago, Ill.

Circle 250 on Inquiry Card

Instrument Catalog

This 101 page catalog contains photos and complete operating characteristics for scientific instruments and oscilloscopes. Described are high and low freq. oscilloscopes, special-purpose large-screen instruments, signal generators, oscilloscope camera and accessories, and oscilloscope accessories. Du Mont Laboratories, Div. of Fairchild Camera & Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.

Circle 251 on Inquiry Card

ASTRODATA

ADVANCED SOLID STATE AMPLIFIERS FOR YOUR CONTROL AND INSTRUMENTATION APPLICATIONS

ASTRODATA advanced design instrumentation amplifiers raise state-of-the-art standards to higher levels for measurement . . . conditioning . . . monitoring . . . indicating . . . control.

For custom designs, Astrodata's extensive experience provides a well-qualified capability for satisfying your specific performance needs.

Model 884 Wideband (dc to 100 kc) Floating, Guarded Amplifier . . .
Model 885 Wideband (dc to 10 kc) Differential, Isolated Amplifier . . .

high-gain/performance amplifiers for low-level, wideband systems at lowest cost. Completely transistorized, these state-of-the-art amplifiers use field-effect transistors in place of mechanical choppers to achieve lowest drift rate, freedom from microphonics and maximum reliability. Gain range to 3000 and a continuously adjustable 10-turn vernier control are provided as standard features. Two differential models with ±10 ma or ±100 ma output current from a low impedance can drive long lines, A to D converters, multiplexers, galvanometers or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload recovery times, and minimum phase shift. Common mode rejection is greater than 120 db with up to ±300 volts dc or peak ac common mode voltage.

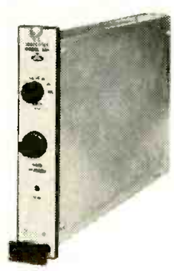
All models have built-in power supplies, feature drift less than 1 μV per week, wideband noise less than 4 μV rms, linearity better than 0.02%. Can be used either separately or in the same rack module with Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated signal conditioning channels.

Model 885-135 Differential Amplifier to drive multiplexers, tape recorders and A to D converters.

GAIN RANGE: 1 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±5 volts at ±10 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 885-235 Differential Amplifier to drive data systems, long lines and galvanometers.

GAIN RANGE: 3 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±10 volts at ±100 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms



Model 1155 Universal Signal Conditioning Unit

Uses plug-in circuit cards to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gages, resistance temperature sensors, thermistors, potentiometers and voltage sources. Can function separately or in same rack module with Models 884 or 885 Amplifiers or Model 890 Filter to provide complete conditioning, calibration and normalizing of transducer signals.

Model 126-101 Charge Amplifier. All solid-state unit with internal dynamic calibration.

INPUT RESISTANCE: 10,000 megohms
INPUT RANGE: 1 to 10,000 psi, g lbs
GAGE FACTOR RANGE: 1 to 11 or 10 to 110 pcmb per psi, g or lb, continuously adjustable
FREQUENCY RESPONSE: 0.3 cps to 150 kc
STATIC CALIBRATE MODE: Extends response virtually to dc for dead weight testing.

Model 120 Nanovolt Amplifier gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

GAIN RANGE: 200 to 1,000,000
BANDWIDTH: dc to 100 cps
NOISE: 0.05 μV rms
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ±5 volts at ±5 ma

Model 121Z Nanovoltmeter provides 0.1 μV full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field and in laboratories.

FULL SCALE RANGES: ±0.1 μV to ±100 mv
INPUT RESISTANCE: 1 megohm
ZERO SUPPRESSION: ±0.5 μV to ±5 mv
AMPLIFIER OUTPUT: Gain 30 to 3 million, delivers ±5 volts at ±5 ma
Overload Indicator

Contact your Astrodata engineering representative for a demonstration . . . or write today for technical literature giving complete specifications.

ASTRODATA INC.
P.O. Box 3003 • 240 E. Palais Road, Anaheim, California • 92803
TEL. (714) 772-1000 • TWX 714-776-3760 • FAX • TELEX 06-78828 • CABLE ADDRESS - ASTRODATA, Anaheim

16b

This is the
world's smallest
rotary switch
for military
applications.

This is the
world's smallest
rotary switch
for commercial
applications.

We make both.

Take your choice! Daven now offers two subminiature switches —Series G for military applications and Series K for commercial applications.

The renowned Series G has been redesigned to give increased reliability, higher dielectric strength and longer life. Manufactured in clean room environment, it meets applicable Mil specs on temperature, humidity, corrosion, vibration, acceleration, shock and immersion, as well as being explosion-proof and waterproof.

Now the new Series K gives you the same size, quality and electrical specifications as the Series G—but at a much lower cost—from **$4.85** to **$3.85** each, depending upon quantity. It was developed to meet instrument and commercial applications where low cost is important and the most exacting Mil specs need not be met. Yet it is a completely enclosed unit, offering such quality features as long life, low contact resistance, high dielectric strength, wide operating temperature range, positive detent action and resistance to corrosion, shock and vibration.

Both Series G and Series K switches are available in single deck, shorting and non-shorting. They may be obtained in various combinations up to 4 poles and 10 positions.

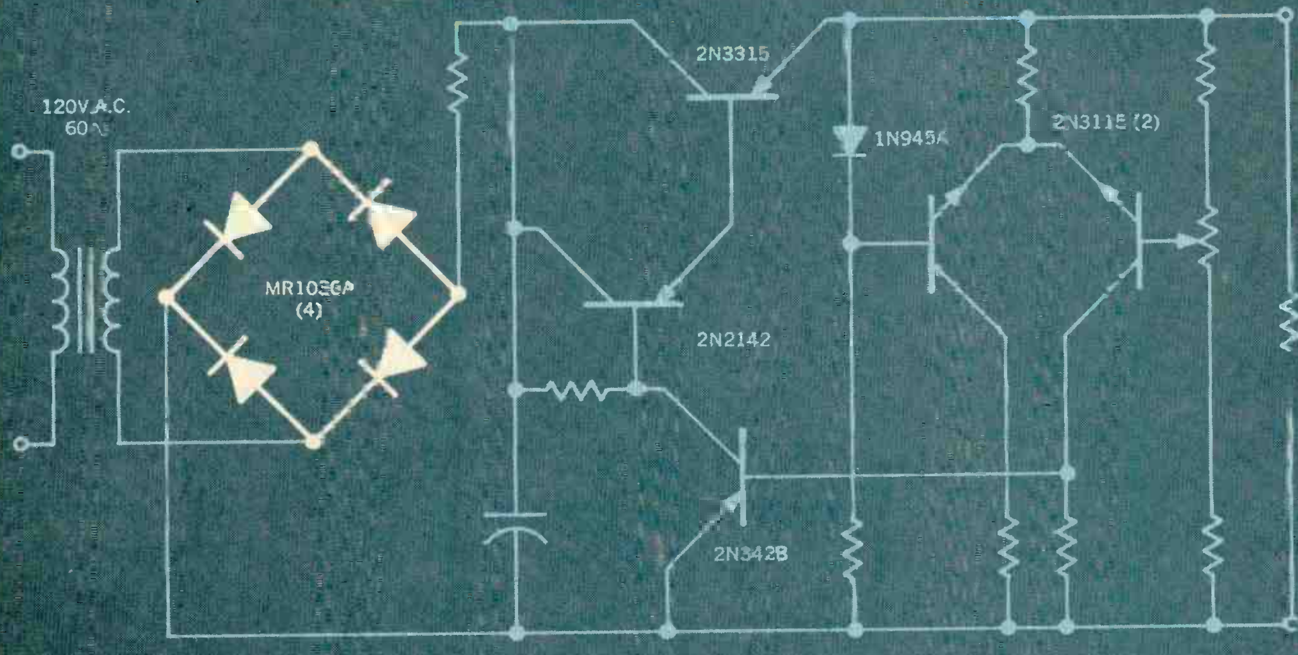
For complete details on either, write today!

DAVEN McGRAW-EDISON

LIVINGSTON, NEW JERSEY

(201) WYman 2-4300 • TWX 201 992-7356 • Cable: DAVEN LIVINGSTON N J

Ordinarily, You'd Pay About $3.00* for the Rectifiers in this Circuit . . .



Regulated Power Supply 5 Amperes, 28 Volts

. . . But With Motorola's New, 3-Amp Axial Lead Rectifiers, Your Cost is Only $1.48†!

If you're interested in cutting costs without sacrificing quality (and who isn't these days), you'll find it worthwhile to evaluate Motorola's new MR1030 rectifier series.

Providing the highest current rating in lead-mounted packages, these devices are priced 50% to 70% lower than conventional, stud-mounted rectifiers in the same current range. They're ideal for circuit board applications where stud packages and heat sinks aren't practical. And where most other axial lead units offer only 20- to 30-amp surge capacity, these new Motorola rectifiers are capable of handling surges up to 300 amperes!

ADDITIONAL ADVANTAGES INCLUDE:

- Welded, hermetically sealed cases
- Flexible, readily solderable leads
- Reverse polarity models available

Max Rating	MR1030	MR1031	MR1032	MR1033	MR1034	MR1035	MR1036
$V_{RM(rep)}$ $V_{RM(wkg)}$ $V_{R(volts)}$	50	100	200	300	400	500	600
$V_{r(volts)}$	35	70	140	210	280	350	420
$I_{O(amps)}$	3.0						
$I_{FM(surge)}$	300A (for ½ cycle)						

Contact your Motorola distributor now for local off-the-shelf delivery. For complete specifications, write: Motorola Semiconductor Products Inc., Dept. TIC. Box 955, Phoenix, Ariz. 85001

*Based on published list prices (100-up) of stud-mounted rectifiers from three semiconductor manufacturers.
†(100-up)

POWER UP . . . with MOTOROLA

YOUR COMPLETE SOURCE FOR POWER SEMICONDUCTORS

3-3881-11

NEW TECH DATA

Power Amplifier

Bulletin TA106640 provides special features, performance, environmental and physical characteristics, configuration and other data on the Model TA-1000 solid-state 10w r-f power amplifier. The amplifier is readily adaptable for easy integration into most telemetry systems. Leach Corp., 1123 Wilshire Blvd., Los Angeles, Calif.

Circle 170 on Inquiry Card

Microcircuit Packaging

Data is available on a special method for etching flat kovar ribbons for microcircuit packaging. The package consists of an insulated glass or ceramic body bonded to a kovar frame. The frames may be of any configuration. They are etched in flats up to 12-in. sq. Leads located on 0.050 in. centers. Buckbee Mears Co., St. Paul, Minn.

Circle 171 on Inquiry Card

Solder

Illustrated Bulletin 37 describes Vaculoy,® a specially processed virgin solder containing an extremely low level of nonmetallic inclusions. A general description, production advantages, illustrations, availability and uses are included. Alpha Metals, Inc., 56 Water St., Jersey City, N. J.

Circle 172 on Inquiry Card

Core Components Catalogs

Two new catalogs of iron core components are available. Volume I, 52 pages, features transformers and inductors. Volume II features 24 pages of electric wave filters, high Q coils and inductors. United Transformer Corp., 150 Varick St., New York, N. Y.

Circle 173 on Inquiry Card

Null Detector

The Model ND-106 null detector/dc amplifier is suited for uses where standard galvanometers cannot be used due to inadequate sensitivity, low input impedance, and insufficient stability. This data sheet gives full operating specs., a functional block diagram, and design features. Julie Research Laboratories, Inc., 211 W. 61st St., New York, N. Y.

Circle 174 on Inquiry Card

Lens Systems

Data is available on 2 Infrared Achromat Lenses, Servocon I and II. Both lenses are designed for high speed and reduced spherical and chromatic aberrations, and are made to cover a wide range of wave lengths. Standard Servocon achromats are supplied with anodized aluminum mounts; special mounts can be made to meet user specs. Optical elements have anti-reflection coatings to provide max. transmission. Servo Corp. of America, Infrared Electro-Optics Div., 111 New South Rd., Hicksville, L. I., N. Y.

Circle 175 on Inquiry Card

NEW TECH DATA

Amplifiers

Amplifiers in microminiature i-f, i-f video, video or standard packages are described in this 2-color catalog. Included are specs. and outline dimensions. All meet Mil-E-5400 and Mil-E-16400 specs. Advanced Products, 825 Bronx River Ave., New York, N. Y.

Circle 176 on Inquiry Card

Weldable Thermocouple

This 2-color data sheet, WT-1A, describes an electrically isolated, weldable thermocouple. These thermocouples are capable of temp. measurement in the range of —310°F to 1400°F. General specs., performance and mechanical specs. are listed. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 177 on Inquiry Card

Connector Catalog

Catalog Form MM764 describes the Series MM-22 micro-miniature rack and panel connectors which meet applicable specs. of Mil-C-8384. The units can be supplied with 5 through 104 contacts, and have such optional accessories as hoods, polarizing screwlocks, and cable brackets. Electrical and mechanical specs., illustrations, and ordering information are given. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 178 on Inquiry Card

Life Testing Programs

A technical paper for engineers in the fields of reliability, quality control and systems design entitled, "Significance of Large Life Testing Programs," is available. The paper raises a question important also to procurement specialists, since vast investments of time and money are expended in testing efforts. Corning Glass Works, Public Relations Dept., Corning, N. Y.

Circle 179 on Inquiry Card

Crimping Tool

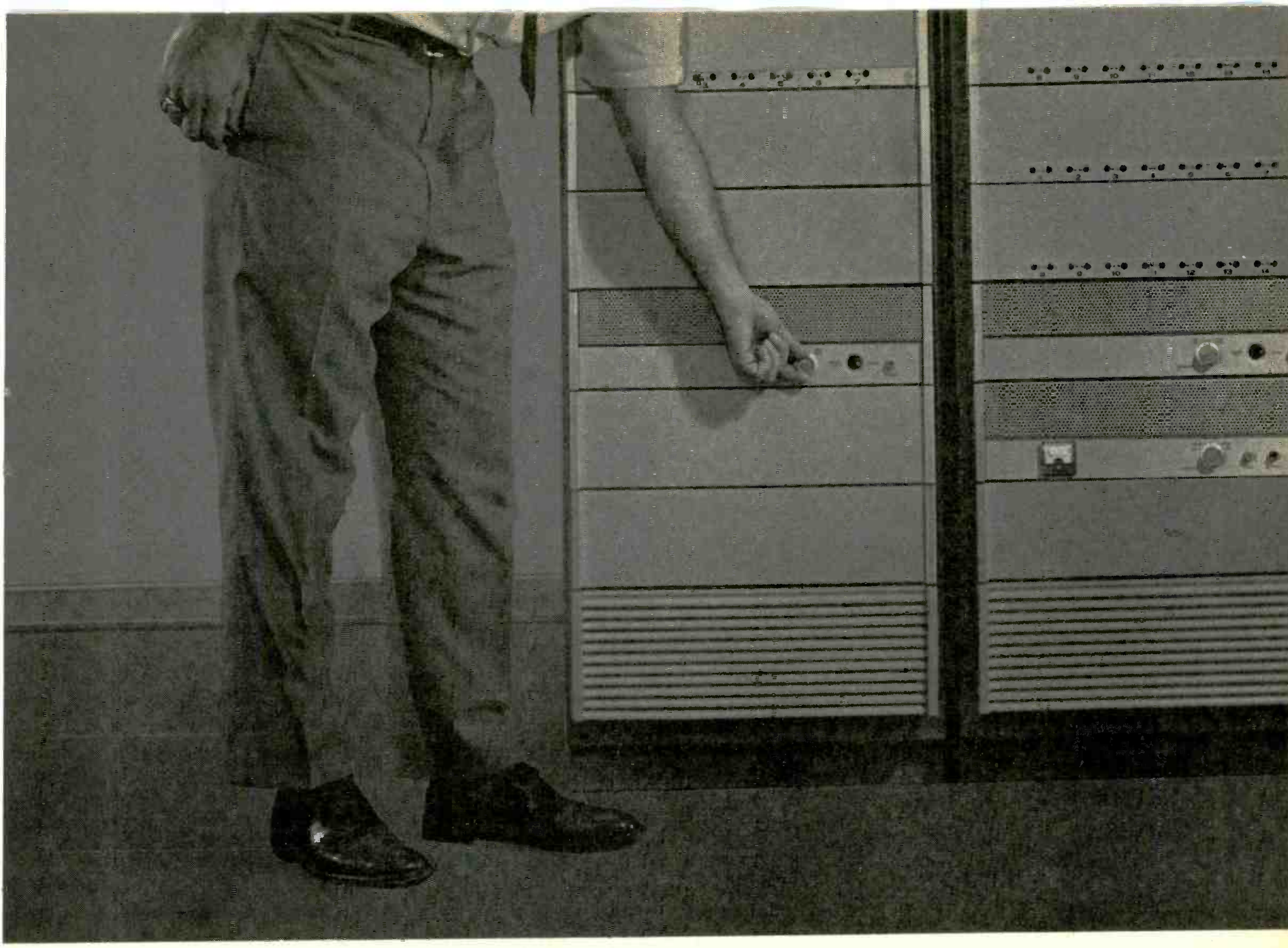
Two-color bulletin AF-4 describes an Automatic Feed Crimping Tool for high-volume production crimping of almost any pin and socket contact from #12 through #20. It fully describes the outstanding features of the tool and includes illustrations. Buchanan Electrical Products Corp., Hillside, N. J.

Circle 180 on Inquiry Card

Panel Meters

Bulletin 2065, 20 pages, lists over 1300 types and ranges for panel meters available from stock. Specs. and prices are shown for pivot and jewel meters, tautband units, contactless meter relays, "Rugged Seal" meters, edgewise type, segmental voltmeters, and elapsed time meters. Also included are shunts, current transformers, and multipliers plus a 3-page glossary of instrument terms. Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

Circle 181 on Inquiry Card



How to reduce hours to split-seconds

It's the newest exclusive talent of CEC's VR-3600

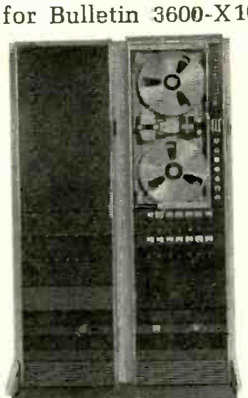
Now, with the simple flick of a switch, it is possible to *automatically* change from wide-band to narrow-band recording/reproducing and vice versa. Reason: standard amplifiers and electronics were modified so that the VR-3600 recorder/reproducer can instantly provide the higher recording bias and signal levels and reproduce equalization required for narrow-band frequencies.

For data reduction, dubbing and similar applications, this means that no more precious hours will be wasted on manual change-overs and recalibrations. *And* . . . with this modification, equipment costs can be reduced as much as 40%.

The following advantages, along with the capacity to store vast amounts of data on a minimum amount of tape, will explain why the VR-3600 is commonly referred to as the ideal "universal" recorder.

- Each of its 7 or 14 record/reproduce channels can be used for data storage in the 400 cps to 1.5 mc frequency range . . . or d-c — 500 kc, or standard IRIG 10 kc FM (54 kc carrier @ 60 ips), wide-band FM to 80 kc (216 kc carrier @ 120 ips) with plug-in electronics.
- Record and reproduce amplifiers are solid-state; the direct system fully amplitude and phase equalized.
- 6-speed pushbutton operation is provided, with no adjustments required between speeds, electronics, too!
- All-metal-front-surface magnetic heads are of high efficiency design with long life characteristics.
- Tape tension is controlled in all operating modes by closed loop servo control.
- Automatic end-of-reel sensing stops tape without leaders; transfer switch provides start command for nearby recorder.
- Individual plug-in-equalizers (6 per amplifier) meet all specifications simultaneously. Buy only those required, then set and forget.
- The system may be supplied in single or dual rack configuration, with or without a dolly.

For the full story about what the VR-3600 can do for you, call CEC or write for Bulletin 3600-X10.



CEC
Data Recorders Division

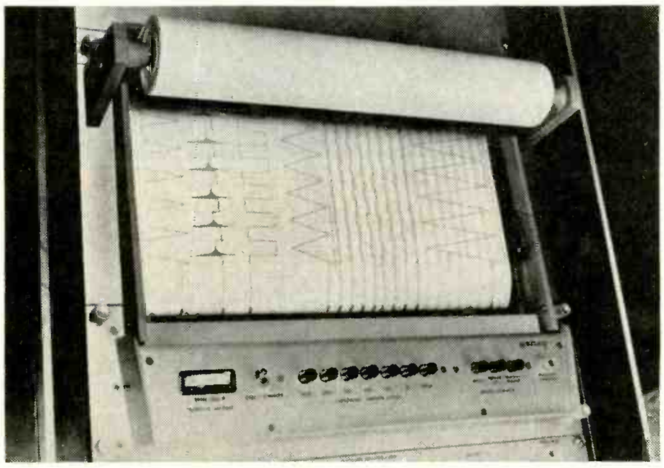
CONSOLIDATED ELECTRODYNAMICS

A SUBSIDIARY OF BELL & HOWELL/PASADENA, CALIF. 91109
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRANKFURT/MAIN, GERMANY

Circle 52 on Inquiry Card

NEW RECORDING CONCEPT

A new concept in direct-writing recording systems permits different types of recording channels to be mixed in any combination desired to suit requirements. Typical charts produced on the Series 1707 include 80mm channel, eight event channels, and four 40mm analog channels. All channels are correlated to same time base. The recorder is a product of Brush Instruments, Div. of Clevite, Cleveland, Ohio.



A bar-graph oscilloscope has been developed for use with telemetry displays. A product of ITT Industrial Products Div., the Model KB-703 displays up to 100 channels of data presented as calibrated vertical bars on a 17-in. CRT. Maximum input sensitivity is 1 volt for FSD. Unit is used wherever the assimilation of much data is involved.

A Transfer Oscillator, in combination with an electronic counter, enables an h-f measuring system to measure directly CW, AM, FM, and pulsed r-f from dc to 15GC. The Model 1292 Oscillator, by Systron-Donnor, Concord, Calif., uses a combination of AFC and phase-lock for CW signals to give a measurement accuracy within 1 part in 1 billion. Measurements are displayed without calculation.

With Telecheck it is possible to test 18 IRIG channel VCOS of a frequency-modulated telemetry system in 2 minutes. The unit applies a calibrated dc voltage to the VCO input, and automatically checks the VCO output frequency boundary. If it is within tolerance, it steps to the next test point. Out of tolerance deviations stops the cycle and indicators show high or low results. The system is a product of Standard Precision Inc., Wichita, Kansas.

Varian Associates has developed a miniature fully synthesized atomic frequency standard. This device makes possible the use of atomic frequency accuracy and stability to such uses as airborne navigation, aircraft collision avoidance systems, manned orbiting space laboratories, and space tracking systems. The Varian R-20 Rubidium Frequency Standard consists primarily of a servo system in which a crystal oscillator is locked to the electron hyperfine transition frequency found in the rubidium atom. This invariant atomic frequency provides the long-term stability reference. The small size and light weight of the R-20 permits easy installation in many airborne systems; the instrument fits in the standard aircraft electronics rack.

A highly accurate method for sensing large amounts of dc current has been developed by Magnetics Inc., Butler, Pa. This method uses a precision dc current transformer having an accuracy of 0.025% of full scale. The transformers are designed for uses such as precision laboratory measurement equipment, where the determination and repeatability of an absolute value of current is essential.

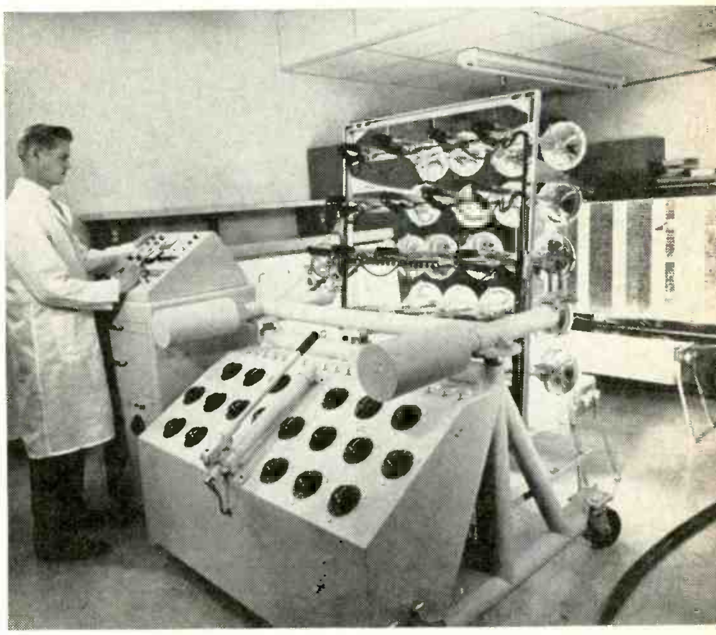
A test system that can uncover a misplaced 0.005-in. wire or an unwanted solder pellet 0.003-in. in diameter will help detect flaws in the spacecraft parts of Projects Gemini and Apollo. Known as Failure Analysis System, the unit was built by Picker X-Ray Corp., Cleveland, Ohio, and installed at Cape Kennedy. The system enables inspectors to see through materials and spot defects in workmanship or function

A phase comparator and timing receiver has been built to receive the 24-hour broadcasts of NBS's WWVB. The Model VLA-26 is arranged to receive transmissions in the 20KC to 60KC range. The unit, a product of Specific Products, Woodland Hills, Calif., can be used to feed a recorder directly. When used with an external recorder, it is adequate for frequency accuracies in 5 parts in 10^{10}.

"PRD Reports" should make a valuable technical reference for microwave engineers. The bound edition contains 163 pages of microwave measurement and test techniques, each of which is thoroughly explained and supplemented with graphs and equations. The report is available at a nominal charge of $1.00 per copy from PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N.Y.

RANGER'S POWER

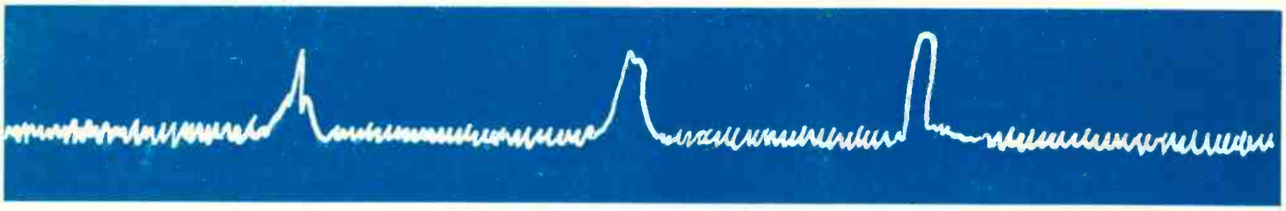
Intensive quality-control and testing were performed on the solar panels for Ranger Seven. In testing the panels, exciter lights which produced 10kw simulated the sun. Each panel produced an output of approximately 30 watts. Individual panels contained 4896 separate solar cells and unfolded in flight to give 24.4 ft. collecting area. Solar panels were built by Electro-Optical Systems Inc., Pasadena, Calif.



