A McGraw-Hill Publication 75 Cents April 20, 1962

electronics

WIDE-BAND ANTENNAS

Survey of recent developments, p 39

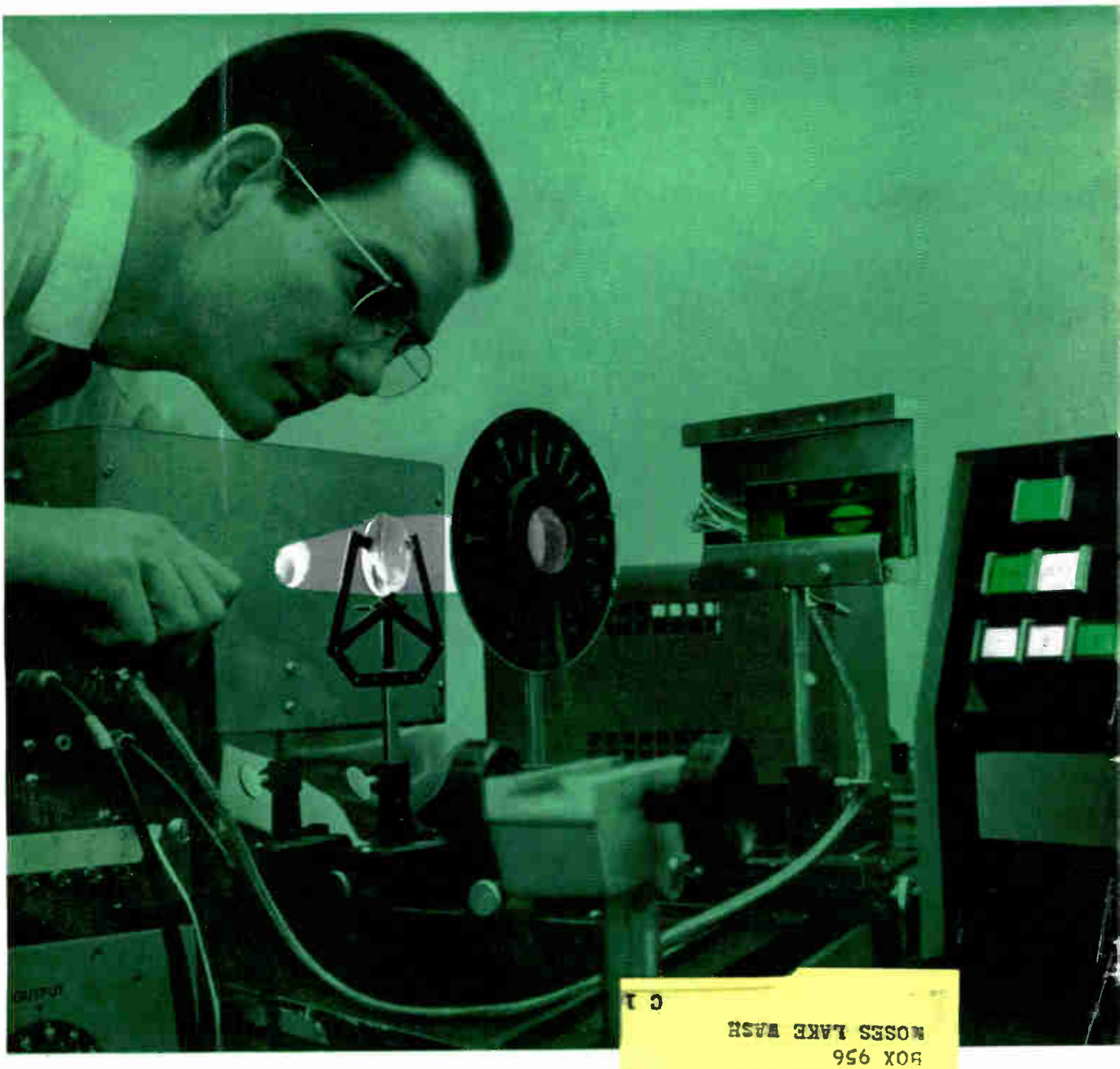
MICROWAVE BREAKDOWN

Rundown of ways to stop it, p 45

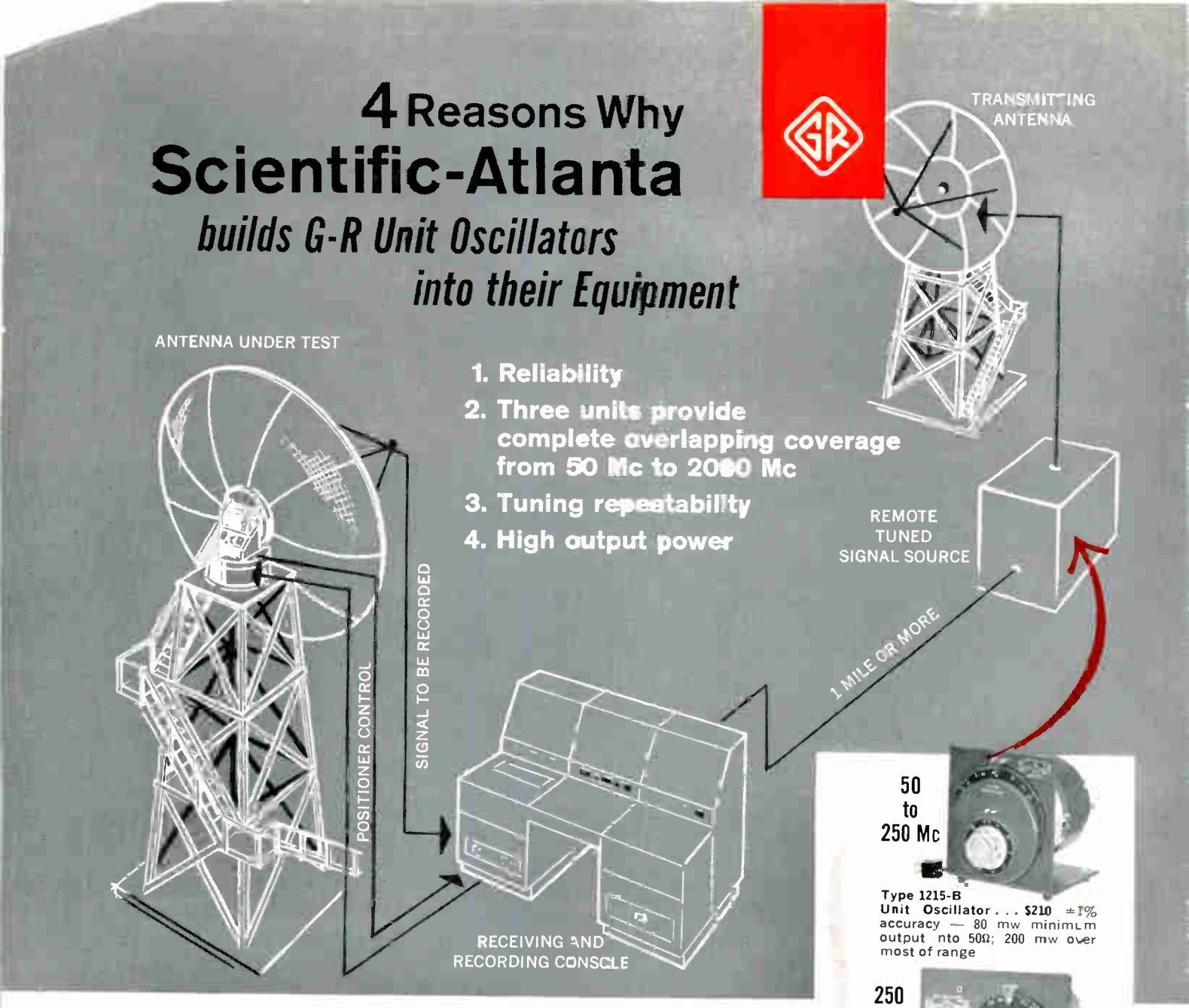
TUNNEL-DIODE SWITCH TESTER

Features go, no-go operation, p 49

Inspecting thin-film shift register by visualizing magnetic domains



4 Reasons Why Scientific-Atlanta builds G-R Unit Oscillators into their Equipment

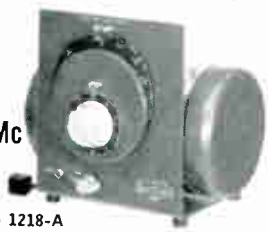


50 to 250 Mc

Type 1215-B
Unit Oscillator . . . $210 ±1% accuracy — 80 mw minimum output nto 50Ω; 200 mw over most of range

250 to 920 Mc

Type 1209-B
Unit Oscillator . . . $260 ±1% accuracy — 200-mw output into 50Ω; 300 mw over most of range



900 to 2000 Mc

Type 1218-A
Unit Oscillator . . . $465 ±1% accuracy — 200-mw output into 50Ω

G-R Unit Oscillators are integral components of Scientific-Atlanta's Model SS-31 Remote Tuned Signal Source. A typical remote tuned Scientific-Atlanta antenna pattern range using the G-R Unit Oscillators is shown above. The three Oscillators, providing r-f power in the 50- to 2000-Mc range, are mechanically ganged and driven by a closed-loop servo system. Remote tuning and band switching are performed at distances of one mile or more. Output power of at least 80 mw into 50Ω is delivered by the Unit Oscillators.

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April 20, 1962

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

Contents continued

electronics

April 20, 1962 Volume 35 No. 16

Published weekly, with Electronics Buyers' Guide and Reference issue, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Indexed Annually in Buyers' Guide and Reference issue.

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

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Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year; $9.00 two years; $12.00 three years. Canada, $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢. Single copies all other countries $1.50.

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Postmaster: Please send Form 3579 to Fulfillment Manager, Electronics, 330 West 42nd Street, New York 36, New York.

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CONTENTS continued

DEPARTMENTS

CROSSTALK

ANTENNAS. Time was when an antenna was a length of wire stretched between a couple of insulators, or an equally simple loop, rod, coil or whip. All that has changed.

Now there are dishes and arrays of dishes, yagis and slotted waveguides, conical horns and pyramidal horns, spirals, pinwheels and antennas that look like fishbones.

Our favorites, for visual drama, are the gigantic, upended gridirons used in big radar systems, and the equally huge antennas favored by radio astronomers, like England's Jodrell Bank dish or the one the U. S. is building at Sugar Grove.

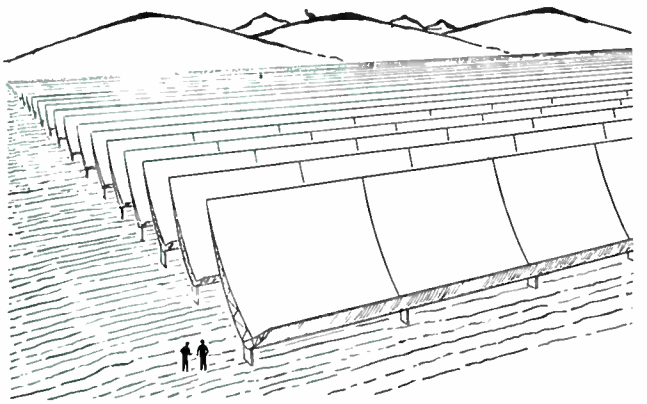
One of the latest ideas in radio telescopes is represented by the picture at left, sent us by Stanford University. To save money and make an expandable system, they would erect an echelon of huge, tiltable panels. Stanford says it would look like a big venetian blind.

However, this is getting us off the subject of the different forms of antennas now of interest to the average electronics engineer.

This week, we are publishing a survey of frequency-independent antennas, by J. D. Dyson, of the University of Illinois. Many of the more complex configurations are included, so Dyson's review should go a long way toward clearing up any confusion. He covers a lot of ground, without dwelling overlong on any particular antenna. But if details must be had, there are 78 references.

BONUS. We remember once a few years ago, after we had routinely sent our honorarium for an article to the author, he called and said: "How did you know I was getting married next week? I'll spend the check on my honeymoon!" Turned out he didn't know we paid for bylined articles.

A doubly-delighted author, we imagine, is E. G. Gear, of General Dynamics/Electronics. We published his article, Manufacturing Molded Electron Guns, in our *Production Techniques* department February 23. GD/E has just announced that the article qualified Gear for the company's $150 writing award, a nice windup to a two-year R&D program that resulted in the article and—more importantly—contributed to more rugged cathode-ray tubes.



FISH HERDING. Providing and protecting man's food supply is the most ancient and basic of industries. It is an industry that electronics has paid considerable attention to, but usually indirectly in the form of processing controls, soil testers, tractor remote controls and similar equipment.

This week, on page 50, C. D. Volz, of the U. S. Fisheries Bureau, tells about a system that could be called an electronic shepherd.

On the western rivers, dam builders are careful not to frustrate the salmon's breeding pilgrimage to the spawning grounds. Fish ladders or locks are usually built so the adult salmon can climb over the dam. The baby salmon must also be helped to reach the sea if it is not to add a small contribution of kinetic energy to the hydroelectric turbine.

Sometimes ladders and locks cannot be provided, for example when a dam is under construction. Then the salmon must be trapped and transported to safe water. This is where Volz's system comes in.

A fence of vertical electrodes placed in the river produces a directional electric field in the water. The fish are urged into traps or bypass streams. In several months of operation at the Brownlee Dam site on the Snake River between Oregon and Idaho it has rescued some 16,000 salmon and steelhead trout.

The fence requires a 360-Kw supply pulsed under ignitron control and so is no installation to be taken lightly. In fact, the circuit might be useful in high-power industrial electronic equipment.

COMMENT

Minaturization and Mayhem

My daughter has a transistor radio; I have a transistor radio. These items have stimulated my imagination. Why not utilize the transistor and other miniaturization to make an "our song" locket-sized music box? Millions of teenagers have an "our song" that is meaningful to them. The music box —which I call Canto—should be small enough to be worn on a charm bracelet or as a locket, or pinned to a young lady's dress. If it can be so miniaturized that it can be made part of an earring, that would be desirable. I recommend that you consider microfilm as well as wire-recording for the Canto. The music should be cartridge-loading so that the Canto can be used as a portable record player as well as an "our song" music box.

I believe the Canto can be made no larger than my wristwatch. If it can be sold for five dollars or less, it will be another Coca-Cola. At ten dollars, the Canto should have sales comparable to transistor radios. To cut costs, your preferred approach quite possibly would be to design the Canto, then have a Japanese manufacturer make them. The various recording companies will flood the market with cartridges to fit the Cantos.

I believe the Canto will provide considerable pleasure and profit to all concerned.

R. A. PURIFOY, JR.
Abilene, Texas

Fortunately, the present state of the miniaturization art is not equal to the task required here. And even when such midget music boxes do become feasible, it is to be hoped that, long before that time, there will have been enacted some local or national law such as the Paris ordnance passed a year or two ago, forbidding the playing of radios in the street or subway. To some, this may seem to be a restriction of freedom, but it does allow a person to listen to what he likes, rather than to whatever someone else prefers.

The radio-to-the-ear syndrome is a common characteristic among many of our young pedestrians, and it is only luck and youthful agility that keeps them from being run over while crossing the street, listening glassy-eyed to the latest twist hit.

The future looks bleak indeed, if one foresees receivers that fit in the ear, and our teenagers so enraptured by the music that they neither know nor care whether the sky is blue or black, the grass green or withered, the world turning or stopped. Mixed indeed are the blessings of miniaturization, electronics, and civilization.

Soldering

A most informative Production Techniques article by Stephen W. Mahon, School for Solderers, Old and New (p 92, Sept. 8, 1961), mentioned a film, "The Art of Soft Soldering."

As a consultant on the type of wiring and soldering the author appears to be concerned with, I have for years felt the need of audio-visual aids in this area, and I am pleased indeed to know such a film has been produced. I am at present working with the Hallicrafters Company on a program to train wirers and especially solderers.

My question is, of course: How does one obtain the film, and for how much? Is it possible to preview it to determine how and where the film would fit into our training?

Mrs. HAROLD S. SHARP
The Hallicrafters Company
Chicago, Illinois

Author Mahon replies:

The film "The Art of Soft Soldering" is available for review and/or purchase ($55.00) from the Precision Film Laboratories, Inc., 21 West 46th Street, New York 36, N. Y. We have found another film entitled "Tips On Irons" to be equally as good. This is also available for review and/or purchase ($275.00), from the American Electrical Heater Company, 6110 Cass Avenue, Detroit 2, Michigan.

S. W. MAHON
Westinghouse Electric Corp.
Baltimore, Maryland

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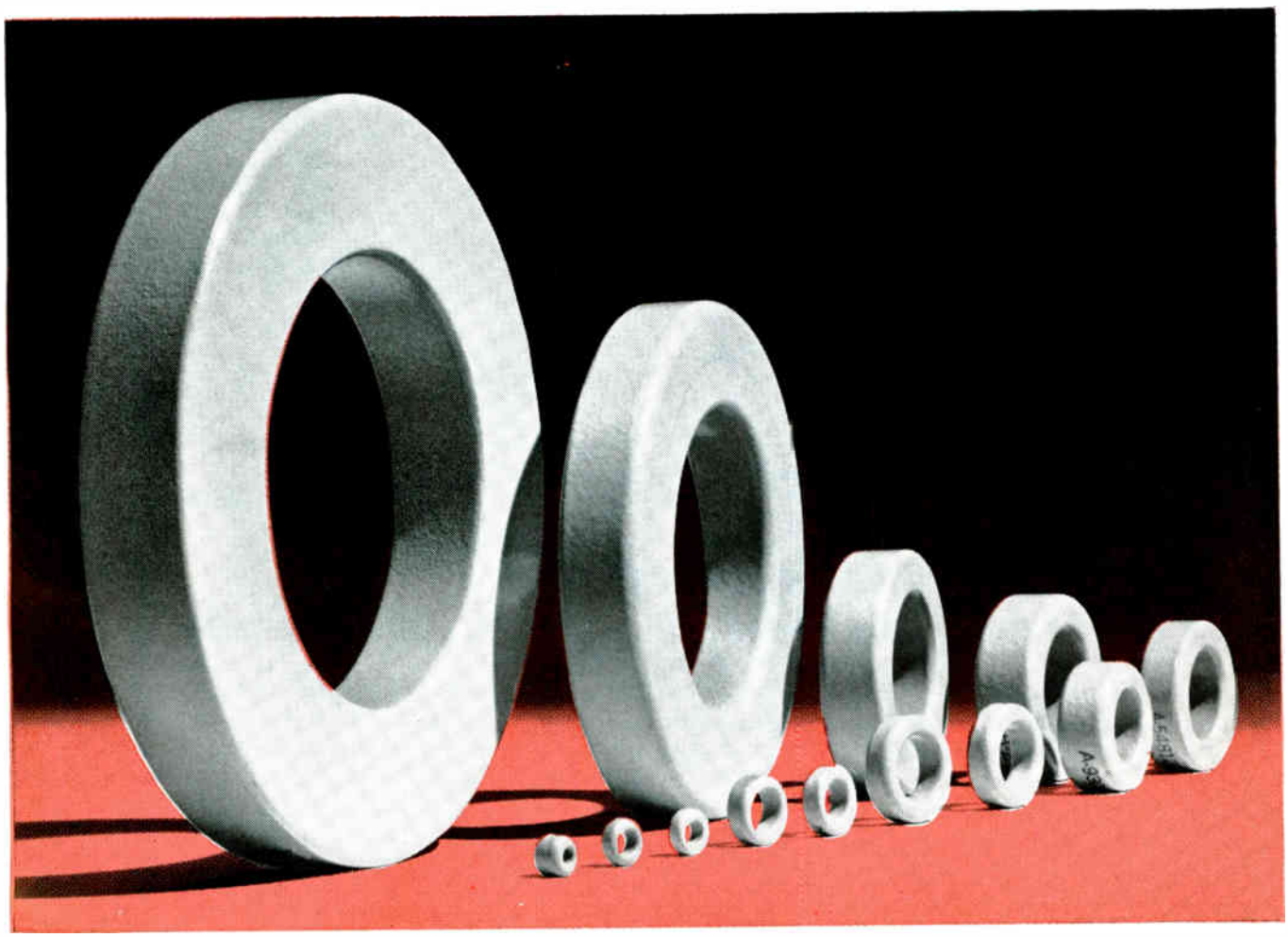

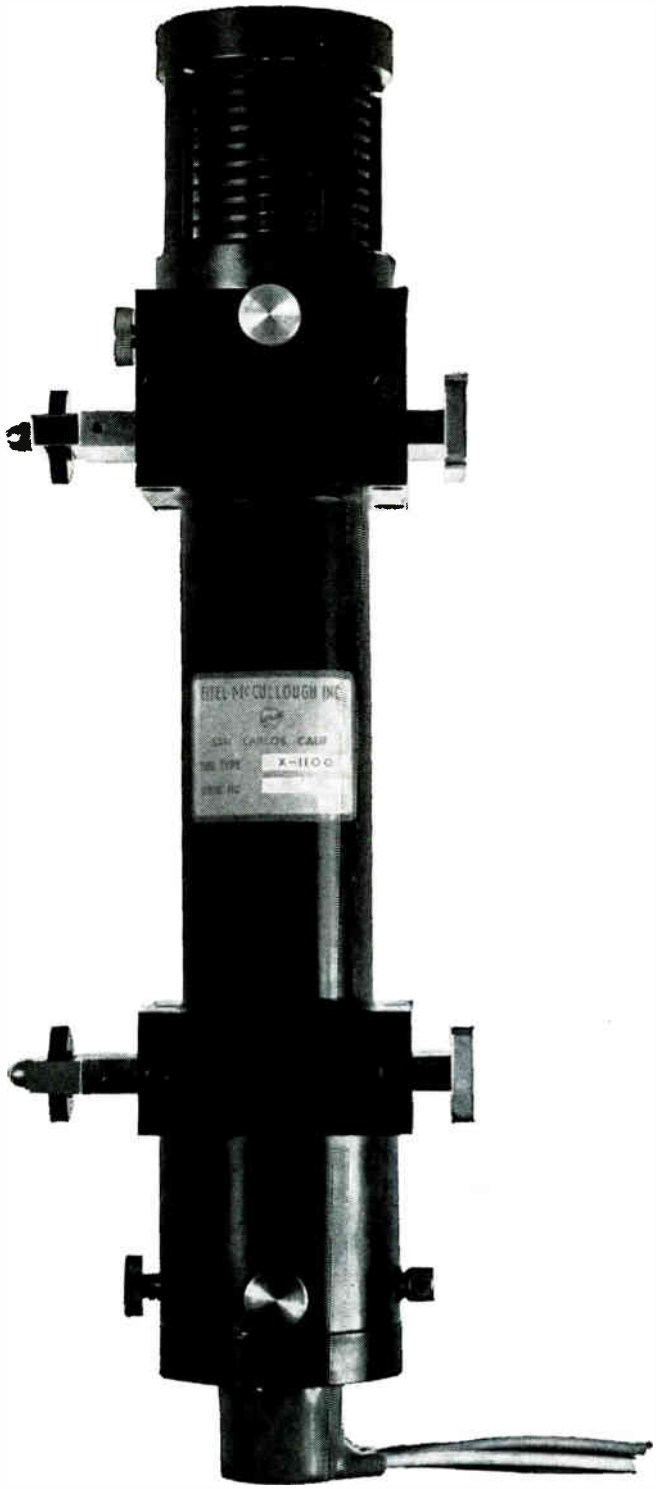

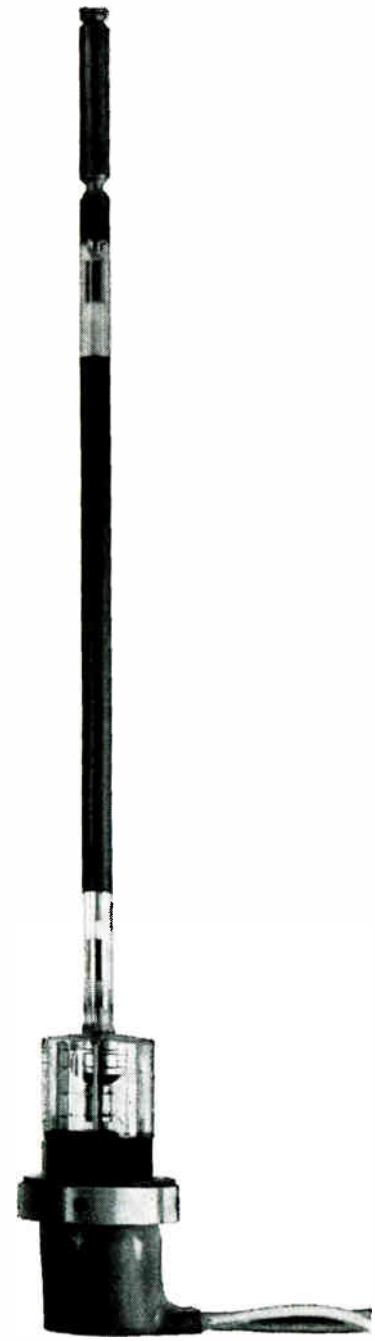

Now: with this Eimac TWT package you don't replace the whole unit.

Just the tube.

Eimac brings you the X-1100—a remarkable new kind of TWT PPM package: the TWT can be easily replaced. You simply plug in a new tube. (With little or no adjustment.) Designed for communication links, the X-1100 operates at 5.9 to 7.5 Gc with at least 5 watts linear output power and a gain of 43 db. It was engineered to operate with depressed collector, further increasing efficiency and contributing to long life. And it's available now. This is another example of the way Eimac research, engineering and manufacturing capability meet tomorrow's tube needs today. Another reason to keep your eye on Eimac—for advanced microwave tubes, high power klystrons, power grid tubes, and accessory products. Eitel-McCullough, Inc., San Carlos, California. Subsidiaries: Eitel-McCullough, S.A., Geneva, Switzerland; National Electronics, Geneva, Ill.

KEEP YOUR EYE ON

ELECTRONICS NEWSLETTER

West Germany Slashes Space Budget

BONN—West Germany has sliced $6.25 million off the $15 million it had planned to budget for space research this year. The Bonn government feels it can't afford more in view of its unbalanced budget and growing concern over the nation's weakening economic health.

The originally planned $2.5 million for the European Space Research Organization will be dropped to $1.25; the European Launching Development Organization will get $5 million instead of $7.5 million, and support of domestic space research programs will be cut from $5 million to $2.5 million.

Behind the cuts is Bonn's first serious deficit budget in years and a rising fear of inflation. Germany's 1962 record budget of over $13 billion involves nearly a $1 billion deficit. In addition, wages have been climbing 10 percent a year while productivity has increased less than four percent. Businessmen are beginning to pass on rising labor costs in higher prices.

To help balance the budget and reduce the inflationary effect of government spending, Bonn has singled out space funds and federal housing support for reductions.

Signals Got Through Mercury Reentry Shield

HOUSTON—R. D. Gilruth, director of NASA's Manned Spacecraft Center, said at SWIRECO last week that the unexpected performance of radar tracking Col. John Glenn's Mercury capsule may ease the problem of tracking returning Apollo spacecraft. Signals got through the ionized air layer during reentry at 3,000-deg temperature and reached a reflector on the capsule. It was thought that r-f signals would be blocked.

Magnetic Field May Cut R-F Window in Plasma

BOSTON—To determine experimentally if r-f windows can be opened in the plasma sheaths that cause communications blackout during reentry, flight tests will be made of the effects of magnetic fields upon anisotropic properties of plasma.

It was disclosed at the Air Force-sponsored Plasma Sheath Conference last week that Aeronautical Systems Division, Wright Field, plans to try it with a niobium-tin superconducting magnet.

The magnet, cooled by a liquid helium dewar with a liquid nitrogen jacket, would generate about 10 kilogauss. During powered reentry at 18,000 fps of a Trailblazer II vehicle, an attempt will be made to transmit data for 10 sec at about 3 Gc. The system is to be built by Bendix.

Chopper Works Like Matched Transistors

INTEGRATED semiconductor chopper device was introduced last week by National Semiconductor Corp. of Danbury, Conn. The component has a collector, base and two emitters. Operation resembles that of two high-speed switching transistors with their collectors tied together, but eliminates the thermoelectric difficulties associated with such a connection and the matching of transistor characteristics generally required in two-transistor choppers. Units offered have offset voltage within 200 and 50 μv.

British Moviemaker to Buy Electronics Firm

LONDON—The Rank Organization Ltd. will make a $14.4 million takeover bid for Murphy Radio Ltd. Murphy is a radio, tv and electronic equipment manufacturer and also has a 10-percent interest in British Relay Wireless and Television Ltd.

The Rank offer of stock and cash caught London's financial community by surprise last week, since Thorn Electrical Industries Ltd. has been discussing purchase with Murphy. Later, Thorn and also Philips Lamp, of the Netherlands, said they are not entering the bidding. Rank also owns Bush Radio.

Bendix Sells Mobile Communications Group

DETROIT—Railroad and Mobile Communications Products Group of the Bendix Corporation's Radio division, Baltimore, has been acquired by the Union Switch and Signal div. of the Westinghouse Air Brake Co., of Pittsburgh.

Bendix will operate the business until June 1, after which it will become part of Union Switch & Signal's Railway and Industrial Communications Products Group, the announcement said.

The product transfer includes 72-v and 12-v transistor transceiver units for trains and vehicles, 117-v base stations and centralized radio

Japanese Use Telemetry to Train Athletes

TOKYO—Leading topic at a recent medical telemetering symposium here was the use of telemetering to train athletes for the 1964 Olympics. Transistor transmitters are carried by the athletes.

Heart, muscle, brain and respiration data are used to determine effects of stress and recovery on athlete and also to evaluate athletes and their training programs.

Among other reports: most transmitters used in medical telemetering employ f-m—f-m modulation, but one speaker said that best performance is obtained in systems with more than five channels by using an a-m—f-m system

control equipment including two-way systems for police, fire, government, industry and general commercial use. Bendix said the transfer does not include marine communications equipment produced by its Pacific division.

One Instrument Company Is Bought by Another

FAIRCHILD Camera and Instrument Corp. has acquired the assets of Di-Tran Corp., a Los Angeles instrumentation firm, in a cash transaction. The facility, including a 20,000-sq-ft test equipment plant, has been assigned to the instrumentation department of Fairchild Semiconductor division. Fairchild indicated the purchase was to extend its instrument line. One of Di-Tran's major products is a multipurpose component tester.

Two-Way Doppler Systems Track Orbital Satellites

SAN FRANCISCO—Two-way doppler systems for tracking orbital satellites are being installed by the Navy's Military Sea Transportation Service on three Pacific Missile Range ships. The system measures the round-trip doppler shift in radio transmissions between the ships and satellites, providing more accurate position information than the one-way systems formerly used.

Amateurs Will Attempt Satellite Relay at Vhf

BOSTON—A group of 83 amateur radio operators called the Office of Satellite Scatter Coordination will attempt to extend the reliable range of vhf amateur radios to 1,000 miles by using Echo A-12 as a relay. The 135-foot reflector is scheduled for launch late this year. Transmission will be at 144 Mc.

OSSC, headed by Raphael Soifer, an MIT student, will be assisted by ARRL and by NASA, which will supply tracking data. Nonaffiliated amateurs with suitable equipment have been invited to participate. OSSC successfully carried out two-way satellite communications in 1960, using the ionized trails of Explorer II and Sputnik III.

Battery-Powered Lamp Has Two-Transistor Inverter

PORTABLE fluorescent lamp powered by flashlight batteries was demonstrated in Los Angeles last week by ITT's Industrial Products division. The lamp uses an inverter containing two power transistors to convert the d-c to high-frequency a-c, also has a dimmer and ferrite-core transformer. ITT says it will supply light intensity equivalent to that of a 50-watt incandescent bulb for 15 hr.

NASA Plans $2 Million Space Education Program

CHICAGO—NASA will begin a $2 million training program next fall for 100 students at 10 universities. Aimed at increasing the supply of space scientists and engineers, the program calls for each university to experimentally train 10 predoctoral students in the first year of the program.

Grants of $2,400 a year, plus expenses up to $1,000 a year will be given students for up to three years. Universities will be reimbursed for expenses. Universities include Rensselaer Polytechnic Institute, Georgia Institute of Technology, Universities of California, Chicago, Iowa, Maryland, Michigan and Minnesota, Texas A & M and Rice University.

Size of Plasma Engine Is Cut by 50 Percent

TARRYTOWN, N. Y.—Republic Aviation has reduced the size of their pulse plasma engine by 50 percent, Alfred Kunen reported at a meeting of the American Physical Society here.

The engine is about 1 ft in diameter and is operated by less than 100 watts of electrical power. The earlier engine (p 28, Oct. 13, 1961) was 2 by 2 ft in size and required 1 Kw. Efficiencies and specific impulse seem practical for electrical propulsion, he said.

In Brief . . .

AIR FORCE has awarded North American Aviation a $16-million contract for R&D on Minuteman ICBM guidance and control.

SPERRY RAND has a $5.6-million Navy contract for missile computers.

BABCOCK ELECTRONICS will produce electronic control systems, and transmitters for Navy under $3.9-million contracts.

TOSHIBA has upped its diode production from 1.2 to 2.1 million a month and expects to go to 2.8 million next month. Increase is mostly high-frequency germanium types for export to U. S.

LASER using a Kerr cell as a pulsed reflector has reportedly reached a peak power level of 10 Mw for 35 nsec, at Hughes Research Labs.

FACSIMILE and teletypewriter communications system installed between Titan ICBM bases and logistic headquarters, by Martin-Denver, has been placed in operation.

BELL TELEPHONE LABS reports that pure molybdenum is a superconducting element. However, transition temperature of 1 K makes its use as a superconducting magnet unlikely.

SUBCONTRACTS awarded by Autonetics for Minuteman components include $1.2 million to RCA, wired structural packages; $1.3 million to Minneapolis-Honeywell, gyros; $750,000 to Transitron semiconductor devices; $370,000 to Fairchild Semiconductor, transistors.

FLIGHT CONTROL computers for Saturn program will be built by Electronic Communications under $174,000 NASA contract. It is add-on to $128,000 R&D contract.

SYLVANIA has $2.2 million in Army contracts for field receiving systems incorporating monitors, and $570,000 Air Force award for doppler radar navigation system components.

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We took a dozen Hoffman 1N1357 ten watt regulators and froze them into ice cubes. Then we dumped the cubes into boiling oil. Finally, we tested the regulators in a circuit. All twelve continued to function right up to specs. No wonder. These straight-from-the-bin, standard regulators meet thermal shock requirements of MIL-S-19500 and operate at −65°C to +°175°C.

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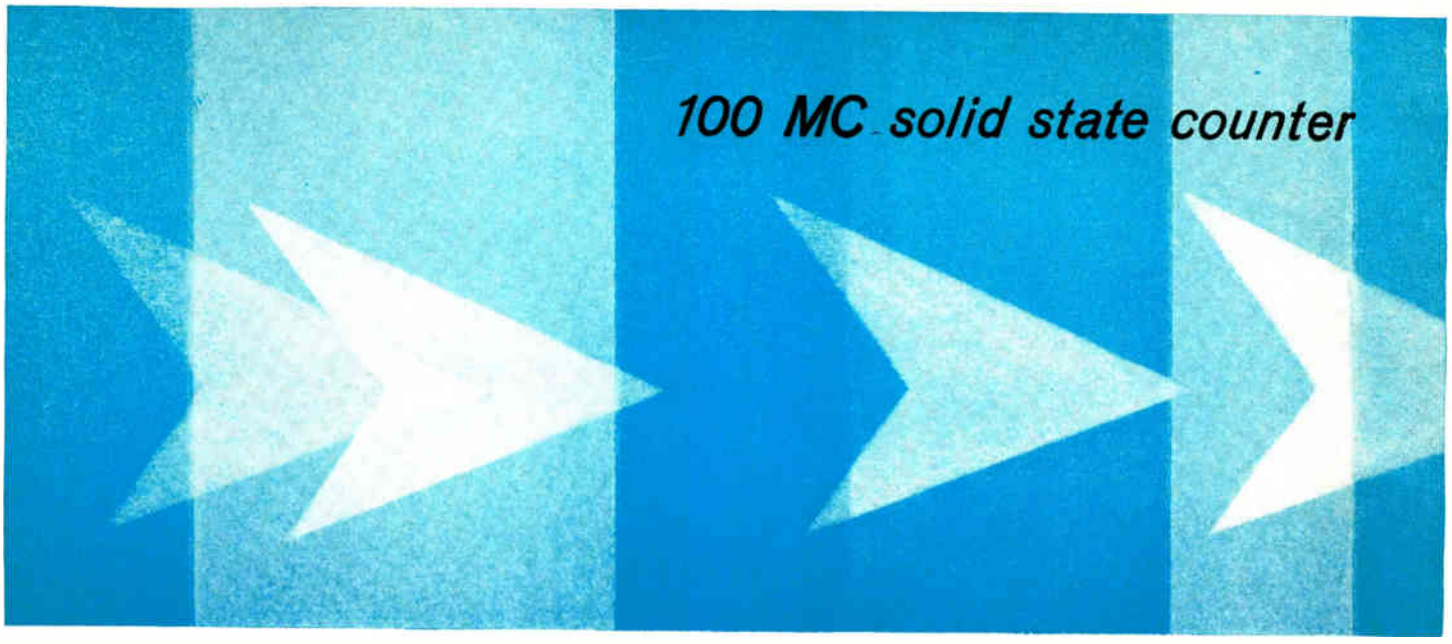


Measure Time Interval, 10 Nanoseconds to 0.1 Second– with 10 Nanosecond Accuracy!

Now you can get 10 nanosecond resolution in wide-range, automatic digital measurement of extremely short time intervals.

Electronic counter accuracy is yours for such measurements as explosive burning rates, speed and acceleration timing of test vehicles in free-flight wind tunnels, and measurements of a broad range of nuclear phenomena.

The new hp 5275A Time Interval Counter, incorporating solid state components, is packaged in the convenient new space-saving hp universal module. It counts 100 megacycles, obtained from an external 1 MC standard by a 100-to-1 multiplying circuit in the counter.

Standard features on the hp 5275A Time Interval Counter include manual front-panel reset, plus automatic and remote reset. A 4-line BCD output permits easy connection for automatic processing and analyzing of data and also may be used to drive the hp 562A Digital Recorder. The unique hp data storage technique provides a non-blinking display which reduces eye fatigue thus reducing reading errors.

Significant to many special measurement problems, as many as 20 hp 5275A Counters may be operated from a single external oscillator (new hp 101A described below). In addition to saving valuable rack space, this multiple counter operation from a single stable precision oscillator provides improved performance over multiple-time-base systems, saves operator time and offers real economy.

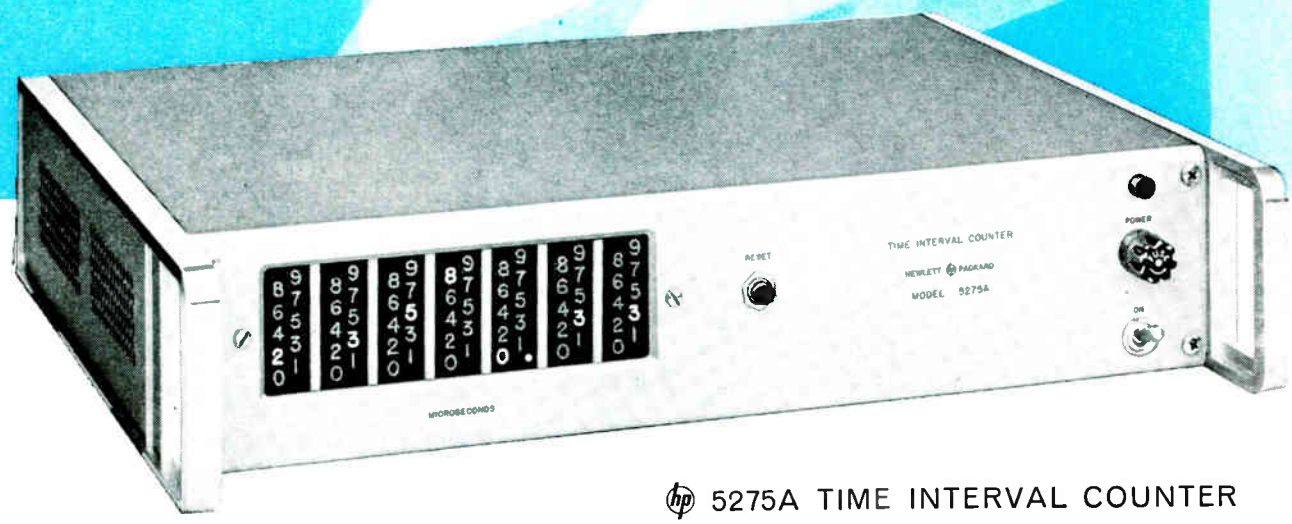
New versatility in a stable, accurate, rugged modular 1 megacycle oscillator! Use as a counter time base or moderately priced secondary standard!

hp 101A 1 MC OSCILLATOR Designed specifically as the time base for hp 5275A Time Interval Counter, the new hp 101A provides five parts in 10^8 per week stability. It also permits increased measurement accuracy as a time base for other electronic counters.

