A McGraw-Hill Publication *75 Cents* *September 14, 1962*

electronics

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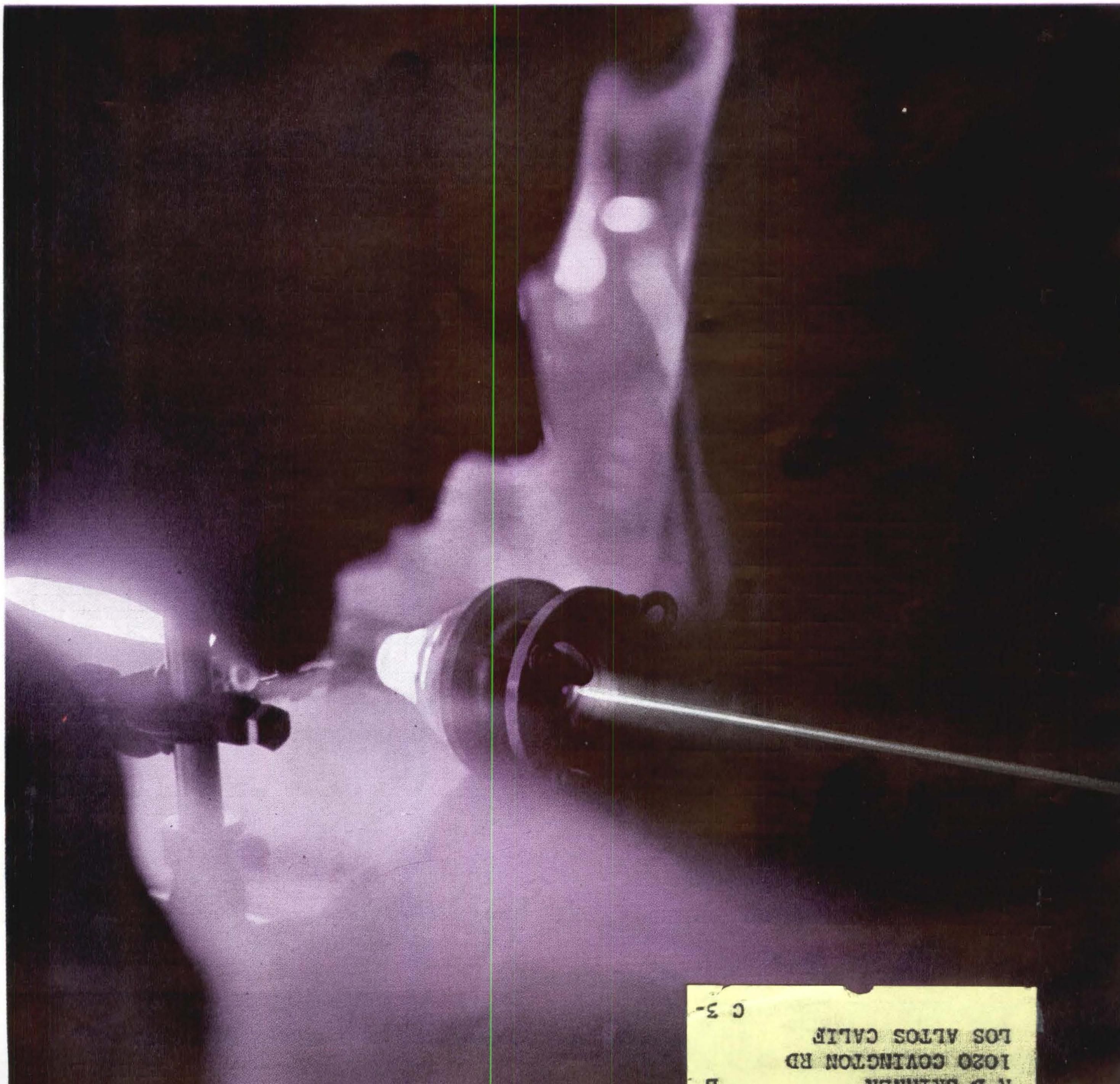

September 14, 1962

electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

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electronics

September 14, 1962 Volume 35 No. 37

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CONTENTS continued

DEPARTMENTS

Department of Science? Let's Go Slowly

EVER SINCE the first Russian sputnik went into orbit on Oct. 4, 1957 the suggestion has been repeatedly advanced that scientists and engineers should have a greater voice in governmental planning and decision making.

One of the first responses to the suggestion was the vesting of more responsibility in the Office of the Science Adviser to President Eisenhower. The trend has continued under the Kennedy administration, and now there is talk of forming a Congressional Commission on Science and Technology, or a cabinet-rank Department of Science and Technology.

ALL THIS ATTENTION is indeed flattering to the scientist and engineer, and it undoubtedly has value in that it focuses public interest on science and engineering as a prime bulwark of our defense. But before we embark upon the planning of a Science Department it would be wise to give more thought to precisely what its function might be.

The present Office of the Science Adviser descends from the Office of Scientific Research and Development (OSRD), the top-drawer government agency that guided much of our research effort during World War II. Appointing such a research body has been part of our wartime syndrome for over a century. Mr. Lincoln's OSRD is still in business—it is the National Academy of Sciences. Mr. Wilson's OSRD is also still around—it is the National Research Council.

THERE ARE TWO VIEWS of what a permanent Department of Science and Technology might do.

It could encompass all the research functions of the federal government: the National Bureau of Standards, Naval Research Laboratory, National Institute of Health, Department of Agriculture Experiment Stations and many, many more. Just how compatible are radio propagation, radar, cancer research and development of prize turkeys? What would be the effect upon the Department of Defense, using its research arms for highly specialized studies aimed at particular missions?

A second view is that the new department could do research on research. This makes more sense but we wonder if it really requires a new cabinet-rank organization to carry it out. Why couldn't the existing National Science Foundation, or the National Academy of Sciences, be strengthened sufficiently to do the job?

THERE MAY BE AN EASIER WAY to better utilize the abilities of scientists and engineers. The President might more often consider appointing engineers and scientists who have proved their ability in management to agencies such as the Atomic Energy Commission and the Federal Communications Commission.

MICROELECTRONICS—For several years now we have been hearing about various approaches to microelectronics. Several experimental equipment types have been built using them. This year applications of microelectronics are coming thick and fast. And the equipment using them is not all just experimental.

We used to talk about three basic approaches. In the first, circuits are built up on tiny modular wafers; this is generally called the micromodular approach. The second makes use of almost molecularly thin films, usually deposited on a glass substrate; this is the thin-film approach and one of its ramifications includes work in cryogenic or very-low-temperature circuits. The third approach uses circuits diffused into solid blocks of silicon. This approach has been called molecular electronics, monolythic circuits, Functional Electronic Blocks, Semiconductor Solid Circuits, Micrologic and probably many more.

All these approaches aim eventually at producing equipment that is smaller, lighter, hopefully more economical and, above all, more reliable. Each approach has its unique advantages and, in fact, we may even see two or more approaches combined in a single piece of equipment.

The article on p 37 by R. DiStefano of RCA is entitled, How To Design Micromodules. But it also tells how to design equipment using micromodules.

Next week we will publish an article on applying functional blocks in system design by the late H. W. Henkels of Westinghouse Electric. These articles will bring you up to date in the technique of applying two of the approaches to microelectronics.

Coming In Our September 21 Issue

POWER HANDLING—One way to handle high power with transistors is to operate in the switching mode so that dissipation is kept within limits for the device. An application of this switching mode in the design of a 500-watt transistor regulator is discussed next week by P. Balthasar, of Bendix Corporation.

COMMENT

Industry-Education Council

I was extremely interested in your August 10 (p 24) article on the Industry-Education Council, entitled West Starts Recruiting Early. I want to commend your magazine for its efforts.

If you have inquiries from any of your readers for information on the Industry-Education Council, you may direct them to my attention at the Industry-Education Council office, 700 State Drive, Los Angeles 37, California.

C. F. HORNE
Chairman of the Board
Southern California
Industry-Education Council
Los Angeles, California

Creativity and Inventions

F. G. Marble's "R&D and Profit" (*Comment*, p 4, July 13) plea for "help and guidance" by editorial policy, should be echoed by everyone in the electronics industry, especially in conflicts between engineers and management, such as those involved in "who gets the patents."

Industry, via its assign-all-patents employment contracts, now takes those patents from its employees. It also wants them when *it* is the employee of the government in cost-plus R&D contracts.

But very strange indeed is the fact that the engineers and scientists who create these inventions, whether in industrial or governmental institutions, have no voice whatever in such conflicts! By common law those inventions are the property of the inventor, his employer receiving only a non-exclusive, royalty-free, manufacturing right in return for his salary and the use of the employer's facilities. It is this law which industry has bypassed with its employment contracts.

It may be countered that no one forces creative talent into these industrial or governmental laboratories, which obviously is an undeniable fact. It goes there of its own free will and accord.

But the climate for independent invention has grown so hostile that it is well-nigh impossible for it to exist. The hostility of the nontechnical courts, the outright piracy of inventions and, if not that, the lone inventor's extremely poor bargaining position, the rough squeeze of the revenue laws on invention returns and on risk capital, all these and more have left only an arid desert in which invention flowers under great difficulty.

If, twenty years ago, a patent was only an invitation to a lawsuit, which an independent inventor might be able to finance against a powerful, piratical industry, its chances now of survival are infinitely worse.

The result: Independent inventors now comprise less than half of the total, whereas a generation or two ago *most* were independents. Realizing the hardships of independent invention in this hostile climate, more than half have gone into industrial or governmental laboratories, willy-nilly signing those assign-all-patents when they did so.

The result of this? The R&D costs of invention have soared, while the quantity and, more importantly, the *quality* of patents has decreased.

When, in speaking of the American free enterprise system, Mr. Marble speaks of rewards "commensurate with the contribution," he unfortunately does not mention the *creative* talent which, now as always, is the source of every product, every industry, all technological progress, as well as our nation's defense against powerful enemies abroad. Most engineers only apply, by copy-cat techniques, what their relatively few creatively endowed brethren have created.

Instead of lessening technical instruction and increasing that devoted to business management, as Mr. Marble finally suggests, *I* would most strongly emphasize *creativity* in technical school curricula, especially in following the teaching of what has already been created or discovered by the *thinkers* who provided that knowledge. To apply old knowledge is important for today, but to create new knowledge is even more so for insuring progress tomorrow!

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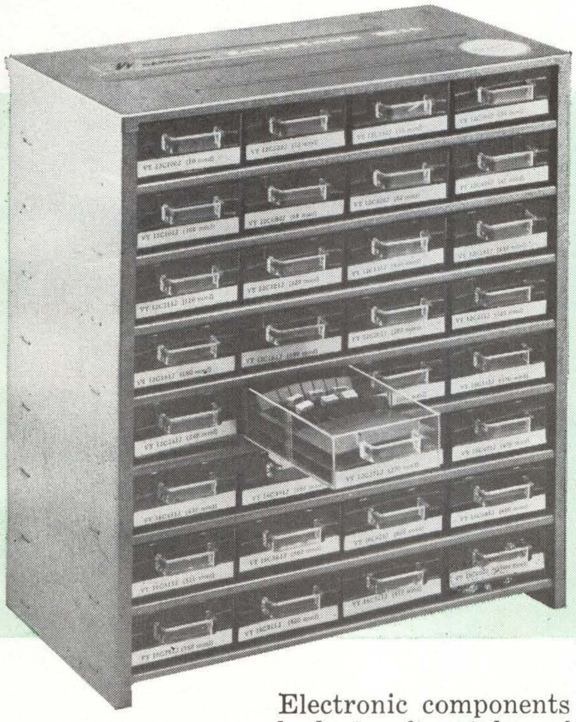

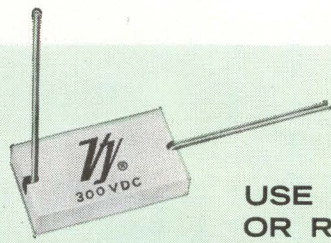

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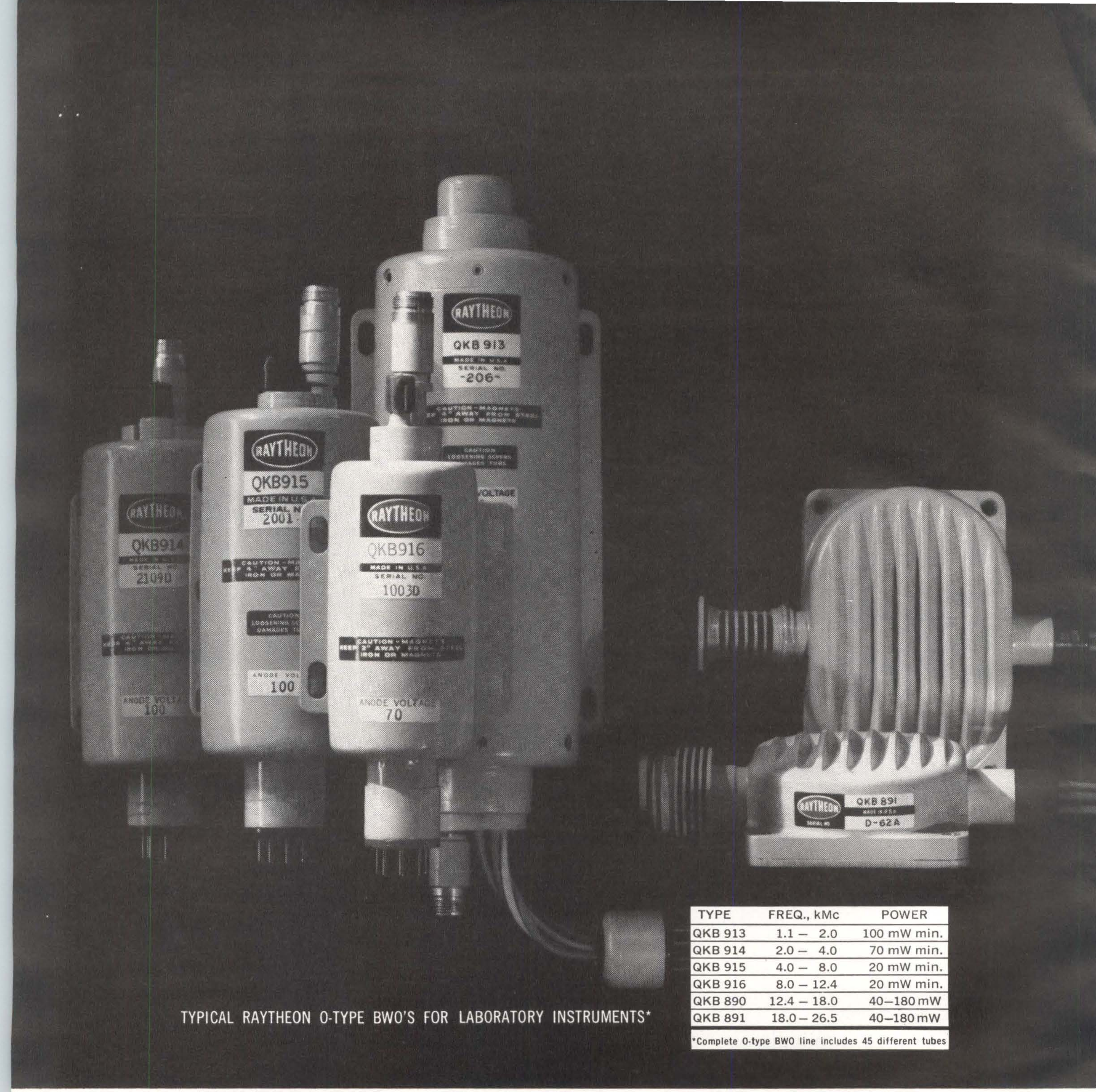

TYPICAL RAYTHEON O-TYPE BWO'S FOR LABORATORY INSTRUMENTS*

ELECTRONICS NEWSLETTER

NASA Negotiates For Lunar Logistics Studies

NEGOTIATIONS are underway for 3-month studies of a lunar logistic system between NASA and Space Technology Laboratories, Inc., Northrop Space Laboratories and Grumman Aircraft. STL would study various type of spacecraft for carrying supplies to the manned Apollo landing site on the moon. Engineering data will be supplied on how subsystems in a 9,000-lb vehicle carrying some 1,500 lb of gear might form the basis for a follow-on development of a 90,000-lb vehicle carrying 20,000 lb of cargo. Boosters could be Saturn C-1 and C-5. Northrop and Grumman would study cargos the vehicles might carry.

Profits Down in 1961 for Printed-Circuit Industry

PRINTED CIRCUIT board manufacturers' profits declined in 1961, reported the Institute of Printed Circuits (IPC). The IPC surveyed independent producers that did 40 percent of the $48 million printed circuit sales in 1961. They said average profits were 1 percent of sales in 1961, compared with 3.2 percent, after taxes, in 1960. The IPC said the reason for the decline of profits was due to the many nonprofit operations in the industry in 1961.

New Computer Memory Planned for Space Use

WOVEN SCREEN computer memory planes are the subject of a $50,000 research contract awarded to Thompson Ramo Wooldridge Inc. (TRW) by the Applied Physics Laboratory of Johns Hopkins University. Made by weaving strands of bare copper wire into a screen mesh and plating the mesh with magnetic material, the memories will be developed for possible use in the Navy's navigational satellite system.

Random access read-write cycles of less than 1 μsec are claimed. The developers say the new design will be more reliable, and will withstand temperature, shock and vibration effects associated with space vehicle launch and flight much better than present core memories. Cost is expected to be a fraction of conventional memory cost.

High-Frequency Magnetron To Be Developed for Army

NINETY-THREE-Gc coaxial magnetron and microwave duplexer will be developed by the Westinghouse Electronic Tube Division for the U. S. Army Signal Corps. The magnetron will be of the inverted type with a circular waveguide output. The duplexer will be a broadband, fixed-tuned transmit-receive switch and a dual transmit-receive switch with 3-db couplers. The two development contracts total $279,204.

TWT Develops 150 Watts at Millimeter Frequencies

HIGH - POWER millimeter - band traveling-wave tube developed by Hughes Aircraft engineers is reported to have an output of 150 watts c-w at 53.3 Gc. Efficiency of the tube is about 30 percent. Precise electron optics employed in the gun structure permit the high-power performance. Beam power density achieved is a megawatt per square centimeter at a beam voltage of 11 Kv. Beam transmission is greater than 90 percent using a magnetic focusing field of 2,700 gauss. Hughes engineers hope to use the tube for communication through the ion sheath encountered by spacecraft on reentry.

Contactless Switch Study Contract Awarded by Navy

CONTACTLESS switching techniques for military aircraft electrical systems will be studied by Ling-Temco-Vought, Inc., under a $79,000, 18-month contract awarded by the Bureau of Naval Weapons. Static switching characteristics of semiconductors, magnetic, chemical and ferroelectric devices will be investigated.

Besides improving reliability of the electrical systems and reducing physical size, contactless switches are expected to reduce maintenance problems and fire hazards. Such switches are compatible with small conductor flat interconnecting cable, molded harnesses and printed circuits. Future applications are expected to be in missiles, space vehicles and support equipment.

Licensing Rates to Drop Ten Percent, Japan Says

TOKYO—Japan Electronics Industry Association (JEIA) reported that the Radio Corporation of America (RCA) has agreed to lower licensing rates by ten percent

Air Force Seeks Builder For Giant Telescope

BOSTON—Air Force is canvassing industry for firms qualified to design and build a giant servo-controlled optical telescope and associated laboratories for studies of the solar atmosphere. A vacuum system and extensive electronic instrumentation will be included with the 300-ft-long, 30-inch aperture telescope planned by the A. F. Cambridge Research Laboratory (AFCRL), Bedford, Mass.

AFCRL's Sacramento Peak Observatory, Sunspot, New Mexico, is the center of USAF solar research, but it has not yet been decided if the new optical system will be built at that site. Formal requests for proposals will be sent to qualified companies by Electronic Systems Div., Bedford, which handles procurement for AFCRL on most new production agreements. Old licensing agreements between RCA and Japanese manufacturers are due to expire at the end of this year.

JEIA reported licensing rates for the production of a-m transistor radios will be lowered from 0.5 percent to 0.45 percent. Rates for f-m tube and transistor radios will be lowered from 10.0 percent to 0.9 percent. Black and white television receiver rates are to go from 1.75 percent to 1.575 percent. The association expects that Japanese industry will save more than $1 million next year after reduction of the licensing fees. JEIA also reported that transistor tape recorders, stereo phonographs, tube stereo and transistor audio amplifiers will be produced in Japan under RCA licensing agreements for the first time next year.

EIA Recommends Standards For Uhf-Vhf Television

RECOMMENDATIONS for all-channel (uhf and vhf) television set standards were submitted to the Federal Communications Commission by the Electronic Industries Association (EIA). Standards recommended were, "The receiver shall be capable of receiving any uhf channel with a noise figure not to exceed 18 db, and the average of the limits of sensitivity of the uhf channels shall not be more than 8 db below the average of the sensitivity of the vhf channels."

The EIA recommendations were based on the present state-of-the-art capabilities of the industry. They were developed at a conference sponsored by the EIA Engineering Department.

U. S. and Japanese Firms Sign Business Agreement

JAPANESE FIRMS, Mitsubishi Electric Manufacturing Co. and Fuji Communication Apparatus Manufacturing Co., have signed an agreement with Litton Industries for production, sales and service of an air defense control system of Japan. The Japanese Air Defense Environment (JADE) system, a series of command and control modules, was developed by Litton. Proposals have been made to the Japanese government on the JADE system, and a contract decision is expected early next year, reported Litton.

Polaris Submarine Simulator Now in Use

SIMULATOR of Polaris submarine missile control room, built by Curtis-Wright Corp., is now in use at the Navy Submarine School, New London, Conn. Duplicating oceanic operating conditions as well as intermediate range ballistic missile launch tasks, the trainer provides realistic crew experience.

Magnetic drums store 2.5 million bits of submarine and missile data in the form of 80,000 instructions and 2,500 evaluation messages. Instructions are given at a rate of 18 million a minute. Prepunched cards inserted at the control console introduce a variety of malfunctions.

Integration Contract For Titan III Is Announced

TITAN III systems integration contractor will be Martin-Marietta Corp., the Department of Defense announced. The system is described as a standardized work horse launch vehicle. Appropriations for Titan III for fiscal 1963 totaled $204 million. Martin had been awarded a previous contract in late 1961 to permit completion of the program definition phase.

Air Force Develops High Speed Camera

HIGH-SPEED CAMERA system, using an image-converter tube, has been developed through Air Force research, the Department of Commerce announced. The system, which works on an overall light gain, can record 16 pictures, each exposed from 3×10^{-7} sec to 3×10^{-6} sec. The converter tube is capable of amplifying light over 25 times. A mesh grid, with a voltage pulse of +65 v applied to it, controls the flight paths of photoelectrons in their flight to a fluorescent screen. Pulses are synchronized.

In Brief . . .

SONARS for surface ships will be built for the Navy by Edo Corp. under a $5.7 million BuShips contract.

MILITARY test equipment will be built for Sperry Gyroscope and Aircraft Armaments by Systron Div. of Systron-Donner Corp. under contracts totaling $308,000.

SPERRY Gyroscope has received a $4.9 million addition to its Nike Zeus contract. Sperry Phoenix has received orders for B-52 bomber electronic controls totaling $4 million.

GAMMA-RAY radiation measurement instruments, pocket size for use by Air Force personnel, will be built by Jordan Electronic Div. of Victoreen Instrument Co. under a $830,000 contract that also includes 165,000 radiological dosimeter chargers.

ELECTRONIC Industries Association reported that factory sales of receiving tubes and television picture tubes dropped to $30.7 million in July, lowest monthly total this year.

BUSINESS and Defense Services Administration of the Department of Commerce reported that shipments of electronic components by U. S. producers in the first quarter of 1962 were 4 percent above the previous quarter's level and 18 percent higher than the first-quarter level last year.

NAVY has selected General Precision, Inc.'s doppler navigation system, AN/APN-153 V, for use on ASW, instruder attack, and early warning planes.

DELCO Radio div. of General Motors has been contracted by Army Signal Supply Agency to improve production techniques for the germanium power transistor (2N1358A). Goal is a device capable of a failure rate of no more than 0.03 percent per 1,000 hours of operation at a 90 percent confidence level at 25 deg C.

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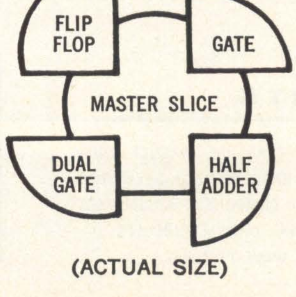

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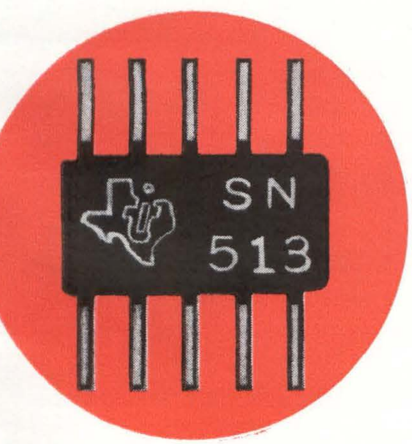

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WASHINGTON OUTLOOK

DOD AWARDS TO SMALL BUSINESS AND DEPRESSED AREAS UP

INCREASING VOLUME of military contracts to small business and to companies in so-called labor surplus areas is pouring new fuel on the simmering political controversy over the award of military orders. Critics in Congress and industry complain that the military serivces are placing too much attention on social and political factors in placing contracts while cost, efficiency and technical factors are frequently down-graded. The critics, obviously, speak for areas which do not rate procurement preference.

The facts are these:

Prime contracts to small business in fiscal 1962, amounted to $4.6 billion, or 17.7 percent of total procurement. This was nearly $1 billion over the previous year's rate.

Prime contracts to firms in labor surplus areas under a partial set-aside program during July 1961—March 1962 were nearly double the amount for the entire fiscal 1961, and triple the dollar volume in fiscal 1960.

The administration is caught between the need to bolster sagging areas of the economy and its reluctance to use defense procurement as a WPA-type project.

SENATE TO ACT ON NEW PATENT MEASURE

LEGISLATION BLOCKING possible trade conspiracy by requiring filing with the patent office of private agreements in settlement of patent interferences is taking the last Senate hurdle toward probable adoption. The reports would become confidential, except to special parties or agencies. The measure, opposed by some industry interests as forcing disclosure of commercial secrets (i.e. license and royalty details of agreements), passed the House, and this month went before a sympathetic Senate Judiciary Committee. President Kennedy, in March, called for publication of such agreements "in view of the potentially anti-competitive abuses to which use of patents and trademarks are by nature subject," and because, "such agreements may include features designed to weaken future competition at the expense of the consumer."

"Recent experience," reported the House Judiciary Committee in recommending approval of the measure, "has indicated that parties have sometimes used these interference proceedings in derogation of the public interest... for the purpose of restricting competition."

NASA REVEALS SOVIET SPACE FAILURES

FOR THE FIRST time, the U. S. has told the Soviets—and the rest of the world—just how effectively our electronic monitoring systems perform. NASA revealed that on Oct. 10 and 14, 1960, the Soviets tried and failed to send a pair of spacecraft to Mars; on Feb. 4, 1961, to Venus; on Feb. 12, 1961 the trajectory to Venus was successful but communications failed; then on Aug. 25 and Sept. 1, 1962, two more Venus shots failed.

Officials won't say how the information was obtained nor why it was released. Although the Central Intelligence Agency may have helped, fact remains that our radar net is better than we thought; reason for releasing the information may have been exasperation at constantly hearing a lopsided version of the Soviet space effort.

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New Pentode-Diode 6GA7 — A horizontal amplifier and damping rectifier, the 6GA7 utilizes a 12-pin integral all-glass base. It delivers performance equivalent to separate 6DQ6B and 6AX4B tubes along with space, socket, and other savings.

Horizontal Amplifiers 6GE5, 12GE5, 17GE5 — New 12-pin integral all-glass base types are equivalents of "-DQ6B" types with greater reliability and uniformity, plus exceptional performance on low-to-high line voltage variations.

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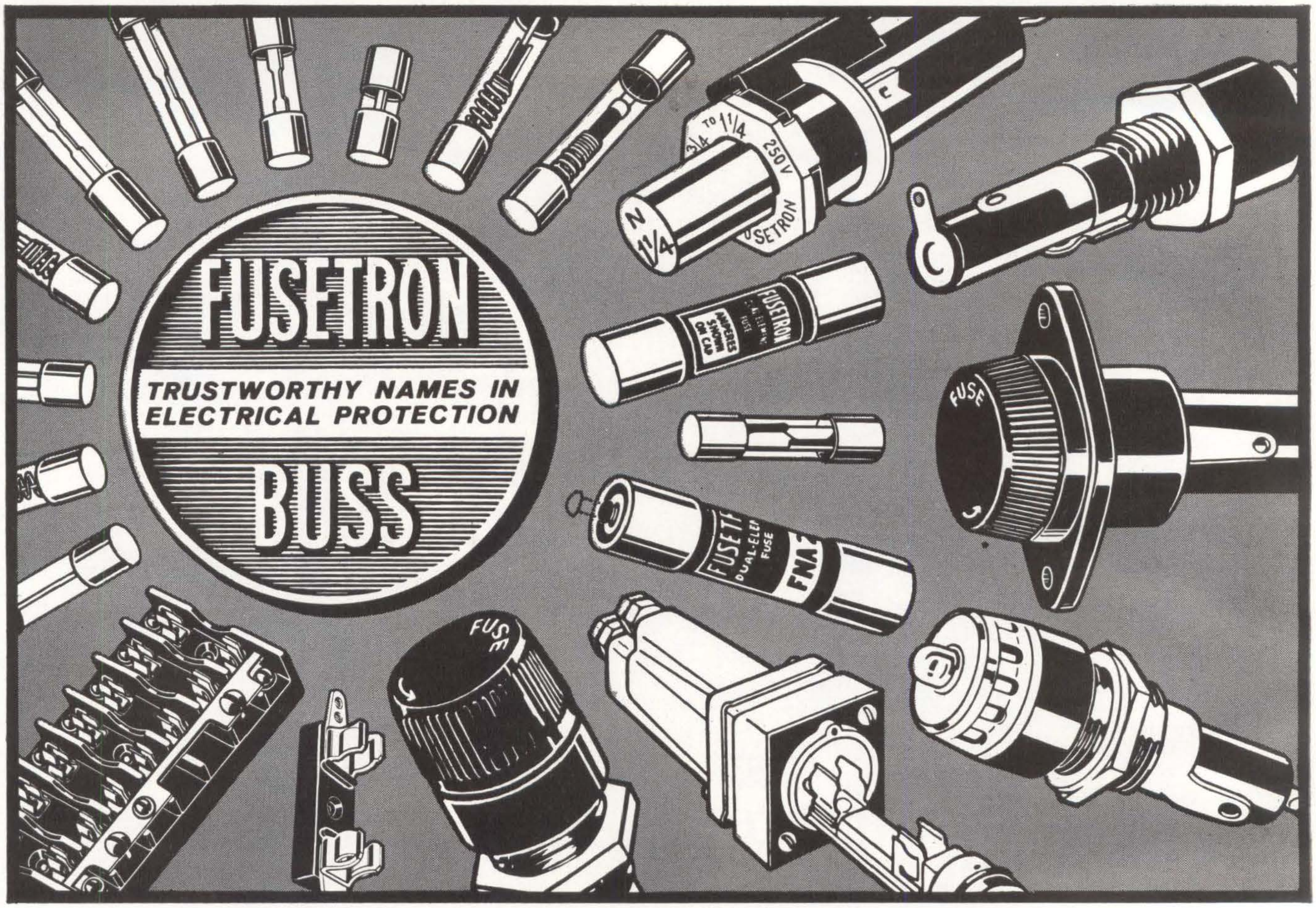

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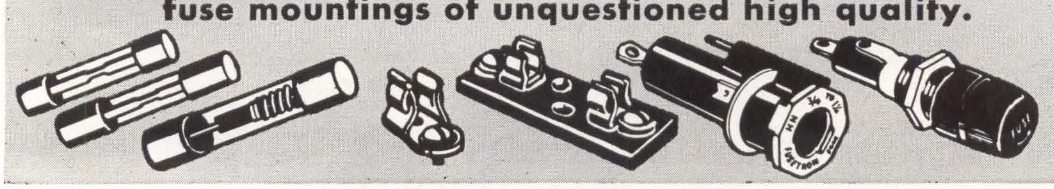

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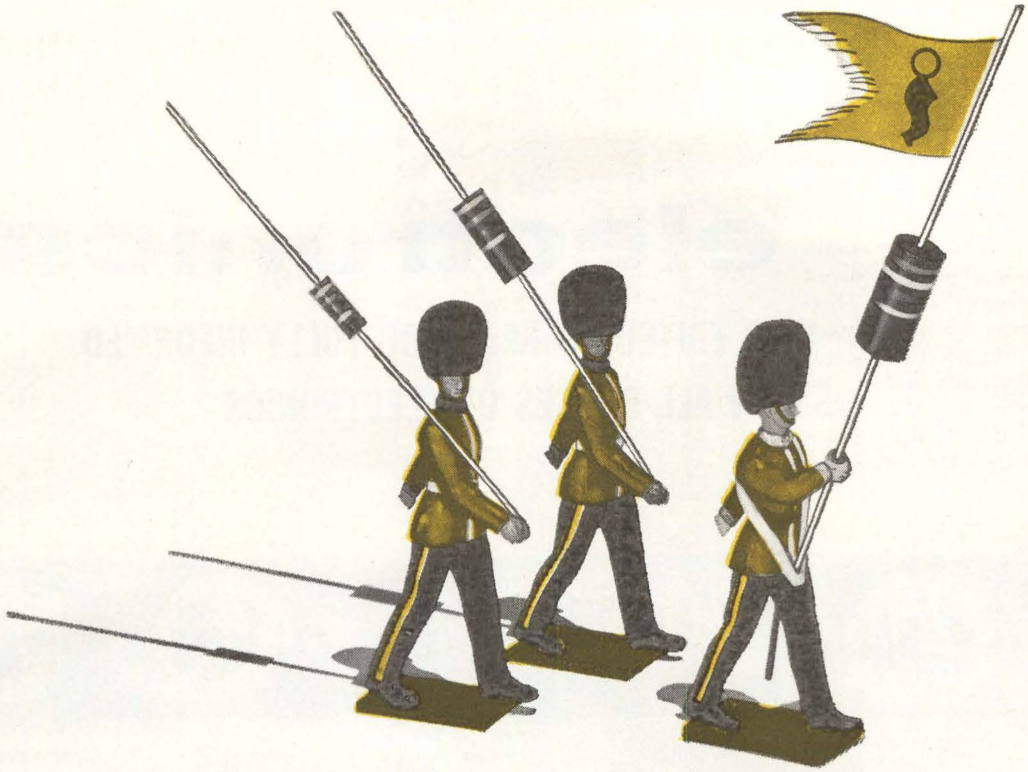

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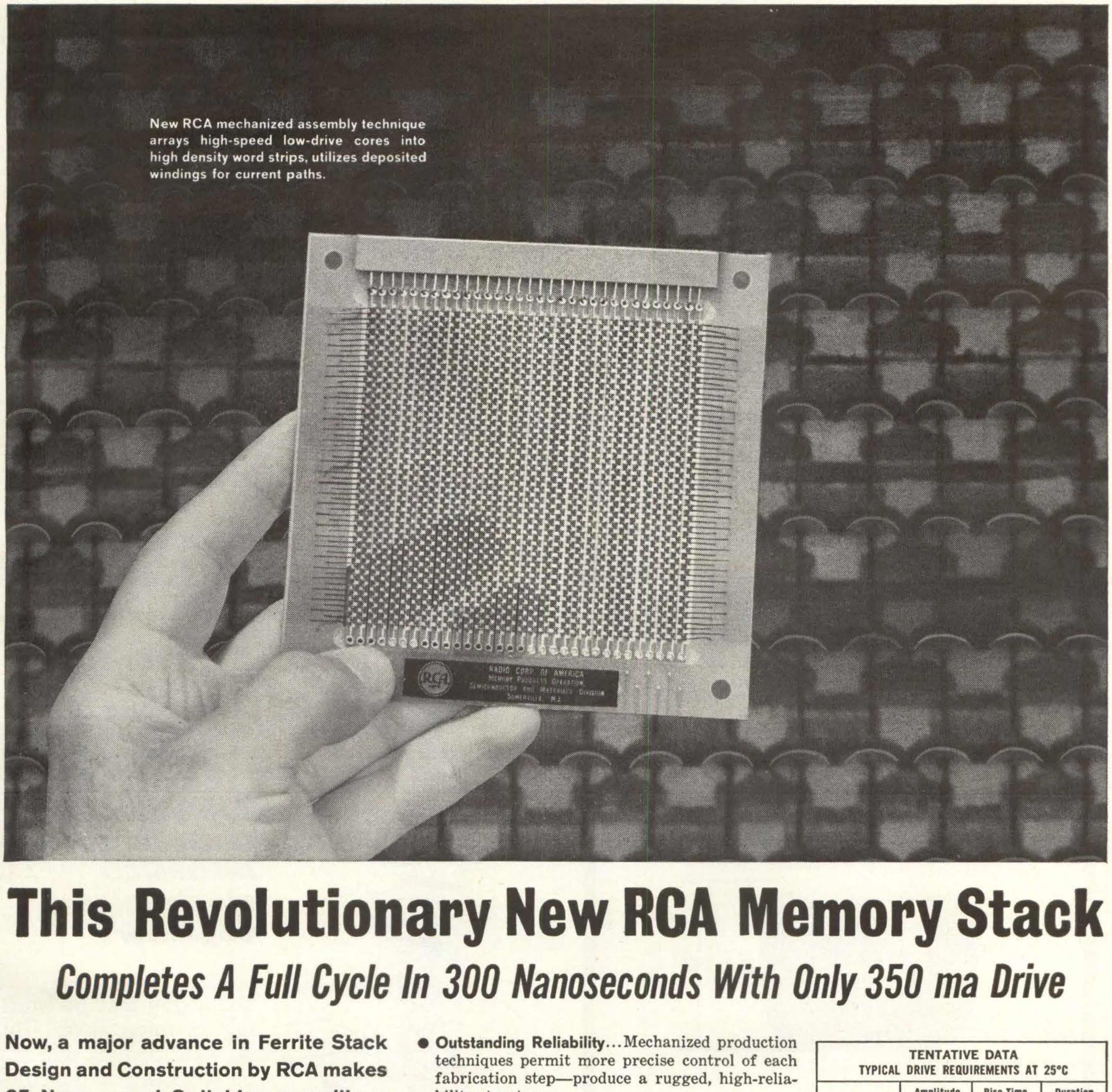

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TYPICAL DRIVE REQUIREMENTS AT 25°C

	Amplitude (ma)	Rise Time (nsec)	Duration (nsec)
Read Pulse	350	30	100
Partial Write Pulse	250	20	45
Digit Pulse	70	15	85

BIT OUTPUT (Two-Core/Bit Word-Address)

		Undisturbed '1' (mv)	Undisturbed '0' (mv)
Bit Out-Puts	Amplitude Sensing	60	12
	BiPolar Sensing	+50	−50

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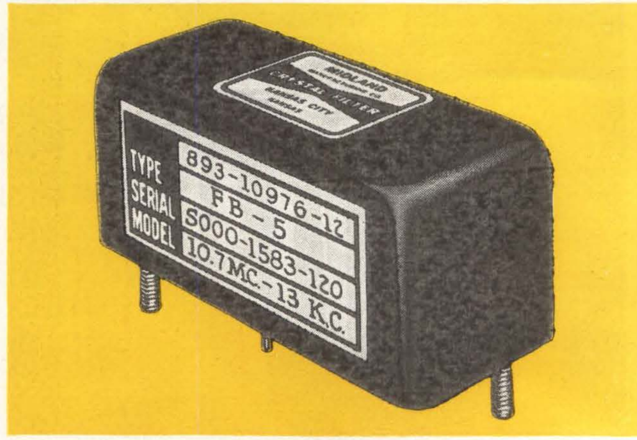

SPECIFICATIONS

Center Freq: 10.7 MC ± 375 CPS
Bandwidth @ 6 db.: 13.0 KC Min. — 13.8 KC Max.
60 db/6 db BWR: 1.8 Max.
100 db/6 db BWR: 2.2 Max.
Ultimate Attenuation: 105 db. Min., 8 MC to 14 MC
Midband Insertion Loss: 0.5 db. Nominal, 1 db. Max.
Inband Ripple: 0.5 db. Nominal, 0.8 db. Max.
Operating Temp. Range: −55° C to +90° C
Zin/Zout Req: 1100 OHMS ± 5% in parallel with adjustable capacitor 0-5 picofarads.
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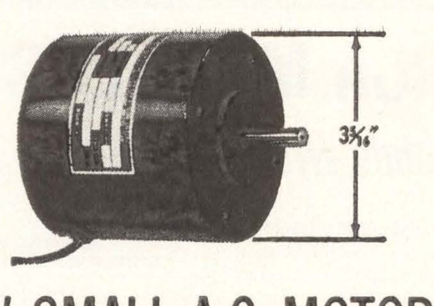
CIRCLE 200 ON READER SERVICE CARD



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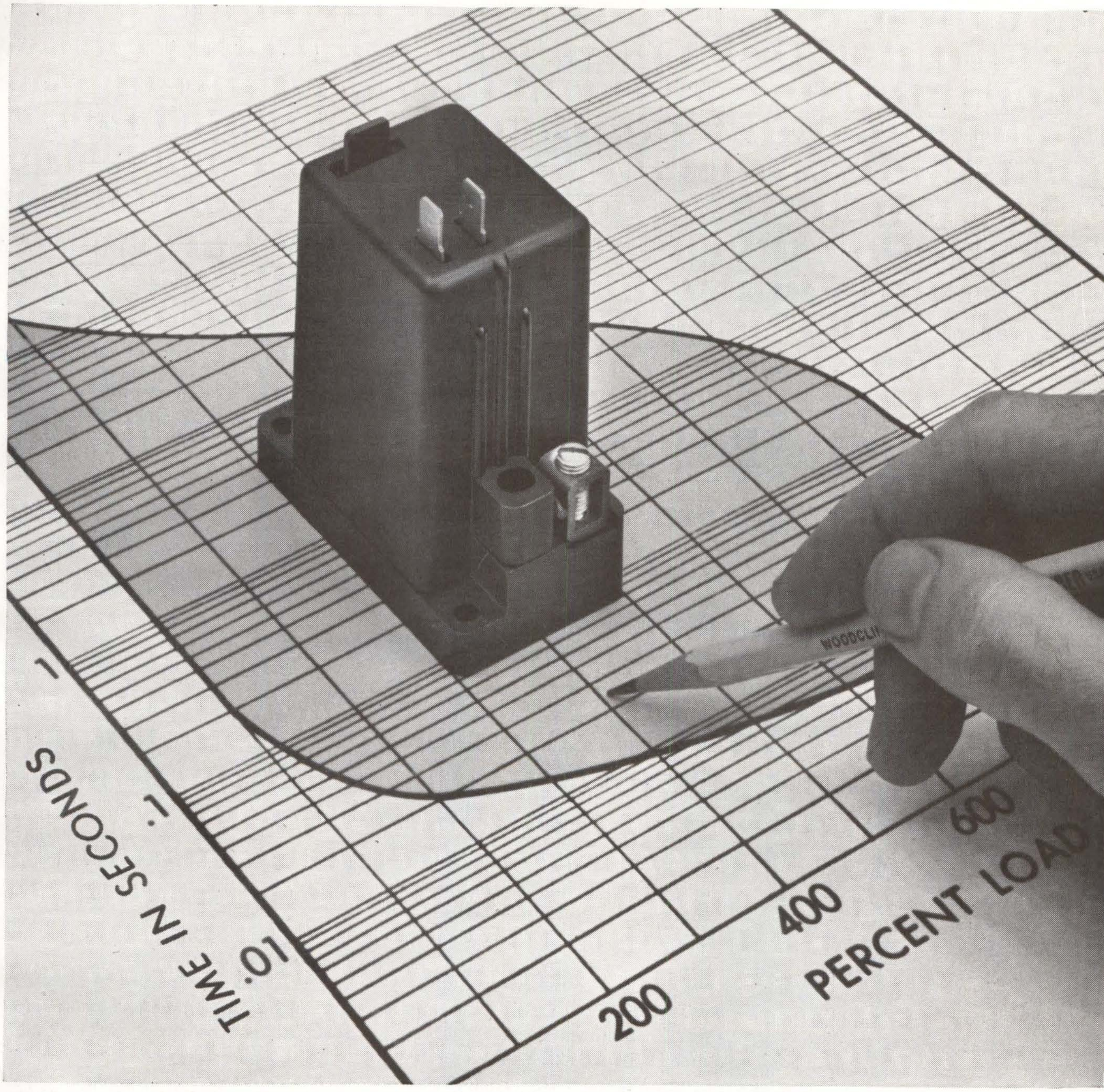

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Where protection requirements are especially critical, you'd do well to consider the Heinemann Type C Overload Relay. Within broad overall limits (defined by the grey area on the above graph), it can give you the exact response characteristics you need.