Mis-application almost surely occurs unless these instruments are thoroughly understood. Presented here are limitations of the various types together with proper application considerations.

Surveying the State-of-the-Art

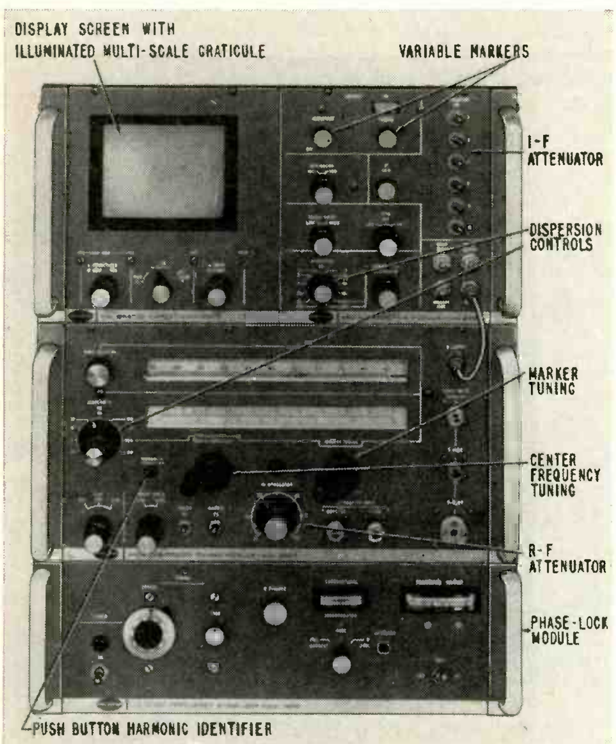
Microwave Spectrum Analyzers



A SPECTRUM ANALYZER provides a calibrated display, usually on a CRT screen, of a rectangular-coordinate plot of signal strength versus frequency. Because all but the simplest unmodulated sinusoidal (CW) signals contain multiple-frequency elements, of differing amplitudes—in other words, a complex spectrum, rather than a single frequency—the spectrum analyzer is an informative, versatile, and accurate tool for design, test, quality control, and troubleshooting.

Microwave Spectrum Analyzers, such as shown in Fig. 1, may be thought of as the combination of a microwave receiver and a cathode ray oscilloscope, together with the circuitry required to sweep the receiver center frequency in synchronization with the horizontal progress of the beam across the CRT screen. The output of the receiver, detected in an appropriate circuit (i.e., linear, square-law, logarithmic) is fed to the vertical channel of the CRO, so that the display that results is the plot of signal strength vs. frequency described above.

Fig. 1: Polarad Model 2994 wide-dispersion modular microwave spectrum analyzer—typical of modern high quality spectrum analyzers.



In Figs. 2 and 3 are shown the two conventional circuit approaches employed—"Swept IF," and "Swept-Front-End." At first glance, a microwave spectrum analyzer would appear to be a relatively straightforward piece of instrumentation, but both the designer and the user of spectrum analyzers soon learn that the realization of this basic concept is far from straightforward, and may be fraught with difficulties, some of them insurmountable at the present state of the art.

Resolution, Dispersion and Sensitivity

One major problem in microwave spectrum analysis has been the inherent limitations in the method employed to produce the spectrum display. First of all, the "swept receiver" method does not yield the spectrum, since it cannot display, at any one instant of time, the actual signal strength that exists across the entire spectrum scanned. No matter how rapid the sweep, the "sample" of signal strength taken at the end of the sweep occurs at some later moment in real time than that taken in the beginning of the sweep. (This inherent limitation is only of importance in a few esoteric applications, but can be overcome only by the use of exotic and complex techniques, such as the "coherent filter" approach sometimes used in the analysis of ultra-high-performance radar pulses and non-repetitive noise-burst spectra.)

By MURRAY H. FEIGENBAUM

Polarad Electronic Instruments
Division of Polarad Electronics Corporation
Long Island City, New York

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

Further, no matter how narrow the bandwidth of the IF amplifier preceding the detector, the signal strength sampled is not coherent. It contains not one frequency but a band of frequencies, thus blunting the resolution of the display. In order to minimize this effect, the IF bandwidth may be made even narrower, but that limits the sensitivity at a given sweep speed, since the total amount of time during which a particular (narrow) sample is taken is so short. The faster the sweep, the shorter is this time, and the lower is the effective sensitivity. Further, if we desire to examine, in a given sweep across the screen, a wide frequency range, or dispersion, the effective sampling time for a narrow-bandwidth (high resolution) device is correspondingly reduced. Thus, both higher dispersion and faster scan rates act to reduce the effective sensitivity. This limitation has been inherent in all commercial analyzers.

The designer must strive to maximize the sensitivity of the receiver by every means possible, until limited by the noise figure of the components and circuits he selects.

At the current state of the art, the sensitivity performance data given in the charts of Figs. 4 and 5 represent the best that can be accomplished in general-purpose production instruments, such as those manufactured by Polarad, Singer, Lavoie, or (Fig. 5 only) Hewlett-Packard. Note that sensitivity is most meaningfully given, in a general-purpose instrument, in terms of that signal level at which "signal + noise = two x noise," or "S + N = 2N."

In the swept-front-end technique of Fig. 3, the dispersion achieved may be very much wider than that achieved by the swept-IF system of Fig. 2, because there is no need for a high fidelity wide-band IF system. Typically, the limit of dispersion of the swept-IF type is 100 mc, and the limit in the swept-front-end analyzer is 2 gc. This advantage is offset, however, by the difficulty and expense involved in achieving "fine-grain" (narrow-band) high resolution, which requires that both the long-term and short-term stability of the local oscillator be extremely high. Phase-lock stabilization is one solution, if the instrument is equipped for it; and, the choice of components and circuits that have inherently low incidental FM, jitter, and drift in mandatory. Still another requirement is that no IF frequency employed in the analyzer be low enough to permit the image of the true signal to appear on the screen, even at the widest dispersion.

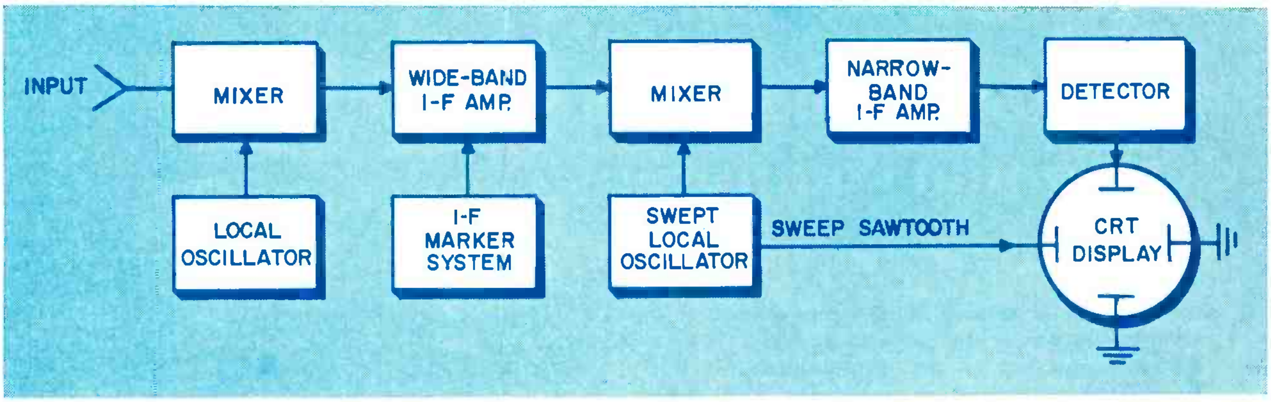
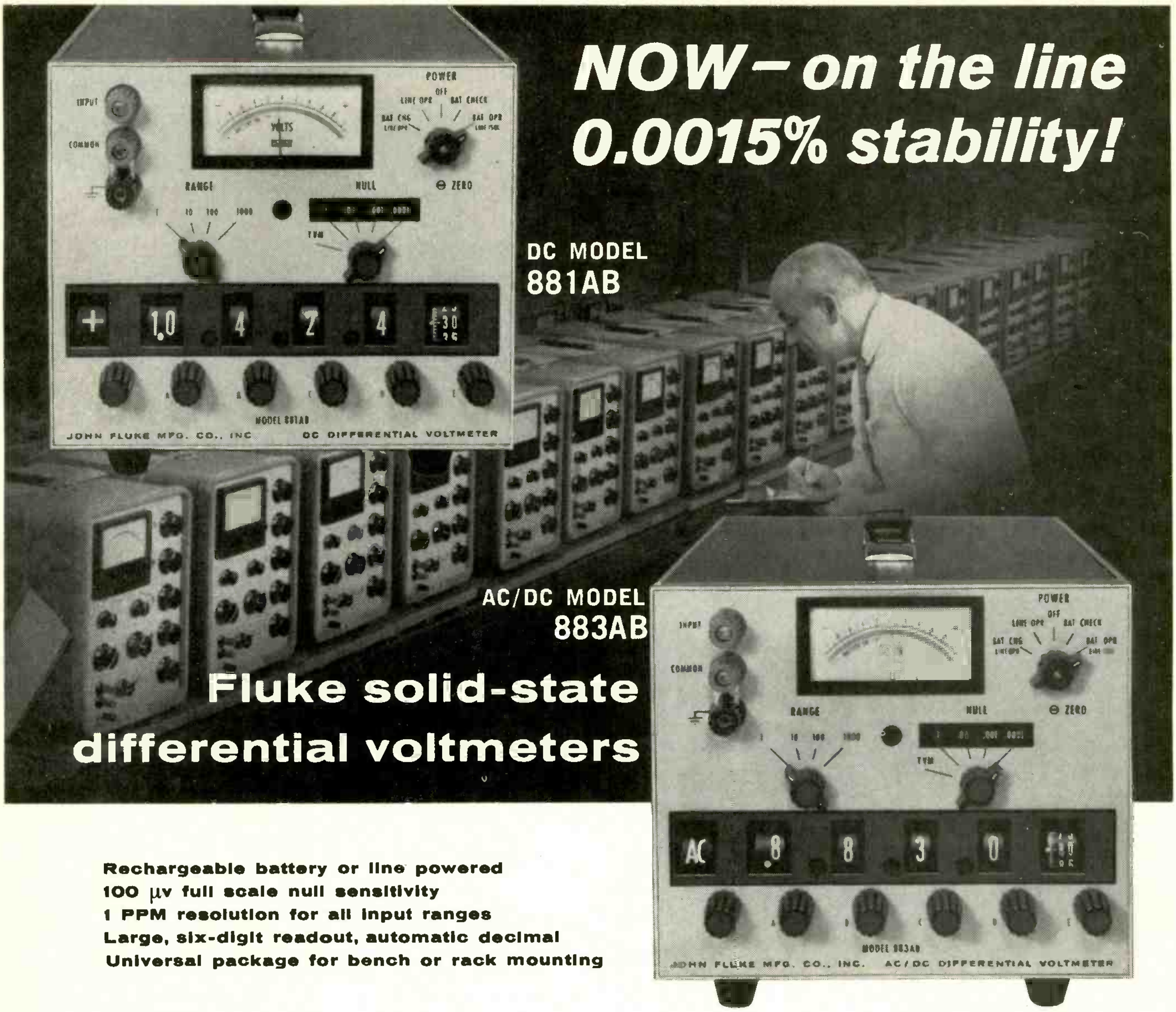


Fig. 2: Swept-IF Spectrum Analyzer Block Diagram. The incoming microwave signal is heterodyned in a crystal mixer assembly with the output of a tunable local oscillator to produce a suitable intermediate frequency, usually of the order of 160 mc. This signal is amplified in the wide-band intermediate-frequency amplifier, whose bandwidth determines the maximum dispersion capability of the analyzer. The amplified signal is then mixed with the output of the "sweeper," or swept local oscillator, the frequency of which is made to vary linearly in time by means of a sawtooth modulating wave.

Calibration, Flexibility and Accuracy

The other important group of limitations associated with modern microwave spectrum analyzers comprises all of the techniques associated with the use of the instrument to make rapid, error-free, accurate, quantitative measurements (both with respect to signal frequency and signal level) over as broad a range of test conditions as possible. Most of the important differences between one commercial instru-

(*Continued on page* 105)



Rechargeable battery or line powered
100 μv full scale null sensitivity
1 PPM resolution for all input ranges
Large, six-digit readout, automatic decimal
Universal package for bench or rack mounting

Stability and temperature coefficient of reference element and precision resistors are often the "hidden" parameters of voltmeter design.

For Models 881AB and 883AB, Fluke processes each zener diode reference to prove ±0.0015% per year stability; ratio stability of critical Fluke-manufactured resistors is ±0.001% per year. Temperature coefficient of the reference and critical resistors is ±0.0002%/°C and ±0.00015%/°C, respectively. This provides more than ample margin for long-term drift and temperature deviations within the overall DC accuracy of ±0.01% of input plus 5 μv for the 881AB and 883AB.

"B" suffix of model number indicates operation from either rechargeable batteries (30 hours on full charge) or AC line (50-440 cps). Severe common mode problems are eliminated by battery operation, as unit is completely isolated from line.

Null detector maximum sensitivity is 100 μv full scale, and maximum meter resolution is 1 ppm of range for all input voltages. Six-digit in-line readout is obtained by four decade switches plus high-resolution interpolating vernier. Input ranges are 1, 10, 100, and 1000 volts, with 10% overranging for 0-1100 volts overall capability.

Stable, solid-state AC to DC converter of Model 883AB is specified from 20 cps to 100 KC, with basic accuracy of ±0.1% of input +25 μv applicable from 1 mv to 1100 VAC and 30 cps to 5 KC.

A single mechanical configuration is ideal for portable field use, bench mounting (tilt-up bale), half-rack mounting (7-inch panel), or side-by-side rack mounting. Mil-spec shock, vibration, and temperature testing were included in development, assuring years of dependable performance under adverse conditions.

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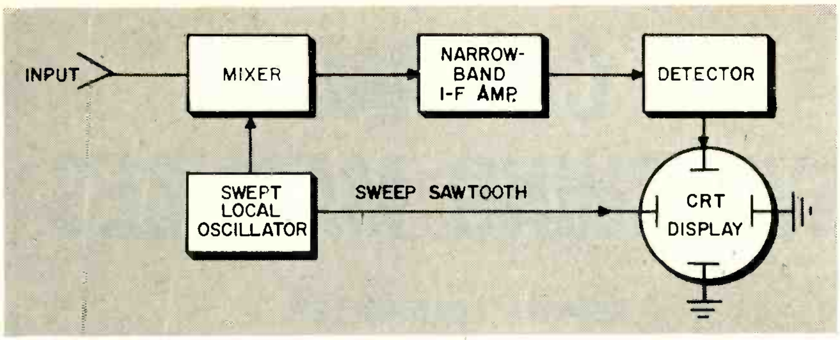


Fig. 3: Swept-Front-End Spectrum Analyzer Block Diagram. The local oscillator is usually a backward-wave oscillator or a voltage-tunable magnetron, electronically tunable over the desired range. In this system, the analysis is actually performed in the first mixer, which need only be a narrow-band device. The first local oscillator is swept in synchronism with the display trace as in the circuit of Fig. 2.

ment and another lie in this area of design. Let us examine some of these features.

Range of Frequency Adjustment

Whether the analyzer has plug-in "front-ends" for each range, or a universal, multi-range tuner, the range of frequencies that may be examined by the analyzer is of primary importance. Representative ranges are given in Figs. 4 and 5. The accuracy of the tuning must be consistent with the intended application, but it is generally improved upon by the use of markers.

Dispersion and Resolution Ranges

These should be as wide as possible while preserving stability, trace clarity, and adequate sensitivity. Typical values for the highest-performance instruments are given in Figs. 4 and 5.

Dynamic Range

There are two specifications for the dynamic range of a spectrum analyzer: Display Dynamic Range, defined as the input amplitude ratio viewable on the screen. This, on most analyzers, varies according to the detection selected, and is normally 10 db for power, 20 db for linear, and 36-40 db for logarithmic displays. Dynamic range is also defined as the ratio of minimum discernible signal level to the signal overload level. This definition is useful when evaluating the ability of the analyzer to measure relative levels of spurious and harmonic signals compared to a large fundamental signal. For example: An analyzer might have −100 dbm sensitivity and a front-end overload point at −20 dbm. The dynamic range of this system would then be only 80 db.

Frequency Markers

Instruments using the swept-IF technique are normally provided with a calibrated IF marker system. This marker may be continuously variable, or a fixed "comb." By heterodyning a crystal-controlled oscillator with the local oscillator of a spectrum analyzer, one can produce evenly-spaced markers, tunable across the entire RF operating range. Since the center frequency of the analyzer IF can be determined accurately by means of its variable marker, these crystal markers can be used as frequency indicators, to an accuracy comparable to that of a crystal oscillator. At high microwave frequencies, the accuracy of this system is equal to that of commercial wavemeters.

Attenuators

Both IF and RF attenuators are provided in the most flexible designs. Attenuator accuracy and linearity are essential to many applications, since the level range of the display should be kept small, for maximum "level resolution."

Display Mode Flexibility and Calibration

Ideally, the most flexible instruments should (and several do) provide all three standard detection modes: Linear, logarithmic, and square-law (power), each individually scaled and calibrated.

Convenience Features

Recent advances in the art have greatly added to the ease, speed, and freedom from error with spectrum analyzers. Three examples:

- **Push-button harmonic identifier.** When a button is pressed, the pattern shifts exactly one division, if the correct harmonic is in use for the frequency band selected.
- **Fixed, calibrated dispersions.** In addition to the usual continuously-variable dispersion control, a multiposition switch permits selection of a wide range of accurately-calibrated, fixed dispersion settings, for rapid, error-free base-line set up.
- **Automatic level-scaling.** As the detection mode is selected, the correct vertical scale marking is illuminated and appears on the graticule screen as a direct, absolute calibration.

The analyzer shown in Fig. 1 incorporates these convenience features, among others. Similar "semi-automatic" features are incorporated in other modern spectrum analyzers.

MICROWAVE AND RADIO RELAY EQUIPMENT

Sales for microwave and radio relay equipment for 1963 and 1964 have been variously placed at around \$85 to \$95 million. Including a rough projection to 1966, a sales table might appear like this:

1963	\$ 85,000,000
1964	\$ 95,000,000
1965	\$105,000,000
1966	\$115,000,000

EDITOR'S NOTEBOOK

TRAFFIC CONTROL in Great Britain is expedited by a new system that links traffic lights and detectors to a computer that automatically adjusts signal changes to traffic conditions. Called ROTRAC, maker Elliott Traffic Automation Ltd., claims traffic flow increases by at least 15%. ROTRAC uses closed-loop cycle from detectors to computer and back via local controllers to signals.

STRANGE OR UNUSUAL devices and materials can be found in a hurry if you need them. German engineers, Paul Kustusch and Dieter J. Schrader, have started a difficult-to-locate-but-we'll-find-it-for-you service at the Holiday Office Center, Huntsville, Ala. Called American Utilities Corp., the firm researches and indexes materials and data from around the world. Users are mostly engineers, scientists.

ELECTRONIC SHARK REPELLER, a battery-powered unit (4 lbs.), broadcasts electronic impulses tuned to shark's nervous system. Shock sets the shark packing and thrashing wildly. Developed by John Hicks, zoologist, and Norman Bean, engineer, both of Miami, unit is worn by swimmers, used by boatsmen, placed around swimming areas, or attached to tuna nets.

ATOMIC LIGHTHOUSE, the first, is a designation now enjoyed by 50-year-old Baltimore light, one of the oldest in U.S. waters. Developed by Martin Company's Nuclear Division, an isotopic power generator (60-watts) will deliver continuous electric power for 10 years without refueling. It is about the size of a trash can, weighs 4,600 lbs., uses 120 pairs of lead telluride thermocouples, and about 20 lbs. (225 K curies) of strontium titanate.

"CODE SIGNALS" from his dormitory room radiator prompted a Pennsylvania college student, and ex-military service radio operator, to report same to authorities. He opined that it might be a clandestine station. FCC Buffalo keyed in on the case and found the the "code" came from college power line signals used to regulate radiator water flow. They concluded that valve clickings could be mistaken for Morse by a rusty operator.

TEKTRONIX *SPLIT-SCREEN* *STORAGE* Oscilloscope

FOR ONLY $1035

TYPE RM564

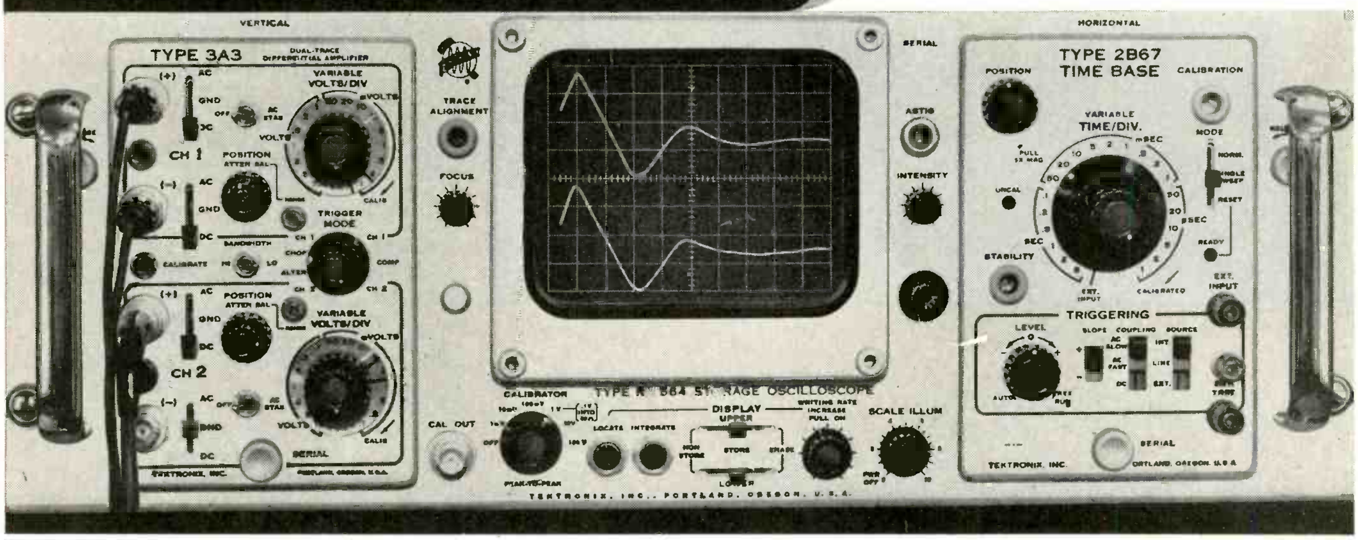
STORED OR CONVENTIONAL DISPLAYS

SAVES FILM—JUST STORE AND ANALYZE

ACCEPTS COMBINATIONS OF 17 PLUG-IN UNITS

SAVES SPACE—ONLY 7 INCHES RACK HEIGHT

OPERATES SIMPLY AND RELIABLY



■ **presents stored or conventional displays**—The Type RM564 presents full-screen stored displays or full-screen conventional displays. Or—with the unique split-screen—stored displays can be presented on either the upper or lower half of the crt with conventional displays on the other half.

■ **saves film**—The Type RM564 permits detailed waveform analysis and simplified waveform comparisons, in many instances, without resorting to photography. Just store and analyze—for periods up to one hour, with quick erase in less than one-fourth second.

■ **accepts combinations of 17 plug-in units**—The Type RM564 adapts easily to such applications as multi-trace, low-level differential, sampling, others—including matched X-Y displays using the same type amplifier units in both the amplifier and time-base channels.

■ **saves space**—The Type RM564 occupies only 7 inches of standard rack height, yet has a full 8-cm by 10-cm display area.

■ **operates simply and reliably**—Although capable of many sophisticated measurements, the Type RM564 retains the operating convenience of a conventional oscilloscope.

Display shows ability of the Type RM564 to store single-shot events. Waveforms represent displacement of leaf springs due to imparted shocks given them during test. Split-Screen Facility—with independent storage and erase of upper and lower half of the crt—permits easy comparison of test waveforms to a reference display.

Type RM564 Storage Oscilloscope	$1035
Type 3A3 Dual-Trace Differential Amplifier Unit	790
Type 2B67 Time-Base Unit	210
15 other plug-in units available.	
Cabinet Model also available	950

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COMPUTER TELEGRAPH SYSTEM PUT IN SERVICE BY RCA

World's first computerized international public telegraph system, described by RCA Communications, Inc., as the fastest, most accurate, and most versatile commercial message system developed, is now in service.

The new system uses two high-speed digital computers developed by RCA. One computer operates the system while the other is on stand-by.

Each is capable of handling 2.5 million characters, or 400,000 words a second. In addition to electronically receiving and transmitting telegrams, the on-line computer can identify in a fraction of a second any one of 7000 cities, states and countries in three languages.

"CALL FOR PAPERS"

National Electronic Packaging and Production Conference

Authors are invited to submit papers for presentation at the National Electronic Packaging & Production Conference (NEP/CON '65) to be held in Long Beach, Calif., at the Long Beach Arena, on June 8 through 10.

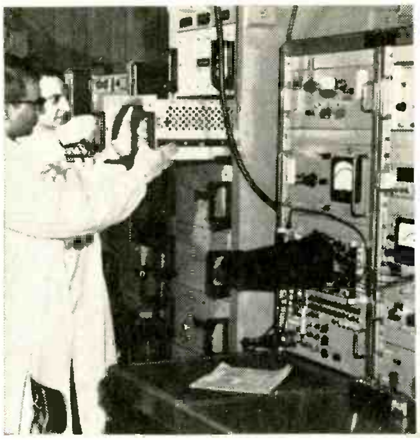
The Papers Committee will consider any paper that deals with a subject of interest to the electronic circuit packaging and production engineer and designers. Although a limited number of basic, tutorial papers will be accepted, these should be restricted to fields in which tutorial surveys are not already available in literature. Most preferable are state-of-the-art innovations, recent examples of the use of advanced techniques, and case histories illuminating interesting and unique aspects of electronic packaging and production.