The hp 101A is a solid state version of the time-proved oscillator used in hp 524C/D Counters and in the hp 100E Secondary Frequency Standard. Long-term stability of $5/10^8$ per week is achieved by the use of a high quality quartz crystal and by housing critical components in a well regulated oven. Short-term stability, including effects of line, load and ambient temperature variation, is better than $3/10^8$. Its rated output of 1 v rms into a 50 ohm load makes it useful for improving the accuracy of counters limited by their own internal time bases. hp 523C/D Counters will operate directly from the 1 MC output of the 101A, and an optional 100 KC output is available for use with counters requiring it.

The 101A also is housed in the new hp modular package, equally suitable for benchtop or rack mount applications.

for time interval measurement



5275A TIME INTERVAL COUNTER

SPECIFICATIONS

5275A TIME INTERVAL COUNTER

Range:	10 nanoseconds to 0.1 seconds
Resolution:	10 nanoseconds
Accuracy:	± 10 nanoseconds, ± time base accuracy
Time Base:	External 1 MC required. 101A recommended
Registration:	7 places, direct digital presentation in neon columns
Reads In:	Microseconds, with decimal point
Input Requirements:	Start and stop trigger pulses through separate channels
Input Impedance:	Approx. 50 ohms
Output:	4-line 1-2-2-4 BCD
Minimum Trigger Pulse Requirement:	3.0 volts peak, 1.0 volt per nanosecond rise time, 5 nanoseconds width at 50% point
Trigger Polarity:	Selectable, positive or negative, for each channel independently
Reset:	Automatic, manual (from front panel), or remote through rear-mounted terminal
Standard Frequency Counted:	100 MC
Operating Temperature Range:	—20° to + 65° C
Dimensions:	16¾" x 3½" x 11½" deep, 15 lbs.
Price:	$3,250.00.

101A 1 MC OSCILLATOR

Stability:	Short-term: 3 parts in 10^8; long-term, 5 parts in 10^8/week
Output Frequency:	1 MC sinusoidal, 100 KC optional. Rear BNC connectors
Output Voltage:	1 v rms minimum into 50 ohm load
Source Impedance:	Approx. 15 ohms
Distortion:	Less than 4% with rated load
Oven Temperature Indicator:	Front panel dial thermometer
Frequency Adjustment:	Front panel screwdriver adjustment with range of approximately 1 part in 10^6 for calibration from primary standard
Dimensions:	16¾" x 3½" x 11½" deep, 10 lbs.
Price:	$500.00.

Data subject to change without notice. Prices f.o.b. factory

HEWLETT-PACKARD COMPANY

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Cable "HEWPACK" DAvenport 6-7000

Sales representatives in all principal areas

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WASHINGTON OUTLOOK

47 MISSILES WILL TEST NIKE ZEUS

NIKE ZEUS ANTI-MISSILE missile system tests will include 47 ICBM missile launchings from Vandenberg Air Force Base in California to the intercept point near tiny Kwajalein Island in the Pacific. The firing frequency will be about two to three a month, extending the program over an 18-month period or longer.

Primarily, the Nike-Zeus tests will concern the electronic intercept system with particular emphasis on the ability of the interceptor to select out decoys from the actual warhead.

At present, there are no plans to fire live atomic warheads in the test, although the possibility is not discounted toward the end of the test period.

SENATE IS EXPECTED TO PASS EQUIPMENT TAX CREDIT

THE ELECTRONICS INDUSTRY is precisely the kind of growth industry that the administration wants benefited by its proposed tax credit on investment in new production equipment.

Companies would get a reduction in their tax bill of up to seven percent of the amount spent on modern equipment, under provisions of a bill that passed the House and is now the subject of hearings before the Senate Finance Committee.

But one of the largest companies in the industry—and one that would benefit greatly under the tax credit—has testified against it. Alexander L. Stott, vice president and comptroller of AT&T, said that he saw "no justification" for his company to use "tax monies to finance our expansion."

Under the House-approved bill, regulated public utilities would get a three percent credit. Based on AT&T's construction program for 1962 of about $2.8 billion, the company would be entitled to about a $75 million tax saving.

The administration is opposing the tax credit for utilities, on the grounds that they are guaranteed a profit by law and are required by law to expand to serve the needs of their market. But the electric utilities, particularly, lobbied for the credit in the House, and won their point.

The tax credit faces rough going in the Senate Financing Committee. A majority of the members are opposed. The Senate itself is deemed to be more favorable to the administration's requests in this area than the committee.

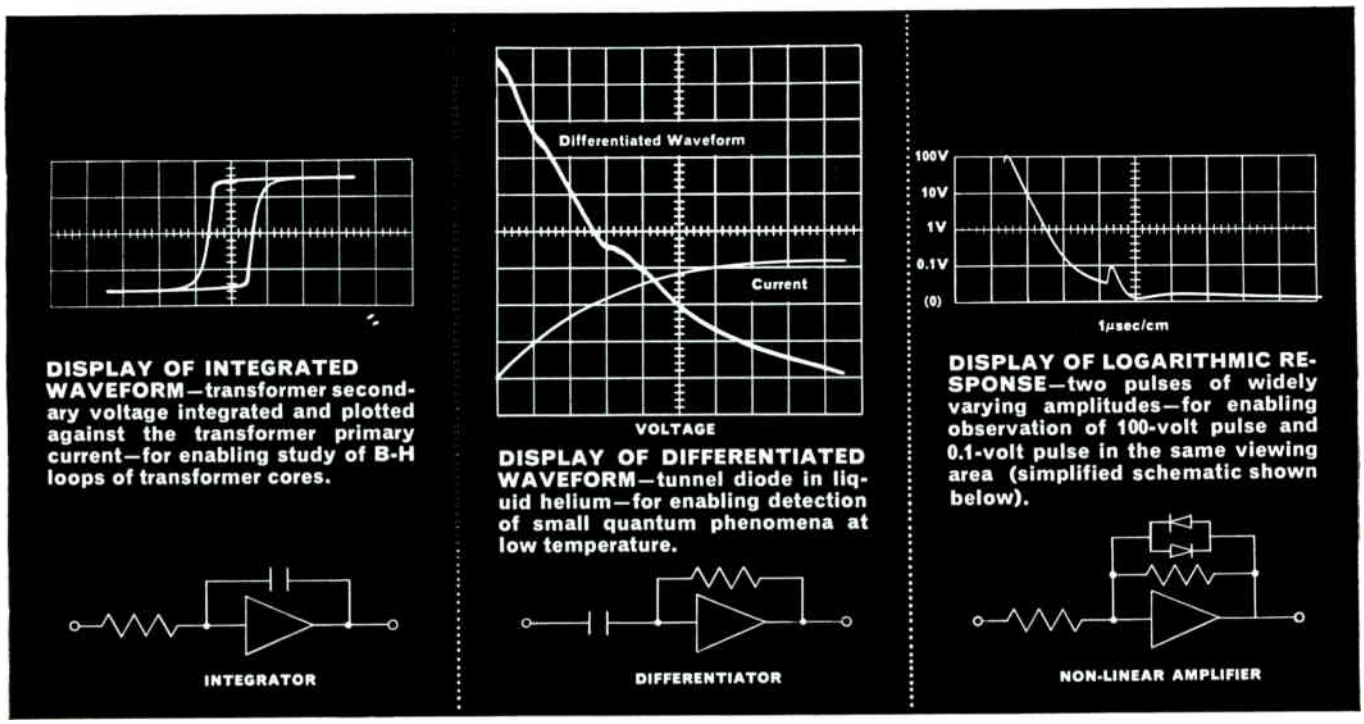
UPDATE PATENT OFFICE

WHAT SOME OFFICIALS are calling the first major Patent Office reorganization in 125 years was announced this week by Commissioner David L. Ladd.

The reshuffle, parts of which will be implemented immediately, parallels a research and development program under recently appointed adviser Ezra Glaser, a programming and data retrieval specialist

Ladd is using both programs to update the existing patent system rather than seek its drastic alteration, in the face of growing backlogs. The management reorganization follows the recommendations of a just-completed 4½-pound report, six months in preparation.

Recommendations include faster upgrading of patent examiners, sharper divisions between technical and administrative responsibilities, better career opportunities and a new Patent Office building.

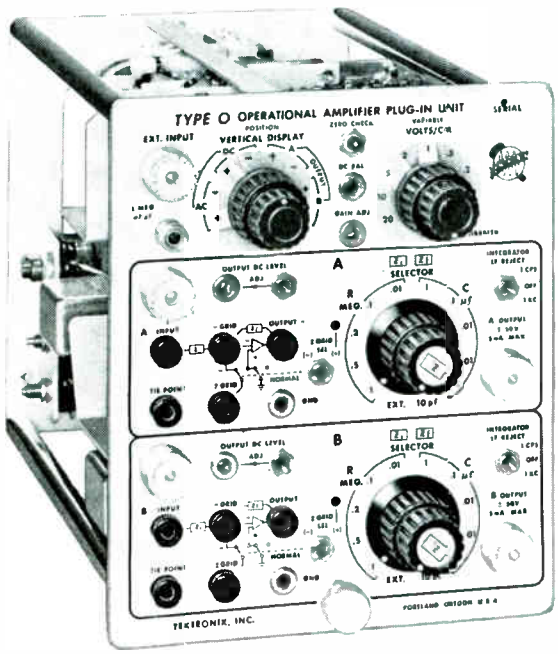


DISPLAY OF INTEGRATED WAVEFORM—transformer secondary voltage integrated and plotted against the transformer primary current—for enabling study of B-H loops of transformer cores.

DISPLAY OF DIFFERENTIATED WAVEFORM—tunnel diode in liquid helium—for enabling detection of small quantum phenomena at low temperature.

DISPLAY OF LOGARITHMIC RESPONSE—two pulses of widely varying amplitudes—for enabling observation of 100-volt pulse and 0.1-volt pulse in the same viewing area (simplified schematic shown below).

New Operational Amplifier Plug-In Unit Permits Oscilloscope Measurements Under Dynamic Conditions



TYPE O UNIT U.S. Sales Price, f.o.b. Beaverton, Oregon $475

To arrange a demonstration of this highly-adaptable Operational Amplifier Unit in your Tektronix Oscilloscope, please call your Tektronix Field Engineer.

TYPE O UNIT—for Tektronix Oscilloscopes that accept letter-series plug-in units.

Using this new Operational Amplifier Unit in your Tektronix Oscilloscope, you can perform precise operations of integration, differentiation, function generation, linear and non-linear amplification.

You can accomplish many of these operations by simply manipulating the front-panel controls—for the Type O Unit features convenient *selection of precision input and feedback components.*

You can use the Type O Unit as a gated integrator . . . as a high-input impedance amplifier . . . as a bandpass amplifier . . . as a constant-current drive amplifier . . . as a peak-memory amplifier . . . as a function generator . . . as a capacitance-measuring device . . . as a low-current measuring device . . . and for many and varied other specialized operations—some performed *with* external circuitry and some *without.*

CHARACTERISTICS

The Type O Unit contains two complete operational amplifiers and one complete vertical preamplifier.

Each operational amplifier features 15 mc open-loop gain-bandwidth product, open-loop dc-gain of 2500, selectable input and feedback impedances, drift rejection for ac integration. The output of one operational amplifier can be applied to the input of the other for combined operations.

The vertical preamplifier can be used independently or to monitor the output of either operational amplifier. In a Tektronix Type 540-Series Oscilloscope, the passband is dc-to-25 mc, the risetime is 14 nsec, and the maximum calibrated sensitivity is 50 mv/cm.

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Single-Place Gyrocopter by Eensen Aircraft Corp.

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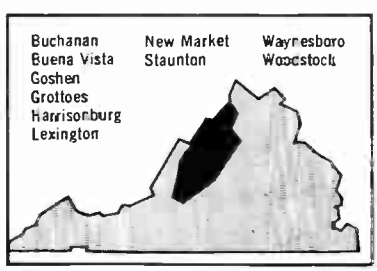
Add to that the small, independent farmer tradition of home-rooted conservatism and hard work. You'll see why you couldn't find a better place, or a pleasanter place to put the power of today's population explosion to work for you. Ask VEPCO for full economic facts about this famous Valley . . . its plant sites, hospitable communities and nearness to both materials and markets. Write, wire or phone.



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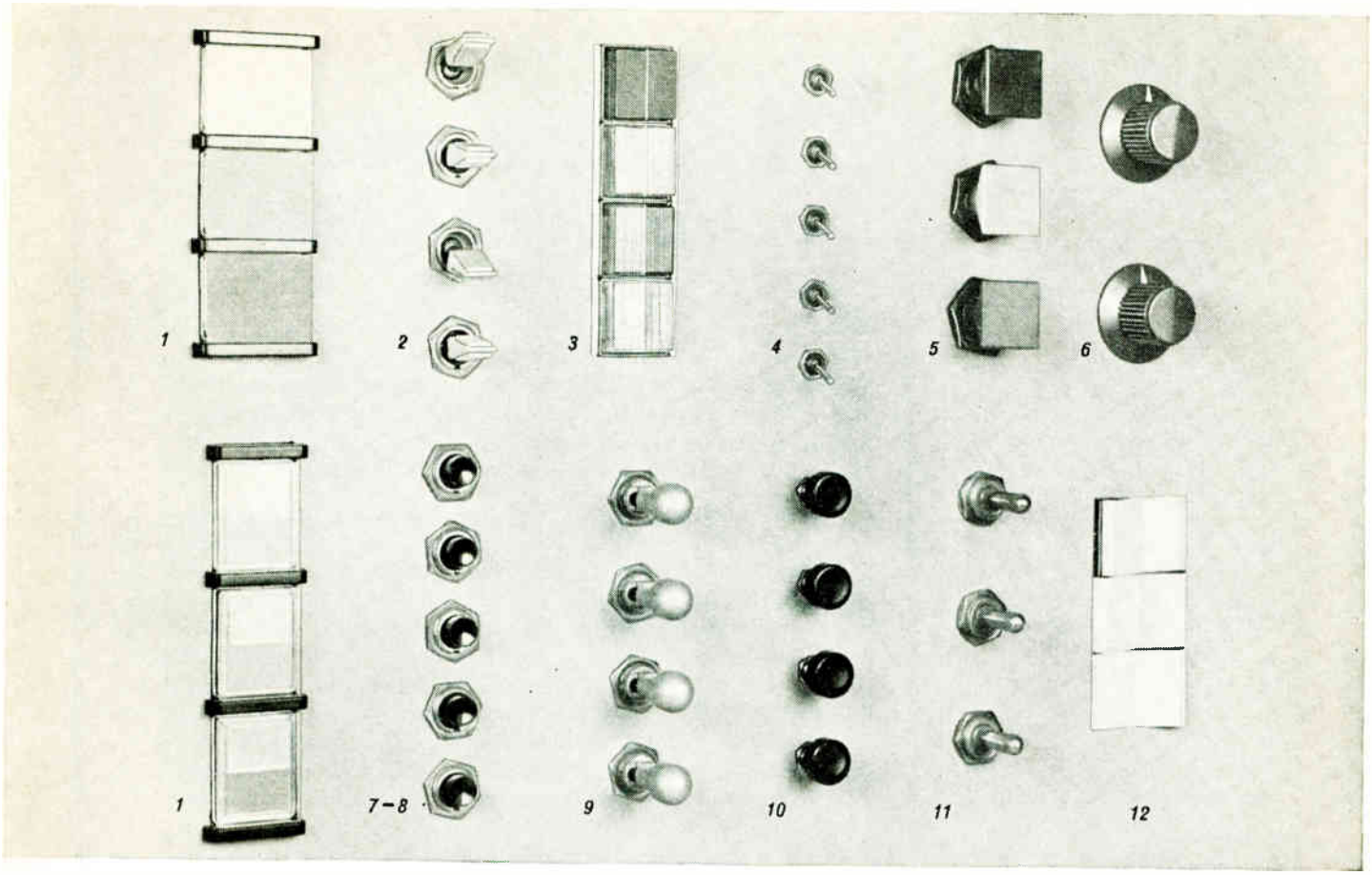

PANEL SWITCHES...DESIGNED TO MEET HUMAN-FACTORS ENGINEERING REQUIREMENTS

The application of Human-Factors to the engineering design of electronic panels and consoles is receiving more and more attention today because efficient mechanical performance usually depends on efficient human operation.

In applying Human-Factors engineering principles, a wide selection of components is necessary. In switches important factors are size, operating feel and force, mounting means, method of actuation—such as push-button, toggle, rotary or rocker. In the MICRO SWITCH line there are hundreds of switches in many variations to meet nearly every possible Human-Factors requirement.

Available are varieties of circuitry, electrical capacities, terminals. For use under severe and hazardous environmental conditions, there are heavy-duty sealed and explosion-proof switches...and for customized panels, multi-circuit miniaturized pushbutton designs with miniature lamps under colored buttons.

No matter what your needs in switches, look to MICRO SWITCH.

See the Yellow Pages for a nearby branch office or distributor. Or send for catalogs.

Left: An assortment representative of many families of switches: Lighted pushbuttons, assemblies of pushbuttons and basic switch units, multiple circuit designs, and switches with a variety of electrical capacities and terminations.

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New!

BUSS VISUAL INDICATING

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for all types of electrical and electronic equipment

New BUSS fuse and holder combination provides quick, positive, visual identification of faulted circuit.

When the fuse opens, an indicating pin pops out of fuse into transparent knob of holder. Head of pin is red. It is clearly visible and makes it easy to spot open circuit, even after power is off.

BUSS HLD fuseholders are for panel mounting in circuits of 125 volts or less. They take ¼ x 1¼ inch BUSS GBA fuses. Knob of holder grips fuse tightly and pulls fuse from holder when knob is removed.

Side terminal is held mechanically as well as by solder. Heat of soldering cannot cause it to loosen or come off.

Vibration will not cause failure of terminals as they are designed to withstand severe service.

Get the full story, write for **BUSS Bulletin SFH-9.**

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BUSSMANN MFG. DIVISION
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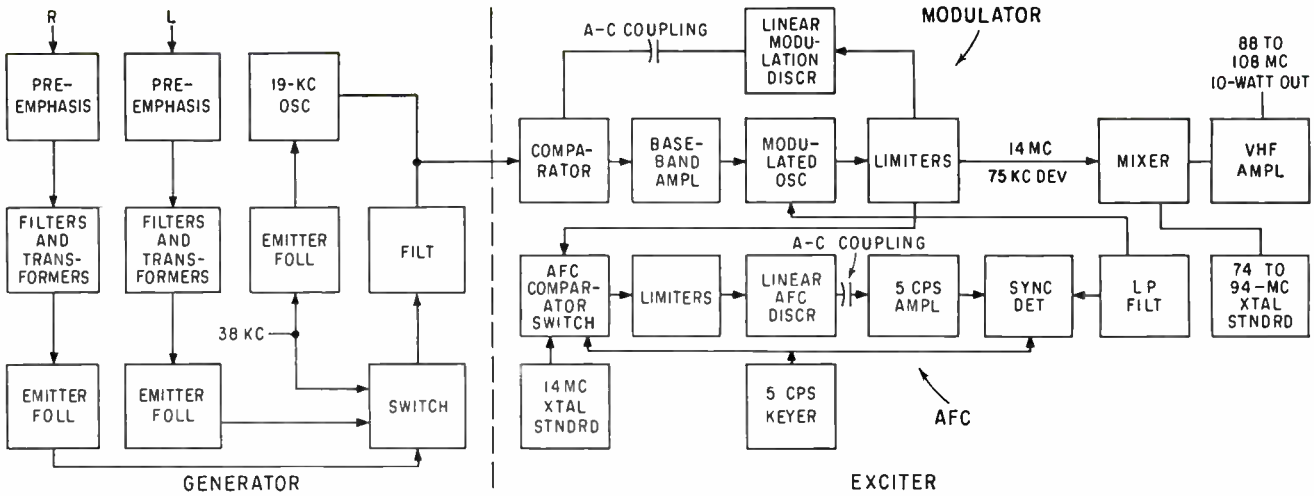


Signal generator's 38-Kc switch feeds a composite f-m stereo signal to modulator of exciter unit. Exciter frequency is controlled by applying error signal to voltage-variable capacitor in the modulated oscillator

F-M Stereo System Samples Channels

CHICAGO—Solid-state f-m stereo broadcast generator and a hybrid exciter were introduced by Collins Radio at the National Association of Broadcasters' annual engineering conference last week.

Major design feature of the generator, reported F. D. McLin and R. J. Hirvela, is that it operates on a time-division principle instead of dual-channel injection. Channel separation does not depend on matching of circuits in separate paths. The entire stereo signal is applied to a single input on the modulator in the exciter. Any shift in gain or phase affects both channels equally, maintaining a 30-db channel separation.

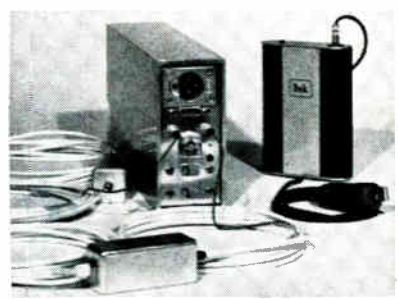
This and other features, they said, make the system simple, reliable and stable. The generator uses eight transistors. The exciter has 20 transistors, plus five tubes to handle its 10-watt output.

In the generator, balanced 600-ohm left (L) and right (R) channels are sampled by a 38-Kc switch that generates the composite stereo signal. The output from the switch is equivalent to L + R, plus the L − R double sideband components centered on the 38-Kc switching components and its odd harmonics.

Emitter follower amplifiers ahead of the switch isolate the channels and drive the switching circuit. A locked oscillator, which divides the 38-Kc driving signal, adds a 19-Kc pilot carrier to the output for phasing reference.

The 50-cps to 53-Kc generator output goes to the modulator in the exciter. The exciter can accept a 30-cps to 75-Kc signal, so can also handle a monaural signal with two SCA channels or a stereo signal with an SCA channel (subsidiary communications authorization, at 59 to 75 Kc).

The heart of the modulator is a 14-Mc L-C oscillator, frequency-modulated by a voltage-variable silicon capacitor. Operation in a feedback loop keeps distortion down to about 0.4 percent. An automatic frequency control compares the modulator output to a 14-Kc standard and corrects for error.



Wireless microphone's diversity receiver has two wire-coil dipole antennas

The comparator is an electronic switch operating at 5 cps. Its output is limited to remove any 5-cps a-m which might be present due to amplitude difference between the standard 14-Mc signal and the modulator output.

A frequency error in the modulator output shifts the limiter output frequency at a 5-cps rate between 14 Mc and the actual modulator frequency. This signal, applied to a discriminator, results in a 5-cps square wave whose amplitude is proportional to the error. The error signal is converted to a voltage proportional to the error and of the correct polarity. This is direct coupled to the variable capacitor in the modulator to reduce the modulator's frequency error.

Final carrier frequency is determined by the sum of the frequencies of the 14-Mc standard and a second crystal standard between 74 and 94 Mc. The second standard's frequency depends on assigned station frequency.

During a panel discussion on stereo, the question of how much to spend in equipping a station was raised. Estimates ranged from

$3,000 to $15,000 and one broadcaster, Harold Tanner, of WLDM, Detroit, said his station spent $100,000 to "do it right."

A newly developed system for interleaving sound in the tv picture signal during audio interruptions was described by J. L. Hathaway, of the National Broadcasting Company. It is being given final tests by NBC and AT&T.

A special filter clears the selected channel before injection of sound at about one percent level and half the horizontal scanning frequency. The system would take over when there is a break in the regular audio circuit. There is no perceptible disturbance in the picture seen by the viewer.

Station automation was a popular theme at the exhibits and in the technical sessions. Ralph Haberstock, of Gates Radio, told how to use tones to trip control switches. A supersonic tone control is also used in a 950-Mc studio-to-transmitter microwave link described by John Moseley, of Moseley Associates. The tones control the microwave unit, which operates the transmitter and associated equipment in remote locations.

Among tv equipment displays was a film recording system that presents the tv picture on a flat subplate behind the tube's heavy glass face. RCA says this eliminates distortion and light dispersion. To control exposure, light output and contrast of the display tube is automatically compared to a standard. The camera uses a double aperture to produce 24 frames a second while a synchronous shutter blanks out each fifth tv field to avoid shutter bar effect.

RCA also had a simplified tv switching system that, combined with memory and time controls, can automate a full day's programming.

Itek Corp. showed a wireless microphone with a diversity receiver. The receiver has twin dipole antennas made of coils of wire and 35-db preamplifiers. When signal strength falls below a preset level, an antenna selector switches automatically. The antennas can be connected to the receiver by up to 500 ft of coaxial cable. Microphones are crystal-controlled so up to six microphones can be used simultaneously in the low-power broadcast auxiliary band.

Array May Guide Planes

BENDIX reports that its Microvision pilot display system has reached the feasibility stage after two years of development. The system is designed to outline a landing area with microwave beacons, in a manner similar to an array of lights.

Beacons will randomly transmit microsecond pulses at a rate of 400 a second. Antenna pairs, vertically and laterally oriented on the aircraft, will measure the relative direction of arriving pulses. Each pulse received generates a difference pulse whose amplitude is related to pulse arrival angle.

The arrival angles are translated into vertical and horizontal distances on a pilot display tube. A bright spot for each difference pulse provides a pictorial presentation of the runway oriented to the approaching aircraft.

The beacon array may become part of an all-weather, aircraft landing system proposed by Bendix.

The pilot would monitor automatic operations and override the system only in an emergency.

Equipment would include a split-channel autopilot, a series of computers as shown and a vertical velocity display. At cruise altitude, the pilot would set the coordinates for the glide-slope capture aim point. The let-down computer working with distance-measuring equipment then computes distance to landing, let-down angle, time to go, ground speed, and so on.

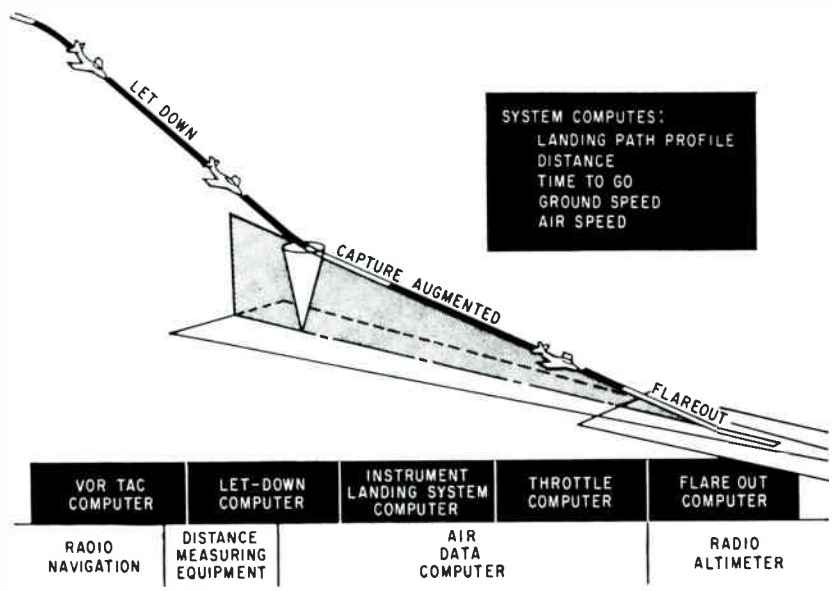
Initially, the glide-slope capture beam of a standard instrument landing is followed, using an instrument landing system coupler. During the final landing approach, when the instrument landing system is subjected to severe ground clutter interference, the ILS computer would automatically transfer control to throttle and flare-out computers. They would use radio altimeter and data inputs to compute flight commands.

The systems were described by W. H. Schofield, chief flight engineer of Bendix's Eclipse Pioneer division, at the Air Force-Industry Conference on Electronically Controlled Systems, at Palm Springs.

Douglas Aircraft engineers S. D. Clayton, A. P. Chase and C. J. Jenkins said at the conference that jet aircraft should carry system analyzers to trouble-shoot electronic equipment.

The overwater version of the DC-8, they pointed out, has more than 200 subsystems, many with multiple inputs. It is difficult to pinpoint component or circuit faults.

In its next-generation aircraft, Douglas plans to build analyzers and monitor panels into the electronic systems.



In proposed automatic landing system, series of computers controls descent of aircraft. Pilot would override in emergency

- ½% FM DISTORTION
- SOLID-STATE POWER SUPPLY
- ELECTRONIC VERNIER TUNING
- AUTOMATIC RF LEVEL SET
- SHOCK-MOUNTED RF UNIT

NEW! BRC

FM-AM SIGNAL GENERATOR

TYPE 202-H

RADIO FREQUENCY CHARACTERISTICS
RF RANGE: 54-216 MC
RF ACCURACY: ±0.5%
RF OUTPUT RANGE:
0.1 μv to 0.2 volts*
*Across external 50 ohm load at panel jack
ACCURACY:
±10%, 0.1 μv to 50 K μv
±20%, 50 K μv to 0.2 volts
AUTO LEVEL SET:
Holds RF monitor meter to "red line" over band
IMPEDANCE: 50 ohms
VSWR: <1.2

AMPLITUDE MODULATION CHARACTERISTICS
AM RANGE:
Internal: 0-50%
External: 0-100%
AM ACCURACY:
± 10% at 30% and 50% AM
AM DISTORTION:
<5% at 30% <20% at 100%
<8% at 50%
AM FIDELITY:
±1 db, 30 cps to 200 KC

FREQUENCY MODULATION CHARACTERISTICS
FM RANGE:
Internal: 0-250 KC in 4 ranges
External: 0-250 KC in 4 ranges
FM ACCURACY: ±5% of full-scale*
*For sine-wave
FM DISTORTION:
<0.5% at 75 KC (100 MC and 400 cps modulation only)
<1% at 75 KC (54-216 MC)
<10% at 240 KC (54-216 MC)
FM FIDELITY:
±1 db, 5 cps to 200 KC
SIGNAL-TO-NOISE RATIO:
>60 db below 10 KC

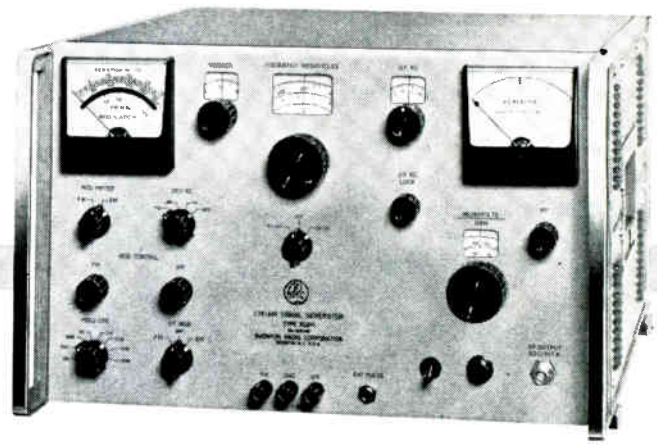
PULSE MODULATION CHARACTERISTICS
PM SOURCE: External
PM RISE TIME: <0.25 μsec
PM DECAY TIME: <0.8 μsec

MODULATING OSCILLATOR CHARACTERISTICS
OSC FREQUENCY:
50 cps 7.5 KC 1000 cps 15 KC
400 cps 10 KC 3000 cps 25 KC
OSC ACCURACY: ±5%
OSC DISTORTION: <0.5%

PHYSICAL CHARACTERISTICS
MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting
FINISH: Gray engraved panel; green cabinet (other finishes available on special order)
DIMENSIONS:

Height:	Width:	Depth:
10⅜"	16¾"	18⅜"

POWER REQUIREMENTS
202-H: 105-125/210-250 volts, 50-60 cps, 100 watts



The Type 202-H FM-AM Signal Generator covers the frequency range from 54 to 216 MC and is designed for the testing and calibration of FM receiving systems in the areas of broadcast FM, VHF-TV, mobile, and general communications. The generator consists of a three-stage RF unit, together with a modulating oscillator and power supply, all housed in a single cabinet which may be adapted for rack mounting.

The RF unit consists of a variable oscillator, a reactance tube modulator, a doubler, and an output stage. The modulator is specially designed for minimum distortion and operated in conjunction with the electronic vernier to provide incremental changes in RF output frequency as small as 1 KC. The RF output is fed through a precision, waveguide-below-cutoff variable attenuator; automatic RF level set is incorporated which maintains "red line" on the RF monitor meter over the entire band. The entire RF unit is shock-mounted for minimum microphonism.

An internal audio oscillator provides a choice of eight frequencies which may be used for either FM or AM modulation. A modulation meter indicates either FM deviation or % AM and is calibrated for sine-wave modulation.

A completely solid-state power supply furnishes all necessary operating voltages and may be switched for inputs of either 105-125 or 210-250 volts, 50-60 cps.

Model 202-J is also available for the 215-260 MC telemetering band.

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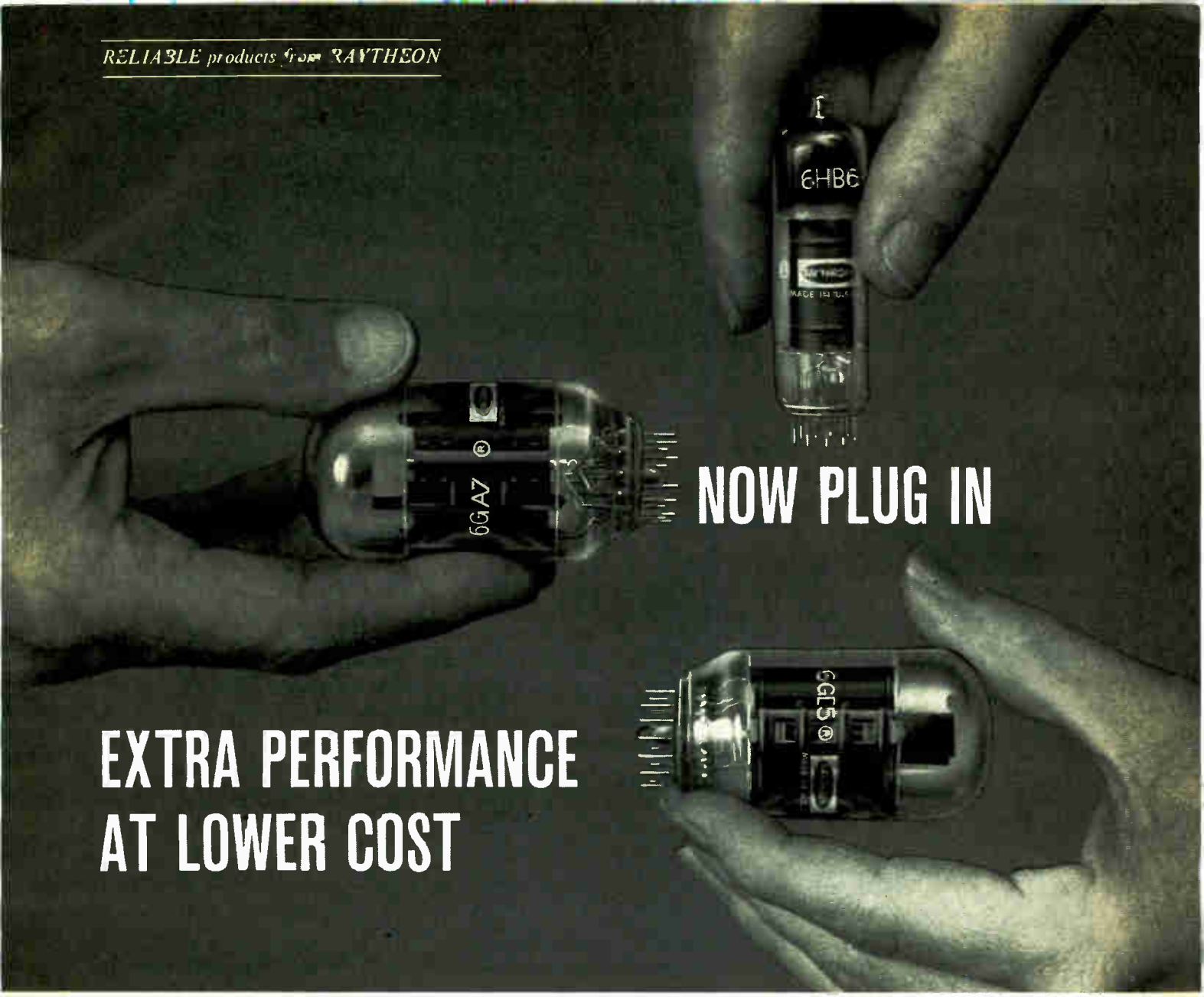

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Raytheon's exclusive design features can improve the performance of your radio, television receiver and high fidelity designs. To illustrate:

Video Pentode 6HB6, 15HB6 — A unique Raytheon grid winding makes possible twice as much sensitivity as conventional tubes and increased voltage output. This tube with transconductance in excess of 20,000 μmhos is ideal as a luminescence amplifier in color TV; video amplifier in single-rectifier b&w receivers.

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.

For special engineering assistance on your specific application as well as technical data on these tube types, please contact: Raytheon Company, Receiving Tube Operation, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

For small order and prototype requirements see your local franchised Raytheon Distributor.