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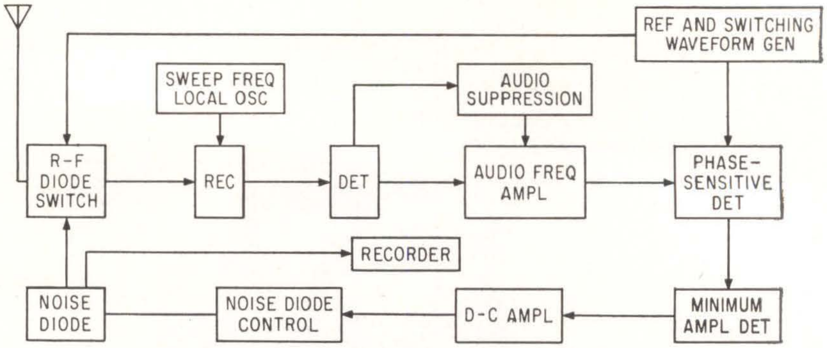
IQSY PARTICIPANTS

Thirty-six countries will participate in IQSY. They are: Argentina, Belgium, Canada, France, Czechoslovakia, Denmark, Finland, German Federal Republic, Hungary, India, Ireland, Italy, Japan, Korea, Malagasy Republic, Netherlands, Poland, Republic of South Africa, Spain, Switzerland, Taiwan, United Kingdom, USA, USSR, Australia, Bolivia, Chile, Iran, Yugoslavia, Mexico, New Zealand, Pakistan, Rhodesia, Nyasaland, Rumania and Vietnam



RIOMETER *is used to measure degree of ionosphere absorption of radio waves. Most tests will be in the polar regions, where radio waves reflected from the ionosphere are often completely blacked out*

Scientists Prepare to Study Quiet Sun

Communications industry hopes to benefit from solar activity studies

SOLAR STORMS and their effect on communications will be more clearly understood—scientists hope—as a result of the International Year of the Quiet Sun (IQSY) program.

Thirty-six nations will participate in the program during 1964-65, a period when solar activity is at a minimum for the first time since concentrated studies of the sun began. Solar activity runs in an eleven year cycle. Studies of a period of high activity were conducted during the International Geophysical Year (IGY).

New experiments are being devised for IQSY to obtain further information about the electromagnetic waves and corpuscular radiation emanating from solar activity. In addition, several experiments begun during the IGY will be continued, after modification to take advantage of the fact that solar outbursts, being at a minimum, will be relatively isolated.

PROJECTS—Solar patrols begun during IGY will be continued, as will studies of geomagnetism, aurora and airglow, the ionosphere and cosmic rays. Newly developed experiments will include a series of optical, radio, radar and magnetic observations.

Sun-earth relationship studies to be developed for IQSY will include investigation of particle events, flare effects in the ionosphere, the solar daily geomagnetic-field variation in the Pacific, geomagnetically trapped radiation and micropulsations.

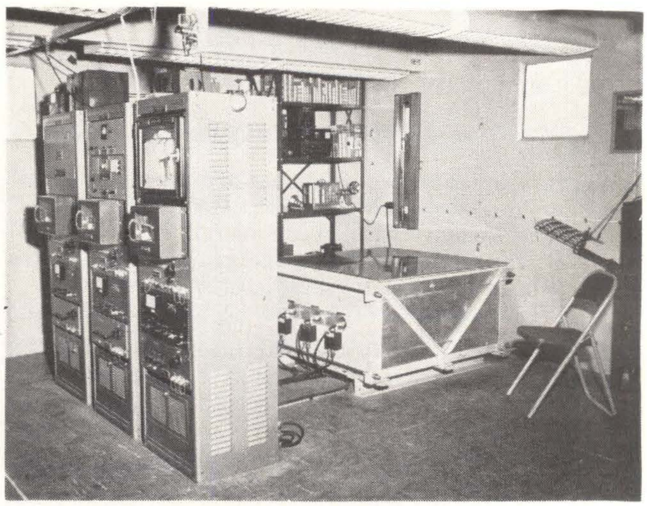
Aeronomy studies will include investigations of the density structure of the atmosphere, electron density and structure of the ionosphere, ionospheric motions, airglow relationship and red arcs, and ozone. Cosmic ray studies will include investigations of the primary cosmic ray spectrum, latitude effects and variations in cosmic ray flux.

In addition to the on-ground projects mentioned, NASA will launch several satellites designed to supplement information received from ground experiments (ELECTRONICS, p 87, November 17, 1961). These satellites will be similar to the Orbiting Astronomical Observatory (p 22, February 23) and Ariel (p 32, April 20), both launched this year. An advanced Orbiting Solar Observatory, now under development, is scheduled for launch in 1965.

RIOMETERS — Relative ionospheric opacity meters (riometers), used to measure the degree of absorption of radio waves by the ionosphere, have improved considerably in design since they were first built for use during IGY.

Extensive use in polar regions during IQSY is expected to further clarify the phenomena of polar cap absorption. Absorption is so strong in the polar regions that radio waves reflected from the ionosphere

COSMIC RAY *station in McMurdo Sound, Antarctica, is maintained by the Bartol Research Foundation*



RADIOACTIVE *radium element is placed in cosmic ray neutron monitor pile at Bartol Research Foundation's Antarctica base*

are often completely blacked out.

Riometers are usually used to measure cosmic radio noise in a frequency range of 20 Mc to 50 Mc, above the critical frequencies of the ionosphere. By comparing the intensity of the cosmic noise at any time with the expected intensity under normal ionospheric conditions, the ionospheric absorption of the signal can be measured.

The input signal from an antenna (see diagram) is continuously compared with a signal from a noise diode source. When the signals differ, the error signal derived from the receiver output is amplified and applied to a phase sensitive detector. The d-c output of the detector is positive or negative, depending on which of the two input signals is stronger. The magnitude of this output is a function of the difference in amplitude of the antenna and noise diode signals.

This phase sensitive detector output is then applied to a control amplifier, which is used to regulate the filament voltage of the noise diode such that its output signal is equal to the antenna signal. By recording the current flowing in the noise diode, a direct proportion to the noise power of the antenna signal is obtained.

The Geophysical Institute at the University of Alaska presently has one of the longest runs of continuous riometer data, riometers there having been in operation since 1957. During IQSY, the Geophysical Institute will operate six riometers throughout Alaska, plus a seventh unit at Thule, Greenland.

TYPICAL PROGRAM—Belgium's proposed program for IQSY is typical of the proposed programs announced by several of the participating countries. Geomagnetic studies will involve recording the geomagnetic field and earth currents. Recordings of the spectra of the night sky will be used to make studies of aurora and airglow.

The Geophysics Center at Dourbes, Belgium, will make measurements aimed at helping to understand the ionosphere. Cosmic radiation observations will also be made at the center.

Solar activity studies include the use of radio astronomy and optical observations. Meteorology studies will be undertaken at the aerology station in Uccle.

Analyzer Checks Computer Circuits in 45 Seconds

FAULT-ISOLATION device, a computer chassis analyzer, has been developed by the Martin Co. The analyzer is able to isolate computer logic malfunctions down to the gate and wire level, checking an entire computer chassis in from 15 seconds to 45 seconds.

Punched tape commands control the logic of the analyzer, which is capable of checking all wiring and components comprising the logic paths of a chassis, as well as considering multiple errors. Tests on logic paths are conducted in a specific order.

Test results showed that 218 gates and 600 wires could be checked in a time-frame ranging from 0.9 sec to 7.0 sec. Martin said it has no immediate plans to market the analyzer.

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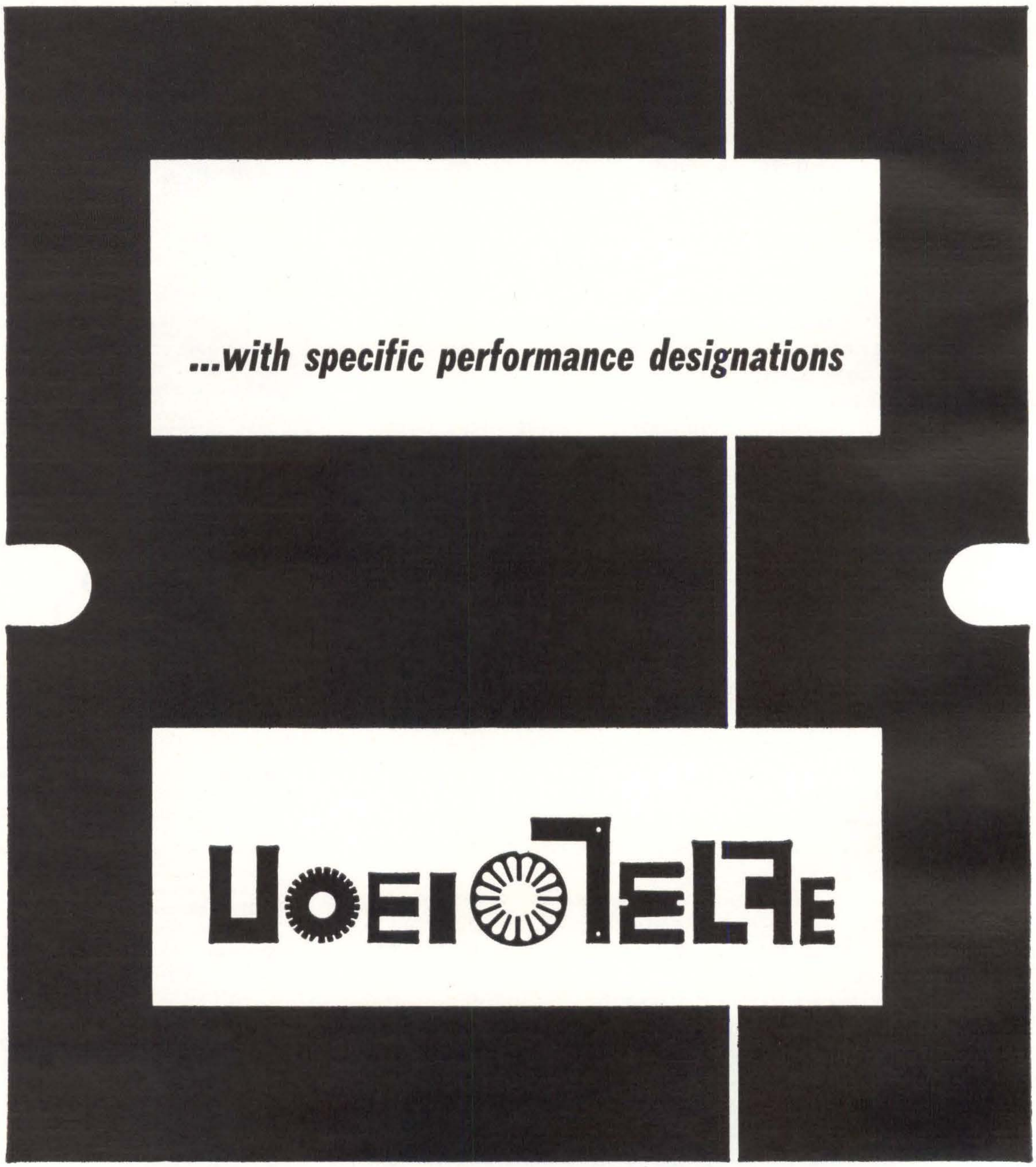

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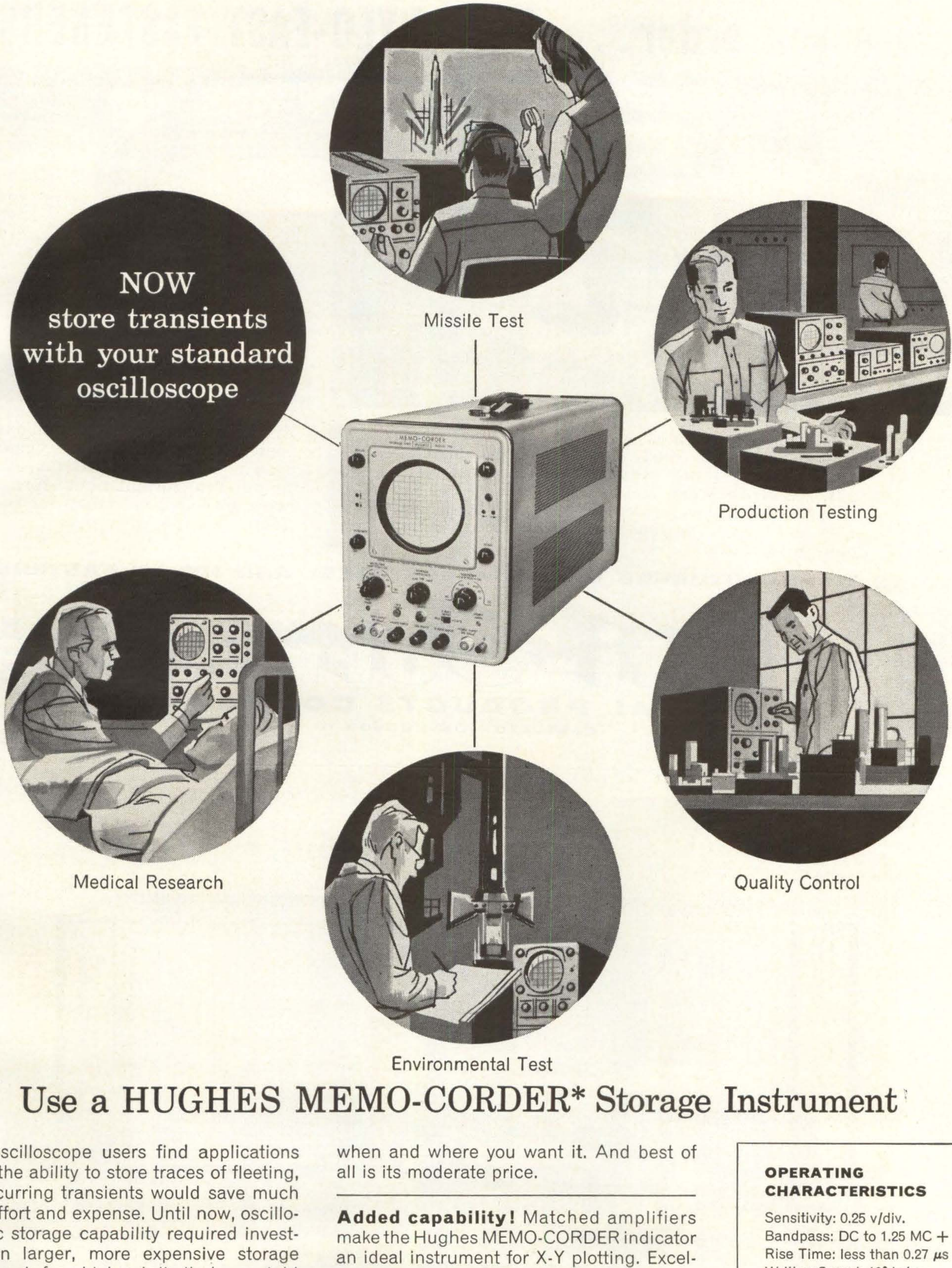

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Sensitivity: 0.25 v/div.
Bandpass: DC to 1.25 MC +
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Writing Speed: 10^6 in/sec.
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CIRCLE 23 ON READER SERVICE CARD

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CIRCLE 25 ON READER SERVICE CARD

Industry Help Sought in Airspace Utilization

Computers and displays will help attain goal of faster delivery

ATLANTIC CITY, N.J.—Philosophy and design of the nation's airspace utilization system up to 1975 will not deviate from the present philosophy nor will the design call for revolutionary changes.

A 733-page report, prepared by the Federal Aviation Agency's System Design Team and released on a limited basis late last month, emphasizes that the plan is evolutionary, not revolutionary.

Reasons for this approach are numerous: the present system, although not adequate for the future, is basically a good one. About $1 billion is already invested in it. The present system could not be junked overnight even if some cure-all concept were available—the FAA doesn't have the money, flight operations could not be interrupted, nor could users afford to outfit their planes with the new gear.

The System Design Team's plan does predict air-traffic conditions through 1975, the control that must be exercised from now until 1975, the kind of subsystems that can and can't be used, and the performance required of these subsystems.

How the technical problems will be solved and what form some of the subsystems will take is left up to the engineering community, both in FAA and industry.

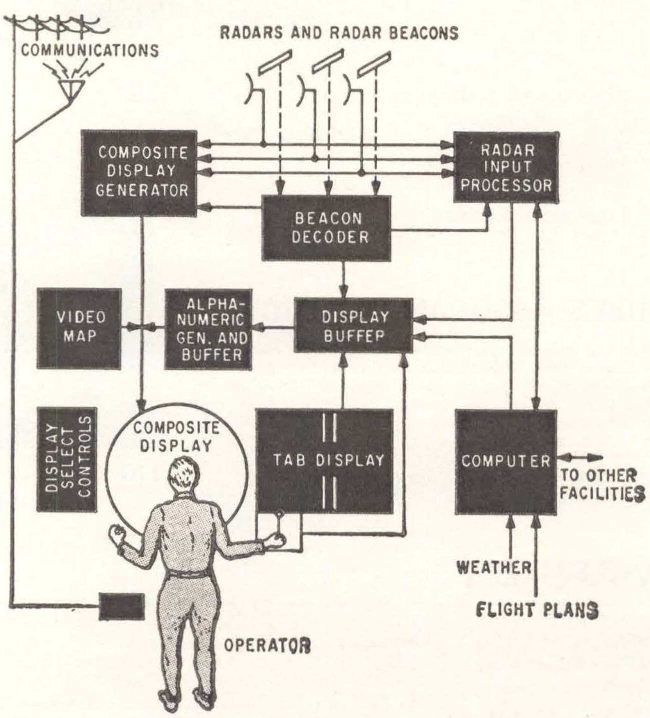
Here is the objective of the program: to deliver better information, more quickly, to the individual requiring it. The big push, therefore, will be toward improved data acquisition, automation wherever possible, better data processing and electronic displays.

DATA PROCESSING—Computers to process information and electronic display consoles to present it both must be bought outright. These two items represent probably the biggest innovation in the new system. Those control centers now equipped with computers use them as aids to their manual method of operation, and electronic displays are virtually nonexistent. The new system calls for automated control centers.

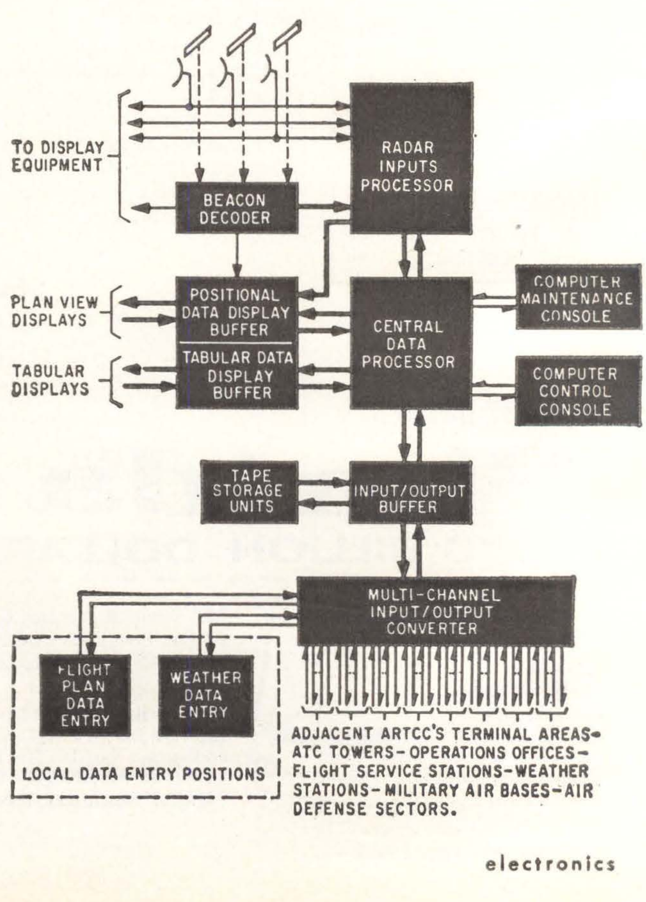
Whether one computer will handle a center, its several terminal areas, and a number of towers, has not been decided. Probably, each center will represent a different problem and each solution will be an individual one.

RADAR—While acquisition of position data by radar will be improved by upgrading present equipment rather than installing new gear, there has been one major decision: the problem of determining aircraft elevation for the controller on his radar scope without voice communication with the planes has been resolved in favor of automatic transmission of altitude information by airborne radar beacon transponders.

FAA would like to have a transponder or secondary radar system



AIR TRAFFIC CONTROL *subsystem includes data processing and multiple radar coverage*



DATA PROCESSING *configuration allows display of both raw and processed radar data*

 By JOHN F. MASON, Associate Editor

that would save money by eliminating primary radars that skin-track aircraft not carrying beacon transponders. There are still, however, unresolved technical, economic and political problems in such a move.

The big height-finding radar at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, N.J. will, nevertheless, continue to undergo tests. Conceivably, busy terminals will one day be equipped with height-finding radar. Until 1975, however, FAA will rely on beacons as well as primary radar.

One change in viewpoint is the new acceptance by FAA of composite displays from a number of radars and from computer-derived data. Alphanumeric information will be displayed, as well as extrapolated position of aircraft during poor radar reception.

Air-defense radars and FAA radars will be remoted to centers by microwave links and narrow-banding techniques. The latter will be introduced slowly and may become the major remoting method of the future. This technique will enable a single controller to monitor a greater geographical area and will fit in with the plan to cut down on the number of centers in the national system.

NAVIGATION — Ground-based navigation will continue to be VORTAC (vhf omnirange and Tacan). Distance Measuring Equipment (DME) will be required for IFR (instrument flight rules) operations in terminal areas. Pictorial displays to be used by the pilot will not be required before 1975, but continued development of this gear is encouraged. NAFEC's Experimental division findings indicate that such gear would be helpful to the air traffic control (ATC) system. The division's findings on the possible value of airborne doppler navigation sets in ATC is not yet complete.

LANDING AIDS — At airports meeting specified traffic criteria ILS (instrument landing system) or GCA (ground-controlled approach) will be used for final approach and landing. Other landing aids under evaluation at NAFEC include: a modified version of Bell Aircraft's GSN-5, designated GSN-5A, to be ready in December for testing; the British Bleu, a system that may use either the ILS localizer or magnetic leader cables for alignment with the runway, and North American Aviation's Autonetics Division APN-114, which provides a vertical measuring unit to be used with the ILS localizer. In the Experimentation division, two breadboard systems are being examined: Gilfillan's Regal, which has achieved range elevation angles with a 0.05-deg accuracy; and Airborne Instruments Laboratory's Flarescan, a system based on angular measurement rather than distance.

Final recommendation from NAFEC may be a composite system using the best techniques being examined. Already of aid to the project is an improved ILS directional localizer that uses a 117-ft wave guide. NAFEC is now experimenting on a new one 300 ft long.

COMMUNICATIONS—The system will depend on direct pilot-controller ground-air-ground communications for control. The equipment to be used is two-way vhf/uhf voice radio with 50-Kc vhf channel selectivity.

Actual advances in communication techniques will not be pushed until the amount of communications that will be needed is determined. Automatic data link from pilot to controller providing periodic flight data plus the use of computers in control centers may obviate the need for increased voice communication. A number of companies are working on automatic data links.

WEATHER — NAFEC has produced a system design for a weather system that is now being studied by the Weather Bureau and the Department of Defense. The goal is to deliver useful weather information to the pilot and controller in time for them to use it. New sensing devices, communications, data processing and display equipment are being proposed. FAA is now handling the U. S. portion of the Air Force 433-L global weather information system. USAF is in charge of the areas outside the U. S.

COLLISION-AVOIDANCE — Both collision avoidance systems (CAS) and pilot warning instruments (PWI) are still hopes for the future. Techniques proposed to date did not interest the design team sufficiently to include them in their pre-1975 plans.

Radiation Won't Alter NASA's Plans

NASA DOES NOT now plan to reschedule any of its satellite launchings because of the increased radiation in space from the U. S. July 9 nuclear test. A spokesman told ELECTRONICS that NASA had considered delaying some launches but decided to go ahead as planned; one advantage would be acquisition of more data on the exact nature of the radiation belt.

Also, a DOD spokesman said, no military satellites have been delayed by the new radiation.

According to an AEC-DOD announcement, the inner Van Allen belt has been extended to lower altitudes, and within the natural belt there is a "substantial and greater than anticipated increase" in radiation intensity that may persist for years. Electron densities at the lower altitudes were said to be disappearing as predicted, however.

The new radiation is reported to have damaged solar cells in Navy's Transit IVB and Traac satellites and the U. S.-British Ariel satellite, and halted transmission. The altitudes of these satellites, however, are above those planned for manned flights in the near future.

Military Maintainability Specs Aim at Simplifying Repair Jobs

Military's outlook on maintenance problems featured at conference

DENVER—Maintainability specifications in military contracts and the military's concern about electronic equipment maintainability were highlighted at the recent Fourth Conference on Maintainability of Electronic Equipment sponsored by EIA and the Department of Defense. It was held at the University of Colorado.

Conducted in a new symposium format, the conference featured 15 workshops for each of five maintainability areas. The workshops were devoted to discussion of data and material, evaluation of techniques and endorsement of methodology for assuring optimum maintainability of the design product. The five areas were personnel and training, testing techniques, design configuration, trade-offs and design reviews.

The only session that did not use the workshop format was conducted by a DOD spokesman who gave the 250 convention delegates the latest information on proposed specifications of maintainability for military equipment.

MILITARY—The Air Force is now using management maintainability specifications for systems and equipment procurement, reported Major W. P. Crumpacker, Air Force Systems Command headquarters.

"It is our policy to apply this specification (management maintainability), as well as quantitative maintainability requirements, in all system and equipment contracts," he said.

G. Sibthorp, Army Office of the Deputy Chief of Staff for Logistics, reported that separate specifications have been or are being prepared for the two major categories of Army electronic equipment: communications/electronics and missile systems.

The communications/electronics specifications are composed of three parts: generalized maintenance requirements, a compendium of design features whose absence from an equipment would be detrimental to the ease of maintenance, and specific requirements, constraints, and guidance pertinent to the particular equipment under development.

Missile system specifications are based on several concepts. Complexity of maintenance should be minimized through design. Malfunction recognition and faulty component identification should be rapid and positive. Repair and service of equipment should be simple. It is expected that in future missile system contracts an adaptation of maintainability specifications developed by the Air Force will be used by the Army.

AUTOMATION—A tendency toward the adoption of the philosophy that automatic test equipment should extend man's capabilities rather than replace man was cited by J. Cooper, of Thiokol Chemical, at one of the trade-offs section workshops. He proposed a maintainability concept using this philosophy.

Cooper suggested the possibility of a machine that gives a series of logical alternatives to the cause of a malfunction, obtaining these alternatives from the specific symptoms given to the machine. The maintainance technician would then be provided with a limited set of actions to take to track down the malfunction. In this way, automation would extend man's capabilities, leaving the final decision up to him, instead of replacing him.

MAINTAINABILITY SPECIFICATIONS

AIR FORCE—has adopted MIL-M-26512B (USAF), 23 March 1962, superseding MIL-M-26512A (USAF), 5 December 1960, a specification detailing maintainability requirements for aerospace systems and equipment.

—has adopted AFR 66-29, 17 January 1962, a regulation stating Air Force policy, responsibility and basic procedures for the USAF maintainability program for systems, subsystems and equipment.

—has adopted AFSCR 80-9, 26 December 1961, a regulation applying to all elements of AF Systems Command responsible for conduct of current and future AF research, development and production programs.

ARMY —has drafted a specification, adapted from MIL-M-26512B (USAF), revised 1 June 1962, a proposed specification dealing with maintainability requirements for Army Ordnance Missile Command contracts. It contains as an annex an extract from MIL-M-11991A (ORD), 30 April 1959, a general specification for electrical-electronic equipment, surface and guided missile weapon systems.

—has adopted SCL-4301B, 29 March 1962, superseding SCL-4301A, 19 January 1962, a Signal Corps technical requirement detailing maintainability design requirements for signal equipment.

NAVY —has adopted MIL-M-23313 (SHIPS), 12 June 1962, a specification detailing maintainability requirements for shipboard and shore electronic equipment and systems

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Contracts Let for Gemini Command and Display Gear

DIGITAL COMMAND system, for the two-man Gemini orbital space program, will be developed by Motorola's Military Electronics Division. Decoders, r-f command receivers and a buffer storage unit will be installed in the spacecraft to receive command signals from the ground and convert them for control of the various spacecraft systems. Motorola components and equipment used in the Mariner program will be redesigned to fit Gemini needs.

A flight director-attitude indicator, to be developed by Lear Siegler, Inc., will be the central control display for Gemini. The single pictorial display, indicating the spacecraft's attitude in roll, pitch and yaw in relation to the horizon, will depict corrections in attitude that must be made during launch and insertion, in orbit and at time of reentry.

Lear is also developing control-display systems to be used in other manned air and space vehicles, under a $500,000 USAF contract. Five systems, three of which are intended for flight evaluation in the X-15, will be developed. The systems are a combined temperature, velocity and angle-of-attack display, a computer programmer, a flight director mode selector, a three-axis rate sensor, and a wing temperature and yaw angle display.

War Games Score Keeper

TILT, *a device that shoots infrared beams instead of bazooka shells, keeps score in war games. It was developed by Raytheon*

MICROMODULES *will be used in a family of combat radios. At left is the conventional AN/PRC-25 case now equipped with micromodule circuits. At right is the AN/PRC-51 micromodule radio transmitting, with micromodule receiver clipped to the soldier's helmet*

Micromodules Show Durability Plus Radiation Resistance

Micromodules reaching production stage have high reliability

RELIABILITY of micromodules going into production (ELECTRONICS, p 7 Sept. 7, and p 37, this week) has been proved in a full range of environmental tests, RCA engineers told ELECTRONICS last week. In addition, they were found to have a radiation resistance equivalent to three years exposure in the Van Allen belt.

TEST RESULTS—Over 6,000 component wafers or elements, built up into 800 micromodule circuits exhibited a mean time to failure of $6\frac{1}{2}$ million hours (for the elements). All elements were under high stress at 60-percent confidence level.

Solder connections in the modules were tested to a total of over 250 million electrical-connection hours with no circuit failure. These tests were run at temperatures close to the junction temperatures of the transistors—75 degrees C with germanium transistors and 125 degrees C with silicon transistors. Although all connections, to date, have been solder type, RCA engineers said they are also working on welded connections.

Radiation tests were made in the Princeton atomic reactor in a neutron field equivalent to 5×10^{14} neutrons/cm^2.

One micromodule was shot out of a howitzer, subjecting it to 20,000 g's. In a first test, the module suffered an external failure due to an improper mounting of its pins in the module base, but in a repeat test, it survived without failure.

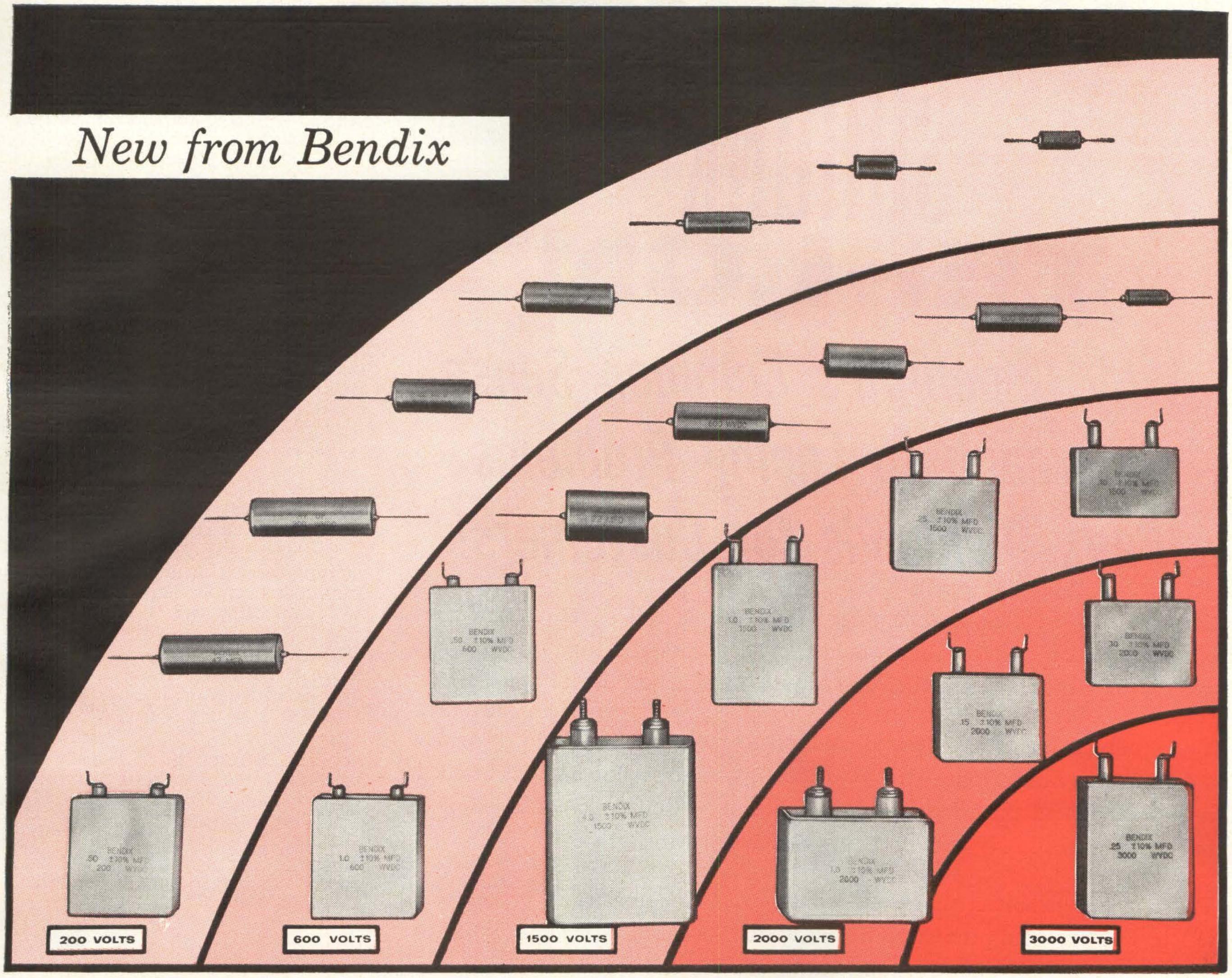
CIRCUITS — Microwafers, originally intended for single components such as resistors, capacitors, inductors, crystals, transistors and diodes, are in some cases now made with multiple components and are compatible with other microelectronic techniques being developed.

For example, one micromodule has been constructed with three wafers, each wafer mounted with a Texas Instruments Solid Circuit package. Designed for logic circuits, the module wafers hold two gates, two emitter followers and one flip-flop.

RCA is also working on other techniques using solid ceramic circuits. This work, in cooperation with the Signal Corps, is aimed at constructing an advanced computer for the field army.

Micromodules, it is claimed, can be used for almost all low-power, transistor-type circuits now being used in military equipments. Over 500 different kinds of germanium and silicon transistor-type circuits have been designed, of which more than 120 have been fabricated for communications and control functions. More than 85 digital circuits for computer applications have been demonstrated thus far.

Signal Corps' Micropac computer will employ over 10,000 micromodules. It occupies 2.7 cubic feet, weighs 90 pounds, and requires 250 watts d-c power. The unit is to be delivered to the Army for testing in November. Micromodules are also being applied to a family of combat portable radio receivers, transmitters and other equipment.



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MEETINGS AHEAD

ELECTROCHEMICAL SOCIETY MEETING; Statler-Hilton Hotel, Boston, Mass., **Sept. 16-20.**

RECTIFIERS IN INDUSTRY MEETING, AIEE; Desher-Hilton Hotel, Columbus, Ohio, **Sept. 18-19.**

INDUSTRIAL ELECTRONICS ANNUAL SYMPOSIUM, IRE-PGIE, ISA; Sheraton-Chicago Hotel, Chicago, Ill., **Sept. 19-20.**

TUBE TECHNIQUES NATIONAL CONFERENCE, Advisory Group on Electron Devices in the Office of the Director of Defense Research and Engineering; Western Union Auditorium, N.Y.C., **Sept. 19-21.**

BROADCAST ANNUAL SYMPOSIUM, IRE-PGB; Willard Hotel, Washington, D. C., **Sept. 20-29.**

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

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

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

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

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

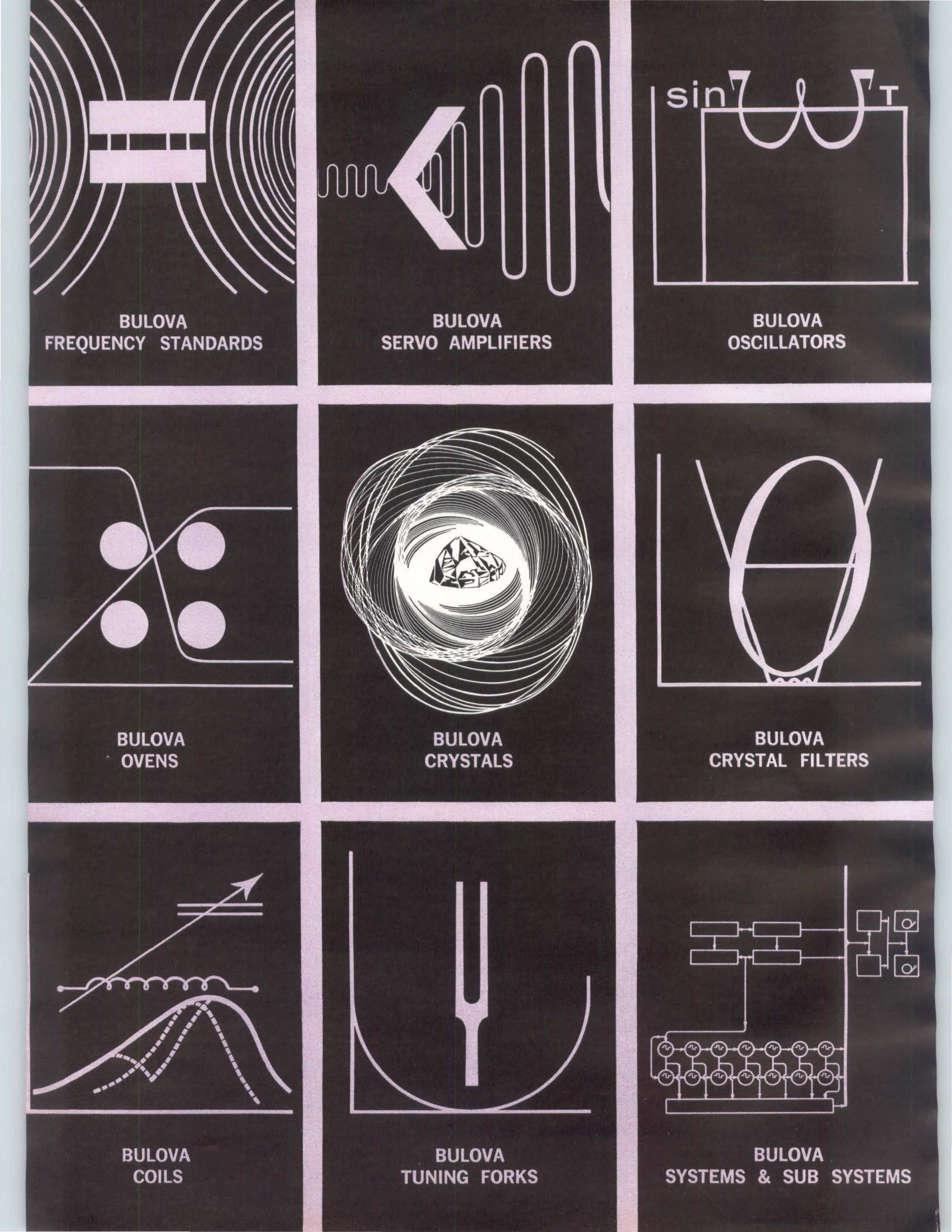
AEROSPACE ELECTRICAL/ELECTRONIC EQUIPMENT & SYSTEMS DISPLAY, Aerospace Electrical Society; Pan Pacific Auditorium, Los Angeles, **Oct. 10-12.**

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

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

ADVANCE REPORT

NONLINEAR MAGNETICS INTERNATIONAL CONFERENCE, IRE, AIEE; *Shoreham Hotel, Washington, D. C., April 17-19, 1963. Nov. 5 is the deadline for submitting 200-word abstract to: J. J. Suozzi, Technical Program Chairman, Bell Telephone Laboratories, Inc., Whippany, N. J. Conference theme will emphasize theory and application of advanced nonlinear magnetic devices in computation and control. Papers will be given on recent developments in: computer logic and memories (thin magnetic films, etc.); power devices (magnetic amplifiers, etc.); nonlinear magnetics and semiconductor combinations (silicon controlled rectifiers, etc.); recording and instrumentation.*



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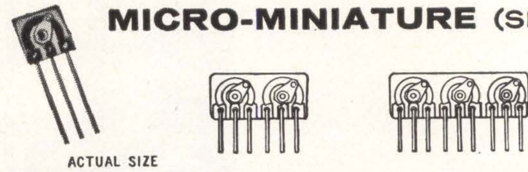
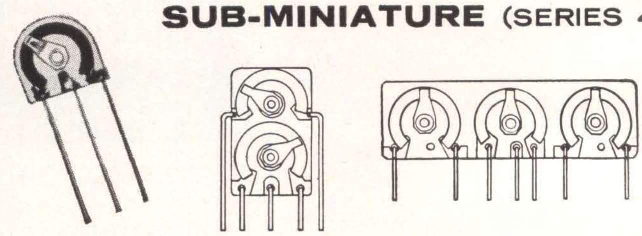


ACTUAL SIZE

Single trimmer measures only 0.250" square, 0.100" deep, rated at .05 watts at 70° C. Multiple trimmers can include up to 5 fixed resistors, depending upon value and voltage rating.