Preferred length of the paper is 2500 to 4000 words.

Before submitting the paper, prepare an abstract, in triplicate, of from 300 to 500 words which details the contents of the paper. Be careful when preparing this abstract! The potential value of the subject or methods described in the abstract is the basis for selection. The abstract must be submitted before Dec. 31, 1964. The completed paper is required on April 15, 1965.

Abstracts should be forwarded to Industrial and Scientific Conference Management, Attn: NEP/CON Papers Committee, 222 West Adams St., Chicago 6, Ill.

MINUTEMAN RADIO SYSTEM



Technicians insert final drawer of equipment for initial radio communication sub-system for the Minuteman ground electronics system. Test console, right, used to check out performance of system, made by Sylvania Electric Products, Inc., before shipment for testing, and then to Air Force. System will provide control and missile data when a regular cable system becomes inoperative.

LASER MODULES OFFER PRECISION, LOW COST

A new series of injection laser system modules developed by Maser Optics permits university and research laboratories to obtain precision equipment at reasonable cost, according to the firm. They are especially suited for study of coherent radiation from gallium arsenide laser diodes.

The modular design approach includes three distinct GaAs laser heads; each can be used with any one of three compatible injection laser DLP Series pulse generators, reports Maser Optics.

A user can use module heads and pulse generators interchangeably, depending on needs. The savings in time, says Maser, is equally as significant as money.

THINNEST LAMINATE

The "thinnest laminate for multilayer circuit use" is announced by General Electric. New Textolite® Microbond® thin-glass laminates are clad or unclad in three standard grades: 11558, 11622 and 11578. Prepregs—resin impregnated bonding sheets—are companion materials for copper-clad laminates in grades 11331 and 11330.

Microbond's thinness offers marked advantages where high-density electronic packaging is a problem, reports GE. Thirteen circuits bonded together with prepregs can be condensed into a "sandwich" only 5/16″ thick. (General Electric Co., Laminated Products Dept., Sect. 587, Coshocton, Ohio.)

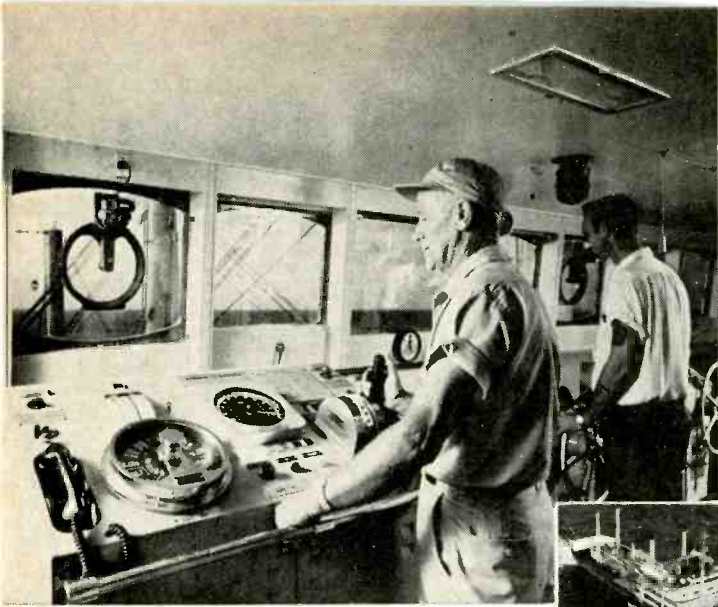


Fig. 1. Automated bridge console permits speed control direct from bridge, no longer requiring tug handling.

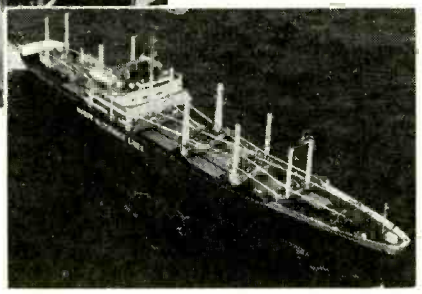


Fig. 2. Moore-McCormack's automated flag vessel, the Mormacargo.

Electronic Controls Guide New Cargo Ship

FULL ELECTRONIC CONTROL is being used for the first time on a flag vessel in the U. S. Maritime Service. The result is direct speed and engine control from the bridge and one-man engine room operation; but even more important, it results in greater economies of operation, faster turn around in port and faster freight shipments.

The main engine throttles are mechanized to permit operation of a throttle lever on the bridge or in the engine room. A solid state function generator in the main engine room console linearizes the throttle lever position with shaft rpm. This, with shaft rpm feedback, establishes engine rpm and direction as called for by the throttle lever position.

Also automated is the main circulator pump, the main circulator pump sea valve and the astern guardian valve. When shaft rpm drops below a pre-set point the auxiliary circulating system starts automatically and opens the astern guardian valve.

Numerous safeguards are provided electronically such as an ultra-violet-flame detector system to automatically secure fuel oil to individual burners should a flame fail.

Pressure and water level overrides are included in the throttle control system to safeguard the boilers. If a main lube oil pump fails the stand-by unit starts automatically. Remote temperature points are scanned, recorded and alarmed at the main console. A bell logger records time, date, telegraph or throttle order and engine response. Numerous other safety features, interlocks, alarms, and automatic devices are installed. Among these are an automatic shaft alley bilge well sump pump, automatic recirculation for feed and condensate pumps, low water level alarm and shut-off, force draft fan failure alarm and shut-off of fuel, solid state regulation of main generator voltage, and automatic dump on distilling plant.

Remote start-up of major components can be accomplished from the engine room console. A watch calling system and an extensive telephone system are provided to permit a one man engine watch.

The first vessel so equipped is Moore - McCormack's SS Mormacargo, a 550-ft. ship built by the Ingalls Shipbuilding Div. of Litton Industries. The $10 million vessel will operate between New York and Scandinavian ports. Because of the crew-saving features brought about by mechanization and automation, each crew member has a separate state room for the first time in maritime history.

Typical of electronic control functions aboard ship are those of throttle control, temperature monitoring and lubricating oil temperature control.

Throttle Control

The ahead and astern throttle valve hydraulic actuators are motor operated. Position of the steam valves and the speed of the propeller shaft are fed back into the control system to maintain the selected rpm. The shaft speed is fed back by two analog tachometer generators driven off the shaft ring gear which drives the normally installed shaft tachometer for the engine room and bridge rpm indicators. An additional digital tachometer provides zero speed signal for the shaft-stopped alarm.

Interestingly, this application of electronics involves essentially no new electronic principles. The ingenuity was in adapting electronics know-how to a problem that could have been solved long ago.

TI MAKES TINY ENCODER FOR AIR FORCE AVIONICS

A working Pulse Code Modulated telemetry encoder weighing only 15 oz. and taking up only 15 cu. in. has been delivered from Texas Instruments, Inc., to the Air Force Avionics Laboratory's Electronic Technology division in Dayton, Ohio.

Parts of the microminiature 22-channel encoder are so tiny that a 10-power microscope was used for assembly. It is 1/50th the weight and 1/100th the size of a similar transistor unit.

Its construction was possible through use of new high-precision thin film resistor-capacitor networks. The encoder also includes newly-announced molecular opto-electronic devices using light as the signal carrier to reduce electrical noise by 99%, and 285 SOLID CIRCUIT® linear and digital semiconductor networks.

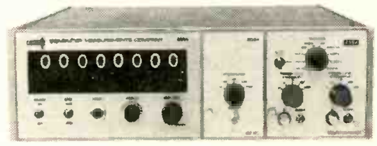
Purposes are to show the feasibility of using linear (amplifying) as well as digital (switching) semiconductor integrated circuits, and the effect size and weight reductions. It was also built to compare performance with conventional equipment.

CMC COUNTERS

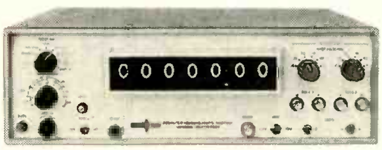
JUST A FEW EXAMPLES OF CMC INSTRUMENTS TO COUNT, MEASURE & CONTROL

FIRST ALL-SILICON SOLID STATE COUNTER. Ultra-reliability with frequency range 2 cps to 1.2 Mc. Measure frequency ratio, totalize, single and multiple period averages. −35° C to +75°C available. 5-decade inline biquinary display tube readout with memory. Digital output for printer, tape punch, etc. "Mother-Board" circuit system reduces components 10%, improves maintenance and reliability. **Model 603.**

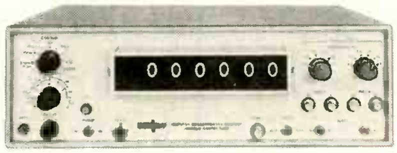
ALL-SILICON UNIVERSAL COUNTER-TIMER Five decade inline biquinary display tube readout with memory. First all-silicon universal counter-timer provides all features of 600-Series. In addition, provides frequency range of 0 cps to 1.2 Mc. Also time interval measurement from 10 microseconds to 10^6 sec. Two year warranty. **Model 605.**



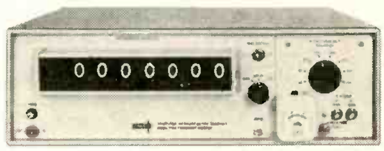
NEW ALL-PURPOSE SOLID STATE COUNTER. NIXIE readout, memory. Exclusive: 3 frequency range plug-ins, (25 Mc, 50 Mc, and 110 Mc). 7 function plug-ins: Frequency-period, Counter-Timer, 600 Mc Heterodyne Converter, Integrating Digital Voltmeter, Direct Counting Adapter, Digital Phase Meter. **Series 800 Digi-Twin.**



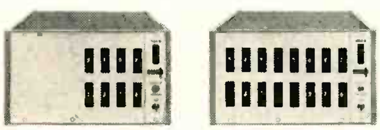
DC to 50 Mc SOLID STATE COUNTER-TIMER. With seven decade inline NIXIE readout and memory. Multiple period (1 to 10^7). Crystal stability of ±5 parts in 10^8, oven controlled. Sensitivity 0.1 v rms. Resolution 0.1 μsec. Single period and time interval range 0.3 μsec to 10^8 sec. Operates at only 75 watts. **Model 727D.**



LOW COST UNIVERSAL COUNTER-TIMER. Six decade inline NIXIE readout, with display storage optional. Frequency range is DC to 13 Mc. Multiple period (1 to 10^7). Single period and time interval range of 0.3 μsec to 10^7 sec. Oven controlled crystal stability of ±5 parts in 10^8. Price under $1900. **Model 726C.**



SOLID STATE DIGITAL FREQUENCY METER. Seven decade inline NIXIE readout. Direct measurement range from 10 cps to 100 Mc; extends to 500 Mc with optional plug-in positive switching turret-type heterodyne converter. Bench model is rugged ,easy-to-use. **Model 738A** (shown with converter) only $1925. Portable field unit with vertical readout, **Model 738B,** only $1750.



SOLID STATE GO-NO-GO COMPARATOR. Provides visual display in the form of high, low, and in-limit lights as well as contact closure outputs for control purposes. Four-digit readout, with up to eight digits optional. Optional remote presetting of limits. Half-rack size permits dual mounting. **Model 404A.**

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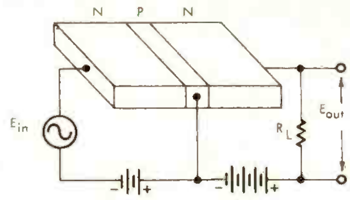
Is Your Knowledge of Computer Fundamentals &

TEST YOUR SKILLS IN THESE ELECTRONICS GROWTH AREAS

Engineers and technicians at General Electric, North American Aviation, ITT, General Dynamics, Raytheon, Philco, Douglas Aircraft, Continental Device, Automatic Electric, and other leading companies have selected 5 initial subjects in these areas for their own personal development.

Test **your** knowledge of these fundamental subjects. Here are some sample questions from comprehensive examinations being used in the electronics industry to measure performance in these areas. Try them yourself.

INTRODUCTION TO TRANSISTORS



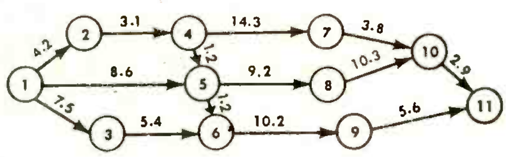
29.

(a) The NPN transistor circuit illustrated above operates as a(n) ________________.

(b) With reference to the circuit shown above, MATCH the items below on the left with those on the right by placing one letter in each blank:

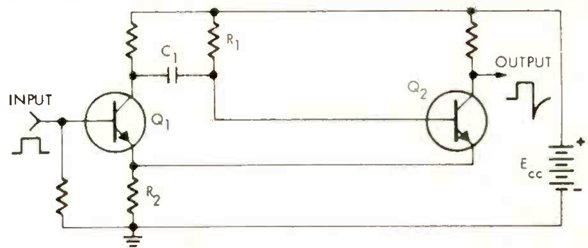
A. base-collector junction	1.___high impedance
B. emitter-base junction	2.___input impedance
	3.___low impedance
	4.___output impedance

PERT



12. Examine the network you have just constructed.
   (a) Identify the critical path by giving the sequence of events along the path: ________________.
   (b) Give the T_E which you calculated for the ending event of the network ________ weeks
   (c) It is now reported that activity 6-9 cannot be completed in less than 11.8 weeks. Will it still be possible to meet T_L? ☐ yes ☐ no
   (d) If the changes mentioned in (c) above would make it impossible to plan completion of the project by the time the allotted span has run out, what can he do to replan so that he does meet the schedule?

BASIC TRANSISTOR CIRCUITS



27.

(a) The schematic diagram above shows an emitter-coupled one-shot ________________.

(b) In the stable state Q_1 is ☐ on ☐ off and Q_2 is ☐ on ☐ off.

(c) The positive pulse turns on Q_1 which in turn: ☐ cuts off Q_2 ☐ turns on Q_2.

(d) When C_1 discharges, Q_2 is: ☐ cut off ☐ turned on.

(e) When Q_2 conducts, drawing current through R_2, Q_1 becomes ________________ biased.

COUNTING SYSTEMS & BINARY ARITHMETIC

3. PERFORM THE FOLLOWING ARITHMETIC CONVERSIONS.

(a) CONVERT the decimal numbers 85 and 35 into binary equivalents and

(b) ADD their binary equivalents, then

(c) CONVERT the sum back to decimal

(d) CONVERT the decimal number 26 into its binary equivalent and

(e) SUBTRACT it from the binary sum you found in (b)

(f) CONVERT the result back to decimal

(g) CONVERT the decimal number 20 into the form it would have been in number systems with a base of 2___5___8___.

BOOLEAN ALGEBRA (in development)

SHOW the Karnaugh map of the function $AB\bar{D} + A\bar{C}\bar{D} + B\bar{C}\bar{D} + \bar{A}\bar{B} + \bar{A}CD$ by SHADING the appropriate boxes in the diagram below:

CD \ AB	00	01	11	10
00				
01				
11				
10				

The Karnaugh map shows that the minimum inputs required for this function are________________.

A Joint Service of ELECTRONIC INDUSTRIES MAGAZINE and

THE EI VIEWPOINT

by Dr. Walter East

President, Electro Instruments, Inc.

So far, in this series, I have talked nothing except industrial jobs our instruments have contributed to in the past, or are contributing to now.

In this I am going to do a bit of speculating on how our measurement instruments could benefit present non-users

I recently read an interesting history, covering everything from the first gasoline engines to today's highly complex jets. Reading it set me wondering why engine manufacturers wouldn't benefit from devices which could precisely measure contents of engine exhaust gases. Ultimately it might contribute to the reduction of smog.

Dr. East

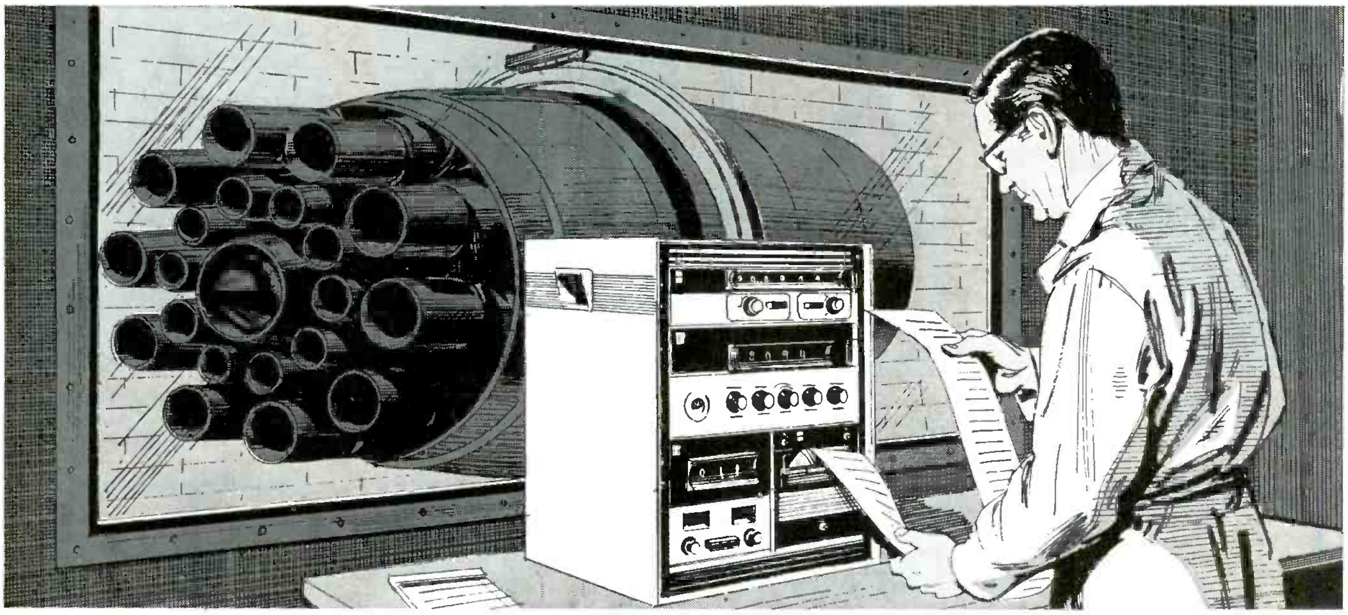
Exhaust A "Record"

With few exceptions, exhaust gases are containers of elements which provide a direct clue to engine performance. Measurements of exhaust residues, for example, can reveal much about the quality of the fuel mixture used, or the degree of total burning achieved. If, therefore, certain quantities present in exhaust gases can be precisely measured, engine manufacturers are in possession of valuable information about proper fuel mixtures, injection pressures, and overall engine efficiency.

Methods of making such measurements, both with jet engines and the automobile engine, are the subjects of the two stories contained herein.

Classic Jobs of Measurement

Performed by Electro Instruments



Typical set-up for running tests on jet engine's exhaust gases

Analyzing Exhaust Gases of the Jet Engine

Fast, accurate and reliable measuring of a variety of elements is the principal problem involved in analyzing the performance of a new jet engine.

The performance of a conventional piston type engine can be extrapolated for various conditions of outside air temperature and density from data taken under standard sea level conditions. This is quite difficult with a jet.

More Data Required

The compression of the manifold air before combustion results in a non-linear function making extrapolation for other conditions difficult. Much more data is required before performance characteristics under non-standard conditions can be established.

Of critical importance is the composition of the exhaust gases. From these, measures of percent of combustion and engine efficiency may be determined. These must be taken from a remote position while the engine is operating. Instrumentation is the key.

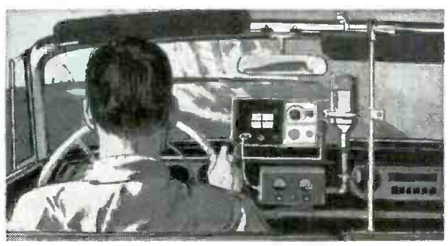
By offering a wide selection of amplifiers and other measuring instruments, Electro Instruments can provide systems that will operate reliably under the most adverse of test conditions, and provide a record of results for immediate evaluation or for further processing in a computer.

Tests involving strain gauges, or tests involving vibration and torque indications, can also be made with Electro Instruments equipment—swiftly and accurately.

Write today for full information.

Oscilloscope Displays Car Engine Tests Immediately

A battery-operated oscilloscope offers a reliable means of quickly checking the performance of automobile engines. Through the use of suitable sensing devices, such features as torque, timing, pressure and temperature may be monitored while the vehicle is actually traveling. Measurements will be given instantaneous visual display—often more desirable than printed records which must await further evaluation.



Electro Instruments, Inc.

8611 Balboa Avenue, San Diego, California 92112

ELECTRO INTERNATIONAL, INC., ANNAPOLIS, MARYLAND • TRANSFORMER ENGINEERS, SAN GABRIEL, CALIFORNIA

Reporting late developments affecting the employment picture in the Electronic Industries

MORE TECHNICAL PERSONNEL REACH CORPORATE LEVELS

Figures from U. S. Department of Labor and National Science Foundation suggest the importance of initiating more and better management development programs for engineers and scientists.

A breakdown of 852,000 engineers and scientists in all categories throughout industry in 1962 shows 18.1% of them engaged in management or administrative fields. In 1961, out of 815,000 engineers and scientists, 17.4% were so classified.

In some electronic categories, engineers and scientists in various managing or administering posts in 1962 accounted for about 15.1% of those in communications equipment, 16.3% in components and accessories, and 12.2% in radio and television receiver industries.

The conversion of scientists and engineers into successful managers has been referred to as "a key to tomorrow's technology." Accordingly, many companies are turning to engineers and scientists in an attempt to fortify all levels of management with technical brainpower.

Data for 1962 for some 114,965 scientists alone show 25.3% in management or in administration.

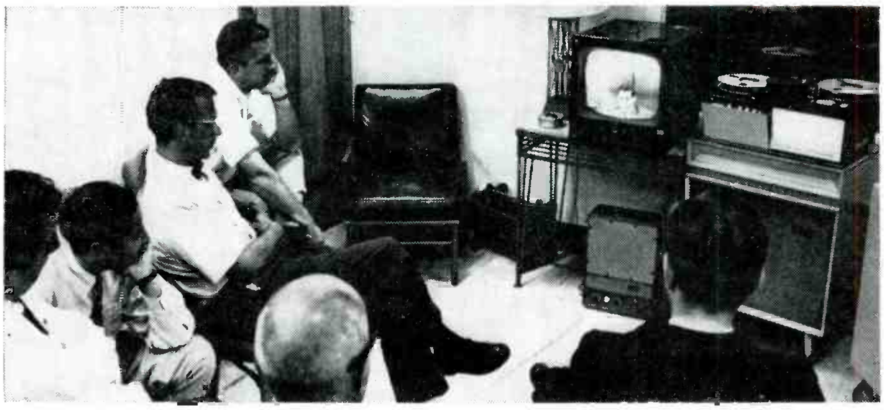
ARMA SEEKING U. S. MONEY TO RETRAIN ITS ENGINEERS

In the first request of its kind, American Bosch Arma Corp. has asked for $200,000 in Federal funds to provide training in advanced subjects for 300 of its most experienced engineers who, for various reasons, have not kept up with technology.

The Garden City, N. Y., firm applied under the Manpower Development and Training Act to the Office of Manpower, Automation, and Training (OMAT), charged with administering the MDT Act of 1962.

Owing to defense contract losses, Arma payroll has dropped from 1961's 5,500 to about 1,400. Those who remain are primarily engineers with long seniority. Arma hopes the program will help bring in new contracts.

SOMEDAY ENGINEERS WILL DO IT, TOO



A young interne at Columbia University reported his goals in psychiatry to a resident selection committee at Stanford Medical Center over a 3,000-mile interview via TV tape. Applicant saved cross-country money when a friend recorded his interview on his department's Precision Instrument portable PI-3V recorder, like the one pictured above.

PROBLEM SOLVING ABILITY KEY TRAIT IN ENGINEERS

"Problem solving ability" is the most desirable characteristic in engineers, reports a recent survey of non-supervisory engineers.

About 54% of engineers canvassed painted this general picture of the ideal engineer: "Ability to get to the meat of the problem . . . keen analytical approach without frills . . . ability to quickly reach simple, logical conclusions to complex problems . . . immediate comprehension—quick to detect important points, good or bad."

Some 44% mentioned technical capability: "Excellent technical capabilities—general overall knowledge of job . . . technical understanding of engineering and scientific fundamentals . . . technical knowledge tempered by experience."

Supervisory engineers surveyed, however, reversed order of importance, with 61% mentioning technical capability and about one third dwelling on problem-solving ability. They also mentioned communications skills (19%) creativity and inventiveness (15%), adherence to goals (12%).

ENGINEERS SAY ADVANCEMENT BEST REWARD FOR GOOD JOB

Engineers consider advancement in position, or at least eligibility for promotion, the best reward for a job well done, according to a recent survey among engineers and engineering supervisors.

Among 1000 persons, the survey indicated that the largest group, about 40%, thought the most meaningful form of recognition would be advancement along technical lines to positions of greater responsibility and authority.

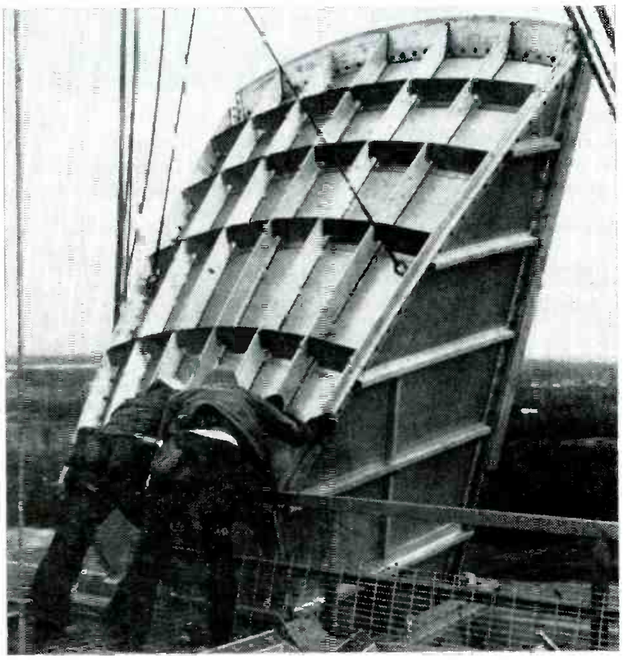
FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 120.