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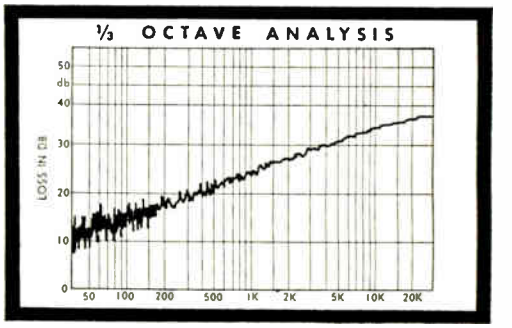

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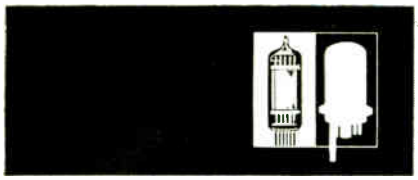
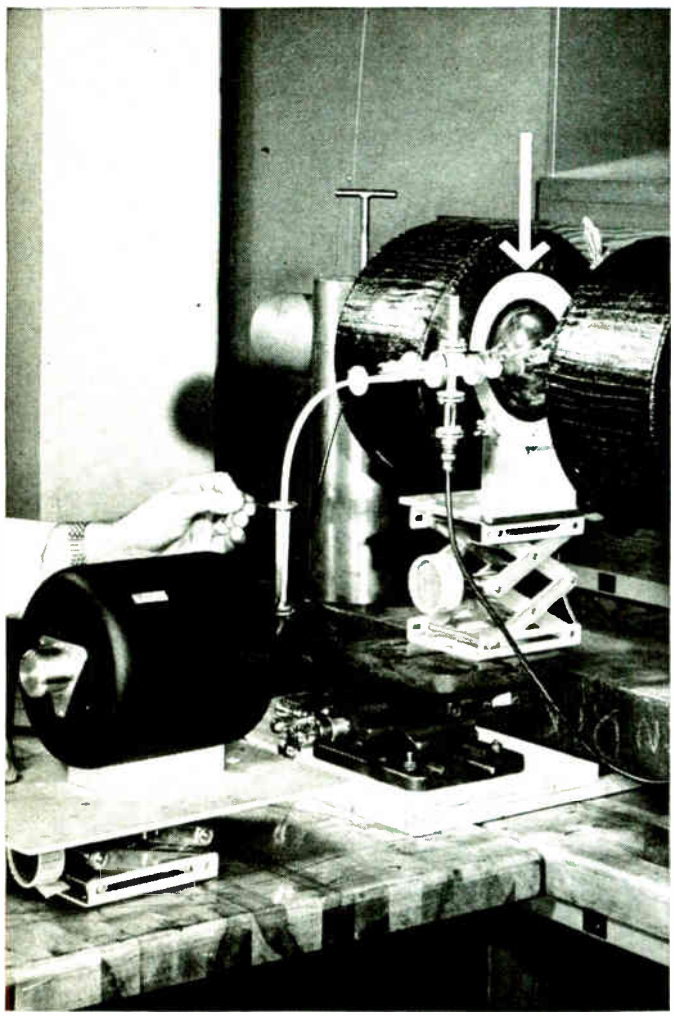
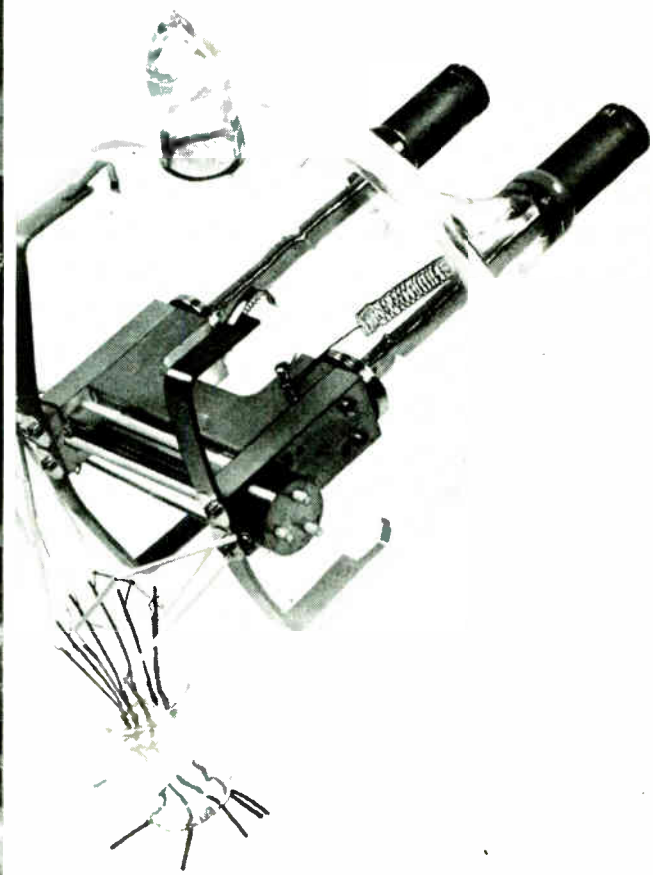


Bendix Craftsmanship at work for you



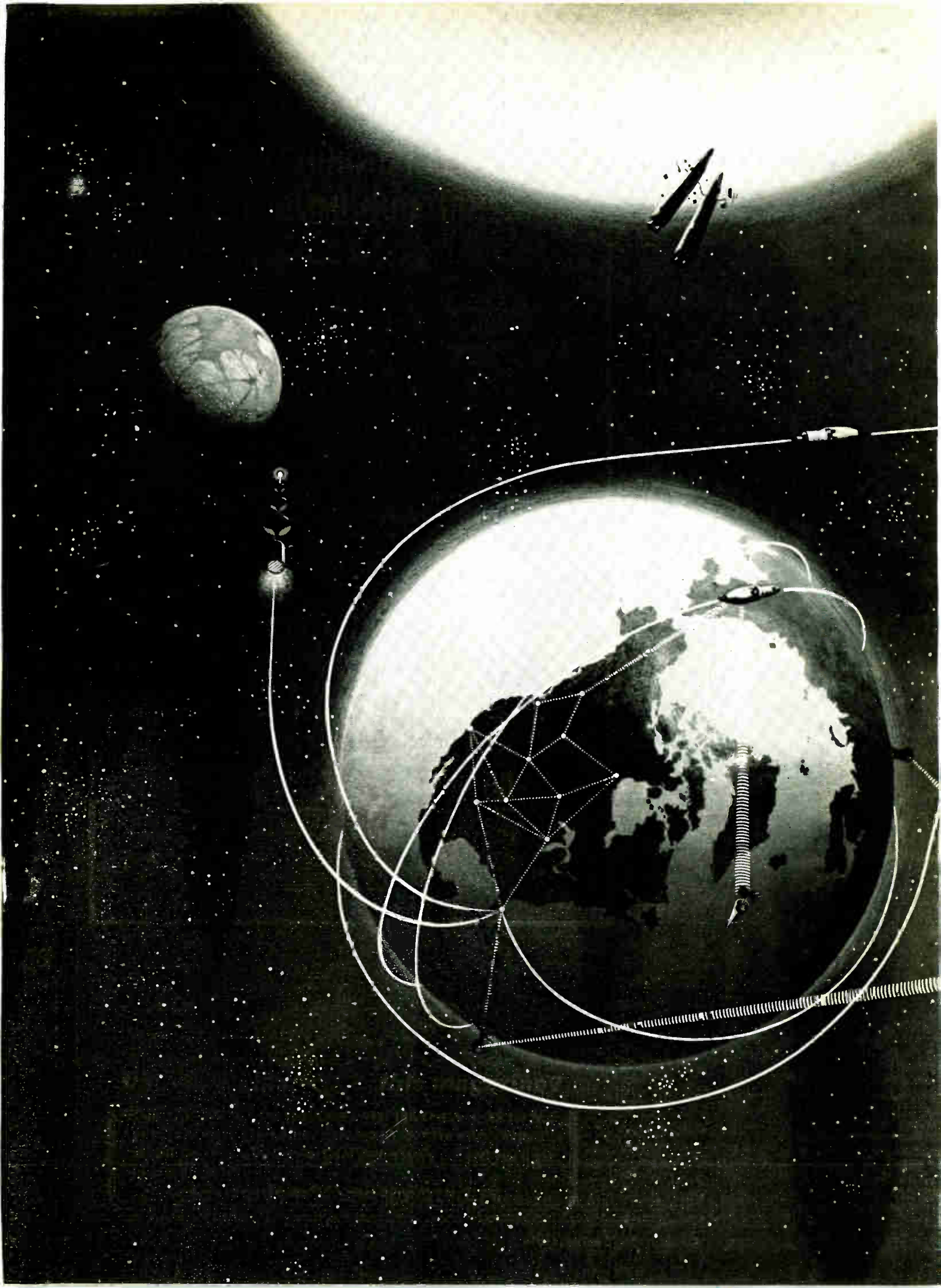


Test unit in use at Electron Tube Group, Bendix Research Laboratories Division.

KEY TO 200+ Gc BWO! This special test device—designed and built by Bendix—helps speed development of Bendix permanent magnet focused millimeter wave Backward-Wave Oscillator tubes. Using this, theoretical designs of electron guns and r-f structures can be tested empirically without first building prototype tubes. Also, measurements can more easily be made on fundamental design parameters. Present development programs using this and other advanced Bendix research equipment are aimed at producing BWO tubes operating at frequencies above 200 Gc. Meanwhile, for information on Bendix® BWO tubes operating from 30 Gc up to 180 Gc, write Electron Tube Products, The Bendix Corporation, Eatontown, N. J.

Red Bank Division

THE Bendix CORPORATION



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Bomber Defense System Is Pushed

Air Force will build 34 weapons control centers to back up Sage, wants first stations operational in 1963. Procurement emphasis is hardware, not R&D

By THOMAS MAGUIRE
New England Editor

BOSTON—Air Force is planning to build 34 weapons controls centers to reinforce Sage, the continental air weapons warning and control system. The new program, called Buic for Backup Interceptor Control, is intended to fill in holes that an enemy ICBM attack might open up in the Sage system.

Behind the Buic program is the military thesis that even if an enemy were to use ICBMs for an initial attack on prime targets—knocking out some Sage centers—the attack would be followed by a manned bomber mop-up. U. S. forces would have to be ready to detect invading aircraft and control the air battle.

Buic was initially interpreted as a backup for Bomarc unmanned interceptors only. But the concept has been broadened to cover post-attack control of the entire North American Air Defense Command's weapons inventory: Bomarc, manned interceptors and Nike batteries.

This underscores an Air Force conviction that second-strike protection against bombers is needed, even in the missile era.

The Air Force doesn't want to lose any time getting the centers into operation. There will be no attempt to push the state of the art or to experiment with R&D equipment. Some 45 contractors have already been asked to bid on the multimillion-dollar system.

Equipment to be procured includes solid-state computers and other electronic data-processing devices, and display systems. The contractor must also have utility-type programming capabilities.

"Both time and the available dollars dictate that only state-of-the-art equipment and techniques will go into Buic," says Col. Dale R. Tidball. The program is being handled by the Sage Systems Program Office at Electronic Systems Division, Hanscom Field, Bedford, Mass., under his direction.

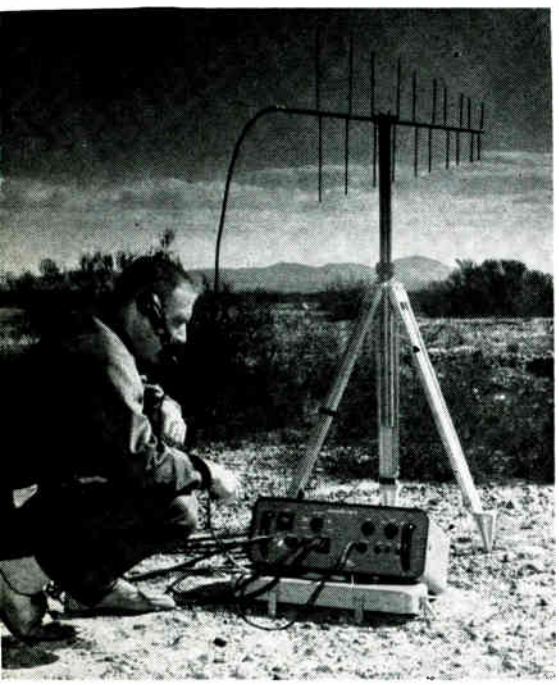
First Buic center, initially a test station but later operational, will be in the northeast area of the U. S. Some centers are expected to be operational in late 1963. All will be manned by the military and will have independent power facilities for switchover from commercial sources.

Although there will be 34 Buic centers, 13 more than there are Sage sectors, the program will be more austere than Sage in both cost and operation.

Centers will be built on existing radar sites, so there will be no land acquisitions nor major construction. Buic centers will be removed from Sage sector buildings, to minimize the possibility of an enemy knocking out both Sage and Buic centers. Nor will Buic equipment be near centers of population or target areas.

Buic might be termed a Sage in miniature, much less complicated than the primary command and control system. Buic will use the same radar sensors and such aids

Mapmakers Use Radiolocation System



MISSILE TRACKING principles are used in a system designed by Cubic Corp. for geodetic surveying with aerial photos, or for determining distance between ground points by trilateration. The company says distances up to 150 miles can be measured within three feet by detecting the phase difference in signals transmitted on a round-trip path.

Four transceivers are sequentially interrogated from the plane when the camera shutter opens. Interrogation signals are retransmitted to the other transceivers. Detected phase changes are fed to a data handling station that computes, prints and plots range information. The station can be on the ground or in the plane.

Photogrammetric plane interrogates transceivers in field

as TDDL (Time Division Data Link), but it will be less automatic and will not put as many aircraft through as many maneuvers as a Sage center could. It will control Bomarcs in much the same way as Sage. For Nike batteries, it will give target and trajectory information and advice, but fire control will be up to the Nike units themselves.

In control of manned interceptors, it will not include, for example, automatic-return-to-base features of Sage. Nor will it give the weapons control officer the capability of electing as many combinations of methods of attack.

Automation in the Buic system will solve intercept equations—course of target, speed, point of interception—but Air Force commanders will make the key decisions in the air battle.

Buic will use existing radar sensors, or newer models now being phased into Sage, and updated communications techniques. There will be some passing of information between Sage and Buic centers, and there will be links between Buic centers for handover.

Although Buic centers will not be hard-core subsurface facilities, plans include a higher level of protection from fallout than the Sage centers have.

Gun Barrel Is Waveguide for Tests

TWO MICROWAVE measuring techniques that, in effect, use a gun barrel as a waveguide, were described recently at a hypervelocity environments symposium at the University of Denver. One system measures the velocity of a projectile; the other measures the velocity and position of a shock wave.

The technique of measuring projectile velocity was reported by P. L. Clemens and R. E. Hendrix. It was developed for use in a large hypervelocity range being constructed by ARO, Inc., at the Air Force's Arnold Engineering Development Center. The facility will be used to simulate reentry conditions.

The launcher barrel is modified by addition of an antenna at the end. For a 20-mm barrel, a quarter-wave probe is inserted in the barrel as shown. A wire loop is used in a 40-mm barrel.

The barrel waveguide is excited in one distinguishing mode by an X-band klystron, through the antenna, which transmits and receives. The wave is reflected from the face of a fiber glass projectile.

The projectile is analogous to a tuning stub for standing-wave measurements. The reflected wave cyclicly changes in amplitude with projectile travel. The reflected signal returns through a directional coupler to a crystal detector and is filtered, amplified and recorded. Velocity measurements derived from the recording fall within one percent of values obtained by other techniques, it was reported.

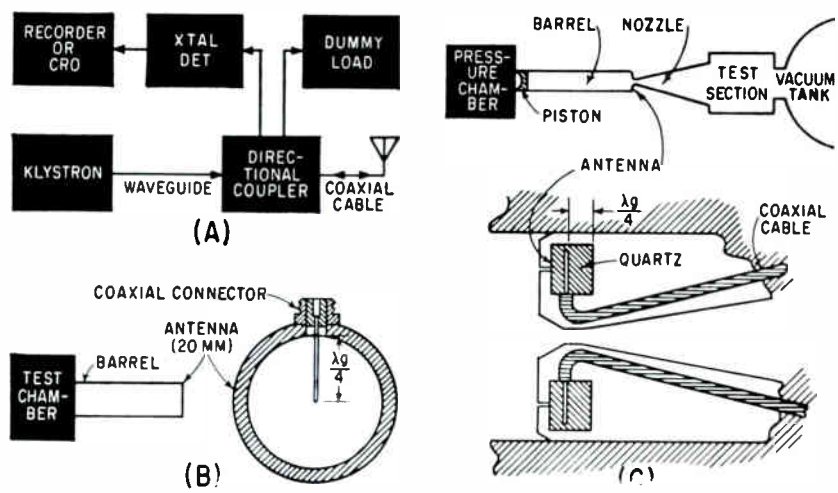
A similar setup for a microwave interferometer was described by L. Pennelegion, of the British National Physics Laboratory. The interferometer continuously determines displacement and velocity of an ionized shock wave in a free-piston gun tunnel.

In this case, a radially symmetrical mode TM_{01} is established in the barrel. The resultant of the signal reflected from the piston and the instantaneous transmitted signal undergoes a maximum to minimum change in voltage for a change in piston position.

Pennelegion emphasized the problem of designing antennas to withstand pressure differentials of $\frac{1}{2}$ to 200 atmospheres and temperature of 2,000 K at stagnation pressure of 350 atm.

A suitable antenna, designed in Canada, is made of four quartz-filled waveguides. While each operates in phase in the dominant TE_{11} mode, they are slot-coupled to the main gun barrel to sustain a TM_{01} mode. The slots, milled in a metal cover that protects the quartz cylinders, are arranged symmetrically about the nozzle throat and do not interfere with tunnel operation.

High-g telemetry techniques were discussed by M. Letarte and L. E. Moir, of the Canadian Armament R&D Establishment. One portion of their report concerned a sensitive temperature telemetering transmitter. The subcarrier oscillator is a free-running, transistor multivibrator operating at about 30 Kc. A resistive temperature gage is placed in the collector lead of one side of the multivibrator, so frequency varies with temperature.



Simplified diagram of velocity-measuring setup (A). In American system, antenna extends into barrel (B); in British system, it is recessed in nozzle throat (C)

AIR FORCE'S 1963 SPENDING PLANS:

$636 Million for Ground Electronics

Money sought will buy cryptographic and intelligence equipment, data processors, radar, communications and nuclear blast detectors

By JOHN F. MASON
Associate Editor

AIR FORCE is seeking $636.1 million for its fiscal year 1963 ground communications and electronic equipment program. Lt. Gen. J. Ferguson, deputy chief of staff, research and technology, presented the request recently to the U. S. Senate Committee on Appropriations.

The bulk of the money will be spent on 13 electronic telecommunications command and control systems (see table). Air Force also wants large appropriations for cryptographic equipment and missile communications support.

Cryptographic equipment: the bulk of these items are mobile, tactical, teletypewriter, voice and data decryption devices which provide for traffic security as well as message content security for printed, voice and data messages.

Tactical Aircraft Control and Warning System—412-L: a semi-automatic, air and ground transportable tactical air control and warning system for the Composite Air Strike Forces of the Tactical Air Command, plus a fixed ground environment in the USAF European area. All radar and automatic data processing equipment for 13 sites was bought with 1959 through 1962 funds. The new money will buy ground/air communications and automatic switching gear.

Continental Aircraft Control and Warning System—416-L: back-up for Sage to insure survivability (see page 28 this issue). The system consists of high-powered radars, gap filler radars, computer-equipped direction and control centers and air-ground communications.

North American Air Defense Command's Combat Operations Center—425-L: hardened control center in Cheyenne Mountain, Colorado Springs. Money will buy display equipment, computer programming and initial training gear.

Air Traffic Control System—431-L: for high-speed USAF planes at bases where FAA facilities cannot be used. New money will buy equipment for emergency missions support consisting of air transportable navigational aids and communications facilities.

Weather Observation and Forecasting System—433-L: new shopping list includes local weather radar, runway visual range computers and minor ancillary gear.

Intelligence Data Handling System—438-L: the system will coordinate man-machine techniques for data retrieval, displays and interpretations. New money will buy input and query consoles, printers, print readers and other equipment for development of improved capability with the equipment of participating agencies—AF Intelligence Center, Aeronautical Chart and Information Center, Foreign Technological Div., intelligence directors of major AF commands.

Strategic Air Command's Command and Control System—465-L: new funds will put the system in operation plus buy more equipment for the system's planned buildup.

Post Attack Command Control System, PACCS—481-L: ground subscriber equipment will be bought.

Intelligence Collection System—466-L: money will provide a modernized capability to the USAF Security Service.

Headquarters USAF Command and Control System—473-L: this system acquires data from USAF's farflung commands for USAF Chief

USAF'S FISCAL YEAR 1963 APPROPRIATIONS REQUEST FOR GROUND COMMUNICATIONS AND ELECTRONICS

	(millions of dollars)
Cryptographic Equipment	$ 49
System 412-L Tactical Aircraft Control & Warning	30.1
System 416-L Continental Aircraft Control & Warning	78.6
System 425-L NORAD Combat Operations Center	9.9
System 431-L Air Traffic Control	20.1
System 433-L Weather Observation and Forecast	8.1
System 438-L Intelligence Data Handling	7.5
System 465-L SAC Command and Control	43.1
System 466-L Intelligence Collection	37.8
System 473-L Headquarters USAF Command and Control	18
System 474-L Ballistic Missile Early Warning	34
System 477-L Nuclear Detonation Detection & Reptg.	3
System 480-L Air Force Communications	74.1
System 481-L PACCS	5
Missile Communications Support	37.8
Organization and Base Support	3.2
Supplies and Materials	145
Modification	27.5
Industrial Facilities	4.3
Total Requirements	$636.1

of Staff in the Pentagon. System will be capable of evaluating war plans, alerting forces, printing and distributing plans and orders and providing timely, current answers to operational and logistics problems posed by both routine and contingency operations. New money will continue buying computer programming, display devices and ancillary gear to support the operational system.

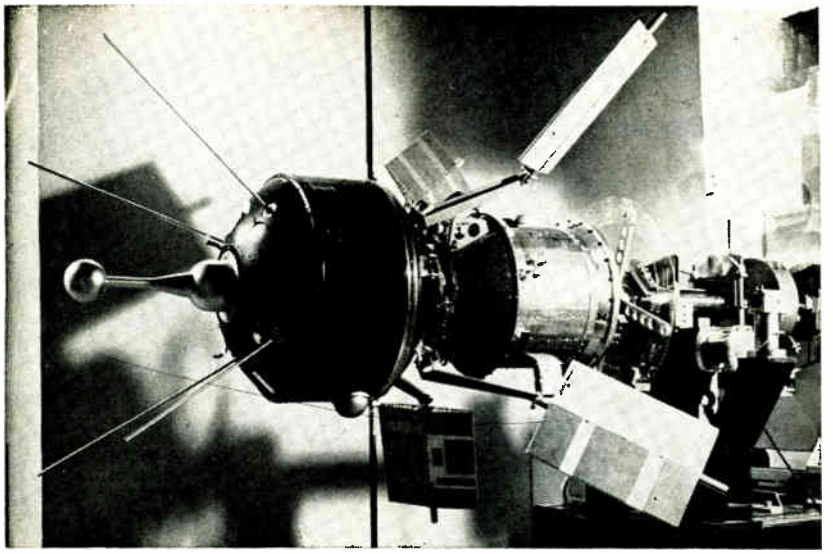
Ballistic Missile Early Warning System—474-L: Alaska and Greenland sites are operational; third and last site, Flyingsdale, England, will be operational by July, 1963. New money completes procurement of the basic hardware for the site in England.

Nuclear Detonation Detection and Reporting System (Nudets) —477-L: an electronic system for detecting, locating and reporting data on nuclear detonations occurring within NORAD's area of responsibility. It will consist of a network of sensors deployed to monitor all important target areas. New request will initiate procurement of system.

Air Force Communications System—480-L: money for Aircom, USAF's world-wide communications system, will provide increased range and reliability in the SAC positive control communication system, and an increase in flexibility and utilization of voice communication systems in the Pacific and European areas.

Organizational and Base Support Equipment: for minor items of equipment for the Air National Guard units, and minor base support items.

Supplies and Materials: repair parts used annually to maintain and operate the major communications systems and equipment items bought in this appropriation. Examples are electron tubes and transistors used in USAF's radio and radar facilities and electrical supplies such as cable and switches used for air base operations. Approximately $54 million (37 percent of the total $145 million) will be used to buy initial stockage of spare parts for the major command and control systems. The rest of the money will be spent for those recurring parts requiring annual replacement for all other equipments or systems in use.



Satellite on spin-test equipment at Goddard Space Flight Center before launch. Basic structural material is plastic-bonded fiber glass

Eight Nations Join in Space Experiment

FIRST INTERNATIONAL SATELLITE was scheduled to be launched by now from Cape Canaveral. The National Aeronautics and Space Administration built and launched the satellite, is responsible for all subsystems except the experiments, and for tracking, data acquisition and processing.

Four British universities or colleges provided its six scientific experiments—University College, London; University of Birmingham; Imperial College; University of Leicester. Eight nations—the U. S., U. K., Chile, Peru, Ecuador, Union of South Africa, Australia and Newfoundland—will track it at NASA Minitrack stations.

Called S-51, the satellite is designed to acquire more knowledge of the ionosphere and its complex relations with the sun. Orbit altitude will range from 200 to 600 mi. Data transmission will be cut off after a year.

The United Kingdom has responsibility for the design, fabrication and testing of all flight sensors and their associated electronics up to the telemetry encoder input; also, data analysis and interpretation.

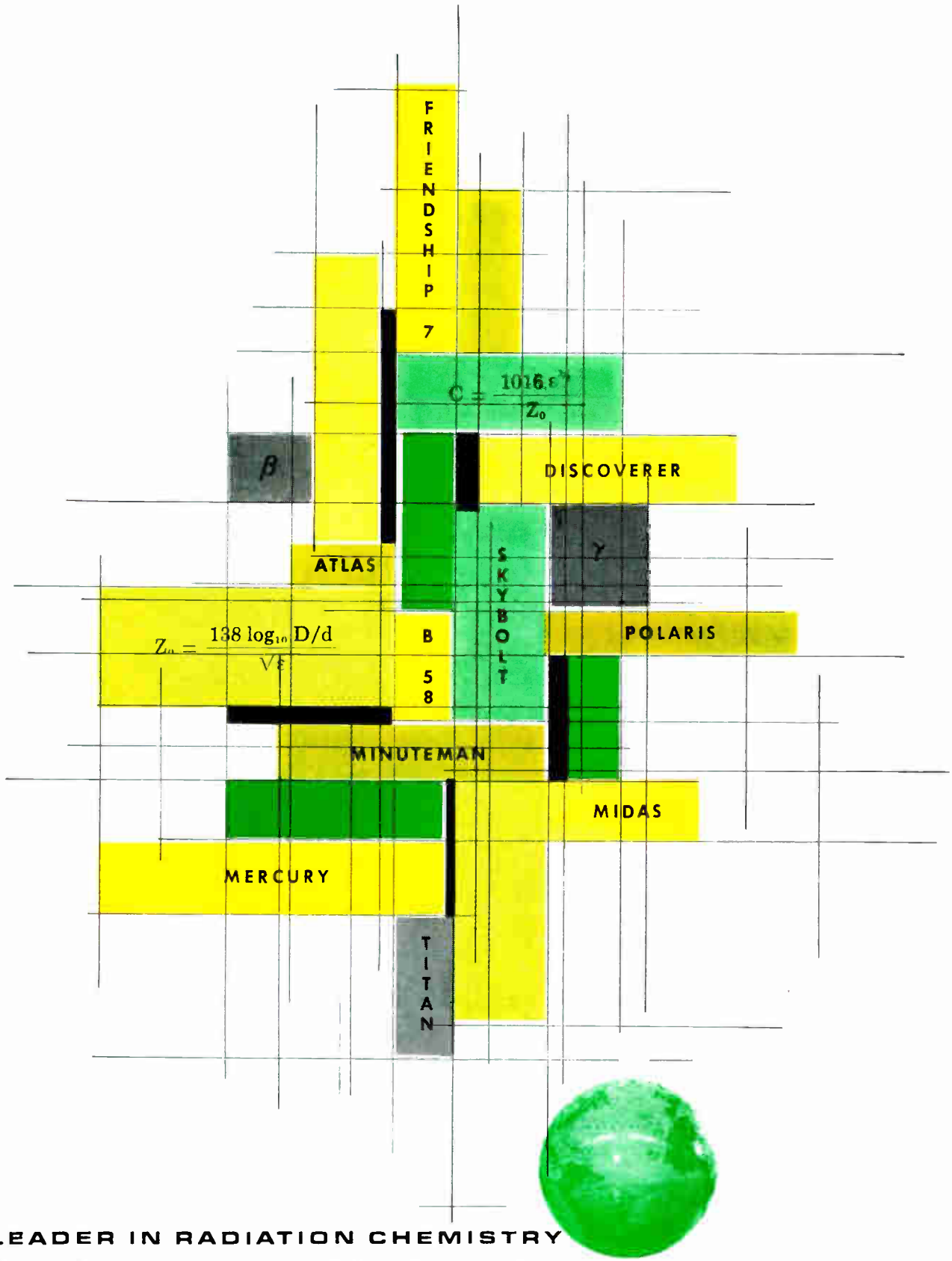
Three ionospheric experiments will measure electron density and temperature and the composition of positive ions. Two experiments will monitor the intensity of radiation from the sun in the ultraviolet (Lyman-Alpha line of the sun's surface, or chromosphere) and x-ray bands of the solar corona. The sixth experiment will attempt to measure cosmic rays. This experiment will be supported by simultaneous measurements of cosmic rays from the ground and by aircraft and balloon flights.

Sensors include two electron temperature gages and tape recorder; hemispherical solar aspect sensor, cosmic-ray Cerenkov detector, and ion mass sphere; three flush-mounted solar radiation (Lyman-Alpha) gages on the satellite skin; two proportional x-ray counters opposite the Lyman-Alpha gages.

A 250-mw, 136.410-Mc transmitter will provide both telemetry and tracking signals. The transmitter will use a phase-lock receiving system in the ground stations.

Some 66 parameters will be telemetered (pcm). In addition there will be three sync outputs generated in the encoder. A recorder stores encoded data for time periods up to 100 minutes. Data is transmitted to ground on command to a single-channel, a-m, command receiver. Power for the systems is furnished by four solar cell paddles and batteries.

Telemetry antennas are a slightly-modified, crossed dipole or turnstile array on the upper part of the spacecraft.



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MEETINGS AHEAD

FREQUENCY CONTROL SYMPOSIUM, U.S. Army Signal Research and Development Laboratory; Shelburne Hotel, Atlantic City, N. J., April 25-27.

PULP & PAPER INSTRUMENTATION SYMPOSIUM, ISA; Jacksonville, Fla., April 26-27.

MANNED SPACE FLIGHT SYMPOSIUM, IAS; Chase Hotel, St. Louis, Mo., April 30-May 2.

INSTRUMENTAL METHODS OF ANALYSIS SYMPOSIUM, ISA; Daniel Boone Hotel, Charleston, W. Va., April 30-May 2.

SPECTROSCOPY SYMPOSIUM, Society for Applied Spectroscopy; Conrad Hilton Hotel, Chicago, April 30-May 3.

JOINT COMPUTER CONFERENCE, IRE-PGEC, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3.

CLEVELAND ELECTRONICS CONFERENCE, IRE, et al; Engineering-Scientific Center, Cleveland, Ohio, May 1-3.

HUMAN FACTORS IN ELECTRONICS, IRE-PGHFE, Lafayette Hotel, Long Beach, Calif., May 3-4.

POWER INSTRUMENTATION SYMPOSIUM, ISA; Hotel Texas, Fort Worth, Texas, May 6-9.

COMPONENTS CONFERENCE, IRE-PGCP, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D. C., May 8-10.

NORTHEASTERN MEETING, AIEE; Statler-Hilton Hotel, Boston, Mass., May 9-11.

NATIONAL AEROSPACE ELECTRONICS CONFERENCE, IRE-PGANE; Biltmore Hotel, Dayton, Ohio, May 14-16.

AERO-SPACE INSTRUMENTATION SYMPOSIUM, ISA; Marriott Motor Hotel, Washington, D. C., May 21-23.

MICROWAVE THEORY & TECHNIQUES NATIONAL SYMPOSIUM, IRE-PGMTT; Boulder, Colo., May 22-24.

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., Aug. 21-24.

ADVANCE REPORT

RELIABILITY AND QUALITY CONTROL, NATIONAL SYMPOSIUM, IRE: *Sheraton-Palace Hotel, San Francisco, Calif., Jan. 22-24, 1963. May 15 is the deadline for submitting 10 copies each of titles, abstracts (not more than 800 words), and brief biographies to: Mr. Leslie W. Ball, The Boeing Company, P.O. Box 3707, Seattle 24, Washington. Papers previously presented at local meetings are acceptable.*

ENGINEERING IN BIOLOGY AND MEDICINE CONFERENCE, *Conrad Hilton Hotel, Chicago, Illinois, Nov. 4-7. June 1 is the deadline for submission of 50-word abstracts to: Program Committee, P.O. Box 1455, Evanston, Ill. The technical program will consist of 18 sessions including: artificial organs, biological control systems, bionics, cardio-pulmonary physiology, computer technology, electrical physiology, neuro-physiology, instrumentation.*

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Female chassis
connector wire solder
terminals. Knob on
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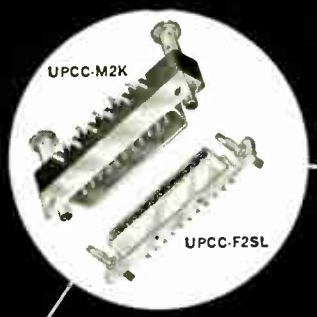
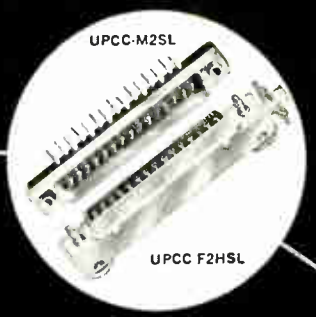
solder terminals.





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Male chassis connector-
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Female hooded
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terminals.

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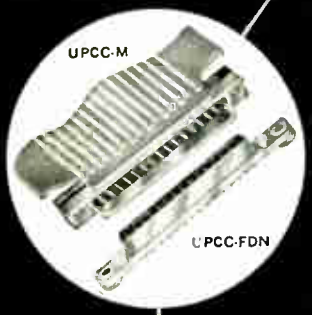
solder terminals.



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(15 or 23 contacts.)
Mates with UPCC-M
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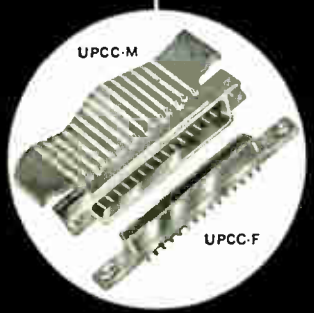
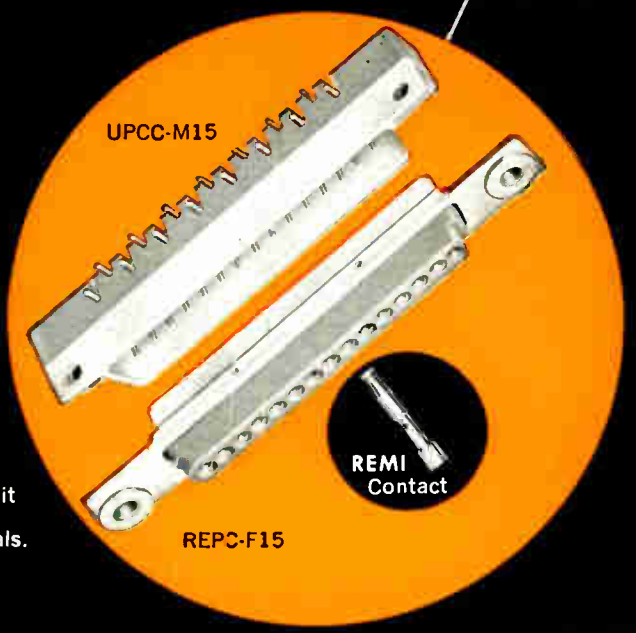


Series UPCC-M & -F
NAS standard.
Male card connector-dip
solder terminals.
Female chassis unit with
wire-solder terminals.



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family of Printed Card Connectors . . . the new, removable crimp-type Series REPC-F bringing the total of different available types to over 1500.

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UPCC-M & -F units available with wire solder, turret type, solderless series 37, or dip solder terminals (1/16", 1/8", 1/4" boards).
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REPC-F units take removable crimp-type contacts accommodating #18 thru #30 A.W.G. wire. Crimping tool meets MIL-T-22520 (WEP).

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Insulation Resistance	over 5000 megohms
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Current Rating	7.5 amps

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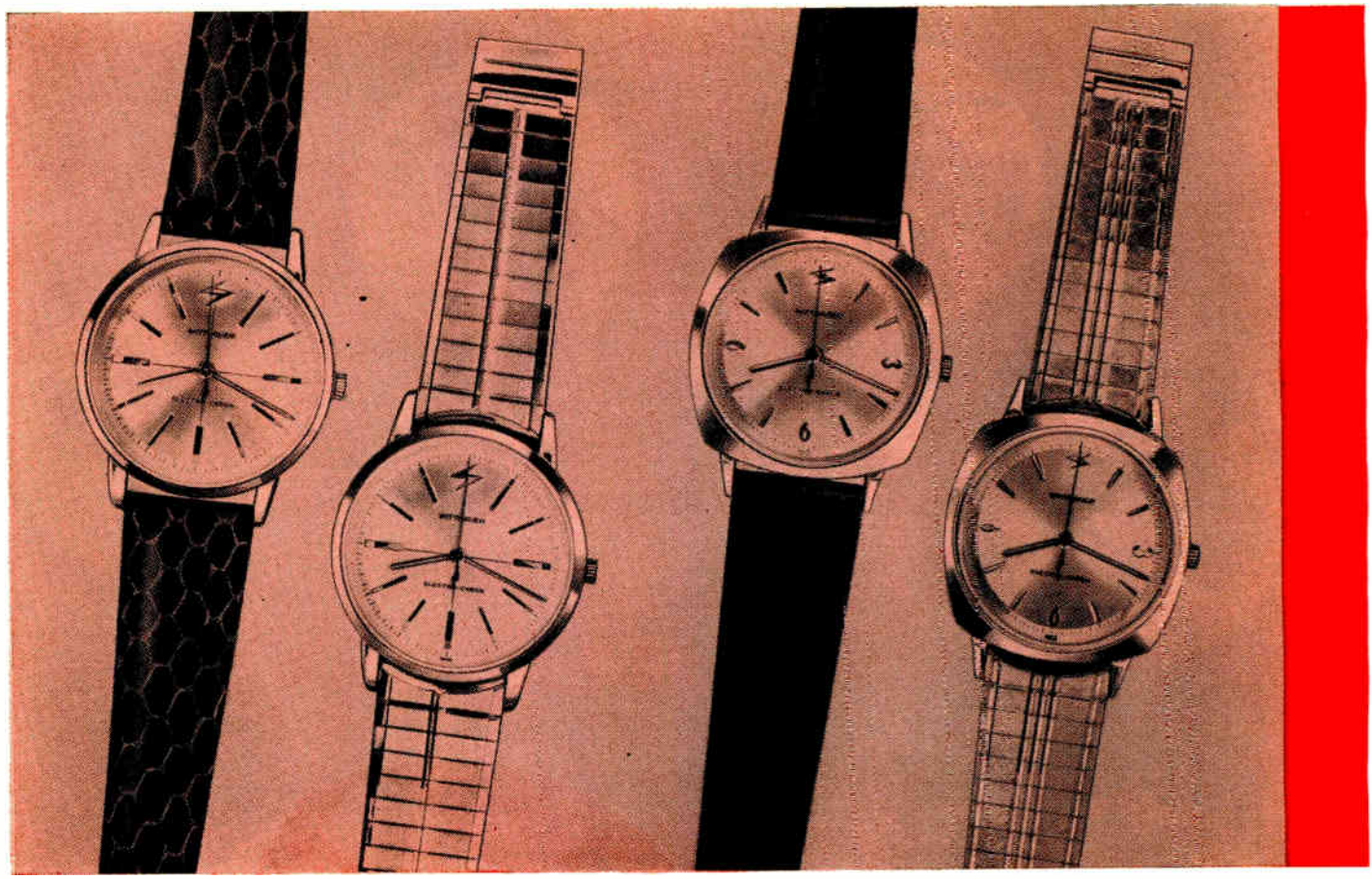
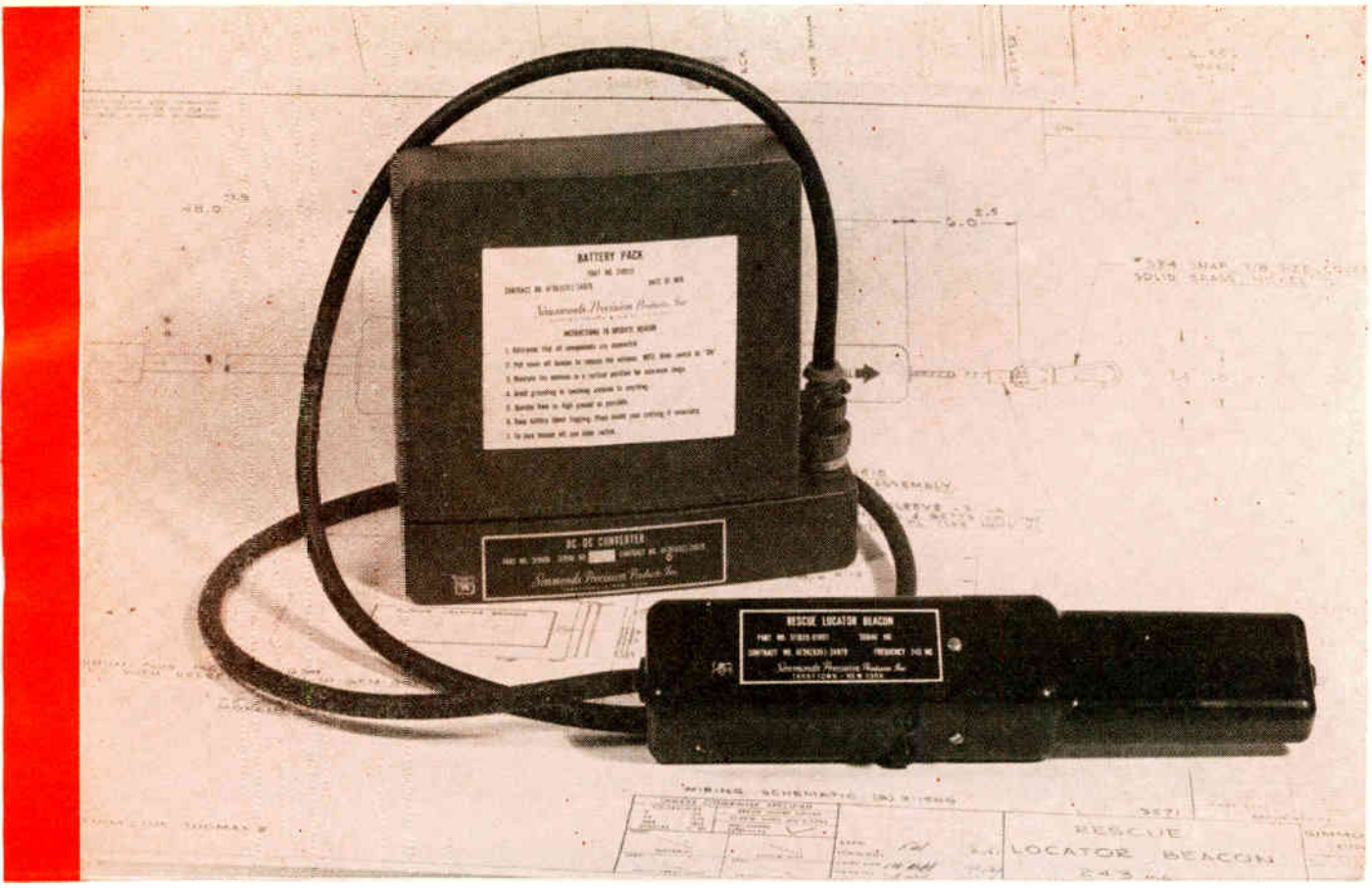


Wittnauer "Electro-Chron" waterproof electric watches tell "time without care" . . . use special Mallory Mercury watch batteries that give constant power, last two years. Wafer-thin battery design aids in the watches' slim styling.