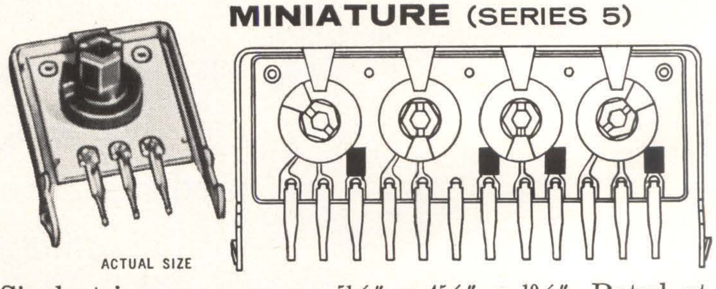
SUB-MINIATURE (SERIES 4)



ACTUAL SIZE

Single trimmer measures only 0.406" x 0.438" x 0.125", rated at 0.1 watts at 70° C. Triple trimmers can include up to 8 fixed resistors, depending on value and voltage rating.

MINIATURE (SERIES 5)



ACTUAL SIZE

Single trimmer measures 51/64" x 45/64" x 19/32". Rated at 1/4 watt at 70° C. Available with leads, solder or wire-wrap terminals, in a wide range of mounting styles for modern production techniques. One to four variable resistor elements and up to 12 fixed resistors on a single plate. Knob permits adjustment by finger tip, internal or external hex wrench, or screwdriver.

For additional information on these units write for CENTRALAB *Engineering Bulletin 42-1216.*

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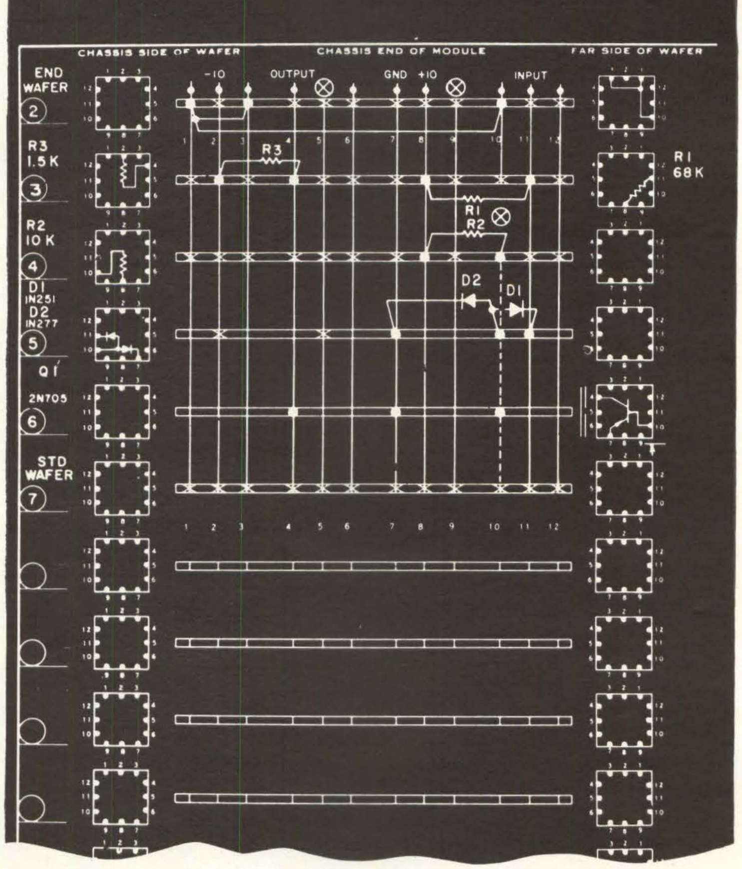
electronics

September 14, 1962

Step-by-step procedure for designing wafer-mounted microelements and assembling them to riser wires, with design considerations, module assembly methods and system assembly methods



MICROMODULE ASSEMBLY *layout sheet shows component locations, jumpers, riser-wire lengths and solder points—Fig. 1*

How To Design Micromodules

By RENATO DISTEFANO, JR.
Semiconductor and Materials Div
Radio Corporation of America
Somerville, N.J.

DESIGN METHODS for micromodule electronic or electromechanical systems can be applied to existing systems that require a minimum of redesign, as well as to developmental systems that consist of only a performance specification and a list of environmental requirements.

In either case, the design of the system begins with the breadboard construction of the entire system, or of that portion of the system to be redesigned in micromodule form. The completed breadboard is subjected to all specified operating and storage environmental test conditions, with the exception of such tests as shock, vibration or thermal dissipation, which yield no applicable information when conducted on a breadboard.

DESIGN CONSIDERATIONS — The present range of microelement capability is shown in Table I. When possible, a micromodule is designed to include the microelements required for a complete functional unit or stage, such as an amplifier stage, mixer, local oscillator, multivibrator, inverter or gate. This method of circuit division provides design simplicity and minimizes the number of connections between micromodules. In certain cases, such as cascaded intermediate-frequency stages, the requirement for isolation of signal leads strongly influences the manner in which the circuit is divided into micromodules.

The designer divides the circuits of the entire system or subsystems into sections, each of which represents a separate micromodule, and

KUDOS FOR MICROMODULES

Just two weeks ago, Major General E. F. Cooke, Chief Signal Officer, said that the Chief of Staff for Logistics has issued a directive to incorporate the micromodule concept in Army equipment where appropriate (ELECTRONICS, p 7, Sept 7). Meanwhile, six items considered highly suitable for micromodule application have been funded for R&D by the Army in 1963-64. These include an airborne h-f ssb radio, a lightweight hand-held surveillance radar, a "flash ranging set" to detect gun flashes, an electronic teletypewriter, a tactical digital communications system and the production version of Micropac, small field computer to be delivered in November by RCA

TABLE I — PRESENT MICROELEMENT-CAPABILITY

RESISTORS

	Carbon	Cermet
Number of Resistors per Microelement	1 to 4	1 to 4
Value Range per Resistor (ohms)	10–150,000	10–150,000
Value Range per Microelement (ohms)	2.5–600,000	2.5–600,000
Maximum Dissipation per Resistor (watts)	1/8	1/8
Maximum Dissipation per Microelement (watts)	1/2	1/2
Maximum Micromodule Temperature for Rated Dissipation (degrees C)	70	70
Temperature Characteristic (ppm per degree C)	±1,300	±200

CAPACITORS

	Precision (T. C.)	General-Purpose	Electrolytic (Tantalum)
Number of Capacitors per Microelement	1	1	1
Value Range	5 pf to 3,000 pf	100 pf to 0.15 mf	1 to 47 mf
Tolerance (percent)	1 to 10	10 to 20	10 to 20
Temperature Range (degrees C)	−55 to +85	−55 to +85	−55 to +85
Temperature Characteristic	±30 ppm/°C (nominal)	+10%, −30%	±15%
Maximum Dissipation	0.001	0.015	0.06 at 120 cps
Maximum D-C Voltage	50–100	50–100	35 (470 mf-volt) max.

INDUCTORS

Maximum Inductance (millihenries)	1.5
Maximum Operating Frequency (megacycles)	50

DIODES

Most miniature diodes that are not larger than 0.2 inch may be mounted on a microelement wafer. From one to four diodes may be mounted on a microelement, depending upon dimensions and terminations. Diodes are now available in packages suitable for microelement mounting

TRANSISTORS

Any transistor that can be mounted on a microelement wafer so that its case does not short to the micromodule riser wires is suitable for use in micromodules

notes the occurrence of repetitive circuits that can utilize identical micromodules. Identical modules in repetitive circuits are especially desirable in systems to be produced in large volume, because they result in cost savings of materials and testing.

Micromodules can be constructed with external leads at both ends; however, interconnection considerations have made the single-ended micromodule definitely preferable for most systems. The single-ended micromodule normally has twelve external leads spaced on a 0.075-inch grid pattern at one end.

Although micromodules can be made in heights up to one inch, most units are between 0.4 and 0.8 inch high. Micromodule lengths within this range can accommodate many types of stages without exceeding the twelve-lead limit on external connections. Some of the more complicated amplifiers, multivibrators, and other types of stages are subdivided into two or more micromodules; similarly, some simple repetitive stages, such as gates, may be combined with one or more similar stages into a single micromodule. In some cases, the maximum height of one or more micromodules in a system is limited by the volume specifications for the complete system.

A rough estimate of the height of a micromodule may be made by adding the space requirements for each of the microelements, or wafers, of which it is composed. The space requirement for each wafer is determined by adding 0.01 inch to the maximum allowable thickness of each wafer. The 0.01 inch includes the height required by soluble spacers which are inserted between the wafers during the assembly process. Additional allowances of up to 0.02 inches may be required where riser wires are "cut," as explained below.

Since the maximum allowable thickness of standard resistor microelements is 0.02 inch, an allowance of 0.03 inch is made for each resistor in the micromodule. Because each resistor wafer has a maximum dissipation allowance of one-half watt, each wafer can accommodate either four one-eighth-watt elements, or two one-quarter-watt elements, one on each side of the wafer. When a resistor wafer has two resistors on one side, the ratio of the higher resistance value to the lower should be less than five, and the terminations of the two elements must be so arranged that the elements do not cross each other.

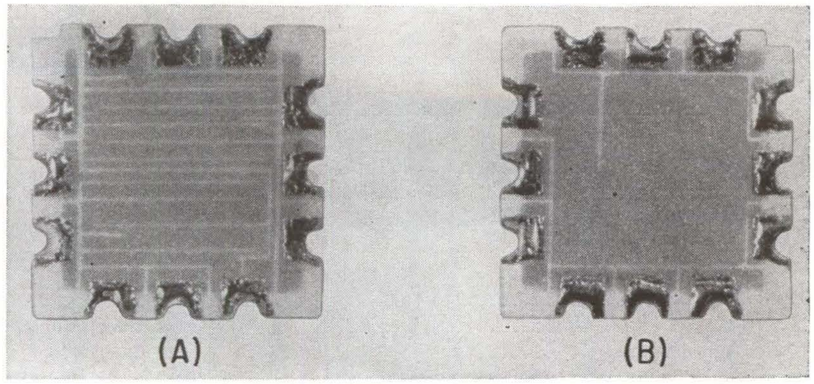
For microdiodes mounted in wafers, space allowance is 0.03 inch more than the maximum diode diameter, for each diode wafer used.

The space requirements for some of the other types of microelements are listed in Table II.

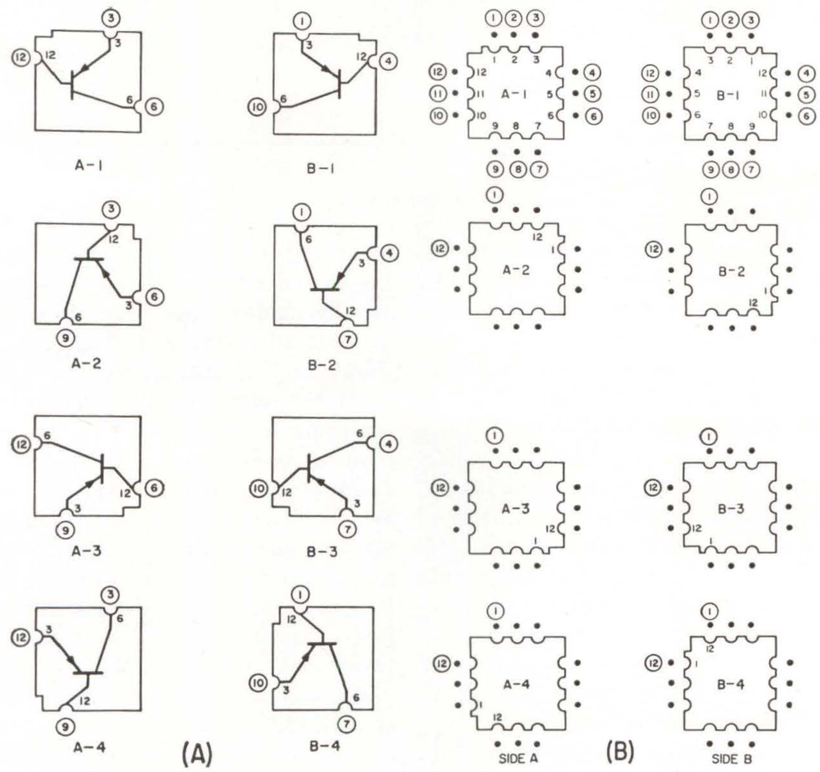
When the space requirements for all of the microelement wafers in the micromodule have been determined, they are added, and an additional 0.12 inch is added for encapsulation, end wafers, module pedestals, and building tolerance. The total is the maximum estimated height of the micromodule; the actual height may be as much as 25 percent less, depending on the actual microelement dimensions, number and location of riser-wire cuts, and similar considerations.

When the height of each micromodule has been estimated, the total height is compared with the system volume specifications to determine if the circuits to be included in each micromodule must be adjusted to fit the space available.

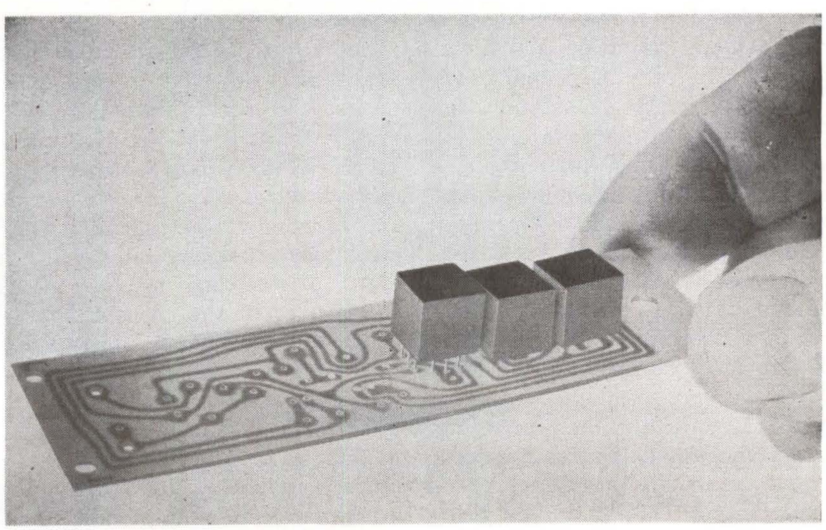
MODULE ASSEMBLY—Figure 1, a completed micromodule assembly layout, shows the method of numbering riser wires. Figure 2B shows the system of numbering notches on the microelement wafers. The uncircled numbers are the notch numbers; the circled numbers refer to the corresponding riser-wire numbers. On those wafers that are mounted in the normal, or *A1* position, the notch numbers coincide with the riser wire numbers. The rectangular index notch in the corner of the wafer is used for orientation during assembly. On the assembly drawing, notch numbers are not shown, but all notches not mounted in the normal or *A1* position with respect to the micromodule riser wires are indicated by three short vertical lines adjacent to the drawing of the far side of the wafer. The mounting position of all wafers not mounted in the normal position is indicated by an



RESISTOR *wafer, showing first side (A) and reverse side (B)*



POSSIBLE MOUNTING POSITIONS *for a transistor microelement (A); for a microelement wafer (B)—Fig. 2*



MICROMODULES *mounted on a printed-wiring board—Fig. 3*

TABLE II — MICROELEMENT DIMENSIONS

Element	Value Range	Dimension Requirements* (Inches)
Capacitor (T.C.)	to 250 pf	0.03
" "	250 to 1,000 pf	0.04
" "	1,000 to 2,200 pf	0.065
Capacitor, Gen. Purp.	0.003 to 0.022 μf	0.04
" "	0.022 to 0.1 μf	0.09
Capacitor, Electrolytic	1 to 3 μf	0.065
" "	4.7 to 22 μf	0.105
Diode, Microelement	—	0.08
Transistor, TO-46 Package Mounted on Wafer	—	0.115
Transistor, Other Suitable Package Mounted on Wafer	—	Package height plus 0.035 inch

* Includes 0.01 inch allowance for spacers, etc.

arrow which points to the long side of the wafer index notch, as is the microlement Q_1 (item 6) shown in Fig. 1.

The various microelement wafers are connected by hard-drawn, solder-coated, tinned copper wires, which also form the external leads. These riser wires form the nodes of the module circuits. If thirteen nodes are required in one module, one of the riser wires is extended only far enough through the module to connect all the elements which meet at one of the nodes. An additional node is formed by placing a short section of a riser wire between those wafers, beyond the end of the shortened, or "cut" riser wire, which contain the elements to be connected to the thirteenth node. This procedure may be repeated with as many as seven additional riser wires to form additional nodes as required, but at least one riser wire on each of the four sides of the micromodule must extend along its entire length and form one of the external leads. Where the additional nodes formed by such segmented riser wires consist of connections between adjacent wafers having no more than 0.003 inch of build-up on each side of the substrate, the connection between the wafers is made by solder bridging during the dip-soldering process, and no riser-wire segment is required.

Transistor microelements and mounting wafers for transistors in TO-46 and similar types of cases are usually made so that the element is terminated to the wafer notches as shown in Fig. 2A, which also indicates the eight possible mounting positions for this wafer in the micromodule. When a micromodule is designed with two transistors connected in a common-emitter configuration, one unit can be mounted in the *A1* position and the other in the *B1* position, with a connection or jumper located on an end wafer between riser wires 1 and 3.

An end wafer is usually placed at each end of the module to protect the microelement wafers during manufacture, and to provide a mounting for jumpers between riser wires. When necessary, an end wafer may be eliminated if it contains no jumper and if the adjacent wafer does not contain an element on its outer face. Elimination of an end wafer will shorten the module height by about 0.015 inch.

Riser wires may also be shortened for additional isolation of a tuned circuit or other critical element located at the end of the module farthest from the chassis. The operation of such circuits may also be improved by locating input and output leads on opposite sides of the micromodule, and by designing the module so that the two riser wires on each side of a critical signal lead are grounded on the printed-circuit interconnecting board.

If less than twelve leads are required on a single micromodule for external connections, one or two of the riser wires on each side of the module may be cut off within 0.015 inch of the end wafer after the module is assembled to simplify the wiring on the printed-circuit interconnection board, as in the case of riser wires 5 and 9 in Fig. 1. However, in all such cases, at least one of the uncut external leads on each of the four micromodule sides must extend through the length of the micromodule. Printed-circuit interconnection board wiring may be further simplified, on occasion, by providing jumpers on micromodule end wafers between leads which do not connect to nodes within the micromodule, as shown for the end wafer at the chassis end of the micromodule in Fig. 1.

Unless element isolation requirements or cuts in riser wires dictate otherwise, resistors are usually located at the end of the module closest to the chassis, followed by capacitors, inductors, silicon semiconductors and germanium semiconductors, in that order, to ensure the most efficient transfer of heat from the micromodule. When one or more of the micromodule riser wires are shortened, the configuration of the various circuit nodes determines the order in which the wafers must be assembled. In Fig. 1, a cut is indicated on riser wire 10 inside the module, and the riser-wire segment used for the node identified as 10′ on the schematic diagram is shown as a dashed line. In this case, the node cannot be formed by solder bridging because one of the wafers involved has more than 0.003 inch of build-up on both sides.

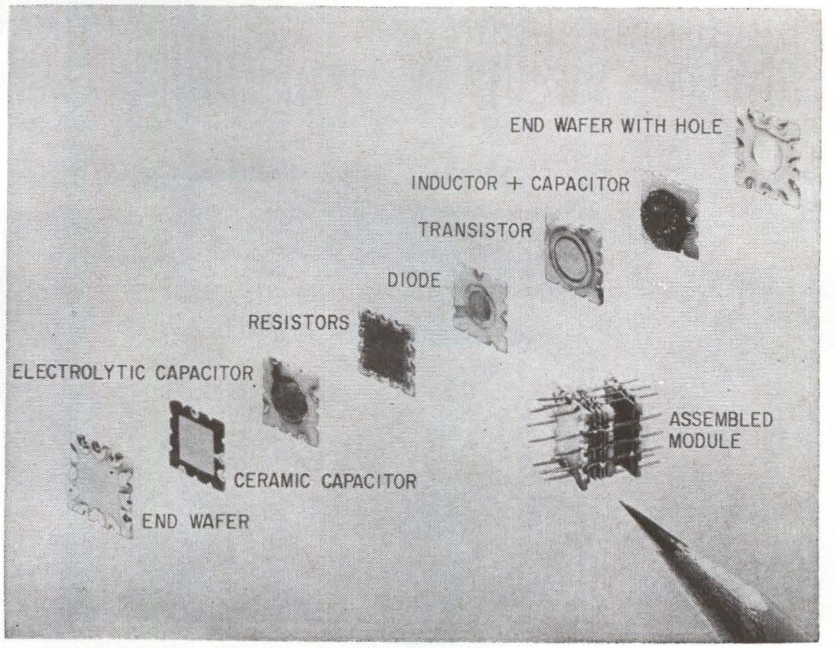
The first step in the design of a micromodule incorporating the circuit shown in Fig. 1 is the assignment of riser-wire numbers. For optimum micromodule system design, this assignment is made during the layout of the printed-circuit board on which the micromodules are to be mounted. Because it is preferable to use the standard transistor microelement wafer (Fig. 2A) when possible, the riser wires that connect to the emitter and collector of Q_1 are assigned first, and the printed-circuit mounting board is then laid out. Riser-wire numbers are then assigned to the remaining nodes of the micromodule.

The printed-circuit board layout usually determines the assignment of riser-wire numbers to the remaining circuit nodes which must connect to the board. As shown in Fig. 2A, the transistor base should connect to riser-wire 10; however because riser-wire 10 has already been assigned as one terminal of a jumper wire associated with the external circuits, the wire must be cut to form node 10′ for the transistor base.

With all the nodes of the circuit assigned, the microelement layouts can be completed. The jumpers required by the external circuits are placed on the end wafer, and R_1 and R_3 are placed on the adjacent wafer. Since R_2 connects to 10′ it is placed on the third wafer in order that riser wire 10 may be attached to the required minimum of two wafers before it is cut. The two diodes are mounted on the fourth wafer, followed by the transistor and the second end wafer.

Micromodules may be designed to include circuits tuned by trimmer capacitors with ranges up to sixteen picofarads. In such cases, the trimmer is mounted at the end of the module for access when tuning, and the transformer is mounted on the adjacent wafer, which may also include a larger fixed capacitor connected in parallel with the trimmer. This arrangement also provides some isolation from the remainder of the micromodule.

In the design of a micromodule system, it is often helpful to construct a breadboard of the micromodule by mounting hard-drawn wires about two inches long in each pin of a twelve-pin phenolic plug. The other ends of the wires are secured to a phenolic disk, which is similar to the base in diameter and separated from it by a small two-inch sleeve mounted at the axis of the connector. The twelve wires are numbered according to the numbers of the plug, and the circuit elements to be used in one micromodule may be connected between the riser wires. The resulting totem-pole arrangement is an electrical equivalent of the module in analogous physical form. An entire system may be made in this totem pole configuration, and the test circuits for the system may be mounted on a master board fitted with receptacles for the totem-pole plugs. This arrangement is often convenient for the tuning, testing, and adjustment of the prototype micromodules or systems of micromodules because, with an adapter socket, one or more micromodules may be substituted for the corresponding totem-pole units.



EXPLODED VIEW *of a typical micromodule*

SYSTEM ASSEMBLY—After assembly, micromodules are tested and encapsulated in an epoxy resin. When the completed micromodules have been tested again for specification performance, they are ready for assembly in the system for which they were designed. Micromodules are usually interconnected on a printed-circuit board, as shown in Fig. 3.

The printed-circuit board is designed so that the micromodules are spaced 0.4 inch between centers, but, if room is available, this spacing may be increased to accommodate a complex printed-circuit-board wiring pattern on a single side of the printed-circuit board. If the spacing between the micromodules cannot be increased beyond 0.4 inch, a double-sided printed-circuit board may be used.

A micromodule may be enclosed in a shield covering all surfaces except the chassis end; the major part of the chassis end may be shielded by a portion of the ground plane on the printed-circuit board.

If the system being designed requires components which have not yet been adapted to the micromodule form, the components may be mounted directly on the printed-circuit interconnecting board near the micromodules to which they connect.

The foregoing is a general survey of micromodule system design procedure as it exists in March, 1962. As a result of extensive development work underway at the time of writing, it may be anticipated that the coming months will further improve on the already large range of component values and operating specifications of microelements which are now available, and that the constantly improving favorable situation of micromodules with respect to operating reliability will become an achievement goal for all future generations of microelectronic concepts.

The guidance and comments offered by the author's colleagues, particularly by R. Wilson, R. Pew, H. Keitelman and R. Samuel are gratefully acknowledged.

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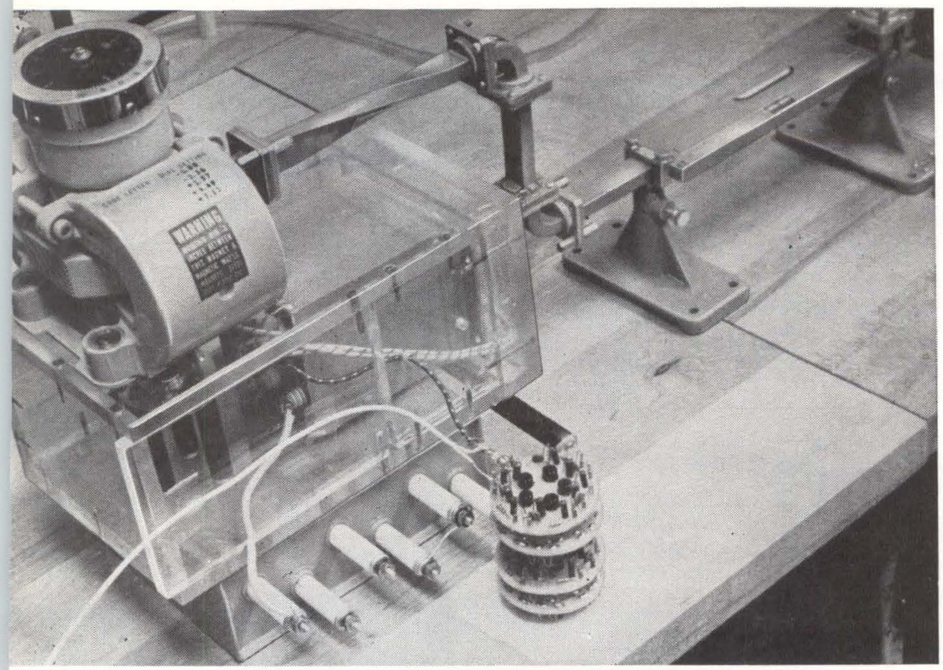


SWITCH ASSEMBLY *with 50-ohm pulse-forming network, pulse transformer beneath magnetron and simple charging resistor modulates magnetron that provides about 100 Kw at 16 Gc*

MODULES *in 8-Kv experimental switch assembly are mounted back to back to limit inductance*

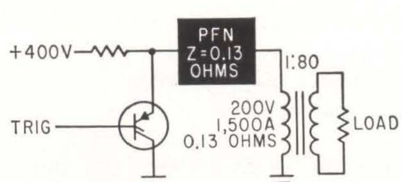
Semiconductor Modulators for Modern

Pulse modulator has been developed that delivers 300 Kw and lab setup has provided 640-Kw output. Extending the same design techniques should enable semiconductor modulators to drive the most powerful magnetrons. These modulators can also improve efficiency, reduce size and weight and provide high reliability

THIS SEMICONDUCTOR high-power modulator has been developed to improve efficiency, reduce size and weight, and provide greater reliability. Extensive use of radar in aircraft, missile and satellite applications spurred development of the unit. However, the high-power modular switch could also be useful in high-current pulse generators, short-circuit protection for high-voltage traveling-wave tubes and klystrons, linear accelerators and lasers.

Several approaches to design of high-power semiconductor pulse modulators have been taken. Reviewing their operation will aid in understanding the design of the new 300-Kw pulse modulator. All designs discussed use either *pnpn* diodes or *pnpn* transistor switches in line modulator circuits.

Drive requirements of a 100-Kw magnetron, listed in Table I, will be used as design objectives. The combination of 16.5 Kv and 18 amperes can be transformed using a suitable output transformer to achieve the 300-Kw output with lower voltage and correspondingly higher current.

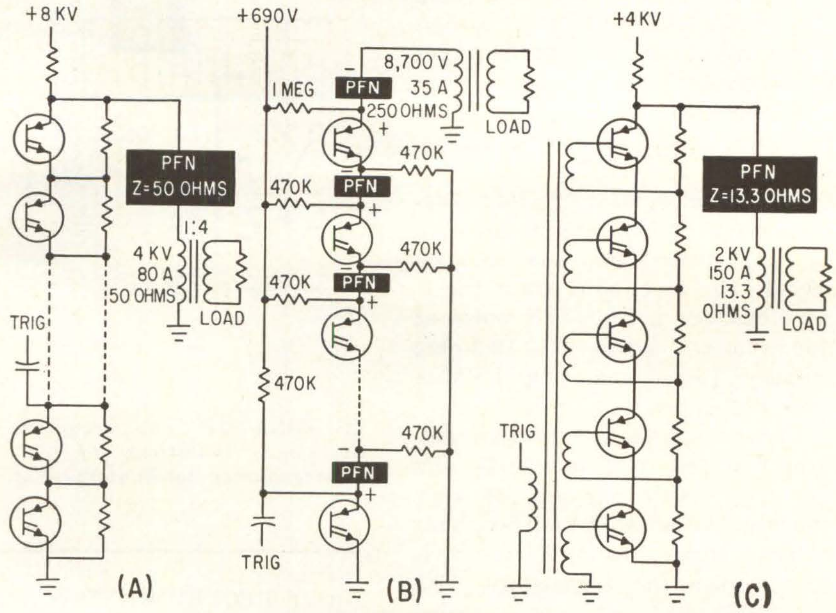


LINE-TYPE *modulator uses single pnpn transistor—Fig. 1*

A magnetron modulator has been described that uses a single *pnpn* transistor[1] to obtain 10-μsec, 250-Kw pulses. A similar circuit that operates from a 400-volt supply is shown in Fig. 1. To provide 17-Kv output, a transformer with a 1:80 turns ratio is chosen. The resulting input impedance is 0.13 ohm, so pulse-forming network impedance is also 0.13 ohm. When the trigger switches the *pnpn* transistor, it places a short circuit across the input to the pulse-forming network. The network then produces the de-

IS THIS THE ANSWER?

Radar designers have long been aware of advantages in weight, size and reliability of semiconductor modulators. However, using semiconductors in modern radar presents many problems, not the least of which is the ever growing demand for higher power. A promising solution seemed to be provided by the versatile pnpn *devices, and a number of designs based on these devices have been reported. But, as the authors point out, some of these approaches have serious limitations. The authors describe a modulator designed to overcome these disadvantages. It's also based on* pnpn *devices and looks like it will be adequate for even the most powerful magnetrons*



MULTIPLE *pnpn modulators can use single pulse-forming network (A) and multiple pulse-forming networks (B) as well as multiwinding transformer trigger (C)—Fig. 2*

Magnetrons

By F. A. GATEKA
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sired 200-volt, 1,500-ampere pulse across the transformer primary.

This circuit requires only a small number of components and a low-voltage supply. However, it has series inductance in the high-current loop. Only 0.1-μh series loop inductance will limit rise time of a 1,500-ampere pulse to about 1 μsec. Also, *pnpn* transistors that can switch 1,500 amperes are necessarily large and have rise times of about 1 μsec. The simple charging resistor could be replaced by a conventional resonant-charging arrangement, permitting operation from a lower supply voltage. A similar substitution could be made in all these modulators.

A second approach[2] uses a series arrangement of *pnpn* diodes, as shown in Fig. 2A. If modulator impedance of 50 ohms is chosen, the 300-Kw load requires about 4,000 volts at 80 amperes and the series *pnpn* diodes must sustain 8,000 volts in the off state. Since the best available *pnpn* diodes have breakovers of about 400 volts, 20 are required to sustain the 8-Kv charging potential of the pulse-forming network (PFM).

A network of shunting resistors is used to avoid unequal voltage division across the *pnpn* diodes. Switching can be done in two ways. A trigger can be provided to the string that is sufficient to exceed the breakovers. This method requires that distribution of the breakovers of the *pnpn* diodes be closely controlled, since the trigger signal is divided across the string.

MODULATOR DESIGNS—Using the triggering method shown in Fig. 2A, the lower two units are switched, permitting the remaining diodes to be switched by the steeply rising voltage transient. However, this method depends on a presently uncontrolled characteristic of *pnpn* diodes and could result in problems. Another problem is the variable delay between trigger and output pulse, which results in jitter.

Another approach is a variation of the spark-gap apparatus.[3] This circuit, shown in Fig. 2B, uses 25 *pnpn* diodes in a series arrangement. An output impedance of 250 ohms was chosen, which requires the modulator to supply 8,700 volts at 35 amperes. The required modulator impedance is achieved by effectively connecting 25 10-ohm pulse-forming networks in series. The 25 *pnpn* diodes are placed in the series string so that the pulse-forming networks are separated from each other by *pnpn* diodes.

Charging the pulse-forming networks is achieved by using large resistors from ground and from the 690-volt supply to each side of the networks. The voltages add in series when the *pnpn* diodes are switched, providing the desired high-voltage output. Triggering is accomplished by providing a pulse to the diode nearest to ground. When this diode switches, a steeply rising voltage pulse propagated through the string switches the remaining diodes.

One serious problem associated with this modulator is that 700-volt *pnpn* diodes are not presently available. Other problems include the design of a pulse-forming network that will produce an acceptable pulse when operated in series, using transient switching of *pnpn* diodes, and delay and jitter between trigger and output pulses.

Among modulators that use series arrays of *pnpn* transistors, the circuit in Fig. 2C is a direct extension of a 3-Kw modulator previously described.[4,5] A pulse transformer with an 8.7:1 turns ratio has been selected. The modulator must therefore produce a 2,000-volt pulse at 150 amperes across the 13.3-ohm primary. Impedance of the PFM is thus 13.3 ohms.

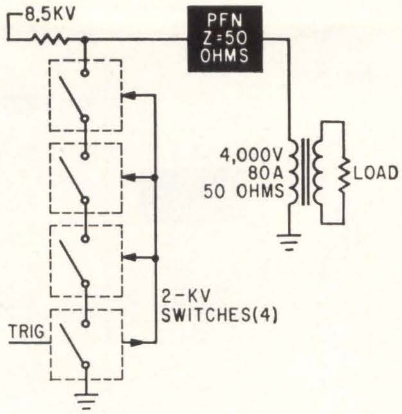
Five *pnpn* transistors with breakover voltages of at least 800 volts are required to sustain the 4-Kv charging potential. A resistor shunt network ensures equal voltage division across the transistors. The gate trigger signal is supplied through a multiwinding transformer, which must be insulated for 4 Kv and capable of supplying 0.5 amp at 3 volts to each gate.

A major problem is that an 800-volt 150-amp *pnpn* transistor that will switch up to 150 amperes in less than 100 nsec is not yet available. Also, considerable power is dissipated in the resistor network, and design of a multiwinding triggering transformer is difficult.

The trigger transformer might be simplified by supplying gate trigger current to the lower three transistors and allowing the remaining two to switch as two-terminal devices. However, delay and jitter result from the *pnpn* transistors switching as diodes.

300-KW MODULATOR—The modulator in Fig. 3 has been developed to overcome the limitations of the modulators described. Standard modulator impedance of 50 ohms was chosen, resulting in a pulse output requirement of 4 Kv at 80 amp. The 1-μsec PFN charges to 8 Kv through a 0.47-megohm resistor from the 8.5-Kv supply. Four 2-Kv switch modules are arranged in series to complete the modulator circuit. A trigger is provided to the lower 2-Kv module, which in turn provides simultaneous triggers to the other modules.

A simplified overall circuit diagram is shown in Fig. 4A. The 16-Kv 20-ampere pulse is supplied to the 7208 magnetron through the bifilar pulse transformer in the filament circuit. The pulse is gen-



MODULATOR *was designed to overcome limitations of earlier semiconductor modulators—Fig. 3*

DRIVE REQUIREMENTS—TABLE I

FOR 100-KW MAGNETRON		
Pulse Power Input....	300	Kw
Pulse Voltage Input..	16.5	Kv
Pulse Current Input..	18	amp
Pulse Width.........	1	μsec
Pulse Rise Time......	125	nsec

PERFORMANCE CHARACTERISTICS—TABLE II

Input Voltage........	8.5	Kw
Input Current........	4.5	ma
Input Power.........	38	w
Output Voltage Pulse.	4	Kv
Output Current Pulse.	80	amp
Output Power Pulse..	320	Kw
Duty Cycle..........	0.005	%
Average Output Power	16	w
Efficiency...........	42	%

erated in a standard 50-ohm PFN, which has an output of 4 Kv at 80 amperes for 1 μsec. Each 2-Kv module includes a series arrangement of five 2N1765 *pnpn* transistors. Each transistor can sustain at least 400 volts in the forward direction and can switch 80 amperes in 1 μsec. Rise time to 80 amperes is less than 125 nsec.

The 500-pf capacitors were chosen to be large enough to provide adequate triggering current to each *pnpn* transistor for at least 100 nsec but small enough to be effectively discharged in less than 1 μsec. Initial gate current for each transistor above the lowest one is about 400 ma and rapidly decreases as the capacitors discharge. The lower capacitors in the figure must supply increasingly higher currents so successively smaller ones are needed when the modules are stacked as in Fig. 4A.

The 1-μh coils were chosen so that inductance would be as low as possible without significantly affecting the trigger pulse. Small inductances effectively terminate the *n* emitter to gate of the *pnpn* transistors, enhancing their forward breakover and recovery characteristics. Since gate to *n* emitter voltage during turn-on is essentially constant at 1 volt, shunt current in the 1-μh coil at 100 nsec after trigger is: $i = 1/L\int vdt = (V/)\ \Delta t$. Therefore, if V is 1 volt, L is 1 μh and Δt is 100 nsec, $i = 1/(1 \times 10^{-6}) \times 100 \times 10^{-9} = 100$ ma.

As a result of the combined effects of capacitor discharge and linearly increasing inductor shunt current, the trigger for each *pnpn* transistor is a short high-current pulse that is terminated before completion of the 1-μsec high-current output pulse. This type trigger ensures rapid recovery of the transistors permitting reasonably rapid recharging of the PFN.

SWITCHING MODULES—Each 2-Kv module of the experimental 8-Kv switch assembly in the photograph contains five 2N1765 transistors. The 400-volt regulator diodes for each stage are composed of two 1N672 and one 1N671 voltage regulators in series. The 2-Kv modules are back to back so that the high-current path is alternately clockwise and counterclockwise to limit inductance.

The complete circuit of a 2-Kv module is shown in Fig. 4B. To describe operation, terminals 1, 2 and 3 are assumed to be at ground potential and terminal 6 at +2,000 volts. The voltage-regulator diodes maintain voltage across each *pnpn* transistor at 400 volts, and the charge on each 500-pf capacitor is also 400 volts. A 0.5-ampere, 3-volt trigger is supplied to the gate of the transistor nearest to ground. When this transistor switches, voltage at point A is reduced by about 400 volts. Because of the voltage-regulator diodes, voltage at point B and every comparable point in the string is reduced by 400 volts.

The 500-pf capacitors have been charged to 400 volts through the

1,000-ohm resistors. When voltage at point *A* is reduced by 400 volts, voltage on the forward-biased gate terminal of the *pnpn* transistor is correspondingly reduced so that there is a 400-volt potential across the 1,000-ohm resistor. Thus the capacitor supplies 400 ma to the gate of the second transistor. Simultaneously, a 400-ma gate signal is provided to the gate of each transistor in the string.

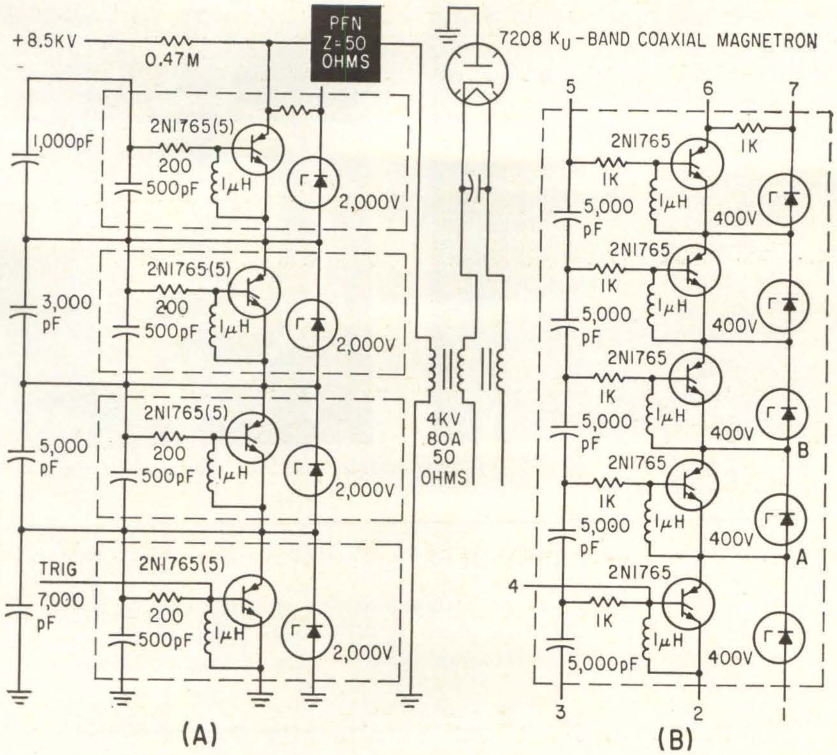
DIODE CURRENT—Time is required for the voltage-regulator diodes to accomplish the 400-volt change at point *B* and comparable points. When the module is in the high-impedance state, the diodes are reverse biased into their avalanche regions. When the first transistor is triggered and the voltage-regulator diodes are voltage-stressed by switching of the first transistor, reverse current of the top diode is increased from the 1-ma off-state current to 400 ma peak. Reverse current of the second diode from the top increases to 800 ma, since it carries the current of the top diode as well as the 400-ma trigger current supplied to the top *pnpn* transistor. The third and fourth diodes from the top carry 1,200 and 1,600 ma, respectively, during the early part of the turn-on transient. Since the diodes were in the avalanche region and are driven further into it, less the 1 nsec is required to change current.