ENGINEER/SCIENTIST DEMAND CONTINUES TO FALL

In a recent report on its Engineer/-Scientist Demand Index, Deutsch & Shea traces the demand for technical persons from July 1960 to June 1964. Demand for engineers and scientists built up to a peak more than 50% above the base year of 1961, then entered a slow but steady decline that still continues.

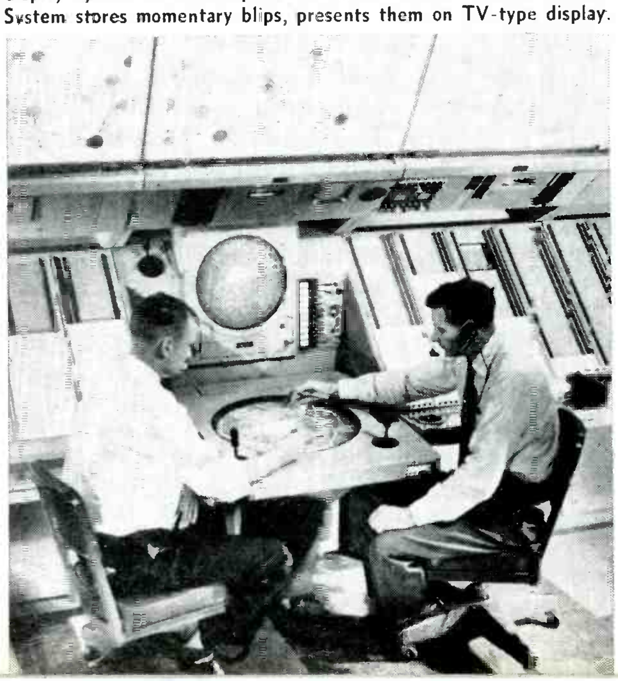
From July 1963 to June 1964 the average Index figure has been almost 20 points below the base. This downtrend has lasted almost 30 months or more, during which the Index moved from a high of 153.7 to the current figure for June 1964 of 75.1.

Sperry Gyroscope engineer tests low-level radar altimeter that will allow pilots to maneuver safely at low altitudes once considered impractical because of limited measuring capabilities.



A.T.&T. engineers and workmen position section of large horn antenna on top of a TD-2 microwave radio relay tower near Mt. Royal, N. J., part of 54,000 miles of Bell's microwave network.

Controller's eye view of air traffic presented by Raytheon bright display system at Indianapolis Air Route Traffic Control Center. System stores momentary blips, presents them on TV-type display.



By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

Microwave Growth

MICROWAVE BUSINESS, BOOMING AS RECENTLY AS 1961, slackened around 1962-63, and now challenges suppliers to survive or thrive during the competitive 1960's. In future, astute management and marketing can play as big, or a bigger, role as microwave technology.

Sharp drops in defense radar procurement broke the microwave boom. Defense Department trimmed budgets, except for a few classified contracts. Among these was over-the-horizon radar that curves with the earth to detect hostile missiles or airplanes, revealed by President Johnson in September. Many government contractors wailed the blues, yet kept going by providing spares, retrofits, and follow-ons that extended, refined, or refurbished microwave systems. But the bloom was off the boom.

Market planners now are cued by two-way DOD decisions: Backward, refining and improving present systems, and Forward: pushing the state of the art. Since May 1960, military communications were centralized and are being revitalized under Defense Communications Agency and its Defense Communications System. Most noteworthy, global military weather data collection and communications systems are being made and remade from analog into digital systems. DCA and U. S. Air Force, for example, selected International Telephone & Telegraph to advise upon and plan future satellite and other communications systems, including the microwave millimeter area.

Air Force also is evaluating microwave frequencies for air-to-air, ground-to-ground relay of communications, high-speed data and video. Other aircraft contracts include RFI work on airplane systems, plus the A-4E, E-2A and F-4C aircraft projects.

Altimeter Markets

"Hot" production markets are anticipated for low-level radar altimeters, ranging from $5,000 to $10,000 each, to increase airplane safety and all-weather operation. Units could equip or retrofit possibly thousands of military aircraft, for 0-to-5,000 feet, and possibly hundreds of commercial aircraft, with altimeters, for 0-to-2,500 feet. Altimeters generally use 4,300 megacycle C-band microwaves, and around

Once a booming and blooming market, microwaves now find most U. S. agencies either well equipped or low in money, buying only replacement parts. To prop up the market, microwave firms are turning to industrial, business, and consumer products—and rapidly growing exports. The market may bloom again—but not exactly tomorrow.

Hinges on Expanding Markets

1,600 megacycle L-band.

Radar altimeters tell military pilots or autopilots when to pull down while flying low-level missions, to avoid radar detection. Though altimeters should be rugged and reliable, they also are complex units requiring proper calibration and maintenance. Suppliers include Sperry Gyroscope Co. which makes many APN-150 low-level altimeters, and some APN-42A high-level altimeters for the Air Force. Sperry Phoenix Co. makes SPA-10 low-level altimeters for commercial aircraft.

Insights into Army electronic future microwave developments include: a) advances in solid state components and microcircuits; b) new concepts to achieve high efficiency, while reducing size and weight of microwave tubes; c) phased array and other approaches either to eliminate rotating antennas, or limit their motion to one plane yet provide "three dimensional" data; d) penetration aids systems; e) studies of new interaction mechanisms, such as transverse wave interactions of a dense electronic beam and a smooth waveguide, to establish criteria to build devices operable at super-power levels and frequencies heretofore unattainable; f) studies of magnetically compressing electron beams to achieve these extra-high-beam densities.

Solid state R&D and production may cut into predominant yet lagging microwave tube markets. Gradually, solid state units may move into the traveling wave tube market, and still later into self-modulating tubes. Tighter defense budgets heighten the argument against expending major funds for minor tube refinements. Yet a successful 1 megawatt CW klystron would represent major technical-economic value.

Rewarding work may be done in microwave plasma. And, technical-marketing success involves keeping posted and cooperating with DOD's Electromagnetic Compatibility Center at Annapolis, Md. Such activities go beyond developing markets for RFI control filters and instruments to measure electromagnetic clutter.

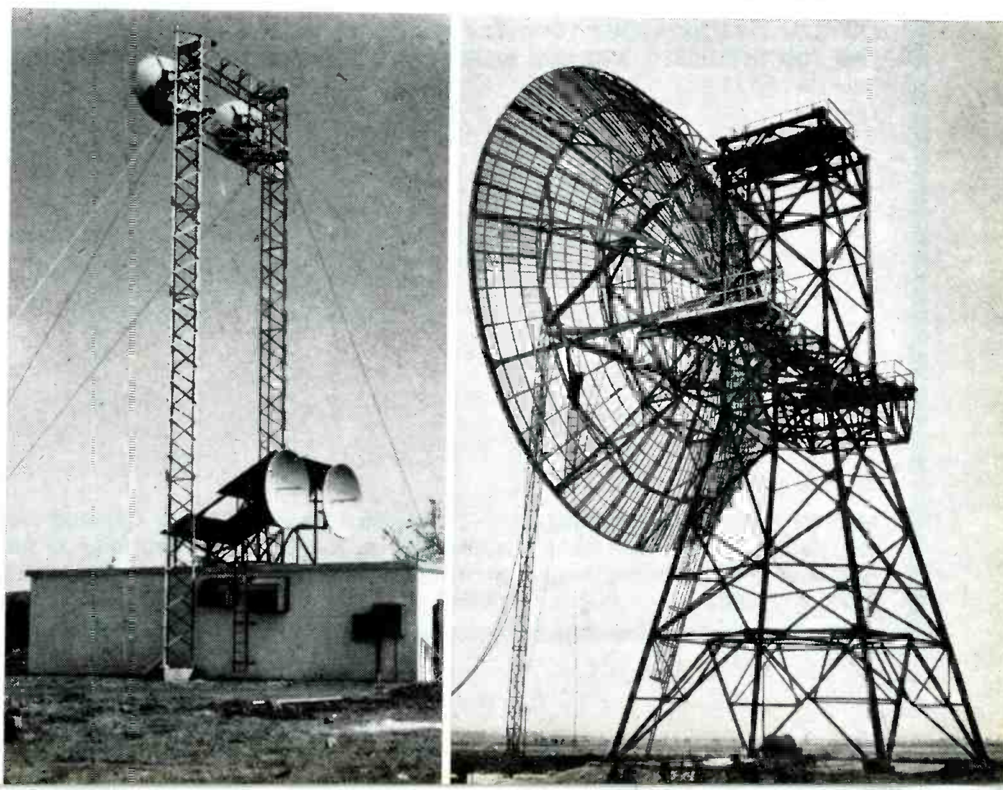
Short on Production

Much microwave aerospace business still is "way out," being long on studies and short on production. One instrument maker describes business as being "onesies and twosies" for Gemini and Apollo programs. Other firms serve projects including OGO, SCORE, SECOR, SPADAT and STINGS.

In ELECTRONIC INDUSTRIES last November ("Microwaves—A Market In Transition") we noted the historic turning point when DOD was transformed from "the foremost hardware buyer" into "the biggest microwave user." DOD also is the biggest customer of American Telephone & Tele-

(*Continued on page* 121)

Antenna and relay station (right) part of Western Union's new transcontinental microwave transmission system now under construction. (Left) 60-ft. paraboloid antenna in Sardinia for over-the-horizon microwave link with Minorca, made and installed by IT&T.



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ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

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Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area ________

Salary Desired to Change Jobs and relocate in another area ________

Professional Memberships ______________________

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

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Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

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graph's Bell System. DOD's heavy use of AT&T and Western Union Telegraph Co. facilities has encouraged expansion of those systems, particularly in microwave areas.

Today DOD and other Federal agencies argue before the FCC for AT&T to maintain its controversial wholesale-rate communications service called Telpak. Opposing AT&T are Western Union, Motorola, ITT and other microwave hardware suppliers. These firms got their toes into the microwave communications door which FCC left ajar in 1959 by opening microwave frequencies to the general business community.

Yet AT&T had opened its first microwave route in 1947, then countered with Telpak. Today, the Bell System uses over 54,000 miles of microwave network to serve the U. S. AT&T eyes the thick rich volume of business machines, chiefly data from computers, automatic machines, and electronic facsimile.

Microwave facilities also help Western Union to survive and grow by rapidly changing from a narrowband telegraph carrier to a broadband telecommunications carrier of voice, data, facsimile and video. WU now offers microwave services including Telex, Autodin, PATS, push-button telephone, Jet Propulsion Laboratory links with its deep-space tracking station in the California desert.

Sell to Private Firms

Paradoxically, electronic suppliers such as Motorola, GE, RCA, ITT, Collins, Lenkurt, Lynch, Philco and others sell microwave components and/or systems to private industries (chiefly petroleum, utilities and transportation companies) as well as to AT&T's supply arm, Western Electric. These companies now are private communications carriers, competing with AT&T. And, AT&T is using microwaves to fight microwaves.

To-date, FCC has: a) ruled against AT&T's proposed WADS (Wide Area Dial Service) tariff; b) received recommendation from its Common Carrier Bureau head not to change rates for WATS (Wide Area Telephone Service); c) tentatively decided there was no competitive necessity for Telpak A (DOD is the biggest user) and B, and apparently no justification for Telpaks C and D, for which new rates may be scheduled. Litigation continues, with electronic interests involved. For example, AT&T's allies include Xerox Corp. which argues that its LDX high-speed electronic facsimile needs Telpak national network service.

Future AT&T systems planning anticipates using more coaxial cables. Back in the 1940's AT&T used coaxial extensively, then switched to microwave radio relay in the 1950's for added high capacity broadband channels and initial lower cost. Now AT&T uses both systems, but tends back to coaxial. "An upsurge in the use of coaxial cable systems in the microwave art" also was reported by Samuel Freedman, general manager of Chemalloy Electronics Corp.

AT&T finds hardened cable is less vulnerable to storm damage or military attack. Unlike microwave, cable is not subject to atmospheric interference and is good for transmitting data sensitive to minor interruptions and noise pulses. And, telephone circuits are rapidly using up the microwave radio spectrum.

Still, private industry and public utilities are broadening microwave facilities. One petroleum industry spokesman admits "a few years almost certainly will see an appreciable increase in frequency and severity of interference problems and ultimate possible microwave frequency shortage, as severe as that now confronting us in the VHF mobile bands. We can only hope that technology and regulation will advance together, and rapidly enough, to forestall such a development."

MICROWAVE TUBES TO INDUSTRY

From the total of 240,000 microwave tubes of various types shipped in 1963 at $134,852,000 in sales, 78,700 tubes were delivered for use in and by U.S. industry. Cost: $21,285,000.

	Units	Dollars
Klystrons	65,400	$10,211,000
Magnetrons	7,400	$ 3,325,000
Forward/Backward Wave	5,900	$ 7,749,000

(Source: BDSA)

Enterprising System

A most enterprising microwave system is being installed by American Electric Power Service Corp. which in 1963 sold 33.24 billion kilowatt hours of electricity for $494 millions, to 1,456,000 customers in Ohio, Indiana, Michigan, W. Virginia, Virginia, Kentucky and Tennessee. Its six operating utilities, already interconnected by high-voltage transmission lines, will be further integrated by a centralized computer complex (with slave computers) linked by microwave.

AEP's communications engineers designed their system. They bought RCA's RF equipment, GE's tone equipment, Lynch Communications' multiplex equipment. Two IBM digital computers will serve mainly for accounting, billing and reporting data. An analog computer, from Leeds & Northrup, will control electric generators. These operations will be integrated by some 1,700 miles of microwave due to be fully operational sometime in 1965.

Similarly, at Public Service Co. of New Mexico, an IBM computer receives data about power demands from distant points by microwave radio, then directs operations of five generators. A future master plan to interconnect all electric utilities into a coast-to-coast network may require parallel microwave network expansion.

Transmission of power by microwave radio was

(Continued on following page)

MICROWAVE MARKET (Concluded)

unsuccessfully attempted by Nikola Tesla in 1889, and discussed before the Institute of Radio Engineers (IRE, now IEEE) in 1961. W. C. Brown, chief of super-power at Raytheon's Spencer Laboratory, suggested ultimate possible uses may be to transmit power into upper atmosphere or space, and for short distances over rough terrain. RF-to-DC conversion devices have as low as 25% efficiency, which is improving. Raytheon's Amplitron was rated about 80% efficient. Other electronic markets could develop here for super-power microwave tubes, and specially-designed antennas to beam power efficiently between points.

Microwave magnetrons to prepare food for restaurants, vending machines and/or homes, are commercially packaged by Raytheon, Litton, GE and others. Tappan Co., licensed by Raytheon, sees microwave oven business rising "slowly, but steadily." It made nearly 600 commercial installations, but home models are limited partly by the $795-per-installation price.

New Magnetron

Amperex Electronic Corp. announces a new magnetron for around $85 in limited production, and about $50 in higher production. Oven costs could dip below $400 but still be in the limited luxury market. However, magnetrons remain to be marketed to oven-makers who, in turn, must educate away consumer resistance to microwave cooking.

Countless other microwave applications, ranging from drying printer's ink to freeze-drying foods, have varying degrees of marketability. Other interesting areas include Lasers, RF energy for induction/dielectric heating, UHF and community antenna television systems, civil aviation, and safety-alarm "watchmen." Johnson Service Co. now sells the Microwave Motion Detector, and Sound Methods, Inc. sells the Intrudalarm whose related Telalarm automatically dials police and a facility's owner when the microwave alarm is triggered.

FCC opened another growth area on July 25, 1963 with Instructional TV Fixed Services offering 31 channels in the 2,500-2,690 megacycle microwave S-band. A representative system here is offered by Adler Educational Systems/Litton Industries. Teachers' instructions are relayed from studio to transmitter, are beamed by antennas to several points where signals are converted to VHF, then distributed into classrooms via an unused channel of a regular TV set.

But the fastest-growing microwave markets are being tapped abroad. A small stampede has brought U. S. microwave companies into greener pastures overseas.

Increasing microwave market prospects derive from the growing roster of the United Nations—from 51 original members in 1945 to 112 in 1964. Many new members are the underdeveloped nations of Africa and Asia which sorely need telecommunications systems.

Modern Facilities

Yet, well-established West European nations, and Japan, have installed modern video and telecommunications facilities. Many pan-European "Eurovision" programs are carried by microwave. Systems, by ITT and others, range across Australia and Canada, in the Caribbean, and over Malaysia. The experimentally evolving European Common Market may further broaden markets.

MICROWAVE PRODUCTS AND SYSTEMS

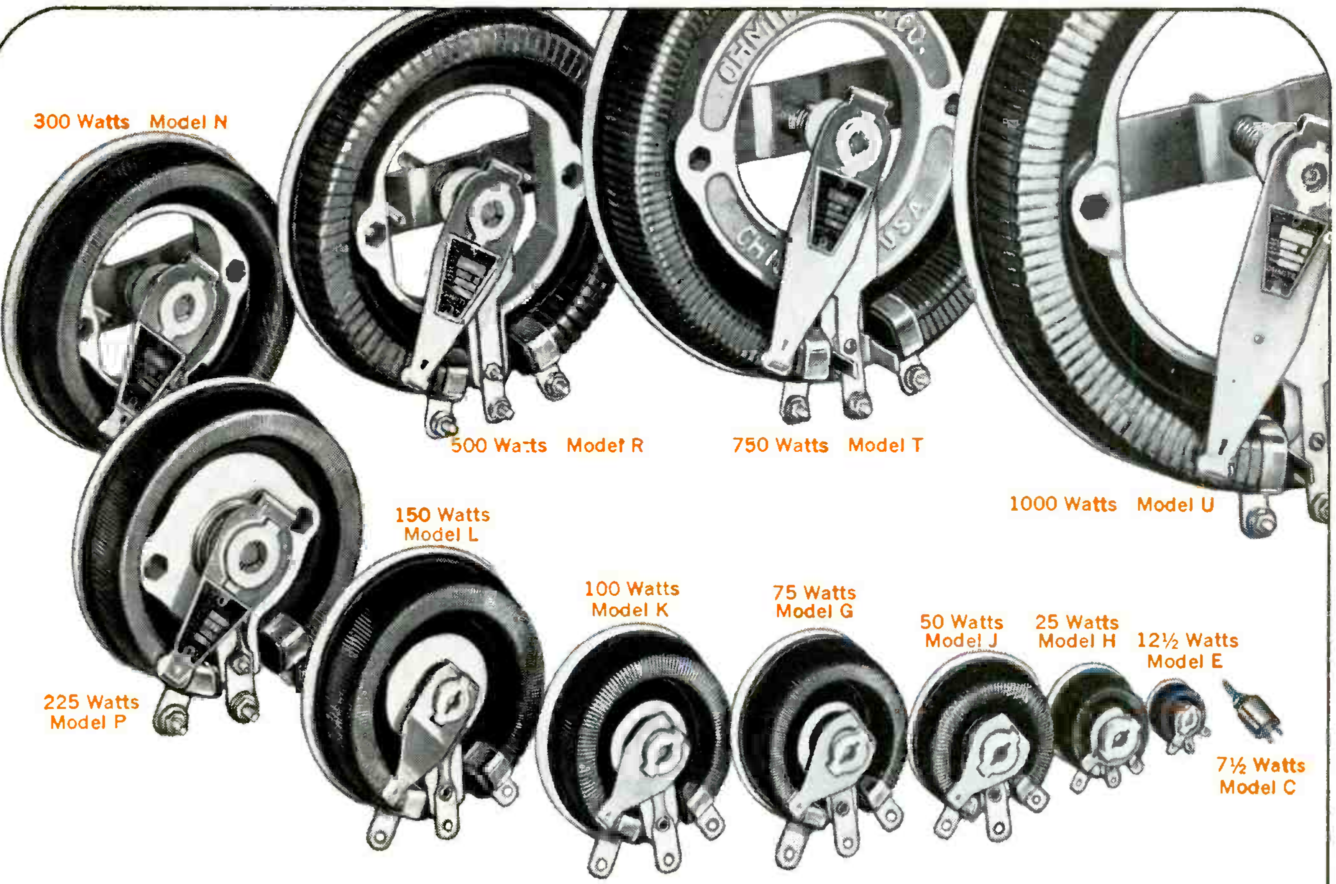
The estimated value of microwave products sold in 1963 is $238.4 million. Orders for microwave systems reached a value of $85.4 million out of the total for microwave products, according to EIA.
Another source suggests that total sales for microwave waveguides in 1963 were $142 million, and that 1964 will show sales of nearly $150 million for such products.

In military markets, U. S. microwave firms have an edge because DOD heavily funds projects such as: a) Ace High communications for the Supreme Headquarters Allied Powers Europe (SHAPE); b) the lingering NATO Air Defense Ground Environment (NADGE) system; c) recently completed Central Treaty Organization (CENTO) telecommunications system linking Iran, Pakistan, and Turkey; d) U. S. Navy's consolidated Southeast Asian Naval Communications, headquartered in the Philippines, called NAVCOMMSTA PHIL.

Thus far, U. S. microwave companies find it relatively easy to penetrate foreign markets. Still, U. S. firms must compete with the Dutch, English, French, German, Japanese, Norwegian and Swedish electronic firms, both in West Europe and in third countries, such as those in South America.

"European technical capabilities have excelled in some microwave areas, such as carcinotrons and traveling wave tubes, and now are catching up rapidly with U. S. technology in other areas."

Thus observes Joseph P. Schindler, vice president/marketing, Polarad Electronic Instruments, recently back from West Europe. "Now West European sales organizations must catch up with U. S. marketing techniques. Some foreign trading firms still are order-takers who are technically-unqualified. Only those firms that will acquire necessary technical competence will succeed in selling abroad, representing U. S. firms."



if it's a rheostat, you can get it from Ohmite

Need a miniature 7½-watt rheostat? Or something at the other extreme, say, 1000 watts? Ohmite makes all 12 basic sizes. With these as a starting point, you can branch out into literally hundreds of electrical, mechanical, and motor-driven variations . . . too many to even begin listing here.

Ohmite is the *only* rheostat supplier who can fill 100% of your requirements (plus many you probably will never run into).

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Motor-Driven Rheostats: Technically, these are classified as specials. But Ohmite makes so many of them that some models are practically standard.

"*Way Out*" *Specials?* No matter how unusual your requirement, contact the factory. For over 30 years, Ohmite has been solving tough rheostat problems. Maybe yours is even among them.

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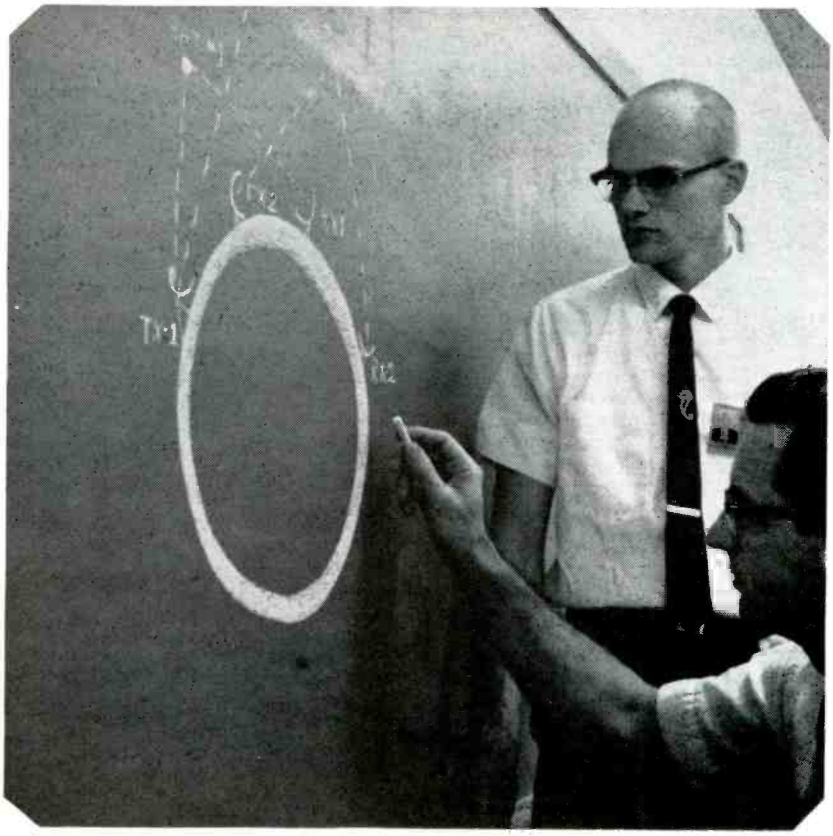


"CROSS-CORRELATION" MAY REVOLUTIONIZE RADAR USE

While learning more about sun signals that bounce off the moon, two Purdue professors are using a mathematical technique called "cross-correlation" that may revolutionize the use of radar.

The project, backed by a grant from NASA, is to find out whether useful information about the lunar surface can be obtained by comparing signals coming directly from the sun to earth and those that bounce off the moon first.

Researchers George R. Cooper and C. D. McGillem, School of Electrical Engineering, believe that their technique could be used to establish nature of radar targets. With the new technique, trackers could measure size and shape, could spot satellites as friend or foe, or obtain vital data about dangerous storms.

Cross-correlation involves multiplying two signals and averaging the product. Using it, the researchers can determine if signals are related—that is, are two or more reflections from the same target, or do they come from different sources.

MULTIPLEX SYSTEM OFFERS 600 VOICE CHANNELS

A solid-state multiplex system said to provide up to 600 voice channels when used with either microwave radio or wire lines has been disclosed by the Microwave Department, RCA Broadcast and Communications Products Division.

The equipment, called RCA type CV-600, makes use of channel units that are the same for all channels. This provides complete interchangeability, improved flexibility in maintenance, and reduces inventory needs for spare modules.

NEW EIA MARKETING HEAD

Daniell L. Dailey, manager of market planning for the United Aircraft Corp., East Hartford, Conn., has been appointed director of marketing services for the Electronic Industries Association to succeed William F. E. Long, it was announced by EIA executive vice president James D. Secrest.

Mr. Long, after 10 years with the EIA, has joined the staff of George Washington University, in Washington, D. C., as assistant professor of marketing and economics.

FIRST AND LAST

Stirling M. Olberg, senior engineer at Raytheon's Bedford, Mass., Lab, checks out SBE-33 transmitter-receiver for the last watch he will stand on board USS Massachusetts during the battlewagon's "dead-ship" tow from Norfolk, Va., to Fall River, Mass. He was first Sparks assigned to the ship more than 22 years ago. He served on the battleship throughout World War II.