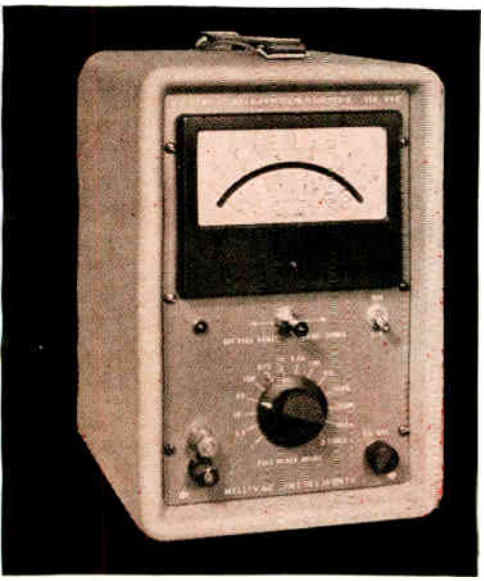
Mallory Mercury Batteries

FM Wireless Microphone. Small as a cigarette pack, the "Mike-Caster" made by Federal Manufacturing & Engineering Corporation transmits with high fidelity, free from interference. Two Mallory Mercury TR-165 Batteries supply power for over 30 hours of continuous service.



Reliability means Survival... in the "SARAH" Rescue Beacon, made by Simmonds Precision Products, Inc. The transmitter sends a coded signal to guide search planes to downed airmen. Mallory Mercury battery pack powers 35 hours of transmission at 32°F, or 50 hours at normal temperatures.

Can Give Your Product Extra "Sell"



Direct Reading Ohmmeter made by Millivac Instruments, Inc., uses a Mallory Mercury cell . . . selected because of its high stability as source of measuring power, its freedom from leakage, and expected service life of a year or more under low-drain usage.

You can give your battery-powered product new features that customers want, by designing around Mallory Mercury Batteries.

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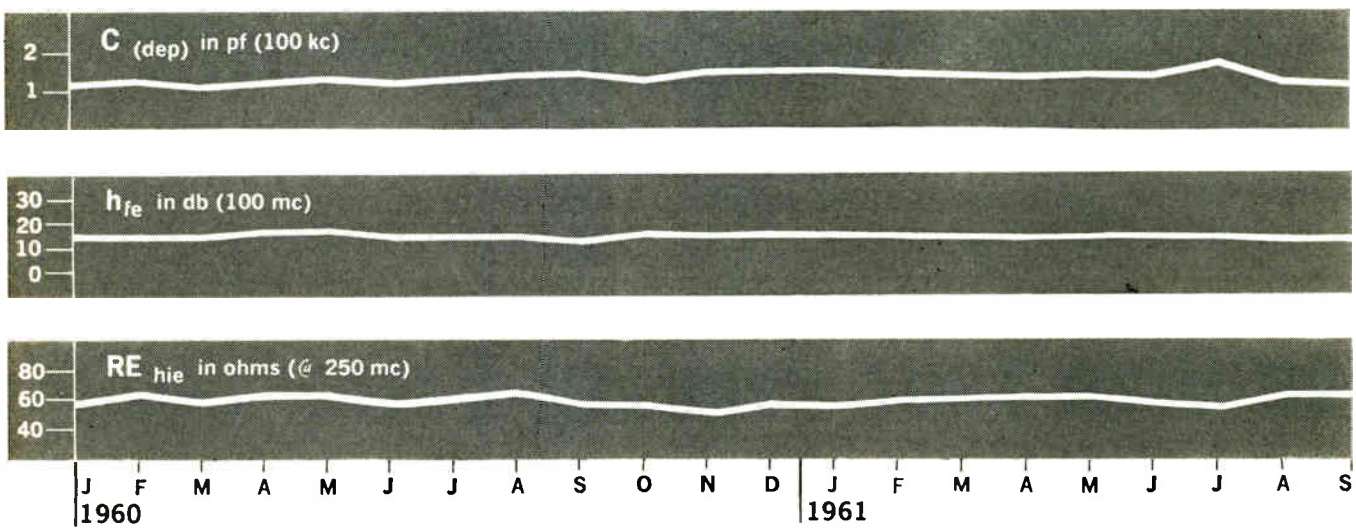

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MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

electronics

April 20, 1962

FIG. 1—Balanced planar equiangular or logarithmic spiral-slot antenna (left) radiates a broad circularly polarized beam on each side of, and perpendicular to, the plane of the antenna

Frequency-Independent Antennas

SURVEY OF DEVELOPMENT

Antennas now provide continuous coverage of large portions of the frequency spectrum. These very-wide-band antennas offer a challenge to the systems engineer to design equipment that will match bandwidths now available

By JOHN D. DYSON
University of Illinois,
Urbana, Illinois

THE NECESSITY of providing continuous coverage of large portions of the electromagnetic frequency spectrum for defense purposes has exerted great pressure on the antenna engineer to produce antennas that could be used over wider and wider bands of frequencies. Such requirements have led to an important breakthrough in the antenna field. The conception of the frequency-independent antennas at the University of Illinois and their development at this and at other laboratories has produced advances in the state of the art that now puts pressure on the electronics and system engineer to design equipment that will match the available antenna bandwidths. The purpose of

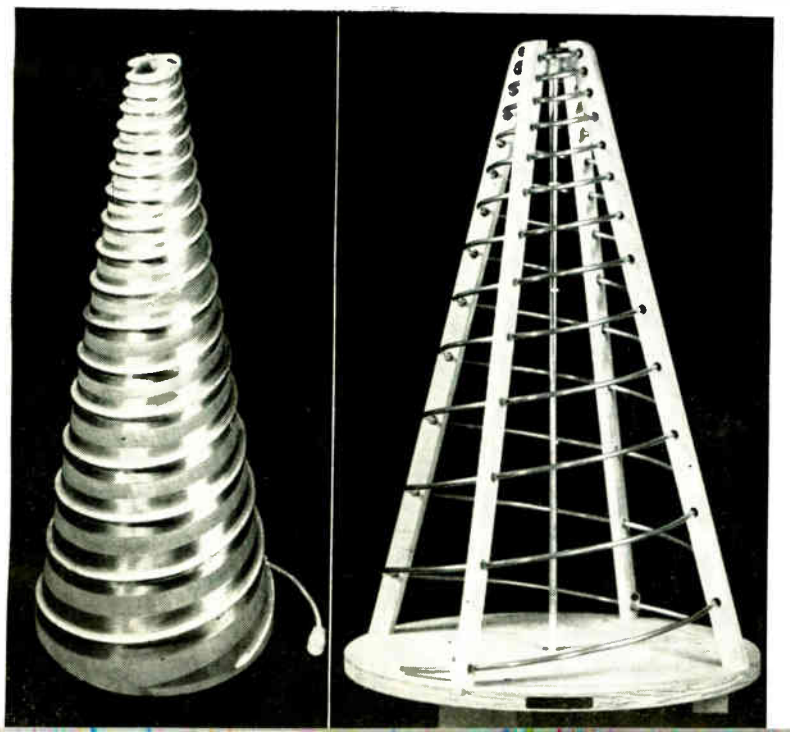

FIG. 2—Balanced conical logarithmic spiral antenna (left) with feed cable carried along one arm; wire version of balanced conical logarithmic spiral antenna (right), fed with coaxial line and balun along axis of cone

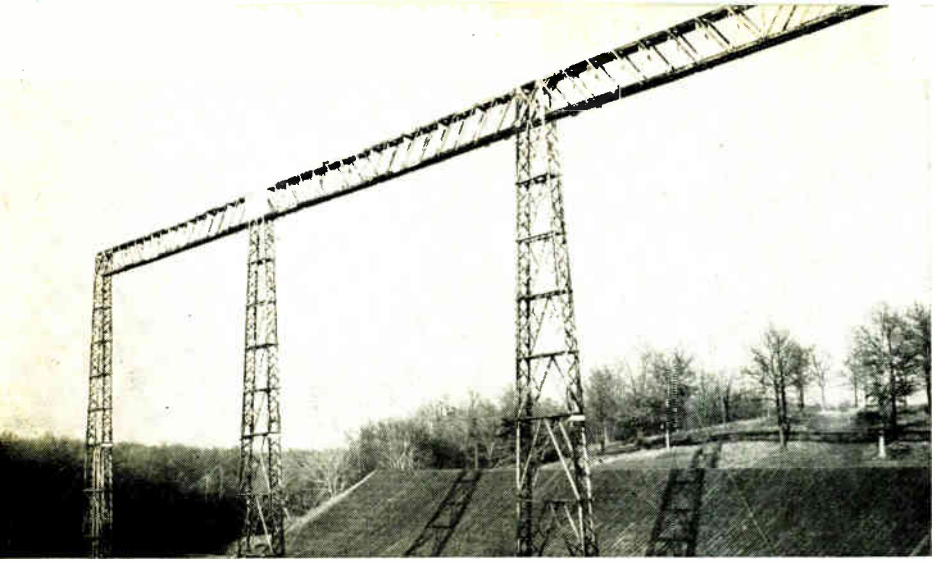

FIG. 3—The University of Illinois radio telescope. The focal line array, 153 feet above the 400-by-600-foot parabolic reflector, is visible below the wooden truss

this survey is to outline the development of these antennas.

As of 1945, antenna research and development had led to a few structures that operated over a 2 to 1 or slightly greater range of frequencies, with acceptable radiation and impedance characteristics. In a majority of cases, it was the radical changes in the radiation pattern with changes in operating frequency which limited the usefulness of antennas to somewhat less than this 2 to 1 range, since antennas had been developed with an input impedance that remained relatively constant with a change in frequency.

The discone antenna[1] introduced in 1946 was one of the first antennas that could be used over approximately a 4-to-1 range of frequencies. Advances during the next 7 or 8 years were limited, mainly, to increasing the bandwidth of existing antennas by a few percent. The one exception during this period was a modified helical antenna[2, 3, 4]. These unbalanced conical helical structures, fed against a ground plane, had acceptable pattern bandwidths of 4 or 5 to 1.

The spiral antenna introduced in 1953 was a major step forward in wide band antenna design. This construction consists of two flat, narrow, constant-width metallic arms, wound in an Archimedean spiral.[5] Fed at the center in a balanced manner, it radiates a broad circularly polarized lobe on each side of the plane of the antenna. Subsequent development of this configuration produced forms that had stable pattern and impedance characteristics over bandwidths up to 10 to 1.[6–13]

Arrays of the Archimedes spiral antenna provide variable polarization of the radiated field[14] and beam scanning by simple rotation of the antennas.[15–17]

In 1954 a major breakthrough occurred when V. H. Rumsey suggested that an infinite length structure based upon the equiangular or logarithmic spiral could be specified completely in terms of angles, and hence it should have characteristics independent of frequency. A study of balanced planar antennas based on these curves disclosed the equiangular spiral antenna to be the first antenna of practical size that had characteristics associated with an infinite structure.[18, 19] This structure became the first of a class now called frequency-independent antennas.[20]

This descriptive term is applied to antennas set apart from the usual concepts of operating bandwidth. The upper and lower frequencies at which these antennas may be operated are determined by independent paramters, and hence the bandwidth over which the radiation pattern and input characteristics are essentially constant is theoretically unlimited. Actually, the bandwidth is limited only by practical considerations of construction, and such antennas have been built to operate over a bandwidth of more than 42 to 1. There is no fundamental reason why this bandwidth cannot be extended.

The general philosophy behind the frequency-independent antennas is to design a radiating structure such that successive applications of a scaling factor result in structures identical with the original, or which at most, differ by some rotation about an axis through the origin of the original structure. Although the structure must be infinite in size to fulfill the scaling condition of exact equivalence, forms based upon the equiangular, or logarithmic, spiral curve may be truncated to a finite size and still retain, over an extremely wide range of frequencies, characteristics associated with the infinite structure.

A second breakthrough occurred in 1955 when R. H. Du Hamel proposed to force radiation from otherwise angular structures by periodic discontinuities. This led to a linearly polarized antenna with pattern and impedance characteristics that repeat periodically with the logarithm of frequency.[21–22] Although these logarithmic-periodic antennas scale exactly at only certain discrete frequencies, they can be designed so that the radiation characteristics do not change appreciably over the period between these frequencies. Hence they also exhibit nearly frequency-independent characteristics.

Many versions of the log-spiral and log-periodic antennas have been developed. The planar log-spiral antenna shown in Fig. 1 is bidirectional, radiating a broad circularly polarized beam on each side of, and perpendicular to, the antenna plane.[23] This spiral antenna may be made unidirectional, and hence more useful, by an orthogonal projection of the balanced spiral arms upon the surface of a cone (see Fig. 2 left).[27–29] For included cone angles less than about 45 degrees, radiation is confined to one broad circularly polarized lobe with maximum radiation off the apex of the cone. The antenna is balanced, with the feed voltage applied between the two arms at the apex of the cone. This feed voltage may be supplied by a conventional balanced line carried along the axis of the cone, or by a coaxial line and balun.

The characteristics of equiangu-

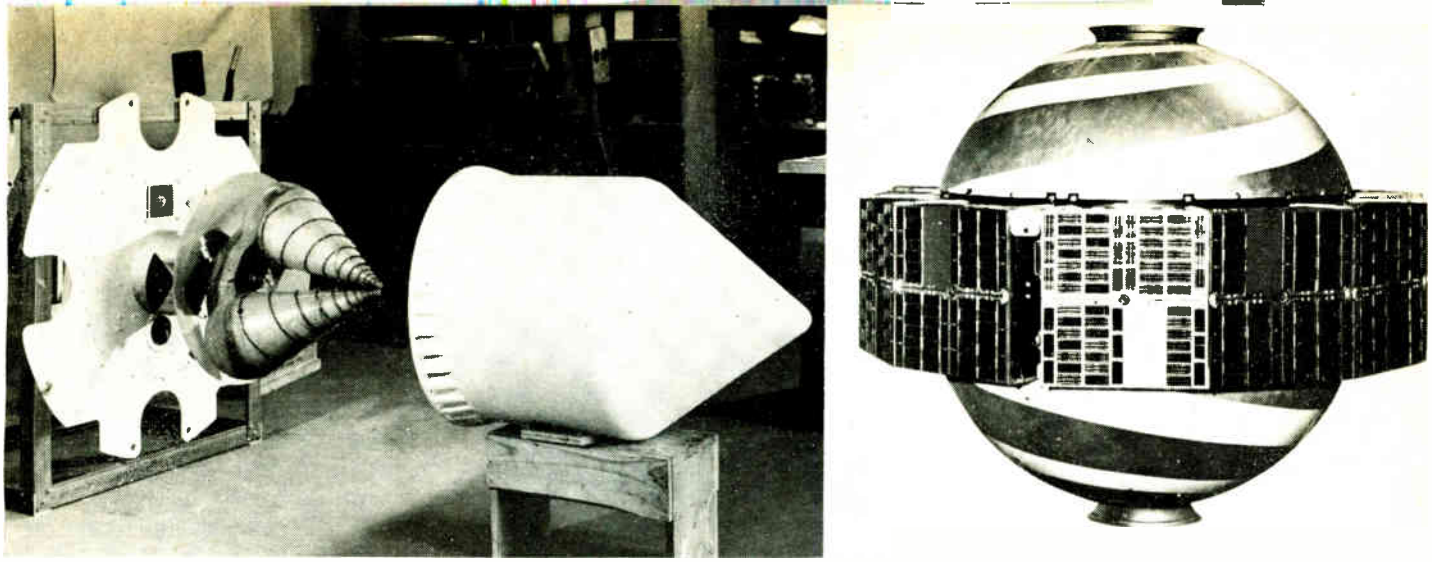

FIG. 4—First production of Dynatronics 500-to-4,000-Mc dual conical spiral Autorack feed for 40-foot diameter parabolic reflector (left); Transit 3B satellite (right) by Applied Physics Lab. of the Johns Hopkins University. The logarithmic spiral antenna projected onto the spherical surface provides for transmission at 54, 108, 162 and 216 Mc

lar spiral antennas permit a third method. The feed line, a coaxial cable, may be carried along and soldered in contact with one of the arms. The amplitude of the antenna currents on the arms, and also on the outside of the cable, fall off rapidly with distance from the apex, so the ends of the arms where the cable enters carry negligible antenna current. This optional feed, conveniently and automatically, provides a frequency-independent balun, permitting feeding the balanced antenna by means of an unbalanced line.

Conical log-spiral antennas have been constructed to operate over more than 40-to-1 bandwidths. The upper usable frequency is determined by the truncated region at the apex which must remain less than 1/4 wavelength at the highest frequency of operation. The lowest usable frequency is determined by the base diameter of the cone which, for tightly wrapped antennas, must be approximately 3/8 wavelength at lowest operating frequency.

A highly practical conical log-spiral antenna can be constructed by allowing the exponentially expanding arms to degenerate into narrow constant width structures following the logarithmic spiral curve (see Fig. 2 right).[27-29] For tightly wrapped spirals this version has characteristics similar to the original antenna. This wire version, simple to construct, may be excited by bringing the feed cable up the axis of the cone. If the infinite balun feed is desired, the feed cable itself can become one of the arms, with a dummy cable becoming the second arm of a balanced structure.

The balanced conical log-spiral antenna has characteristics other than bandwith that are attractive. The electromagnetic fields radiated by these antennas are essentially circularly polarized over very wide angles off the axis of the antenna. In addition, the phase of the far field of the two-arm antenna has essentially a one-to-one relationship with the azimuthal angle around the antenna. These two properties were utilized in the line feed for the University of Illinois radio telescope shown in Fig. 3. The focal-line array for this 400-by-600-foot parabolic reflector consists of a linear array of 286 conical logspiral antennas.[71]. The beam is steerable in declination ±30 degrees and the phase adjustment to provide this scan is secured by a physical rotation of each element of the array to a prescribed orientation. Thus it is of importance that the beam of each element be circularly polarized over at least a sector ±30 degrees from the axis and that the phase of the radiated field be linearly related to the angle of orientation around the antenna.

Multiarm versions of the balanced conical log-spiral antenna operate in several distinct modes.[32-33] Thus a four-arm symmetrical structure may be excited to radiate an axial beam with an $e^{\pm j\phi}$ variation, that is, the phase of the far field varies linearly with the azimuthal angle ϕ, around the antenna. It can be excited to produce a conical beam with an $e^{\pm j2\phi}$ and a conical beam with an $e^{\pm j3\phi}$ variation. Since orientation of the maximum of the conical beam may be controlled by varying the rate of spiral of the antenna arms, it can be positioned perpendicular to the axis of the antenna to provide a simple very-wide-band circularly polarized omnidirectional source. The well-behaved phase characteristics of these antennas suggest the basis for many variations of phase-comparison direction-finding systems.[31]

The conical log-spiral antennas have been developed as feeds for dishes used in tracking applications.[73, 71, 75] A modernization program is now under way to equip many of the large parabolic reflector antennas on the Atlantic Missile Range with dual conical spiral feeds designed to cover a 10-to-1 range of frequencies.[73] The first production model of one of these feeds is shown in Fig. 4 (left).

In an interesting modification of the log-spiral geometry, the planar antenna, was projected upon a spherical surface and used on the Transit satellites[37] shown in Fig. 4 (right). Although this geometry is no longer frequency independent, the antenna operates well over four frequencies, spaced from 54 to 216 Mc. Similarly, the planar antenna can be projected upon a myriad of surfaces. However, it can be shown that the conical surface, which in-

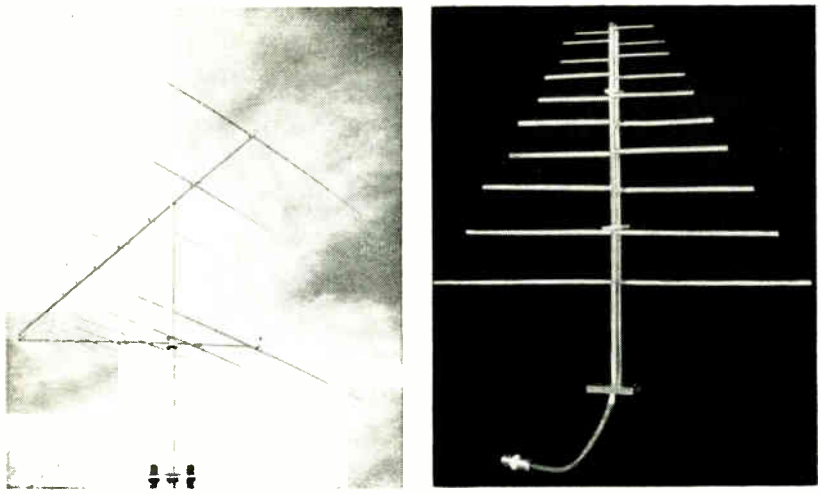

FIG. 5—Trapezoidal tooth nonplanar log-periodic antenna (left) designed by Collins Radio Company to cover 6.5 to 60 Mc; and logarithmic periodic dipole array (right)

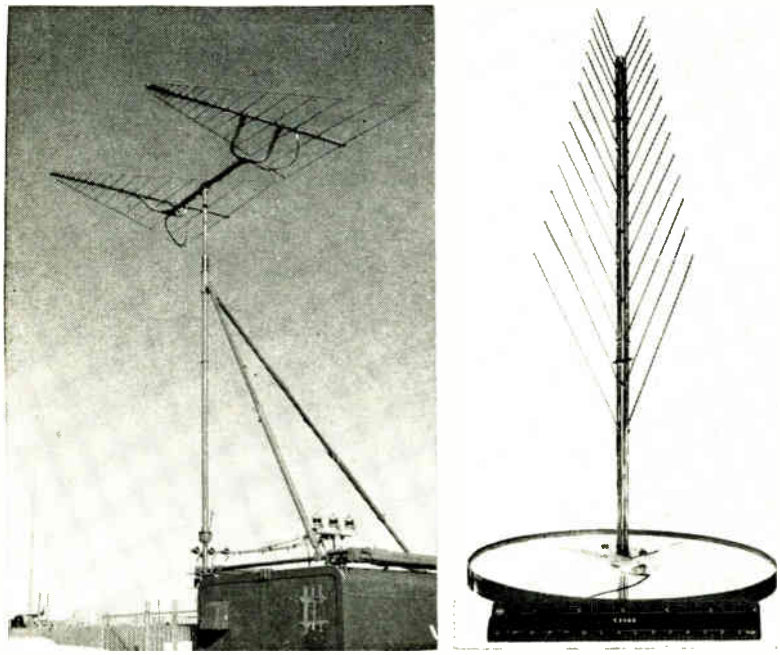

FIG. 6—Militarized version of the log-periodic dipole array (left) by Collins Radio Company; and log-periodic resonant-V array (right), an adaption of the log-periodic dipole array, designed to operate in several different modes

cludes the plane, is the only surface satisfying the required scaling principles for unlimited bandwidth.

The log-periodic antennas have been extensively investigated. The planar antenna can be modified to provide unidirectional patterns by forming the two elements of the antenna into a V, that is, a nonplanar arrangement.[38] A wire version of the log-periodic elements (see Fig. 5 left), and omnidirectional horizontally polarized, and unidirectional circularly polarized log-periodic antennas have been described.[39] Multielement arrays have been described,[40] and design information for log-periodic antennas as feeds for dishes, and as point-to-point h-f communications antennas has been given.[41, 42]

The dipole array of Fig. 5 (right) is a simple log-periodic structure.[46] The length of each element in this array bears a fixed ratio to the length of the preceding element, and the adjacent element spacings bear the same ratio one to another. The pattern and impedance characteristics of the array at frequency f_n, such that the nth element is resonant, will be repeated at a higher frequency f_{n+1}, which makes the $(n + 1)$th element resonant. The characteristics repeat periodically at all frequencies given by $\tau^n f$, where n is an integer and τ the ratio of the lengths of adjacent elements. The geometry shown in this figure provides an excitation with a 180-deg phase shift between elements. Thus it radiates a single-lobe, linearly polarized beam, directed toward the apex of the array. Analysis and design information for this array has been presented.[47-48] A militarized version of the antenna is shown in Fig. 6 (left).

In an extension of this work, a log-periodic monopole array has been described in which simple reactive networks produce the proper monopole current amplitude and phase distribution for unidirectional frequency-independent operation.[49] A slot complement of the log-periodic dipole array has also been investigated.[50]

The log-periodic resonant-V array[51] (Fig. 6 right) is an adaptation of the log-periodic dipole array, designed to operate in several modes. In the lowest order mode, the performance approximates the log-periodic array. The active portion of the antenna centers around elements whose lengths are near a half-wavelength at the frequency of operation. As the operating frequency is increased, this active region moves toward the apex. The antenna may be designed so that as the $\lambda/2$ region moves off the apex of the antenna the large elements on the other end approach a $3\lambda 2$ resonance. Thus, as the operating frequency is increased, the active region moves through the array in the $3\lambda/2$ wave mode, then in the $5\lambda/2$ mode, etc. Forward tilt of the individual elements insures a unidirectional beam and provides increased directivity. This antenna has transition regions between modes where the characteristics deteriorate, but it can provide a gain of approximately 18 db over an isotropic radiator in the higher modes.

Triangular or zig-zag log-periodic structures have received considerable attention. A flush-

mounted sinuous structure, fed by a waveguide, has been studied,[63] and a balanced zig-zag antenna has been proposed.[51] A vertically polarized log-periodic zig-zag antenna[55] is shown in Fig. 7. The teeth bent parallel to the ground plane serve as a delay line to phase the vertical radiating portions.

Tapering structures, not constructed in a logarithmic periodic manner, have led to antennas of appreciable bandwidth. One tapered ladder antenna[58–59] consists of symmetrical elements excited by a balanced line. In addition long slot, tapered feed, structures that can be used over a 10-to-1 bandwidth have been proposed.[60] A radiating horn with side walls of periodically spaced wires,[61] when fed from a ridged waveguide, can be operated over a 4-to-1 range of frequencies.

The frequency-independent antennas have opened up a new era in wide-band antennas. However, in view of their complex geometry, the experimental and empirical development of these antennas have outstripped their theoretical analysis.

The theoretical problem of the log-spiral antenna has received considerable attention. This problem has been attacked by calculating the fields due to a logarithmic spiral filament,[63] and the fields produced by an infinite number of planar logarithmic spiral filaments.[64,65] An approximate analysis for the radiation patterns of a filamentary log-spiral antenna with an assumed current distribution has been published.[66,67,68]

A recent comprehensive analysis of the log-periodic dipole array has been reported.[48]

A new and promising approach considers the log-periodic antenna as a locally periodic structure whose period varies slowly, increasing linearly with distance to the origin or apex.[70] This approach indicates that the basic ingredients for a frequency-independent antenna are a slow-wave transmission medium and a series of radiating elements, satisfying the similarity condition, coupled to the transmission medium at points spaced in geometric progression. Such a structure produces a wave substantially radiated toward the feed point with characteristics that vary little as the operating frequency is varied over extremely wide bandwidths.

A general consideration of the log periodic zig-zag antennas and the conical log-spiral antennas as locally periodic, slow wave structures has led to a better understanding of their operation and to some useful design criteria.[55–72]

This survey has covered the work of many people. It has been impossible to acknowledge the work of many others, however an extensive list of references has been included.

The original work on logarithmic spiral and logarithmic periodic antennas was conducted at the University of Illinois, sponsored by the Aeronautical Systems Division, Wright Air Development Division under contracts AF33(616)-3220 and AF33(616)-6079.

This article is based upon a paper by the author published in the Journal of Research of the National Bureau of Standards, Section D, January 1962.

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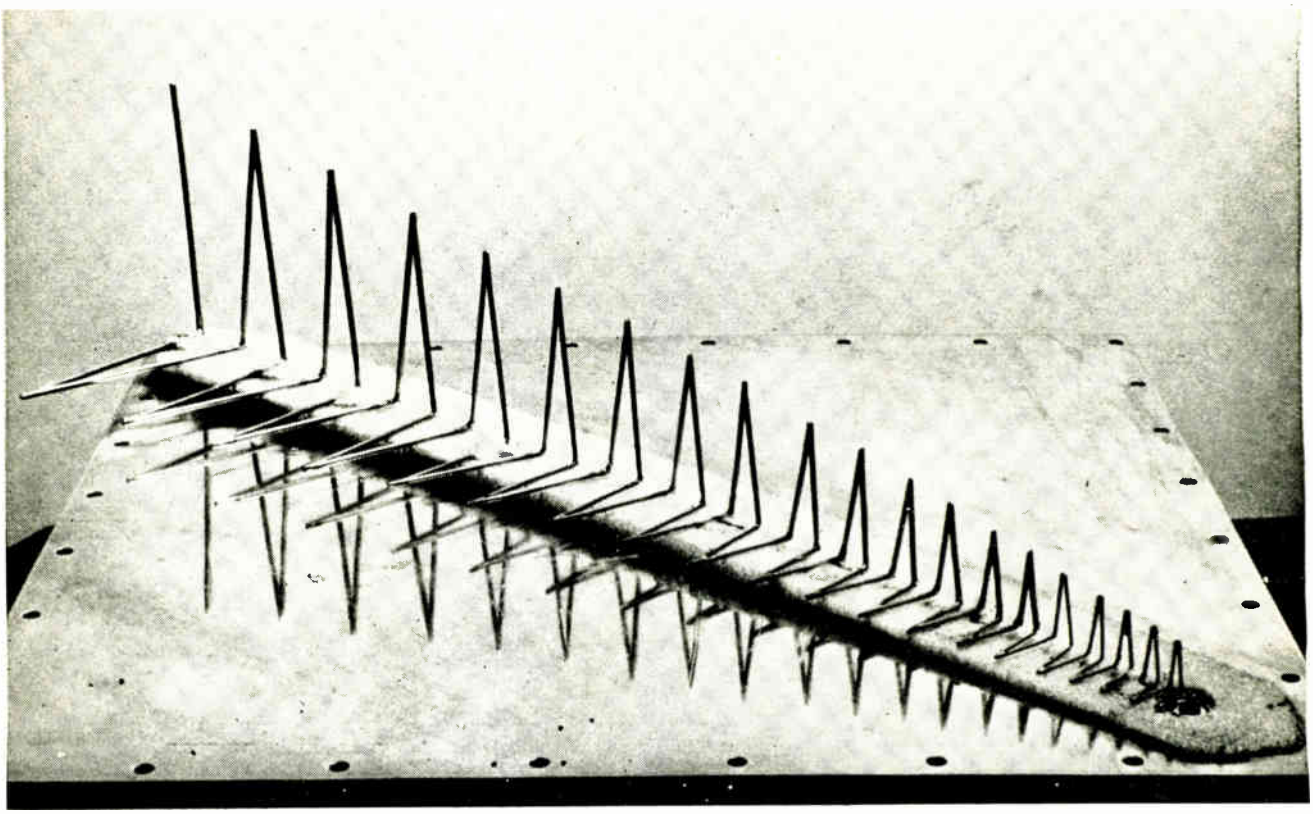

FIG. 7—Teeth of the vertically polarized log-periodic zig-zag antenna bent parallel to the ground plane serve as a delay line to phase the vertical radiating portions

GASEOUS BREAKDOWN IN
Pressurized Microwave Components

Factors that cause electrical breakdown in waveguides and other microwave components are discussed along with the means to prevent this type of breakdown

By R. M. WHITE and R. H. STONE, Traveling-Wave-Tube Product Section, General Electric Company, Palo Alto, Calif.

PRESSURIZED MICROWAVE transmission systems frequently arc over or break down electrically at power levels far below the handbook values for transmission lines themselves.[1] In some instances such low breakdown values are observed because of arcing in complex components—such as rotary joints—having breakdown thresholds far lower than those of the interconnecting transmission lines. Analysis of the fields in these components may be so difficult that it is preferable to rely on empirical designs. In many other cases, low breakdown levels are encountered because the physical characteristics of the transmission components are not identical with those assumed in the theoretical breakdown analysis. It is often possible to correct this by making the actual and the theoretical characteristics more nearly alike.

The more common reasons for differences in the two sets of characteristics are: microwave power at frequencies out of the recommended operating range, heating of the gaseous dielectric, dust or other foreign particles in the system and improperly designed and connected components. Often elimination of one or more of these conditions eliminates the arcing problem.

Breakdown electric field strength for common gases at or above atmospheric pressure is independent of frequency in the microwave range. Yet a mixture of a small amount of harmonic or out-of-band spurious power with the fundamental may reduce the permissible fundamental operating power level to a fraction of the theoretical level.

In some components, out-of-band power may be high relative to the fundamental power as a result of frequency-dependent coupling in components such as directional couplers (Fig. 1A). High harmonic electric fields may arise because of resonances in components which are well matched at the fundamental frequency (Fig. 1B). Transmission line impedances may be high for harmonic power near higher mode waveguide cut-off frequencies (Fig. 1C), permitting electric fields to rise to the breakdown level.

A microwave system may operate well shortly after being turned on, but then may arc during warm up. Heating of the gaseous dielectric in this period in a constant-pressure system produces a reduced density of gas molecules and a consequent lowering of the breakdown threshold. At constant pressures above 1 atmosphere, the breakdown power level, $W\ (T)$, at a temperature T degrees absolute is proportional to the level, $W\ (T_o)$, at some reference temperature T_o, times the square of the temperature ratio

$$W\ (T) = W\ (T_o)\ (T_o/T)^2$$

Thus relatively small tempera-

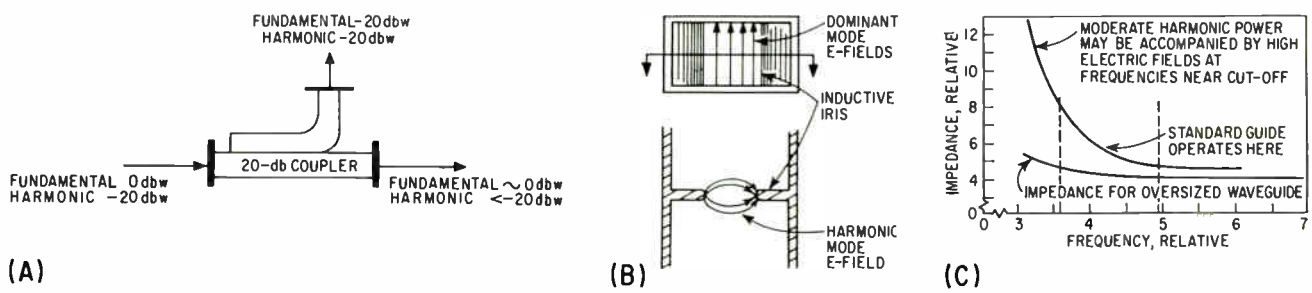

FIG. 1—Breakdown may be caused by high values of harmonic power such as at (A) where the fundamental and harmonic are equal at the exit from the side arm. In (B), the inductive iris may cause a breakdown when harmonic power in a transverse mode is present. Transmission line impedance is affected by frequency (C) and influences breakdown characteristic

DEPENDENCE OF BREAKDOWN LEVEL UPON WALL MATERIAL AND SURFACE FINISH

Waveguide Material	Bump			Power Level (relative)
	Material	Finish	No.	
Al	Al	f1	1	1.07
		4	2	1.09
		4	3	1.06
	Iridite on Al	4	5	1.13
		32	4	1.09
		300	6	1.05
Cu	Cu	f1	7	1.09
		4	8	1.09
		4	9	1.10
		300	8	1.00
		300	8	1.05
		300	7	1.10
Cu	Brass	f1	13	1.00
		4	11	1.04
		4	15	1.06
Cu	Al	f1	1	0.98
Al	Cu	4	7	1.03

Data taken in air at one atmosphere in an S-band test cell similar to that shown in Figure 3. Results show breakdown level is independent of wall material and surface finish over the range from f1 to f300

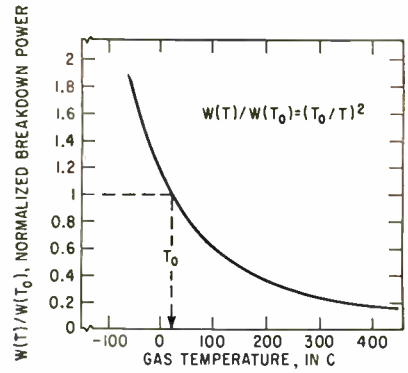

FIG. 2—Dependence of waveguide breakdown power upon gas temperature at fixed pressure

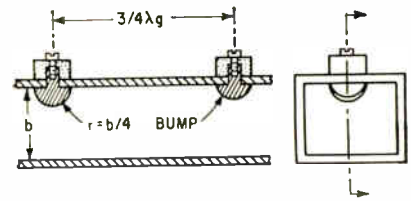

FIG. 3—Section used for breakdown test contains two hemispherical bumps spaced at ¾ wavelength for matching. One bump is flattened to insure breakdown at other bump only

ture changes may produce large changes in the breakdown power level, Fig. 2. Calculations of the temperature rise which can occur in typical S-band waveguide carrying a 20-megawatt peak signal having 300-microsecond pulses and a 0.005 duty cycle, show that with air convection the temperature of the inner waveguide wall may rise 175 C above the outside ambient air temperature.

Dust in hemispherical waveguide spark gaps, Fig. 3, has been found to lower the breakdown power level to 10 percent of its theoretical value. Similar results were obtained when metal filings were placed in the system.