Switching waveforms of the 300-Kw modulator operating at full power output are shown in the photograph: 0.25 μsec per horizontal division and 4,000 volts per vertical division. The 4-Kv, 300-Kw output pulse is shown at the top. Rise time and pulse length are determined by characteristics of the PFN. Voltage across the 8-Kv switch assembly during switching is shown at the bottom. Rise time of the 600-Kw closure is 125 nsec.

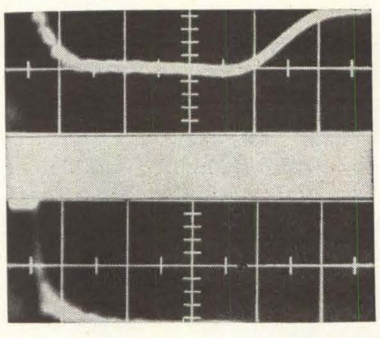
Performance data for the 8-Kv switch assembly made up of four 2-Kv modules is shown in Table II. A 300-Kw pulse at a duty cycle of 0.005 percent is delivered to a 50-ohm load. Pulse repetition rate is limited by thermal design of the switch assembly and could be improved by potting, encapsulating the assembly in oil or air cooling.

Modulator efficiency could be improved by using a resonant-charging diode and inductor instead of the charging resistor, which would eliminate about 6 watts of dissipation. Efficiency has been improved significantly by using voltage-regulator diodes to stabilize voltage across the *pnpn* transistors. If resistors with the same dynamic resistance as the diodes were used, power losses would be increased.

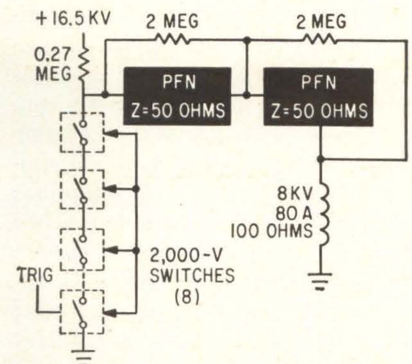
The 8-Kv, 300-Kw switch assembly in the photograph is being used to modulate a 7208 magnetron, which has output power of about 100 Kw at 16 Gc. The experimental setup includes a 50-ohm PFN and pulse transformer (under magnetron) and a simple charging resistor.



DEVELOPMENTAL *300-Kw modulator (A) uses four 2-Kv switching modules (B) in series—Fig. 4*



MODULATOR *operating at full power has 4-Kv output waveform shown above. Waveform across 8-Kv switch is shown below*



EXPERIMENTAL *modulator switches 1.28 megawatts to provide 640-Kv output—Fig. 5*

Two 8-Kv switch assemblies were wired in series with two 50-ohm pulse-forming networks with suitable balancing resistors, as in Fig. 5. With this arrangement, a switching operation from 16 Kv to 80 amperes has been obtained.

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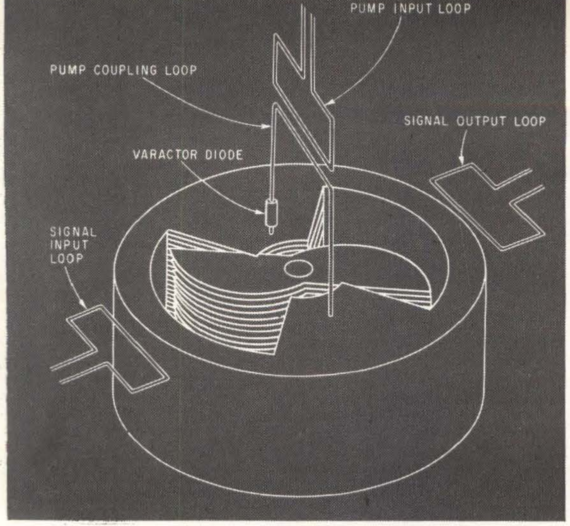

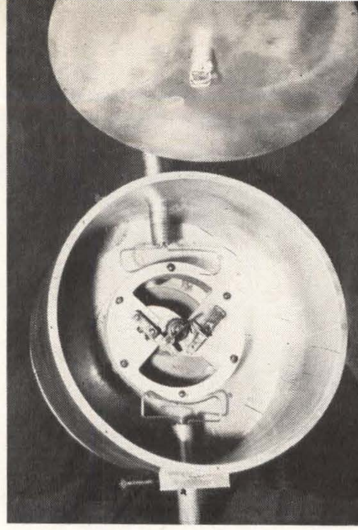

EXTREME SIMPLICITY *of parametric amplifier is evident in these pictures—Fig. 1*

Is This the

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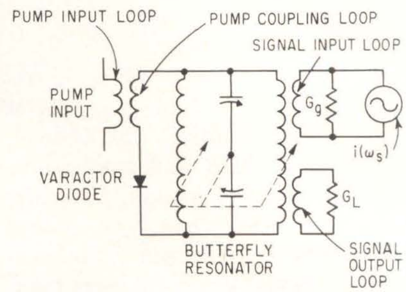


ONLY ONE *butterfly resonator, one varactor diode, with coupling loops for signal and pump frequencies, make up the amplifier circuit —Fig. 2*

DESIGN FOLLOW-THROUGH

Dick Mayer discussed the preliminary design of this vhf parametric amplifier in ELECTRONICS, *Dec. 15, 1961. Since then he has made several important design changes. Now he says it may the simplest paramp ever constructed*

POSSIBLY the simplest parametric amplifier ever constructed consists of only one butterfly resonator and one varactor diode with coupling loops for the signal and pump frequencies. In addition to its simplicity and low cost, the amplifier features a wide operating frequency range: it is tunable over at least a two-to-one frequency band. It operates in a quasidegenerate mode; both signal and idler frequencies are within the passband of the single resonator. This new amplifier differs considerably from a design suggested in an earlier article.[1]

Butterfly resonators have these desirable features at vhf and lower microwave frequencies:[2] freedom from erratic behavior—no sliding contacts; wide tuning range—a tuning ratio (ratio of max to min resonant frequency) of the order of 5:1 is possible; high Q—typical values range from 200 to 1,000; accessibility of points between which maximum impedance is developed; ease of tuning; and small size relative to other resonators covering the same frequency range.

NEW DESIGN—Figure 1 shows the new amplifier. The signal is magnetically coupled to the butterfly resonator. The varactor diode is in series with the pump coupling loop across the high impedance points of the resonator. The pump signal is magnetically coupled through the pump input loop to the varactor. The circuit is shown in Fig. 2 where G_g and G_L are the signal generator conductance and the load conductance, respectively. Although this circuit is unlike that of the conventional parametric amplifier, which has been thoroughly analyzed,[3-5] it can be shown to be subject to the same analysis. The circuit (Fig. 2) is reduced to that used by Blackwell and Kotzebue in their analysis of the degenerate amplifier.[6] First, the equivalent circuit at the pump frequency is considered to show that the pump input signal appears across the varactor, but not across the signal input and output terminals. The butterfly resonator, tuned to the signal-idler frequency, is essentially a short circuit to the pump signal. The equivalent circuit at the pump frequency thus reduces to that in Fig. 3A, and virtually all pump power coupled to the pump coupling loop appears across the varactor.

Average capacitance of the varactor is only about 1 to 3 pf. Therefore, its impedance at the signal-idler frequency is much greater than the pump-coupled-impedance. The equivalent circuit at the signal frequency thus becomes that of Fig. 3B. For convenience, the butterfly resonator has been replaced by a parallel tuned circuit that has a finite passband. For quasidegenerate operation, both the signal and the idler frequencies are within this passband so that only this single tuned circuit is necessary. Finally, the signal input and load conductances can be transformed to appear directly across the signal circuit. In Fig. 3C, where G_g' and G_L' are the equivalent, transformed, generator and load conductances, respectively. This circuit is identical to the equivalent circuit used by Blackwell and Kotzebue.

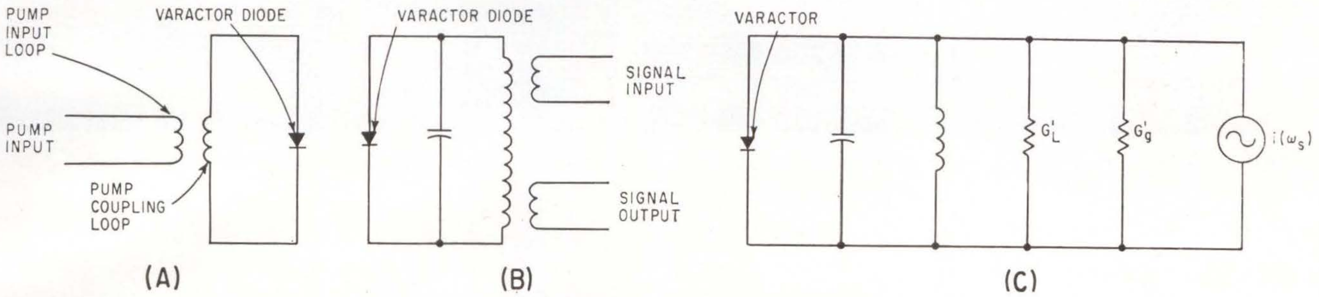
DESIGN EQUATIONS — Transducer gain, g_t, at signal frequency, ω_s, is given by:[6]

$$g_t = \frac{4G_g'G_L'}{\left[G'_g + G'_L - \dfrac{\omega_s\omega_i(\gamma C_0)^2}{G'_g + G'_L}\right]^2}$$

where ω_i is the idler frequency; γC_0 comes from the assumed varactor capacitance variation at the pump frequency, ω_p. Its expression is $C(\omega_p) \cong C_0 + 2C_0\gamma \cos \omega_p t$. The single-sideband noise figure is $F_{ssb} = 2[1 + (T/T_0)(G_s'/G_s)]$ where G_s is the varactor loss conductance, T is the operating temperature and T_0 is the standard noise temper-

Simplest Paramp Ever Built?

This quasi-degenerate parametric amplifier for vhf and lower microwave frequencies features simplicity and low cost. It is tunable over at least a two-to-one frequency band



EQUIVALENT CIRCUITS *at pump frequency (A), at signal-idler frequency (B) and for mathematical analysis (C) where G_g' and G_L' are the equivalent, transformed, generator and load conductances—Fig. 3*

ature of 290 degrees K.

In Fig. 1, the pump input loop is in the container cover (top of photo). The amplifier is inside the round, brass container, and the shaft of the resonator rotor protrudes from the container so that the resonator may be tuned from the outside (tuning knob not shown). The signal coupling loops are on either side of the resonator, and the varactor and the pump coupling loop are seen in edge view.

TEST RESULTS—Both a spectrum analyzer and a receiver were used during tests. The amplifier was intended as a low-noise amplifier at 150 Mc. On the spectrum analyzer display, the 150 Mc signal and idler differed by approximately 300 Kc, although operation at differences anywhere below about 500 Kc is possible, depending on pump frequency.

Bandwidth is approximately 200 Kc. Maximum stable power gain is about 25 db, although maximum long-term stability is obtained by operating below about 17 db.

Operating frequency can be changed by retuning the resonator and changing the pump frequency. Power gains of 20 to 30 db were obtained at signal frequencies up to 300 Mc. The only tuned circuit is the resonator that tunes the frequency band 135 to 485 Mc; the amplifier insertion loss (pump off) over this entire band is less than 5 db. Therefore the amplifier should operate over this band if adjustments of the pump frequency are made. However, the upper frequency was restricted to 300 Mc because the power output of the pump source used was too low for operation above 600 Mc. (For quasi-degenerate operation, the pump frequency is approximately twice the signal frequency.) About 200 mw pump power was required. Microwave Associates, MA 450 series varactor diodes were used (MA 450A thru MA 450E diodes produced no change in operating characteristics).

The amplifier was operated without a circulator because none was available for frequencies below 250 Mc. Thus, the amplifier is sensitive to small changes in generator or load impedance, and it is difficult to measure noise figure. A conventional noise source cannot be used because of the change of impedance of the noise source between on and off conditions. Kotzebue[7] reported this difficulty in an earlier investigation; he measured the noise figure of his amplifier by visually observing its noise output on a spectrum analyzer.

Noise output was too low to be observed on the spectrum analyzer. Crude measurements of the noise figure were made by measuring input and output signal to noise ratios. These measurements yielded a single-sideband noise figure of about 3.5 db, an indication that the noise figure is low.

This amplifier should be operated at signal frequencies of 250 to 3,000 Mc where both circulators and butterfly resonators are available. Besides increasing stability, the circulator will double the voltage-gain-bandwidth product.

The author is indebted to Dwight E. Isbell for his suggestions which led to this development.

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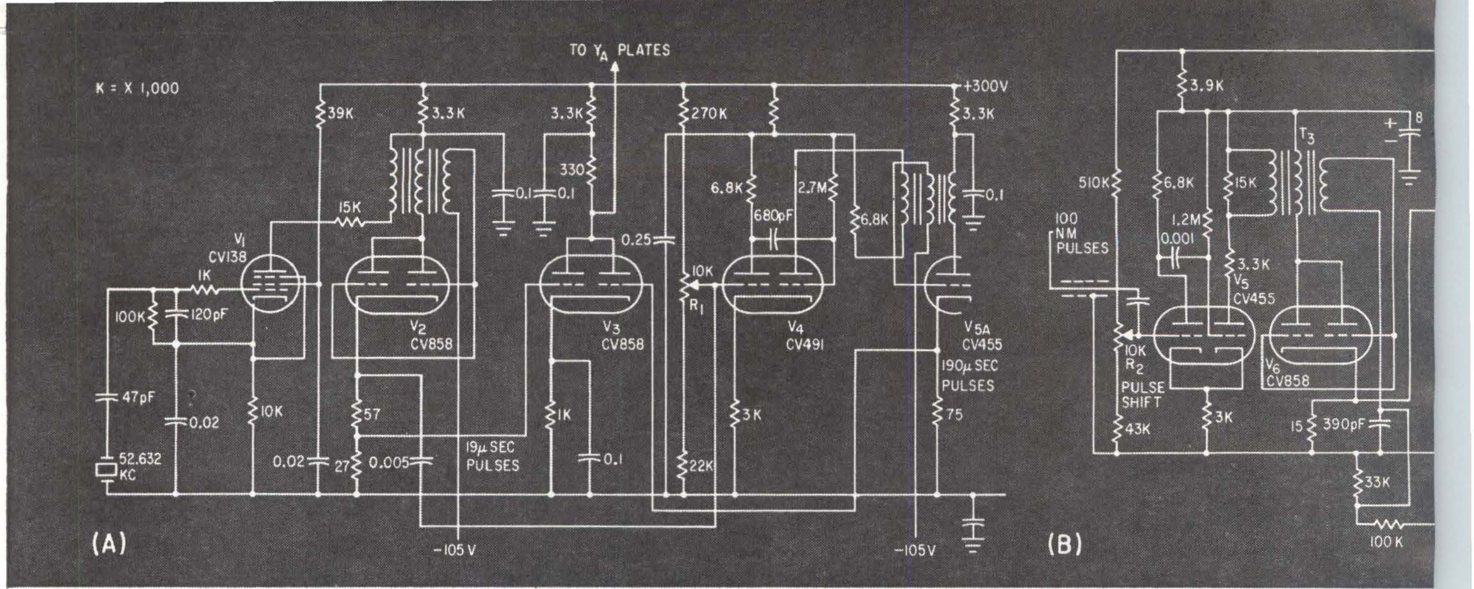


CIRCUITS *of marker pulse generator (A), transmit pulse generator (B) and time-base delay (C)—Fig. 1*

Compact New Instrument

By F. JONES
General Post Office
Research Station
Dollis Hill, England

J. H. REYNER
Furzehill Laboratories Ltd.,
Boreham Wood, England

Pulse-echo instrument identifies shunt or series faults, pinpoints them within 0.1 mile in a 50-mile range. Dual-beam oscilloscope contributes to fast operation, is easy to read

THIS NEW pulse-echo instrument for locating faults in submarine telephone cables is both fast and compact; it has to be for use aboard modern cable-repair ships. This instrument abandons the usual highly-complex circuits in favor of a simple scanning system coupled with crystal markers calibrated in nautical miles. But it retains the accuracy of earlier instruments.[1]

It measures only 21 by 18 by 23 inches, but can locate, in a few minutes, the position of a cable fault to within 0.1 mile. The maximum range is 50 nautical miles. It can select any 1 or 10-mile spread within this range, for an accuracy of location of ±0.5 percent or ±40 fathoms, whichever is greater.

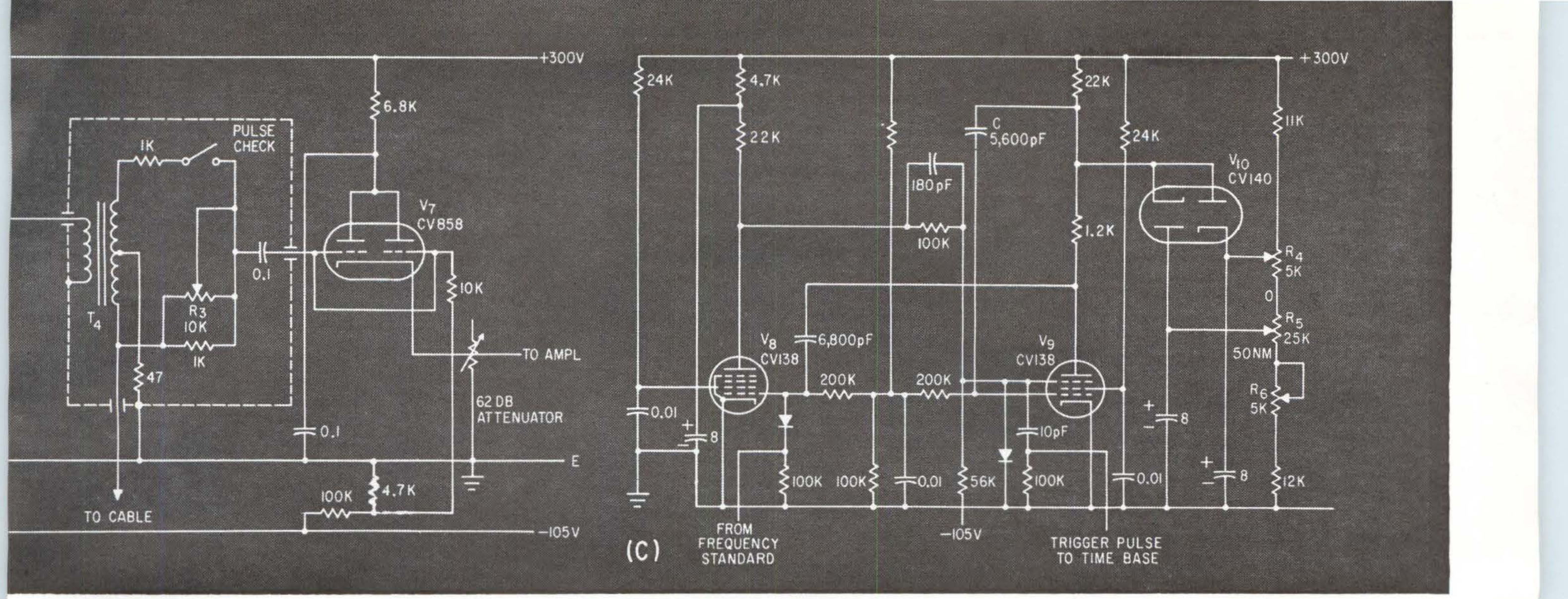
BASIC DESCRIPTION—A pulse of 2-v amplitude and approximately sine-squared shape is applied to the input of the cable. Any fault that produces an abnormal variation in impedance causes this pulse to be reflected and received at the sending end after a time interval that is a measure of the distance to the fault. The pulses are displayed on the upper trace of a double-beam crt. The lower trace displays crystal-controlled marker pulses at intervals corresponding to one nautical mile with every tenth marker of increased height. The transmitted pulse is applied to the cable through a variable delay network that enables it to be aligned with a pulse marker so that the distance of the received pulse can be readily assessed. Figure 2A illustrates the display.

The relative direction of the reflected pulse indicates the type of fault. If it is in the same direction as the transmitted pulse it indicates a series fault, the extreme being an open circuit which gives 100 percent reflection. Conversely a shunt fault gives a reflection in the opposite direction, the extreme being a short circuit which again gives 100 percent reflection.

Initially, the full sweep width corresponds to 50 nautical miles. A range switch then permits the 10-mile sector in which the fault occurs to be expanded to full screen width. A further expansion can

WHY ANOTHER FAULT FINDER?

For people concerned with cables, here is another piece of British ingenuity—a pulse-echo instrument for cable-fault location. Since fault locators using the echo technique have been around for over fifteen years, we were wondering what advantages the new instrument had over previous ones. The answer? Most cable-fault locators are accurate, sophisticated, but bulky. This one is not only accurate but also simple, compact and fast—just what was needed aboard cable repair ships



Finds Undersea Cable Faults

then be obtained of the appropriate 1-mile sector so that with full-screen width representing one mile the distance can readily be assessed to an accuracy of better than 0.1 mile.

MARKER GENERATOR—A block diagram is shown in Fig. 2B. The heart of the instrument is the crystal-controlled marker-pulse generator, which produces pulses at intervals corresponding to one nautical mile. The velocity of propagation in a cable depends upon its construction but for most submarine cables a coaxial construction with polythene dielectric is used, and for this type of cable the velocity is 9.5 μsec per nm.

Hence, the time taken to go and return is 19 μsec per nm and marker pulses are therefore arranged to occur every 19 μsec, corresponding to a frequency of 52.632 Kc.

For any other type of coaxial cable the indicated distance of the fault must be multiplied by a correction factor based on relative phase velocity. This is usually known as part of the cable specification.

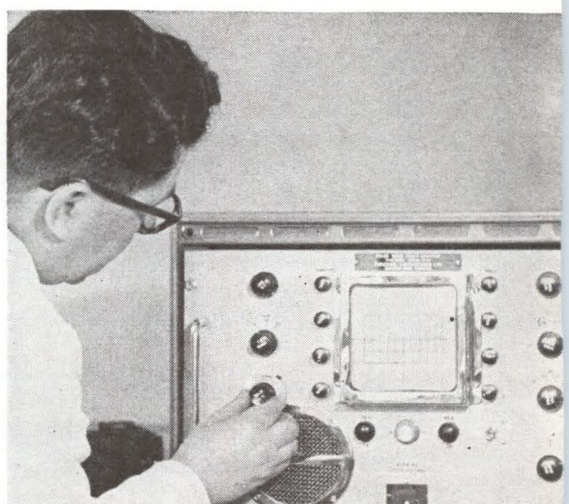
A crystal oscillator generates a primary frequency of 52.632 Kc, which triggers a blocking oscillator to produce sharp pulses at 19-μsec intervals.

Since the coarse display covers 50 nm it is desirable to accentuate every tenth pulse. This can be accomplished by generating a larger pulse every 190 μsec and superposing it on the smaller 19-μsec pulses.

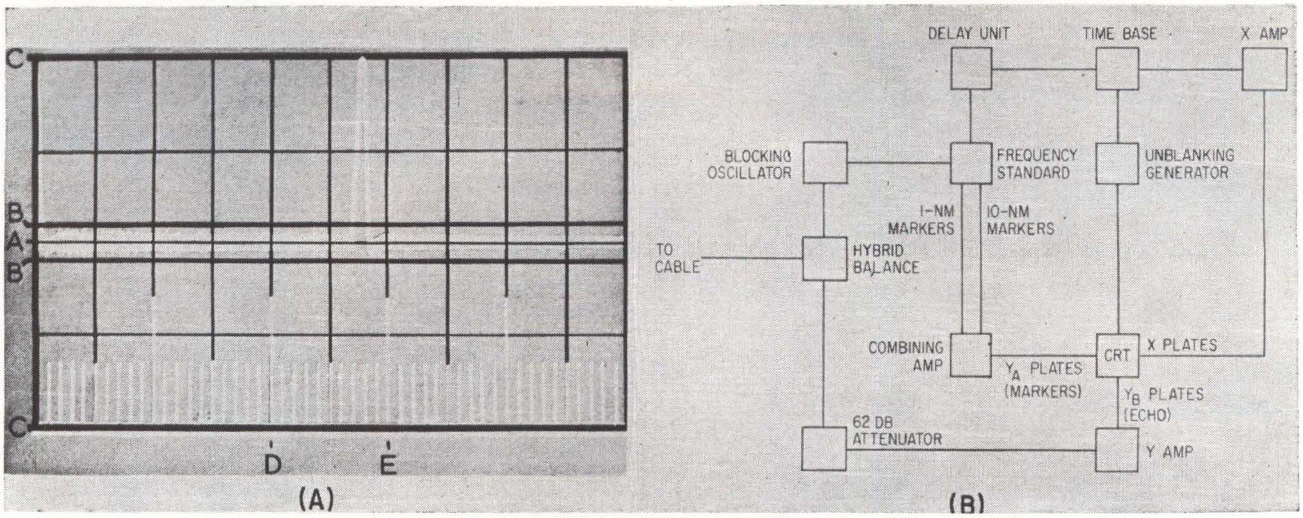
The marker-generator circuit is shown in Fig. 1A. Crystal oscillator V_1 is followed by blocking oscillator V_2. Sharp pulses are produced in the cathode of V_2. These are approximately sine-squared in form and have a half-amplitude duration of about 0.1 μsec. The pulses are fed to a monostable multivibrator V_4, whose output is differentiated and triggers a second blocking oscillator V_5. In the cathode of V_5, pulses are generated similar in form to those in V_2. The 19-μsec and 190-μsec pulses are then combined in double triode V_3 and fed to the marker plates of the crt.

TRANSMITTED PULSE — The 190-μsec pulses are also applied to a similar dividing circuit that generates pulses at intervals of 1,900 μsec, corresponding to 100 nm. These pulses are applied to the cable under test. However, since there is a minimum delay of 190 μsec in the operation of the time base, it is necessary to delay the transmitted pulse by a corresponding amount. It is convenient to make this delay variable over a small range to enable the transmitted pulse to be aligned with one of the 10-nm pulses.

The trigger pulse is then applied to a monostable multivibrator (V_5 of Fig. 1B) in which a delay of between 171 and 228 μsec (9 to 12 nm) is obtained by adjusting the potential on the first grid. The



LOCATING *a cable fault using pulse-echo technique*



ECHO *from fault in cable, with 1 and 10-mile markers (A); complete fault locator (B)—Fig. 2*

square-wave output from this circuit is then differentiated in T_3.

Tube V_6 develops a pulse at the cathode of approximately $\frac{1}{3}$ μsec half-amplitude duration that is fed to transformer T_4, which has a center-tapped secondary. The pulse developed in one half of the secondary (approximately 2-v amplitude) is applied to the cable. This pulse is also fed to the display amplifier but is offset by an equal and opposite pulse developed across the other half of the secondary so that the amplifier is not blocked, whereas the reflected pulse is applied unattenuated direct to the amplifier input. By adjusting the balancing network, the displayed amplitude of the transmitted pulse may be set to a convenient height comparable with the received pulse.

The display amplifier uses conventional circuits, has a total gain of 77 db, and supplies symmetrical signals to the upper Y plates of the crt. An attenuator of 62 db in 1-db steps allows adjustment of the display amplitude.

With the pulse-check switch open, the hybrid balance is inoperative and the full pulse amplitude is applied to the amplifier. The attenuator is adjusted until the pulse height is the same as that of the received pulse; the additional attenuation required is the pulse attenuation in the cable.

TIME-BASE GENERATOR—Conventional circuits are used to generate the horizontal sweep, but a variable delay circuit is incorporated to permit an amplifier display of selected portions of the trace. See Fig. 1C. The pulses from the frequency standard are fed to time-delay circuit V_8-V_9. At rest, V_9 is cut-off but upon the arrival of a pulse, capacitor C begins to discharge, producing a linear fall of plate voltage. The duration of this fall is controlled by the setting of delay network R_4 to R_6. The minimum delay with R_5 at zero can be set by R_4 to 190 μsec or 10 nm and the maximum with R_5 at maximum is set by R_6 to 1,140 μsec or 60 nm. Potentiometer R_5 thus covers a delay range corresponding to 50 nm. Thus, the beginning of the sweep can be made to coincide with the transmitted pulse, for coarse display, or any point immediately preceding the reflected pulse, for closer estimation of distance.

The saw-tooth pulses in the plate circuit of V_9 are accompanied by square pulses at the screen. These are differentiated and trigger the time-base generator, that uses a bootstrap circuit and feeds a symmetrical amplifier driving both sets of X plates on the crt. Three sweep ranges are provided, giving sweep times that correspond to full screen widths of 50, 10 and 1-nm. The crt trace is normally blacked out but is restored to normal brilliance during the sweep by unblanking pulses derived from the time-base gate.

OPERATION—The width of the pulse initially $\frac{1}{3}$-μsec half-amplitude duration, increases as it progresses along the cable due to the attenuation against frequency characteristic. This might cause errors, but it is found that errors can be obviated by measuring the distance between the 10-percent amplitude points of the sent and received pulses. The crt graticule is provided with a main mark 1-inch from the center line and a subsidiary mark at 0.1-inch. The amplitude of the pulses is adjusted to the main mark by attenuator and pulse control. Distance to the fault is then assessed by the intersection of the pulses with the 10-percent line.

The instrument is first used on the 50-nm range with zero delay, producing a display as shown in Fig. 2A. The time base is then changed to the 10-nm range and the fine control adjusted so that the 10-nm markers coincide with the beginning and end of the scan.

The time-base delay is then increased, noting the number of 10-nm intervals, indicated by the traverse of the 10-nm markers across the screen, until the reflected pulse appears. Total distance can be read off with greater accuracy. The process can be repeated on the 1-nm range, permitting the location of the fault to be determined to an accuracy of ±0.5 percent.

The authors thank the engineer-in-chief of the British Post Office for permission to publish these details, and to J. W. Glazbrook of the GPO Research Station, for much detailed work during the development of the equipment.

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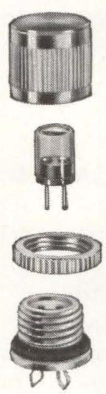

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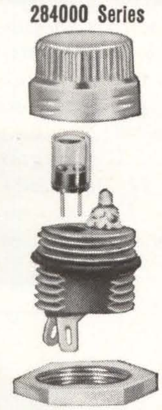

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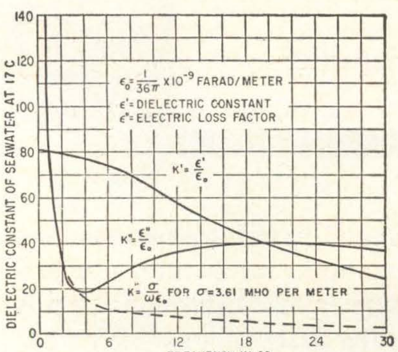
The Navy knows its vlf well indeed. Stations at Annapolis, Maryland and Balboa, Canal Zone were on the air before World War II. During World War II, the big 16.88-Kc alternator at Haiku, Hawaii came on the air using an antenna strung between two mountain peaks. Right after the war, the rig was replaced with a ½ megawatt vacuum-tube job at Lualualei.

Big Jim, a 1-megawatt transmitter with a frequency range from 14.5 to 35 Kc is located in a deep valley at Jim Creek, Washington (ELECTRONICS, p 98, Dec. 1952). Now Big Jim has a brother; another 1-megawatt rig near Camden, Maine

Getting Signals Through to Submarines

Characteristics of sea water and the air-to-water interface are highly unfavorable for electromagnetic communication. Signal attenuation at high frequencies is thousands of db per meter

By E. J. HILLIARD
U.S. Naval Underwater Ordnance Station, Newport, Rhode Island



DIELECTRIC CONSTANT *of sea water at 17 C—Fig. 1*

SEA WATER IS KNOWN to be an extremely poor transmission medium for electromagnetic waves. In tests made so far, no windows have been found up to 100 Gc, and it is unlikely that any will be found. Nevertheless, for radio control of, or communications with, submarines or other submerged devices, sea water and the air-to-sea interface have characteristics that allow some signal transmission.

The signal transmitted to the submerged receiver can generally be maximized by using a vertically polarized transmitting antenna, since this allows the maximum signal through the interface and also minimizes the dependance of signal strength on angle of incidence.

Transmission parameters of interest are attenuation, wavelength and intrinsic impedance, from 10 cps to 100 Gc. Also required for an understanding of radio transmission through the air-water interface are transmission coefficient against angle of incidence for both horizontal and vertical polarization of the incident wave.

The curves are for sea water at 17 C. No attempt has been made to determine how far the values for other temperatures will depart from those plotted. These curves are intended as a handy guide to electromagnetic radiation into and through sea water, and as a theoretical starting point for further investigation.[1, 2, 3]

WHAT THE CURVES MEAN—Of the many curves that can be plotted there is space here only for the most descriptive and most useful. The dielectric constant of sea water in the rationalized mks system is given in Fig. 1.

Intrinsic impedance Z of sea water against frequency is shown in Figure 2, where $Z = E/H$ with E in v/m and H in amp/m. While the plot of phase

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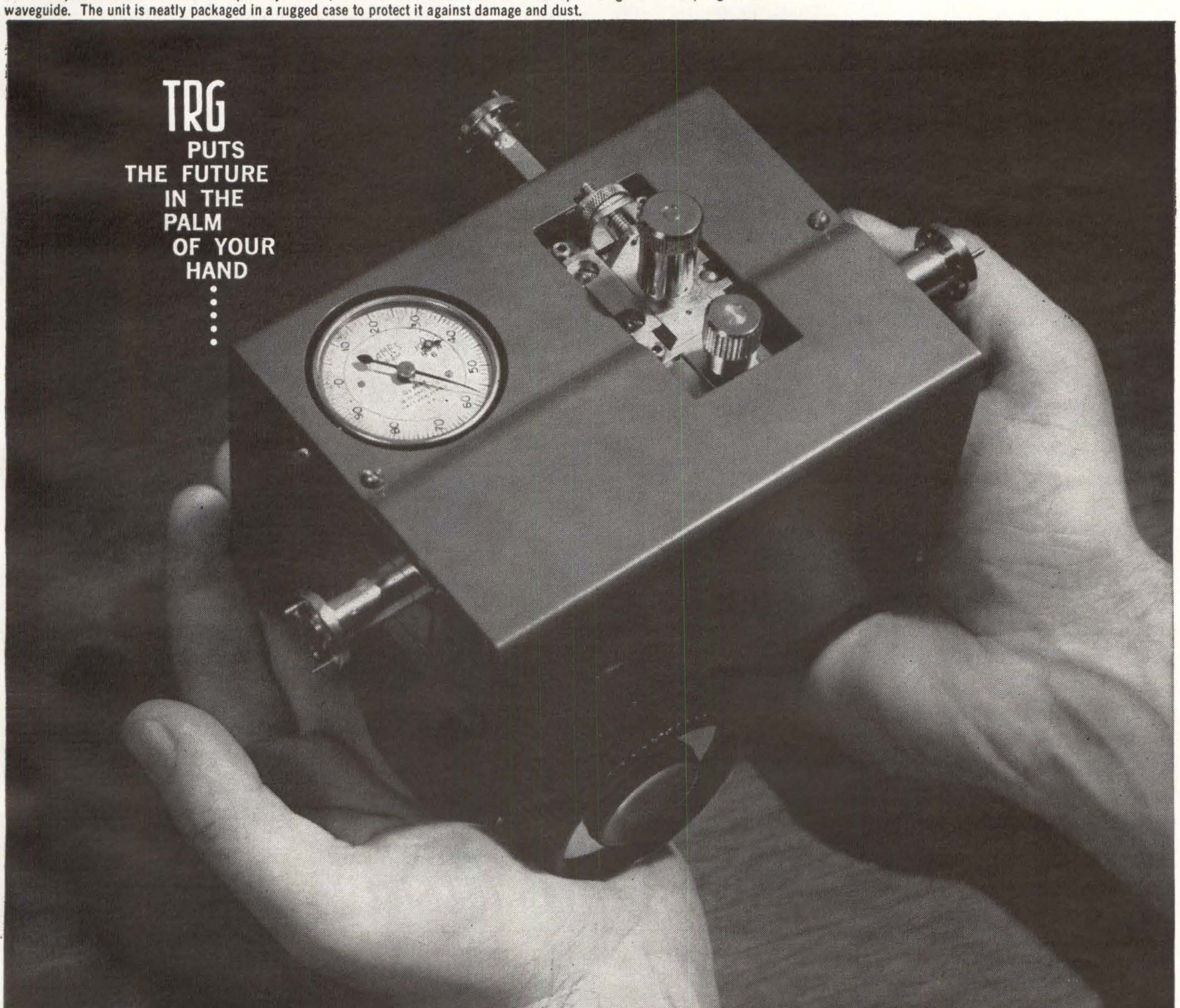
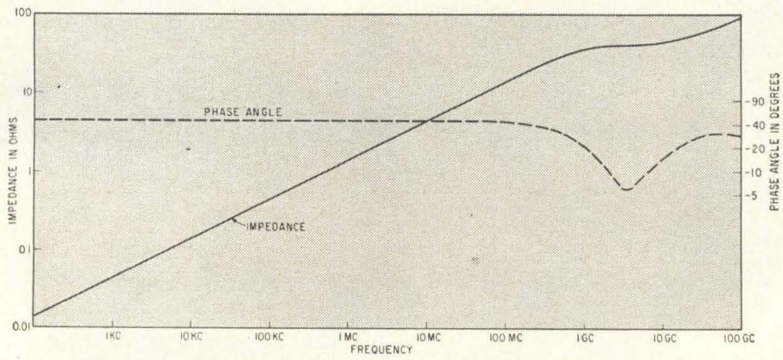


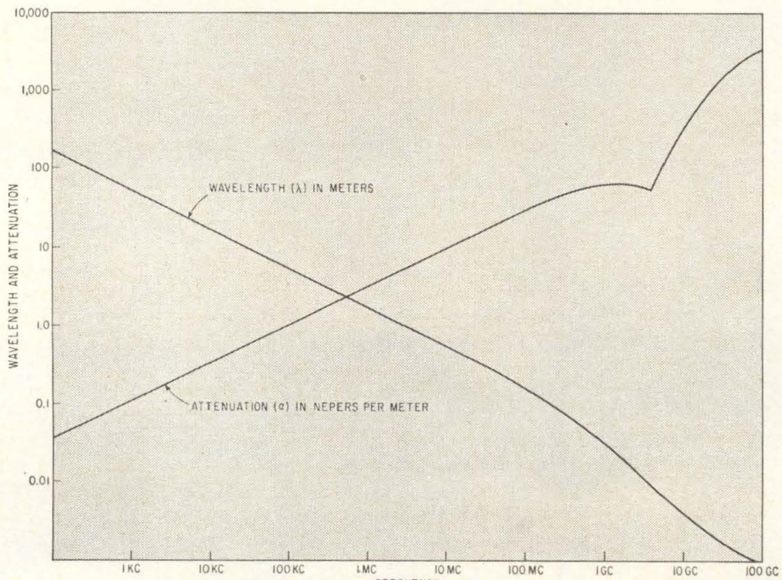
FREQUENCY RANGE-KMC	A-band 26-40	B-band 33-50	V-band 50-75	E-band 60-90	W-band 75-110	F-band 90-140	G-band 140-220
MODEL NUMBER	Under Development	B740	V740	E740	W740	F-740	Under Development

angle is somewhat distorted by the log-log scales, the scale allows the amplitude and phase angle to be plotted on the same graph. The plot shows that the impedance varies directly as the square root of frequency and the phase angle stays at 45 degrees up to 100 Mc. The dip in the phase angle curve corresponds with the minimum in K_2 (relative dielectric constant of sea water at 17 C) at approximately 3.5 Gc.[4]

Wave length of electromagnetic radiation in sea water as shown in Fig. 3 varies inversely as the square root of frequency up to 100 Mc. Attenuation (also shown in Fig. 3) varies directly as the square root of the frequency up to 100 Mc. Of interest is the notch in the region between 3.5 and 4 Gc. The depth of the notch, measured from the local maximum at about 2 Gc, is at most 5 nepers per meter. In db, this is 5 × 8.686 = 43.4 db. Since the level in this region is about 70 nepers per meter (608 db per meter), the percentage decrease is a minute 0.8 percent. Beyond this valley the curve rises sharply to the imposing height at 100 Gc of 4,000 nepers per meter or 34,800 db per meter.



INTRINSIC IMPEDANCE *rises exponentially as frequency increases. Phase angle remains at 45 degrees to almost 100 Mc—Fig. 2*



SIGNAL WAVELENGTH *and attenuation of electromagnetic radiation in sea water at 17 C—Fig. 3*

Figure 4A shows the variation of transmission coefficient with angle of incidence for vertical polarization of the incident wave. For the lower frequencies, the transmission coefficient is practically independent of angle of incidence (ϕ) for angles below 89.5 degrees. The angles of refraction were always less than 6.5 degrees for the values of ϕ chosen. For 10 Gc and below, the angles of refraction were always below 1 degree. Figure 4B shows transmission coefficient plotted on an expanded scale of angle of incidence between 80 and 90 degrees.

Figures 4C and 4D are for horizontal polarization of the incident wave. Here the transmission coefficient falls rapidly toward zero as the angle of incidence increases. At zero angle of incidence, at corresponding frequencies, transmission coefficients for both horizontal and vertical polarization are identical (Fig. 4A and 4C). For a wave directed perpendicular to an interface, the sense of polarization is lost.

FREQUENCY EFFECTS—As frequency increases the transmission coefficient increases, as does the attenuation. In the region of the frequency spectrum where 10 to 50 percent of the incident field strength is obtained on the under side of the interface, the attenuation is so high that the signals are useless. In the region where attenuation is more reasonable, the losses through the interface are large.