TV SET MAKERS RECEIVE SYLVANIA COLOR CRT SAMPLE

Sample deliveries of a new 25-inch, 90° rectangular color TV tube that uses new phosphors are now being made, reports Sylvania Electric Products Inc.

With 19% more picture area than a standard 21-inch tube, the Sylvania 25-inch tube uses the firm's recently disclosed red "rare earth" europium phosphor plus improved green and blue phosphors. These phosphors, coupled with a "unique screening process, provide pictures substantially brighter than other 25-inch tubes."

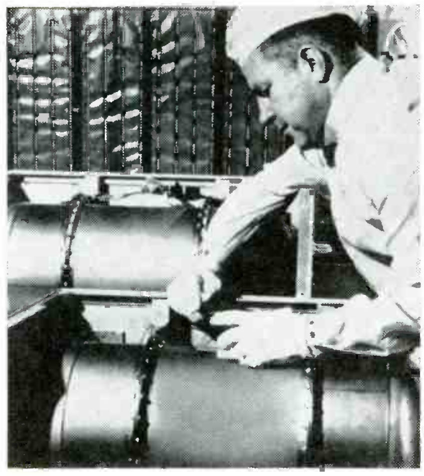
The new phosphors and screening process produce tubes that are more than 40% brighter on the average than other available color tubes, according to Sylvania engineers. The phosphors will be used in all Sylvania 25-inch tubes. The firm also has disclosed a special line of Sylvania-developed color receiving tubes that allow the operating voltages of color TV sets to be reduced from 400 to 270 volts.

THERMOELECTRICS FILM

"Thermoelectrics," the first and only motion picture on solving temperature problems using the new technology, is being introduced at Princeton, N. J., by Industrial Education Films, Inc.

The 15-minute film features principles and practical applications of thermoelectric cooling, heating, and temperature control.

FUEL-CELL SYSTEM



Communications, controls and other equipment in Gemini spacecraft will be powered by this fuel-cell system, which contains two batteries, each containing nearly 100 individual fuel cells in three separate stacks. Two batteries, shown in shipping containers before delivery by General Electric Co., will produce up to 2,000w of power.

SOLID-STATE REGENERATOR FOR START-STOP SIGNALS

A regenerator for start-stop signals at rates up to 1000 bauds has been announced by ITT World Communications Inc.

Engineers report that the new completely solid-state device corrects signal distortion up to 45%. Changes in code configuration and modulation rate are accommodated using a strap and/or resistor change principle. Thus the basic regenerator can be used on data circuits having either 5-information-unit (7.0, 7.42, or 7.5 start-stop) or 8-information-unit (10 or 10.5 start-stop) codes originated by a teleprinter or by data sets. The units take stop pulse variations without any adjustment.

Regenerators include a remote control provision to bypass the unit for dial-type information. The remote control enables regeneration on international telex trunks using class-B dial signals.

EDUCATIONAL TV GRANTS

Grants totaling $6.1 million to establish or expand non-commercial educational television broadcast facilities have been awarded to 37 institutions by the Department of Health, Education and Welfare.

Federal assistance is extended to schools and colleges which are building up a transcontinental network of educational television stations. Other applications for about $2 million currently are being processed.

FREE!

Use this card for:

- Catalogs, Bulletins, Literature
- New Tech Data for Engineers
- Information about new Products

NAME TITLE

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SPECIAL PRIORITY REQUEST: For immediate need or a call by a sales representative, write number (s) in box (do not circle above) →

Electronic Industries now provides you with a new "Special Priority Request" service to be used when you need immediate product information or want a sales representative to call.

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These requests are given special handling at our computer center. They will be rushed to each manufacturer. Please use this service only if fast action is required.

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THE READERS WHOSE NAMES APPEAR BELOW HAVE REQUESTED IMMEDIATE INFORMATION OR A CALL BY ONE OF YOUR REPRESENTATIVES

ELECTRONIC INDUSTRIES
CHESTNUT & 56TH STREETS
PHILADELPHIA, PA. 19139
A CHILTON PUBLICATION
215 SHERWOOD - 8-2000

TO:

ISSUE DATE ITEM NO. ITEM DESCRIPTION PRODUCT CODE

ELECTRONIC INDUSTRIES

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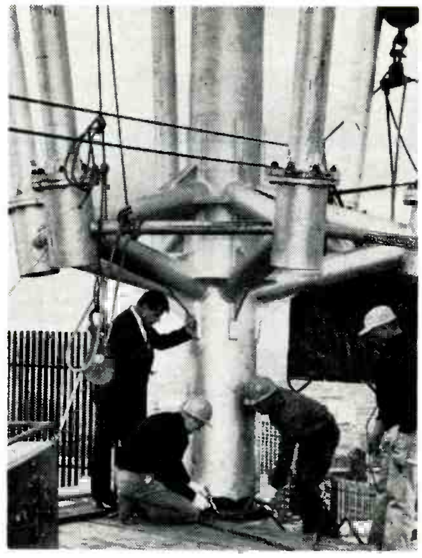
Another service to you from Electronic Industries the State-of-the-Art magazine for electronic engineers.

MARINA TV TOWER



Non-destructive testing used on WBKB 174-ton TV mast atop Marina City tower in Chicago. Mobile test equipment from Magnaflux Materials Testing Lab use intense magnetic field set up in weld area dusted with ferro-magnetic particles to search out and detect any possible dangerous cracks in the metal. Erected by M&H Communications Co., the TV tower will reach 426 feet above Marina's roof and 1,000 feet above street.

SPACE GENERATOR TESTED, IS POTASSIUM-COOLED

First tests of a liquid potassium-cooled space electric generator were completed recently by the Westinghouse Aerospace Electrical Division. A 50-kw model of the SNAP-50/SPUR system generator was successfully operated, according to R. W. Esarey, general manager of the Westinghouse division at Lima, Ohio.

The model generator was designed as a preliminary part of the SNAP-50/SPUR development program. Planned rating of the generator is 350kw. The work is being done for the AEC through the U. S. Air Force jointly with AiResearch Mfg. Co.

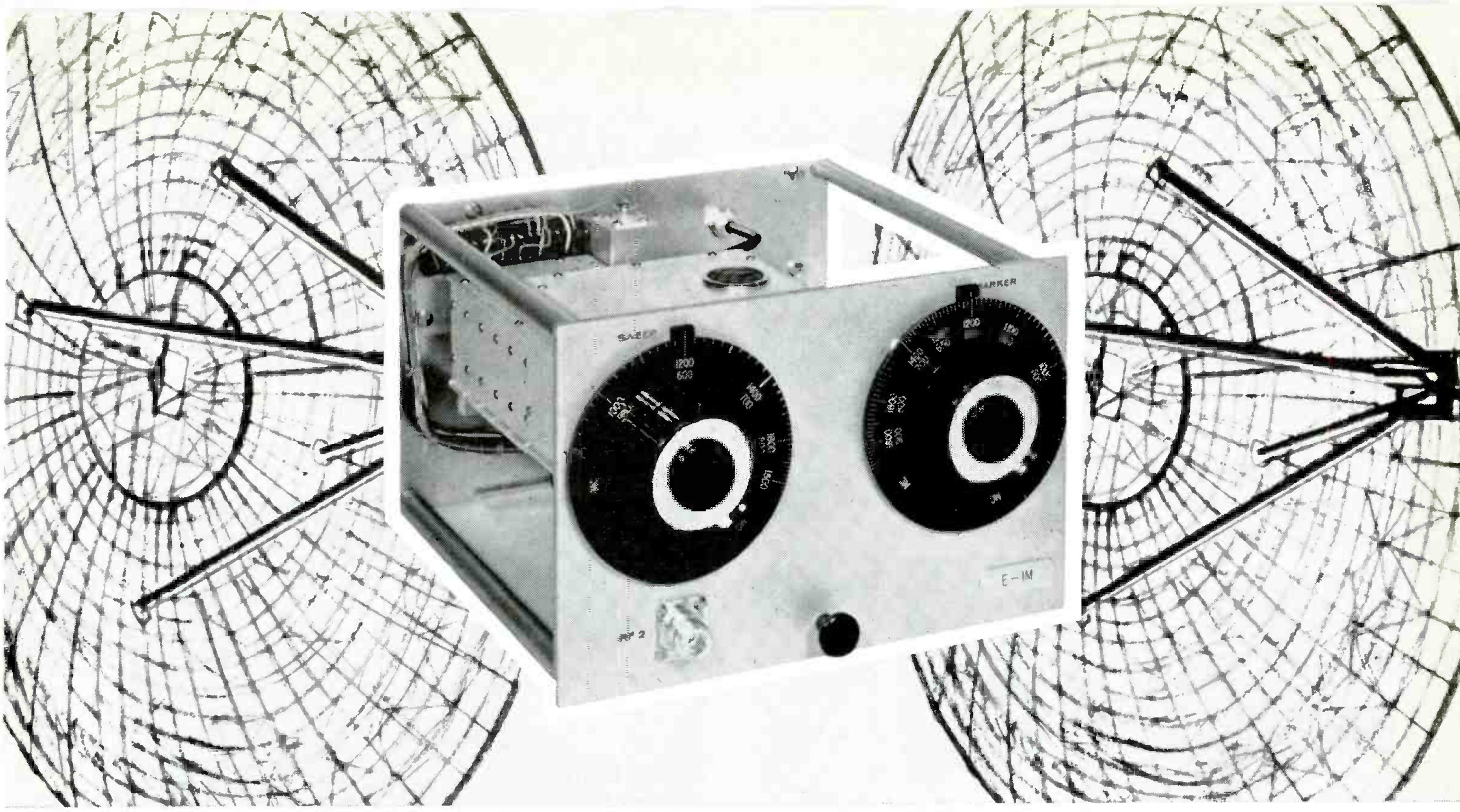
With a speed of 24,000 rpm and a power factor of 0.75 lagging, the generator is inductive with a solid rotor. Power is 50kw, voltage is 120/208 ac, and frequency is 3200 cps.

NEW LINE OF MODULES

A complete new line of silicon logic modules has been developed by Wyle Laboratories' Products Division.

The line consists of 19 card types that perform the printed circuit logic functions required of a digital system.

Modules are conservatively rated from DC to 1.5mc. Each logic element has an active element in output circuit. Operation is $-20°C$ to $70°C$.



Three low-cost Telonic Plug-in Heads cover .4 to 3 Gc

SWEEP MICROWAVE FREQUENCIES

It's almost like a three-for-the-price-of-one sale. That's about the price difference between the Telonic microwave sweep oscillator heads and everyone else's. Yet, that's only where the savings begin. Because of the preciseness of these Telonic microwave plug-in oscillators, valuable checking time in laboratory and production lines is reduced to a minimum. On one of the plug-in models, the sweep oscillator tube cost is less than $5—a more than impressive saving when compared with approximately $1000 for a BWO. As for accuracy in frequency marking for units under test, an optional variable marker is available. The marker is a tuned oscillator which can be varied over the entire fundamental range of the sweep oscillator. Specific information, including price, on the three models are included within the chart below.

SPECIFICATIONS

	E-1 $750*		E-2 $995*		E-3 $995*	
TYPE	R.F.1	R.F.2	R.F.1	R.F.2	R.F.1	R.F.2
CENTER FREQUENCY	460-920 Mc	920-1840 Mc	600-1200 Mc	1200-2400 Mc	550-1000 Mc	1650-3000 Mc
SWEPT RANGE	435-970 Mc	870-1940 Mc	570-1250 Mc	1140-2500 Mc	530-1040 Mc	1590-3120 Mc
SWEEP WIDTH	0.02-10%		.02-10%		.02-8%	
OUTPUT-R.M.S. INTO 50 OHMS	Band 1- 1v r.m.s.	Band 2- 0.25v r.m.s.	Band 1- 1v r.m.s.	Band 2- .25v r.m.s.	Band 1- .75 r.m.s.	Band 2- .15v r.m.s.

The "E" Series microwave plug-in heads, as well as other models covering specific or broad frequencies between 20 cps. to 3,000 MC, are used in conjunction with the Telonic Sweep Signal control chassis, Model SM-2000.

**Excluding Variable Marker*

Telonic® INDUSTRIES, INC.

60 North First Avenue, BEECH GROVE, INDIANA

Representatives in: Baltimore, Boston, Chicago, Cleveland, Dallas, Dayton, Denver, Huntsville, Indianapolis, Los Angeles, New York City, Orlando, Philadelphia, San Francisco, Seattle, St. Louis, Syracuse and principal cities throughout the world.

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

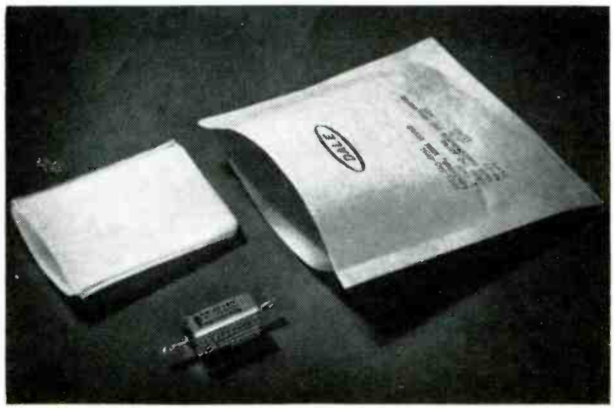
Circle 69 on Inquiry Card

WHAT'S NEW

PARTS PROTECTION

A NEW PACKAGING CONCEPT is helping manufacturers of small electronic devices meet stringent military packaging requirements.

The envelopes, called Foamvelopes®, are fabricated from Ethafoam® by Donray Products Co., Cleveland. Ethafoam flexible polyethylene foam, a product of



Foamvelope protects the delicate part and keeps the sharp edges of the resistor from tearing through the outer envelope.

LASER-EXCITED SPECTROMETER

THE INTENSE, MONOCHROMATIC LIGHT OF THE LASER is being used as an excitation source for a commercial spectrometer. The Laser-Excited Raman Spectrometer, developed by the Perkin-Elmer Corp., Norwalk, Conn., uses a continuous helium-neon gas laser. It may be used for structural studies of molecules and analysis of chemical samples.

With the new device, Raman spectra can be obtained on many industrial or research samples that used to be hard to handle. As in infrared studies, the spectral curves produced by the Raman method are "fingerprint" characteristic of the substance being examined. The Raman method uses a second order scattering effect rather than an absorption phenomenon as in infrared. The infrared and Raman spectra are usually different for a given molecule, but both are uniquely characteristic of the molecule.

The laser-beam brightness and monochromaticity make it an ideal source for exciting Raman spectra.

MICROWAVE SOLID-STATE DEVICES

Sales for microwave solid-state devices in 1963, according to estimates, vary between $16 and $20 million. A projected table for such products may take on the following form:

1963	$16,000,000
1964	$18,000,000
1965	$22,000,000
1966	$28,000,000
1967	$36,000,000

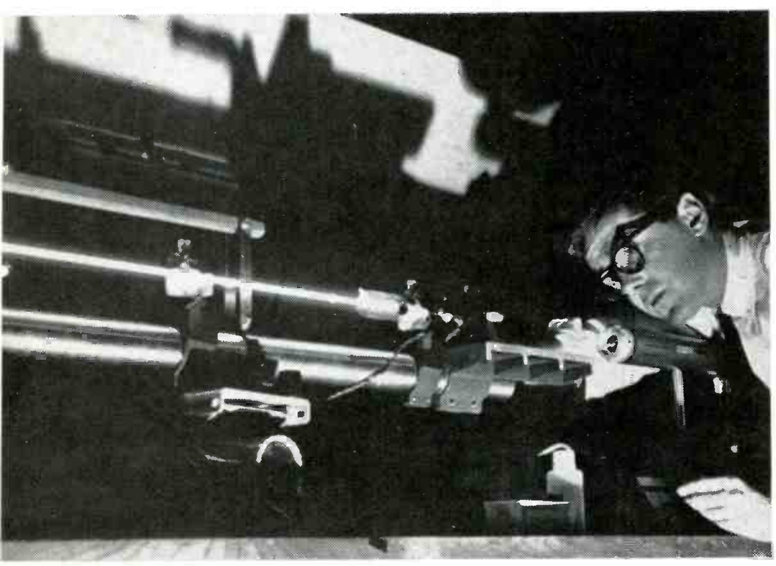
The Dow Chemical Co., is a closed-cell foam formed by expanding polyethylene until it is about 30 times lighter than water. The primary features of Foamvelopes are their good absorption of shock, resistance to impact, and ease of use.

Dale Electronics, Inc., Columbus, Nebr., is using the envelopes to meet military packaging specifications in heat-seal uses. The military requires that housed lug-type wirewound power resistors be wrapped in a dry, non-corrosive cushioning material. This material must also prevent contamination damage to the part which could occur if its sharp edges punctured the outer package. After a resistor is placed in Foamvelope, it is heat-sealed in a second envelope made from a foil/film laminate. The Foamvelope keeps the sharp edges of the leads and housing from tearing through the outer envelope.

Unitized packages with multiple pouches can be fabricated, filled, then packed flat in cartons. Not only do such packages protect the components, they facilitate packing, shipment, storage and overall handling.

In the Raman effect, highly monochromatic light falls on a sample and scatters. The scattered radiation consists of original monochromatic exciting light and additional light (the Raman lines). This light is weak and differs in wavelength from the exciting light. Differences in wavelength between these lines and the parent wavelength, in terms of frequency, relate to sample's molecular vibration frequencies characteristics.

The red beam from a continuous gas laser enters a glass sample cell where it is scattered by the sample liquid. The type of scattering is characteristic of the given sample and is detected by an electro-optical spectrometric system.



HOW PROMOTION SELLS COMPONENTS TO ENGINEERS

By HOWARD W. HANSON, III
Supervisor, Advertising & Sales Promotion
Electronic Products Division
Corning Glass Works
Raleigh, N. C.

A WELL-PLANNED PROMOTION AND ADVERTISING PROGRAM, with objectives and goals clearly defined, is essential to the growth of firms built upon new products, new technologies and new concepts.

The Electronic Components Division of Corning Glass Works in 1959 was merely a department with only 100 employes on the roster. Effective merchandising and sales promotion, coupled with astute management, helped this embryo department grow into a full division with more than 1500 employes.

Early in 1959, the promotional picture was cloudy. Our advertising was being handled by a Rochester, N. Y., agency, and was coordinated through the advertising manager of our Technical Products Division. Once or twice a year the agency, the technical products ad manager, plus someone picked on the spur of the moment from electronic components, would sit down for a day and decide on promotion and advertising. Product data was fed spasmodically to the agency. Ad insertion schedules were irregular, catalog sheets were scrambled, and a promotional plan with objectives was non-existent.

90% Stopped at Booth

That year about 90% of 60,000 attendees at the IRE (now IEEE) show stopped by our booth to tell us they didn't know we were in the electronics business—and "Why didn't we stick to glass?"

After much soul searching, we decided the broad promotional objectives for 1959 and 1960 were:

1. To become known as a components supplier to the electronics industry. We would establish our *own* image but *still* be known as part of Corning Glass Works.

2. Make known to key influences the good performances of Corning's electronic components.

That was the first step; we had objectives.

Specific Goals

Now we needed specific goals.

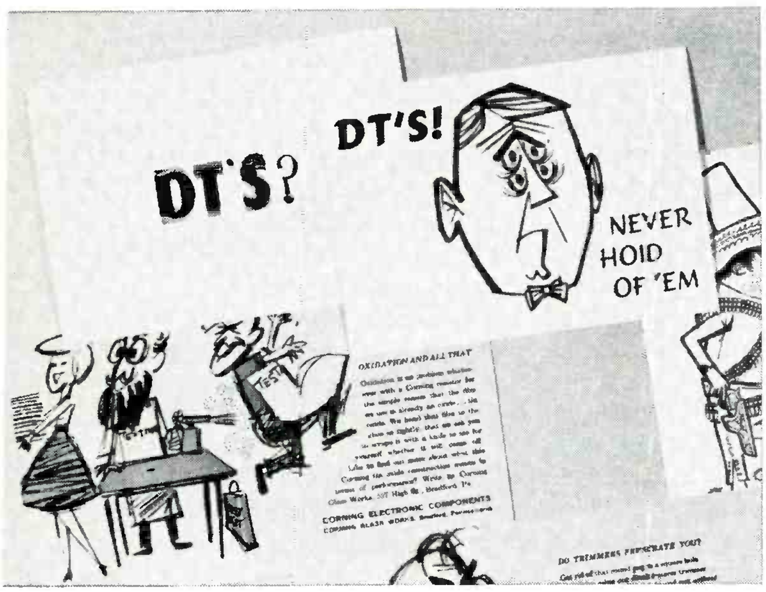
Goal One: by IRE Show time in 1960 at least half the people coming to our booth should know we were in the business.

Among managerial programs that
will help growth of a new division
is effective advertising and promotion.
"Effective" here means
"knowing the market,
having objectives and goals,
selection of tools,
and sensible scheduling of promotional ideas."

Goal Two: by IRE time in 1961 virtually all should not only know this, but should come to see our products and ask how they might use them.

Again, in our unsophisticated way, we had hit upon the second basic requirement of an effective promotion program: A goal against which we could measure our performance.

Working with our agency personnel, who were delighted to work directly with our department, we came up with a pretty simple scheme. If Corning wanted to become known as a supplier of electronic



We stuck our toe in the water with a series of comic trade show teasers and postcard mailers. We won; engineers loved them.

components, why not change our copy theme to just that? We changed our logo from a complete tie-in with glass to one of electronic components. The tie-in with Corning Glass Works was moved up into the copy.

Small ads were run regularly in the weekly newspaper of the industry. Our whole message was *"Corning Electronic Components."*

Started Catalog

At the same time, we went to work on a catalog. Again, we kept our promotional goals in mind: Make the division known and play up essential product features. We again merchandised Corning with electronic components. About this same time,

(*Continued on Page* 134)

HOW PROMOTION SELLS (Continued)

we became aware of the word *image*. We began to create an image of someone who's here to stay by using glossy paper, two colors, quality. To help build this image, we created a booklet to tell people about our facilities and products.

Now we were really starting to roll along. We had advertising and literature to build our tie-in with electronics. We had new products coming out of the factory which we started to merchandise with this new look in ads and literature. And here we reached our first check point—the 1960 IRE Show.

We went to the show with some apprehension, but we were soon relieved. Spot surveys indicated that about 70% of visitors at the booth were not surprised to find us in the business. Some actually came to the booth *specifically to see* components.

More Sophisticated

We decided to get a little more sophisticated with other merchandising tools. At the same time, we brought identification with Corning Glass back into our "look" so we wouldn't lose it. The Glass Works logo was placed under the Electronics logo but in smaller type face.

One obvious merchandising tool we were not using very well was the mail. Our research found that the prime influence for choosing new components was the electronic design engineer, he was king. So, we built a mailing list of design engineers.

Here is a simple key to success in merchandising a new product, new product line, or new business: Who is the key decision maker to specify your product? This function is different in different industries—and it can change.

On a limited budget, we used existing artwork and ad layouts. This turned out to be a good technique, and we still use it. It builds continuity of communication across various media.

Met Objectives

At this point we felt we were meeting our objectives. This was borne out at the 1961 IRE Show. Virtually everyone knew us. *Now* the company was ready to take a new look at promotional objectives.

We kept past objectives, but with new emphasis. Objective one, to become known as a major electronic component supplier, was made a continuing but secondary objective. The difference now was that we were ready to take specific aim with our product features at specific key groups.

To do this, we switched our emphasis in trade paper and direct mail advertising to product-type copy. We started to fill out our product lines during 1961. Previously, we had been merchandising *this* new product and *that* new product. These products were now beginning to fall into complete product families, which were easier to sell in the market place but harder to use in trying to keep the exciting aura of new things about us.

During this time we took a close look at our merchandising methods. We found we were merchandising pretty much like everyone else. Our sales had been growing and we had indeed become a "big boy." What could we do to keep our growth? How could we be a little smarter? What traps had we fallen into?

Out of these came some answers. We could try to look bigger, and we did. One method we used was decreasing our frequency while increasing our exposure size in the industry newspaper.

A Mistake

With this we used different type formats on trade magazine ads. This was a mistake. We had been getting good readership and excellent recall on our previous ads. With the mixed and varied formats, both fell off.

We looked at studies and found that *engineers liked to read dry tabular information and performance data!* We were giving it to them, but so was everyone else. It was true that our ads got above average readership, and we had good feedback from our mail and publicity, but this wasn't enough for the growth we wanted.

The thought came to us that maybe we could put a little life into our promotions. We stuck our toe in the water with a series of comic trade show teasers and postcard mailers. We won this one; engineers loved them.

In the same year, we took a long, hard look at our distribution system. Corning had been selling electronic components directly in large quantities through factory sales engineers and in small quantities through a super distributor to reps to distributors. This had worked nicely to get us fast, wide distribution for our products, but we lacked the necessary channels of communications with our distributors to do an adequate merchandising job. Gradually, we took over our distributors.

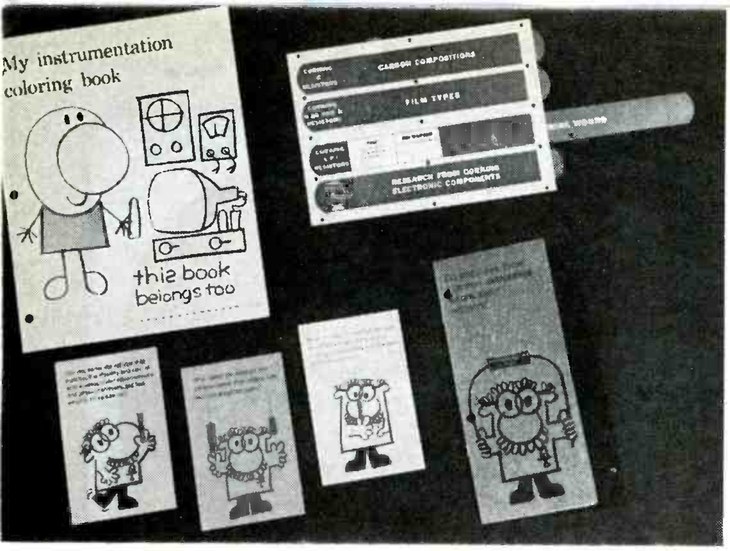
2 Promotion Plans

In 1962, we came out with two separate promotion plans which were designed to work together. Our program aimed at the OEM (Original Equipment Manufacturers), was directed specifically at the electronic design engineer and the technical evaluation person; the latter had now joined the designer as a prime influence for new products.

We designed trade paper ads which told our story, but in a different way. We tried to make them more interesting. We hit unique marginal differences.