Flanges and other circuit joints frequently initiate corona and the production of free electrons and ions that lead to breakdown. This sizzling at joints may result from improper design, fabrication or installation of parts. Figure 4 shows a cover flange and waveguide that arced where breaks in the current paths were introduced by a poor braze joint. Good and bad locations for brazes or welds are shown in Fig. 5. Tests of cover and choke flanges indicate that cover flanges with radiused front surfaces permit greater misalignment during circuit assembly than do choke flanges. Passing the smooth waveguide through the flange as shown in Fig. 5C and 5E improves performance since it eliminates the possible ridge where the waveguide joins the flange. Proper placement of welds and joints will avoid shorts and discontinuities, and will improve mechanical structure.

Breakdown can often be eliminated in obvious ways. Spurious signals such as those produced by all high-power microwave tubes can be eliminated by filtering.[2] Design of components to avoid large amplitude standing waves is possible in systems where the spectra of the spurious signals are known. The gaseous dielectric can be kept cool by passing the gas through a heat exchanger external to the microwave lines, by cooling the system walls, and even by improving the radiative heat transfer from the system by liberal applications of black paint. Foreign particles can be removed from components by thorough cleaning during manufacture. Components can be kept sealed until they are assembled. Absolute filtering of the gas circulated (for example, by electrostatic precipitation) through the system will keep the system free of dust during operation. Design of joints and alignment during installation can reduce the severity of that source of arcing.

Tests indicate that in high-pressure systems the breakdown level is independent of the internal surface finish in the range of finishes from f4 to f300 (RMS surface excursions between 4 and 300 microinches respectively). Test results are in agreement with theoretical analysis[3], which shows that breakdown thresholds are unaffected by

small regions of high electric field provided those regions occur near a material wall such as the inner wall of a waveguide.

An important role is played in breakdown by ionizing radiation. If the cumulative ionization breakdown process is to begin, free electrons must be available in the gaseous dielectric. The initial electrons may be produced by corona discharges occurring at sharp discontinuities, or by external ionizing radiation such as cosmic rays or X rays produced by a high-voltage vacuum tube. Breakdown measurements should be made on components under test in their operating environments, including the characteristic radiation which will be encountered during operation. In laboratory testing, a radioactive source or an industrial X-ray machine provides a radiation background permitting rapid measurements of minimum breakdown power levels.[4]

In conclusion, several means have been mentioned here for bringing actual operating levels closer to the theoretical breakdown levels. These means include attending to such details as the signal frequency spectrum, heating of the dielectric, cleanliness of the system, and component design and installation. By combining these means it is possible to reduce the magnitude of the derating safety factors commonly divided into the theoretical power handling values for pressurized transmission systems. These safety factors—which are actually indications of ignorance of the operating system characteristics—can be reduced by making sure the characteristics of the operating system are identical with those of the model system on which the theoretical analysis is based.

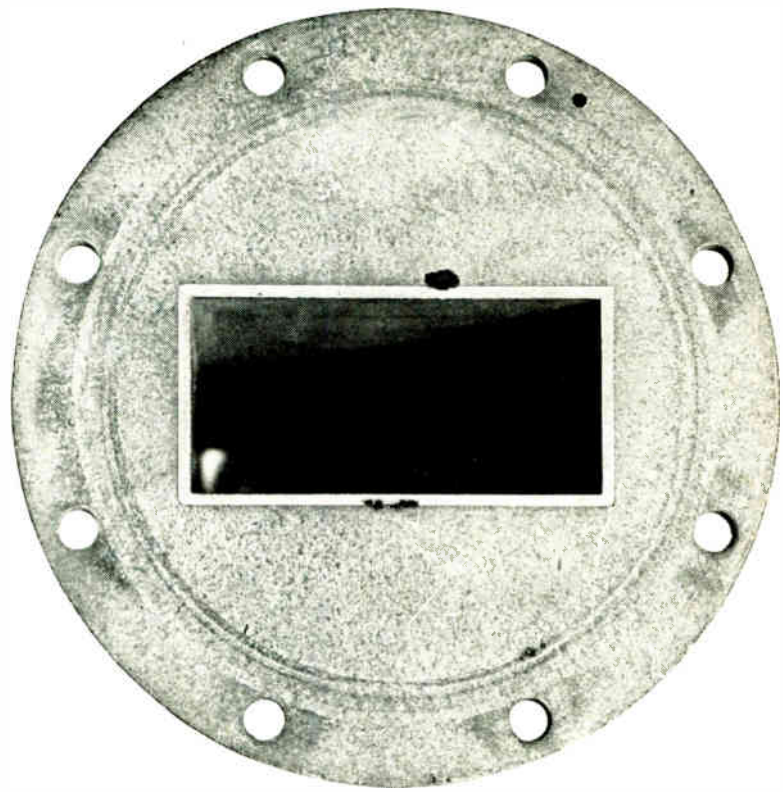

FIG. 4—Discolorations on this cover flange were caused by arcing

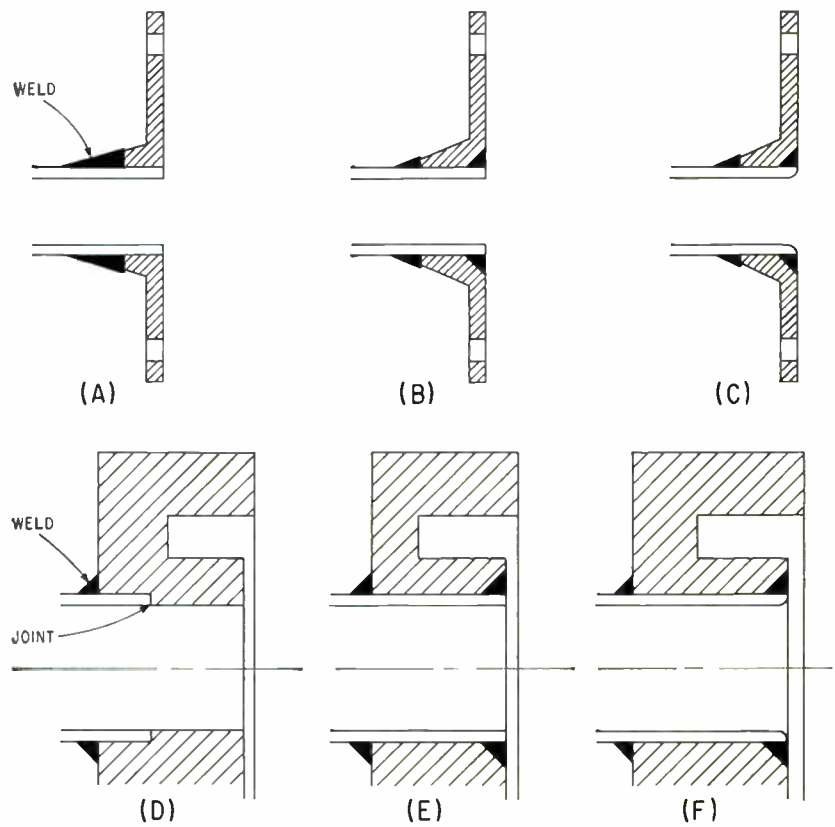

FIG. 5—Heavy weld on cover flange (A) would avoid possibility of a short caused by welding on face (B), but (B) makes a better flange. Rounding corners (C) improves behavior. Joint in choke flange (D) could cause discontinuity that could result in arcing. Solution is to pass waveguide through flange (E) and round corners (F)

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Switching-Time Tester for

Easily operated switching-time comparator enables quantity testing of tunnel-diode switching speed. Rapid test rejects diodes that switch slower than predetermined rate on go no-go basis

PRODUCTION QUANTITIES of tunnel diodes can be tested to establish that switching time does not exceed a predetermined limit. A switching-time comparator has been designed that requires only a few seconds to check each diode. Testing time is limited only by the speed at which diodes can be inserted and removed from the test socket.

If switching time of a tunnel diode is within the specified limit, pressing a test pushbutton causes an indicator lamp to light. However, if the tunnel diode switches too slowly, the lamp does not light. Thus operation of the comparator requires little training. In contrast, switching time of tunnel diodes is usually evaluated by highly trained personnel using an r-f bridge and several other pieces of expensive test equipment. The only additional equipment needed with the comparator is a well-regulated 12-volt supply and any pulse generator that can provide a negative 25-volt pulse into its characteristic impedance.

Operation of the comparator is based on slope detection of the switching waveform. The tunnel diode under test is switched by a slowly rising input current like that in Fig. 1A. Tunnel-diode output voltage in Fig. 1B is applied across an R-C differentiating circuit having a short time constant compared to diode switching time. Voltage across the resistor, a short pulse like that in Fig. 1C, is inversely proportional to switching time. Switching speed is primarily dependent on peak-to-valley current ratio, shown in Fig. 1D, and junction capacitance.

The switching waveform can be approximated by a ramp input to the differentiating circuit with the origin at 1 in Fig. 1B, in which $e = Kt$, where $K = (V_c - V_p)/ts$, which is the slope of the switching waveform. Differentiator output is described by $e_{in} = e_o + 1/C \int idt$, the solution[1] for which is $e_o = KRC(1 - e^{-ts/RC})$. If ts is large compared to RC, the equation becomes $e_o = KRC$.

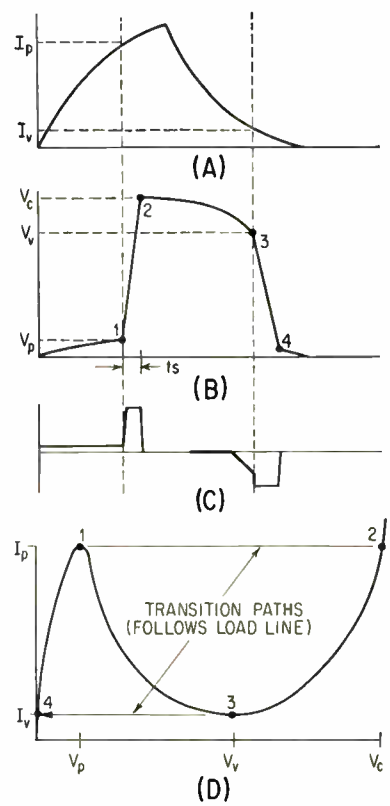


FIG. 1—Slowly rising current (A) switches diode, the output voltage (B) of which is differentiated to produce a pulse (C) inversely proportional to switching time. Peak-to-valley current ratio (D) and junction capacitance are primary factors determining switching time

Pulse output of the slope detector in Fig. 2 is amplified to increase sensitivity and applied to the amplitude threshold circuit, which passes only those pulses exceeding the predetermined amplitude threshold. Pulses passed while the test button is depressed activate the latch circuit, causing the indicator lamp to light. Releasing the test button resets the latch circuit.

Pulse generator output is integrated by R_1C_1 in Fig. 3 and applied through R_2 to the tunnel diode under test. The value of R_1 is equal to the characteristic impedance of the pulse generator. The time constant of R_1C_1 is long compared to tunnel-diode switching time to avoid excessively high amplitude at the differentiator output. A sufficiently large resistance is used for R_2 to isolate the tunnel diode under test from the input and to enable the diode to switch.

The differentiator consists of C_2, R_3 and R_4, and the values in Fig. 3 provide a 0.5-nsec time constant. However, time constant can be shorter to test diodes having switching times less than 1 nsec.

The emitter follower and amplifier configuration was chosen to provide the most gain possible with the least number of components. The emitter follower prevents loading of the differentiating circuit.

The tunnel-diode latch circuit provides amplitude comparison, d-c latching and indicator lamp power. The versatility of this circuit combined with its high frequency characteristics makes it particularly well-suited to the comparator.

Germanium tunnel diode D_1 is biased near its peak in the low-voltage state so that a small pulse above

Tunnel Diodes

By J. E. GERSBACH and I. LIEBER
International Business Machines Corp., Poughkeepsie, N. Y.

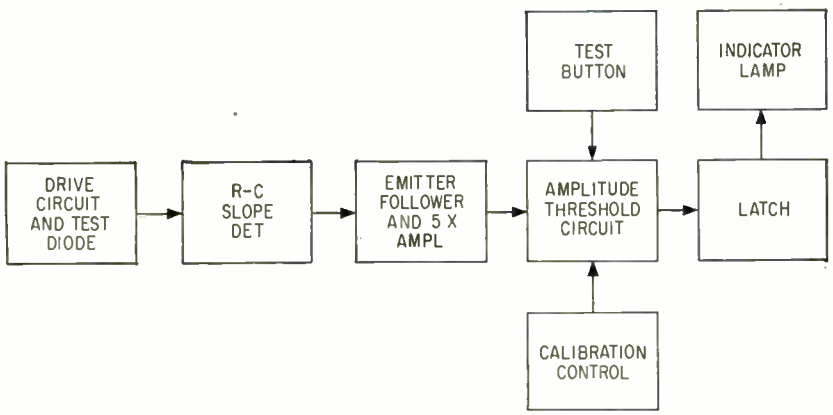


FIG. 2—If diode switching time is within predetermined limit, threshold circuit passes slope detector output pulses, causing latch circuit to light indicator when test button is pressed

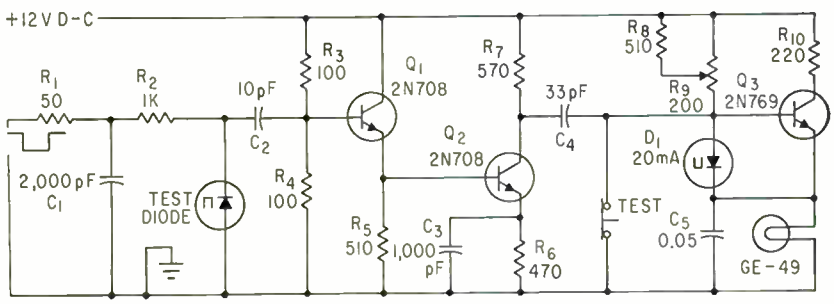
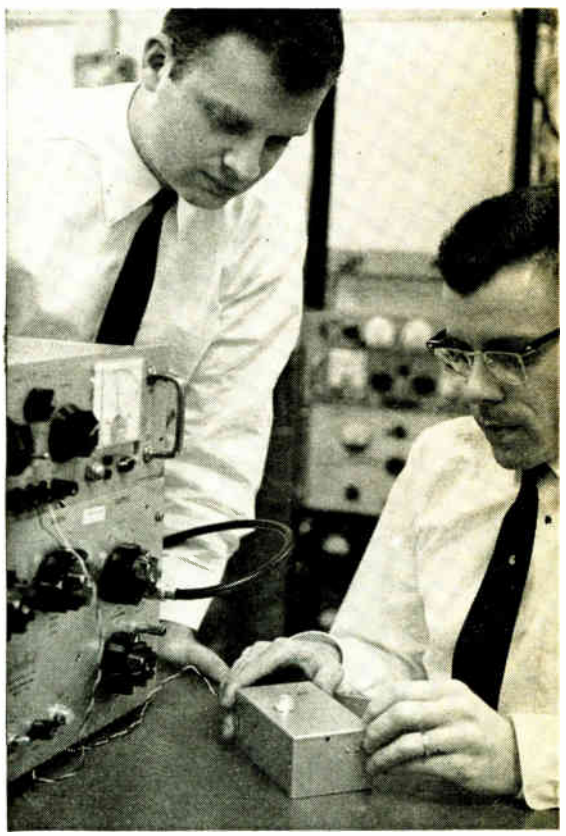


FIG. 3—Amplified differentiator pulse above level set by calibration control switches D_1, causing Q_3 to saturate and lamp to light when normally closed test switch is open



Switching-time comparator is used by authors Lieber (left) and Gersbach to conduct tunnel diode test

the predetermined amplitude level causes the diode to switch if the test switch is open. Diode switching causes Q_3 to saturate and the indicator lamp to light. Calibration control R_6 establishes the operating point of D_1 and thus the pulse amplitude that causes it to switch.

Silicon transistors were selected for the emitter follower and the amplifier because of their more stable temperature characteristics and their low leakage currents, which tend to limit drift in the a-c gain. Power dissipation was kept low for the same reasons.

A germanium transistor must be used for Q_3 to be compatible with the forward voltage drop of D_1. Peak current in D_1 must permit a value of R_9 that provides sufficient base current to ensure that Q_3 saturates when it is switched on.

The basis for selecting component values is indicated by some approximate design equations. Time constant $R_1C_1 >> ts > C_2(R_3R_1)/(R_3 + R_1)$, where ts is switching time of the tunnel diode under test, and $R_2 >> 1/-G$, where $-G$ is negative conductance of the test diode. Also, $V_{b1} = V_{cc}R_1/(R_3 + R_1)$ and $R_5 = (V_{b1} - V_{be1})/(I_{c1} - I_{b2})$.

Resistor $R_8 = (V_{b1} - V_{be1} - V_{be2})/I_{c2}$, $R_7 \cong$ voltage gain $(r_{e2} + r_{b2}/\beta_2)$ and $R_7 < (V_{cc} - V_{b2})/I_{c2}$, $R_9 + R_6 = V_{cc}/(I_p - I$ pulse $- I_{cq3})$, where I_p is peak current in D_1 and $I = C_1(dV_a/dt)$ in which V_a is amplified pulse voltage, and $R_9 + R_6 < (V_{cc} - V_{be3} - V_1)/(I_v + I_{c3}/\beta_3)$, where I_v is valley current in D_1 and V_1 is lamp voltage. Resistor $R_{10} = (V_{cc} - V_{c3} - V_1)/(I_1 - I_{b3} - I_v)$, where I_1 is lamp current.

In these equations, I_{cq} of Q_1 and Q_2, which is in the range of nanoamperes, is neglected. Capacitors C_3 and C_5 are assumed to be short circuits to the pulse.

A reference tunnel diode is required that is known to have the maximum permissible switching time. It is inserted in the test socket, and the calibration control is adjusted with the test pushbutton depressed until the lamp just switches on to establish the threshold. Any diode subsequently tested causes the indicator lamp to light if its switching time is equal to or less than the reference diode.

The tester is sensitive to noise and subject to drift. About 20 minutes is required for initial warmup, and recalibration every hour is recommended. The comparator should not be operated near noise sources like power tools or other machines that consume large currents at high frequencies. The tester power supply must be independent of line-voltage fluctuations and transients.

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Ignitron-Pulsed Electric Fence

GUIDES MIGRATING SALMON

Direct-current pulses fed to immersed electrodes keep fish out of hydroelectric turbines, help them reach their breeding grounds without mishap. Sequential ignitron triggering gives pulse-sweeping effect.

By CHARLES D. VOLZ, U.S. Fish and Wildlife, Sand Point Naval Air Station. Seattle 15, Washington.

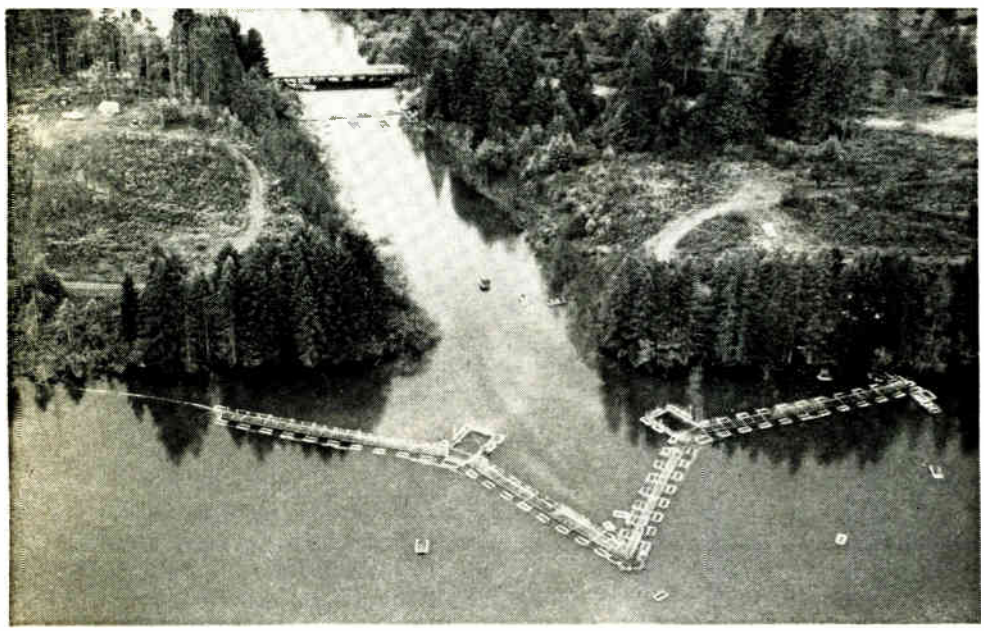


FIG. 1—Electric fence, powered by 360 Kw d-c generator, is on Lake Tapps, near Auburn, Washington

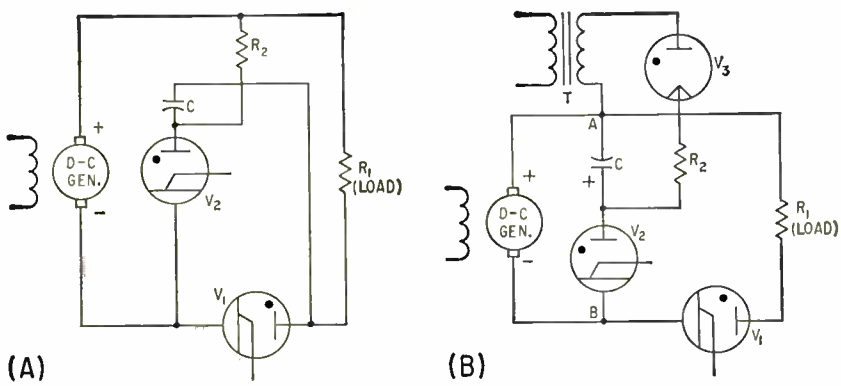


FIG. 2—Ignitron V_1 (A) passes pulses to fish fence, second ignitron V_2 turns V_1 off. In (B), precharged capacitor C is connected by V_2 across the terminals to reverse ignitron V_1 polarity and terminate the pulse

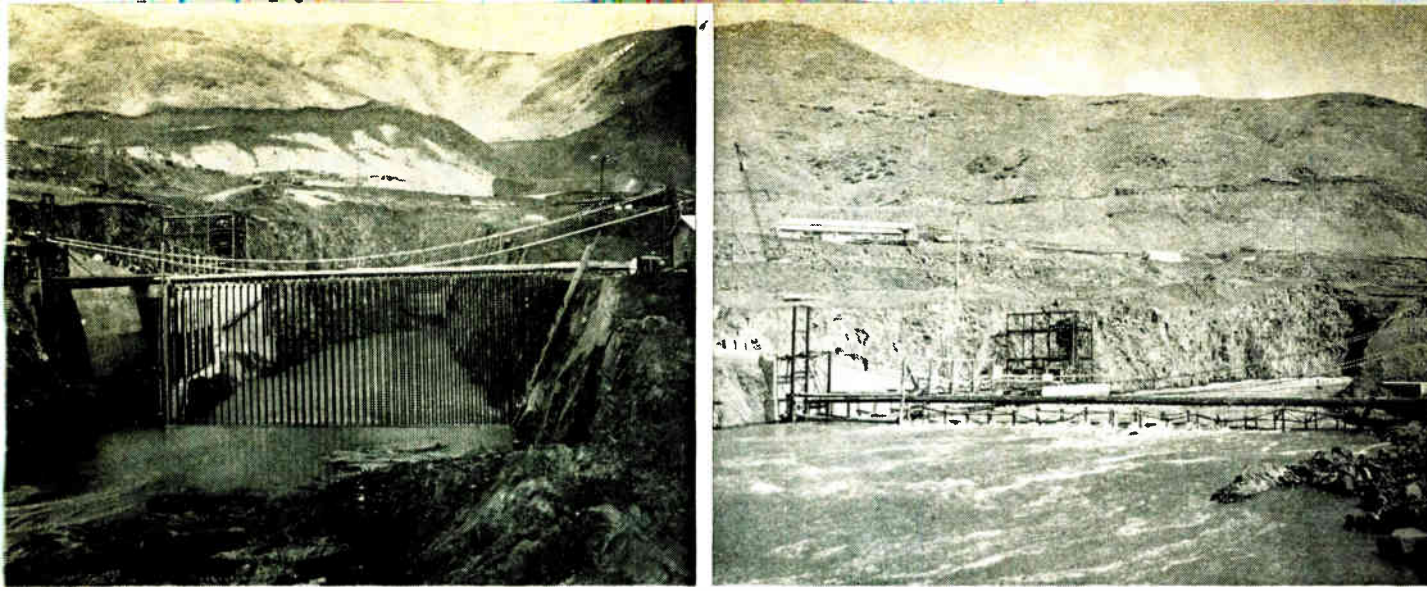
THE U. S. DEPARTMENT OF FISHERIES has taken a cue from the cattlemen and is now using an underwater electric fence to shepherd migrating and spawning salmon into the right traffic lanes for their journey to and from the ocean.

Construction projects for dams and hydroelectric power station frequently bypass the water flow by using diversionary tunnels; since the water velocity in these tunnels is high, salmon returning to their breeding grounds cannot swim against the current. In such cases, the salmon are diverted to fish-traps, where they are caught and put into fish tanks for transportation to a calmer region upstream.

Using d-c pulses,[1,2,3,4] electric fish screens are successful in guiding fish into fish traps, and at the Brownlee dam site on the Snake River between Oregon and Idaho an electric fish fence about 105 feet long and 40 feet high diverted 16,000 salmon and steelhead trout during a period of several months.

An improved model of the equipment has been built for studies on salmon fingerlings at Lake Tapps, an artificial impoundment near Sumner, Washington. An outlet from the lake leads to the intake for a hydro-electric generating plant. This arrangement, Fig. 1 uses a W shaped array using two traps and has given encouraging results over a two-year operating period.

The pulse generator uses a pair of high-current ignitron tubes, one



Electric fence (left) under construction at Brownlee dam site. Fish traps are seen through opening on left. Fence in use (right) prevents fish fighting upstream against current in diversionary tunnel, directional electric field urges them into fish traps where they are caught and transported past the diversion

to turn-on the pulse, the second one to turn the pulse off. A basic circuit is Fig. 2A while Fig. 2B shows an elementary version of the actual circuit. In Fig. 2A tube V_1 is turned on by an input signal to its grid, so applying the pulse to the underwater electrodes. To turn the pulse off, tube V_2 is triggered and while the capacitor C is charging, tube V_2 effectively parallels V_1. By using a turnoff tube with a lower arc-drop than the turnon tube the plate potential of V_1 is depressed below its conduction level by the low arc-drop of V_2, hence is extinguished.

In the actual circuit, Fig. 2B, commutating capacitor C is connected to the generator bus rather than to the anode of the load tube V_1. This gives a better pulse shape with sharper cutoff, and moreover allows a number of load sections each powered by its own ignitron, to be controlled by one commutating capacitor and turnoff tube. An auxiliary power source is needed in Fig. 2B to charge the commutating capacitor.

Operation of the pulse generator of Fig. 2B is as follows. Capacitor C is charged by its auxiliary power source to approximately the same voltage as the generator output. Control tube V_1 fires (time t_1) and the load current builds up with a time constant determined by armature inductance and circuit resistances, Fig. 3A. The generator voltage drops momentarily then follows Fig. 3B for the duration of its cycle.

To end the pulse, turnoff tube V_2 is fired and connects the commutating capacitor directly across the generator output. Since the commutating capacitor voltage cannot change instantaneously (there is a finite time-constant involved) the voltage at the positive bus is forced negative and in doing so, cuts off the control tube, V_1.

Load current when V_1 goes off, is diverted through V_2, which discharges through the armature. As it does so the voltage across the busses rises sinusoidally (time t_3) to a high positive value owing to armature inductance. If the bus voltage remains initially negative sufficiently long for control tube V_1 to become deionized, this tube will remain off when the bus voltage returns to its normal level and will be readied for the next triggering input.

The voltage across the generator busses may be approximated for the interval t_2 to t_3 by

$$V(t) = E_g + \sqrt{\frac{L}{C}} \times i(0) \times \sin \frac{t}{\sqrt{LC}} - (E_g - E_c) \times \cos \frac{t}{\sqrt{LC}}$$

where E_g is the generator voltage at t_2, $t = 0$, E_c is the capacitor voltage less the tube arc drop, i (0) is the load current at t_2 ($t = 0$), L is the armature inductance and C is the capacitance of the commutating capacitor.

Armature resistance has been assumed much smaller than armature inductance, and inductance is assumed constant. Then

$$\text{at } t_2, \quad t = 0, \quad V(t)1 = E_c$$

$$\text{at } t_3, \quad t = \pi\sqrt{LC}, \quad (t) = 2E_g - E_c$$

At midpoint of t_2 and t_3,

$$t = \frac{\pi}{2}\sqrt{LC}, \quad V(t) = E_g + \sqrt{\frac{L}{C}} \times i(0)$$

The interval available for deionization is represented by the "delta" symbol in Fig 3. This interval is determined by the value of t for $V(t) = 0$. The sine term is zero for $t = 0$ and $t = \pi\sqrt{LC}$ and maximum at

$$t = \frac{\pi}{2}\sqrt{LC}.$$

Figure 4 shows part of the control system. A special feature of the control arrangement is the provision for connecting up the 5 pairs of load switching ignitrons to the electrodes so that pulses are applied sequentially to bunches of electrodes, rather than to all of them simultaneously. The resulting effect is to give a moving pattern of electric charges in the same way that lights around a movie house provide a directional pattern of movements.

The off or commutating circuit is shown in detail in Fig. 5A. Positions of the capacitor and ignitron are the reverse of those shown in Fig. 2B to put the charging thyratron cathodes at generator negative. The diode charging rectifier of Fig. 2B is replaced by full-wave connected thyratrons, which are fired by a delayed gate so that

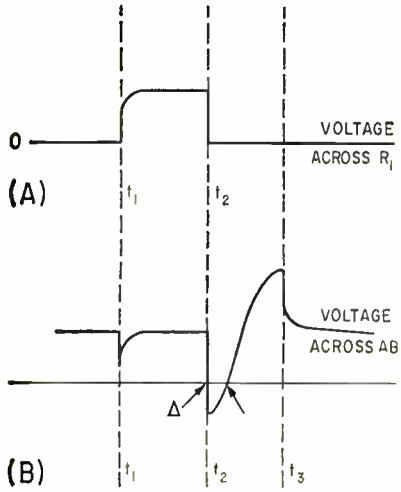


FIG. 3—Upper waveform shows pulse applied to electric fence; lower waveform shows generator terminal voltage

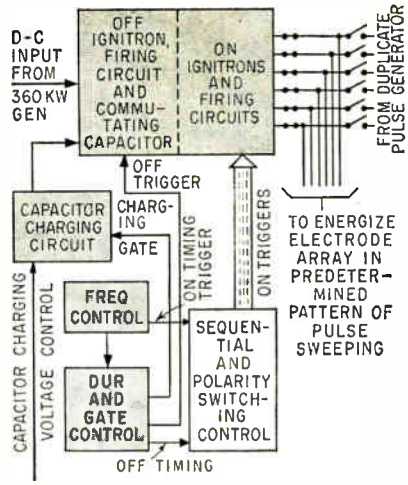
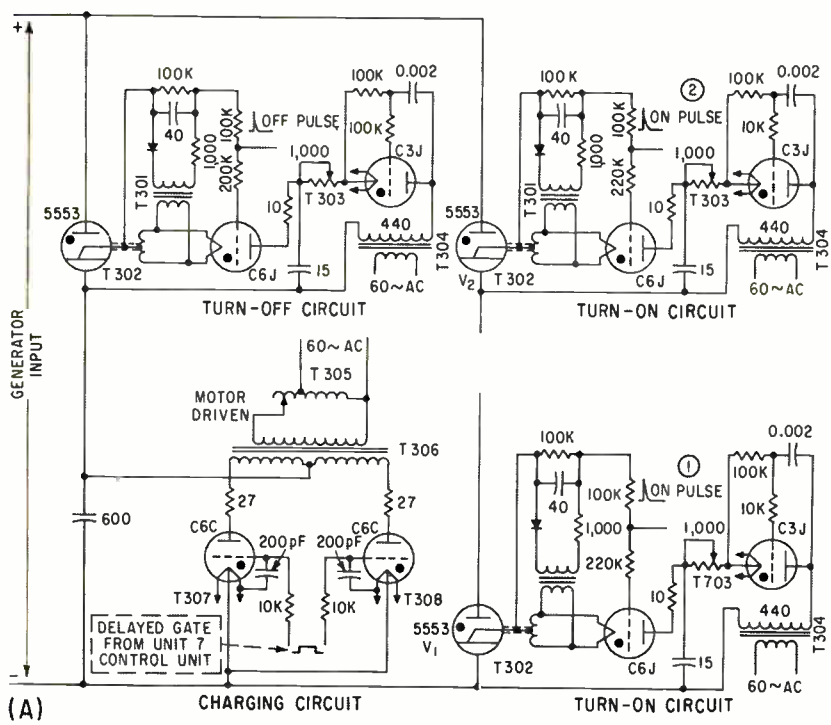


FIG. 4—Control equipment uses five pairs of load-control ignitrons to pulse sections of the electrode array in a sequence to steer the fish



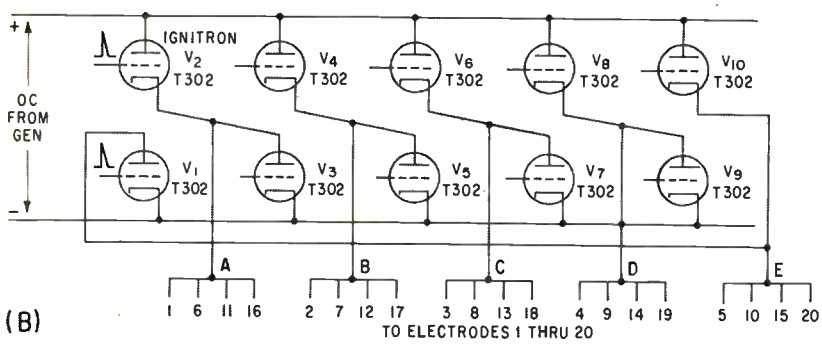


FIG. 5—Single turnoff ignitron terminates the pulse period of whichever load ignitrons are conducting (A). One arrangement of connecting the five pairs of load thyratrons to 20 immersed electrodes to give pulse sweeping effect as the ignitrons are sequentially triggered (B)

they do not fire while the commutating ignitron is conducting.

The five pairs of on or load ignitrons can be interconnected by jumpers in any desired fashion and fired in any sequence or combination. Three of the eleven ignitor firing circuits are shown in detail; all eleven are identical. Capacitor firing is used because of the d-c source and the range of frequency used. The C3J thyratron has a phase-advance network in the grid circuit which causes it to fire very early in the first positive half-cycle of plate voltage, eliminating the transients caused by irregular firing of diode rectifiers.

The polarity and sequential switching circuits use plug-in units, including cathode followers, inverters, gates, multivibrators and pulse amplifiers. These may be interconnected in various ways to produce different firing sequences; for example, the simplest produces a simple sequence firing in which one pair of ignitrons is fired at a time as shown in Fig. 5B.

Four years of operation of this type of equipment has produced highly encouraging results, as an overall diverting effectiveness of at least 90 percent is indicated. It is hoped that within a few years a simple, practical system of fish control and diversion, utilizing electrical techniques, may be developed, which will make a significant contribution to the management of the salmon fishery.

The author wishes to acknowledge the valuable cooperation given by the Idaho Power Company at Brownlee Dam and by the Puget Sound Power and Light Company at Lake Tapps. Charles C. Gillespie is responsible for the mechanical and much of the electrical design of the Lake Tapps equipment, including the automatic overload protection and standby changeover.

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(1) H. William Newman, Effect of field polarity in guiding salmon fingerling by electricity. U. S. Fish and Wildlife Service, Special Scientific Report-Fisheries 319. 15 p, 1959.

(2) Howard L. Raymond, Effect of pulse frequency and duration in guiding salmon fingerlings by electricty. U. S. Fish and Wildlife Service, Research Report 43 19 p, U. S. Govt. Printing Office, Washington, D. C., 1956.

(3) Herbert J. Reich, Theory and application of electron tubes. 2nd ed. McGraw-Hill, N. Y., 1944.

(4) Parker S. Trefethen, Exploratory experiments in guiding salmon fingerlings by a narrow d.c. electric field. U. S. Fish and Wildlife Service, Special Scientific Report-Fisheries No. 158. 42 p, 1953.

Kodak reports on:

speed trials at the raster . . . f/1 lenses for 2μ to 14μ . . . a paper trick for instrument designers

Honest physical labor

It is possible to earn a living as a physicist without dealing in deep questions. With so many occasions arising today where a c-r tube image is to be transformed into a photographic image, the ranking of film speeds for this purpose is useful work, and it makes the time pass pleasantly between breakfast and supper. Here is what we found:

RELATIVE SPEED

to a 525-line raster, two interlaced fields lasting 1/30 sec over-all, measured at a net density of unity (Transit time of the electron beam past a given point of the phosphor = 5 x 10^{-8} sec)

***Normal Development:* 4 minutes in KODAK Developer D-19 at 68 F.**

Phosphor	P11	P4	P15	P16	P24
FILM					
Kodak Photoflure, Blue Sensitive	2400	180	60	200	83
Kodak Cineflure Kodak Photoflure, Green Sensitive Kodak Linagraph Ortho	1800	500	250	130	240
Kodak Royal Ortho (sheet)	1000	250	130	80	130
Kodak Linagraph Pan Kodak Tri-X Negative	900	320	120	82	120
Kodak Linagraph Shellburst	500	180	60	48	73
Eastman High Speed Positive	360	51	25	45	28
Kodak Royal-X Pan Recording	320	150	65	23	47
Eastman Fine Grain Sound Recording	123	17	5.2	41	4
Eastman Television Recording	*100	11	5.2	7.5	5.2
Eastman Fine Grain Release Positive	35	4	2	6	2
Kodalith Ortho, Type 3	32	5	8	5	8
Kodak High Contrast Copy	20	12	6	4	5

*Arbitrary basis of scale.

Surprised?

Just to show that there is a little more to this than you might think, we invite attention to what happens to the figures when the same developer acts for 15 minutes:

Phosphor	P11	P16	P24
FILM			
Kodak Royal-X Pan Recording	6300	600	1200
Kodak Photoflure, Blue Sensitive	5400	500	220
Kodak Cineflure Kodak Linagraph Ortho	4100	250	360
Kodak Royal Ortho (sheet)	3900	220	400
Kodak Tri-X Negative Kodak Linagraph Pan	2600	200	370
Kodak Linagraph Shellburst	2400	190	260
Eastman High Speed Positive	630	82	25
Eastman Television Recording	250	19	14

You are not supposed to get excited and order a carload of film on the basis of these figures. First you are supposed to write for the pamphlet "P-37" to Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y. There is more to picking a film than just speed. Don't ever forget that.

A sharp eye for infrared

KODAK IRTRAN-2 Lenses transmit usefully from 2μ to 14μ. Two focal lengths, 2-inch and 3-inch, are offered off the shelf. At *f*/1, we seem to have done well at providing high collecting-power for energy without undue sacrifice of sharpness. Sharpness was the goal. For both lenses, the minimum circle of confusion *computes* at less than .001" for any wavelength from 4.25μ to 10μ. The italics mark where we hurt.

Much care and a valuable ingenuity have been exercised in impressing our tenth-degree equation upon the concave side of these meniscus lenses, in

The concave side is trickier.

grinding and polishing the spherical convex side, in placing the center of the spherical curvature on the axis of the asphere, in maintaining the center thicknesses at the 9.1 and 10.4mm values respectively that the calculations assume, in the optical homogeneity of the IRTRAN-2 material. More than this we cannot claim. To the extent that the care and ingenuity have succeeded in making the calculations represent the actuality, the circle of confusion is less than .001". The customer's willingness to take a chance that we have hit it will, in good sense, depend on how badly his project needs a 2μ-14μ infrared image of high definition and high aperture.

To demonstrate experimentally at those wavelengths that the circle of confusion is indeed that small is a task which we have simply been too busy to complete up to the time these words were written.