Figure 5 shows the total attenuation to be expected through the interface and through sea water to any depth. Vertical polarization of the incident signal was chosen because the transmission coefficient is virtually in-

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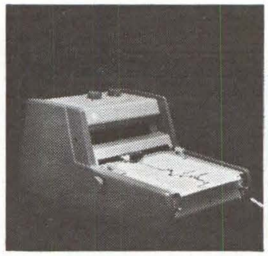

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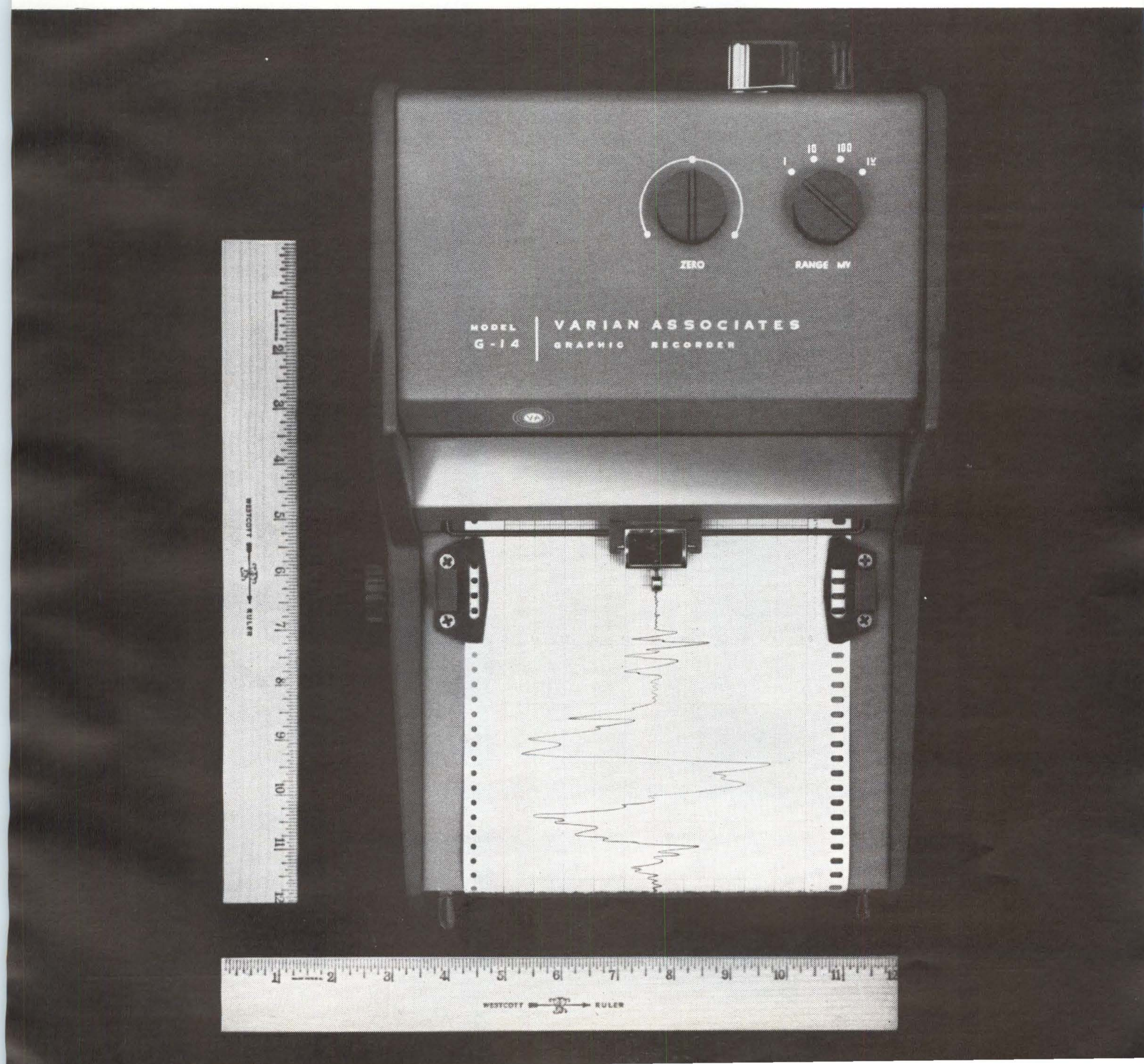
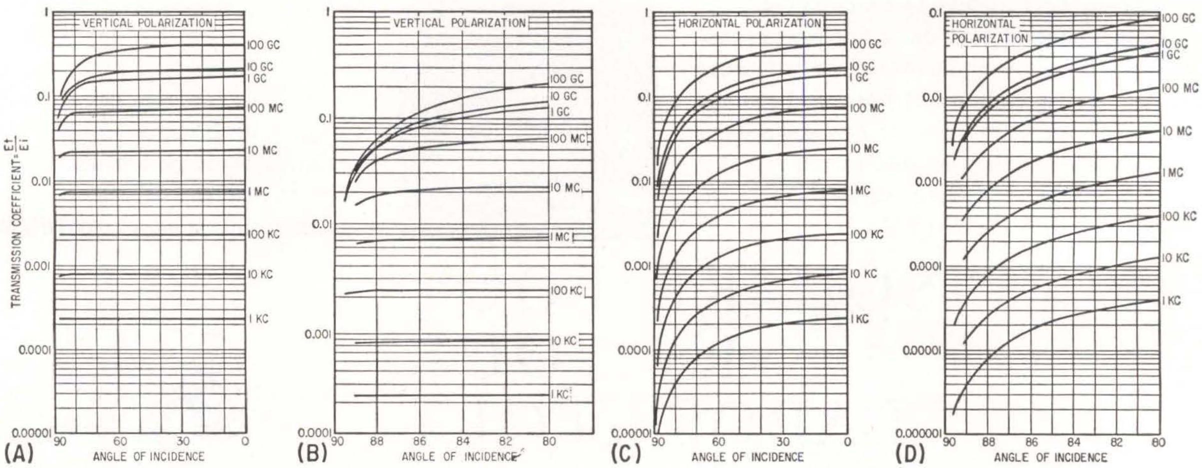




TRANSMISSION COEFFICIENTS *for vertically and horizontally polarized waves. At an angle of incidence of zero, transmission is identical for both polarizations for the same frequency—Fig. 4*

dependent of angle of incidence. In addition the curves represent the most favorable limit for total attenuation. Horizontally polarized signals will give higher values for all angles of incidence.

The following functions were obtained graphically

α (interface) $= 13.25\ f^{-.0667}$

α (sea water) $= 0.0037\ D\sqrt{f}$

where f is the frequency in cps, D is the depth of penetration in meters and α is attenuation in nepers. These values of attenuation agree with the results shown in reference 1. The frequency at which the total attenuation is a minimum for any fixed depth D is

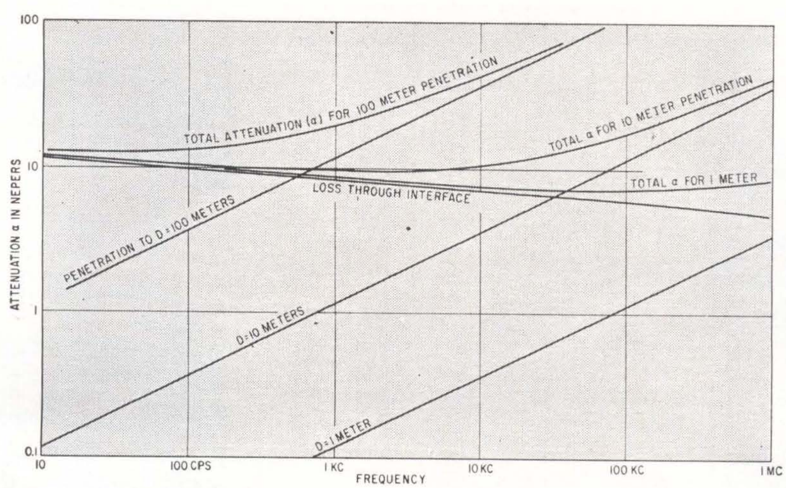
$$f = \left[\frac{478}{D}\right]^{1.76}$$

The table shows some representative values for frequency f and depth of penetration D. The values for total attenuation are optimistic, not conservative.

Frequencies different from those given will increase the total attenuation α, as will horizontal polarization. In selecting a carrier frequency for underwater vehicle control systems, the minimum interface-to-sea water attenuation formula should be carefully considered.[5]

MINIMUM ATTENUATION AT BEST FREQUENCY FOR VARIOUS DEPTHS

D	f for α Min.	α Total at f
100 m	16 cps	13 nepers (113 db)
10 m	900 cps	9.8 nepers (85 db)
1 m	52 Kc	7.2 nepers (62.5 db)



ATTENUATION *suffered by a signal passing through the air-to-water interface and penetrating to a given depth increases with frequency. Total attenuation curves are obtained by adding penetration loss to interface loss—Fig. 5*

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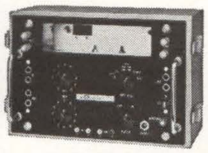

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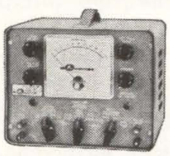

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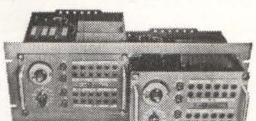

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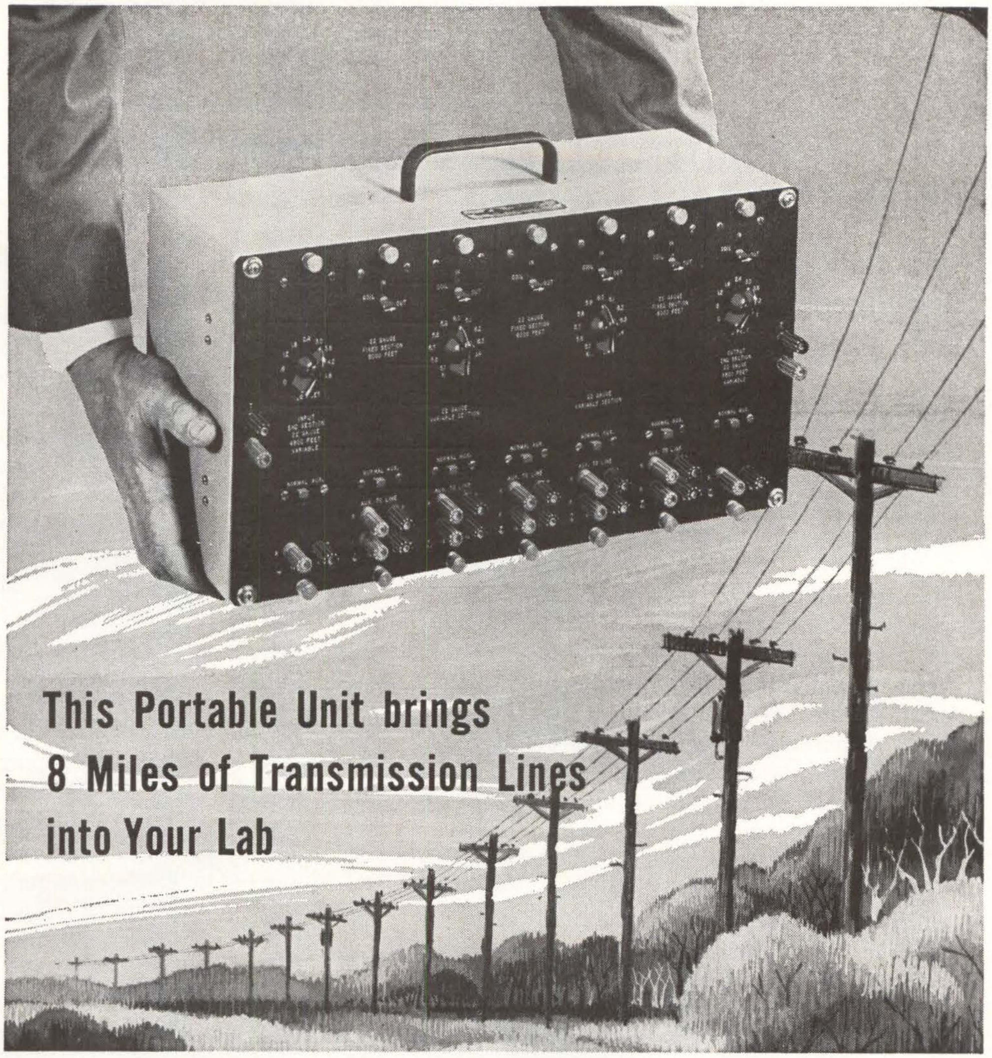

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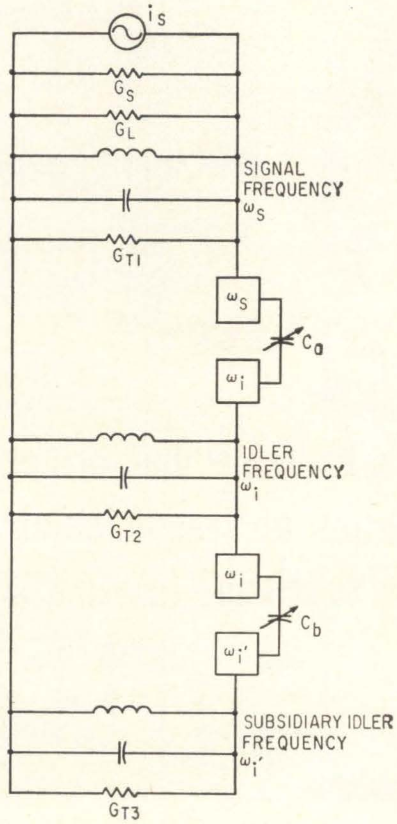
Ann Arbor, Michigan

CASCADING technique promises increased gain and improved efficiency from ferromagnetic parametric amplifiers. The quasicascaded parametric amplifier could provide one of the smallest and most economical microwave amplification methods available. The new type amplifier also offers a relatively simple and rugged design that promises good reliability.

Power amplification in the quasicascaded parametric amplifier is increased by properly supplying energy to a second stage of gain. Probably the most convenient device for cascading using this method is the ferromagnetic amplifier. This amplifier requires only a microwave cavity, a sample of ferromagnetic material, a d-c magnetic field and a power source at the cavity resonant frequency. The ferromagnetic material, suitably positioned in the cavity of the ferromagnetic amplifier, can also be used as the extra stage in the quasicascaded parametric amplifier.



NARROW-BAND *ideal bandpass filters for signal, idler and subsidiary idler frequencies are represented by boxes in equivalent circuit* —*Fig. 1*

AMPLIFICATION—An equivalent circuit for a parametric amplifier is a pair of parallel resonant circuits coupled by a time-varying reactance driven by a sinusoidal source or pump. The pump must exceed a threshold and pump frequency must be the sum of the resonant frequencies of the tuned circuits. Power supplied to one of the tuned circuits (signal circuit) at resonance is amplified because a negative conductance is reflected across the signal circuit at resonance. When magnitude of the negative conductance exceeds conductance in the signal circuit, input impedance becomes a negative conductance.

If the time-varying reactance is a capacitor, magnitude of the reflected conductance is $G = C_c^2\omega_s\omega_i/G_{Ti}$, where C_c is magnitude of time-dependent part of the capacitance, ω_s is signal frequency, ω_i is frequency of second tuned circuit (idler circuit) and G_{Ti} is loss conductance of the idler circuit.

For quasicascading, another circuit (subsidiary idler) is coupled through a second time-varying reactance to the idler, which now becomes the signal circuit for the second parametric amplifier. Power into the idler circuit at its resonant frequency is amplified. In the equivalent circuit in Fig. 1, the subsidiary idler reflects a negative conductance through the coupling capacitor to the idler circuit, lowering loss conductance of the idler circuit. Because the negative conductance reflected to the signal circuit is inversely proportional to the loss conductance of the idler, a larger negative conductance is reflected to the signal circuit. As this negative conductance increases, power gain increases until the circuit becomes unstable.

Magnitude of the larger conductance is $G_1 = C_{c1}^2\omega_s\omega_i/[G_{T2} - (C_{c2}^2 \omega_i\omega_i'/G_{T3})]$, where, in terms of the equivalent circuit in Fig. 1, $C_a = C_{ao} + C_{c1} \sin (\omega_{pa}t + \phi_a) = C_{bo} + C_{c2} \sin (\omega_{pb}t + \phi_b)$, in which ω_{pa} is pump frequency for signal-idler pair, ω_{pb} is pump frequency for idler-subsidiary idler pair, G_{T1}, G_{T2} and G_{T3} are loss conductances of signal, idler and subsidiary idler, respectively, and ϕ_a and ϕ_b are the phases of the two pump signals. Phase relationships have no effect on gain in this amplifier.

EFFICIENCY—For any particular value of power gain, the cascaded amplifier requires less power to operate than the uncascaded amplifier. In fact, if pump frequency for the idler-subsidiary idler pair is the second harmonic of pump frequency of the signal-idler pair, operating power can be made about half that of the uncascaded amplifier. This rough estimate depends on efficiency of the coupling capacitors but is a reasonable expectation for proper adjustment. For microwave amplifiers in which a cavity is used, the second harmonic of the pump is most convenient for the second pump.

A practical cascaded amplifier must consist of a device having three mutually coupled resonant circuits, and the ferromagnetic amplifier is such a device. It uses a small yttrium iron garnet sample in a cavity that has many natural modes of oscillation of the sample magnetization. The sample must be placed in a large d-c magnetic field that is directed along the static

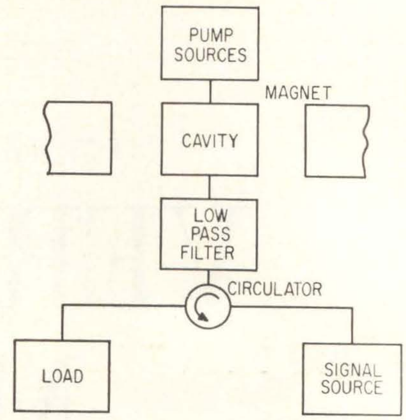
magnetic moment. The resonant frequency of the modes depends on the strength of the d-c field.

The unloaded Q of the modes is large, and the fields associated with them are such that energy can be conveniently coupled into particular modes. Coupling to certain modes can be accomplished by a loop of wire around the sample. If the loop terminates a coaxial transmission line into which energy is fed at the resonant frequency of a mode, energy is coupled to this mode. The amount of coupling can be controlled by the proximity of the loop to the sample.

MODE COUPLING—The relationship of these modes to a parametric amplifier comes from two of their essential features: they are energy storage resonant modes; they can be coupled together by an r-f magnetic field of sufficient intensity and correct frequency. The r-f magnetic field is the pump for parametric amplification. Its frequency must equal the sum of the resonant frequencies of the two modes it is to couple, and it must exceed a threshold. Thus, if the sample is placed in a cavity so that it is properly biased with a d-c magnetic field and so that the r-f magnetic field is maximum, energy can be coupled into one of the modes at its resonant frequency and amplified. The most efficient coupling of the modes occurs with the r-f magnetic field directed along the sample static moment.[1]

Only certain modes can be coupled together with less than infinite pump power. These modes are characterized[2] by a set of three integers (n, m, p). For coupling a pair of modes (n_1, m_1, p_1 and n_2, m_2, p_2), n_1 and n_2 must be both even or both odd and m_1 must equal $-m_2$.

Curves of resonant frequencies of various modes plotted against d-c biasing field[3] enables a pair of modes to be located that can be coupled. This technique can also be used to locate a set of three modes (n_1, m_1, p_1; n_2, m_2 p_2; n_3, m_3, p_3) to build a cascaded amplifier. In these modes, n_1, n_2 and n_3 must be all either odd or even and m_1 must equal $-m_2$ and m_3. If the modes selected satisfy these conditions, coupling can exist between modes 1 and 2 and modes 2 and 3 but not between modes 1 and 3 since m_1



MICROWAVE *setup includes low-pass filter to keep pump power from load in ferromagnetic amplifier—Fig. 2*

does not equal $-m_3$. If the appropriate r-f fields at the respective pump frequencies are present, the equivalent circuit for the arrangement is that in Fig. 1.

When a set of modes has been selected, curves of resonant frequency versus d-c magnetic field are plotted for each mode. One mode must be chosen as the signal mode, another as the idler and the third as the subsidiary idler. By superposing the field frequency curves, a value of d-c magnetic field and a pump frequency are selected so that $\omega_s + \omega_i = \omega_p$ and $\omega_i + \omega_i' = 2\omega_p$.

CONSTRUCTION — The cavity must resonate at ω_p and $2\omega_p$ with a large Q at both frequencies. The sample can be mounted in a quartz tube, which is separated from the cavity wall by a Teflon post.[1] The coaxial through which the input is fed can be terminated in a loop surrounding the quartz tube at the sample location. Thickness of the quartz tube can control coupling of the signal mode.

In the general microwave circuit in Fig. 2, the low-pass filter is adjusted to keep pump power out of the load, which is relatively easy if modes with resonant frequencies near $\omega_p/2$ are selected for signal and idler. Such modes also require the lowest pump power for amplification.

The second pump harmonic can be generated by a ferrite doubler. When amplitudes of the pump fundamental and second harmonic can be controlled individually, amplifier operation can be controlled by adjusting relative pump power at ω_p and $2\omega_p$. Usually operation is most efficient using minimum power at ω_p. Amplifier gain can be controlled by varying power at $2\omega_p$.

Cascading should enable gain of ferromagnetic amplifiers to be improved materially. Alternatively, the cascading technique should improve operating efficiency at a particular level of gain.

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Accuracy Is Improved in Vidicon Bandwidth Tests

By J. PIRKLE

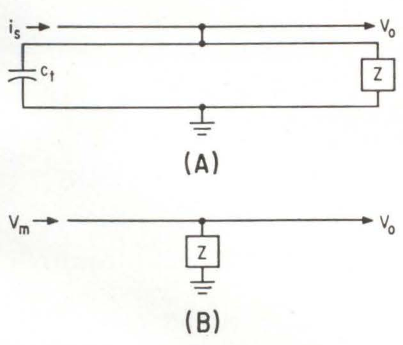
Surface Communications Div.
Radio Corp. of America, Camden, N. J.

BANDWIDTH of vidicon cameras can be measured by a method that is both convenient and accurate. The technique eliminates variations in results by isolating the test signal source from the load.

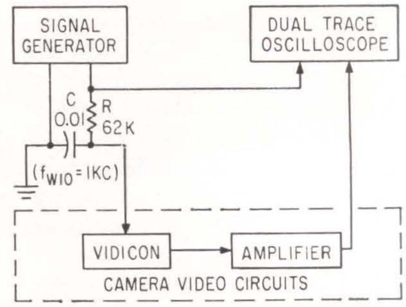
In normal operation, the mesh of the vidicon is at a-c ground potential and is therefore in parallel with the target load. If an impedance, Z, is assumed for the load, the transfer circuit can be represented as in Fig. 1A, where V_o is target signal voltage, $i(s)$ is target signal current, c_t is target-to-mesh capacitance and Z is target load, for which

$$V_o = i(s)\,Z/(j\omega c_t Z + 1) \qquad (1)$$

Bandwidth is measured conventionally by substituting a constant-current signal source for $i(s)$. How-



SOURCE *of constant current (A) can be replaced by voltage source (B) applied through target-to-mesh capacitance—Fig. 1*



SETUP *for measuring vidicon bandwidth is both convenient and accurate—Fig. 2*

ever, applying this source to the load invariably disturbs stray capacitance, thereby modifying results. An alternate method is to connect a voltage signal source at c_t, which isolates the load from the source. If test signal voltage V_m is applied to the mesh with the socket removed, the transfer functions is as shown in Fig. 1B, for which

$$V_o = V_m j\omega c_t Z/(j\omega c_t Z + 1) \quad (2)$$

Equating Eq. 1 and 2 for the required function of (V_m) to simulate $i(s)$ results in

$i(s)Z/(j\omega c_t Z + 1) = V_m j\omega c_t Z/(j\omega c_t Z + 1)$, which solved gives

$$V_m = i\,(s)/j\omega c_t \quad (3)$$

Eq. 3 indicates that if $i(s)$ is constant, (V_m) must vary inversely with frequency. If (V_m) is derived across the capacitor of a series R-C circuit from voltage source (V_g),

$$V_m = V_g/(j\omega RC+1) \approx V_g/j\omega RC \quad (4)$$

$$(\text{for } \omega > 4/RC)$$

Substituting Eq. 4 into Eq. 3 and rearranging:

$$i\,(s) = V_g\,(ct/RC)$$

Thus a true constant-current signal source can be simulated by using the target-to-mesh interelectrode capacitance for signal insertion. The setup for this measurement is shown in Fig. 2. If c_t is assumed to be 3 $\mu\mu$f, $i(s)$ (mμa) $= 5\ V_g$.

Selective Sensors May Spot Enemy Missiles

ENEMY missile detector is one likely application of property sensing cells under development at Armour Research Foundation. Patterned on selective animal vision systems, these single function cells—by filtering out extraneous data at their source—reduce bandwidth and simplify signal processing.

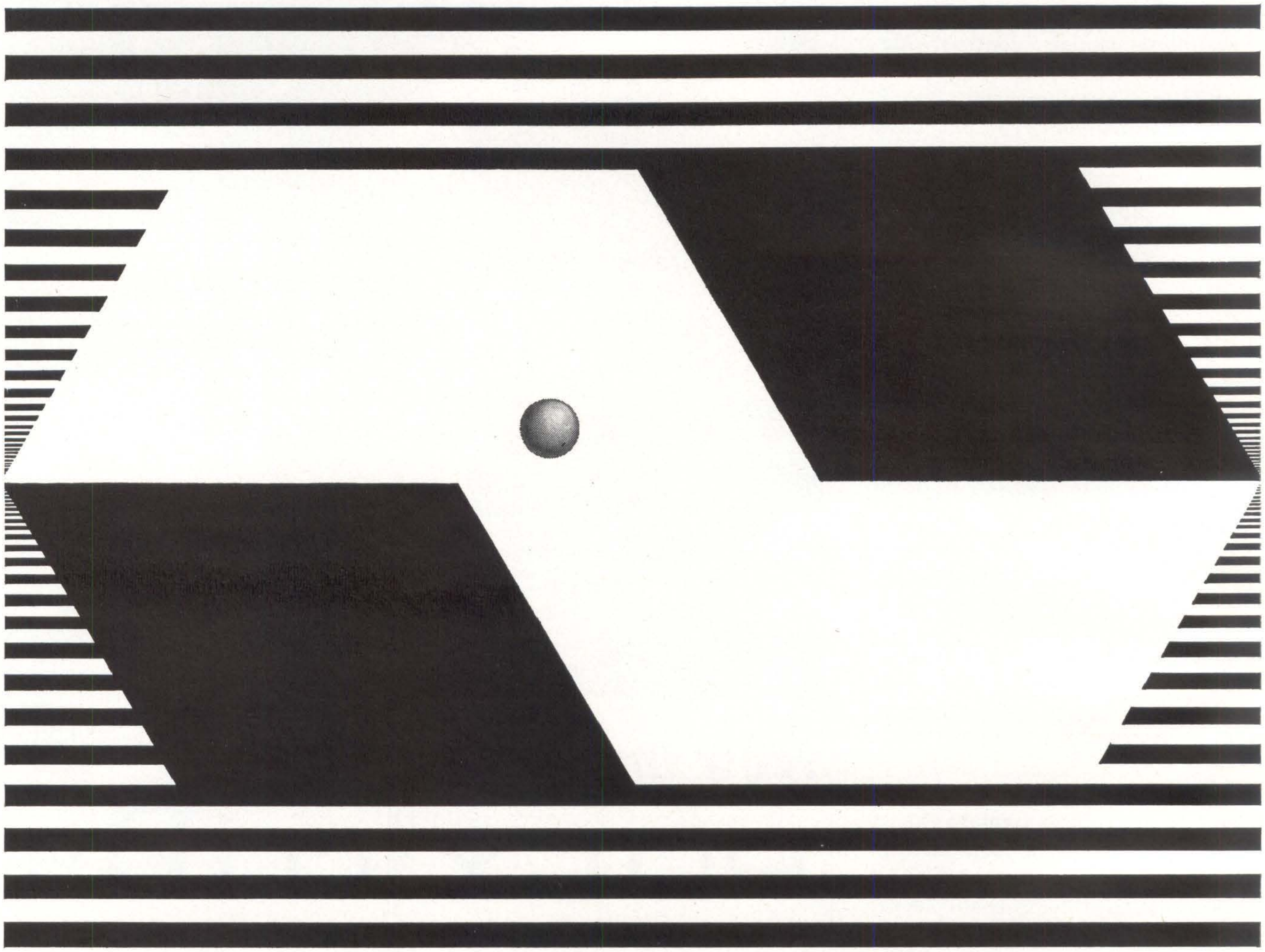
Cadmium sufide contrast detector cells deliver an output only when they are nonuniformly illuminated. They deliver no output when illumination remains uniform or overall illumination is changed. Contrast-consciousness could be useful in identifying enemy missiles or industrial complexes during satellite reconnaissance orbits.

Sensor cells as small as 0.5 by 0.5 mm can be formed into a sequentially scanned mosaic retina, according to preliminary work at the microelectronics lab. A single cell in this retinal array of edge detectors, detecting an enemy missile in flight as a nonuniform signal, could provide the earliest possible automatic warning of the potential threat. Industrial buildings, factories, streets and lots yielding nonuniform responses would trigger more detailed scanning, and recording equipment would be energized only when an industrial area was in view.

BACKGROUNDS — One critical problem in airborne satellite threat detection has been nonuniform backgrounds of earth and clouds. Sensitivity thresholds could be set so that only the borders of broad areas of homogeneous terrain would elicit a response. The system can also be arranged so illuminated cell outputs are suppressed when a cell cluster indicates large objects.

Greatest current effort in the investigations of property-sensing cells is aimed at developing multiple-output sensors, which yield a signal when several conditions are satisfied, such as from alphanumeric type images. Multiple electrodes have been arranged on a photosensitive material. Each character is then centered on this sensor, and impedance measurements are made between adjacent electrodes. Mathematical analyses of vector distances, inner products and cross correlations determine whether these readings can differentiate each character.

Future investigations are planned in which the size, orientations and fonts of characters will be varied. Ultimate goal is an electrode configuration and a mathematical measuring technique to assure recognition despite misalignments.



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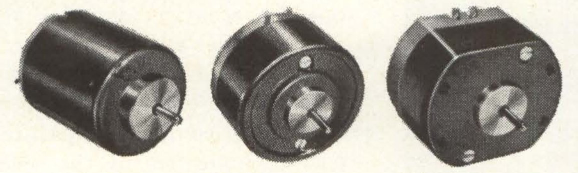

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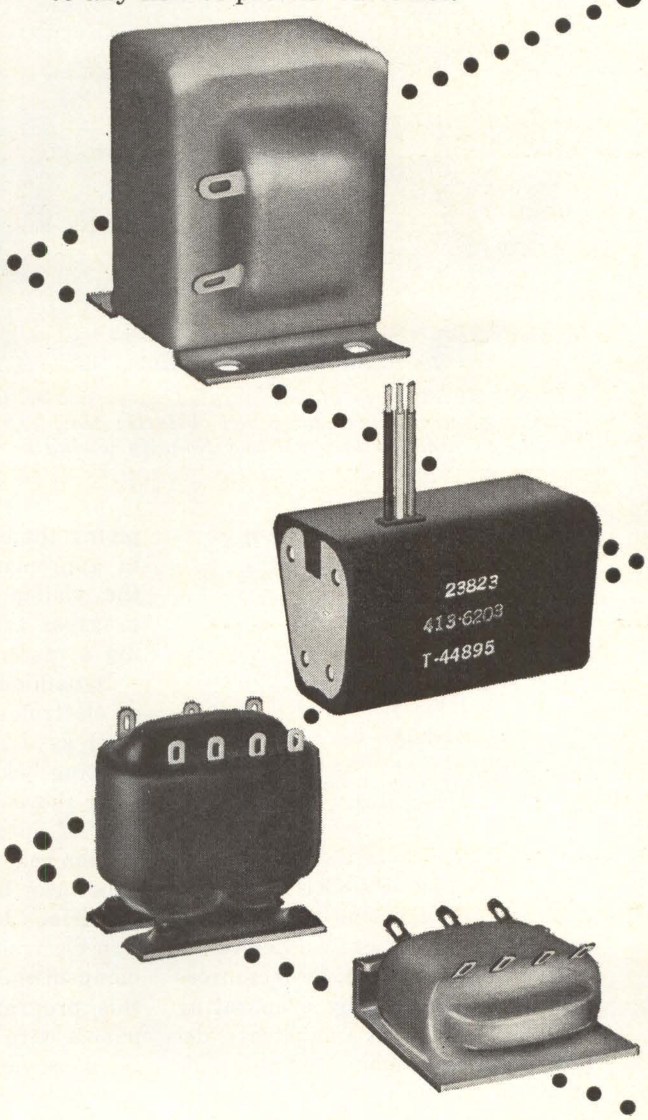

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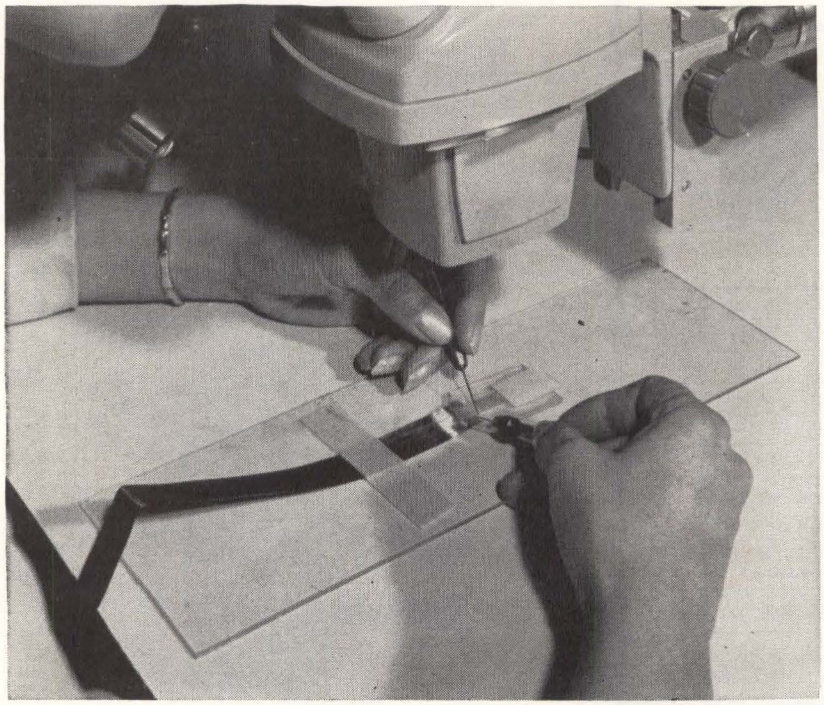
New Approach to Electroluminescent Displays



LONG FLAT *strip of fine parallel wires, mated to substrate, overcomes major electroluminescent panel obstacle: How to make hundreds of electrical connections to panel and simplify wiring to electronic circuit*

Solving optical problems common to high-resolution flying-spot scanners

By P. F. EVANS, C. G. COOK
D. R. REED
Astronautics Products Dept.
Kearfott Division, General
Precision, Inc., Little Falls, N. Y.

COORDINATE PANEL has been made to the exacting needs of an operational electrooptical device.

Electroluminescent light sources can be constructed by evaporating conductive lines on a substrate, depositing a resin-embedded phosphor over the lines, and finally laying down a set of transparent conductive lines at right angles to the first set. Hence a grid pattern is created with a potential light source at each intersection.

If a voltage is applied to each of two intersecting lines, light is generated at the intersection. By applying the electric field sequentially to appropriate external terminals, the visible spot can be made to progress across the panel, producing a raster scan.

Dynamic information is displayed on electroluminescent panels. When used as a navigational or tactical plotting board, a moving pattern of light shows direction of motion and rate of speed. Actually any information that can be plotted on graph paper can be displayed.

Various low and medium resolution electroluminescent panels were being manufactured at the start of this program; but high-resolution panels with 90,000 elements per sq in. were not available either commercially or on special order.

Although other considerations were involved, the greatest obstacle to high resolution was that of making 300 electrical connections per inch on each of the substrates. The problem of making many connections to fine, tightly space lines was sidestepped by a new approach.

Instead of evaporating lines on the substrate, a process was developed whereby a long flat strip of fine, parallel wires could be mated to the substrate. Thus the wires which were external to the coordinate area could be separated and easily connected to the electronic circuit used to provide the raster scan.

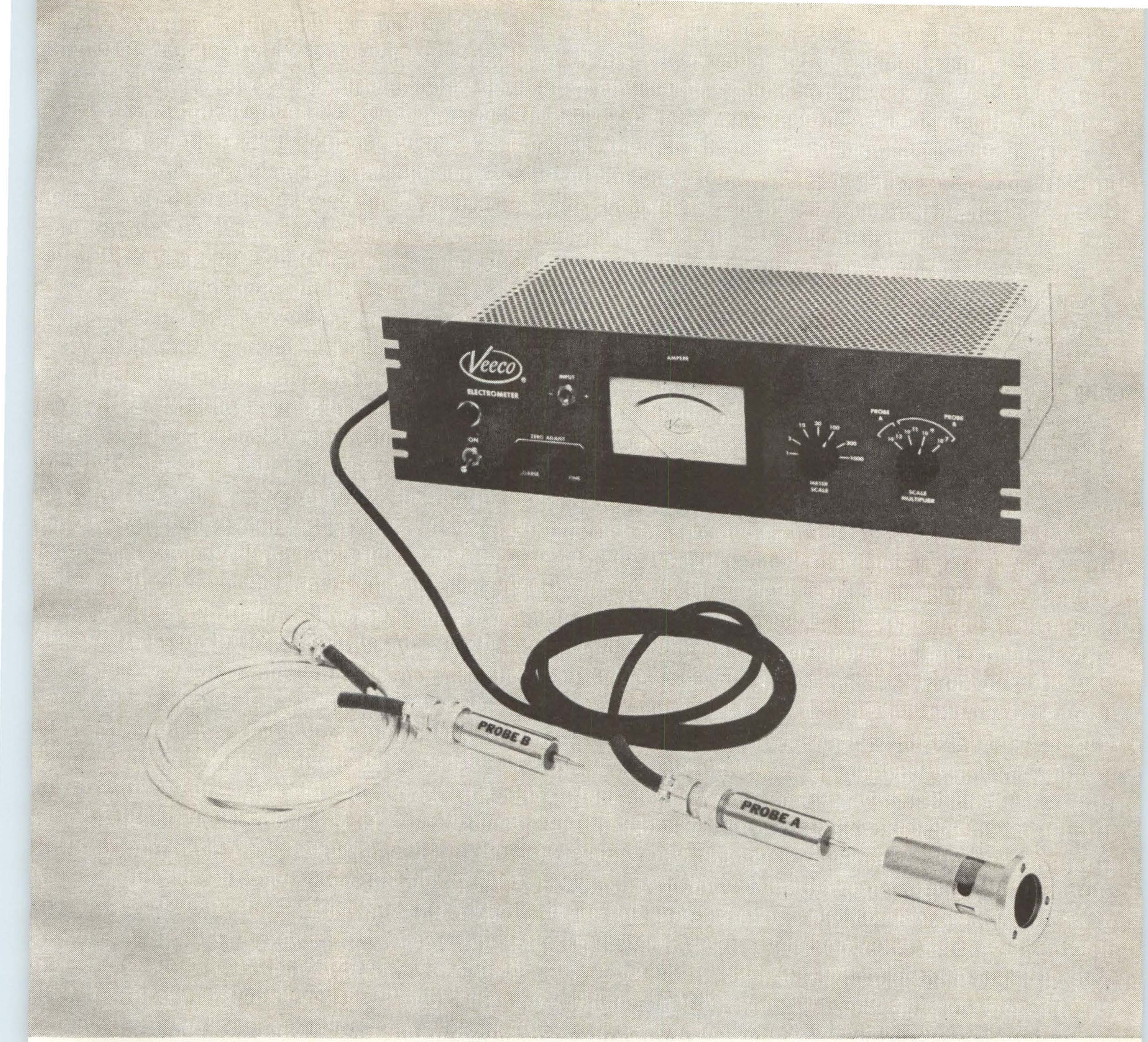
A flat strip of parallel wires is made by passing No. 41 wire through a guiding device and winding it on a mandrel. After winding the wire tightly, a bonding coating is applied and allowed to harden. The bonded wires are then slit and removed from the mandrel, forming a sheet of parallel, insulated conductors. Ordinary wire is not suitable for the transparent matrix, and special wire is made by coating glass filaments with a transparent conductive substance and a transparent insulation.

Phosphors were not only evaluated for brightness and discrimination ratio, and had to be tested in the end-use configuration and embedment, as well as energized by pulses appropriate to the end use.

EVALUATING PARAMETERS—A dual trace oscilloscope technique displaying both voltage and the emitted light waveforms was used to evaluate the effect of changes in various parameters on the light output produced at each coordinate intersection.

The experimental panel is mounted on an optical bench and a lens is used to produce a magnified image of the panel at the aperture of a photometer. Magnifying the image of the panel made it possible to use a larger aperture at the photometer, eliminating the need for an accurately made 0.0033 square inch reticule.

Output of the photometer is coupled to a dual trace oscilloscope so that both the electrical excitation of the panel and the resultant light output can be observed simultaneously. Photographs made with a Polaroid camera provide a perma-



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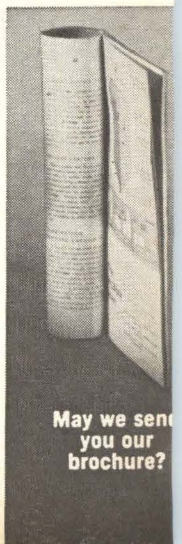


VACUUM-ELECTRONICS CORP. Veeco

TERMINAL DRIVE, PLAINVIEW, LONG ISLAND, NEW YORK nent record of test results.

Shift register normally used for panel testing produces pulses which are 850 volts peak to peak, and the peak brightness of the light produced is usually between 300 and 400 foot lamberts. This value represents the brightness of a single spot and is contained within an area of slightly less than 20 millionths of a square inch.

Although the peak brightness of a single spot is quite high, the light appears for less than one ten-thousandths of a second and a single flash in invisible to the eye. A spot on the coordinate panel would have to be pulsed 2.5 times for each cycle of a Westinghouse Nightlite lamp for the eye to see a continuous average brightness of two foot lamberts.

The small size of the spot would make even a brightness of two foot lamberts difficult to see. To simplify testing, each spot is pulsed 1,000 times per second to produce a sufficient average brightness for visual alignment.

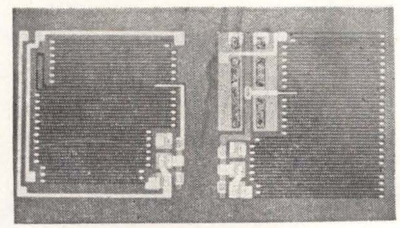
EYE LIMITS—A resolution of 300 lines per inch is too high for the human eye at normal reading distance, although it is ideal for applications where optical systems are used. However, by ganging conductors at the panel's edges, the resolution can be lowered to within the eye's limit. Ganging two conductors gives 150 lines per inch, ganging three gives 100, and so on. Switching can be used to vary the ganging and thus give the panel a variable resolution capability.