One of these unique marginal differences is a new concept to the resistor business—design tolerance—shown in ads. Another is a new concept in noise in

(*Continued on page* 136)



We followed "Directions for Profit" meeting with series of ads (above) using unusual illustratoins to get attention. The final mailers, (left) included a coloring booklet designed as a teaser that told a strong story. Slide rule was used for a sales pitch.

HOW PROMOTION SELLS (Continued)

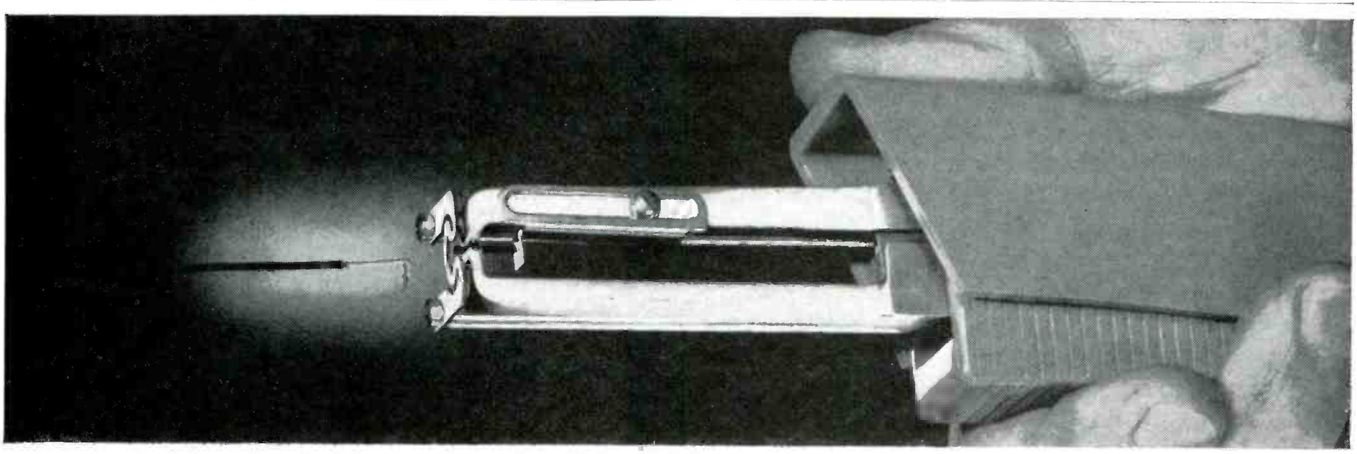
resistors. Although others said it couldn't be done, our engineers established a correlation between electrical noise and performance, so we merchandised it. Also, the industry was interested in reliability and size so we merchandised them in our components around Corning's capabilities.

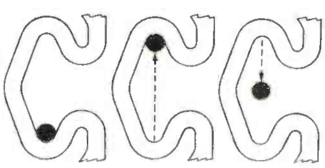
On schedule, we sent out mailing pieces on using our ads and literature data packages. In a promotion aimed at the instrument market we got a little "consumerish" to make dry data interesting. Teaser post cards built curiosity. The final mailer, a booklet designed as the teasers, told a strong story. The slide rule was used for a sales pitch to "hot prospects" generated by the mailing. The comic coloring book was a giveaway.

Free Samples

In one series of promotions on a new product, we even offered free samples to engineers in select geographical areas. This series prompted about 200 companies in the Philadelphia-Baltimore-Washington area to use our product after evaluating the samples. Samples and initial sales were coordinated through franchised distributors in the area.

In our 1962 distributor promotion program we had two problems. The first was to promote our image to distributor management so they would





think kindly of us and stock our products in depth. The second was to stimulate our distributors to use promotional tools to move these products.

We felt that our own distributor personnel were getting the impression that Corning was really no better a supplier than anyone else, and to grow we needed their support as the top supplier. We decided to boost morale with a promotion campaign to reach our distributor top management.

'Directions for Profit'

At company expense, we flew all of our distributors to our electronic components plant for one day and to our corporate headquarters and laboratories the next day. Top distributor management people heard and mingled with Corning's top personnel.

We followed this "Directions for Profit" conference with a series of ad messages aimed primarily at telling people why our distributors were good and why they should use them. In these ads, unusual illustrations were used to get attention.

Then came distributor promotion number two: Help move Corning components off the distributor shelf. In early 1962, we worked up our first program, then followed it up with an improved version. We found that, given enough help and being sold on a product line, distributors would promote it heavily with their own money.

Promotion Manual

The latest distributor promotion manual is in seven sections. Section one shows the distributor some items we have to help him sell Corning; these are supplied at no charge. It describes a selling course for his salesmen, a literature rack for his sales office, and the literature.

Section two describes the first of several sales tools, a pocket sample case for our products.

Section three describes advertising sales tools we make available. If ABC Electronics wants to run a Corning ad, we supply free plates in any size for any product.

Section four covers special promotions. As new ones become available, they are inserted.

Section five describes OEM and distributor support advertising to help pre-sell our products.

Section six shows mailers on products, with space for the distributor's imprint. It also tells of help available on trade shows.

Section seven gives distributor management both annual and monthly planning calendars with which to plan their Corning tie-in promotions.

CRUNCH—ZZZT—FFFT

We continued to try the unusual to telling our "unique marginal differences." A series of capacitor ads, which we call the CRUNCH—ZZZT—FFFT series, told the story of glass as a capacitor material.

(*Continued on Page* 138)

HOW PROMOTION SELLS (Concluded)

Also, we used balloons to announce a price decrease to the industry. The action was not merchandised as a price decrease, but as a rise in value. Phone slogans were used in sales offices as a tie-in. The balloons were used as both mailers and distributor handouts, and stickers went out on all correspondence.

There are some factors that can definitely contribute to effective promotion of new industrial products. These are:

1. *Know Your Market*—Simple as this seems, many promotions are mis-aimed because someone didn't take the time to learn his market. Before any promotion is launched you must know what is being used, who is specifying it, and why.
2. *Find Your Honest Unique Differences*—This also seems so simple that it's hard to believe people overlook it. Why should a specifying influence in your target market buy your product? If you don't have a reason, better not get in the business!
3. *Have An Objective*—Whether you're going to promote a product, product line, or service, you must have a definite promotional objective.
4. *Have A Goal Or Goals*—This helps you tell whether you've reached your objective. Have definite measurable goals with dates.

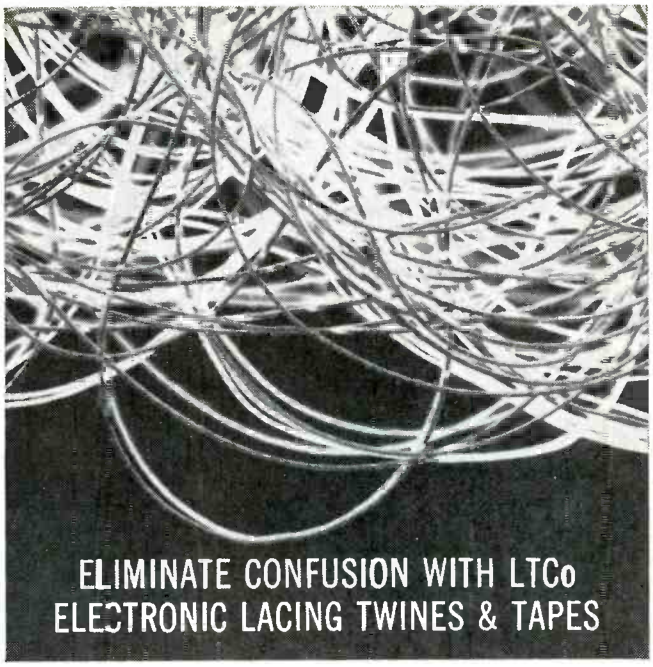
5. *Use the Smartest Tools*—There are many communication tools. Common ones include space advertising, mail, editorial information, sales handouts, point-of-purchase materials, phone slogans, premiums, etc. Be imaginative both in their use and presentation. Don't rule out so-called wild ideas.

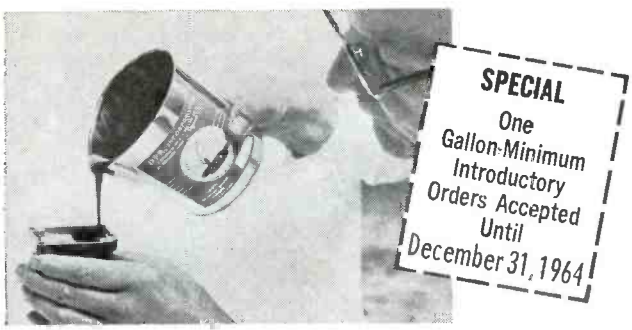
6. *Schedule Your Promotion*—Having now found out about the market you wish to reach, decided how to promote your product, set promotional objectives and goals, and selected the best promotional tools, schedule your promotion for maximum impact and the most for your dollar.

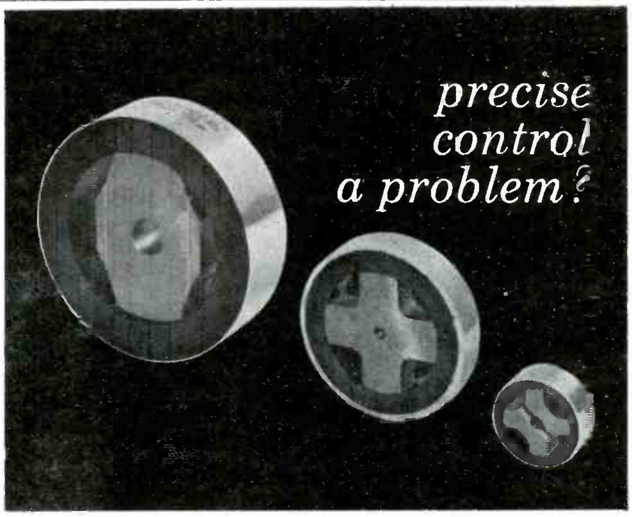
7. *Don't Be A Sales Fall Guy*—Industrial-type promotions, with few exceptions, cannot be designed to make proposals and close orders. Therefore, you cannot judge a promotion by increase—or decrease—in sales. It should be judged by your promotional goals, which must be communications, training, penetration, and sales leads type goals.

A promotion goal could be to inform 80% of the buyers in the market about a new improved gizmo by June first and to get inquiries from 50% of them. So the promotion goes on, inquiries come in, you give them to sales department, no sales.

You find that distributors aren't stocked or don't make calls and that's why no sales are made. The sales manager says, "Lousy promotion." I say, "It wasn't." It was effective promotion if realistic promotion goals were set and met.







NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

DIRECTIONAL COUPLERS

Offers 15db min. of directivity over 250-1000mc, 750 - 3000mc, or 1000 - 4000mc.

Two octave bandwidth directional couplers are available in coupling values of 6, 10, 15 or 20db. These couplers offer lightweight, small size, rugged encapsulated design with reliable performance over a broad freq. band. Special order couplers are available as narrow band (1 octave), high directivity models, or as extremely broad band (up to 4 octaves) models. LEL, Inc., 75 Akron St., Copiague, N. Y.

Circle 182 on Inquiry Card

DIRECTIONAL COUPLERS

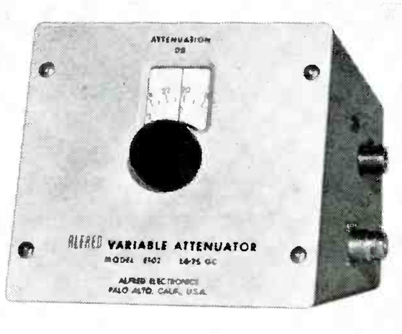
Features ±0.5db coupling flatness and a freq. range of 10-200MC.

Model 3060-20 has a coupling value of 20db within ±0.3db of nominal value over the 20:1 band. Calibration indications to ±0.2db accuracy at 6 freqs.: 10, 30, 60, 100, 150 and 200MC. The unit's VSWR is low, but 1.2 max. over the full octave freq. range. Typical insertion loss for basic input/output is 1.5db; max. is 2.1db. Power ratings are 1w average, and 100w. peak. Narda Microwave Corp., Plainview, L. I., N. Y.

Circle 184 on Inquiry Card

VARIABLE ATTENUATORS

Insertion loss of 5db at 0db setting allows use with limited power.

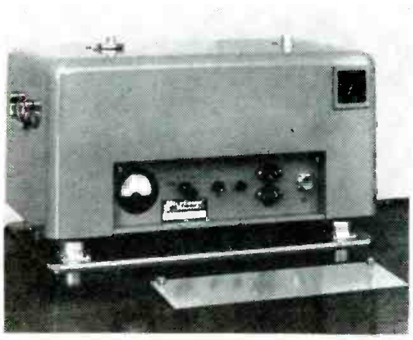


Model E 102 attenuator covers the 1.4 to 2.5GC range. It features low insertion loss, flat response, wide range, and fine resolution. Calibrated attenuation range is 0 to 60db. Freq. sensitivity is less than ±½db at min. attenuation, with external terminations possessing a VSWR of less than 1.1:1. At midband, calibration is ±0.2db or ±2%, whichever is greater. Power rating is 100w. Alfred Electronics, 3176 Porter Dr., Palo Alto, Calif.

Circle 186 on Inquiry Card

MICROWAVE RELAY

Significantly increases power output from existing vacuum type transmitters.

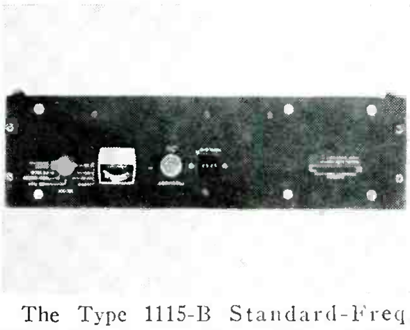


The MA-8509 broadcast microwave relay is a self-contained portable 10w. (min.) 20w. typical output TWT r-f power amplifier. All circuit elements other than the TWT are solid state. The power amplifier is primarily intended for TV broadcast mobile relay operations. Advantages of higher power output offer extended range, improved S/N ratio; increased power output in omnidirectional antenna uses; extended range in point relay. Microwave Associates, Inc., Burlington, Mass.

Circle 183 on Inquiry Card

FREQUENCY STANDARD

Freq. is divided to supply outputs at 1MC and 100KC as well as the 5MC.

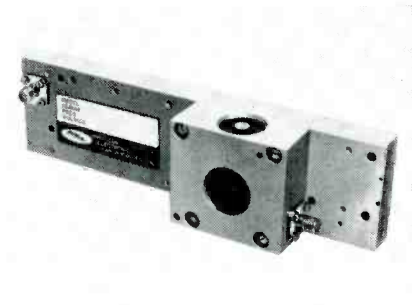


The Type 1115-B Standard-Freq. Oscillator uses a 5MC, fifth-overtone gettered crystal in a 3-stage transistor oscillator. Crystal, oscillator, and AGC circuits are all enclosed in a proportional-control oven. Short-term stability is 100 parts in 10^{11} RMS over a 300µsec. averaging time, 1 part in 10^{11} RMS over 10 sec. Spectral line width is under 0.25 CPS at X-band. Noise pedestal is 145db down for a 1 CPS bandwidth at the 5MC output. A built-in nickel-cadmium battery supply takes over and operates the standard for 35 hrs. if ac-line fails. General Radio Co., West Concord, Mass.

Circle 185 on Inquiry Card

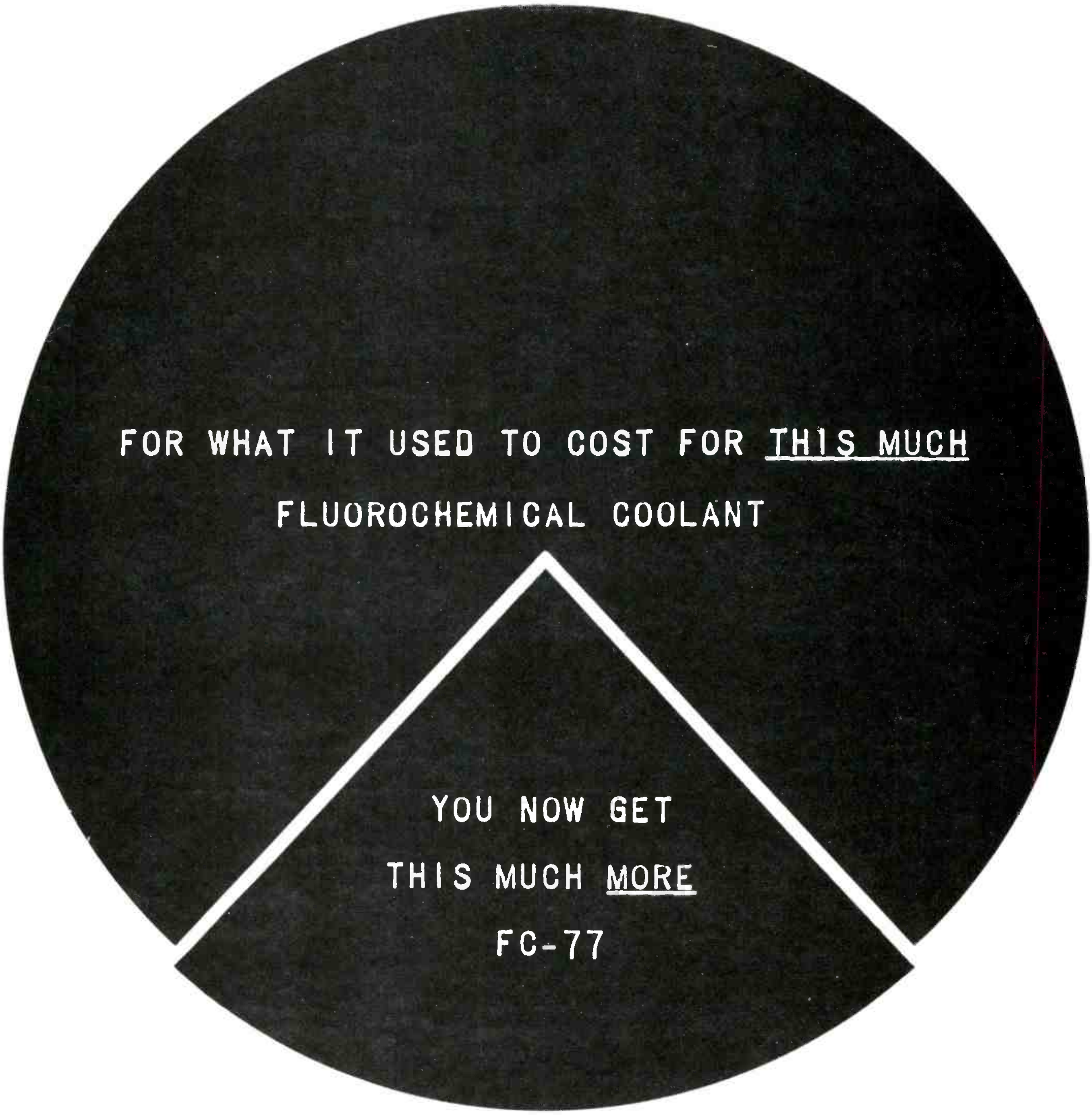
FREQUENCY MULTIPLIER

Provides 12% instantaneous bandwidth at X-band. Conversion loss is 10db max.



The AEL model MT829A freq. multiplier has a circulator built into the input circuit network to maintain an input VSWR of less than 1.5:1. A circulator has been integrated into the output network to provide isolation between mismatched loads in the freq. multiplier. By a careful selection of varactors, conversion efficiencies of 7db are obtainable. Nominal conversion with standard varactors is approx. 9 to 10db. American Electronic Laboratories, Inc., Richardson Rd., Colmar, Pa.

Circle 187 on Inquiry Card



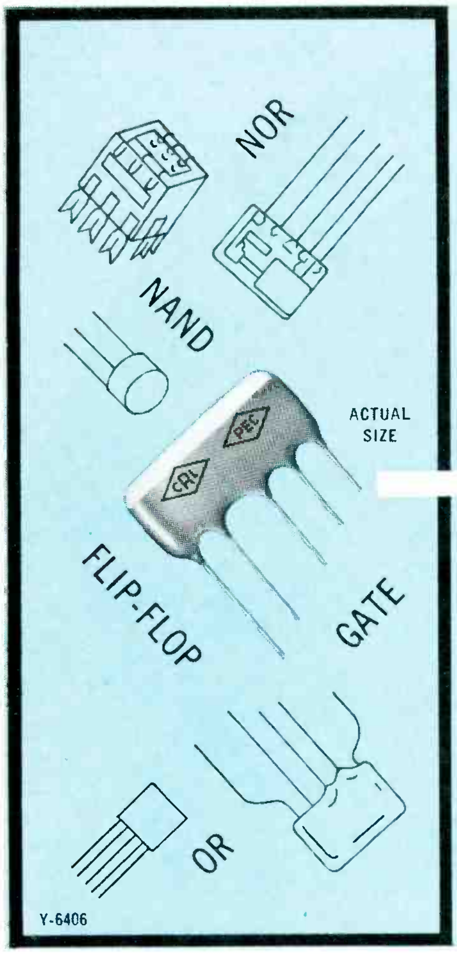
Fact is, this newest entrant to 3M's fluorochemical coolant family, 3M Brand Inert Liquid FC-77, is cutting the cost of coolants at least 25%! These new prices make FC-77 practical for many new electronic and aerospace designs.

FC-77 takes the heat away faster than non-volatile organic liquid coolants. Secret? It boils at about 100° C. Thus it vaporizes and carries off heat at a higher rate than other conventional convective coolants. FC-77 easily handles high heat fluxes with minimal changes in temperature of component. Retains its high electric strength (in excess of 35 KV) when changing from liquid to vapor. And unit size can be reduced as much as 4 to 1, weight by 2 to 1.

FC-77 is neither affected by, nor does it affect, metals, plastics, elastomers—chemically or electrically. And when used in an efficient closed system, it lasts as long as the equipment it cools.

Find out more about FC-77 and other members of this fluorochemical coolant family, FC-75 and FC-43. Write Chemical Division, Dept. KCQ-114, 3M Company, St. Paul, Minnesota 55119.

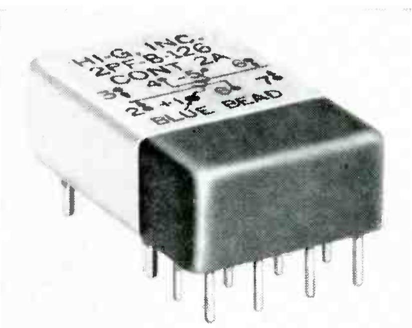
Chemical Division 3M COMPANY



NEW PRODUCTS

MINIATURE RELAYS

Three sensitivities are available: 250mw, 100mw, and 40mw.



The Side-Step® series are offered in three sensitivities and designed for PC board uses. All three meet the requirements of Mil-R-5757D. The dimensions are: 0.400 x 0.800 x 1.255 in. max. The relays operate without chatter while undergoing shocks as high as 50g and vibrational forces of up to 20g. Hi-G Inc., Spring St. & Route 75, Windsor Locks, Conn.

Circle 194 on Inquiry Card

ULTRASOUND GENERATOR

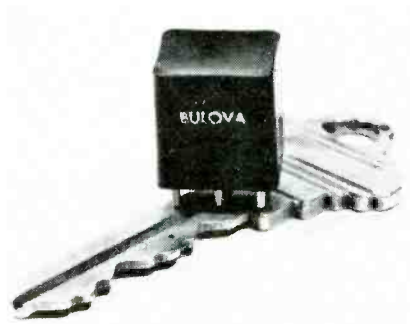
Operates in the freq. range of 900KC through 15MC in 3 overlapping bands.

Model C-4942 is a medium power output device ranging from 0 to 100w. It is designed as the driving source for ultrasonic testing systems. It operates on 110-120vac at 50-60 cps. Plate power may be varied from 0 to 1kvdc. Impedance matching is controlled by the user, and a wide range of load impedances may be matched. James Electronics, Inc., 4050 N. Rockwell St., Chicago, Ill.

Circle 195 on Inquiry Card

BROADBAND TRANSFORMER

Freq. response is 3MC to 60MC. Insertion loss max. is ½db.



The K-572 is a broadband transformer measuring 0.13 cu.-in. in volume. Applications include balance mixers, balance modulators, ring modulators and the output stages of linear exciters. Power level is 0.3wac. Primary impedance is 170Ω center tapped; secondary is 50Ω. Max. allowable dc current in primary is 250ma. Bulova Watch Co., Inc., 60-20 Woodside Ave., Woodside, N. Y.

Circle 196 on Inquiry Card

SILICON TUNNEL DIODE

Used in low-level, high-speed switching circuits where operating temps. vary.

The JEDEC types 1N4393 through 1N4399 have peak current ratings of from 0.47 to 10ma. They offer extreme stability over a wide temp. range (—65° to 150°C), and feature closely controlled electrical and mechanical tolerances. Units have gold-plated weldable leads for max. installation flexibility. They meet the requirements of Mil-S-19500 or Mil-STD-750. Heliotek, Div. of Textron Electronics, Inc., 12500 Gladstone Ave., Sylmar, Calif.

Circle 197 on Inquiry Card

FREQUENCY STANDARD

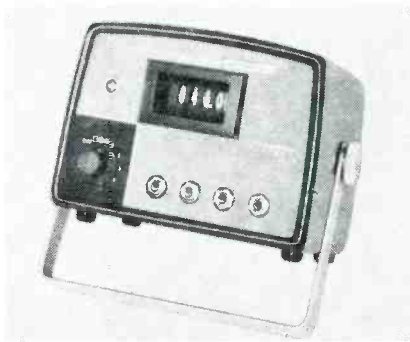
Unit has three output frequencies and is stable to 5 pp 10^{10}/day.

Model 1210 has output freqs. of 100KC, 1MC and 5MC. The crystal is contoured 5MC, AT cut, operating at the turning point in the 5th overtone mode. Modular construction is used throughout. Freq. dividers are of the regenerative fail-safe type. They must be manually restarted after any interruption of input signal. A short circuit on any of the 3 outputs will not affect the unshorted ones. This unit is all silicon, solid state. Borg Electronics, 120 S. Main St., Janesville, Wisc.

Circle 198 on Inquiry Card

DIGITAL THERMOMETER

Interchangeable probes provide flexibility in thermistor-based unit.