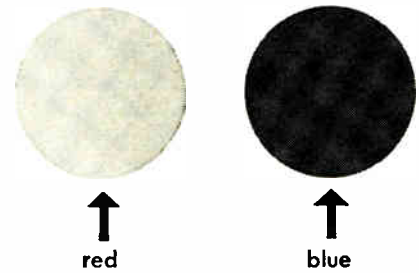
In the lead sulfide region, the sharpness does not compute to be as good as farther out in the infrared. Yet we have customers who use the lenses there and are happy with confusion-circle minima as large as .008".

In comparison with reflective optics hitherto used, IRTRAN-2 aspheres offer compactness and a wider field that doesn't even show any appreciable deterioration as far as 2° off axis. You do give up the perfect achromatism of reflective optics. In the 2-inch lens the minimum circle of confusion for 10μ radiation is located 2mm beyond the minimum circle of confusion for 4.25μ radiation; in the 3-inch lens the separation is 3mm.

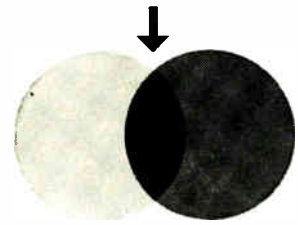
We have said enough to establish our frankness and to indicate whether there is any need for you to burden the long lines to Rochester, N. Y., Area Code 716, LOcust 2-6000, Extension 5166, which is one way to reach Eastman Kodak Company, Special Products Division. Bear in mind that IRTRAN-2 *material has a hardness of 354 Knoop, is not at all brittle, withstands thermal shock and the solvent action of water, and can get very hot without losing transparency or giving off toxic fumes.*

Overlap in black

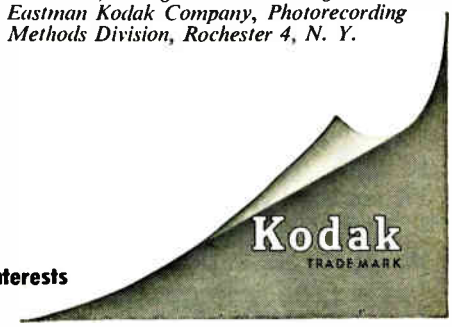
What would you say to a photographic paper that comes out red or blue, depending on the color of the exposing light



and black where they overlap?



If you would like to buy some for experimentation, we might be able to oblige. Write Eastman Kodak Company, Photorecording Methods Division, Rochester 4, N. Y.



This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Measurement Units Used With Lasers

Use this nomograph to determine relationships between units that express the characteristics of lasers and other optical and infrared devices. Among these units are angstroms, electron volts, teracycles per second, and wave numbers

By BRUNO F. LUDOVICI, Scientist, Hoffman Electronics Corp. Science Center, Hoffman Drive, Santa Barbara, Cal.

RAPID DEVELOPMENT of lasers has created a literature that must be read by engineers and physicists who want to keep up with the exploding laser technology. Readers who are rusty in their quantum physics and optics can find the going difficult. Unfamiliarity with the physical-unit systems that are used in laser literature is one of the impediments to quick understanding. The nomograph in this article makes such reading easier by showing the relationships between physical units and making it easy to estimate the approximate bandwidth of a laser spectral line.

The lightly-drawn lines connected to the line running diagonally through the chart indicate the most important laser materials and host crystals. The five lines of the Ne-He gas laser denote five output lines of this laser.

The ordinates show radiation wavelength in microns μ, angstroms (A) and meters. The abscissae show frequency (in cps and teracycles per second) and the corresponding wave number (in cm^{-1}) and the corresponding energy (in Joules and electron volts (ev)) of the radiation. (Many engineers prefer to work with Joules and meters.)

Physicists often use cm^{-1}, which is the number of wavelengths in a cm.

Energy-level diagrams, which appear frequently in the literature, often indicate energy in electron volts. Note that hf, the product of Planck's constant (h) and the radiation frequency, equals energy, which may be expressed in terms of Joules or electron volts.

The vertical and horizontal inset scales indicate the bandwidth, in cps and angstroms, respectively, of a laser spectral line. For example, the intersection of the horizontal broken line with the vertical inset shows that a ruby laser, whose output line is centered at about 6,943 A, has a $df/d\lambda$ of about 6.2×10^{10} cps/A. This means that a change of the ruby-laser's output wavelength of an angstrom is equivalent to a frequency shift of 6.2×10^{10} cps. A recent paper[1] gave the wavelength change resulting from temperature change of a ruby laser as 0.065 A/deg C. Since $0.065 \times 6.2 \times 10^{10} = 4.02 \times 10^{9}$, the thermal frequency shift of the ruby laser is 4.02×10^{9} cps/deg. C, or about 4 Gc/deg C.

The vertical broken line indicates that the energy of ruby radiation is about 1.8 electron volts, or 2.9×10^{-19} joules. This energy corresponds to 14,400 cm^{-1}.

Maiman's original paper gave an energy-level diagram for ruby that showed two radiation wavelengths emanating from two closely spaced energy levels.[2, 3] The ordinate of this diagram was in cm^{-1}; the separation of these energy levels was described as being 29 cm^{-1}. The nomograph shows that at 14,400 cm^{-1}, 1 cm^{-1} corresponds to a wavelength shift of 0.48 A; hence, 28 cm^{-1} corresponds to approximately 14 angstroms.

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(2) T. H. Maiman, Stimulated Optical Radiation in Ruby, *Nature*, 187, p 493, Aug. 6, 1960.

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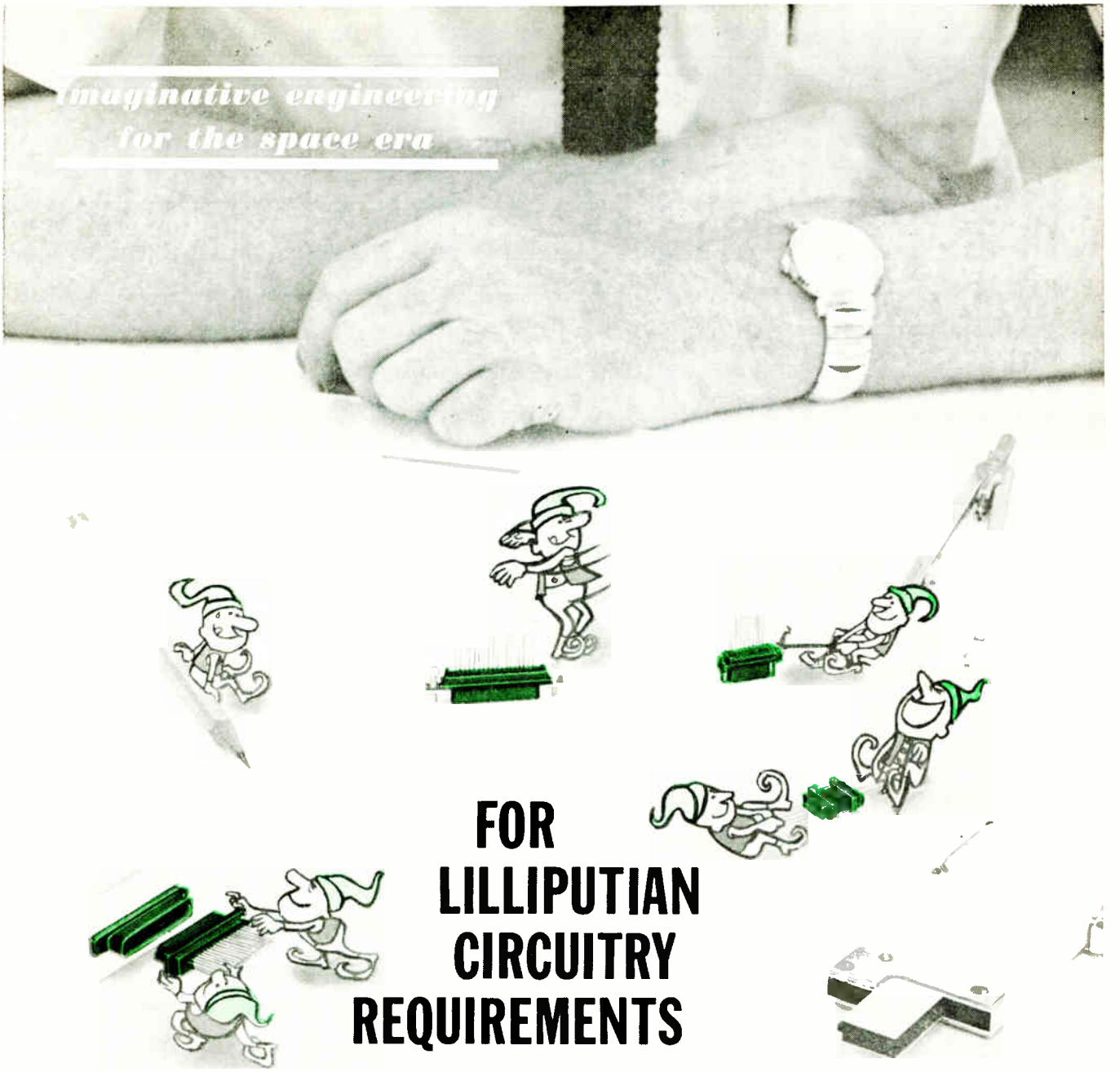
(Continued on p 56)



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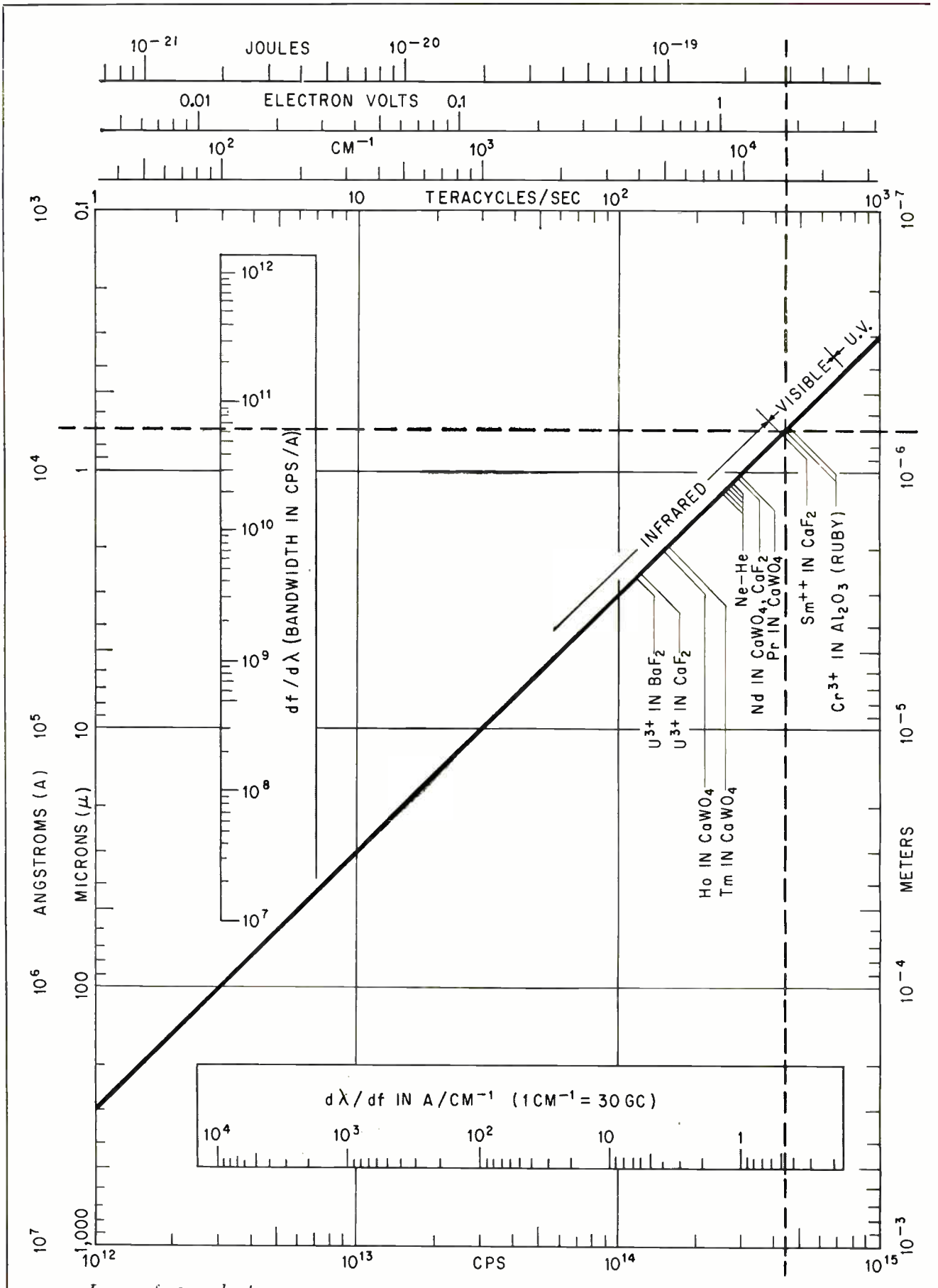
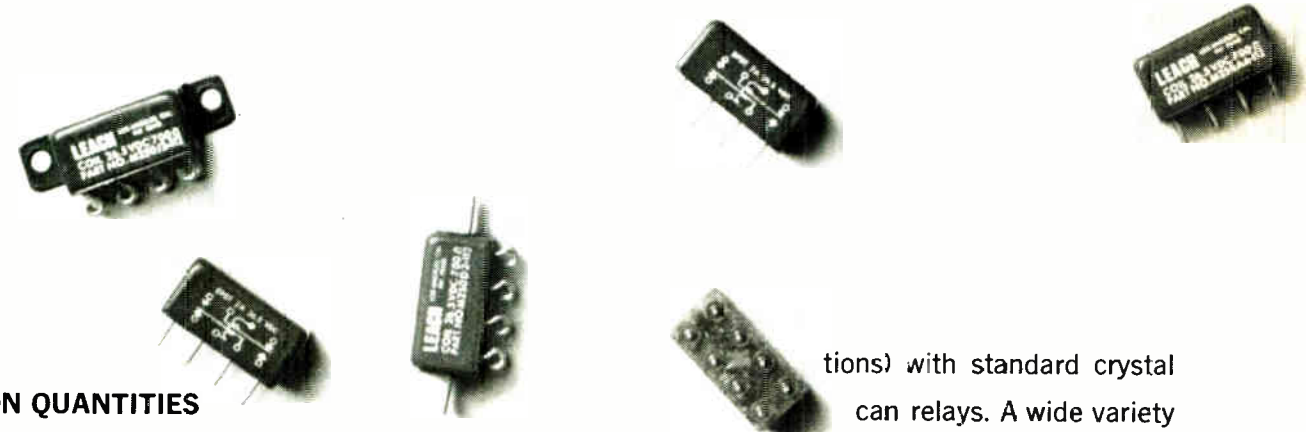


Laser reference chart

NEW LEACH HALF-SIZE CRYSTAL CAN RELAY



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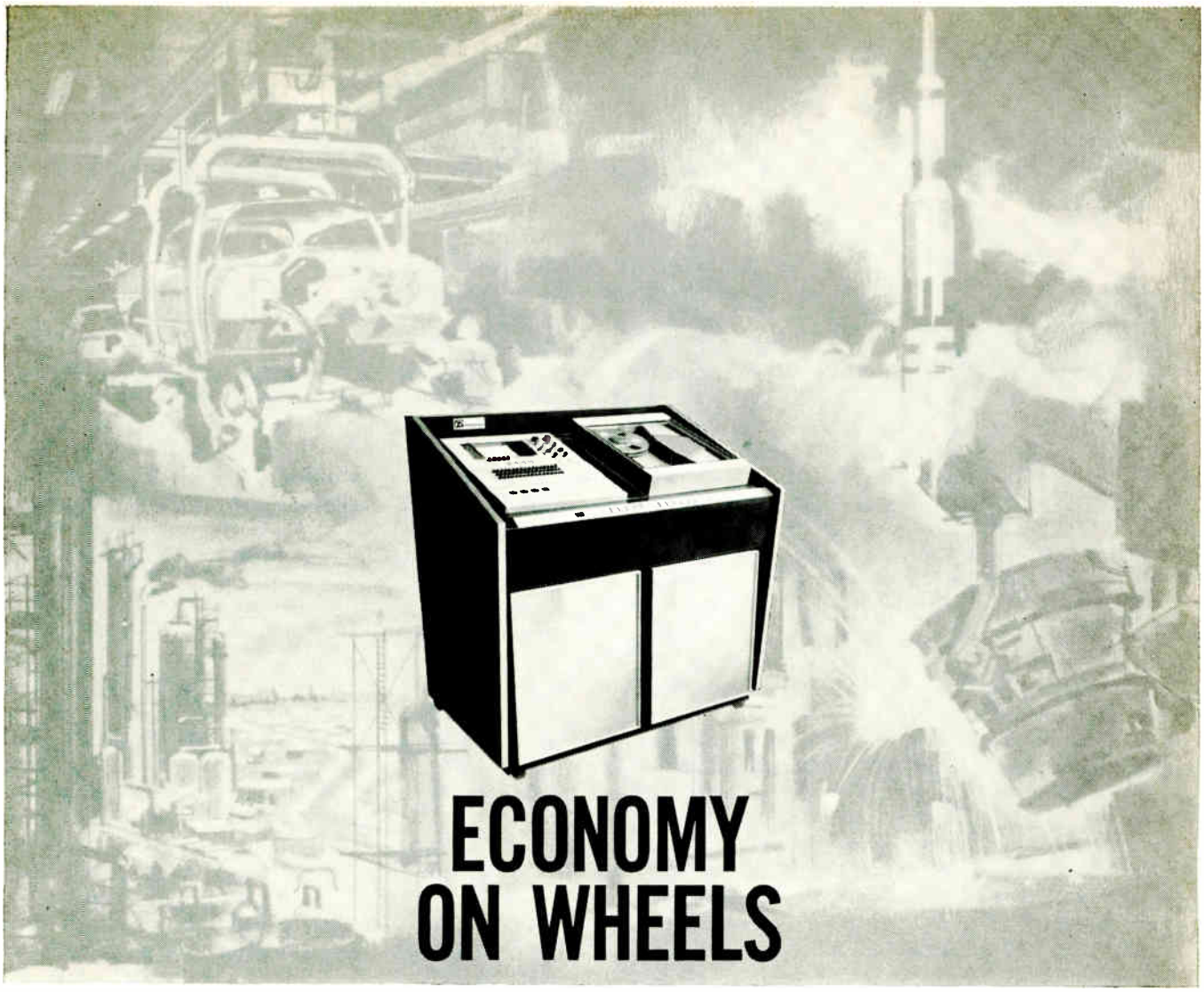

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Selecting data from low-level analog pick-offs and putting them into the *right* format for entry into a digital computer is frequently the most costly step in a performance evaluation program. RADATAC (Radiation's Data Acquisition Cart) permits you to take this step directly and rapidly—eliminating much expensive data processing equipment and appreciably reducing computer time.

RADATAC combines Radiation's Radicon analog/digital converter, Radiplex low-level electronic commutator, and an Ampex tape recorder (with the necessary logic circuitry and power supplies) into a single mobile unit. The system handles up to 47 low-level analog inputs from resistive or thermocouple sources (as low as ± 5 mv full scale) with a resolution of ± 10 μv. After digital conversion, the information is recorded in computer format on magnetic tape. Data formats are available which are directly compatible with most large and medium scale digital computers.

For more complete data on RADATAC, write to Dept. EL-42R, Radiation Incorporated, Melbourne, Florida.

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Marine Tv-Radar Identifies Boat of User

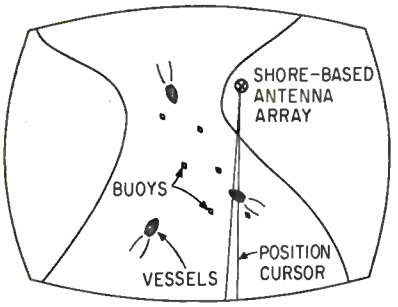


FIG. 1—Converted PPI is constantly visible on tv receiver while intermittent line identifies blip of user vessel

ALL-WEATHER marine navigation aid could be provided in harbors and along shore lines at low cost. Basic equipment needed by voluntary participants is a standard tv receiver. The blip representing the user vessel would be distinguished from other traffic in a radar image transmitted from a shore-based tv transmitter.

The radar-tv position indicator was described in a paper by A. Roberts, General Precision, Inc., at the 1962 IRE Show. The scan-converted PPI image would be available simultaneously to all vessels in the area. Position of a user vessel would be established without two-way communications with the shore-based station.

Tv receivers have a significant advantage in original and maintenance costs over radar and are considerably easier to operate. The display could be observed in daylight and could be of a quality available only in expensive high-resolution radars.

The PPI display in Fig. 1 is transmitted by an omnidirectional antenna and is continuously visible on the tv receiver. Another signal from a highly directional antenna is continually swept in azimuth. When it is directed toward a particular vessel, a line-of-sight cursor is superposed on the display. The line originates at the shore station and intersects the blip representing the vessel. When not directed toward the vessel, the cursor disappears from the display.

As the PPI radar in Fig. 2 scans the harbor, the radial scan is converted to a standard horizontal-scanning television sweep. Standard tv synchronizing pulses control the scan converter and are mixed with the video signals. The composite signal is fed to an r-f modulator and transmitted by the omnidirectional antenna.

A white line painted on a black disk is rotated in front of a tv camera to generate the position line. The rotating display is slaved to a rotating directional antenna, and the same synchronizing circuits control the camera that control the scan converter. During each horizontal sweep of the tv camera, a video pulse is generated as the rotating white line passes. The pulses control a gate to which the r-f signal being fed to the omnidirectional antenna is fed. The resulting gated r-f is reversed in phase and fed to the directional antenna.

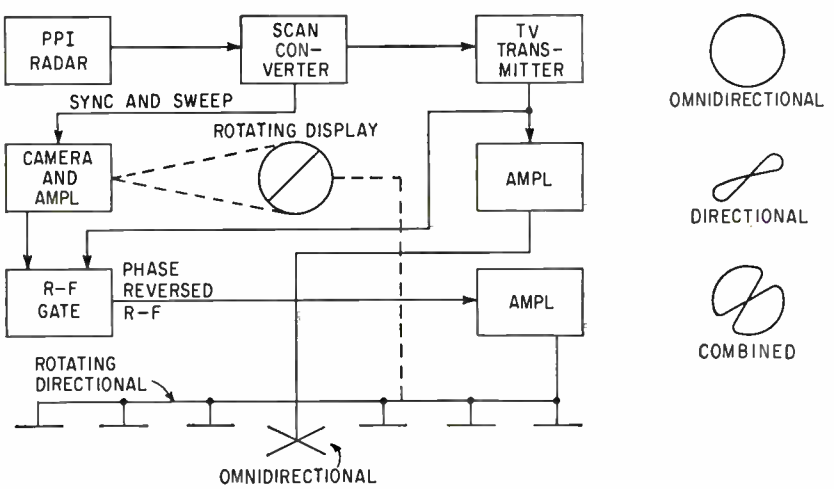


FIG. 2—When tv camera scans white line in rotating display, directional pattern is produced which is combined with omnidirectional pattern to produce combined output at lower right

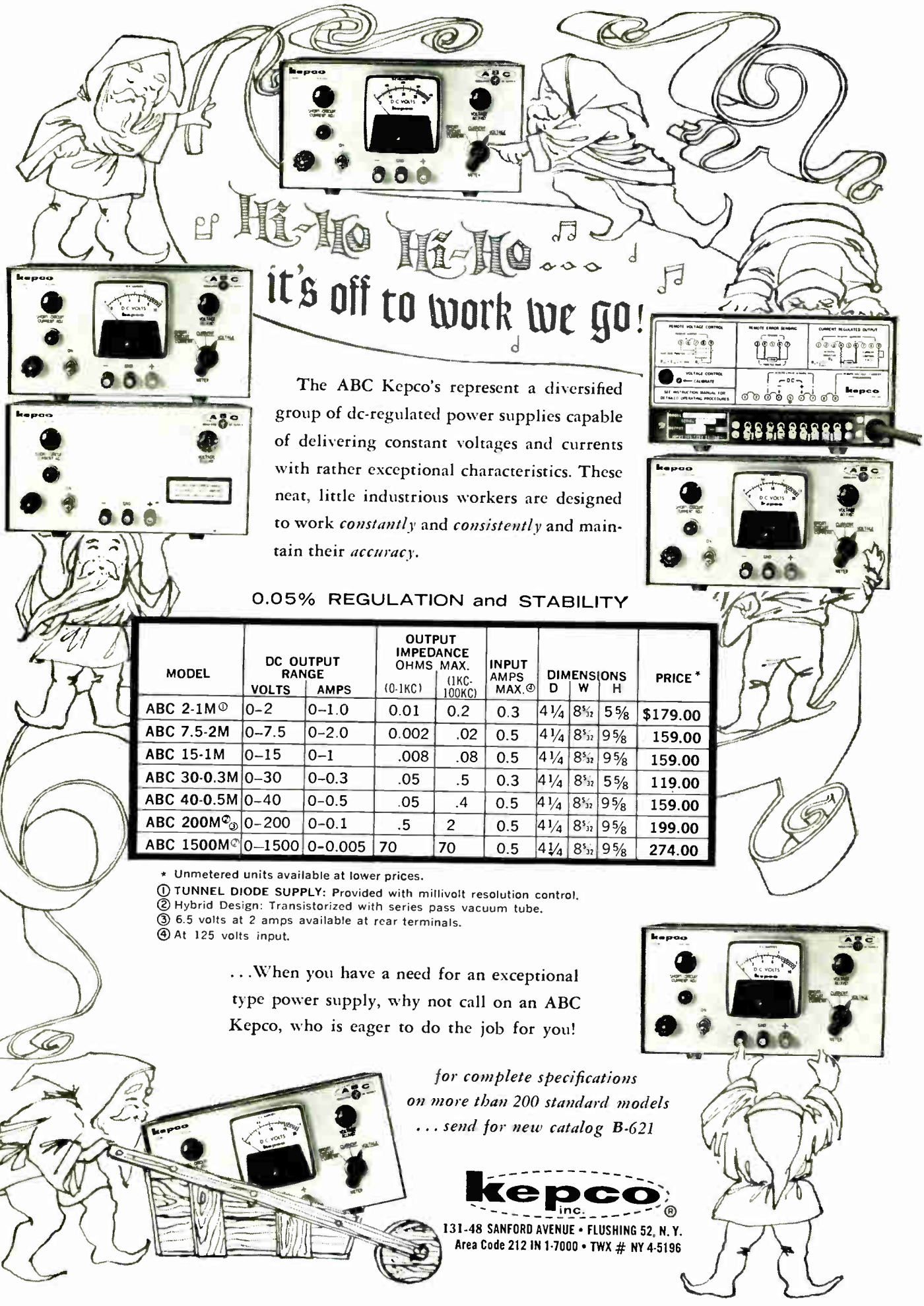
Antenna Configuration

In the antenna in Fig. 2, the omnidirectional section comprises two crossed dipoles forming a turnstile antenna. By exciting the dipoles in phase quadrature, a substantially circular radiation pattern is generated. A series of dipoles on each side of the turnstile are excited with equal currents in phase to form two narrow beams. Patterns are shown at the right of Fig. 2. Current fed to the directional section multiplied by the number of dipoles is equal to current fed to the omnidirectional section.

When the rotating white line is scanned, radiation from the directional antenna is near zero. Thus a white spot is produced on each horizontal sweep of receivers in the direction of the antenna. If the antenna rotates at 3 rpm, the two radiation nulls would cause the position line to cross the field of view 6 times per minute and appear on the screen every 10 seconds. For a 5-degree beamwidth, the line would last about $\frac{1}{3}$ second.

The effect of distortion in tv receivers could be offset by placing a rectangular grid overlay over the display at the shore station. A nonlinear receiver sweep would distort the grid, enabling the operator to better judge his position relative to surroundings by noting the distortion around the blip representing his vessel. In larger vessels, television receivers with precision sweep circuits would probably be used to assure more accurate positional information.

Among a number of possibilities



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ABC 7.5-2M	0–7.5	0–2.0	0.002	.02	0.5	4¼	8 5/32	9⅝	159.00
ABC 15-1M	0–15	0–1	.008	.08	0.5	4¼	8 5/32	9⅝	159.00
ABC 30-0.3M	0–30	0–0.3	.05	.5	0.3	4¼	8 5/32	5⅝	119.00
ABC 40-0.5M	0–40	0–0.5	.05	.4	0.5	4¼	8 5/32	9⅝	159.00
ABC 200M②③	0–200	0–0.1	.5	2	0.5	4¼	8 5/32	9⅝	199.00
ABC 1500M②	0–1500	0–0.005	70	70	0.5	4¼	8 5/32	9⅝	274.00

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for refinement of such a system is reduction of bandwidth if channel space is limited. With the basic system, it would be possible to monitor and record harbor conditions at the shore station. The PPI display could also be superimposed over a high-contrast chart of the particular area. Supplementary information such as weather data could also be added to the picture or transmitted over voice channel.

Test Speeds Computer Development

THE FRONT COVER. Discrete bits on thin-film stepping strip were made visible for microphotograph by Kerr optical effect

DEVELOPMENT TIME for a microminiature airborne computer is being reduced by the Kerr optical effect. This phenomenon is being used to make magnetic fields on a thin magnetic film shift register visible under a microscope. The computer is being developed by the Guidance and Control Systems division of Litton Systems.

Light from an arc source used to illuminate the memory surface of the shift register is first collimated and polarized. The polarized light interacting with the magnetic field produces a light-interference pattern that corresponds with the magnetic domain orientation. Bits appear as light and dark areas representing ones and zeroes. This visual representation provides a simple method for checking shift register performance. Magnetic fields crossing the 3-inch long shift register make 96 steps, all of which can be checked optically.

The laboratory arrangement eliminates much equipment that could only provide displays of input and output without actually monitoring performance individually of each of the 96 steps across the shift register. The technique is now only used in development of the computer but is also expected to prove useful for computer testing.

The computer is being developed under the Army-Navy Instrumentation Program for which Douglas Aircraft is prime contractor. Sponsoring agency is the Office of Naval Research. The microminiature computer is intended to perform at high speed in adverse military environments. Some of the design objectives are high reliability, high operating frequency, wide bandwidth and stability.

Tanker Pilots Get Help From Closed Circuit Tv

LONDON—Piloting of large tankers with the aid of closed circuit television is under investigation by Marconi International Marine Communications Company Ltd.

In conventionally designed tankers, as well as in other long bulk carrier vessels, bridges are located aft. Pilots often find that objects in the path of the ship are obscured by the bow.

To overcome the problem, television cameras were installed in the bows of some ships. Monitoring screens are located on the bridge.

Initial results have been sufficiently promising, according to a Marconi spokesman, to encourage further study.

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B	16	5-8	2	3 to 48	19	3½	14⅞
C	30	2	2	3 to 48	19	5¼	7⅛
		2	4	3 to 48	19	5¼	7⅛
		2	8	3 to 48	19	5¼	7⅛
		2	15	3 to 48	19	5¼	7⅛
		1	30	3 to 48	19	5¼	7⅛
D	35	4	2	3 to 48	19	5¼	11⅜
		4	4	3 to 48	19	5¼	11⅜
		4	8	3 to 48	19	5¼	11⅜
		2	15	3 to 48	19	5¼	11⅜
		1	30	3 to 48	19	5¼	11⅜
E	40	6	2	3 to 48	19	5¼	14⅞
		6	4	3 to 48	19	5¼	14⅞
		5	8	3 to 48	19	5¼	14⅞
		2	15	3 to 48	19	5¼	14⅞
		1	30	3 to 48	19	5¼	14⅞

* Any combination of watts per unit (up to maximum wattage) available on C, D, & E chassis at no extra charge.
**Depth behind panel.

OPTIONAL FEATURES AVAILABLE:
M1. Pilot light, switch, fuse.
M2. Pilot light, switch, fuse, voltmeter.
M3. Pilot light, switch, fuse, voltmeter, front panel pot adjust.

Here's real power supply flexibility. Design to your own requirements. Select up to eight different voltage outputs, or up to six different wattage-voltage combinations, in a single installation.

Sorensen's new QM Voltage Selector Series, with rack-mount features, offers scores of power combinations, each with the precise regulation and ripple characteristics of standard QM supplies. As many as eight different (or identical) QM supplies can be mounted on a single chassis (see table), with eight voltage outputs preset. The use of standard QM models assures prompt delivery at low prices.

Standard QM Voltage Selectors are shipped without panel controls (each unit is individually adjustable on chassis through pot adjust hole). See table for optional features.

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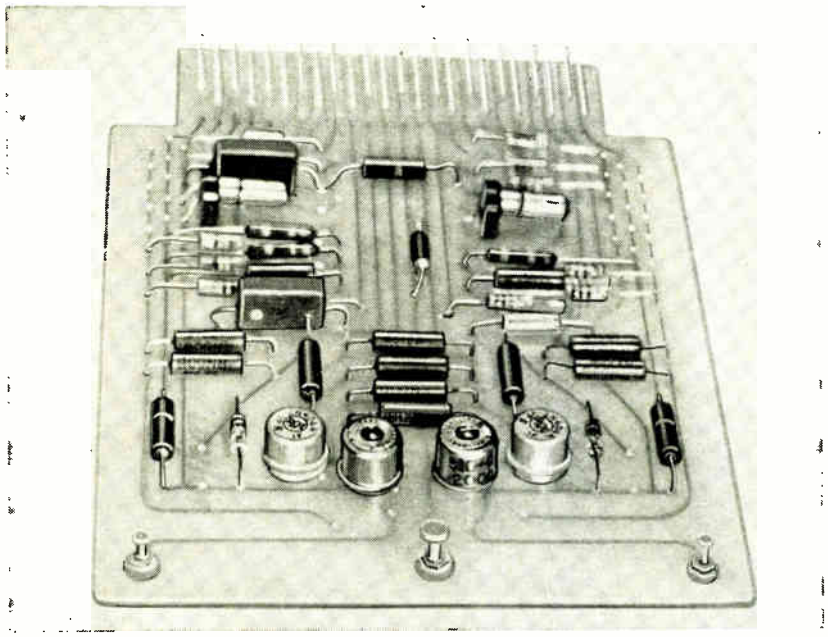
Recent Advances in Trimmer Pots



Single turn potentiometers, here seen mounted on printed circuit board, embody features for critical applications requiring total hermetic sealing, high power dissipation, and automatic assembly. In addition to wire-wound resistance element, units are available in evaporated metal film and carbon-film types

By G. V. GERBER,
Director of Component Development Engineering, Potentiometer Division, Daystrom, Inc., Archbald, Pa.

THE SOLID STATE era has established the trend toward smaller components, and the need for higher reliability and minimum service time has given birth to a number of different component packaging techniques. Precision adjustable trimming potentiometers have kept pace with this trend, and potentiometers packing more performance into smaller and smaller packages.

In addition to size, the use of encapsulated assemblies, welded packages, and automatic assembly of components onto printed circuit boards adds other critical parameters that must be satisfied by the new generation of trimmer potentiometers now coming off designers' drawing boards.

A transistor-size trimmer, called Transitrim is a single-turn precision adjustable potentiometer packaged a T05 case.

This single-turn unit embodies a number of features designed to fit critical applications requiring total hermetic sealing, high power dissipation, and automatic assembly onto printed circuit boards.

Three Models

In designing the trimmer parts, component development engineers recognized that certain applications also require the resolution and extended resistance ranges not available in wire-wound potentiometers. Accordingly, three potentiometer types accommodate several different type resistance elements within the same transistor-size housing:

A wire-wound unit—with resistance values from 10 ohms to 30 kilohms; an evaporated metal film unit—with resistance values from 100 ohms to 50 kilohms; and a carbon film model—with resistance values from 200 ohms to 100 kilohms.

Volume of the new design, is only 0.0256 cubic inches. The JEDEC T05 configuration was chosen for the package because of its broad acceptance in the transistor field. Many potentiometer users have inspection equipment designed to accommodate the T05 size, while certain users automatically assemble transistors to printed circuit boards. One major computer manufacturer employed an unusual assembly operation whereby all components, with the sole exception of trimmer potentiometers, could be assembled onto printed circuit boards automatically. The trimmer potentiometers were the only manually assembled component.

The T05 configuration was a logical choice for potentiometers specifically designed to solve this problem. Consideration was also given to packaging a number of potentiometers in "cartridges" in magazines to facilitate their feed into the automatic printed circuit assembly machines.

Although a number of applications still exist that do not require sealing, and still more that require only resistance to humidity, certain applications require sealed potentiometers.

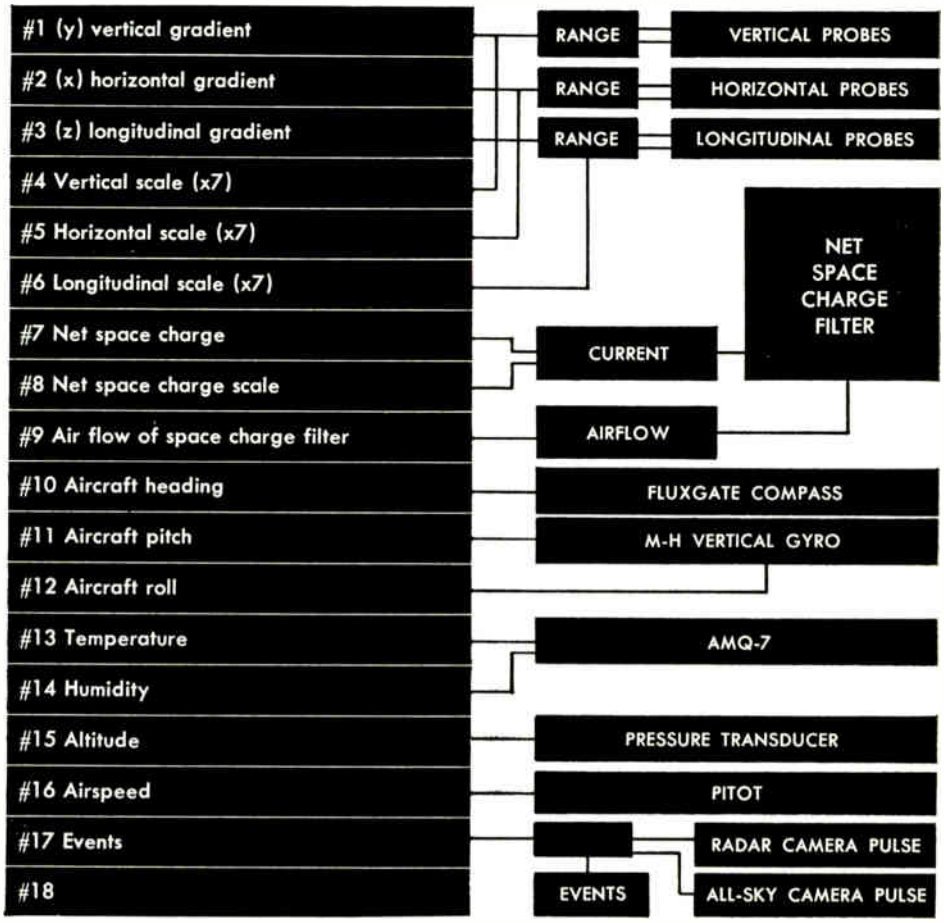
Encapsulation Process

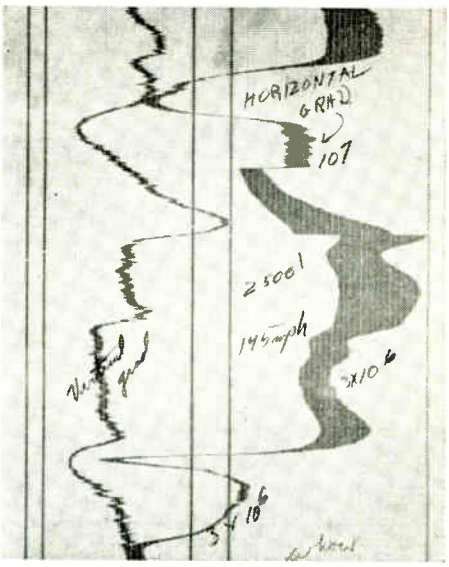
In vacuum encapsulation, an epoxy sealant is drawn into a mold by completely evacuating the mold prior to injection of the potting compound. The advantage of this type of encapsulation is that the encapsulant fills all cracks and small asperities, leaving no air bubbles or voids. If the potentiometer is not hermetically sealed, the encapsulant will be sucked into the potentiometer, rendering it useless as a variable resistor.