Connections for power and signals can be remote. There is little limitation in size, large or small, that a display panel can have. Even curved or flexible panels can be fabricated for special applications. Storage matrices can be built into the panel by using laminations.

With a given configuration, variations of electrical excitation also affects the light output characteristics. In general, higher voltage increases brightness. Higher frequency will also increase brightness, but tends to shift the emitted color to a lower wave length. Similarly, square wave and shaped-pulse excitation have been shown to affect mainly brightness, rise and decay time, and emitted color in complex ways.

Preparation of the phosphor screen contributes another element in control of light output. Phosphor screens are deposited in panels by using a precision Gardner blade. Thin layers, typically one mil thick, are deposited over a copper wire matrix. A second layer is deposited to adhere the conductive glass filaments to the screen.

Microwatt Counter For Space Computer



MICROWATT *counter stage dimensions are 100 × 200 × 5 mils*

THIN-FILM technology for passive components and the usual surface passivated planar technology have been combined both in and on the same wafer with the development of a new microelectronic counter stage that operates at a supply power level of less than three microwatts.

The heavily oxidized silicon surface of the wafer serves as the substrate for vacuum deposited metal resistors. Concept of microwatt microelectronics was formulated by W. W. Gartner, M. Schuller, C. Heizman and C. Levy, all of CBS laboratories. The new counter is now being incorporated into NASA systems.

Counter consumes 10 microwatts d-c at 0.75 volts and operates between −50 and 100 C. Pulse repetition rate is 10 Kc.

Bent Wire Retains Superconductivity

NIOBIUM-TIN wire can now be processed so that normal mechanical bending does not impair its superconductivity or almost zero resistance to the flow of current at very low temperatures.

Niobium-tin has the highest transition temperature—the point at which the material starts superconducting—of any material sc far investigated. It becomes superconducting at 18 deg Kelvin (−255 deg C). However after bending, superconductivity has been lost. Processing methods developed by Materials Research Corporation retained all current carrying capacity of the niobium-tin.

Testing performed at NASA laboratories in Cleveland recently showed that the processed niobium-tin, before bending, carried 200,000 amperes per square centimeter at an applied field of 100,000 gauss. After bending around a ⅜-in. radius, the material had the same current response to the field.

Most immediate application of this material is in winding for magnets. Solution of the superconductivity problem opens the door to many other applications for niobium-tin. Work on this project is being conducted under an 18 month U. S. Air Force contract awarded to Materials Research Corporation of Orangeburg, N. Y. for the establishment of a pilot production facility.

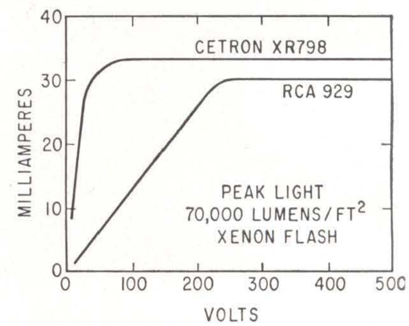
Tin-Coated Wire Tests At Subzero Temperatures

RESULTS OF EXPOSURE of tin-coated wire to temperatures of −40 F to −67 degrees F for periods up to five years were described by Jack Spergel, U. S. Army Signal Research and Development Laboratory at this year's Symposium on Soldering held by the American Society for Testing and Materials in New York City.

Transformation of tin at subzero temperatures from a white solid metal to a gray powder has been known but the concern for this problem has grown recently due to the expanded use of electronics in arctic regions. The complexity of modern electronic equipment has increased the quantity of wiring and components with tin coatings susceptible to transformation. The presence of gray tin powder in electronic equipment may produce a permanent failure or improper performance.

Observations of the tin-coated wire exposure tests disclosed no transformation of white tin to gray tin powder in hot-dip tinned wire, whereas numerous transformations were exhibited in electroplated tinned wire. Transformation in some cases occurred within three months at a temperature of −40 deg. An effective measure in preventing transformation was found to be co-deposition of antimony with the tin.

Phototube Used For Short Flash Observation



VOLT-AMPERE *characteristics of close-anode XR-798 phototube, and 929 phototube, with a peak light of 7 × daylight or 70,000 lumens per square foot. Area of 929 is 0.0035 square foot. Light on cathode is 235 lumens—Fig. 1*

By HAROLD E. EDGERTON
PAUL W. JAMESON
Department of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

ACCURATE MEASUREMENT of short pulses of light requires certain circuit conditions as discussed by Edgerton and Shaffner.[1] A typical circuit might consist, for example, of a 929 phototube with a 100 ohm load resistor, giving a circuit time constant of 0.015 microseconds. To get a peak output of 3 volts from this circuit requires an applied voltage of 300 volts.

It occurred to one of us that a closer spacing between the anode and cathode might enable the circuit to produce the same output voltage and current with a much lower total applied voltage.

Two sample tubes made by the Cetron Electronic Corporation of Geneva, Illinois show that a plate voltage of 100 v, instead of 300 v, is needed to produce a similar signal to that of the 929.

Figure 1 shows the transient volt-ampere characteristics of the

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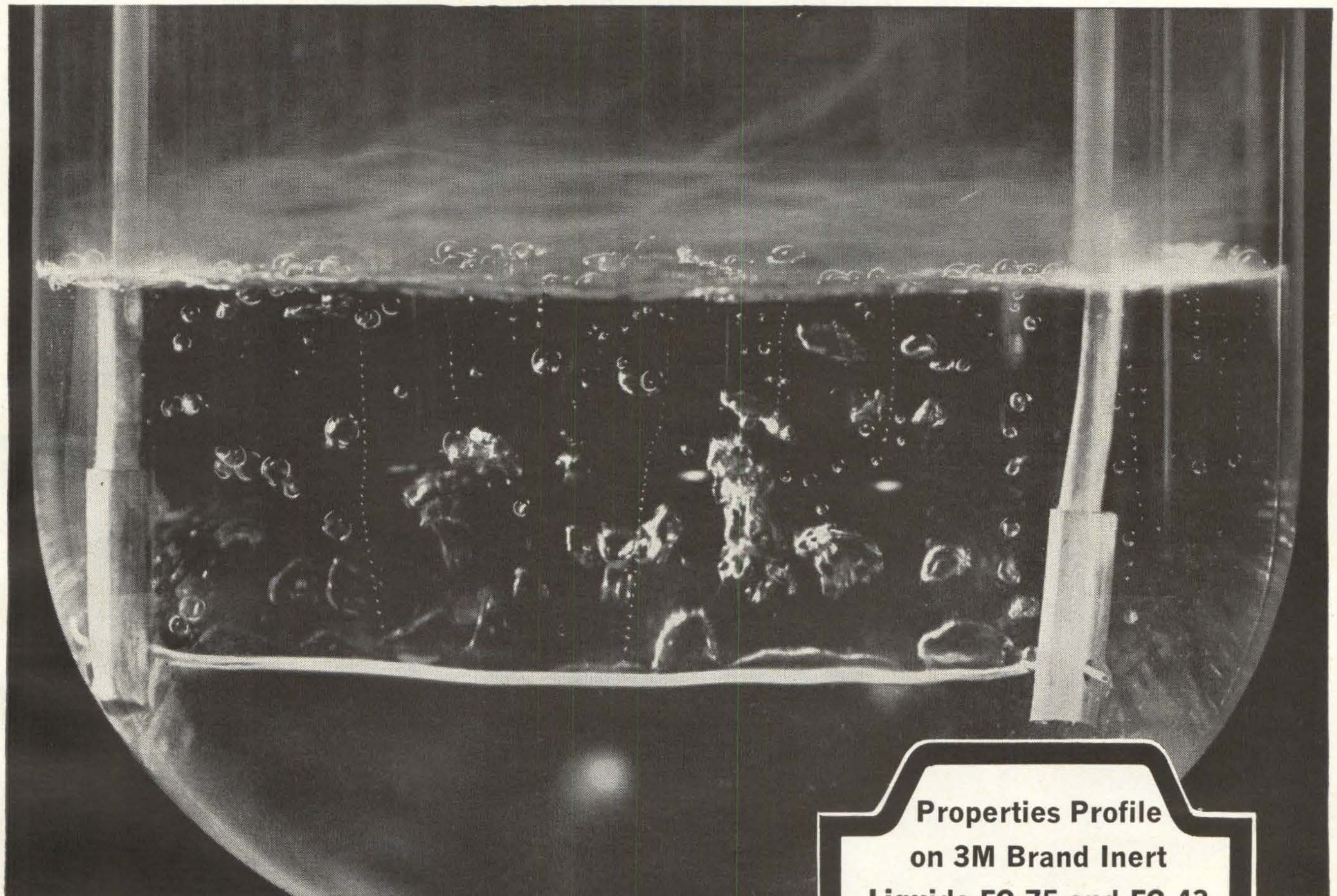


Heat Fluxes (150-500 watts/in.^{2}) no problem when FC-75 cools components!

Using Inert Fluorochemical Liquid FC-75 as a heat transfer medium for cooling electronic gear, designers can practically eliminate hot-spot problems. Heat fluxes—from 150 to 500 watts per square inch, for example—can be handled by this coolant with minimal changes in temperature of components.

FC-75's low boiling point (214°F) permits a high heat transfer rate by evaporation, as illustrated above. Hot spots in a component part attain a temperature above the boiling point of the FC-75, then remain relatively constant. Because of the rapid transfer of heat from the component by the boiling FC-75, burn-out dangers are minimized.

FC-75, as well as its companion product FC-43, are at their best when equipment is specifically designed around their remarkable cooling abilities. FC-75 can remove up to 10 times more heat than such coolants as transformer oil. Thus new designs using FC-75 can drastically reduce the size of electronic units. Design space-savings up to a factor of six have been achieved.

FC-75 is stable up to 750°F and is completely compatible with most materials. It is non-explosive, non-flammable, non-toxic, odorless, and non-corrosive. Unimpaired by arcing, it heals itself in either the liquid or vapor state. Because of its thermal stability, no sludges are formed. Write for further information, and for specific application details.

MINNESOTA MINING & MANUFACTURING CO. 3M

Properties Profile on 3M Brand Inert Liquids FC-75 and FC-43

ELECTRICAL PROPERTIES

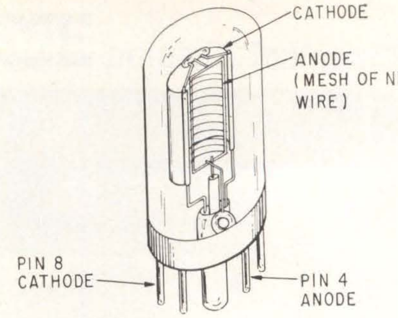
	FC-75	FC-43
Electrical Strength	35KV	35KV
Dielectric Constant (1 to 40 KC @ 75°F)	1.86	1.86
Dissipation Factor (1000 cycles)	<0.0005	<0.0005

TYPICAL PHYSICAL PROPERTIES

	FC-75	FC-43
Pour Point	<−100°F	−58°F
Boiling Point	212°F	340°F
Density	1.77	1.88
Surface Tension (77°F) (dynes/cm)	15	16
Viscosity Centistokes (77°F)	0.65 Min.	2.74
Thermal Stability	750°F	600°F
Chemical Stability	Inert	Inert
Radiation Resistance	25% change @ 1×10^8 rads	25% change @ 1×10^8 rads

For more information on FC-75 and FC-43, write today, stating area of interest to: 3M Chemical Division, Dept. KAX-92, St. Paul 1, Minn.

CIRCLE 73 ON READER SERVICE CARD



ANODE-CATHODE *structure of Cetron XR-798 phototube showing mesh anode shaped to give close spacing to the cathode—Fig. 2*

Cetron tube No. XR-798, and the conventional type 929.

The XR-798 Cetron phototube, Fig. 2, is mounted in an octal base so that the tube is interchangeable with the 929. Anode to cathode capacitance of the XR-798 is 7.5 pf while that of the 929 is 4 pf.

The 929 phototube has the type S-4 surface which has a peak sensitivity in the blue, and very small sensitivity in the red. According to the Cetron Company, the XR-798 has a surface resembling the S-10 which like the S-4 lacks red sensitivity.

The close spaced anode-cathode phototube is of great utility in the laboratory for the measurement of the pulses of light from lasers, flash lamps, shock tubes, and similar subjects where light pulses of short duration and high intensity must be measured with good time resolution.

REFERENCE

(1) H. E. Edgerton and R. O. Schaffner, Measuring Transient Light with Vacuum Phototubes, ELECTRONICS, Aug. 25, 1961, p. 56.

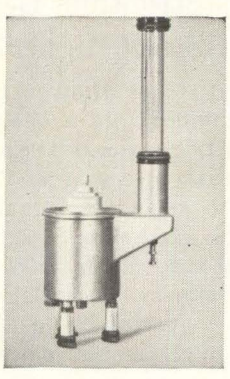
Aluminum Evaluated For Cryogenics

TESTS of aluminum at temperatures approaching minus 460 deg. F, so-called absolute zero, have produced conclusive findings that at extreme cold this versatile metal retains and even improves upon its desirable strength characteristics.

The findings, reported to the Cryogenics Engineering Conference at UCLA by research scientists of the Battelle Memorial Institute are expected to have important bearings on future contributions of aluminum to space ex-

BOILING FOR "COOL" PERFORMANCE

This tube, the new ITT F-7832 Power Triode is in an open glass tank to demonstrate the new evaporative cooling method. Cooling water is shown boiling at the segmented copper cooling fins. Bubbles are rising off the surfaces and steam is escaping. Normally the tube is enclosed in a boiler (photograph at right) which, in conjunction with an external condenser, becomes a complete system.



Conventional water cooling is capable of dissipating 450 watts/sq. in. Forced air cooling dissipates 150. The ITT Evaporative Cooling System will dissipate in excess of 800 watts/sq. in. It will operate in an overload condition at 1600 watts/sq. in. with no damage. In addition, ITT Evaporative Cooling offers the advantages of noiseless operation, absence of rotating parts such as blowers and pumps, minimum servicing, self cleaning of tube, and minimum liquid coolant. ITT Evaporative Cooled Tubes feature ceramic construction. The new rugged, mesh cathode, another design innovation, provides improved emission per watt, quick heating and excellent temperature stabilization.

ITT

Write for information on the new ITT Evaporative Cooled Power Tubes. Application assistance is available for your specific requirements.

ELECTRON TUBE DEPARTMENT ■ COMPONENTS DIVISION

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION, CLIFTON, NEW JERSEY

ITT COMPONENTS DIVISION PRODUCTS: POWER TRIODES AND DIODES • IATRON STORAGE TUBES • HYDROGEN THYRATRONS • TRAVELING WAVE TUBES • SELENIUM RECTIFIERS • SILICON DIODES AND RECTIFIERS • TANTALUM CAPACITORS

CIRCLE 75 ON READER SERVICE CARD

ploration and other applications involving cryogenic temperatures.

The Battelle investigation, sponsored by The Aluminum Association, was undertaken to evaluate the tensile behavior of aluminum alloy No. 5083 at the temperature of liquid helium—minus 452 deg. F. The alloy, one of the 5000 series of aluminum-magnesium alloys, was tested in plate form.

Earlier laboratory tests had established the suitability of this and other aluminum alloys at temperatures as low as minus 423 deg. F, the temperature of liquid hydrogen.

Hermetic Seal for Tantalum Capacitor

SEALING tantalum foil capacitors by means of tantalum-to-glass bonding techniques will be achieved on 10 experimental models to be developed within eight months and 50 final models, with test data, to be readied 10 months later. The units, employing a true hermetic seal, will be made at G.E.'s Electronic Specialty Capacitor plant, Irmo, South Carolina, and delivered to the Signal Corps Laboratory, Fort Monmouth, New Jersey.

The capacitors will be rated 100 μf, 75 v, d-c, 85 C. They will use etched tantalum foil construction and will be enclosed in a single tubular metallic case with axial leads and glass-to-metal and/or ceramic-to-metal seals.

Strontium Generator Seeks Higher Output

TWO FORMS of strontium have been combined into a one-piece thermoelectric generator which serves as its own heat source. The new device is a small strontium-titanate rod with strontium-90 concentrated at one end. Radioactive strontium-90 spontaneously produces heat, which is converted to electrical energy through the thermoelectric effect in the strontium titanate.

Efficiency of the experimental device is low and power output is a tiny fraction of a watt, but continued development at Martin may significantly increase both. Barium and cerium titanates, uranium, and plutonium are also being explored, might use same principle.

The "HH" series is Hitachi's new superior line of television receiver tubes, the ultimate in far-reaching reception of television waves.

For RF amplifier of VHF television tuners, specify the 4R-HH2 and 6R-HH2 which feature very high transconductance, high sensitivity and low noise. These twin triode tubes replace the 4BQ7A and 6BQ7A without change of circuit.

For frequency convertor and local oscillator of VHF television tuners, specify 5M-HH3 and 6M-HH3 twin triodes which replace the 5J6 and 6J6 without change of circuit.

The "HH" series is another fine quality line from Hitachi, one of the most completely integrated electrical manufacturers in the world.

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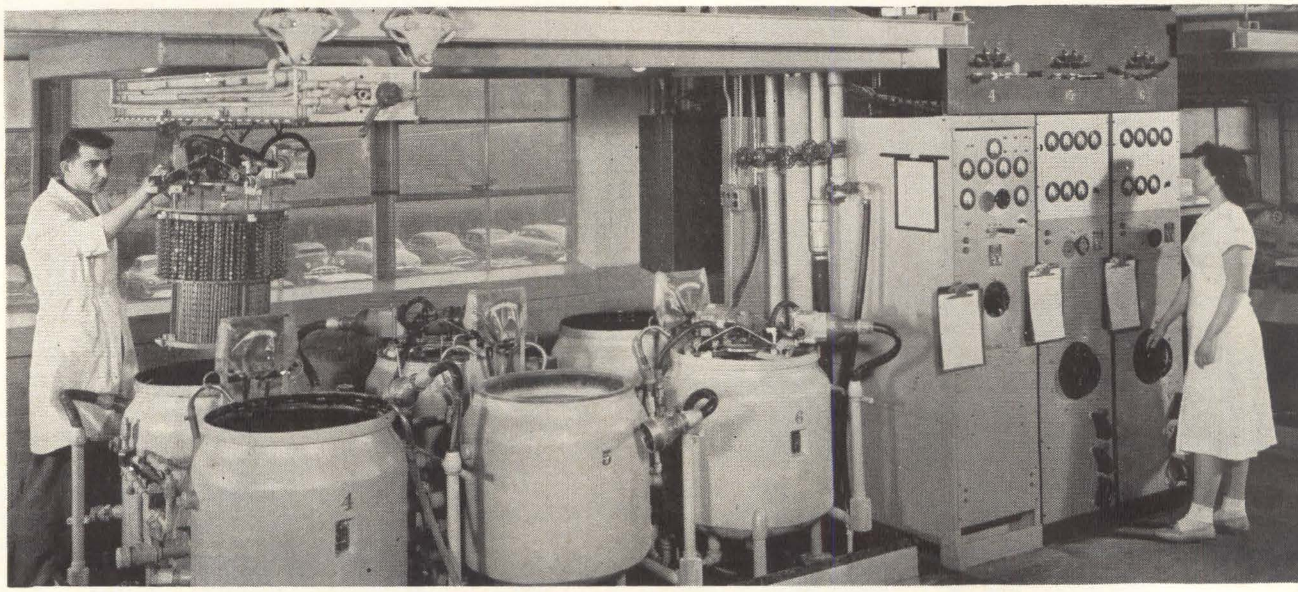


EACH STEP *in capacitor manufacturing was investigated to increase reliability by optimizing materials and operations. Electrical forming or anodizing takes place in these tanks*

Reliability of Tantalum Capacitors Increased

Two-stage case crimping, higher purity materials are the main changes

By JAMES H. HALL
Rectifier-Capacitor Div.,
Fansteel Metallurgical Corp.,
N. Chicago, Ill.

FAILURE RATES for wet tantalum capacitors have been reduced from 3.43 to 0.173 percent per 1,000 hours (life tested at rated working voltage and maximum rated temperature) by a continuing program of production improvement at this division. The program for improving quality control and processing techniques was initiated several years ago, when reliability specs beyond those possible at the time began to appear.

A testing program on samples from production lots was started to identify the design changes and production techniques that held the most promise for increasing reliability. A board of review was established to review data and examine components that failed as well as those that did not. Research, Development, Quality Control, Product Engineering, and Manufacturing were represented on this board.

Some improvements involved design changes while others came from better control of existing production techniques. All changes were monitored after they were made.

TWO-STAGE CRIMP—Wet tantalum capacitors are sealed with an elastomer gasket material. One of the first problems was to produce a more satisfactory, reproducible seal. The silver capacitor case had originally been crimped to the elastomer gasket in a single operation, but this was found to set up high stresses in the crimp, resulting in relaxation after the crimping die pressure was removed. As a result, electrolyte leakage would occur in a few units.

The relaxation problem was reduced by introducing a two-stage crimping machine. The silver case now is only partially crimped at the first stage, thus minimizing the stresses set up, and a second stage crimp completes the seal and compensates for any relaxation following the first crimp. Failure rate per thousand hours was reduced by approximately one-half by this operation. Two-stage crimping is performed on a rotary table with individual stations for each stage, so increased reliability is accomplished with no additional cost.

PURITY LEVELS—A number of production changes deal with the stability and changes in parameters of the capacitors throughout the environmental testing range.

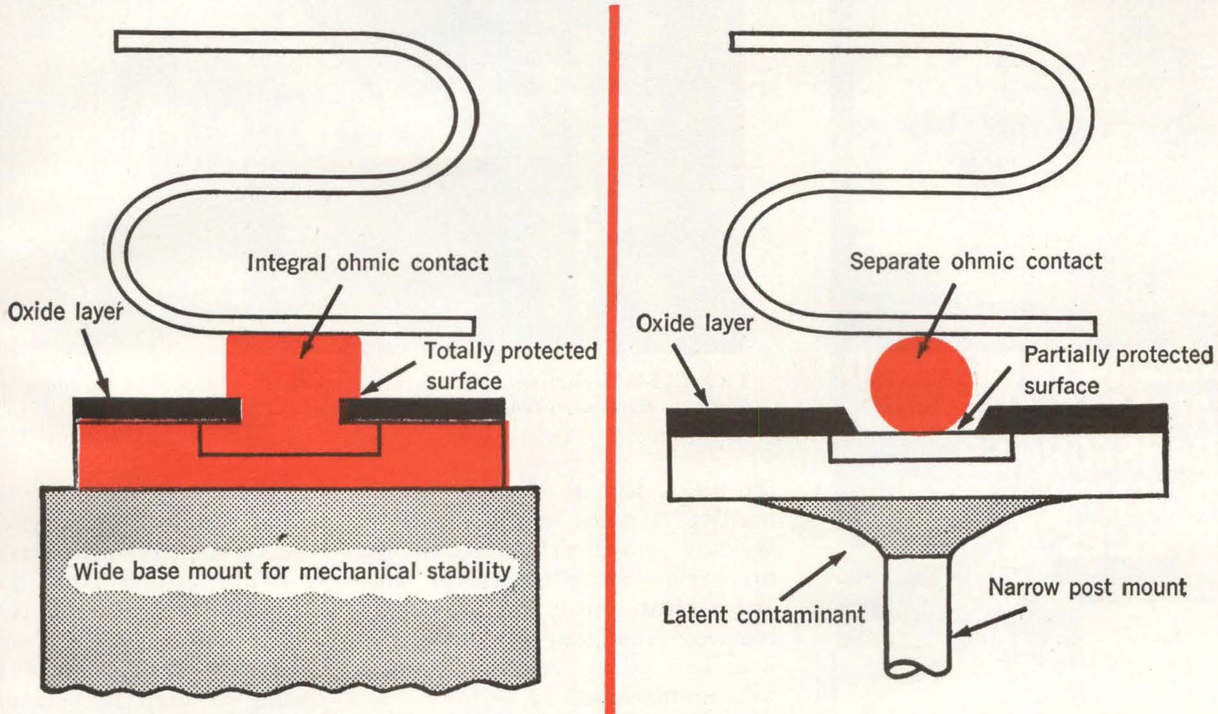
Tight quality control specifications were set up on tantalum powder, sheet, and wire so as to obtain the best electrical characteristics and lowest impurity levels. These specifications continue to get tighter as the technology of producing the raw materials improves and as continuing analysis of failures shows new direction for improvement. Several changes in processing tantalum powder have resulted in the impurity levels being reduced to a few parts per million in the finished product.

WELDING—Another way to improve reliability through production was to improve the weld between the tantalum anode wire and

Reliable Semiconductors
from **RAYTHEON-MOUNTAIN VIEW**

300°C NANOSECOND DIODE

THE INSIDE STORY OF UNIPLANAR* VS. MULTI-PART CONSTRUCTION



RAYTHEON/RHEEM UNIPLANAR* DIODE — **CONVENTIONAL PLANAR MULTI-PART DIODE**

UNIPLANAR* construction boosts silicon diode reliability

Uniplanar* one-piece construction, produced at Raytheon/Mountain View (formerly Rheem Semiconductor), brings a major improvement to silicon planar diode reliability. This is demonstrated by a *300°C* storage capability, unequalled shock and vibration resistance, and more uniform electrical characteristics.

The result of Raytheon/Rheem Uniplanar* construction is a one-piece unit that can't shake loose or become misaligned. The entire chip assembly, *including ohmic contact,* is formed by a single process. This technique permits positive surface passivation of the entire junction area. A high level of uniformity is achieved, since ohmic contacts are chemically formed thousands at a time.

300°C storage is obtained because, for the first time, it is possible to exclude the latent contaminants introduced by multi-part assembly techniques.

Uniplanar* construction is available at no extra cost in such types as 1N914, 1N916, 1N3064, and 1N251. For further information, please contact the nearest Raytheon Field Office.

RAYTHEON

* *Exclusive one-piece planar construction from Raytheon/Mountain View (formerly Rheem Semiconductor).*

TANTALUM *capacitors have been made more reliable by close control of all production operations*

the nickel lead that serves as the positive terminal of the capacitor. Welding equipment was redesigned to provide better control of time and current, and tantalum oxide is removed from that portion of the wire held by the electrodes of the welding machine.

A much more uniform and stronger weld is obtained with the new methods.

SINTERING—Pressing and sintering of the anode structures was modified to produce a more constant density throughout. Sintering temperatures and times were changed as the optimum temperature and time for a particular anode structure and powder type were established.

Sintering furnaces were designed for more uniform temperatures throughout the sintering load, and to eliminate gas leakage and back-streaming.

The changes in sintering and in powder impurity levels produce a much purer tantalum anode, making possible the reduction of the d-c leakage limits to a fraction of previous limits.

LIFE TESTING—The need for more uniform processing of the fine silver cast that forms the cathode of wet capacitors was discovered through the data accumulated from life testing. Techniques were introduced to produce a greater and a more uniform surface area.

Leakage of d-c curent during life testing at high temperatures was another problem where improvement proved possible. While the tantalum oxide film that forms the dielectric of the capacitor is one of the most stable that is known, investigation indicated that even the usual low value of d-c leakage current could be further reduced by using anodizing techniques.

Anodizing involved investigation and establishment of optimum specifications for electrolytes, current density, anodizing electrolyte, anodizing time, and electrolyte temperatures.

Improvements introduced in all of the variables resulted in a substantial increase in the stability of the capacitors and a dramatic increase in reliability. While it is impossible to assign increased reliability rates to any factor individually, they are responsible collectively for the overall improvement of failure rates of present day capacitors.

Precious Metals Make Scrap More Valuable

By W. F. PARRY
Handy & Harman, New York, N.Y.

ONE OF THE MOST overlooked sources of profits in industry is the scrap heap. Many companies can save thousands of dollars a year simply by making sure that scrap with precious metal content is not thrown away indiscriminately.

Scrap often contains quantities of precious metals—gold, silver, platinum—that, when recovered through advanced detection and refining methods, are worth large sums. In many cases not only precious metals but also the base metals from which they are extracted are recoverable and valuable. For example, molybdenum is often gold plated and tungsten silver plated. The molybdenum and tungsten have considerable value even after the gold and silver has been recovered.

The precious metal content of scrap is constantly rising because the use of precious metals in industry is rising. In electronics, precious metals are often used to obtain greater miniaturization with better electrical properties. The nobel metals are being used to a greater degree in all types of instrumentation because of their resistance to corrosion. Photography, including X-ray photography, is another area where valuable scrap is often thrown away.

CHECKLIST — Many electronic companies are using precious metals in one form or another in their manufacturing operations. Not all of the uses are always known.

(1) Does your company buy precious metals in any form? If it does, you have an added stake in a scrap recovery program since a reliable refiner will carry all metal recovered for you on his books in your name and return to you new metal for manufacturing.

(2) Does your company buy parts, components, soldering materials, etc., containing precious met-

als in any form? Since these items are made or assembled elsewhere, it is common to overlook the fact that scraps, rejects, or turnings from these parts or materials may contain quantities of precious metals.

(3) Does your company work such parts, either in assembly or repair operations?

(4) Do any aspects of your operation involve plating solutions and rinse tanks? One company used to scrap silver plating baths; now it receives about $8,000 a year for silver recovered.

(5) Do you run your own photo processing laboratory? Sensitized paper and film are major sources of recoverable silver. For example, many companies throw away unexposed leaders in a roll of film although these have significant recoverable silver.

(6) Do you operate technical or research laboratories in which precious metals are being used?

(7) Do your operations include chemical processing that produces precipitates, sludges, and sediments? For example, do you use catalysts?

Setting up a program to recover valuable scrap is essentially an educational jobs. In many cases the logical person to head up the recovery program is the purchasing agent. He knows whether or not precious metals are purchased directly and in what quantities.

However, a large plant may have a salvage supervisor. Elsewhere it might be the foreman, or heads of departments most directly involved. In other cases the responsibility might logically fall on technicians, if the chief use and recovery potential lies in the technical research areas.

RECOVERY PROGRAM—The following procedures have helped a number of plants recover valuable metals that were previously lost.

(1) Estimate all sources of possible metal recovery. A list of possible sources of disguised precious metals is given in the table. If it is uncertain whether a plant-wide recovery program is worthwhile, a plant survey may be in order.

(2) If it seems likely that sufficient precious metals can be recovered, the plant's scrap disposal

program should be checked.

(3) If the scrap program is not satisfactory, then the movement of all precious metals, from the time the material or part enters the plant until it goes to the scrap heap should be charted. The important thing is to know at all times where the material is, how it is being processed, and what happens to any scrap resulting from processing.

(4) A depot for all scrap, in a separate area, should be established and a security system adopted.

(5) Keep all scrap readily identifiable as precious metal and separate from all other scrap. For example, don't mix silver turnings with steel scrap in a single container, since a small amount of silver, gold, platinum or rhenium may be worth more than a whole carload of unanalyzed scrap.

(6) No matter how worthless scrap may look, if it contains recoverable metals, send a sample to a firm equipped to analyze and refine precious metals. Whether or not the scrap has sufficient precious metal content for recovery can be determined quickly.

PARTIAL LIST OF PRECIOUS METAL SCRAP

Turnings, chips, shavings
Silver on steel bearings
Silver steel turnings
Grindings
Blanking scrap, stampings, strip, wire
Powder mixtures
Screen scrap
Solder scrap
Brazing alloy scrap
Contact alloy scrap
Silver on steel, tungsten, molybdenum scrap
Bimetal scrap
Silver paint waste, wipe rags, paper, cans
Old batteries
Plating solutions
Precipitates, sludges and sediments
Coated copper wire and racks
Filter pads
Anode ends
Tank scrapings
Electrolytic silver
Hypo solutions
X-Ray film
Coated plastics, ceramics, glass, mica, quartz, etc.
Chemicals
Mirror solutions—silver nitrate
Platinum-bearing material
Gold on molybdenum or tungsten wire

What do you need to know about

PURE FERRIC OXIDES
MAGNETIC IRON OXIDES

Since the final quality of your production of ferrites and magnetic recording media depends on the proper use of specialized iron oxides—you'll find it mighty helpful to have the latest, authoritative technical data describing the physical and chemical characteristics of these materials. This information is available to you just for the asking. Meanwhile, here are the highlights.

PURE FERRIC OXIDES—For the production of ferrites, both hard and soft, we manufacture a complete range of iron oxides having the required chemical and physical properties. They are produced in both the spheroidal and acicular shapes with average particle diameters from 0.2 to 0.8 microns. Impurities such as soluble salts, silica, alumina and calcium are at a minimum while Fe_2O_3 assay is 99.5+%. A Tech Report tabulating complete chemical analysis, particle shape, particle size distribution, surface area, etc., of several types of ferric oxides, hydrated ferric oxide, and ferroso-ferric oxide is available.

MAGNETIC IRON OXIDES—For magnetic recording—audio, video, computer, and instrumentation tapes; memory drums; cinema film striping; magnetic inks; carbon transfers; etc.—we produce special magnetic iron oxides with a range of controlled magnetic properties. Both the black ferroso-ferric and brown gamma ferric oxides are described in a Data Sheet listing magnetic properties of six grades.

If you have problems involving any of these materials, please let us go to work for you. We maintain fully equipped laboratories for the development of new and better inorganic materials. Write, stating your problem, to C.K. Williams&Co., Dept. 25, 640 N. 13th St., Easton, Pa.

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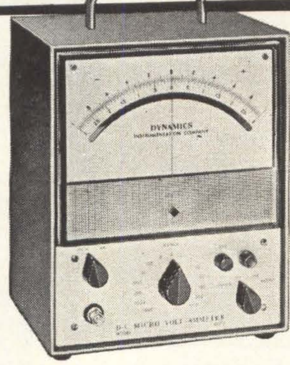

Model 4072—dc micro volt-ammeter. Fully isolated, this instrument operates from an automatically rechargeable nickel-cadmium battery—hence eliminates the power line from low-level measurements in sensitive circuits.

Wide voltage and current range: 100 μv to 1,000 V, and 0.1 μ amps to 1.0 amp.

Mirror-back scale eliminates parallax. Scale is 7.2" long, for easy reading.

Accuracy: ±1.0% of full scale on all ranges.

Typical applications: Potentiometric measurements, null indication, measuring thermocouple output and contact potentials . . . diode matching.

Dynamics manufactures a wide variety of microvoltmeters, micro volt-ammeters, micromultimeters, and general test equipment. Write for complete literature on Model 4072, or the entire line.

DYNAMICS INSTRUMENTATION COMPANY
583 Monterey Pass Road, Monterey Park, Calif. • Phone: CUmberland 3-7773

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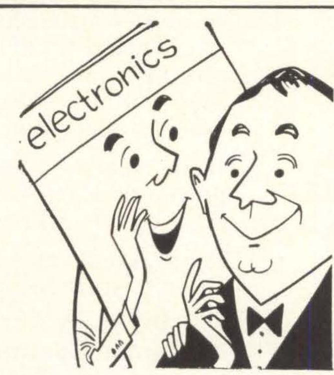

electronics IS EDITED TO KEEP YOU FULLY INFORMED
—a "well-rounded" engineer

What's your *present* job in electronics? Do you work on computers? (**electronics** ran 158 articles on computers between July, 1961 and June, 1962!) Are you in semiconductors? (For the same period, **electronics** had 99 articles, not including transistors, solid-state physics, diodes, crystals, etc.) Are you in military electronics? (**electronics** had 179 articles, not including those on aircraft, missiles, radar, etc.)

In all, **electronics'** 28-man editorial staff provided more than 3,000 editorial pages to keep you abreast of all the technical developments in the industry. No matter where you work today or in which job function(s), **electronics** will keep you fully informed. Subscribe today via the Reader Service Card in this issue. Only 7½ cents a copy at the 3 year rate.

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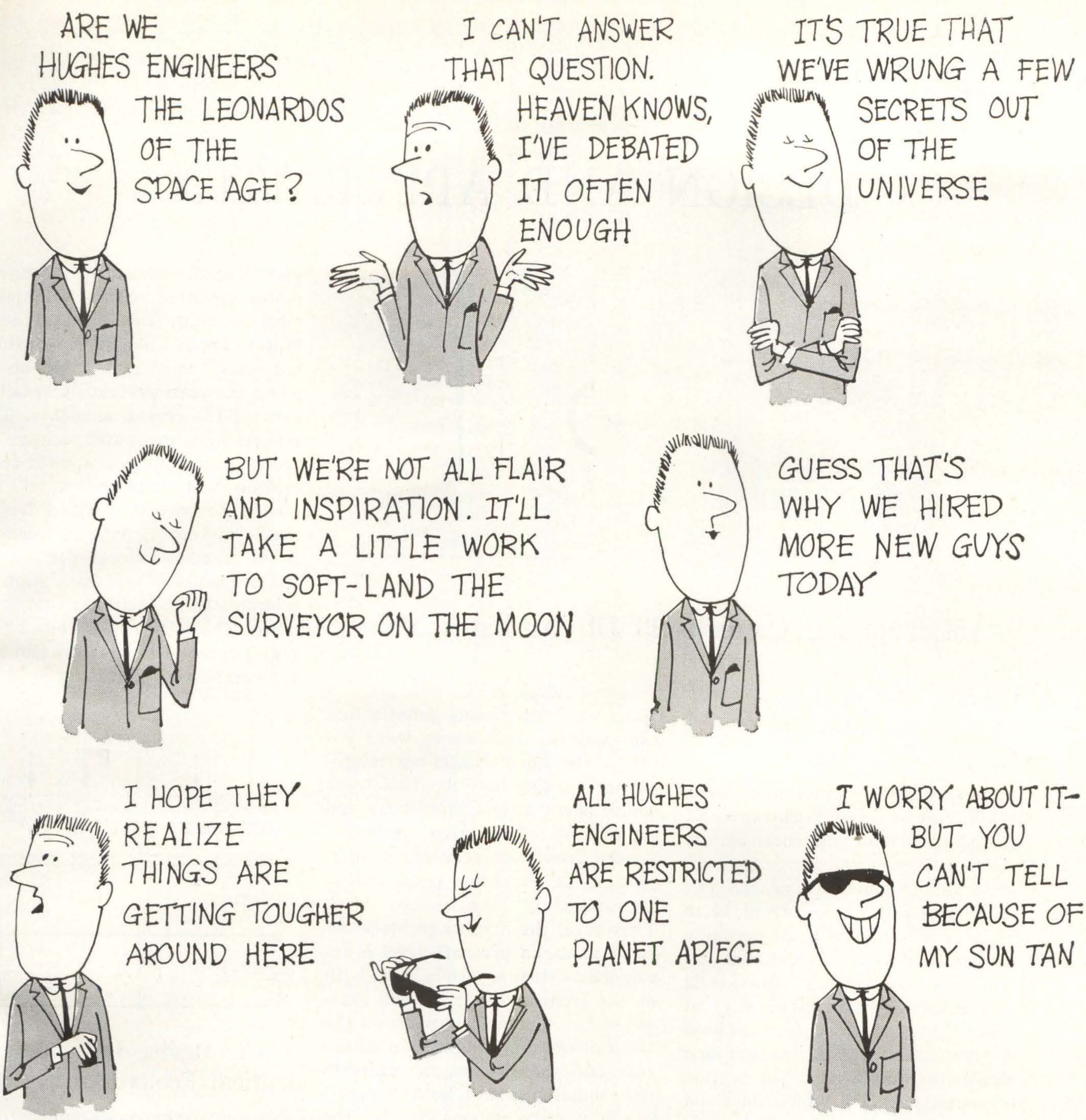

Hughes is hiring! Numerous opportunities now exist in a variety of advanced projects and studies. Examples include: The SURVEYOR—which will soft land an instrumented payload on the moon, SYNCOM—synchronous-orbit communications satellite, VATE—automatic test equipment for ballistic missiles, anti-ballistic missile defense systems—boost-intercept, mid-course and terminal, and many others. Positions are open at all levels for specialists with degrees from accredited universities.

Please airmail your resume to:

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CONTROLS ENGINEERS. Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

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

INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification, air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

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

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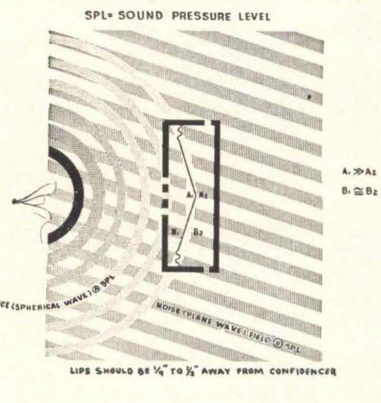


Microphone Cancels 23 Db Ambient Noise

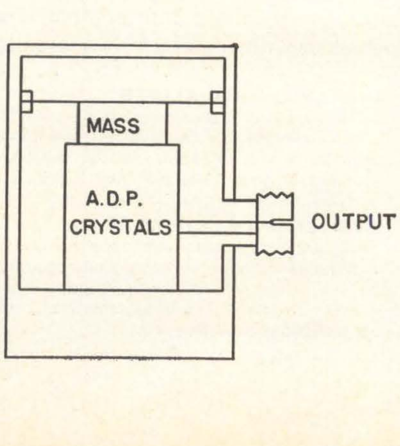
Carbon unit uses two acoustic chambers to balance diaphragm

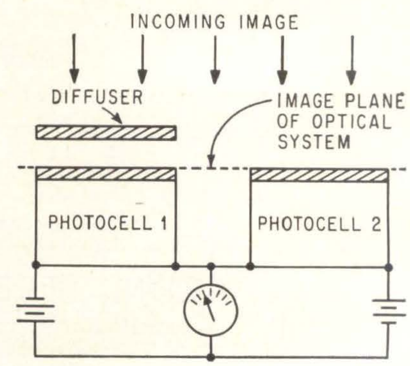
MANUFACTURED by Roanwell Corp., 180 Varick St., New York 14, N. Y., the model C-500 Confidencer carbon microphone fits into a conventional 500-style telephone handset. The unit effectively cancels from 14 to 23 db of the ambient noise normally transmitted by a conventional microphone. As shown in the sketch, the voice consists primarily of spherical wave sound pressure level *A* that enters the front port and strikes the diaphragm. The portion of sound pressure which does not enter the front port impinges on the rear of the diaphragm at a much lower level. Noise, at sound pressure level *B* is primarily a plane wave emanating from a distant source. This plane wave envelops the noise cancelling microphone, entering both front and rear sound ports at the same time and same level. This wave impinges on the front and rear of the diaphragm at the same time and at approximately the same level. Therefore, the diaphragm does not react to sound pressure level *B* inasmuch as its pressure is equal both on the front and rear. Sound pressure level *A* is much greater on the front of the diaphragm than on the rear and the diaphragm reacts to this sound pressure level generating a voltage determined by the voice input.