The DigiTec Series 500 units are thermistor-based, high-resolution instruments capable of measurement and display of temp. in convenient digital form. Resolution is 0.02% of span. Model 500 covers 59°F to 122°F with accuracy of ±0.15°C. Model 502 is a special instrument having a fixed span of 20°C (set anywhere between —50°C and +150°C) with an accuracy of ±0.1°C. A self-contained probe selector switch permits scanning of 4 temp. points. A complete line of interchangeable probes is available for solids, liquids, gasses or surface temp. measurements. United Systems Corp., 918 Woodley Rd., Dayton, Ohio.

Circle 199 on Inquiry Card

SUBCARRIER DISCRIMINATOR

Demodulates center frequencies between 300CPS and 300kc.

Model 229 tunable FM subcarrier discriminator offers continuous tuning across and beyond Inter Range Instrumentation Group (IRIG) center freqs. and intelligence freqs. The unit is useful in PCM, PDM, and PAM applications where the tunable input filter allows optimization of pulse rise and fall times, and the tunable output filter makes it possible to obtain ideal compromise between interchannel crosstalk and noise rejection. Electro-Mechanical Research, Inc., Sarasota, Fla.

Circle 200 on Inquiry Card

A-D CONVERSION MODULES

May be tailored to individual packaging and logic interface requirements.

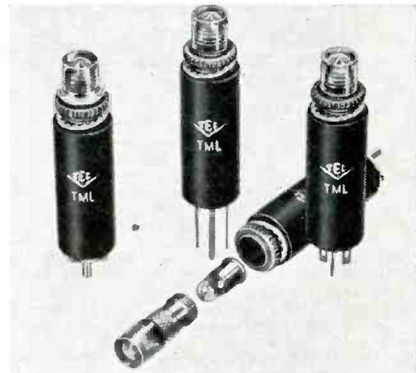
The Microseries 600 are versatile building blocks which meet Mil Spec. requirements for aerospace shipboard and GSE systems uses. They are designed for convenient implementation of a universal interface between any desired configuration of sensors, transducers, actuators or control devices and any given central digital processor, telemetry transmitter or instrumentation recorder. Fairchild Space & Defense Systems, div. of Fairchild Camera & Instrument Corp., 300 Robbins Lane, Syosset, L. I., N. Y.

Circle 201 on Inquiry Card

NEW PRODUCTS

SOLID STATE INDICATOR

Offers memory and internal switch. Gives indication of one-time pulse to 2μsec.

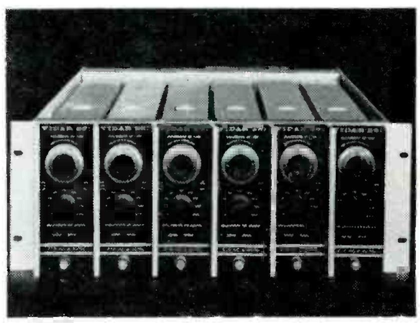


TML-10 Series Memo-Lite indicator turns on with a low-level signal and remains on when the signal is removed. Interruption of supply or use of optional integral reset switch extinguishes the lamp. Indicator is designed for error indication, alarm actuation, and can function as a logic element in computer, industrial control, and missile guidance systems. Solid-state design offers longer life, greater reliability and brighter, easily replaceable incandescent lamps. Transistor Electronics Corp., Box 6191, Minneapolis, Minn.

Circle 210 on Inquiry Card

CONVERTER

Converts change-to-freq. & voltage-to-freq. Center freqs. from 400 CPS to 1MC.



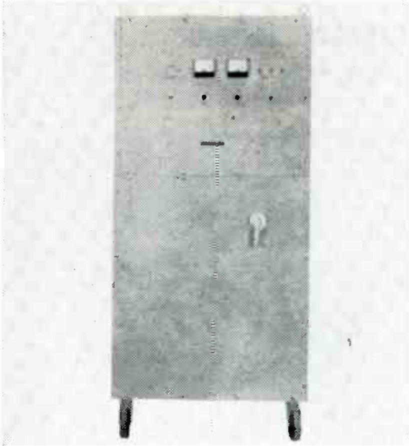
Model 261 can be operated in change-to-freq. or voltage-to-freq. mode via a front-panel switch. Freq. plug-ins are available for all IRIG, constant bandwidth, and FM tape recorder freqs. In the charge mode, the converter answers the need of data systems using piezo-electric and other transducers with high output impedances. In the voltage mode, it works directly from low output transducers such as strain gage bridges, thermocouples, and biomedical sensors. It can be used for FM multiplex systems and straight FM recording. Vidar Corp., 77 Ortega Ave., Mountain View, Calif.

Circle 211 on Inquiry Card

Circle 89 on Inquiry Card

POWER SUPPLY

Output voltage is 20 to 100v. @ 300a. with ±0.05% line or load regulation.

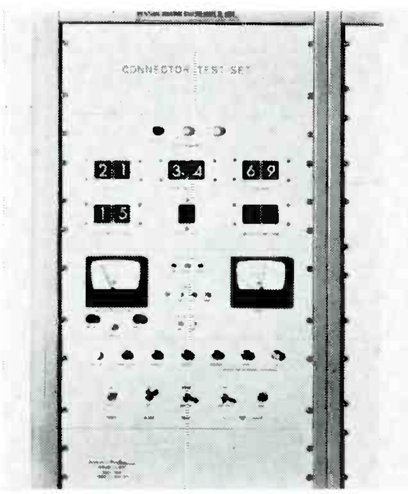


The transistorized Model M3234-1 features voltage programming, series/parallel operation; 0 to 360a. current limiting; dynamic load regulation ±2v. for a 200a. load change; —4v., +2v. for 300a. load change; dynamic line regulation ±0.1% for a 5% line step change. Ripple is 100mv RMS max. Input voltage 208/230/460v. 3 ϕ, 60 CPS. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Circle 212 on Inquiry Card

CONNECTOR TESTER

Automatically checks insulation resistance, dielectric strength and continuity.



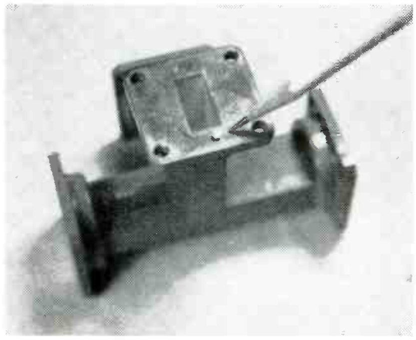
The Model 8594 100-point tester is programmed by a punched card input. The test sequences between the first pin and last as set up by the card, and performs the appropriate test on each until completion or failure. If failure occurs, test stops and failure is indicated on panel. Since card programming permits presetting the first and last pin, connectors having pins with different voltage or insulation resistance ratings can be conveniently handled by a separate programming card for each group of pins. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill.

Circle 213 on Inquiry Card

NEW PRODUCTS

VARACTOR DIODES

Features 300Gc cutoff freq. at —2v. Freq. range of 1 to 20Gc.

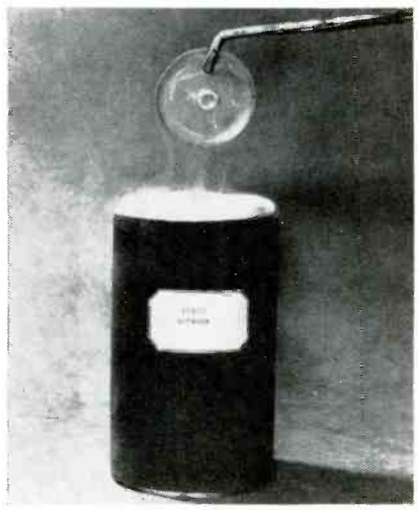


The TIXV01 epitaxial varactors are designed for use in parametric amplifiers with a capacitance range from 0.35 to 1.0pf. They offer high "Q" values and low inductance. The diffused Ga As units come in a variety of packages, including industry-standard configurations and special designs. Texas Instruments Incorporated, Semiconductor-Components Div., P. O. Box 5012, Dallas, Tex.

Circle 214 on Inquiry Card

RESIN SYSTEM

Polyurethane resin system cures void free at room temp.



"Scotchcast" brand polyurethane resin No. XR-5095 is an unfilled, low viscosity, 2-part liquid system that can be cast, brushed, dipped, or sprayed. It cures void free in from 16 to 24 hrs. Heated cure of the material can be done in 1 hr. The material is recommended for electrical and electronic potting and encapsulating uses, particularly modules and connectors, and where strain and heat sensitive circuitry and components are involved. It also may be used for casting coils and transformers. 3M Co. 2501 Hudson Rd., St. Paul, Minn.

Circle 215 on Inquiry Card

PULSE GENERATOR

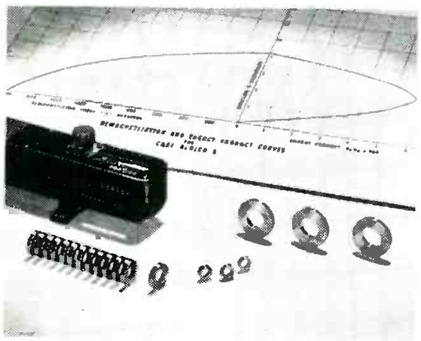
Linear rise and fall times independently variable from 12nsec.

Model 108L has pulse outputs of 50v. into 50Ω. It is ideal for use in conjunction with magnetic memory core and thin-film testing. Repetition rates to 10MC, pulse widths from 30nsec., and variable delays to 5msec. from external or internal triggers are additional features. Passive attenuation control provides excellent waveform at any amplitude from 200mv to 50v. Waveform aberrations are typically less than ±1%. Linearity is within 2% at transition times of 20nsec. and greater, and within 5% at 12nsec. Datapulse, div. of Datapulse Inc., 509 Hindry Ave., Inglewood, Calif.

Circle 216 on Inquiry Card

MAGNETIC ALLOY

Min. coercive force of 1650 oersteds, and a min. energy product of 5 x 10^6.



Improved Alnico 8 is said to have the highest combination of coercive force and energy product of any non-columnar Alnico commercially made. One of the principal uses for the material is for permanent magnet periodic focusing of TWTs. It may also be used as a cylindrical-type straight field focusing magnets for BWOs, and in other shapes for waveguide uses such as isolators. This improved Alnico 8 is non-columnar and is said to have physical properties superior to the chill-cast types. It also has improved physical properties over the older type of non-columnar Alnico 8. The Arnold Engineering Co., Dept. A-8, Marengo, Ill.

Circle 217 on Inquiry Card

NEW PRODUCTS

POTENTIOMETER

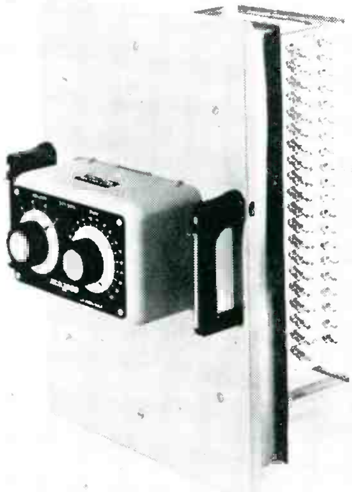
Std. resistance range is 25 - 100KΩ (±3%). Resolution is 0.15 to 0.031%.

The new Model 3560 is a 7/8-in. dia., 3-turn servo-mount potentiometer. It combines high performance with outstanding resistance to humidity. A Silverweld® termination — a virtually indestructible fused bond between the terminal and resistance wire—eliminates the chief cause of precision potentiometer failure. The unit is rated at 1.5w. @ 70°C. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 218 on Inquiry Card

TEST TRAY

For reliably holding and making electrical contact to electronic components.



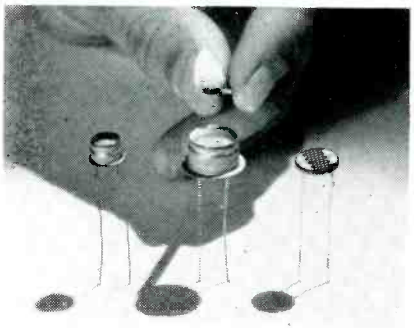
The major feature of the Model 2603 Test Tray is its good electrical and mechanical characteristics over a —200°F to +400°F temp. range. It holds 80 axial-lead electronic components for simultaneous electrical and temp. tests. It fits chambers having a test area opening 7-in. high x 16-in. wide. Max. test voltage is 1500v. RMS; max. current, 10a. dc. Delta Design, Inc., P. O. Box 728, Del Mar, Calif.

Circle 219 on Inquiry Card

NEW PRODUCTS

PHOTOCONDUCTIVE CELLS

The 5 megohm dark resistance decrease to 10KΩ at 2 ft. candles.

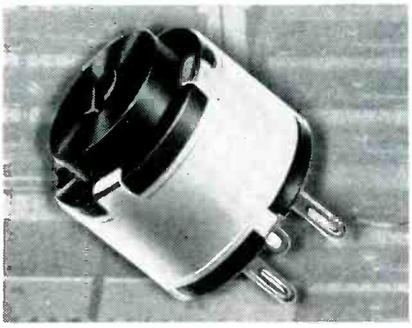


Response time for this new line is approx. 1000-to-1 change in resistance in 10msec. when 25 ft. candles are applied to cells previously held in the dark. The units act as either light-controlled rheostats or relays without contact surfaces. The ½-in. type Y-1206 are rated @ 250v. with 250mw dissipation. The ⅜-in. units, type Y-1332, are rated at either 30 or 60v., depending on the max. pattern width. General Electric Co., Tube Dept., Owensboro, Ky.

Circle 222 on Inquiry Card

TRIMMING POTENTIOMETER

Working voltage is 350vac between end terminals. Breakdown voltage is 750vac.

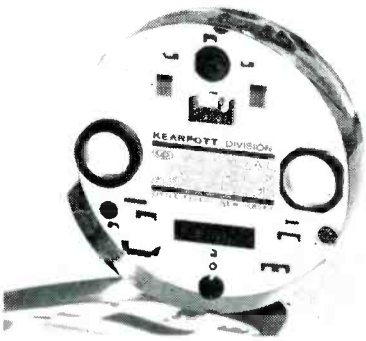


Series 63M-1 and 63M-2 are specifically designed for use on PC boards. When seated, the unit has an overall height of 15/32-in., permitting extremely close board-to-board spacing. Electrical specs. include a 0.25w. dissipation rating at 70°C; metal-to-metal and carbon-to-carbon contacts provide higher reliability, extended life, and low noise. Units are available in a resistance range from 100Ω to 1 megohm. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 220 on Inquiry Card

FERRITE MATERIAL

High permeability recording head designed for computer applications.

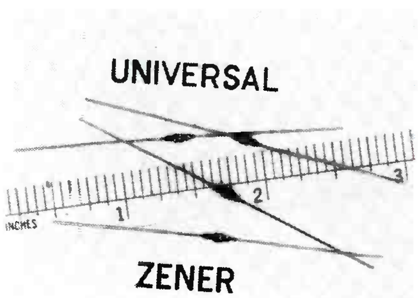


MN-60 is a specially formulated ferrite material particularly applicable as transducer heads for magnetic recording, reproducing, and erasing. It may be used for any magnetic device requiring high flux levels. Outstanding features include high initial and high max. permeability, high resistivities, low core losses, and low temp. coefficient. This ferrite has substituted for laminated metallic alloys to reduce losses, and is ideal for low freq. uses. Kearfott Div., General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J.

Circle 223 on Inquiry Card

ZENER DIODE

One item fills needs for 6 different power ratings from 400mw to 3w.



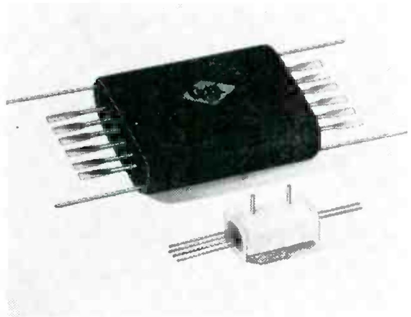
Zener voltages in this unit are available from 6.8v. to 400v. in a package size smaller than presently available 250mw units. The whiskerless construction of the UZ zener is obtained by metallurgically bonding pins and silicon dice of identical dia. A hard glass sleeve is fused onto the junction to form a monolithic void-free hermetic seal. The 0.160-in. long x 0.085-in. dia. unit offers 3w. operating power, 50w. surge, good stability, and high shock and vibration immunity. Unitrode Corp., 580 Pleasant St., Watertown, Mass.

Circle 221 on Inquiry Card

NEW PRODUCTS

RELAYS

Flat-Pac relay coils contain up to 6 magnetic reed switches.

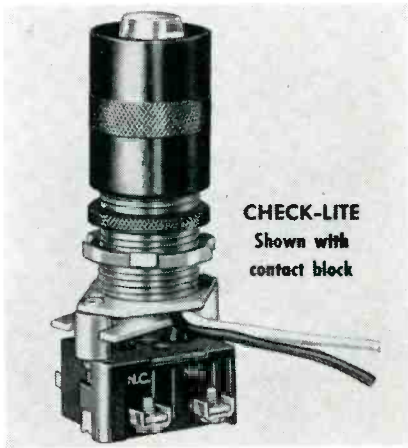


Designed to be more compatible with advanced packaging than round shapes, the new Flat-Pac coils are available with 3, 4, 5 or 6 Form A or Form C reeds (or various combinations with Form B). They are ideal for encapsulation or direct tie-down to a PC board or chassis. Length of coil is 2-in.; thickness, ¾ in.; and width varies from 1⅛-in. (with 3 reeds) to 1¾-in. (with 6). Available from stock 12, 24, 32, 48 or 110vdc. Coto-Coil Co., 61 Pavilion Ave., Providence, R. I.

Circle 224 on Inquiry Card

LIGHT AND PUSHBUTTON

Doubles the number of controls and indicator lights in available space.



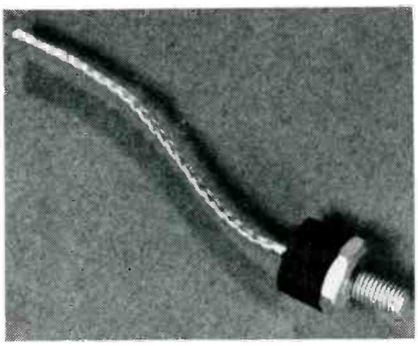
"Check-Lite" can be wired in a number of configurations for indication, warning and push-to-test purposes. The pilot light is a 5000 hr. unit which is available for optional 6, 12, 24, 28, 48, 60, and 120v. service. In many cases this design is said to eliminate a transformer for the pilot light. The lens cap is removable from the front for convenient re-lamping. Adalet Mfg. Co., 14300 Lorain Ave., Cleveland, Ohio.

Circle 225 on Inquiry Card

NEW PRODUCTS

LOW-VOLTAGE STABISTORS

Semiconductor devices with sharp forward breakdown characteristics.



Stabistors offer interesting possibilities for voltage-limiting uses. Typical units consist of one or more series-connected p-n junctions operated in the forward or conducting direction. Voltage ratings, by combining basic values of 0.4 and 0.7v./junction, can be produced. The device can be supplied in current ratings to 25a. Temp. range is −35°C to +65°C. These devices have a negative temp. coefficient and operate at optimum efficiency as a shunting device. Reverse leakage current is in the order of μa. P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

Circle 226 on Inquiry Card

POWER SUPPLY MODULES

Offers a selectable input of 105, 115, and 125v. RMS *all ±10v.*

The fail-safe HY-MO series power supply modules have overvoltage protection as a standard feature. Input freq. is 50-440 CPS single phase. This fail-safe power supply module features current-limit overload protection; is short-circuit proof; has overvoltage protection; low dynamic impedance; remote voltage adjustment; is a repairable module; and has mounting inserts on a 2 x 8-in. surface. Hyperion Industries, Inc., 134 Coolidge Ave., Watertown, Mass.

Circle 227 on Inquiry Card

VARIABLE ATTENUATOR

For 8.2 to 12.4 GC *provides 500w. average power absorption.* VSWR *below 1.15:1.*

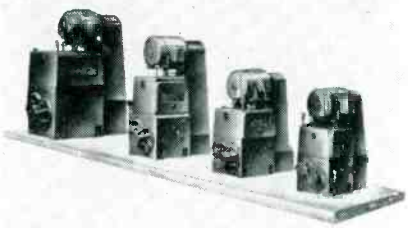
Model DB431 has an initial insertion loss of 0.5db for 50db range. Optional attachments are capable of extending the range to several kw. Fixed, variable, or precision models are available. Other features include calibration accuracy to 0.3db, anti-backlash mechanism, high resolution, and negligible sensitivity to variations of temp. and humidity. Weight is approx. 4 lbs. DeMornay-Bonardi Div., Datapulse Inc., 780 S. Arroyo Pkwy., Pasadena, Calif.

Circle 228 on Inquiry Card

NEW PRODUCTS

VACUUM PUMPS

Balancing technique affords almost vibration-free pumping from 21 to 500 CFM.

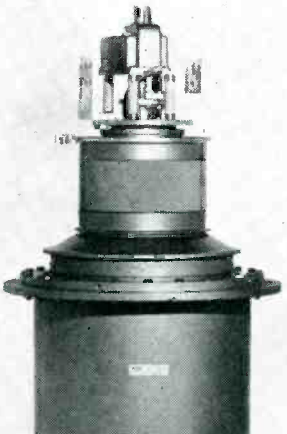


The Triplex series includes 21, 150, 301 and 500 CFM models. Modern compact design and rugged dependability of these pumps reduce the need for floor space and also reduces down time. The pumps guarantee ultimate pressures of less than 10 microns. Kinney Vacuum, div. of New York Air Brake Co., 3529 Washington St., Boston 30, Mass.

Circle 229 on Inquiry Card

SUPER POWER TRIODE

New beaming technique produces grid-to-plate current division of 60 to 1.



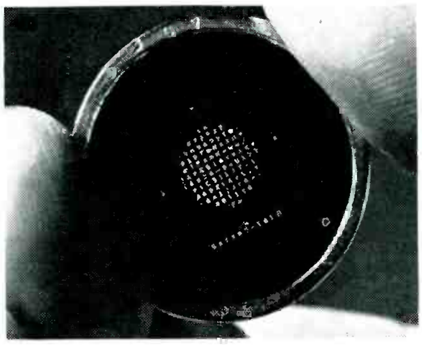
The 60 megawatt ML-8549 requires considerably less grid drive than conventional triodes. It stands 4 ft. high. Pulsed plate efficiencies of more than 90% are achieved by the tube which requires driving power of 70kw. It produces 60 megawatt pulses with 10,000μsec. pulse widths and duty factor of 0.06. Electron interception by the grid is eliminated. This is accomplished by using 2 concentric anode cylinders, permitting double-sided cathode operation with a radial magnetic field channeling the electrons between the grid wires. The Machlett Laboratories Inc., Springdale, Conn.

Circle 230 on Inquiry Card

NEW PRODUCTS

COMPUTER DISPLAYS

Contains 96 different characters and symbols instead of the usual 64.



This display uses a Charactron® tube to translate computer codes into understandable data on its face. A newly developed matrix, the key to the Charatron, presents both upper and lower case letters, plus a variety of symbols and Greek letters. The tube also has a spot writing capability, producing a 0.008-in. spot at 4μa. Character size is variable at a ratio of 5-to-1. Stromberg-Carlson, div. of General Dynamics, P. O. Box 127, San Diego 12, Calif.

Circle 231 on Inquiry Card

SUBCARRIER DISCRIMINATOR

Correlation detection gives good performance at low s/n ratios.

Model 402-175 Astrolock®-Loop Subcarrier Discriminator has performance superior to the best operational characteristics of both the phase-lock-loop and pulse-averaging type of discriminators, without the inherent disadvantages. It is never out of lock under any operating conditions. The Astrolock circuit is entirely automatic, and requires no phase indicating meter, or slewing, phasing, and bandwidth controls. Channel selectors and low-pass filters are available for all standard IRIG and constant bandwidth center freqs. and deviations up to 300KC. Astrodata Inc., P. O. Box 3003, 240 E. Palais Rd., Anaheim, Calif.

Circle 232 on Inquiry Card

NEW PRODUCTS

SHIELDING MATERIAL

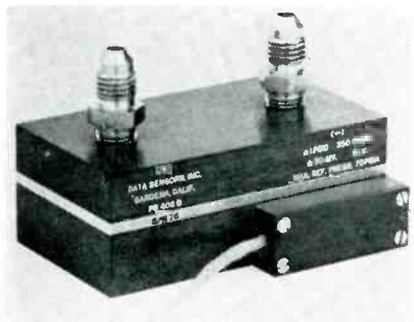
Yields an overall attenuation of 125-135db and a sealing pressure of 30 psi.

Polasheet II is an ultra-thin shielding material using a Dacron and oriented wire weave embedded in silicone rubber. During the high temp. embedding processes, the Dacron degrades leaving the oriented wires suspended in the silicone rubber. Insertion loss measurements are as high as 100db. Polasheet can be die cut to produce a resilient, flexible gasket of odd or complex shapes. This material does not require machined surfaces for proper installation. Metex Electronics, div. of Ferrodynamics Corp., Walnut Ave., Clark, N. J.

Circle 233 on Inquiry Card

PRESSURE TRANSDUCER

Have non-linearity and hysteresis of less than ±0.5% FS.



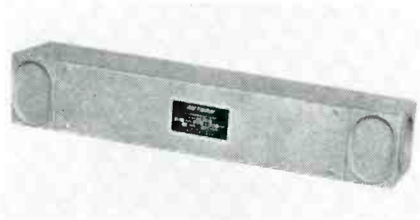
The PB405 series of bonded strain gage differential pressure transducers are available with ranges of 1, 2, or 3 PSID in uni- or bi-directional configurations. Featuring very low response to shock and vibration, they are good for use in severe environments. Compensated temp. range is —65° to +250°F. The thermal sensitivity and thermal zero shifts are both held within 1% FS/100°F. Output is 30mv. for the uni-directional, and ±30mv for the bi-directional unit at 10vdc or ac excitation. Acceleration and vibration error is less than 0.1% FS/G up to 10G along any axis. Data Sensors, Inc., 13112 Crenshaw Blvd., Gardena, Calif.

Circle 234 on Inquiry Card

NEW PRODUCTS

RFI FILTERS

Leakproof units have an attenuation greater than 100db from 14KC to 10GC.