Other applications demanding complete hermeticity are those in which the potentiometer is required to go through final cleaning operations following soldering. In this case, there is always the possibility of solvent seeping into the potentiometer. This is a particularly difficult problem to overcome, especially when materials with extremely high solvency, such as trichlorethylene, are used. Finding

Which comes first... the lightning or the rain?

The Visicorder Oscillograph directly records electrical charges in the atmosphere. ☐ What effect do electrical charges on the atmosphere have on cloud formation? What causes cloud droplets to grow into raindrops? Why does one cloud produce rain while another does not? ☐ These questions are being answered in part by a Model 1108 Honeywell Visicorder Oscillograph, shock mounted in a C45 Beechcraft, flown at 15,000 feet over cloud formations above an electrically-charged airspace in Central Illinois. ☐ The Illinois State Water Survey has scattered a network of 50 rain gages across about 400 square miles downwind from 30 miles of small stainless steel wire stretched in a grid-like pattern 30 ft. above the ground. Seven power supplies energize the wire to about 20,000 volts with each supply having an output of 1 to 3 milliamperes. ☐ Time-lapse sky cameras, radar, and other observatory equipment make records of electrical fields, wind speed and direction. A low-flying Piper traces the plume of electrical charge as it rises from the ground; the Visicorder at 15,000 feet measures the movement of the charge in the higher air, how and where it scatters or dissipates, and what effect it has on the growth of cloud droplets. ☐ Maybe your research project is not as glamorous as these weather studies, but if it is at all complex, or requires high speeds or sensitivities, or if you need to record many parameters simultaneously—or directly—the amazingly versatile Visicorder can do your job. ☐ The schematic diagram of these cloud studies will give you an idea of the many capacities of the Visicorder. *For more details about the Model 1108 (24 channels) and other Honeywell Visicorders, write Minneapolis-Honeywell, Heiland Division, 4800 E. Dry Creek Road, Denver 10, Colorado. Our DDD phone number is 303-794-4311.*





Honeywell

First in Control

a sealant material that will withstand exposure to all solvents used today is an acute problem.

Trimmers are used in dry circuits where power rating is of little consequence. Where power is an important consideration, however, use of a metal and glass envelope to enclose the pot provides a highly conductive heat path and lends itself to excellent power dissipation.

Standard trimmer pots are capable of 1 to 1½ watts dissipation. Radiators are also available to provide a 25 percent increase in heat dissipation, wherever the application may require.

Special Seal Header

An especially designed compression seal header carries an integral pivot in the center of the header which supports the wiper. One lead is connected to this pivot by welding. The weld joint is completely encased in the glass. The two element leads are bent in the glass and travel through the glass, emerging from the inner face of the header to provide the lead attachment adjacent to the element terminations, thereby minimizing end resistance.

Thus, element terminations from the wire-wound units can be made directly to the leads either by welding or soldering. The hop-offs from the film type potentiometer elements are designed to terminate in holes that accept the leads. By cementing the leads to the hop-offs with conductive epoxy, the circuit is completed with a minimum of end resistance. All three leads protrude from the external face of the header to provide the standard 0.2 inch lead circle pin configuration.

The header and the element form one sub-assembly. The other subassembly is composed of the actuating screw, wiper, pressure plate, "O" ring, and wiper support assembled in the shell. An interference fit exists between the high-temperature plastic wiper support and the shell, so that once assembled, this sub-assembly can be transported in bulk. The two subassemblies meet at the final assembly operation, and the shell is welded to the header. The welding can be accomplished in an inert atmosphere, and the total hermeticity of the enclosure method will maintain the inert atmosphere throughout the life of the device.

Stable performance of the potentiometer under conditions of shock, vibration, and acceleration has been verified by environmental testing. This performance is maintained by keeping down the bulk of moving parts.

The lead screw to wiper sub-assembly has a locating flange on the wiper support providing a constant drag against the shell and maintaining setability throughout shock and vibration.

A variety of lead screw configurations can be supplied. While the standard model employs a conventional screw driver slot, an allen head or other head configurations can be accommodated just as easily in the design. In addition, a thumbscrew can be fitted to the lead screw following assembly, making the Transitrim potentiometer a thumb-screw-operated device.

For applications requiring location of the potentiometer inside a systems module, a wrench has been designed that will reach into the module, enabling adjustments to be made from the outside with a turns ratio of 45 to 1.

Good resolution is maintained by use of a technique for winding resistive wire elements. The net result of this special technique is to secure the resistance wire snug in its groove even under severe shock and vibration. A high level of resolution is thus maintained by the "locked in" even spacing of wires.

Potentiometer noise has also been controlled. Because of the type of enclosure used and the high level of hermeticity, no protective lubricant is required for the control of wiper noise. A special alloy resistance wire provides the potentiometer with noise-free performance in all resistance values. This feature is particularly important in those applications requiring occasional field adjustment of the potentiometer.

Total mass of all potentiometer parts is 1.5 grams. Variations of basic designs are available to accommodate all applications. For example, a panel mount bushing can be welded to the top of the can prior to final assembly, making the trimmer a panel-mount version.

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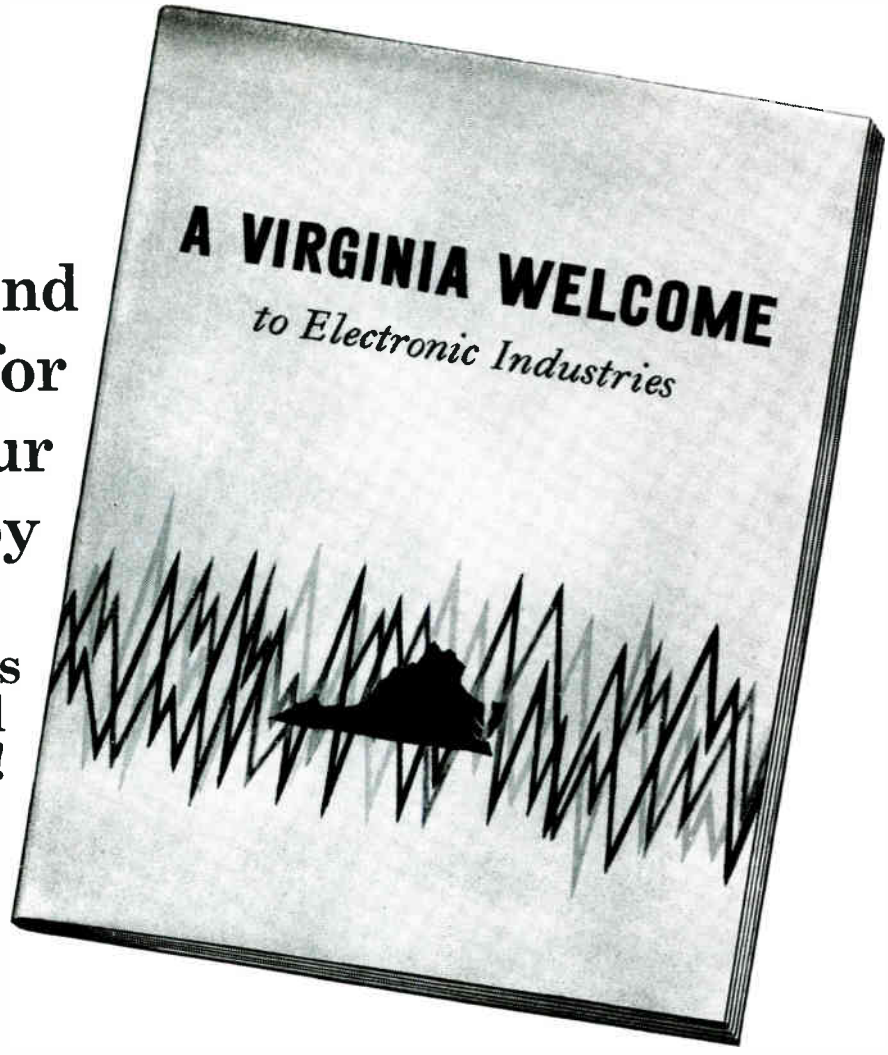

52 electronic companies have located in Virginia during the past 10 years. This new 30-page report gives facts about the experience of many of these companies, and presents maps, charts, statistical tables and short text on topics such as the following:

A directory of the electronic companies in Virginia.

The population and geographic characteristics of Virginia that provide such a wide range of site choices for electronic companies.

The federal military, space and other technical operations in the Washington, D. C. area, the Hampton Roads region and other areas that are in the forefront of the government's electronic programs.

The delivery time by truck from Virginia localities to major electronic markets, the air facilities available at Virginia communities, other transportation data.

Estimates of the number of persons available for new jobs annually and wage rates prevailing in the electronic industries.

Virginia's program of trade and technical courses in electronics.

Engineering graduates of Virginia colleges and universities, present college courses available for company personnel, faculty and equipment at these institutions for company research.

Record of labor-management harmony — salient features of Virginia's favorable government climate.

Recreational facilities in the State.

Whether or not you are immediately planning a new plant, you should have this book in your files. For your copy, write on company letterhead.

C. M. Nicholson, Jr., Commissioner
Division of Industrial Development and Planning

VIRGINIA DEPT. OF CONSERVATION AND ECONOMIC DEVELOPMENT

Room 803-EL, State Office Bldg., Richmond 19, Va.
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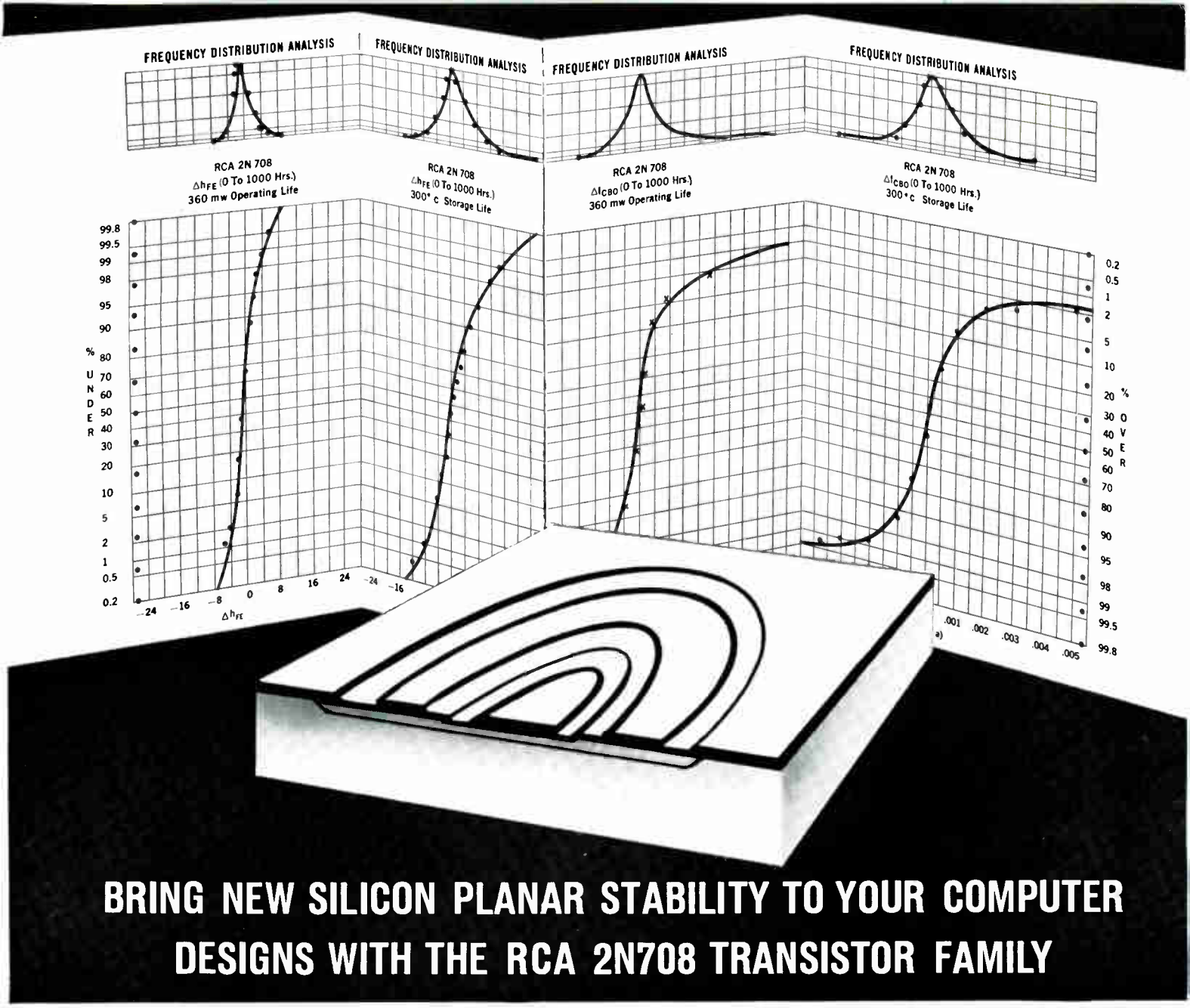

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RCA SILICON DIFFUSED-JUNCTION PLANAR TRANSISTORS

In addition to the popular 2N708 family, here is a lineup of the many other high-speed silicon planar transistors now available from RCA, incorporating all the advantages of surface protection inherent in planar technology:

RCA 2N696...Specially designed and processed to assure stability of characteristics and reliable performance under conditions of severe thermal and mechanical stress. High switching speeds at high current makes RCA 2N696 especially suitable for core driving and other high current applications.

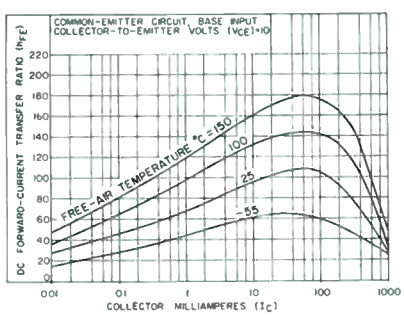
RCA 2N697...High Beta version of RCA 2N696.

RCA "Universal" 2N2102...First silicon n-p-n triple-diffused planar transistor specifically designed for widest possible application in military and industrial equipment. It features high switching speed, high pulsed beta (h_{FE}) at I_C = 1 amp, and controlled beta over 5 decades of I_C. It has high breakdown-voltage ratings, high dissipation ratings, low saturation voltages, and low output capacitance.

RCA 2N699...New triple-diffused-junction silicon n-p-n planar transistor especially useful for vhf and video applications. Triple-diffused-junction design makes possible lower saturation voltages, higher sustaining voltages and lower output capacitance.

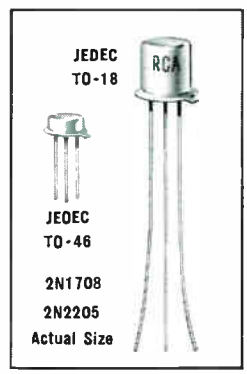
RCA 2N1613...Four-step beta control—specifically designed for wide application in military and industrial equipment. It features low noise and low leakage characteristics. Beta 40 min., BV_{CBO} 75 v min., I_{CBO} at 25°C equals 0.01 μa max.

RCA 2N2270...New economy version of the RCA "universal" triple-diffused silicon planar transistor for applications in military and industrial equipment. It features high breakdown voltages, low V_{CE} (Sat), low leakage characteristics, very low output capacitance. Minimum gain-bandwidth product = 60 Mc, in applications from dc to 20 Mc.



Typical DC-Forward-Current Transfer-Ratio Characteristics for Type 2N2270.

RCA SILICON PLANAR-EPITAXIAL TRANSISTORS



RCA combines two of today's most advanced technologies, planar construction and the epitaxial process, to bring you silicon transistors with excellent stability, high reliability, low saturation voltage and improved switching times.

RCA 2N1708...First silicon planar-epitaxial computer transistor in the TO-46 miniature package offers a V_{CE} (sat) of 0.22v max., Beta(h_{FE}) 20 min., t_s 25 nsec max., BV_{CBO} = 25v min., I_{CBO} = 0.025 μa max. It is especially designed for use in very-high-speed applications in military and industrial equipment requiring high reliability and high packaging densities. See chart for beta stability versus current and temperature.

RCA 2N2205...Electrically identical to the 2N1708, but in the JEDEC TO-18 package. Like the 2N1708, its epitaxial structure insures low collector saturation voltage at high collector current. Planar construction insures low collector cutoff current (I_{CBO}) and exceptional stability throughout life.

RCA 2N2206...High-beta version of RCA 2N1708 in the TO-46 package. Minimum beta 40, Short storage time, 35 nsec. max.

RCA PACKAGING...Whatever your packaging requirements, from transistors and multiple devices in standard JEDEC packages, to special configurations or RCA Minimodules and RCA Micromodules, RCA Semiconductor and Materials Division packaging specialists are ready to work with you to meet your design requirements.

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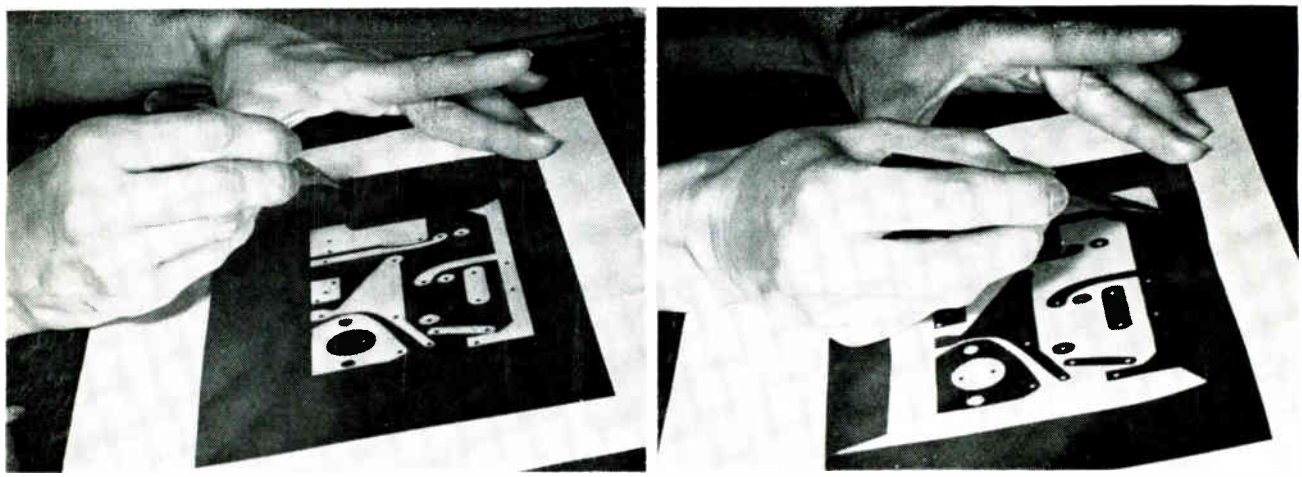
CIRCLE 69 ON READER SERVICE CARD

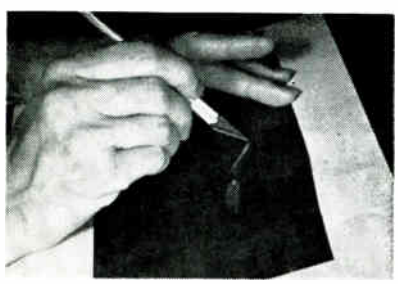


Film is being peeled to form a negative, left, and to form a positive, right. The circuit is the same in both photographs. Oversize drawings are not used in this process

PC Boards Without Photographic Reduction

By ROBERT R. THIBAULT,
Thibault Electronics, Brooklyn, N. Y.

STANDARD practice throughout the electronic industry in producing printed circuit boards is to make the circuit drawing four to five times the size of the finished board. The oversize drawing is then photographically reduced to the required size. This is good practice if there is to be a lot of printing on the finished board, such as part numbers etc.; in many cases, however, only the model number and the actual circuit are required. If production is to be by the photo-resist method, the negative is used; if the board is to be reproduced by the screen-resist method, a positive must be made of the negative.



Lines are traced with sharp knife that has a fine point. The circuit is not blacked in, as the drawing will be used to make both a positive and a negative

Many small shops and laboratories farm out their photo work because of the high cost of cameras and other equipment, or because of a lack of facilities for setting up a dark room. But sending photographic work outside the plant often results in a loss of time. A study of tolerances required of pc boards has shown that for better than 60 percent of the cases, sharpness of detail and not close tolerance is the factor that dictates the use of oversize drawings.

Several types of strippable red film on stabilized plastic backing are suitable for making pc boards without photographic reduction (For example, Ulano Rubylith, made by Ulano Graphic Arts Inc., Brooklyn, N. Y. and Cut 'N Strip, by Keufel and Esser Co., Hoboken, N. J.). The films will produce clean sharp lines, are transparent and at the same time ultraviolet safe.

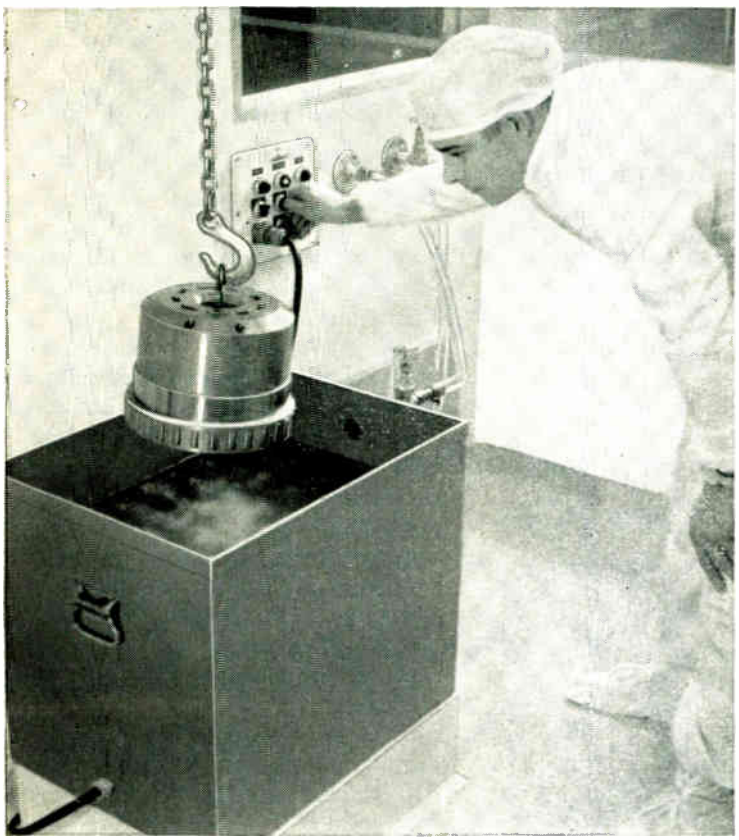
The following process for hand cutting positives and negatives is especially suitable for small shops, providing only that reasonable care is exercised.

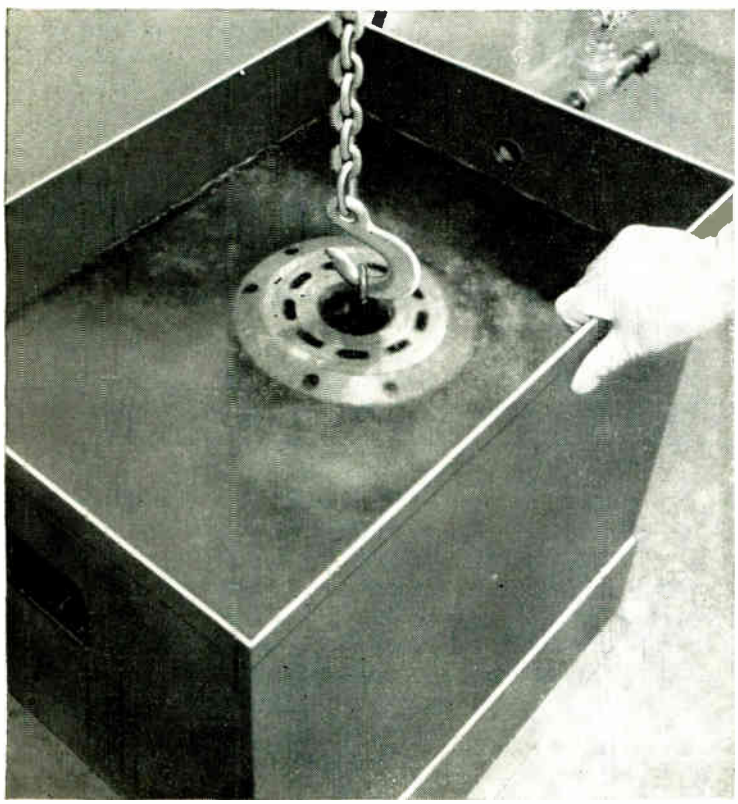
The circuit of the board is drawn to the size of the finished product and a sheet of the film is fastened over the completed drawing, with the film side up. The lines on the drawing are then traced with a razor sharp knife using enough pressure to cut through the film but not into the backing sheet. The knife must be sharp if sharp clean lines are to be obtained; a dull knife will result in ragged edges. The way the film is peeled depends on whether a negative or a positive is required. If a negative is needed, the film between the lines is removed by peeling. If a positive is required, the background is peeled away.

The problem of cutting the holes or making the dots that mark the holes on the lands and conductor lines for components can be solved by making punches from small tubing. As an example, the narrow portion of a brass ballpoint pen refill makes a convenient size punch; the large end can be used if a larger size hole is required. To make the punch, cut the tube just behind the ball, soak the tube in a solvent that will dissolve the ink, file the cut end of the tube square and then dress it on a fine stone. Both ends of the tube are then reamed with a watchmaker's cutting broach.

The holes or dots are made by pressing the punch into the film with enough pressure to go through the film but not cut into the backing sheet. As a time saver, the dots used to mark the holes on the lands

How Denison Precision-Cleans .0002" Tolerance Parts Weighing 180 Lbs.!





PROBLEM: Denison Engineering Div., American Brake Shoe Co., needed reliable precision-cleaning of metal hydraulic components for missile-ground-support equipment they manufacture. Clearances down to .0002 in. had to be maintained, yet cleaned. A familiar situation . . . except that these components weigh up to 180 lbs.!

SOLUTION: They constructed an ultra-modern new White Room using "Freon" fluorinated solvents. "Freon" is an excellent selective solvent, yet is non-flammable and of extremely low toxicity. So it's perfectly safe and practical to work with the relatively large amount of solvent needed for total immersion of these bulky components. Denison needs no hoods or blowers to vent the solvent!

In the photo, one of these hydraulic components, a 65-lb. pump-cylinder barrel is lowered into an ultrasonic bath of "Freon" solvent at Denison's new White Room. According to Denison, the "Freon" has so low a surface tension, it easily penetrates the tiny openings involved. There it washes away atmospheric or process contaminants such as dust, lint or chips, without harming critical metal surfaces.

Denison has found "Freon" dries quickly, leaves no residue on parts, gives better cavitation than previous solvents. And, most important, they can get 90% recovery of the solvent in a simply constructed still. Since using "Freon", they've never had a hydraulic component rejected for cleanliness!

• • •

We'll be glad to give you help in selecting "Freon" solvents for use in your own White Room. Just write on your letterhead to Du Pont, 2420E4 Nemours Bldg., Wilmington 98, Del.

FREON®

solvents

DU PONT

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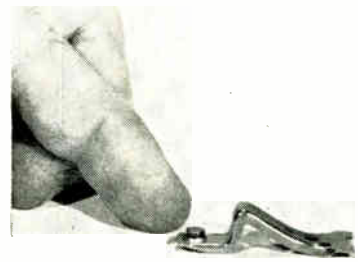
of a negative may be punched on another sheet of the material and put into place with a pair of tweezers; dots are added after the lines have been peeled.

If simple circuit changes have to be made after production has started, they can be made right on the original master film, without doing all the art work over again. For positive film, the changes are cut out on another sheet of material, then peeled from the plastic support and placed on the master film, where it will adhere if slight pressure is applied. For the negative film, the area to be blocked out is filled with a piece of film from another sheet, the new changes cut and the required areas peeled.

Direct Tungsten-to-Steel Welds Cut Contact Costs



AN IMPROVED PROCESS for directly welding tungsten to steel that cuts costs and eliminates galvanic corrosion has been put into high-volume production by the Electrical Contacts and Specialties Div. Fansteel Metallurgical Corp.

The process is being used to make electrical contact assemblies for automotive voltage regulators, distributor and magnetic points, electronic vibrator power supplies, and similar applications where rapidly repeated circuit interruptions are present.

The patented process has cut assembly costs as much as 15 percent compared to other methods. The savings arise because the process eliminates preparation and assembly of brazing material that otherwise had to be inserted between the tungsten disk and the steel. Also, the process can be highly automated.

Prior attempts at direct tungsten-to-steel welding were hampered by contamination from copper welding electrodes and discolorations of the finished parts. These problems have been eliminated in the new technique.

A special tensile testing apparatus has also been developed to verify weld soundness.

Gas-Pressure Bonding Lowers Temperature

PERFECT METALLURGICAL bonds can be accomplished by gas-pressure-bonding, according to a study conducted by the Defense Metals Information Center.

The gas-pressure bonding process uses an inert gas such as helium or argon at high pressure and elevated temperature to fabricate metallic or ceramic materials. Used to produce bonds between similar and dissimilar metals, ceramics and cermet materials, the process can bond brittle materials or materials of widely differing properties. Metals suitable for bonding by the process include beryllium, aluminum, molybdenum, columbium and tungsten.

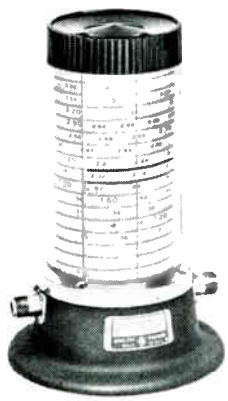
The report summarizes the present state of the art of the gas-pressure-bonding process with regard to both joining and consolidation. Applications of the process are also discussed.

Compaction of power to high density is an important application of the process and even refractory metals can be consolidated to near full density at 2,700. The low temperature allows extremely fine grain size as compared with normal sintered products. Many ceramic materials are also readily densified by this process at temperatures as low as 2,100 F.

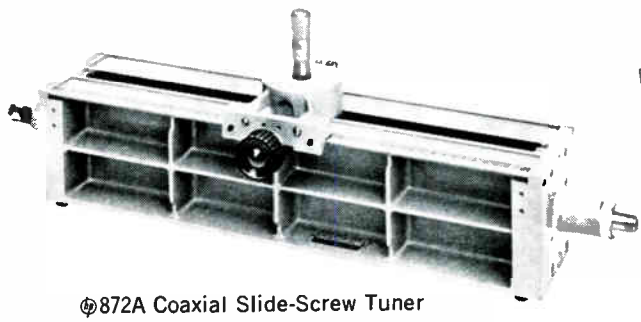
Important areas of application will be joining of super refractories, densification of powder preforms, fabrication of complex structural members from beryllium sheet, consolidation and fabrication of ultraceramic materials such as hafnium carbide, and application of impervious coatings to refractory metals.

A report of the study is now available from the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C.

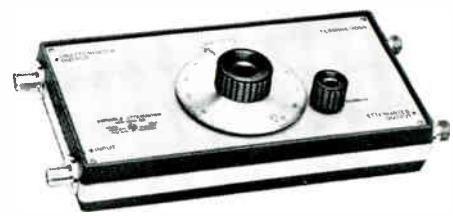
Here's new convenience, versatility in **1 to 4 GC** microwave measurement



536A Coaxial Frequency Meter



872A Coaxial Slide-Screw Tuner



393A/394A Variable Attenuators

906A Coaxial Load

760D/761D Dual Directional Couplers

Here are seven new hp coaxial instruments to simplify your microwave work and give you greater measuring flexibility in the important 1-to-4 GC frequency range. Look at the increased versatility of measurements possible with these instruments, each carrying the assurance of quality, versatility, dependability and value which make Hewlett-Packard's one of the world's most widely used lines of microwave instrumentation.

hp 393A/394A Variable Attenuators

Accurate attenuation in high power coaxial systems is provided by these direct-reading, multi-purpose instruments, the hp 393A, 0.5 to 1 GC, and hp 394A, 1 to 2 GC. They are variable attenuators, variable directional couplers and local oscillator mixers. The direct-reading feature eliminates the need for calibration curves, and the attenuators handle up to 200 watts average, depending on line terminations. Two hp 908A low-power coaxial loads (furnished) permit the instruments to attenuate at levels up to 0.5 watt average power.

Specifications

Frequency Range:	1 to 4 GC
Overall Accuracy:*	±0.14%
Q	>1500
Connectors:	Type N
Dimensions:	9⅛" high x 6" long x 6" deep. 13 pounds
Price:	hp 536A, $500.00

*Includes ±0.02% for 0-100% relative humidity and ±0.0016%/° C from 13-33° C.

hp 393A/394A Variable Attenuators

Accurate attenuation in high power coaxial systems are provided by these direct-reading, multi-purpose instruments, the hp 393A, 0.5 to 1 GC, and hp 394A, 1 to 2 GC. They are variable attenuators, variable directional couplers and local oscillator mixers. The direct-reading feature eliminates the need for calibration curves, and the attenuators handle up to 200 watts average, depending on line terminations. Two hp 908A low-power coaxial loads (furnished) permit the instruments to attenuate at levels up to 0.5 watt average power.

Specifications

Frequency Range:	hp 393A, 0.5 to 1 GC; hp 394A, 1 to 2 GC
Attenuation or Coupling:	hp 393A, 5 to 120 db, hp 394A, 6 to 120 db; both continuously variable
Absolute Accuracy:	Within ± 1 db or 1% of dial (hp 393A), ± 1.25 db or 2% of dial (hp 394A), whichever is greater. (With matched generator and load)
Nominal Impedance:	50 ohms
SWR:	< 2.5:1, 5 - 10 db attenuation; < 1.5:1, 10 - 30 db; < 1.2:1, 30 - 120 db (hp 393A); < 1.4:1, 30 - 120 db (hp 394A)
Directivity:	Greater than 15 db (hp 393A), or 10 db (hp 394A), 10 to 40 db attenuation with loads of less than 1.05:1 SWR
Maximum Voltage:	500 v peak
Connectors:	Type N
Dimensions:	5½" x 12" x 2¾"
Price:	hp 393A, $420.00; hp 394A, $420.00

hp 872A Coaxial Slide-Screw Tuner

With the hp 872A Coaxial Slide-Screw Tuner, insertion of the precision probe carriage into a specially developed slab line is quickly and easily varied with a micrometer drive, and position along the line may be read directly on a recessed scale. Probe travel is at least ½ wavelength at 0.5 GC so that any phase reflection may be compensated. Logging penetration and position of the probe makes repetition of settings simple, and the probe can be withdrawn so that no correction is applied.

Specifications

Frequency Range:	0.5 to 4 GC
Correctable SWR:	10
Insertion Loss at Max. Correctable SWR:	1 db or less
Characteristic Impedance:	50 ohms
Connectors:	Type N
Dimensions:	27" x 6" x 5"
Price:	hp 872A, $525.00

hp 906A Coaxial Load

This sliding coaxial termination is a movable, low reflection load for terminating 50-ohm systems in their characteristic impedance. The load moves at least ½ wavelength at its lowest rated frequency. It features a movable center conductor which insures proper seating in the mating conductor. Included are adapters for Type N connectors, plus storage case.

Specifications

Frequency Range:	1 to 12.4 GC
Load SWR:	Less than 1.05
Power Rating:	1 watt
Travel:	Greater than ½ wavelength at 1 GC
Dimensions:	31" long. 2 lbs.
Price:	hp 906A, $250.00

hp 760D/761D Dual Directional Couplers

New hp 760D/761D Dual Directional Couplers, two-octave vhf-uhf instruments, are especially useful for power monitoring, mixing and power sampling with tightly controlled coupling. High directivity and flat frequency response make them ideal for reflectometer systems. Power capacity is 50 watts cw and 10 kw peak.

Specifications

	Model 760D	Model 761D
Frequency Range:	250 - 1000 MC	1 - 4 GC
Mean Coupling:	20 ± ½ db	20 ± ½ db
Coupling Variation:	± ½ db	± ½ db
Directivity (Minimum):	35 db	30 db
Primary SWR (Maximum):	1.20	1.25
Secondary SWR (Maximum):	1.25	1.30
Connectors:	Type N	Type N
Price:	$200.00	$185.00

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Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR* (Coherent Light Detection and Ranging).

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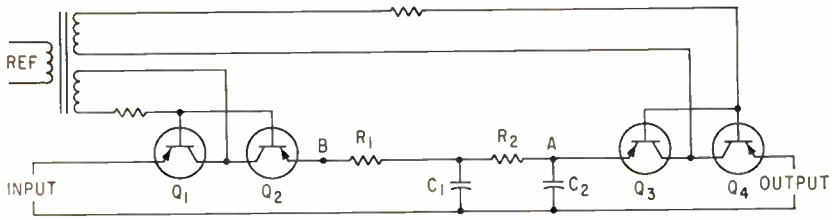
DESIGN AND APPLICATION

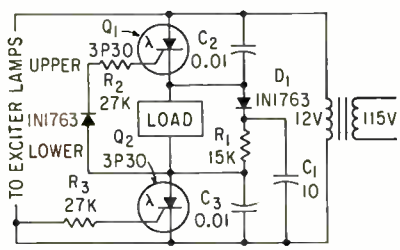


Quadrature Filters

100 TO 1 REJECTION

MANUFACTURED by Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside 77, N. Y., are the model 831 (400 cps, 26 v) and model 832 (115 v reference) miniaturized solid state quadrature rejection filters. Input impedance is 5,000 ohms (plus 2RL) for reference phase and 5,000 ohms for the quadrature component. Rejection ratio is better than 100:1 at the voltage range 0.005 to 6 v. Maximum signal is 6 v at 400 cps, noise is 500 μv maximum, insertion loss is 6 db at 5,000 ohms load, phase shift is 2 degrees maximum and bandwidth is 10 cps. Essentially the circuit (see sketch) consists of a phase-sensitive demodulator, filter network and a synchronous chopper. Reference and input signals are applied to Q_1 and Q_2 which act like a bilateral synchronous switch. Signal at point A is a d-c voltage whose magnitude is dependent only upon the component of input signal in phase with the reference signal. Quadrature component of input signal contributes an a-c component at point B and is filtered out by R_1, C_1, R_2 and C_2. The d-c signal at point A is converted into a-c of reference frequency and phase by the synchronous modulator Q_3 and Q_4.

CIRCLE 301 ON READER SERVICE CARD

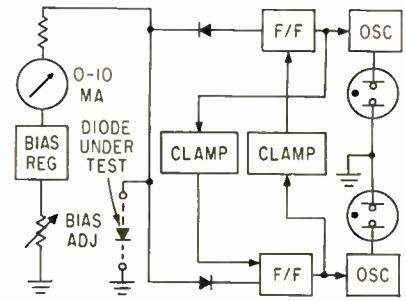


Pnpn Photocell

SURGE TO 5 AMPERES

ANNOUNCED by Solid State Products, Inc., 1 Pingree St., Salem, Mass., is the Phototran series of diffused silicon *pnpn* photocells. These units directly handle 300 ma, have a surge capacity of 5 amperes, an inherent memory, voltage ratings to 200 v, trigger level set by bias and high light sensitivity. The device can be latched on with a light or electrical pulse, and latches off when load current is momentarily interrupted. Electro-optical OR gating can be achieved with gate triggering levels as low as 30 μa. In off state, impedance is over 10 megohms while on state is 10 ohm. The sketch shows typical operation in control of a storage bin. When the bin is above upper control limit, both Phototrans are dark and in off state. When level falls below upper limit, Q_1 switches on. Capacitor C_1 charges through Q_1 and D_1 to peak positive a-c supply. Voltage on C_1 is maintained by conduction of Q_1 during each positive half cycle. When bin level falls below lower limit, Q_2 is triggered on. Half-wave rectified a-c energizes load and bin starts to fill. When level rises above lower limit, Q_2 does not turn off because of holding current through R_1 from C_1. Since Q_1 has no holding current, it will turn off when level reaches upper control. The load is de-energized and voltage on C_1 is not maintained allowing Q_2 to turn off. Resistors R_2 and R_3 bias Q_1 and Q_2 while capacitors C_2 and C_3 prevent transient triggering. Diode D_1 allows inductive load current to free-wheel during negative half cycle.