CIRCLE **301**, READER SERVICE CARD

Accelerometer Features High Sensitivity

DEVELOPED by Massa Div. of Cohu Electronics, Inc., Lincoln St., Rte 3A, Hingham, Mass., the AC-105 accelerometer has an open circuit sensitivity of 600 mv per g, dynamic range between 0.00005 to 200 g, minimum resonant frequency of 10 Kc and a maximum cross axis sensitivity of 2 percent. The unit consists of a mass-loaded assembly (see sketch) of ADP (ammonium di-hydrogen phosphate) crystal plates mounted within a stainless steel housing. For constant acceleration applied along the longitudinal axis, constant stress occurs along the piezoelectrically sensitive axes of the crystal elements. This results in a generated voltage directly proportional to applied acceleration and independent of frequency to beyond 3 Kc. Effect of mass loading the crystal assembly is to increase stress per unit g which results in extremely high accelerometer sensitivity of 600 mv/g. The ADP crystal has a very high degree of uniformity and long time stability. **(302)**

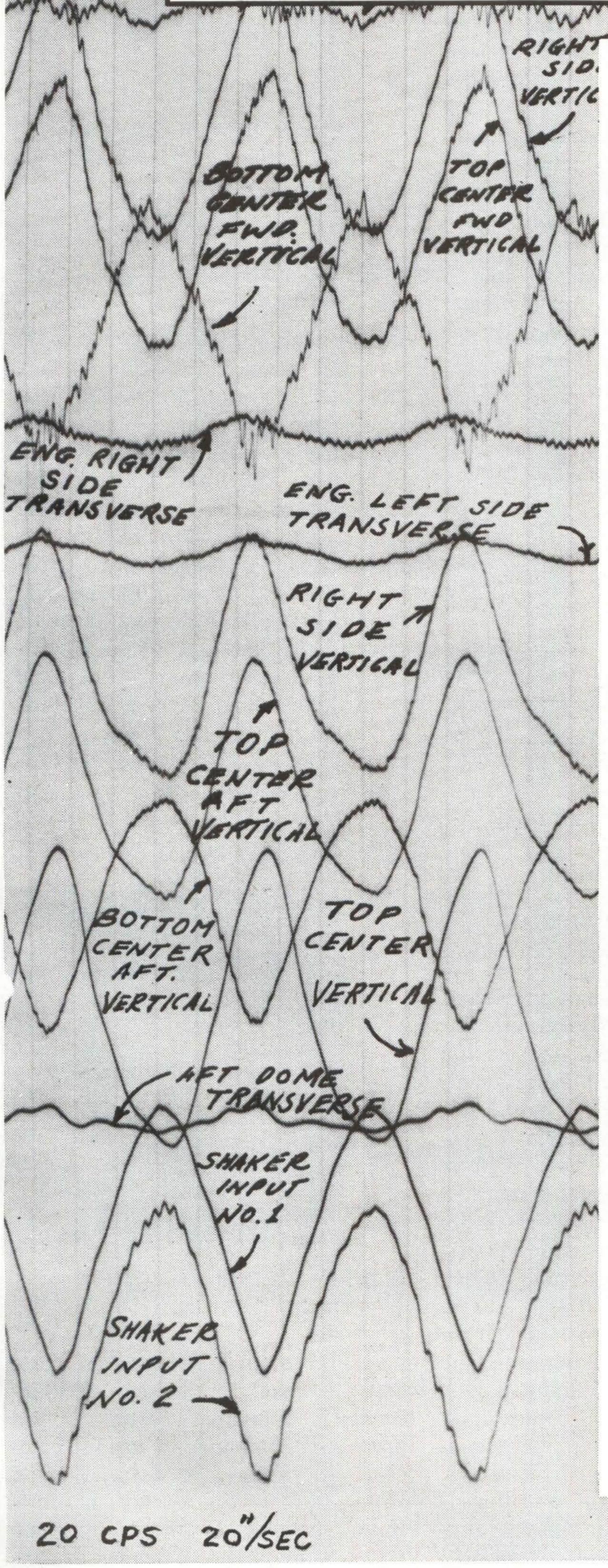




Static Device Indicates Optical Focus Directly

ANNOUNCED by LogEtronics, Inc., 500 Monroe Ave., Alexandria, Virginia, the Focatron meter can be used to check parallelism of a film holder, lens and copy board; checking that ground glass and film holder are in same plane; calibrating and testing autofocus devices; selecting optimum lenses; checking lenses for field curvature and color correction; calibrating tapes; and focusing on a particular spot with a view camera. Three types are available; one for use in view camera, process camera or enlarger easel and the other is intended for on-easel use in any standard enlarger. The third model is for use in microfilm cameras. The basic

Honeywell test instrumentation records structural soundness of missiles



System records 112 test parameters simultaneously

Wyle Laboratory, at its Norco, California, facility, tests the structural soundness of Minuteman, Polaris, and Skybolt missile stages under transportation conditions with a battery of four multiplexed Model 1012 Visicorder oscillographs. The total Wyle-Honeywell system at the three Wyle test sites includes eight 1012 Visicorders, 84 Accudata III amplifiers, and a 14 channel FM tape system.

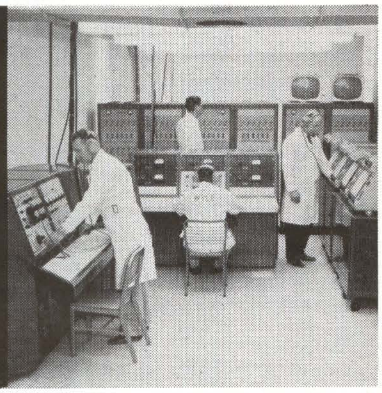
The Wyle test site uses Wyle hydrashaker systems of about 100,000 force pounds, mounted on million pound concrete reaction blocks . . . the only installation of its magnitude in the country. The hydrashaker exciters introduce vibration into the missiles comparable to those encountered during transportation prior to launching.

The specimen record shows data recorded from accelerometers on the third stage of a missile at the locations marked on the record.

The fidelity, contrast, and easy readability of all Honeywell Visicorder records is vividly shown in this record. Where traces are numerous and of this complexity or greater, the trace-identifier interruptions, occurring at regular intervals along the time base of the record, make it easy to identify the individual traces.

For details about Honeywell Signal-Conditioning equipment, the Model 1012, and other Visicorder oscillographs, and the LAR 7400 FM Tape Sub-system write Minneapolis-Honeywell, Heiland Division, 4800 E. Dry Creek Road, P.O. Box 8776, Denver 10, Colorado. Telephone DDD Area Code 303-794-4311.

The Honeywell LAR 7400 FM tape system stores 14 channels of data



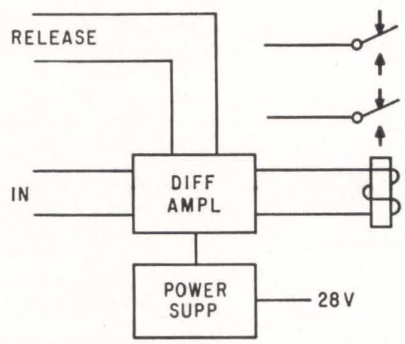
A battery of multiplexed Model 1012 Visicorders directly records 112 parameters of information

Honeywell

First in Control

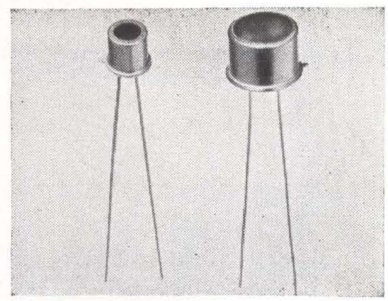
system (see sketch p 86) uses two photocells in the image plane of an optical system cable-connected to the external meter system. Light reaching cell 1 has to pass through a diffuser and only a defocussed image is projected onto its surface. Light path in front of cell 2 is clear so that either sharp or unsharp image appears on its surface. If the incoming image is a checkerboard pattern and the optical system is run through focus, at best focus the brightness difference between the dark and light patches will reach maximum. When a system is defocussed, there will be no brightness difference and meter will read zero. Although theoretically able to focus continuous-tone images, even a live image, its use is presently restricted to those cases where a halftone dot pattern can be inserted into the object plane of the optical system.

CIRCLE 303, READER SERVICE CARD



Voltage Monitor Useful For Many Purposes

RECENTLY announced by Cornell and St. George, Inc., 100 Everett St., Westwood, Mass., the model 709 voltage monitor has an input sensitivity better than 50 mv or 0.1 microwatt power with overload protection up to 100 v. Set point is determined by externally-supplied voltage, input is isolated from ground and input impedance is 25,000 ohms. Drift is less than 30 μv/degree C between 0 and 55 C. Range extension is by external voltage divider, current monitoring is by 50 mv shunts, thermistor input may be used, or a photocell input used where light level is low or environment too severe for sensitive relays. The device consists of a differential amplifier, a floating power supply and a relay capable of switching 3 amperes and 28 v d-c. The power supply provides complete isolation from the power source thus input is insensitive to common-mode voltages. (398)



CdSe Photocells Have Fast Response Times

OPTO-ELECTRONIC DEVICES, INC., 660 National Ave., Mountain View, Calif., offers the OED-3H5 cadmium selenium photocells. Mean rise time specification is 150 μsec, with a max of 1.5 millisec, from SS dark resistance of more than 1,000 megohms to a dynamic light resistance value of 25,000 ohms with neon illumination of 1,000 $\mu w/cm^2$ at 25 C. Max SS light resistance at this illumination is 6,000 ohms with a mean of 3,000 ohms. Fall time from 3,000 ohms to 100,000 ohms is less than 8.0 millisec, with a mean value of 5.0 millisec. (304)

Null Balance Recorder Features Portability

EMCEE ELECTRONICS, INC., P. O. Box 36, Glenside, Pa. Model 1105 recorder is a portable (battery or line operated) instrument used to record d-c voltages as a function of time. It is available with a minimum span of 10 mv, convenient front panel plug-in modules to con-

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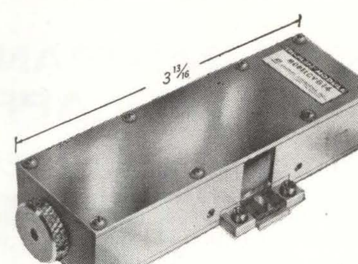
CIRCLE 209 ON READER SERVICE CARD

NEW Variable Phase Shifter Modules



speed breadboarding of microwave circuits

Five new Variable Phase Shifters — for use in all microwave applications where phase angle adjustment or empirical selection of a specific phase angle is required — have been added to the Sanders line of more than 600 TRI-PLATE® Strip Transmission Line Modules.

They are also used: (1) as tuners for matching line impedance to load impedance; (2) as stubs with adjustable lengths to form tunable band reject filters; and (3) as delay lines to establish and control a precise delay.

These new Variable Phase Shifters are used anywhere in the DC to 4 Gc frequency range, have a maximum VSWR of 1.5, and are supplied with a 50 ohm (or 10 ohm) impedance. Model numbers, prices and dynamic phase shift ranges are: MVS8, 30°/KMC, $195; MVS14, 60°/KMC, $175; MVS34, 120°/KMC, $195; MVS54, 240°/KMC, $285; MVS74, 480°/KMC, $485.

Other TRI-PLATE Modules include variable directional couplers, ferrite circulators and isolators, attenuators, hybrid rings, power dividers, tunable filters and over 150 Mounts for standard and advanced semiconductor devices.

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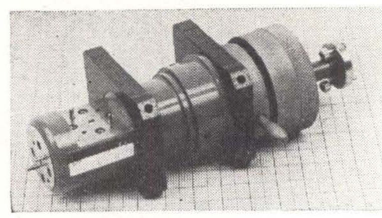
Microwave Products Dept., Nashua, New Hampshire
Please send ( ) complete specifications on Variable Phase Shifters
( ) more information about TRI-PLATE Modules

Name...
Company..
Street...
City...............................Zone......State..................

CIRCLE 89 ON READER SERVICE CARD

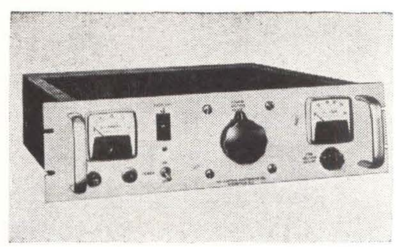
vert the basic instrument to one of a variety of spans, and suppression for either voltage, pressure or temperature recording. Unit has a self-contained power pack.

CIRCLE 305, READER SERVICE CARD



Reflectometers Cover Five Bands

AMERICAN RADIO CO., INC., 445 Park Ave., New York 22, N. Y. Model REF is a CSF reflectometer that measures vswr's as low as 1.03:1 or as high as 100:1 at millimeter frequencies up to 140 Gc in five bands. Device includes a 10 db directional coupler with directivity better than 40 db and a two-way switch in the coupler. Prices range from $1,130 to $2,250. **(306)**



Power Supply Tests Transistor Life

MID-EASTERN ELECTRONICS, INC., Springfield, N. J., has developed a 0 to 36 v 20 amp power supply in a $5\frac{1}{4}$ in. panel without using scr circuitry, primarily for life testing of transistors. Regulation is better than 10 mv, ripple 2 mv, with no overshoot when turning on or off. Unit features automatic tracking overvoltage circuitry and an electronic overcurrent cutoff circuit. Price $820. **(307)**

Motor-Pot

HELIPOT DIVISION of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif., announces the motor-pot, a compact package including potentiometer, servomotor

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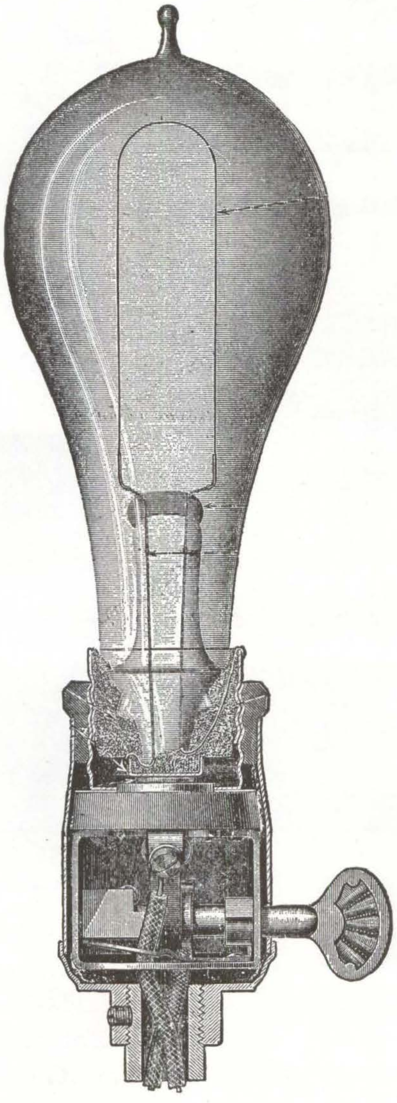

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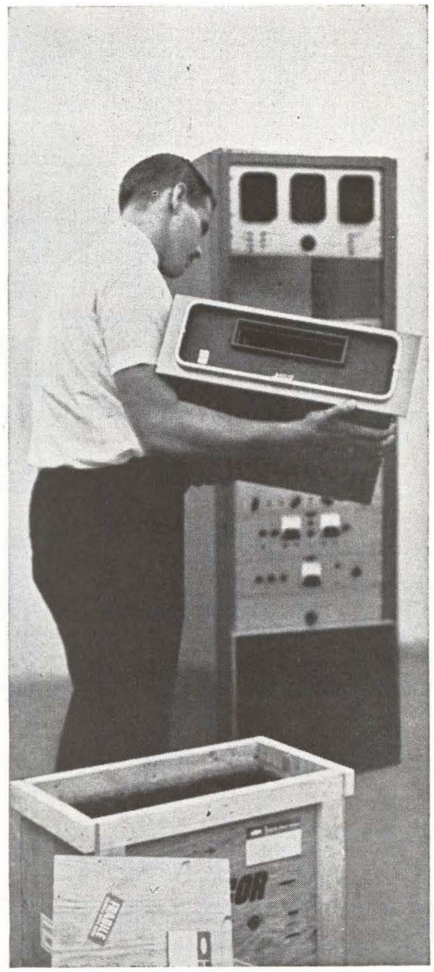

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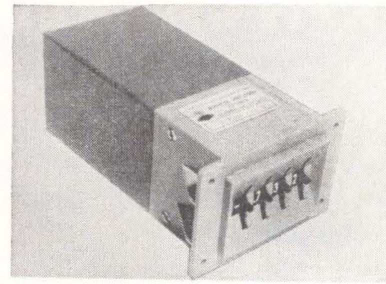
Other models start from $2,775. Both Binary and Binary-Coded-Decimal formats are available. Options include Sample and Hold, Multiplexing, and Over-Range Indication. For more information, write to NAVIGATION COMPUTER CORPORATION, Valley Forge Industrial Park, Norristown, Pennsylvania.

NAVCOR

CIRCLE 91 ON READER SERVICE CARD

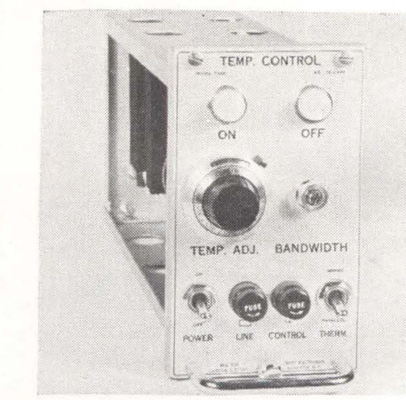
and gearhead—with the gearhead and part of the motor hidden inside the pot.

CIRCLE 308, READER SERVICE CARD



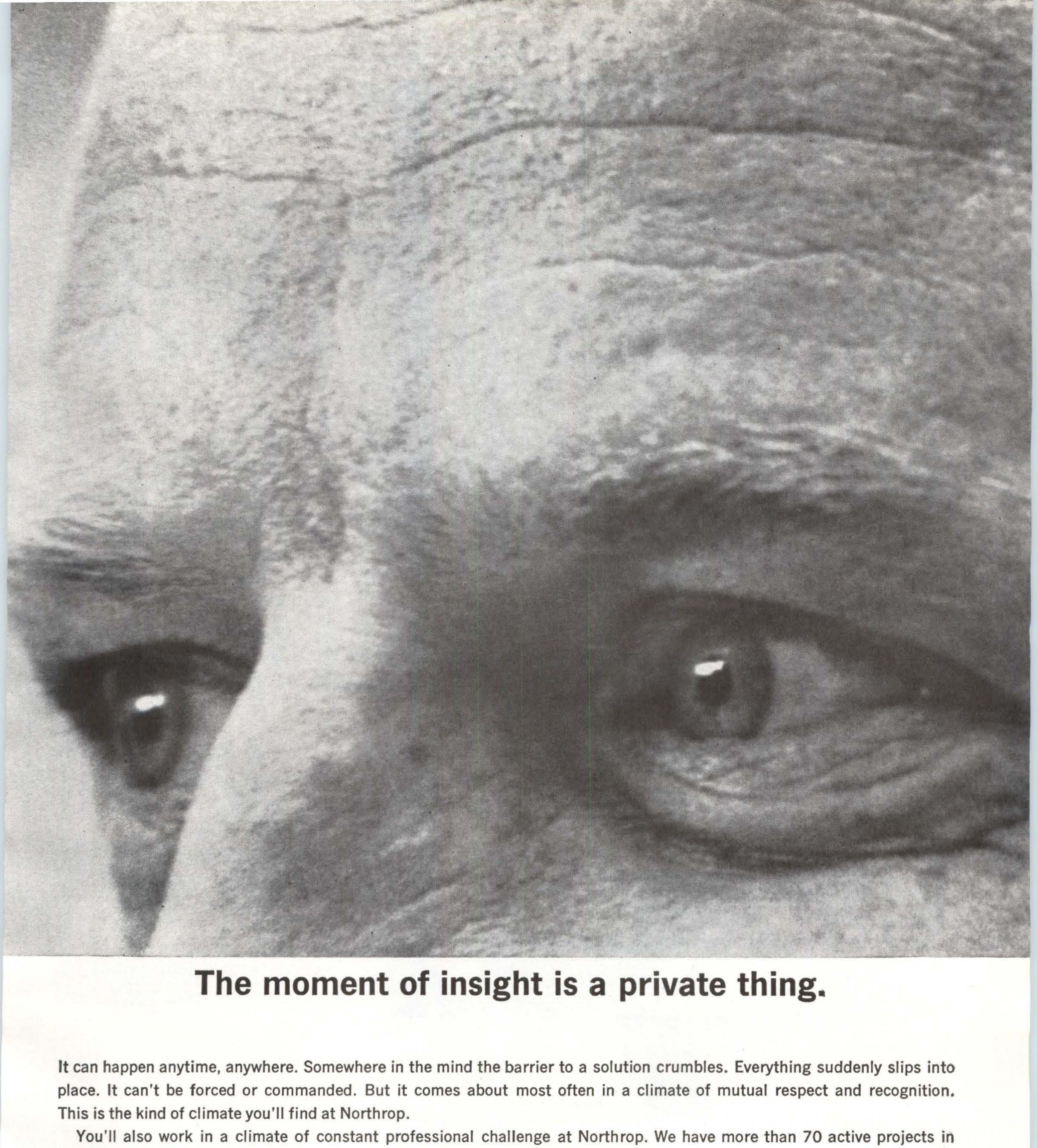
Ratio Transformer Covers 30 to 1,000 CPS

MAGNETIC AMPLIFIERS DIV., The Siegler Corp., 632 Tinton Ave., New York 55, N. Y. The Decatran is a rugged highly precise 3 decade ratio transformer. A multiposition switch arrangement on the front panel produces easily preset ratios of 0.000 to 1.099 and 0 or 180 deg phase. Applications: for a-c potentiometers, transformer checking, servos, instrument calibration and potentiometer testing. Also suited to computers, digital to analog conversion, and a wide variety of automatic sequence operations using analog techniques. **(309)**



Temperature Controller Utilizes SCR's

TROTT ELECTRONICS, INC., 412 Smith St., Rochester 6, N. Y. The TR601A is an all solid state 20 amp true proportional control which utilizes silicon controlled rectifiers in a full wave proportioning circuit. The control is supplied as a plug-in module, which may be mounted singly in a portable case or in groups of 4 in a 7 in. by 16 in. panel space. True proportional



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On the following pages you'll find some specific positions available now at Northrop Space Laboratories and the Norair Division. Look them over. One may be just the spot for you.

But even if you don't find your specialty listed—don't go away. We simply don't have room to mention all the opportunities to be found throughout Northrop's several divisions. If you're the kind of man who has fresh insights into problems, there's bound to be a place for you at Northrop. Write to Dr. Alexander Weir at Northrop Corporation, Beverly Hills, Calif., and tell us about yourself. You will receive a prompt reply.

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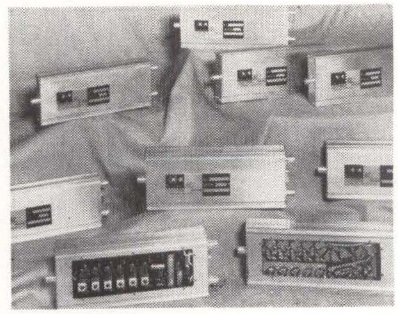
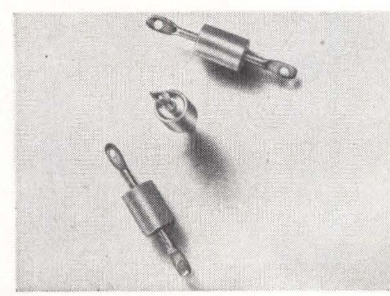
control is accomplished by varying the firing angle of the scr's.
CIRCLE 310, READER SERVICE CARD



I-F Amplifiers Are Low in Cost

AIRBORNE INSTRUMENTS LABORATORY, Deer Park, L. I., N. Y. Low power drain i-f amplifiers feature hybrid preamplifiers, completely transistorized post-amplifiers, and combined pre-post-amplifiers. The preamplifiers and combination units use Nuvistors at the input to obtain low noise figure characteristics. Standard models include both wide- and narrow-band versions at 30 and 60 Mc center frequencies and are available in price ranges from $375 to $485. **(311)**



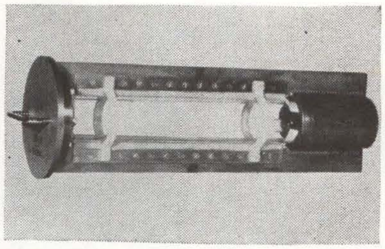
Gyro Terminals Sealed with Clear Glass

VERNITRON WEST, INC., 5353 Strohm Ave., N. Hollywood, Calif., offers hermetic seal gyro terminals of Kovar sealed with matched clear glass which enables visual inspection of the quality of the seal. The new parts have minimum glass climb on the terminals, minimum bubble population, complete freedom from cracks in the glass and total absence of burrs. **(312)**

Toroidal Core

CONNOLLY & CO., INC., P.O. Box 295, Menlo Park, Calif. Toroidal cores, with o-d of 0.310 in., an i-d of 0.156 in. and a thickness of 0.125

in., are designed for quality filters, inductors, pulse transformers and choke coils in the low audio frequencies to 200 Kc. **(313)**



UHF Folded Cylinder Handles 6 Mw Peak

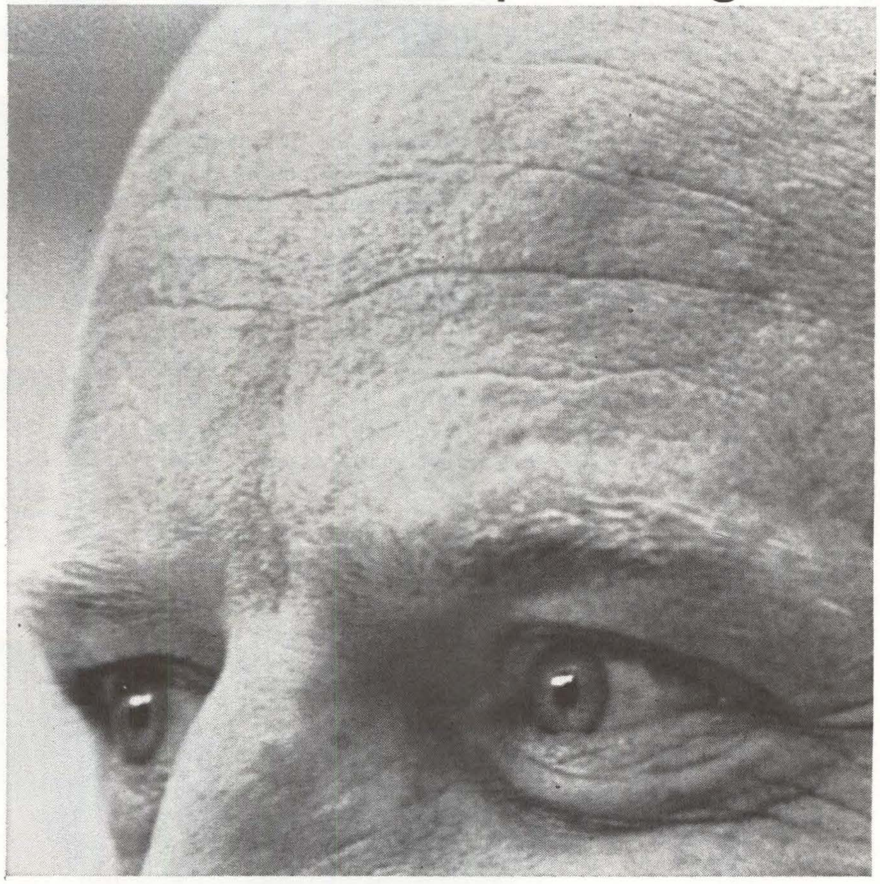
METCOM, INC., 76 Lafayette St., Salem, Mass., offers a uhf folded cylinder TR switch completely mounted for socket type installation. The MPD-19 is designed for slide installation in WR-2100 waveguide transmission line. It will handle 6 Mw peak and 12,000 w average power in the uhf band with extremely long life. Price is $700 each. **(314)**

SSB Receiver Adapter Features Small Size

KAHN RESEARCH LABORATORIES, INC., 81 South Bergen Place, Freeport, L. I., N. Y. Model RSSB-62-1A is designed to convert conventional a-m receivers to ssb operation. It is completely Nuvistorized and operates with a B+ voltage of 60 v which accounts for its small size ($5\frac{1}{4}$ in. high by $18\frac{1}{2}$ in. deep by 19 in. wide) and weight (20 lb). Included is an ell-electronic afc with an improved correction speed of 50 cycles per sec/sec. Also included is circuitry which allows the use of a subcarrier as well as the main carrier for afc purposes. Carrier loss protection is featured. **(315)**

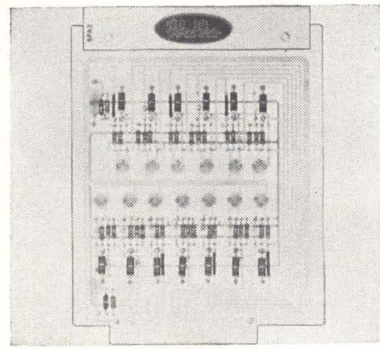
Temperature Chamber

CAMBRIDGE SYSTEMS, INC., 50 Hunt St., Newton 58, Mass. Model 123A thermoelectrically stabilized temperature chamber is designed to



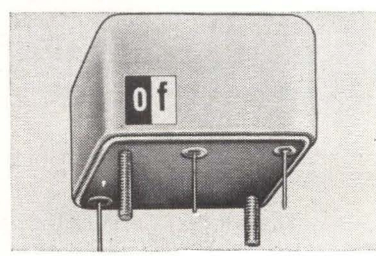
maintain low-level p-c cards at any preset temperature between 20 C and 30 C.

CIRCLE **316,** READER SERVICE CARD



Output Amplifiers Used for A-D Conversion

NAVIGATION COMPUTER CORP., Valley Forge Industrial Park, Norristown, Pa. Each model 5PA2 has 13 inverting amplifiers on a single p-c card. Each amplifier has an output capability of 5 ma at −6.8 v. These amplifiers are used on the digital outputs of Navcor analog-to-digital converters. Price of the 5PA2 is $79. **(317)**

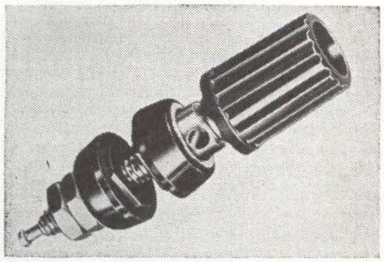


Crystal Filter Used in VHF Receivers

ORTHO INDUSTRIES INC., 7 Paterson St., Paterson 1, N. J., announces model 2102 filter—108 Mc to 112 Mc, with particular application in vhf receiver front ends and satellite tracking receivers. Center frequency is 112 Mc; 6 db bandwidth, 10 Kc; 60 db bandwidth, 40 Kc; insertion loss, 11 db (nominal); passband ripple, 1 db (nominal); input and output impedance, 120 ohms. **(318)**

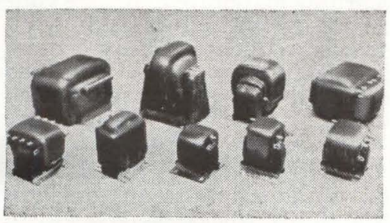
Dummy Load Packages

ELECTRO IMPULSE LABORATORY, INC., 208 River St., Red Bank, N.J., announces high power dummy load packages, 5,000 w to 100,000 w, coaxial or waveguide, completely self-contained with cooling units d-c to 12 Gc, c-w or pulse. **(319)**



Miniature Binding Posts Help Solve Space Problem

THE SUPERIOR ELECTRIC CO., Bristol, Conn. Five-way binding posts are suited for use on electrical and electronic apparatus where panel space is limited. Extend only 53/64 in. from face of panel in closed position, 1$\frac{3}{32}$ in. fully open. Max diameter 0.435 in. for thumbnut, 0.469 in. for panel insulators. Use $\frac{3}{8}$ in. diameter panel hole but D type shoulders on panel insulators permit mounting in keyed panel hole. Mount in panels from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. thick. Rated for 15-amp current capacity and 1,000-v working. **(320)**

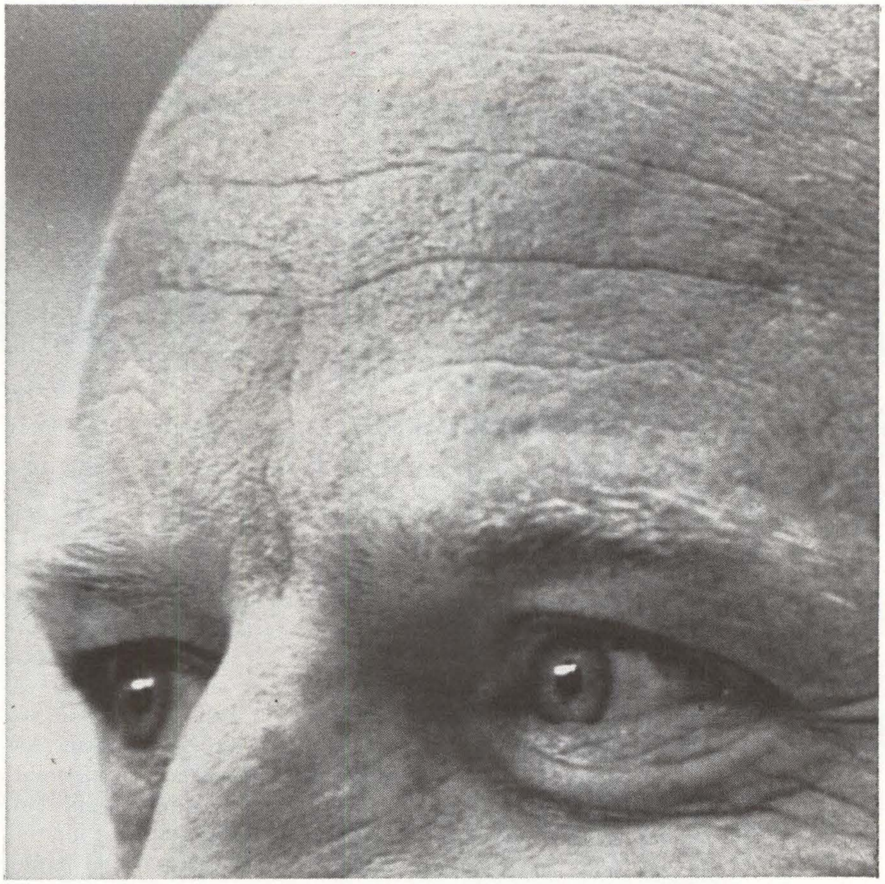


Magnetic Components Meet MIL Requirements

KENYON TRANSFORMER CO., INC., 1057 Summit Ave., Jersey City 7, N. J., is manufacturing encapsulated transformers and reactors which operate at temperatures up to 170 C and will meet military requirements for airborne and ground support equipment. Construction used assures minimum component weight while maintaining long life characteristics. **(321)**

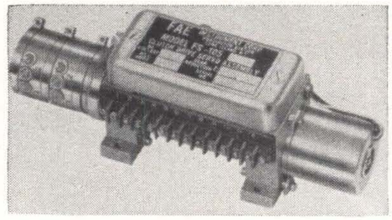
TWT Amplifier Covers 4.4 to 5.0 Gc

HUGGINS LABORATORIES, INC., 999 East Arques Ave., Sunnyvale, Calif. Type HA-35 twt is designed for



severe operating conditions. Frequency range is 4.4 to 5.0 Gc with a power output of 1 w. Gain at rated power output is 30 db minimum and the small signal gain is 30- db minimum. Cooling air requirements are 5 cfm.

CIRCLE **322**, READER SERVICE CARD



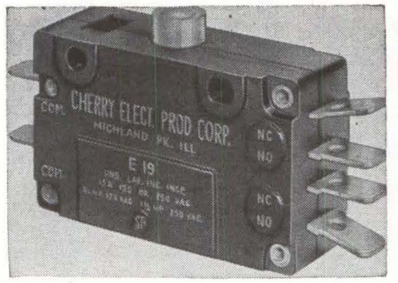
Servo Assembly Offered in Size 11 Frame

FAE INSTRUMENT CORP., 16 Norden Lane, Huntington Station, N. Y. Miniature size 11 servo assembly is shown in one possible configuration. By varying the amplifier output, motor speed, reduction ratio, and the choice of potentiometer, an infinite number of input-output combinations can be effected. Assembly consists of a potted solid-state amplifier mounted on two aluminum end-caps having 4 mounting holes, a specified pot and motor at either end, a speed reducer and a clutch or clutch-brake, and a miniature terminal strip. **(323)**

Time Delay Relays Weigh 2.1 Oz

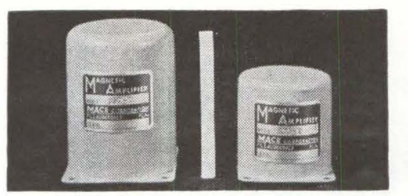
CRANE ELECTRONICS CO., 4345 Hollister Ave., Santa Barbara, Calif. Time delay relays for military and non-military applications are available for operation at various supply and contact ratings, and with dpdt standard contact arrangement.

Packages measure 1⅛ in. sq by 1½ in. high, and weigh 2.1 oz. Prices begin at $55 for standard models in single unit quantities. **(324)**



Basic Switch Combines Two in One

CHERRY ELECTRICAL PRODUCTS CORP., P.O. Box 438-5, Highland Park, Ill. The E19-00A combines two switches into one compact case permitting control of four independent circuits. This double pole, enclosed general purpose switch features special coil spring for long life. Designed to simplify circuitry, provide accurate control and offer flexibility in circuitry design. Suitable for 3 phase motor control. Standard 1-in. mounting holes. **(325)**



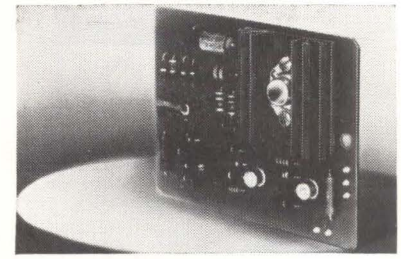
Magnetic Amplifier Will Fire Any SCR

MACE CORP., 900 N.E. 13th St., Ft. Lauderdale, Fla., offers the P series self-regulating scr firing magnetic amplifier that has fail-safe bias. Design is based on the scr as a current triggered device and is thus capable of delivering 200 ma short circuit current but with a low rms current output. Unit delivers 6 v peak with rise time of 100 μsec and pulse duration of 1 millisec for 60 cycle units. Special feedback assures extremely high stability with temperature variation and voltage variation. **(326)**

P-C Board Coating

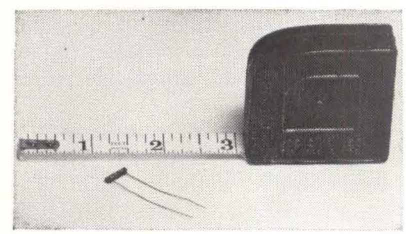
COLUMBIA TECHNICAL CORP., Woodside 77, N.Y. A single-component,

polyurethane coating, HumiSeal type 1A22, is recommended for use where excellent adhesion, flexibility and solderability are important.
CIRCLE 327, READER SERVICE CARD



Circuit Board Coolers Feature Low Profile

WAKEFIELD ENGINEERING, INC., Wakefield, Mass., has designed a line of Delta-T circuit board coolers with low profile and flat bottom (as required for printed circuits and externally mounted power supplies). Models 601 and 602 accept hex. sizes up to 1⅛ in. and are suitable for TO-8. Models 621, 623 and 641 accept all standard transistor case styles and hex. sizes up to 1¼ in. **(328)**



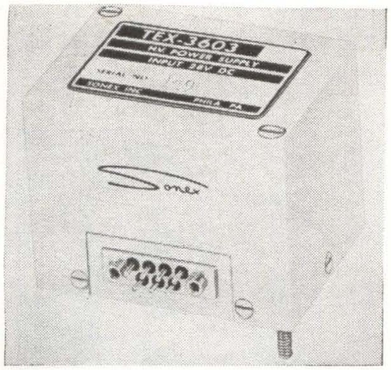
Radial Lead Resistors Designed for P-C Board

CHARLES T. GAMBLE INDUSTRIES, Reeder & Monroe Sts., Riverside, N. J., offers subminiature radial lead, encapsulated, wire wound resistors for p-c board application. On all resistance values of 500 ohms and above, the resistors are noninductively wound. Max resistance value is 50,000 ohms. Tolerance is from $\pm$ 1 to $\pm$ 0.01 percent. Temperature coefficient is 10 ppm per deg C. Operating temperature is 125 C at 0.1 w. Size is 0.093 by 0.375 long. **(329)**

Extension Wire

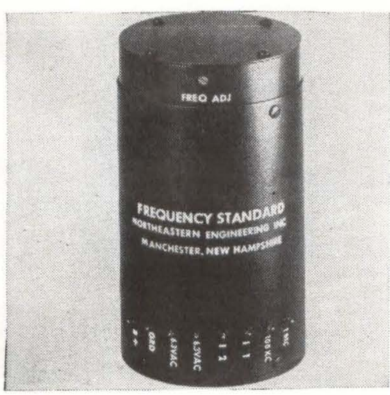
DEKORON PRODUCTS DIVISION, Samuel Moore & Co., Mantua, O. Thermocouple extension wire, type CMX

Twist-Ex, is designed for use with computers and other equipment demanding a signal free from extraneous noise. **(330)**



D-C/D-C Converter Designed for Missiles

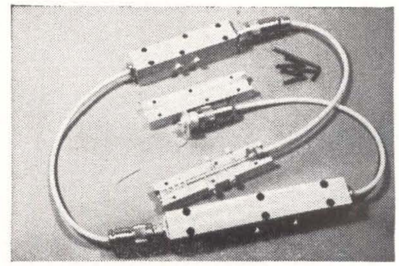
SONEX, INC., 20 E. Herman St., Philadelphia 44, Pa. The TEX-3603 is an all solid state high environmental d-c to d-c converter developed for aircraft and missile applications where reliability, size and weight are of prime consideration. This power supply converts 28 v d-c to the range of 200-250 v d-c for a B+ power source for transmitters requiring up to 140 ma. Ripple on the output is less than 1 v peak-to-peak at full load. Unit will operate from −40 F to +165 F. **(331)**



Clock Standard Used in Counters

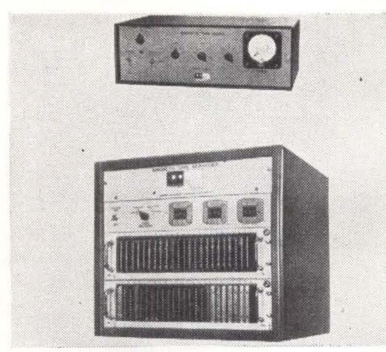
NORTHEASTERN ENGINEERING, INC., 25 S. Bedford St., Manchester, N. H. Model 18-10 clock standard is a basic oscillator which is used in Northeastern electronic counters to obtain the high degree of accuracy and stability specified for them. It produces both 1 Mc and 100 Kc frequencies. It features dual oven vacuum-insulated construction, with oscillator and divider circuits in the inner oven, and dual temperature control operated by a high resolution mercury thermostat.