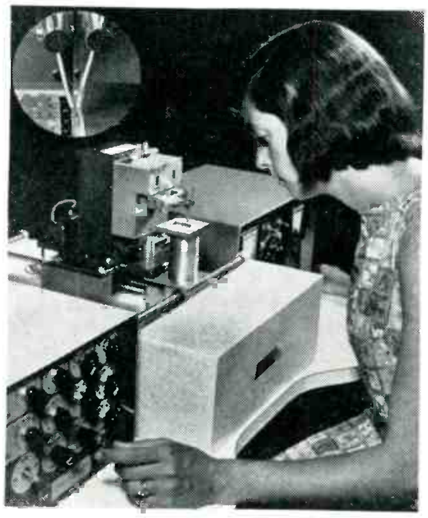


This series provides good overload safety and complies with Mil-F-15733D: 140% of rated current for 15 min. Short-term current overload capability is in excess of 10 times rating without damage. The series is available with current ratings of 25, 50, 100, 150 and 200a. at 250 vac/600vdc, 0-400 cps. Filtron Co., Inc., 131-15 Fowler Ave., Flushing, N. Y.

Circle 235 on Inquiry Card

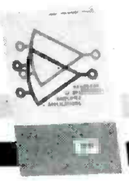
DIGITAL MICRO POSITIONER

For precise location in micro welding. Allows many operations to be automated.



The Model 1187 Digital Micro Positioner is designed for precise X-Y coordinate location of minature welding electrodes, or for movement of micromodules, integrated circuits, thin films or other work under a stationary weld head. Because discrete X-Y positions can be located with an accuracy of ±0.001 in. (of commanded position) and a repeatability of ±0.0005 in., many welding operations required in microminiature fabrication can now be automated. The Micro Positioner uses a 4 decade binary coded decimal input. It can be operated manually, numerically controlled with punched tape, or be equipped for direct computer input. Westgate Laboratory, Inc., Dept. DMP, 506 S. High St., Yellow Springs, Ohio.

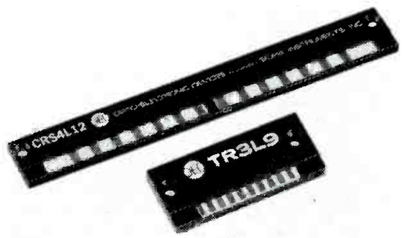
Circle 236 on Inquiry Card



NEW PRODUCTS

TAPE READ HEADS

Dynamic response times sense 1000 holes/sec. or 500 holes/sec.



Six photoconductive read heads are available which convert punched card and paper-tape data to electrical impulses. The readers, which operate at highest speeds compatible with overall system design, offer high signal-to-noise ratios. They are designed for standard 12-row serial and 80-column parallel punched-card reading, as well as for 9-channel paper-tape reading. Switching ratios as high as 500 to 1 are obtainable. A voltage rating to 60v. RMS often eliminates need for amplifier circuitry. Sigma Instruments Inc., 170 Pearl St., Braintree, Mass.

Circle 240 on Inquiry Card

XENON LIGHT SOURCE

Offers a brilliant continuous spectrum from near UV to far IR.

This new light source can be used in fluorimetry, microscopy, photosynthesis, photo-sensitive organics, and general analytical research. All components are contained in 2 packages—the lamp house and the power supply. The lamp house can be quickly connected to the monochromator by means of clamping screws and dowels. The lamp is a 150w, short-arc high pressure type. Bausch & Lomb Inc., Rochester 2, N. Y.

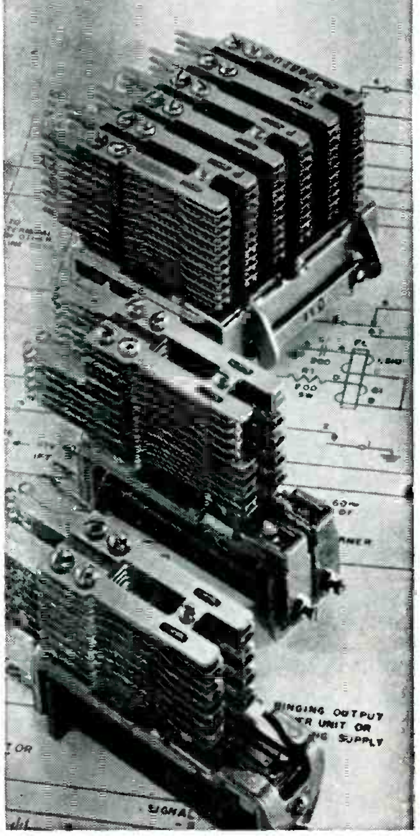
Circle 241 on Inquiry Card

MAGNETIC SHIELDING

Allows close routing of conductors to components or other conductors.

Shieldflex tubing isolates conductors from the influence of external magnetic fields; contains the magnetic field generated by current-carrying conductors; and provides electrostatic shielding. It is said to provide economies since it eliminates time-consuming hand wrapping normally associated with traditional shielding materials. Tests in a 1 oersted, 60 CPS field showed an attenuation of 39db, and flexing of the tubing shows no loss of attenuation after 18,000 stretch and bend cycles. Magnetic Metals Co., 21st & Hayes Ave., Camden 1, N. J.

Circle 242 on Inquiry Card



NEW PRODUCTS

COAXIAL T-PAD ASSEMBLY

Freq. is dc to 4GC with impedance of 50Ω. Operating range is —55°C to +125°C.

This unit has an overall length 1.100 and a center conductor of 0.125 in. dia. These rugged, ceramic shunt and series resistors have an attenuation range from 1 through 20db. Intermediate and higher values can be supplied with sections mounted in tandem for higher values. Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.

Circle 237 on Inquiry Card

CAPPED RESISTOR

The metal-film unit has a 1/20w. rating @ 125°C, derating to 0 at 175°C.

Model MF3C resistors are tested in accordance with Mil-R-10509E requirements. They are said to have been proposed as a miniature size (RN-50) for Mil-R-10509, and that they meet all requirements of this spec. It is available with resistances from 30.1Ω to 100K, and with a tolerance of 1%. Size of the units is 0.150 in. body length, with a dia. of 0.065 in. Electra Mfg. Co., Independence, Kans.

Circle 238 on Inquiry Card

OMNIDIRECTIONAL ANTENNA

Has electrical characteristics of a squirrel cage biconical horn antenna.

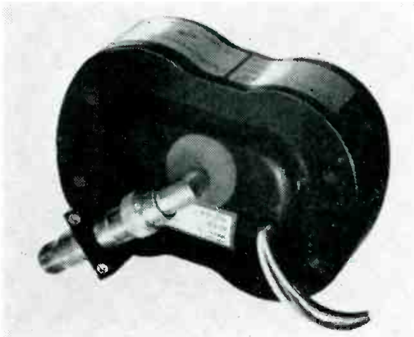
Bicone 601 achieves weight, size and cost reduction through a cylindrical design. The broadband, vertically polarized antenna is used in fixed or transportable communication systems, and is adaptable to freqs. ranging from VHF to microwave. It is particularly suited for use where there are high power, high gain requirements. It has the same radiation and impedance characteristics as a conventional squirrel cage bicone, but achieves weight, size (cross-sectional) and cost savings of greater than 2 to 1 in comparison. Electronic Communications, Inc., Box 12248, St. Petersburg, Fla.

Circle 239 on Inquiry Card

NEW PRODUCTS

VOLTAGE TUNABLE MAGNETRON

Typical noise across the 600-1200MC band is greater than 90db below carrier.



The X-1153 series features noise output of 85db below the carrier. Min. power output is 20mw with typical operation at 40 to 50mw. Applications include receiver local oscillators, sweep signal test equipment, telemetry, radar altimeters, and parametric amplifiers for freq.-agile radars. Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 243 on Inquiry Card

DIODE SWITCH

Typical max. insertion loss is 0.75db. Freq. range is 200MC to 2GC.

Model 7852G is a broad-band SPST diode switch. This unit is 3-in. in dia. x 0.880 in. deep, and has been designed for both air and ground military environmental conditions. Specs. are as follows: Typical min. isolation, 35db; 1kw peak; 5w. CW; switching time, 100nsec. max. This unit is useful for applications such as r-f switching, r-f modulation and voltage-controlled variable attenuation. Arra, Inc., 27 Bond St., Westbury, N. Y.

Circle 244 on Inquiry Card

DELAY-LINE MULTIPACKAGE

Contains 32 removable lines in an isothermal enclosure. Center freqs., 60MC.

In this unit, fused quartz is used as the delay medium in all lines. Delays range up to 500 μsec. Longer delays and other center freqs. are available. Each delay line is accessible from the outside and may be individually taken out without disturbing the remaining lines. Other specs.: impedance 50Ω; insertion loss less than 60db; overall bandwidth greater than 20MC; triple travel (echos) 50db; and random spurious, feedthrough and crosstalk is down more than 55db. Setting tolerance for delays is less than 8nsec. Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston, Mass.

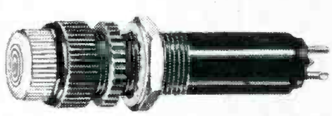
Circle 245 on Inquiry Card

NEW PRODUCTS

INDICATOR LIGHT

An ultra - miniature incandescent unit for 120v., 60 cycle service.

Datalite Cartridge



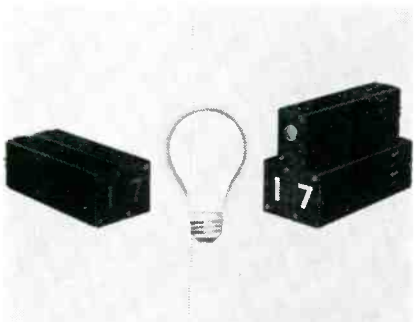
Complete Datalite Assembly

The Series 257 is a complete indicator light package consisting of: an ultra-compact, plug-in cartridge available in a range of voltages from 6v. to 120v.; a lamp holder designed for rear mounting in a 3/8-in. clearance hole; and the new Data Cap lens designed for high light transmission. The T-2 incandescent lamp has 5000 hrs. min. life rating, and a polycarbonate lens with matted back. Six lens colors are offered with transparent or translucent lens. Dialight Corp., 60 Steward Ave., Brooklyn, N. Y.

Circle 202 on Inquiry Card

BRIGHTNESS CONTROL

Automatic brightness control for panel lighting and readouts.

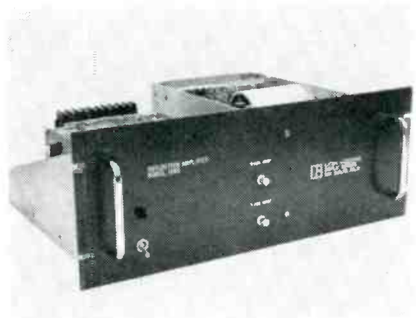


The "Level-Eye" Model LE-100 controls the brightness of lighted messages on the viewing screen of readouts and other panel lighting. By adjusting lamp supply voltage according to amb. light conditions, the control eliminates data loss that occurs when high-intensity light is directed at a dimly-lit panel or readout. A "dark threshold" control allows adjustment to the individual operator's dark adaptivity; after this adjustment is made, the operation of the Level-Eye is automatic. Cal-Glo Co., 111 Eucalyptus Dr., El Segundo, Calif.

Circle 203 on Inquiry Card

YOKE DRIVER

Linearity is 0.04%. Output current through the yoke is rated at 12a. p-p.

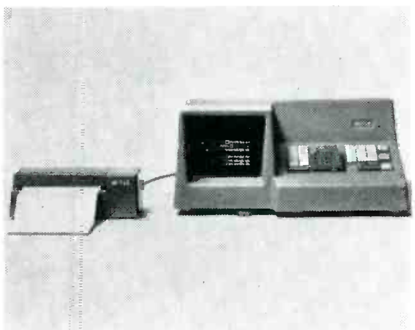


Model 1035 deflection-yoke driver is an all solid-state unit which converts a voltage waveform to a corresponding current waveform suitable for driving CRT electromagnetic deflection yokes or any other inductive load. Input signal amplitude is 6v. p-p. Retrace timer of 9μsec. can be achieved through 40° @ 25kv using a 25μh yoke. Drivers are available for flying spot scanners, recorders, display systems and many special laboratory and airborne uses. Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 204 on Inquiry Card

COMPUTATION SYSTEM

Solves many problems which now require a full-scale computer.



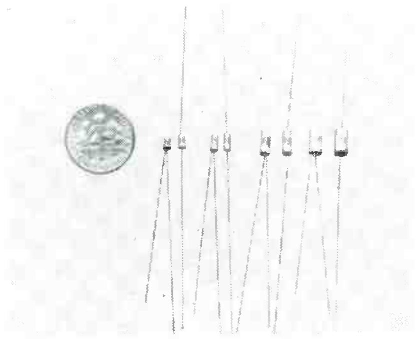
This system combines an electronic desk calculator with a specially engineered card input device that makes it possible for a frequently-used equation or formula to be entered automatically. The equations are punched on cards. Whenever they are needed, the cards are inserted into the card reader. After this, the number of variables are manually entered on the calculator keyboard. Each step of the problem is visible on a CRT display, and the answer is produced automatically. Wyle Laboratories, 133 Center St., El Segundo, Calif.

Circle 205 on Inquiry Card

NEW PRODUCTS

TANTALUM CAPACITORS

Operate over temp. range of −55° to +85°C with no voltage derating.

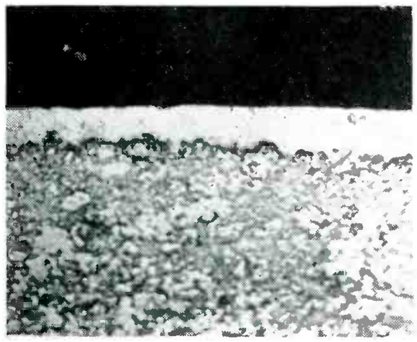


Red Top™ capacitors use plastic resin end seal instead of glass-to-metal seal. They are available in both polarized and non-polarized construction with axial-lead or single-ended terminals. The polarized types 162D and 169D have voltage ratings from 2 through 100wvdc; capacitances are 68μf to 0.033μf. Non-polarized types 163D and 170D are rated at 2 through 100wvdc and 34μf through 0.016μf. Sprague Electric Co., North Adams, Mass.

Circle 206 on Inquiry Card

CONTACT SURFACE TREATMENT

Provides a contact with a silver-rich surface to a depth of 0.001 to 0.002 in.

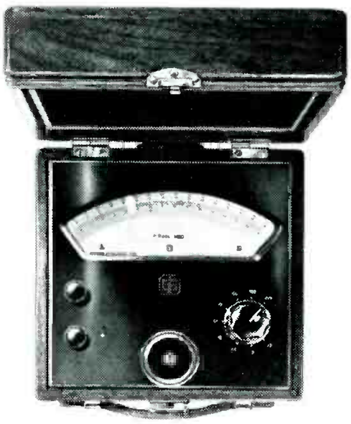


The LT finish is a new contact surface treatment for silver-refractory contacts. The finish is not an electro-plate but can be applied to silver-tungsten and other silver-refractory contacts. This finish lowers the contact resistance and temp. rise of the contacts. The process was developed for use on small molded-case circuit breaker contacts where temp. rise can become a problem. Gibson Electric Co., Box 598, Delmont, Pa.

Circle 208 on Inquiry Card

DC MICROAMMETER

Features 22 full scale ranges—the most sensitive being 0.75μa.

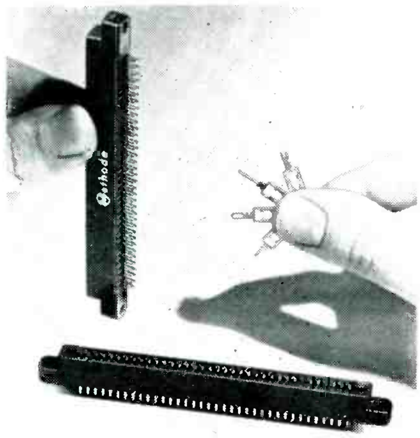


This instrument features a weightless, light-beam pointer which eliminates parallax problems and permits accurate reading at any angle. Millivolt drop and insertion loss at the most sensitive range is 9mv and 6.75 x 10^{-9}w. respectively—thereby causing minimal disturbance to circuits under test. Accuracy is ½% or ¼%; the unit is fitted with the unique dynamic overload protection circuit. Greibach Instruments Corp., 315 North Ave., New Rochelle, N. Y.

Circle 207 on Inquiry Card

CARD RECEPTACLE CONNECTOR

Versatile connector accommodates 4 styles of terminals: S, U, W and L.



This single-side card receptacle connector, SD836 Series, provides 36 contacts on 0.100 in. centers for microminiature uses such as computer circuitry and airborne instrumentation. It accommodates the 36 contacts in the same area normally accommodating only 24 contacts. Flexibility of design permits 4 styles of contacts to be used. Polarizing keys are available for pre-determined polarizing uses. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.

Circle 209 on Inquiry Card

ELECTRONIC INDUSTRIES

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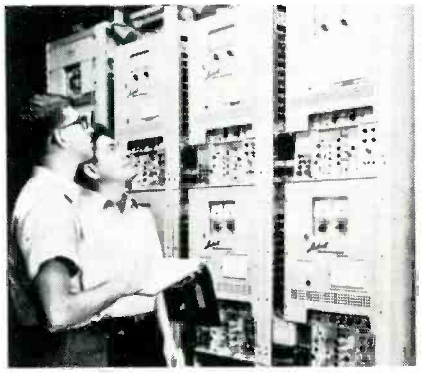
SYNCHRONOUS PASSIVE SATELLITES PROPOSED

A satellite communications system to satisfy world needs through the year 2000 was outlined by an American scientist at the 15th International Astronautical Congress held in Warsaw, Poland.

The system would depend mainly on a passive communication satellite system (comsat), according to Charles Kelly, a Goodyear Aerospace astronautics systems engineer. Less expensive than active satellites that relay only a limited number of voice channels at a time, a passive comsat can reflect an unlimited number of signals simultaneously, Kelly said. Only three satellites would be needed.

Proposed passive satellite under study, according to Kelly, resembles a thick lens from 50 to 1,100 feet in diameter, depending on its proposed altitude and power of radio equipment to be used. It would consist mostly of a wire grid mated to a plastic film. Under ultraviolet rays the film would dissipate, leaving the wire grid to act as the reflective surface for radio, TV and telephone.

MICROWAVE IN PHILIPPINES



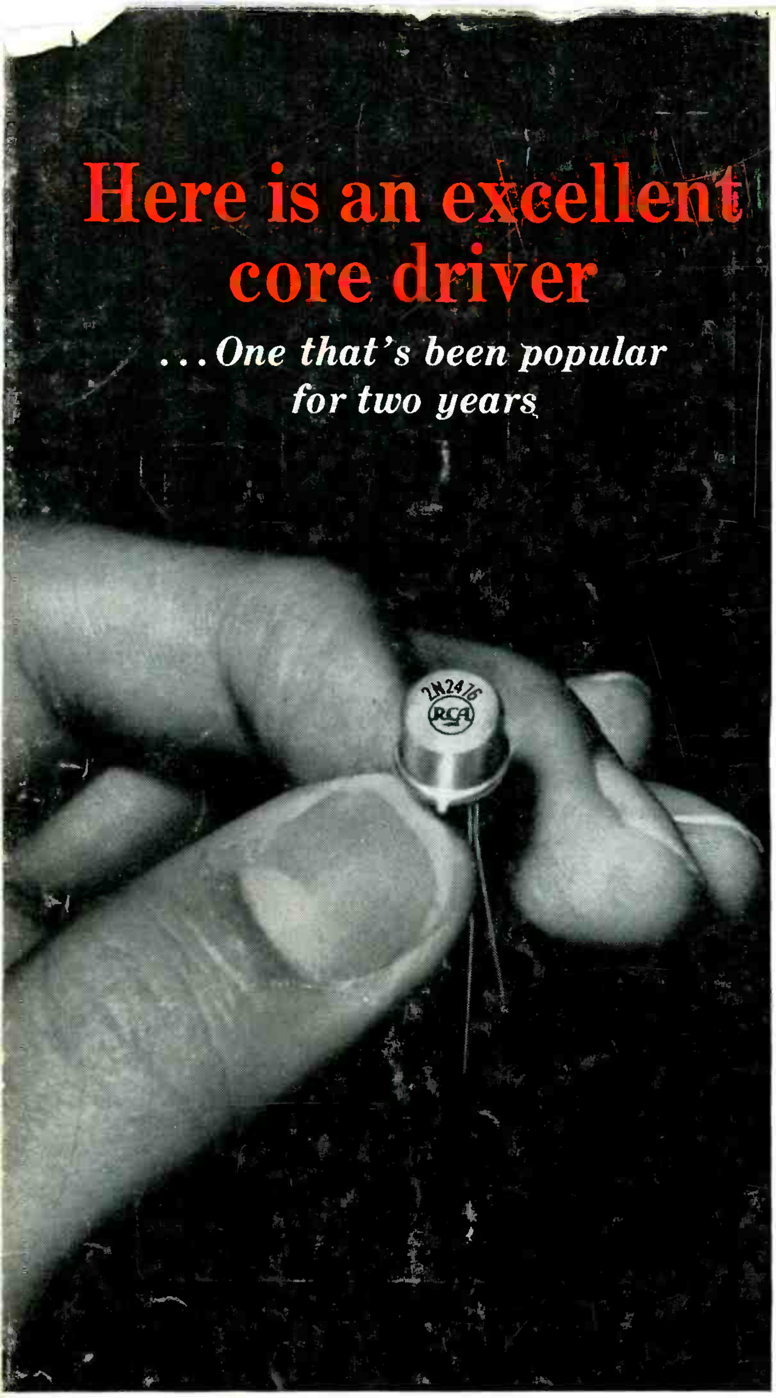
A 150-mile microwave radio system has been installed to consolidate communications for 53 U.S. and Philippine military commands and civil agencies, reports General Telephone and Electronics Corp. An AN/FRC-84 microwave terminal is inspected by a Navy technician (left) and a representative from Lenkurt Electronics Co., Inc., Division of GT&E, which installed the system on Luzon.

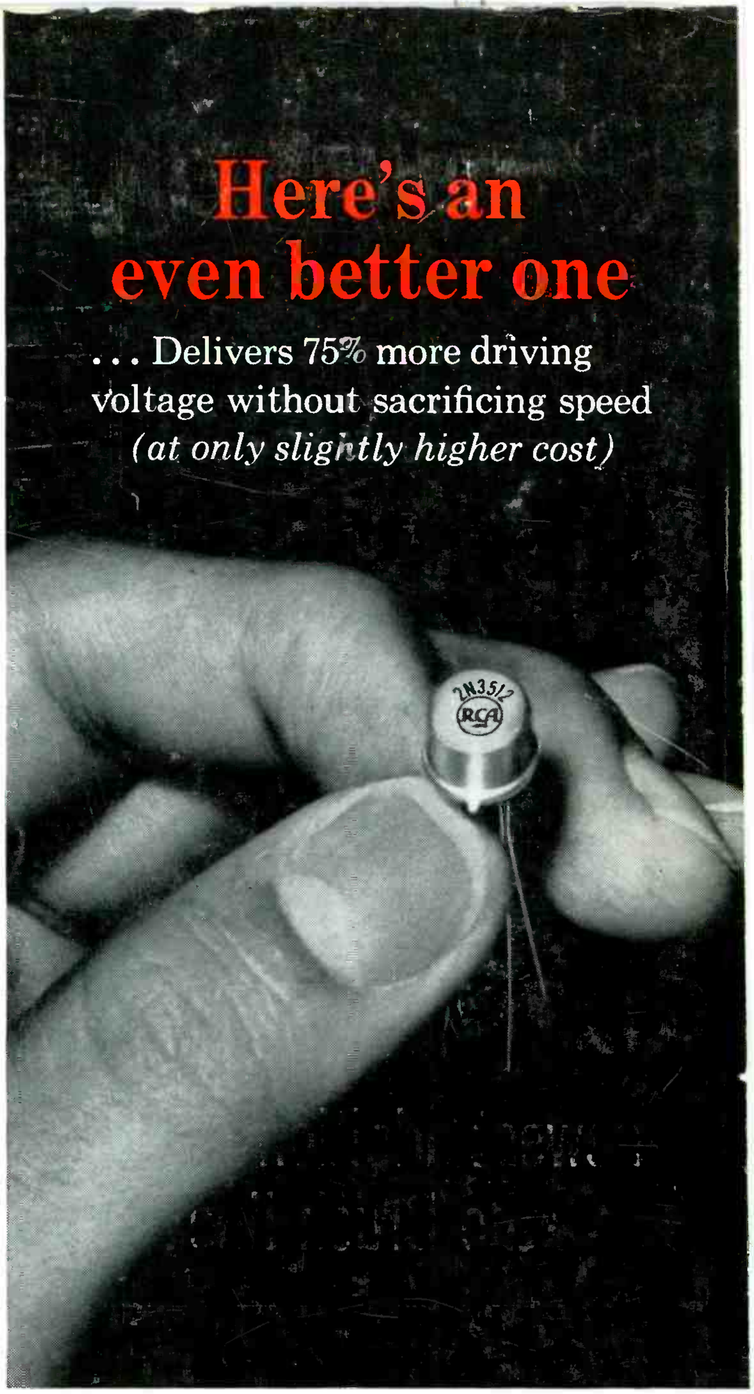
FTC SEEKS RULING TO BAR TV SCREEN SIZE DECEPTION

The Federal Trade Commission wants to eliminate what it calls deceptive and misleading practice in designating viewable area or size of TV receiver screens. They feel that manufacturers should state the actual screen size and viewing area.

A proposed rule states in effect that if the indicated or advertised size is other than the horizontal dimension of the actual viewable picture area, then the size description must state clearly the exact manner of viewable screen measure.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS





That's right! A 75% boost in collector-to-emitter voltage capability ($BV_{CEO} = 35$ volts as compared with 20 volts for the popular 2N2476, 2N2477) makes the new RCA 2N3512 ideal for high-voltage, high-speed, high-current switching applications.

Current capability is the same: 500 ma.

Because of its high voltage capability, the 2N3512 is particularly useful in large, modern computers where memories are both faster and larger...with higher inductive voltages. The high-speed, high-voltage capabilities of the 2N3512 make it applicable not only to large-scale commercial computers, but also to special-purpose digital test and communications equipment.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Other outstanding features of the 2N3512:

- **Turn-on time:** 16 nsec typical, at $I_C = 150$ ma
- **Turn-off time:** 27 nsec typical at $I_C = 150$ ma
- **Storage time:** 17 nsec typical at $I_C = 150$ ma
- **Gain-bandwidth product:** 375 Mc typical
- **V_{CE} (sat):** 1.0 volt maximum, 0.45 volts typical at $I_C = 500$ ma, $I_B = 50$ ma

For full technical information call your RCA Field Representative. Or write: Commercial Engineering, Section E-J-11, RCA Electronic Components and Devices, Harrison, N.J.

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