CIRCLE 332, READER SERVICE CARD



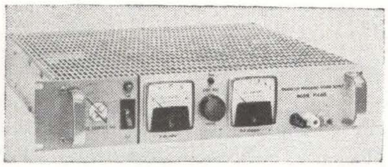
Band Pass Filters Cover 1.0 Gc to 10.75 Gc

APPLIED MICROWAVE ELECTRONICS, INC., 6707 Whitestone Road, Baltimore 7, Md. Series of coaxial band pass filters cover the frequency range from 1.0 Gc to 10.75 Gc in four bands. Insertion loss is 1.0 db max. Rejection at 0.5 of the lower cutoff frequency and 1.5 of the higher cutoff frequency is 60 db. Filters are designed to withstand environmental conditions of MIL-E-5272. **(333)**



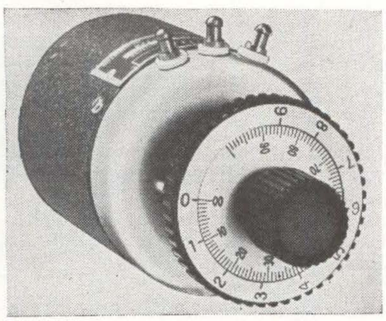
Coder and Searcher Operate Automatically

AIRBORNE INSTRUMENTS LABORATORY, Deer Park, L. I., N. Y., has available a coder and searcher that automatically retrieves and edits data recorded on analog magnetic tape. Use of the units makes it possible for researchers to examine graphical records for data of interest, locate the data on the magnetic tape record, and replay it for subsequent analysis and processing. This automatic method is less difficult and less time-consuming than methods now used in simultaneous recording of data on both graphical recorders and magnetic tape recorders. **(334)**



L-V Power Supplies Have High Regulation

POWER SOURCES, INC., Northwest Industrial Park, Burlington, Mass., has developed a line of low voltage power supplies. Regulation (line) is better than 0.01 percent or 2 mv (whichever is greater) for input variations from 105-125 v a-c. Regulation (load) is better than 0.01 percent or 2 mv (whichever is greater) for load variations from zero to full load. **(335)**



Decade Vernier Pot Has High Resolution

JOHN FLUKE MFG. CO., INC., P.O. Box 7428, Seattle 33, Wash. Model 40A decade vernier pot is a precision voltage divider consisting of high accuracy fixed resistors and a precision wirewound pot which provides continuous interpolation between decade steps. This combination provides linearity accuracy to better than 1 part in 1,000 and resolution of more than 0.02 percent. **(336)**

D-C Amplifier

EPSCO INSTRUMENTS, 275 Massachusetts Ave., Cambridge 39, Mass. Model ADS-1 wideband d-c amplifier is a solid state, chopper stabilized amplifier for use where low noise and drift are of prime importance with high and low source impedance alike. **(337)**

PRODUCT BRIEFS

TIMING SEQUENCERS are high speed, all transistorized units. Counting rates programmed to change during cycle. Ken Lee Electronics, 2869 Kennedy St., Livermore, Calif.
CIRCLE 338, READER SERVICE CARD

REGULATOR MODULE for use in space environment. The 1 cu. in. unit weighs 30 grams. Transformer Electronics Co., Boulder Industrial Park, Boulder, Colo. (339)

PLANAR TRIODE AMPLIFIER for tropospheric scatter communications systems. It features 30 db gain (min), 10 Mc bandwidth (min), 10 w power output (min). Airtron, Hanover Ave., Morris Plains, N.J. (340)

RACK MOUNTED D-C METER offers 42 ranges of voltage and current. Price is $575. Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N.J. (341)

HIGH FREQUENCY STANDARDS RECEIVER is all transistorized. It is accurate up to 1 part in 10^7. Gertsch Products, Inc., 3211 S. LaCienega Blvd., Los Angeles 16, Calif. (342)

DIGITAL VOLTMETER sells for about $395. It has four ranges with an accuracy of $\pm$ 0.1 percent. Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago 13, Ill. (343)

REFRIGERATION COMPRESSOR for airborne and military installations. It is designed for conservative operating speed (3,900 rpm) and long life. Eastern Industries, 100 Skiff St., Hamden 14, Conn. (344)

SOLID STATE DECODER with in-line readout. Unit utilizes plug-in p-c construction. Burroughs Corp., P.O. Box 1226, Plainfield, N.J. (345)

CIRCULAR PLUGS are environmentally resistant. Insulators have a rear-release contact retention system. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. (346)

SILICONE-ASBESTOS LAMINATE solves difficult design problems. It provides long term service at high temperatures. Johns-Manville, 22 E. 40th St., N.Y. 16, N.Y. (347)

SILICON POWER TRANSISTORS are 7.5 amp devices. Collector-to-emitter voltage rating is 250 v. Westinghouse Semiconductor Division, Youngwood, Pa. (348)

WIRE-WOUND RESISTORS for commercial and industrial applications. They are available in 3, 5 or 10-w sizes. Clarostat Mfg. Co., Inc., Dover, N.H. (349)

HIGH-VACUUM MOTOR aids manufacture of microcircuits and thin-film elements. Available in 1/20th h-p at 3,200 rpm. Photonetics Corp., Walker Valley, N.Y. (350)

MAGNETIC CIRCUIT uses Hall effect device. Input-to-output linearity is 1 percent. F. W. Bell, Inc., 1356 Norton Ave., Columbus 12, O. **(351)**

CONNECTOR contains 3 either male or female coax and 12 pin or socket contacts. It accommodates standard hardware. AMP Inc., Harrisburg, Pa. **(352)**

RADIATION-RESISTANT SYNCHRO with very high accuracy. Lead wires are made of silicone impregnated Fiberglas. Sperry Gyroscope Co., Great Neck, N.Y. **(353)**

TUNNEL DIODE AMPLIFIER for 2.2 to 2.3 Gc. It has an operating noise figure of 3.5 db nominal. Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N.J. **(354)**

UHF PREAMPLIFIER for the 500 to 1,100 Mc range. Minimum gain is 20 db, noise figure 12 db max. Applied Technology Inc., 930 Industrial Ave., Palo Alto, Calif. **(355)**

TWO-COLUMN WELDING MACHINE seals diode parts. It has automatic unloading and transfer devices. Thomson Electric Welder Co., 161 Pleasant St., Lynn, Mass. **(356)**

MINIATURE LEAD WIRE used at 1200 F. Flexibility and radiation resistance are offered. Rockbestos Wire and Cable Co., Nicoll and Canner Sts., New Haven, Conn. **(357)**

RELAY SWITCH with a wide range of uses. It is over-center actuated. Chicago Switch Div., F&F Enterprises, Inc., 1733 Milwaukee Ave., Chicago 47, Ill. **(358)**

L-F OSCILLATOR features ± 0.002 percent accuracy with 1 w output. It operates at any frequency from 50 cps to 7 Kc. Accutronics, Inc., 12 South Island, Batavia, Ill. **(359)**

HIGH POWER LOADS for waveguide systems in the 2.6 to 12.4 Gc range. Max vswr is 1.10. PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N.Y. **(360)**

D-C/D-C AMPLIFIER measures 1 cu in. It has two isolated input signal windings and delivers ± 5.0 v. Acromag, Inc., 15360 Telegraph Rd., Detroit 39, Mich. **(361)**

SILICONE PASTE for sealing insulation systems. A cure of 10 minutes at 300 F under pressure is adequate for most applications. General Electric Co., Waterford, N.Y. **(362)**

FILM RESISTORS in ratings of 2, 3, 4, 5 and 7 w. They have welded leads and a hard, heat-resistant finish. P. R. Mallory & Co. Inc., Indianapolis 6, Ind. **(363)**

SPDT THERMOSTAT measures 0.400 in. o-d. It is hermetically sealed in compression glass. Elmwood Sensors, Inc., 675 Elmwood Ave., Providence 7, R.I. **(364)**

HALF HEIGHT SLOTTED LINE in waveguide size WR975. Frequency range is 750 Mc to 1,120 Mc. Antenna Systems, Inc., 349 Lincoln St., Hingham, Mass. **(365)**

Literature of the Week

MODULAR SWITCH ASSEMBLIES North Atlantic Industries, Inc., Terminal Drive, Plainview, N.Y. Instrumentation data sheet gives electrical and mechanical specifications for modular thumbwheel type switches.
CIRCLE **366**, READER SERVICE CARD

INTEGRATING MOTOR TACHOMETER GENERATORS Kearfott Division, General Precision, Inc., Little Falls, N.J. A catalog sheet covers size 8 temperature-compensated integrating motor tachometer generators. **(367)**

PULSE EQUIPMENT General Radio Co., West Concord, Mass. Brochure describes pulse, sweep, and time-delay generators, pulse amplifiers, and variable delay lines. **(368)**

INDUSTRIAL TRANSFORMERS Stancor Electronics, Inc., 3501 W. Addison St., Chicago 18, Ill., has published a 40-page industrial catalog of transformers and related components. **(369)**

VARIABLE RESISTOR CTS of Berne, Inc., Berne, Ind., offers a catalog on a 3-w military grade variable resistor at 2-w industrial price. **(370)**

PRECISION ANGLE SENSORS Del Electronics Corp., 250 Sandford Blvd., Mount Vernon, N.Y. An engineering manual describes the Multisyn, a device capable of measuring and controlling rotary motion with extreme accuracy. **(371)**

SYNCHROS Vernitron Corp., 602 Old Country Road, Garden City, N. Y. Data sheet contains specifications to aid in rapid selection of size 23 MIL synchros. **(372)**

STATIC CONVERTERS Sparton Corp., Jackson, Mich. Product data sheet gives description and specifications of a series of low cost, transistorized d-c/d-c static converters. **(373)**

MICROWAVE FILTERS Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. Technical bulletin covers electronically-tuned microwave filters with rapid-switching capabilities. **(374)**

ELECTRON BEAM GUNS Brad Thompson Industries, Inc., 83-810 Tamarisk St., Indio, Calif. Catalog describes electron guns for both internal and external mounting with ratings up to 6 Kw. **(375)**

VIBRATION GAGE Raydata Corp., 1078 E. Granville Rd., Columbus 24, O., has a bulletin on a self-calibrating, non-contacting instrument for the continuous display of vibration amplitude and frequency. **(376)**

HIGH VACUUM RELAY Resitron Laboratories, Inc., 3860 Centinela Ave., Los Angeles 66, Calif. Data sheet illustrates and describes the RVS-1 high voltage, high vacuum transfer relay. (377)

ACCELEROMETER Clevite Electronic Components, 232 Forbes Road, Bedford, O., has available literature on model 5D41 self-generating, high capacity accelerometer. (378)

RELAYS Ohmite Mfg. Co., 3698 Howard St., Skokie, Ill. A complete line of made-to-order and stock relays is described in a catalog. (379)

CERAMIC CAPACITORS Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. Bulletin covers epoxy-coated miniature ceramic capacitors with weldable leads for cordwood packaging. (380)

MEDIUM FREQUENCY RECORDER Texas Instruments Inc., 3609 Buffalo Speedway, Houston 6, Texas. Bulletin R-509 illustrates and describes the portable Oscillo/Riter medium frequency recorder. (381)

HIGH POWER AUDIO AMPLIFIER Bruno-New York Industries Corp., 460 W. 34th St., New York 1, N. Y. Data sheet describes model 944 compact and rugged, transistorized 20 w audio amplifier. (382)

CAPACITORS General Electric Co., Schenectady 5, N. Y. Bulletin GEC-1745 contains complete information on a line of fixed paper-dielectric electronic capacitors. (383)

PARTICLE DETECTORS Nuclear Diodes, Inc., 1640 Deerfield Road, Highland Park, Ill. Brochure covers a line of silicon surface barrier charged particle detectors. (384)

POTENTIOMETRIC RECORDER Barber-Colman Co., Rockford, Ill. Buletin F-11394 describes a quick change multipoint recorder. (385)

NEW CIRCUITS MANUAL Transmagnetics Inc., 40-66 Lawrence St., Flushing 54, N. Y., offers a technical manual entitled "New Circuits for Solving Unique Design Problems." (386)

MAGNETIC TAPE Computron Inc., 122 Calvary St., Waltham 54, Mass., has published a 10-page booklet entitled "Facts You Should Know About Magnetic Tape." (387)

MAGNETIC AMPLIFIER RELAYS Sigma Instruments, Inc., Braintree 85, Mass. Six-page bulletin covers a series of 400 cps μw-sensitive polarized magnetic amplifier relays. (388)

FERRITE FOAMS Emerson & Cuming, Inc., Canton, Mass., has published a technical bulletin on Eccofoam Fe, a series of ferrite materials in foam and honeycomb form. (389)

SILICON RECTIFIERS Erie Resistor Corp., 644 W. 12th St., Erie, Pa. Bulletin 523 presents specifications for a line of miniaturized encapsulated silicon rectifiers. (390)

THIN-FILM MICROCIRCUITS Halex, Inc., 310 E. Imperial Ave., El Segundo, Calif. Advantages and construction of thin-film microcircuits are described in a bulletin. (391)

DISCUSSING *new product possibilities at Tempo Instrument Incorporated are (left to right) Alfred Multari, vice president and technical director; George J. Sbordone, president; Vincent A. Altomare, marketing manager; and Emanuel Poulous, v-p and head of advanced engineering*

Sbordone: Making Time With Teamwork

NEW PRESIDENT of Tempo Instrument Incorporated, Plainview, N. Y., is George J. Sbordone. His election comes after 4½ years as vice president and general manager. He succeeds Franklin Meyer, now chairman of the board.

The new president has seen Tempo grow from a handful of men and dollars to a group of 135 employees (25 percent of them engineers), which constitute what he calls the "Tempo Team."

Tempo has committee management. To those who would point out the old saw about the camel being a horse designed by a committee, Sbordone points up the fact that the company was up 27 percent in sales in the first quarter of 1962, and expects to do $2.4 million by this year—an increase of more than 20 percent over 1961.

The company was founded in 1957 to bring an idea into reality—an all-electronic, solid-state timer. The first Tempo timer to become a standard component for a missile was for separating the stages of Thor (Douglas). Its timing devices are now used in many American rockets, missiles and satellites.

Although Tempo has been involved primarily in components and subsystems for defense projects, Sbordone emphasized the company's recent progress in devices for industry. For example, it recently developed an all-electronic voltage monitor for electric utilities, and a short magnetostrictive delay line for programmers and computers.

Sbordone brings to his present position a background of 19 years of high level experience in design engineering, project administration cost control and production methods. Before joining Tempo, he spent eight years with Sperry Gyroscope Co., and ten years with Servomechanisms, Inc.

A modest man, Sbordone tells interviewers: "Don't talk about me, talk about Tempo." He says that his only real talent is working with people. He and his wife have four children and live in South Hempstead, Long Island.

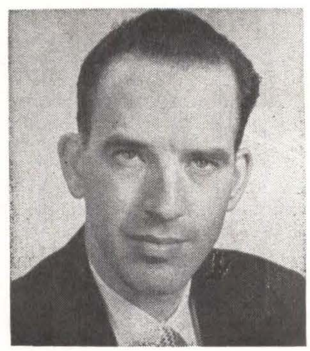
Hawley Products Elects Peck

ARTHUR L. PECK has been elected vice president, manufacturing, engineering and research by the board of directors of Hawley Products Co., St. Charles, Ill. He was formerly director of manufacturing of the company.

Sylvania Hires Bruce Barrow

APPOINTMENT of Bruce B. Barrow as a senior engineering specialist at the Applied Research Laboratory of Sylvania Electronic Systems, Waltham, Mass., is announced. He will be concerned with investigation and application of advanced communication systems.

Prior to joining Sylvania, Barrow was a communications scientist and chief of the scientific information group at the Air Defense Technical Center of the Supreme Headquarters Allied Powers Europe, located in the Netherlands.



Ampex Corporation Names N. L. Head

N. LAWRENCE HEAD has been named senior scientist at Ampex Corporation's magnetic tape laboratory in Redwood City, Calif. He was formerly chief of the chemical and materials laboratory, U. S. Air Force Materiel Command, headquartered at Hill AFB, Ogden, Utah.

GD/Convair Fills Newly-Created Post

APPOINTMENT of W. J. Martin to the newly-created post of director of reliability for General Dynamics/Convair, San Diego, Calif., was recently announced by J. H. Famme, division president.

Martin, with Convair since 1943, will report directly to the division president.

"This new alignment," said Famme, "will enable the company

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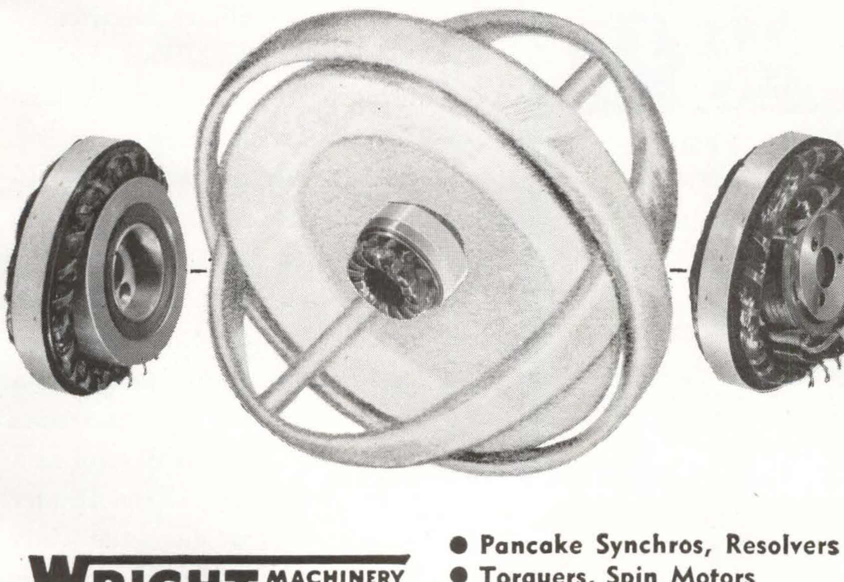

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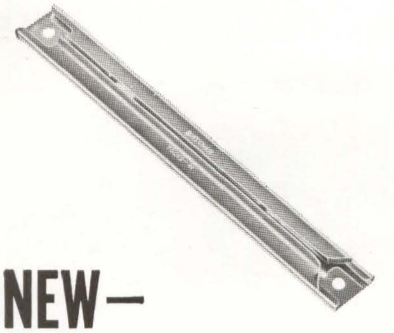

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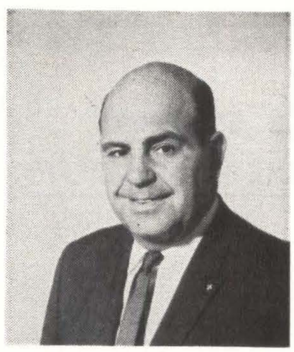
to give the Department of Defense maximum integration of product reliability, quality control and value control surveillance over development and production of systems and all elements comprising delivered products."

Hoffman Electronics Appoints Lowance

FRANKLIN LOWANCE has joined the Military Products division of Hoffman Electronics Corp., Los Angeles, Calif., as chief scientist.

He comes to Hoffman from Electronic Communications, Inc., where he had been president of that company's Advanced Technology division at Santa Barbara, Calif.



ARRA Promotes Louis Gomez

ANTENNA & RADOME RESEARCH ASSOCIATES, Westbury, N. Y., announces the appointment of Louis Gomez to the post of vice president for production.

Gomez' prior position at ARRA was that of plant manager.

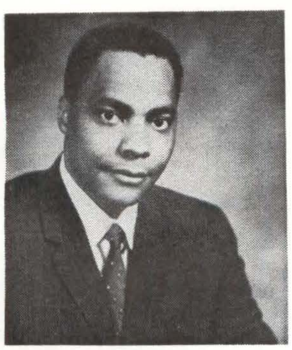
Raytheon Company Advances Yates

DONALD N. YATES, who joined Raytheon Company, Lexington, Mass., in 1961 as director of technical planning, has been elected a vice president of the company and appointed general manager of its Missile and Space Division.

At the time of his retirement from the Air Force as a lieutenant general in 1961, Yates was Deputy Director of Defense Research and Engineering in the office of the Secretary of Defense.

Communicom Names Tom Cook

COMMUNICOM, a division of Chaskin-Dimmick Corp., Palo Alto, Calif., has announced the appointment of Tom Cook as communications project engineer. He was previously with ITT-Kellogg Communications Laboratory, and prior to that with Lynch Communications Corp.



Irving Adams Joins Airtron

IRVING ADAMS has joined the solid state materials staff of Airtron, a division of Litton Industries, Morris Plains, N. J. He was previously vice president of Optech, Inc., in charge of crystal growth and pure materials research.

Bausch & Lomb Names Hasler a Director

MAURICE F. HASLER, chairman of the board of Applied Research Laboratories, Inc., Glendale, Calif., has been named a director of Bausch & Lomb Inc., Rochester, N. Y. Applied Research Laboratories is a wholly-owned subsidiary of Bausch & Lomb.

Announce Formation of New Company

FORMATION of a new electronics firm in San Diego known as Micronetics Inc. has been announced by its president, Robert E. Honer. Company specializes in microwave instrumentation systems.

Honer was formerly manager of product planning for Lockheed's Missiles and Space Co. at Sunnyvale, Calif.

Siltronics Names Schuyler Kase

SILTRONICS, INC., Pittsburgh electronics and communications manufacturer, has named Schuyler Kase as its director of new product development.

Kase comes to Siltronics from Norwalk, Conn., where he served as assistant director of Engineering in the Perkin Elmer Corp.

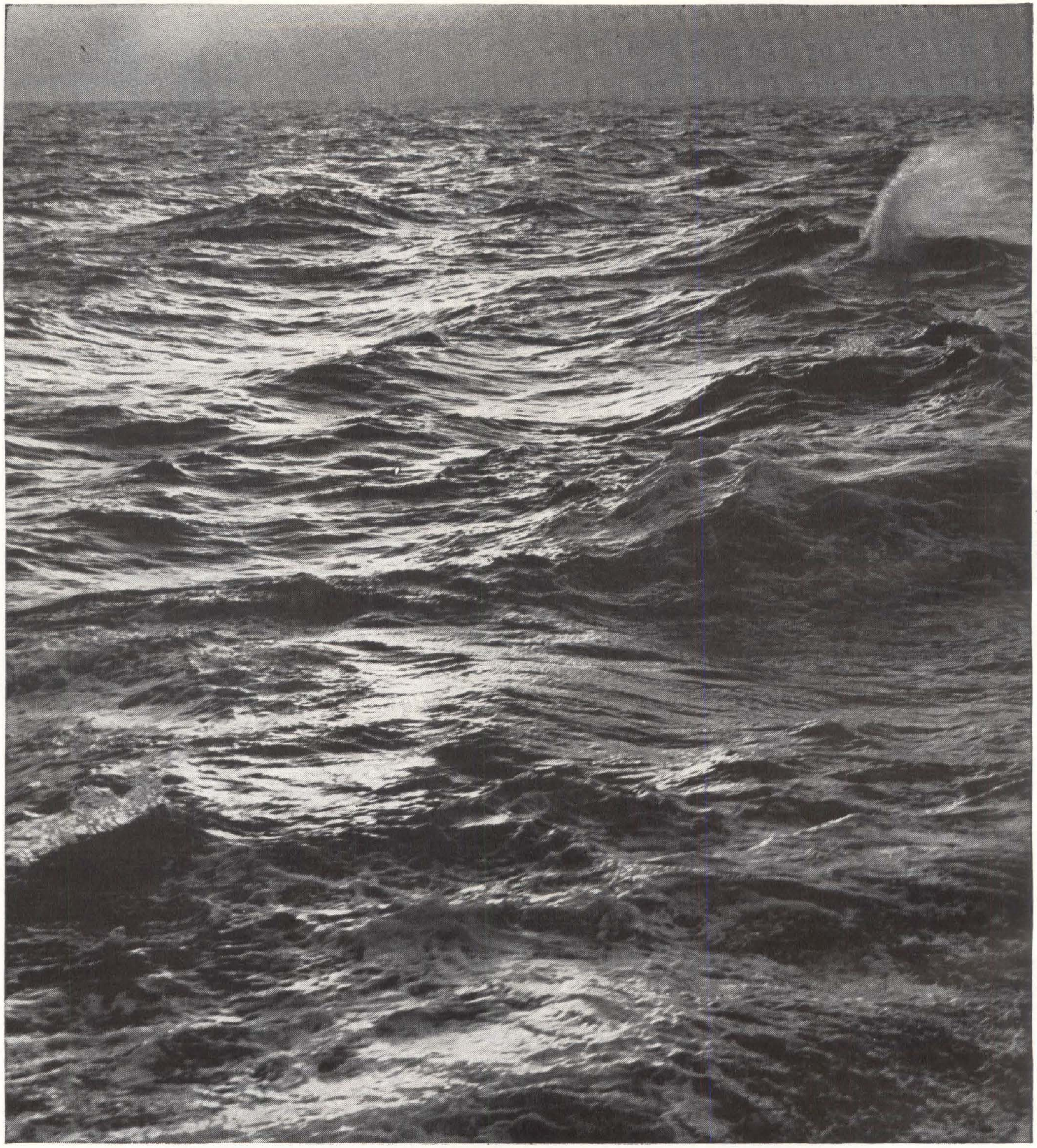
Frequency Engineering Hires Jamison

RUSSLIN P. JAMISON has joined Frequency Engineering Laboratories, Asbury Park, N. J., as electrical engineer in the firm's Systems Engineering Group. He will be assigned to the AN/WLR-1 countermeasures receiver program recently awarded Frequency Engineering by the U. S. Navy.

Jamison was formerly with Hill Electronics, Inc., Mechanicsburg, Pa.

PEOPLE IN BRIEF

Donald S. Jones advances to asst. g-m of Bendix-Scintilla. **Kenneth E. Hunter** moves up to v-p, g-m of the Hycon Mfg. Co. **William D. Gabor**, ex-Perkin Elmer Corp., named senior project engineer in the Communications div. of Manson Laboratories, Inc. **Harold Goldstein**, formerly with Budd Electronics and the Lewyt Corp., joins Paradynamics, Inc., as senior member of the technical staff. **M. L. Clevett, Jr.**, previously with Lockheed Aircraft Corp., appointed to the research engineering staff of the Spindletop Research Center. Taylor Corp. ups **Fred P. Baughman** to v-p, R&D. **Neil L. Brown** leaves Woods Hole Oceanographic Institute to become research mgr. of Hytech div. of The Bissett-Berman Corp. **Russell K. Jackson**, formerly with Minneapolis-Honeywell Regulator Co., now production mgr. of Schaevitz Engineering. **Robert F. Schulz**, ex-Sylvania Electronic Systems, named mgr. of manufacturing for Applied Technology, Inc. Middletown div. of Aeronca Mfg. Corp. promotes **Raymond A. Rugge** to director of engineering. **John F. Moore** of Lockheed Electronics appointed consulting scientist for the company. **John K. Shelley**, previously with the FAA, has joined Systems Inc. as asst. to the v-p of engineering. **Arthur R. J. Johnson** advances to mgr., system products for the Systems div. of Beckman Instruments, Inc. **Peter M. Kelly** transfers from Ford Motor Co. to the Philco Scientific Laboratory as associate director. **A. Robert Masters** moves up to president of the Hugh H. Eby Co., succeeding **Jules Sussman** who has been elected chairman of the board.



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BRISTOL COMPANY Waterbury, Conn.	110*	4
DOUGLAS AIRCRAFT CO., Missile & Space Systems Division Santa Monica, California	37*	5
ESQUIRE PERSONNEL Chicago, Illinois	116	6
GENERAL DYNAMICS/ELECTRONICS A Div. of General Dynamics Corp. Rochester, New York	108*	7
HOUSTON INSTRUMENT CORP. Bellaire, Texas	110*	8
JET PROPULSION LABORATORY Pasadena, California	116	9
LOCKHEED CALIFORNIA COMPANY A Div. of Lockheed Aircraft Corp. Burbank, California	66	10
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(CONTINUED ON FOLLOWING PAGE)

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY ....................ZONE......STATE.............

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

9/14/62

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

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SCHUMBERGER WELL SURVEYING CORP. Ridgefield, Connecticut	117	18
SPACE TECHNOLOGY LABORATORIES INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	15*	19
U. S. NAVAL CIVIL ENGINEERING LABORATORY Port Hueneme, California	108*	20
VITRO LABORATORIES Div. of Vitro Corp. of America Silver Spring, Maryland	116	21
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* These advertisements appeared in the 9/7/62 issue.

ELECTRICAL ENGINEERS or PHYSICISTS

Schlumberger Well Surveying Corporation maintains a program of long-range industrial research projects at its Research Laboratory in Ridgefield, Connecticut.

The program includes such scientific fields as electromagnetic theory, wave propagation, nuclear physics, nuclear magnetic resonance, electronic systems, data processing, sonics, physical chemistry and fluid flow in porous media.

Our openings are for graduate electrical or electronic engineers or physicists with a minimum of 3 years experience in industry or in a research laboratory. The candidates should be familiar with electromagnetic theory.

The experimental projects underway in our Electronic Systems Section are concerned with electromagnetic field distributions, high voltage equipment and solid state circuitry.

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Complete description in McGraw-Hill Radiation Laboratory Series, Volume 1, page 284 and page 209, and Volume 26, page 233.

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AN/TPS 10D HEIGHT FINDER

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L BAND RF PKG.

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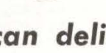

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OA2WA	2.00	4-125A	20.00	26Z5W	1.50	726A	5.00	5763	1.75
OA3	.85	4-250A	35.00	FG-27A	20.00	726B	5.00	5777	150.00
OB2	.60	4-400A	30.00	28D7W	3.50	726C	7.50	5778	150.00
OB2WA	2.00	4-1000A	80.00	FG-32	10.00	750TL	112.50	5783	2.25
OB3	.70	4AP10	10.00	35T	10.00	NL-760	20.00	5784	2.50
OC3	.50	4B31	12.50	35TG	2.50	802	7.50	5787	2.50
OD3	.30	4C35	15.00	FP-54	100.00	803	3.50	5796	10.00
C1A	8.50	4CX250B	30.00	FG-57	10.00	804	15.00	5800/VX-41	7.50
1AD4	1.50	4CX1000A	125.00	RK-60/1641	1.50	805	7.50	5803/VX-55	5.00
1B24	7.50	4D32	15.00	HY-69	3.00	807	1.50	5814A	1.35
1B24A	12.50	4J32	100.00	BL-75	3.00	807W	2.25	5829	1.00
1B35A	3.00	4J34	100.00	75TL	17.50	808	2.50	5836	50.00
1B63A	10.00	4J50	100.00	TG-77	7.50	809	5.00	5837	50.00
1C/3B22	5.00	4J52	35.00	HF-100	10.00	810	17.50	5840	2.50
C1K	7.50	4PR60A	50.00	100TH	12.00	811	2.50	5845	6.00
1P21	32.50	4X150A	13.50	100TL	12.00	811A	4.00	5852	5.00
1P22	8.00	4X150D	15.00	FG-105	25.00	812A	4.75	5876	7.50
1P25	10.00	4X150G	25.00	F-123A	5.00	813	12.50	5879	1.15
1P28	15.00	4X250B	20.00	FG-172	25.00	814	3.50	5881/6L6WGB	2.00
1Z2	1.50	4X250F	30.00	211	2.50	815	5.00	5886	4.00
2-01C	12.50	5BP1A	9.50	212E	50.00	816	2.25	5893	10.00
2AP1A	8.50	5C22	17.50	FG-235	50.00	826	3.50	5894	19.85
2B23	20.00	5CP1A	9.50	242C	10.00	828	12.50	5915	1.00
2BP1	10.00	5CP7A	9.50	244A	3.50	829B	10.00	5931/5U4WG	3.50
2C36	22.50	5D21	7.50	245A	3.50	832A	7.50	5933/807W	3.00
2C39	5.00	5J26	50.00	249B	10.00	833A	37.50	5948/1754	100.00
2C39A	9.75	5JP1	7.50	249C	6.50	836	2.50	5949/1907	50.00
2C39B	15.00	5LP1	7.50	250R	10.00	837	1.00	5963	1.00
2C40	7.50	5R4GY	1.25	250TH	25.00	842	7.50	5964	.85
2C42	3.00	5R4WGA	4.00	251A	50.00	845	7.50	5965	.85
2C43	7.50	5R4WGB	6.00	254A	3.50	849	75.00	5976	50.00
2C46	5.00	5R4WGY	2.00	FG-258A	100.00	851	50.00	5993	5.00
2C50	4.00	5RP1A	9.50	259A	3.50	866A	1.90	6005/6AQ5W	1.50
2C51	1.50	5Y3WGT	1.25	262B	3.50	869B	50.00	6012	4.00
2C52	1.50	5Y3WGTB	2.50	267B	5.00	872A	5.00	6021A	2.00
2C53	7.50	6AC7W	.50	271A	12.50	884	1.25	6032	10.00
2D21	.65	6AC7WA	2.00	274A	3.50	885	.85	6045	1.15
2D21W	1.25	6AG5WA	1.50	283A	3.50	889RA	150.00	6072	1.50
2E22	3.00	6AG7Y	1.00	287A	3.50	891R	200.00	6073	1.50
2E24	2.25	6AK5W	1.25	QK-288	250.00	913	9.50	6074	1.75
2E26	2.50	6AK5 (WE)	.75	HF-300	25.00	920	2.50	6080	3.35
2J42	75.00	6AL5W	.60	300B	5.00	927	1.50	6080WA	5.00
2J51	50.00	6AN5	1.75	304TH	35.00	931A	3.50	6080WB	10.00
2J55	90.00	6AN5WA	3.50	304TL	35.00	1000T	80.00	6082	3.35
2K22	25.00	6AQ5W	1.00	307A	.50	R1130B	10.00	6087/5Y3WGTB	2.50
2K25	8.50	6AR6	.75	310A	3.50	1500T	150.00	6101/6J6WA	1.50
2K26	35.00	6AS6W	1.00	311A	3.50	1614	2.75	6106	1.50
2K28	25.00	6AS7G	2.50	313C	1.50	1620	4.00	6115/QK351	50.00
2K29	25.00	6AU6WA	1.25	323A	6.00	1624	1.00	6130/3C45	6.50
2K30	50.00	6B4G	3.35	328A	3.50	1625	.50	6136/6AU6WA	1.25
2K33A	200.00	6BA6W	.75	329A	4.50	1629	.50	6146	3.00
2K34	75.00	6BE6W	1.50	336A	2.50	1846	50.00	6159	3.50
2K35	200.00	6BF7W	2.00	337A	3.50	1855	250.00	6161	35.00
2K39	150.00	6BH6W	2.75	347A	1.00	2050	1.25	6186/6AG5WA	1.50
2K41	50.00	6BL6	20.00	348A	4.50	ZB-3200	100.00	6189/12AU7WA	1.50
2K42	125.00	6BM6	25.00	349A	3.50	5516	7.50	6197	1.75
2K43	200.00	6BM6A	30.00	350A	3.50	5528/C6L	3.50	6199	35.00
2K44	125.00	6C4W	2.50	350B	2.50	5545	20.00	6201/12AT7WA	1.85
2K45	20.00	6C4WA	1.00	352A	8.50	5550	30.00	6202/6X4WA	1.50
2K47	150.00	6C21	17.50	354A	12.50	5552/FG235	50.00	6211	.75
2K48	50.00	6D4	1.50	355A	12.50	5553/FG258	100.00	6213	2.50
2K50	175.00	6F4	3.50	371B	2.50	5557/FG17	5.00	6216	3.00
2K54	10.00	C6J	10.00	388A	2.00	5558/FG32	10.00	6236	125.00
2K55	15.00	C6J/A	15.00	393A	5.00	5559/FG57	10.00	6248	250.00
2K56	50.00	C6J/K	20.00	394A	3.00	5560/FG95	25.00	6263	9.00
2P21	40.00	6J4	1.75	395A	2.25	5561/FG104	50.00	6265/6BH6W	2.75
2X2A	1.25	6J4WA	2.50	396A/2C51	1.50	5586	125.00	6291	35.00
3A5	.75	6J6W	.60	398A/5603	3.00	5608A	6.00	6293	4.50
3AP1A	3.50	6J6WA	1.00	401A/5590	1.00	5636	2.25	6299	37.50
3B4	2.50	6K4	2.00	403B/5591	3.00	5642	2.25	6316/BL800A	100.00
3B24W	3.00	6L6GAY	1.25	404A/5847	7.50	5643	3.00	6322/BL25	12.50
3B24WA	5.00	6L6WGA	1.50	407A	3.75	5647	3.50	6336	8.75
3B25	2.50	6L6WGB	2.00	408A/6028	2.75	5651	1.00	6336A	12.75
3B26	2.25	6Q5G	2.50	409A/6AS6	1.00	5654/6AK5W	1.50	6344/QK235	500.00
3B28	3.00	6SJ7WGT	1.25	410R	75.00	5656	5.00	6350	1.25
3B29	5.00	6SK7W	.75	GL-414	80.00	5663	1.00	6352	7.50
3BP1A	7.50	6SK7WA	2.00	416B/6280	20.00	5665/C16J	35.00	6385	10.00
3C22	15.00	6SL7WGT	1.25	417A/5842	9.50	5667	125.00	6390	125.00
3C23	4.00	6SN7W	.50	418A	9.50	5670	1.00	6394	12.75
3C24/24G	7.50	6SN7WGT	1.00	420A/5755	5.00	5672	1.35	6438	5.00
3C33	7.50	6SN7WGTA	2.50	421A/5998	7.50	5675	10.00	6442	25.00
3C45	3.50	6SU7GTY	.85	429A	6.50	5676	1.25	6463	1.00
3CX100A5	12.50	6V6GTY	1.00	GL-434A	10.00	5678	1.25	6485	1.50
3D21A	5.00	6X4W	.75	450TH	40.00	5686	2.25	6533	7.50
3D22	8.00	6X4WA	1.50	450TL	40.00	5687	1.50	6542	5.75
3DP1A	5.00	6X5WGT	1.00	578	5.00	5691	5.00	6550	3.50
3E29	7.50	SRL7H	100.00	KU-610	5.00	5692	3.50	6807	20.00
3GP1	2.50	7AK7	2.50	NL-623	10.00	5693	3.50	6883	3.50
C3J/A	9.50	7MP7	22.50	631-P1	5.00	5696	1.00	7044	1.50
3J21	35.00	10KP7	15.00	673	15.00	5718	1.50	7521	100.00
3J31	100.00	12AT7WA	1.50	676	30.00	5720/FG33	17.50	7580	35.00
3JP1	5.00	12AU7WA	1.50	677	40.00	5721	100.00	8002R	25.00
3K21	125.00	12AX7W	1.35	701A	5.00	5725/6AS6W	1.50	8008	7.75
3K22	125.00	12AY7	1.00	703A	1.50	5726/6AL5W	.75	8013A	5.00
3K27	150.00	12GP7	25.00	707B	2.50	5727/2D21W	1.25	8014A	30.00
3K30	100.00	C16J	25.00	715C	15.00	5728/FG67	10.00	8020	4.50
3KP1	9.75	FG-17	5.00	719A	12.50	5749/6BA6W	1.00	8025A	7.50
3RP1	7.50	HK-24	5.00	721B	5.00	5750/6BE6W	1.75	9003	2.00
3WP1	12.50	25T	10.00	723A/B	3.50	5751/12AX7W	1.35	9005	3.50

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No Charge or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT," to locate Surplus new and used Electronic equipment **not currently advertised.** (This service is for USER-BUYERS only). **How to use:** Check the dealer ads to see if what you want is **not currently advertised.** If not, send us the specifications of—the equipment wanted on the coupon below, or on your own company letterhead to:

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c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.
Please help us locate the following equipment components.

....
....
NAME ....
TITLE ....
COMPANY ....
STREET ....
CITY 9/14/62

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High gain

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Fairchild Planar process alone makes this matching practicable in volume production

Matching Characteristics	2N2060 Min.	2N2060 Max.	2N2060 Units	2N2223 Min.	2N2223 Max.	2N2223 Units	2N2223A Min.	2N2223A Max.	2N2223A Units	Test Conditions
Beta Ratio	0.9	1.0								$I_C = 1.0$ mA $V_{CE} = 5.0$ V
Beta Ratio	0.9	1.0		0.8	1.0		0.9	1.0		$I_C = 0.1$ mA $V_{CE} = 5.0$ V
V_{BE} Differential		0.005	Volts							$I_C = 1.0$ mA $V_{CE} = 5.0$ V
V_{BE} Differential		0.005	Volts		0.015	Volts		0.005	Volts	$I_C = 0.1$ mA $V_{CE} = 5.0$ V
ΔV_{BE} Tracking		10	μV/°C		25	μV/°C		25	μV/°C	$I_C = 0.1$ mA $V_{CE} = 5.0$ V $T = -55°$ C to $+125°$ C

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SS111 is designed to serve as a reliable local oscillator in most applications demanding moderate rf power output. SS504 is a tunnel-diode device well-suited for radar and telemetry applications—or wherever low-noise (5.5 db max.), low-power converters are required.

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Announcements of other new solid-state products will be made soon. For specifications of SS111 and SS504, see accompanying chart. For additional technical information, consult your RCA Industrial Tube Representative or write: SectionI-19-Q-2,Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

Typical Operating Conditions

SS504 ELECTRICAL	
Input Frequency (4)	1250 Mc
Output Frequency	30 Mc
Input Impedance	50 ohms
Noise Figure (1)	5.5 db max.
Bandwidth	3 Mc
Tuning Range (2)	± 20 Mc
Isolator	None required
R.F. Input Power	
Dynamic Range (3)	Up to 0.1 mw
CW	1.0 watt max.
Maximum Input Pulse Energy	80 ergs
Local Oscillator Power	5.0 mw
MECHANICAL	
Weight	7 oz.
Size	2" diam. x 1½"
SS111 ELECTRICAL	
Ebb	0.4 to 0.6 volt
Ibb	0.5 to 0.8 amp
Frequency	1600 Mc
Power Output	6.0 mw min.
MECHANICAL	
Size (5)	
(excluding connectors)	2½" diam. x ¾"
Weight	5 oz.

NOTE 1
This is a double sideband noise figure based on employing a 30-Mc, 300-ohm input impedance intermediate-frequency amplifier with a noise figure of 1.7 db, and a bandwidth of 3 Mc.

NOTE 2
By varying the frequency of the local oscillator

NOTE 3
Minimum power input at which the gain is reduced by 3.0 db from its small-signal value

NOTE 4
Units having similar performance can be supplied in the frequency range of 800 to 1500 Mc.

NOTE 5
Units can be supplied with type N, BNC, or TNC connectors

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