CIRCLE 302 ON READER SERVICE CARD



Transient Monitor

DURATION TO 50 NSEC

RECENTLY announced by Micro Instrument Co., 3851 Sepulveda Blvd., Culver City, Cal., is the model 5200 self-contained, battery-powered transient monitor whose response goes from d-c to 10 μsec down to d-c to 0.1 μsec. The a-c coupled input impedance is 100 ohms nominal, sensitivity is -0.5 v for negative transients and $+1.4$ v for positive transients. An internal bias supply provides 0 to 10 ma into a test diode or a 100-ohm load. Readout is neon indicator lamps. Applications include semiconductor shock and vibration testing, sequencing monitor, go-no-go monitor, and high-speed decision circuit device. In operation (see sketch) transients appear at both channels. Coupling diodes direct

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ITT Kellogg designs and manufactures a broad range of electronic and electro-mechanical components for hundreds of industrial and commercial applications . . . including:

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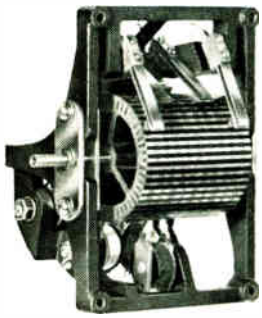
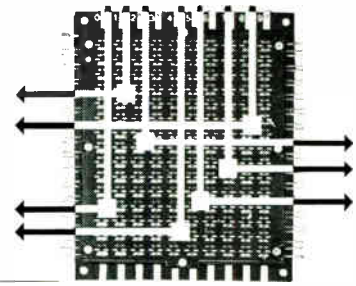
ITT Kellogg will engineer relays for the special, exacting needs of the modern systems and control designer. Write or call for a specialist to discuss your needs. Whatever your problem, ITT Kellogg has the experts to help you. No obligation.

THESE ARE ONLY A FEW EXAMPLES OF ITT KELLOGG COMPONENTS



MAGNETIC DATA-STORAGE DRUM

Non-destructive store, 250 bit 5 track, selective pulse record and erasure contact closure for read-out. High reliability.

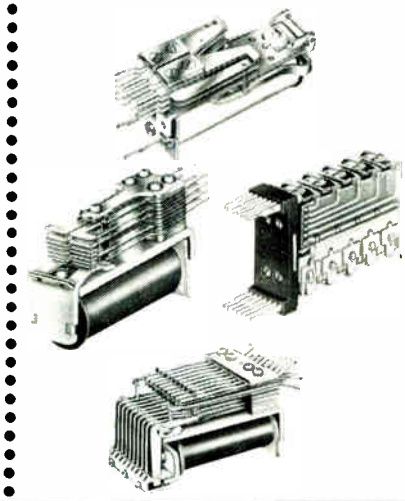


MINIATURIZED TRANSLATION MATRIX

For automation systems, plug-in selenium disc rectifiers, not soldered or wired . . . rearrange circuits by simply repositioning discs.

COMMUNICATIONS EQUIPMENT AND COMPONENTS

Telephones, handsets, hook switches, dials, cam keys and accessories, lamps, caps, jacks, plugs, mountings, plates . . . all types of telephone-type hardware for industrial application.



LOW-COST INDUSTRIAL RELAYS AND MAGNETIC IMPULSE COUNTER

For a multitude of uses . . . types for "memory" devices, binary data storage, multiple-circuit operation, special requirements.

FOR MORE INFORMATION, OR A DISCUSSION OF YOUR NEEDS, WRITE OR CALL YOUR NEAREST REPRESENTATIVE—OR, SEND THE COUPON AT RIGHT.

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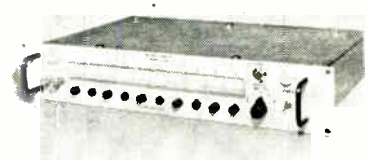
the transients according to polarity and reject opposites. High-speed 50 ns flip-flops respond to the transients and trigger their appropriate blocking oscillators. Output appears as a lit neon tube. When the first flip-flop operates, a clamping circuit shuts off the other channel, so only the first occurring transient registers. Response time can be changed by introducing integrating capacitors in the flip-flop circuit. Self checking facilities are provided.

CIRCLE 303 ON READER SERVICE CARD

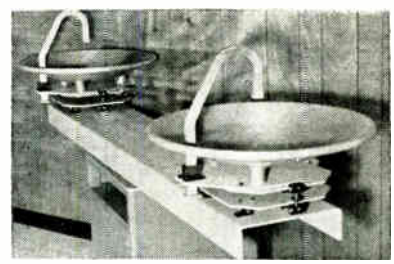


Automatic Scanner

TEN-LINE UNIT

RADIATION INC., Orlando, Fla. Model 7210 automatic 10-line scanner does not affect the signals it samples. It is designed for telegraph work. Cumbersome patch cord changes are eliminated, allowing faster traffic with no interruptions and less chance for error. Unit permits 10 individual circuits, either polar or neutral, to be scanned sequentially. Each circuit is scanned for a preselected time interval.

CIRCLE 304 ON READER SERVICE CARD

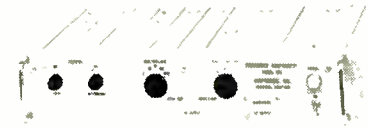


X-Band Antenna

SPUN ALUMINUM

APPLIED MICROWAVE ELECTRONICS, INC., 6707 Whitestone Road, Baltimore 7, Md. This spun aluminum reflector and waveguide horn feed operates over the range of 8.2 to 12.4 Gc with a nominal gain of 33 db. Maximum vswr is 1.35 to 1 and side lobes relative to the main beam are suppressed at least 22 db over the entire band. The 24-in. parabola mounting facilities provide for adjustment in azimuth and elevation and selection of either vertical or horizontal polarization.

CIRCLE 305 ON READER SERVICE CARD



Frequency Comparator

FULLY TRANSISTORIZED

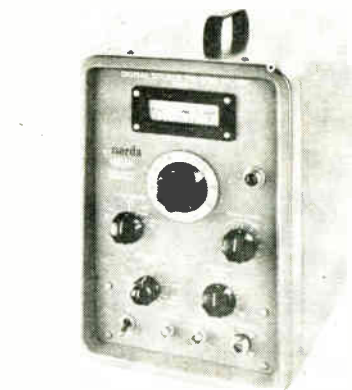
MONTRONICS INC., 1212 West Main, Bozeman, Mont. Model 100 frequency comparator, through frequency difference multiplication, reduces the time required to make accurate frequency comparisons. It provides, when used with the model 100A indicator-recorder unit, a continuous permanent record of the magnitude and sense of the difference frequency.

CIRCLE 306 ON READER SERVICE CARD

Static Relay

MAGNETICS INC., Butler, Pa. The Micro Sentry, a static relay with an adjustable turn-on point, can directly replace sensitive meter relays to give protection in applications such as reverse current protection, over-temperature control, over-speed control.

CIRCLE 307 ON READER SERVICE CARD



Signal Source

LOW COST, COMPACT

THE NARDA MICROWAVE CORP., Plainview, N. Y. Model 451 covers the frequency range of 750 to 2,750 Mc, and provides power output from 100 to 300 mw over most of the band.

with at least 10 mw output even at band edges. Complete modulation is built into the single solid state design unit, providing for internal c-w, square wave or pulse modulation at a rate of 400 to 2,000 cps and a variable pulse width of 0.5 to 20 μsec. Price is $1,325.

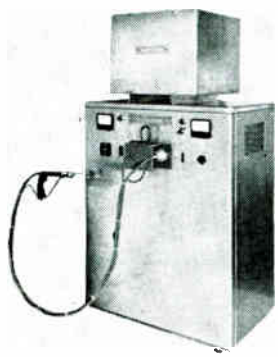
CIRCLE 308 ON READER SERVICE CARD

Digital Voltmeter

PORTABLE UNIT

UNITED SYSTEMS CORP., 918 Woodley Road, Dayton 3, O. Digi-Tec model 200 features an easily read lighted display in four ranges from 0.000 to 1,000 v and will follow bi-directional voltage changes without flicker or back-tracking. Certified—2 digit accuracy, ½ digit resolution and repeatability, 2 sec average reading time, over voltage and incorrect polarity protection. Unit is completely transistorized and lists at $287.50.

CIRCLE 309 ON READER SERVICE CARD



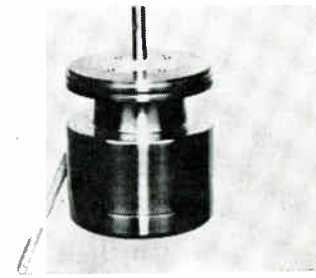
Induction Generator

BASICALLY AIR-COOLED

REEVE ELECTRONICS, INC., 603 W. Lake St., Chicago 6, Ill. A 5 Kw induction generator is sold complete with dual output terminals for single or multi-turn coils with no internal matching. It also includes thyratron power control and automatic electric timer. Model shown is the unit with flexible cord and pistol-grip handgun. Unit has self-

contained water cooling system mounted on the generator. Generator basically is air-cooled, requiring only 1 gpm for cooling tank coil and work coil.

CIRCLE 310 ON READER SERVICE CARD



Rotary Pot

HERMETICALLY SEALED

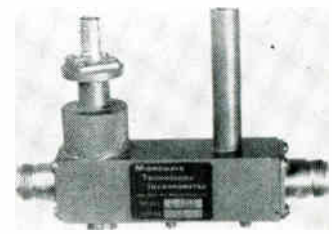
HUMPHREY, INC., 2805 Canon St., San Diego 6, Calif. Hermetically-sealed rotary pot, capable of operating at cryogenic temperatures, is available in two configurations. CP14-0101-1 is a servo mount type, 2 in. in diameter and 2 in. long. It may be furnished with total resistance ranges from 50 to 100,000 ohms and angular travels from 30 to 360 deg continuous rotation. CP14-0201-1 is a bracket mounted unit, 1.25 in. in diameter and 2 in. long. It may be furnished with total resistance ranges from 50 to 50,000 ohms and angular travels from 45 to 360 deg continuous rotation.

CIRCLE 311 ON READER SERVICE CARD

Epoxy Adhesive

RADIATION APPLICATIONS INC., 36-40 37th St., Long Island City 1, N. Y., announces Raiseal 5019, an epoxy adhesive suitable for bonding polyurethane to metal.

CIRCLE 312 ON READER SERVICE CARD



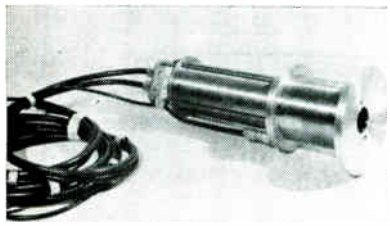
Diode Switch

AT L-BAND

MICROWAVE TECHNOLOGY INC., 235 High St., Waltham 54, Mass., announces model L-401 diode switch

at L-band to meet stringent power requirements. It operates at a frequency range of 1,250 to 1,350 Mc. Isolation is greater than 20 db while insertion loss is less than 0.4 db. Switching time is less than 10 nsec. Unit can handle 25 w peak power and 5 w average power.

CIRCLE 313 ON READER SERVICE CARD

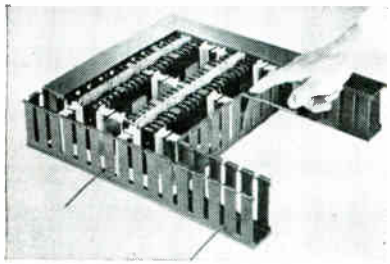


Electron Gun

FOR VACUUM METALLURGY

BRAD THOMPSON INDUSTRIES, INC., 83-810 Tamarisk St., Indio, Calif. Model 776 electron gun has a power rating of 0 to 7½ Kw with maximum ratings of 25 Kv and 300 ma. Maximum effective spot size is 0.050 in. Features: replaceable filaments, interchangeable beam forming sources, magnetic focusing and deflection, and grid control of the electron beam. Gun has been used to melt and weld refractory metals including tungsten to 0.050 in. thickness.

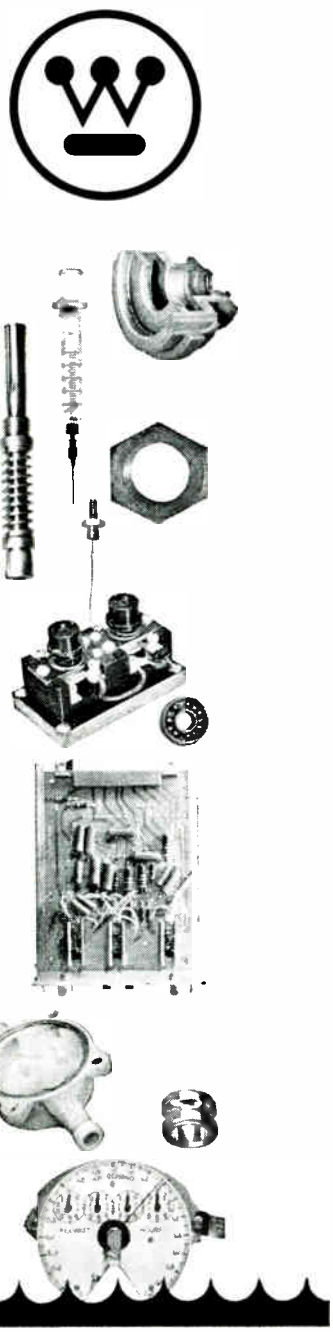
CIRCLE 314 ON READER SERVICE CARD



Duct System

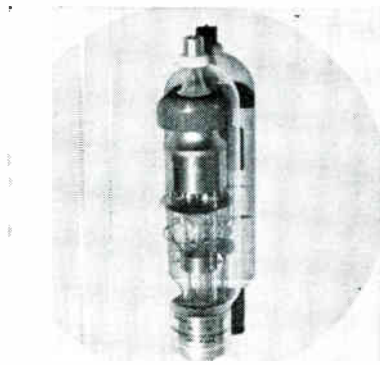
FOR MODULAR RELAYS

PANDUIT CORP., Tinley Park, Ill., announces the Panduct system for use with 10 amp, 300 v modular industrial relays. Modular relays are mounted side-by-side in rows, forming a trough for wire between rows. Company supplies Nylon cover clips which are mounted between rows of relays and on the perimeter of relay groups. Wires are snapped into the cover clips, providing wire retention. Panduit also supplies a vinyl half duct which is mounted on the outside edge of perimeter



cover clips. The half duct is available with standard Panduct snap-slots to facilitate wiring to adjacent terminal blocks, etc.

CIRCLE 315 ON READER SERVICE CARD



Rectifier Tubes

MERCURY FILLED

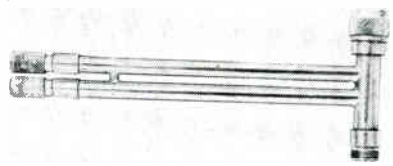
NATIONAL ELECTRONICS, INC., Geneva, Ill. The NL-575A and NL-673 are designed for h-v power rectifier applications. They are mercury filled for high efficiency and long life. Ratings: piv, 15,000; d-c amp max, 2.5; max instantaneous amp, 10; filament volts, 5; and filament amp, 10.

CIRCLE 316 ON READER SERVICE CARD

Flat Filters

DALTRONICS INC., 100 Manton Ave., Providence, R.I., offers a line of filters with ultra-flat response within the pass-band. A high pass filter can be furnished with a sharp cut-off below 300 cycles and flat within ±0.25 db above 300 cycles all the way to 1,500 Kc.

CIRCLE 317 ON READER SERVICE CARD



Coaxial Stub Tuners

THREE TYPES

RLC ELECTRONICS, INC., 25 Martin Place, Port Chester, N.Y., announces a line of coaxial stub tuners for operation from 200 Mc to 11 Gc. Units are designed to provide means for tuning out reflections of transmission lines, and for obtaining maximum power transfer

between an r-f source and its load. They are available in two frequency ranges, from 200 to 1,000 Mc and from 1 to 11 Gc; and are supplied in single, double and triple types.

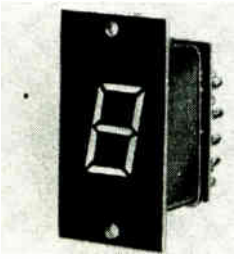
CIRCLE 318 ON READER SERVICE CARD

Delay Lines

MINIATURIZED

ALLEN AVIONICS, INC., 255 E. 2nd St., Mineola, N. Y., announces a series of miniature lines. Delays range from 0.05 to 2.8 μsec with 248 standard lines available in 100, 500 and 1,000 ohm impedance. Size range is from 0.5 by 0.8 by 1½ in. to 0.5 by 0.8 by 4.2 in. Metal cans are used with glass headers. Units are foamed or epoxy filled. Provision is made for one tap. Delivery is normally 3 weeks.

CIRCLE 319 ON READER SERVICE CARD



Numerical Display

NO MOVING PARTS

ROBOTOMICS, INC., 2422 E. Indian School, Phoenix 16, Ariz. Miniature solid state display uses no moving parts. Model D1620 displays 1 in. high in-plane numbers when 1 of 10 lines is grounded. Operates on +10 to +12 v at 80 ma. Dimensions are 2½ in. high by 1⅜ in. wide by 1⅞ in. deep. Displays weigh 3 oz, draw less than 1 w of power, and mount on 1⅜ in. side by side centers.

CIRCLE 320 ON READER SERVICE CARD

Miniature Chopper

LOW NOISE

CAMBRIDGE SCIENTIFIC INDUSTRIES, 18 Poplar St., Cambridge, Md. The 920 series choppers feature opera-

tion from 0 to 500 cps while maintaining precise dwell time and balance. It has less than 5 μv noise into 100,000 ohms at 60 cps. Unit is available in the standard 7 pin miniature, 1$\frac{7}{16}$ in. height as well as the new 0.670 diameter by 1$\frac{1}{4}$ in. long. All various mounting methods can be employed. Rigid environmental specs can be met.

CIRCLE 321 ON READER SERVICE CARD

Dry-Reed Relays

EPOXY ENCAPSULATED

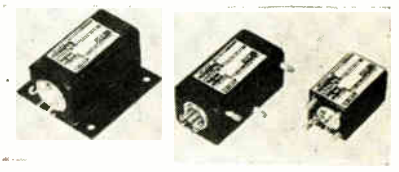
WINTRONICS, INC., 1132 So. Prairie Ave., Hawthorne, Calif., offers series EW dry-reed relays, with 1 form C contact arrangement, none biased. Contacts enclosed in glass capsule hermetically sealed from environmental conditions in atmosphere of inert gas. Suitable for computer and low level switching for hundreds of millions of operations. Length is 1$\frac{3}{4}$ exclusive of leads and 3$\frac{3}{8}$ overall including terminals. Available up to 6 form C.

CIRCLE 322 ON READER SERVICE CARD

Signal Analyzer

RAYDATA CORP., 1078 E. Granville Rd., Columbus 24, O. Model 41 signal analyzer is a portable instrument with an extended frequency coverage and extreme dynamic range for industrial and laboratory measurements.

CIRCLE 323 ON READER SERVICE CARD



Preset Time Delays

SOLID STATE

JORDAN ELECTRONICS, a Div. of The Victoreen Instrument Co., 121 So. Palm Ave., Alhambra, Calif., offers timers that utilize unijunction transistors and are of the delayed

THE MOST WELL BALANCED STOCK OF MICRO-DRILLS IN THE U.S.A.

SPHINX

IN STOCK FOR IMMEDIATE DELIVERY

TYPE	STYLE	STOCK SIZES
Spirec Pivot Drills	Right Hand	0.10mm to 3.00mm by 0.01mm increments
Flat Pivot Drills	Right Hand	0.04mm to 1.00mm by 0.01mm increments
Spirec Pivot Drills	Left Hand	0.10mm to 1.00mm by 0.01mm increments
Spirec Center Drills	Right Hand	0.10mm to 0.70mm by 0.05mm increments

Other sizes and styles available on special request.

SPHINX known the world over as the symbol of the finest in micro-drills. Insist on them by name. Your best assurance of quality and precision.

SEND FOR COMPLETE DRILL CIRCULAR

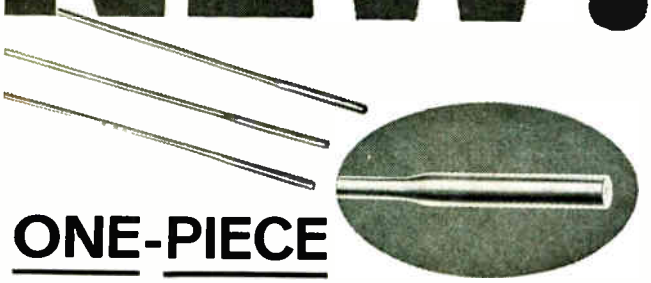
LEVIN®

LOUIS LEVIN & SON, INC.

3573 Hayden Ave., Dept. E • Culver City, California

CIRCLE 206 ON READER SERVICE CARD

NEW!



ONE-PIECE LEAD WIRES!

Better because...

- Eliminates weld-joint failures
- Unaffected by salt-spray tests
- Supplied in glass-sealing alloys
- Wide range of diameters — .020 to .080, necked down as much as 50% of original diameter.

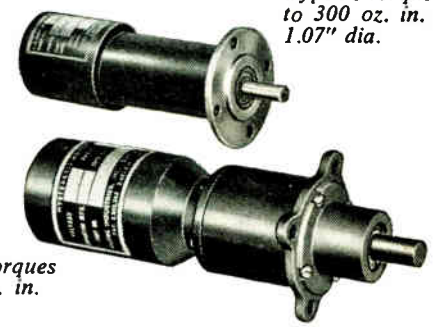
Send blueprints or sketches, get full details and prices.

ART WIRE AND STAMPING CO.

18 Boyden Place, Newark 2, N. J.

CIRCLE 207 ON READER SERVICE CARD

Type SC torques to 300 oz. in. 1.07" dia.



Type MC torques to 1000 oz. in. 1.25" dia.

MINIATURE A.C. GEARMOTORS

Globe Type SC and MC motors with planetary or spur gearheads provide more than 101 standard ratios, even and odd. Custom winding and gearing provide all in-between speeds for the exact speed-torque you need—up to 1000 inch ounces. SC and MC motors are hysteresis-synchronous or induction types, 115 to 208 v.a.c., 60 or 400 cycle or variable frequency, weigh 2½ and 6½ oz. respectively; gearheads add 1¾ to 6 oz. depending on type and ratio of gearing. MIL specs are routine. Ask about commercial versions and check us if you need larger or smaller gearmotors. Please specify your speed; many prototypes shipped in one day, larger quantities soon after. Bulletin SMG. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.

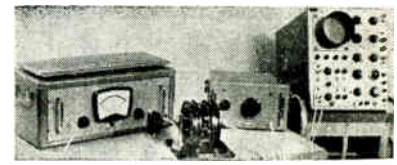
GLOBE

GLOBE INDUSTRIES, INC.

CIRCLE 87 ON READER SERVICE CARD

pull-in variety. Preset time delay may range from 0.1 sec to 60 sec with an accuracy of ±5 percent to ±10 percent depending upon requirements. Input voltages may be from 18 v d-c to 30 v d-c and rated loads vary from 2 to 10 amp at 28 v d-c or 115 v a-c. Recycling is possible within 10 millisec after pull-in and minimum life is rated at 100,000 cycles. Timers meet MIL spec environmental requirements.

CIRCLE 324 ON READER SERVICE CARD

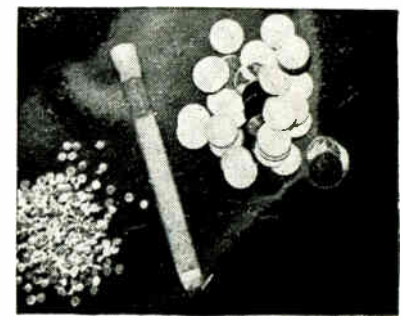


Materials Testers

TWO MODELS

INSTRUMENT SYSTEMS CORP., 129-07 18th Ave., College Point 56, N. Y., offers a system to display hysteresis loops on a cro and to determine the coercivity and remanence of magnetic materials. Types M101/A and M101/B are suited for the testing of magnetic coatings, as on film type memory storages and magnetic recording tapes, and for the evaluation of magnetic alloys in strip or wire form. The hysteresis loop testers are made of 3 separate units; a measuring head; an amplifier; and a power supply, with coercivity ranges extending to 2,000 oersteds.

CIRCLE 325 ON READER SERVICE CARD



Metal Disks

EXTREMELY FLAT

SEMI-ALLOYS, INC., 20 North MacQuesten Parkway, Mount Vernon, N. Y. Manufacture of silicon rectifiers requires extreme flatness in the metal disks used for base tabs in order to assure that it will match up to the crystal. Company has available molybdenum, tantalum

and tungsten disks 0.0001 in. flat. They may be clad and/or plated with a wide range of metals including nickel, gold, silver, copper, Antimony, Kovar, aluminum, steel and others.

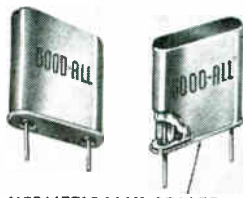
CIRCLE 326 ON READER SERVICE CARD

Power Triode

FORCED AIR-COOLED

CALVERT ELECTRONICS, INC., 220 E. 23rd St., New York, N. Y., is marketing a power triode designed for use in high power r-f induction heaters. Type BR1143, manufactured by English Electric Valve Co., Ltd., is a forced air-cooled triode with a 20 Kw anode dissipation. The dissipation figure allows ample temporary overload capacity. The tube may be operated at 10 Kv up to 10 Mc. Filament voltage is 12.5 v and amplification factor is 37. Tube measures 21¾ in. by 14 in.

CIRCLE 327 ON READER SERVICE CARD



HERMETICALLY SEALED

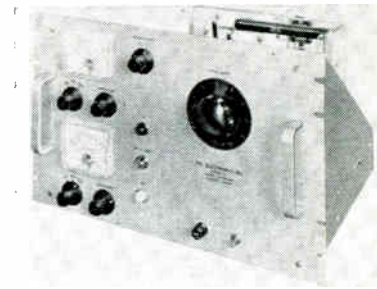
Sealed Capacitor

FLAT SHAPE

GOOD-ALL ELECTRIC MFG. CO., Ogallala, Neb. Type 605 capacitor for transistor circuitry combines thin, flat shape with a hermetically sealed metal case of oval cross section. It meets all Mil-Spec environmental requirements and is available in capacitances from 0.01 to 0.33 μf in 50 v ratings only. Temperature

range is −55 C to +125 C at full rated voltage. Tolerances are ±20 percent, ±10 percent and ±5 percent and the dielectric is Mylar.

CIRCLE 328 ON READER SERVICE CARD

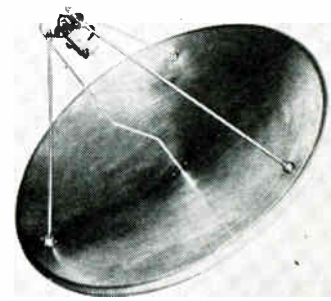


Power Supply

0 to 15,000 V D-C

PRL ELECTRONICS, INC., 232 Westcott Drive, Rahway, N. J. H-V power supply is rated at 0 to 15,000 v d-c at 10 ma max. Voltage doubler circuitry provides a ripple of 0.5 percent rms and optional positive or negative polarity. A pair of meters monitor output voltage and current. Safety features include automatic output grounding switch; zero start interlock; all doors are interlocked; all front panel controls at ground potential; safety resistor in output lead.

CIRCLE 329 ON READER SERVICE CARD



Millimeter Antenna

3-FT DIAMETER

TRG, INC., 400 Border St., South Boston, Mass. Model V836C is a tracking antenna for operation at 70 Gc. The conical scanning antenna has an offset rotating circular waveguide feed which operates in the TE_{11} mode. Polarization is held fixed during the scan by a rectangular to round waveguide transition. However, the plane of polarization can be rotated 90 deg by rotating the waveguide and feed. Scan speed is continuously variable from 15 to 1,600 rpm.

CIRCLE 330 ON READER SERVICE CARD

PRODUCT BRIEFS

RECORDER/REPRODUCER provides bandwidth up to 1.2 Mc. Mincom Division, Minnesota Mining and Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. (331)

MULTISPEED TRANSMISSIONS feature modular construction. Brush Instruments Division of Clevite Corp., 37th and Perkins, Cleveland 14, O. (332)

X-Y RECORDER solid state circuitry. Electronic Associates, Inc., Long Branch, N. J. (333)

DPDT CHOPPER for commercial d-c instrumentation. James Electronics, Inc., 4050 North Rockwell St., Chicago, Ill. (334)

TUNNEL DIODE OSCILLATOR small size, light weight. Sylvania Electric Products Inc., Mountain View, Calif. (335)

TRANSISTOR TESTER versatile unit. GC Electronics Co., 400 S. Wyman St., Rockford, Ill. (336)

DIGITAL DATA RECORDER high-speed. Perkin-Elmer Corp., Norwalk, Conn. (337)

SILICON MODULES wide temperature range. Packard Bell Computer, 1905 Armacost Ave., Los Angeles 25, Calif. (338)

FUNCTION GENERATORS transistorized. Physical Instruments, Inc., 4565 Ponce de Leon Blvd., Coral Gables, Fla. (339)

HALL-EFFECT DEVICES high-output. Instrument Systems Corp., 129-07 18th Ave., College Point 56, L. I., N. Y. (340)

D-C POWER SUPPLIES low-cost. Electro Products Laboratories, Inc., 4500 Ravenswood Ave., Chicago 40, Ill. (341)

DOUBLE LOOP COUPLER highly directive. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa. (342)

GLASS LASER RODS doped with Europium. Semi-Elements Inc., Saxonburg Blvd., Saxonburg, Pa. (343)

QUARTZ CRYSTAL FILTER intermediate bandwidth. Bulova Watch Co., Inc., 40-01 61st St., Woodside 77, N. Y. (344)

Literature of

MAGNETIC FIELD EVALUATOR Magnetic Shield Division, Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill. Data sheet 156 describes an a-c magnetic field evaluation probe. (345)

KLYSTRONS Westinghouse Electronic Tube Division, Box 284, Elmira, N. Y. Microwave klystron tubes now available are presented in four-page Quick Selector booklet ET-1309. (346)

FANS AND BLOWERS Rotron Mfg. Co. Inc., Woodstock, N. Y. A 24-page catalog contains specifications on a line of fans and blowers for electronic and instrumentation cooling. (347)

POTENTIOMETRIC TRANSDUCERS Carter Mfg. Corp., 23 Washington St., Hudson, Mass., offers a bulletin on the push-pull model 118GS $\frac{3}{8}$ in. diameter potentiometric transducers. (348)

DIGITAL SERVOS Digital Servo Corp., 13425 Wyandotte Ave., North Hollywood, Calif. Brochure explains the application of digital techniques to a 400-cycle carrier analog servo system. (349)

WIRE MARKERS W. H. Brady Co., 726 W. Glendale Ave., Milwaukee 9. Wisc. Bulletin 729 describes self-sticking B-400 electronic wire markers. (350)

BLOCK TAPE READER Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. A catalog sheet describes the TP-414, a 96-bit bidirectional block tape reader. (351)

SOUND VELOCITY OSCILLATOR Ramsay Engineering Co., 707 N. Los Angeles St., Anaheim, Calif., has available a data bulletin on the model SV-311 sound velocity oscillator. (352)

D-C POWER MODULES ACDC Electronics, Inc., 2979 North Ontario St., Burbank, Calif. Bulletin TP-660 covers a series of transistor regulated d-c power modules. (353)

ELECTRONIC WEIGHING Gilmore Industries, Inc., 3355 Richmond Road, Cleveland 22, O. An 8-page electronic weighing brochure de-

the Week

scribes case history applications in several different industries. (354)

TRANSDUCER/AMPLIFIER Taber Instrument Corp., 107 Goundry St., North Tonawanda, N. Y. Bulletin features the model 185/295-1 transducer/amplifier. (355)

CAPACITORS Vitramon, Inc., Box 544, Bridgeport 1, Conn. Catalog covers VK microminiature ceramic capacitors and VY solid state porcelain capacitors. (356)

MICROWAVE POWER GENERATORS Raytheon Co., 225 Crescent St., Waltham 54, Mass. Microwave power generators and accessories designed for a variety of laboratory applications are described in an 8-page brochure. (357)

POWER SUPPLY Radiation Dynamics, Inc., 1800 Shames Drive, Westbury, L. I., N. Y., has available a booklet entitled "Duo-Dynaply Power Supply" B-162. (358)

TEST EQUIPMENT Arenberg Ultrasonic Laboratory, Inc., 94 Green St., Jamaica Plain 30, Mass., has published brochures listing the specifications and prices of the Arulab series of test equipment. (359)

MEDICAL SYSTEMS Electronic Medical Systems, Inc., 1449-51 University Ave., St. Paul 4, Minn. Electronic monitoring systems and medical instrumentation are described in a brochure. (360)

TRANSMITTING MULTICOUPLER Granger Associates, 974 Commercial St., Palo Alto, Calif. Technical data sheet describes a four-channel transmitting multicoupler used in conjunction with broadband antennas. (361)

CIRCUIT MOUNT Sanders Associates, Inc., 95 Canal St., Nashua, N. H., has released a data sheet on the new universal transistor circuit mount. (362)

AIR CLEANING CABINET Dexon Inc., 3517 Raleigh, Minneapolis 16, Minn. A data sheet contains description and prices of the Primaire, Jr., a compact climate control cabinet. (363)

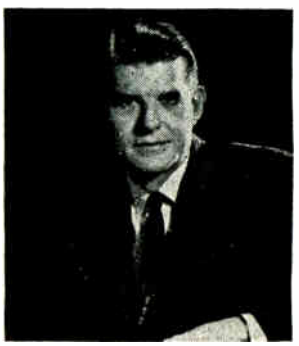
in top management services in the areas of R&D, engineering, production, profit assurance, and in new product and plant acquisition activities.

Peterson Advances At Lenkurt Electric

E. KENNETH PETERSON has been named manager of advanced development at Lenkurt Electric Co., Inc., San Carlos, Calif., where he has been a member of the product planning staff since joining the company in August, 1960.

GE Leases Facility In Oklahoma

GENERAL ELECTRIC CO. has leased a 150,000 sq ft facility in Oklahoma City to make components for electronic guidance systems. The company has also taken an option on 1,000 acres west of Oklahoma City for possible future expansion to develop and build equipment for missiles, satellites, and space vehicles.



Parry Accepts ICS Position

APPOINTMENT of Charles A. Parry as director, telecommunication network engineering, of ITT Communication Systems, Inc., Paramus,

N. J., has been announced.

A subsidiary of International Telephone and Telegraph Corp., ICS provides engineering and management for global and other advanced communication and electronic systems.

Parry was vice president and director of telecommunication systems for Page Communications Engineers, Inc., Washington, D. C.

Elect John Wilson Metrotek President

JOHN B. WILSON has been elected president of Metrotek Electronics, Inc., Raleigh, N. C. He succeeds John C. Hanner, who resigned.

Metrotek's chief activities are in the fields of communications, control, and bio-medical instrumentation.

Wilson comes to the Raleigh firm from Sperry Rand Corp.

PEOPLE IN BRIEF

Harold Bauman and **Frank Atha** advance at Transco Products, Inc. to general mgr. and chief engineer, respectively. **Wilford E. Morris** leaves RCA to become chief research engineer at the Scintilla div. of The Bendix Corp. **Harold Lipschultz**, formerly with P. R. Mallory Co., named mgr. of manufacturing engineering of the New Bedford div., Aerovox Corp. Information Products Corp. has added **Eli Anfenger**, previously with Epsco, Inc., to its engineering staff. **Joseph DeVincent** promoted to Paramus plant mgr. for ACF Electronics. **Elmer F. Burns**, ex-Technology Instrument Corp., now operations v-p of Accuracy, Inc. **Allan Karson** moves up to v-p in charge of Data Systems div. of The G. C. Dewey Corp. **Vincent A. Melfi**, from General Electric Co., to systems mfg. mgr. for Electro-Mechanical Research, Inc. Microdot Inc. elevates **Donald W. Moore** to mgr. of the Magnetics div. **A. Robert Masters**, a v-p of R.E.D.M., appointed exec v-p of its subsidiary, Hugh H. Eby Co. **William T. Summerlin**, formerly with Philco Corp., joins McDonnell Aircraft Corp. as mgr. of engineering reliability.

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electronics

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The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

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WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualificotion Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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ATOMIC PERSONNEL INC. Philadelphia, Pennsylvania	126*	2
BOEING COMPANY Seattle, Washington	93*	3
ESQUIRE PERSONNEL SERVICE INC. Chicago, Illinois	126*	4
FEDERAL ELECTRIC CORP. Div. of International Telephone & Telegraph Corp. Paramus, New Jersey	18	5
GENERAL ELECTRIC CO. Communication Products Dept. Lynchburg, Virginia	99	6
GENERAL ELECTRIC CO. Light Military Electronics Dept. Utica, New York	126*	7
INTERNATIONAL BUSINESS MACHINES CORP. Poughkeepsie, New York	100	8
LEL INC. Copiague, L. I., New York	100	9
LOCKHEED MISSILES & SPACE CO. Div. of Lockheed Aircraft Corp. Sunnyvale, California	26, 27	10
MICROWAVE SERVICES INTERNATIONAL, INC. Denviile, New Jersey	100	11
NATIONAL CASH REGISTER CO. Dayton, Ohio	124, 127*	12

CONTNUED ON PAGE 100

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME .....

HOME ADDRESS .....

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

HOME TELEPHONE .....

Education

PROFESSIONAL DEGREE(S) .....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check)

42062

☐ 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 .....
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☐ Electron Tubes	☐ Optics	☐ .....
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Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

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Please send resume to
Mr. William Byman

GREENWICH ENGINEERING DIVISION

AMF

AMERICAN MACHINE & FOUNDRY COMPANY

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Opportunities in all geographic areas. Submit resume to:

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577 Wash. St., Boston, Mass.

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Prefer graduate Electronic, Electrical or Mechanical Engineers with several years design experience in these or related fields.

These are permanent positions providing challenging work in the design of industrial process plants and advanced test facilities for Saturn and Nova Space programs.

Salaries commensurate with ability, moving allowance and many employee benefits.

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Test Engineer. Nationally known progressive company in transportation equipment field has opportunity in Research and Development Department in Chicago area for B.S.E.E. with three years' minimum experience in the operation, maintenance, and development of electronic and electro-mechanical transducers and instrumentation for test purposes. M.S.E.E. degree may be substituted for experience. Must be capable of supervising experienced electronic technicians in test group. Understanding of dynamics particularly in mechanical systems desirable. Will consider B.S.M.E. with experience described. Above average benefit program including tuition reimbursement. Please send resume in confidence stating salary desired. P-8738, Electronics, 645 N. Michigan Ave., Chicago 11, Ill.

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Submit resume in confidence to:

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- Test Equipment Design Engineers (EE)
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- Transistor Circuit Design Engineers (EE)
- Transmitter Engineers (EE)
- Receiver Engineers (EE)
- Electromechanical Engineers (EE or ME)
- Component Evaluation Engineer (EE)

▶ Facility located 4 easy driving hours from Washington, D. C., in the beautiful, Blue Ridge area of Virginia. For a prompt review of your qualifications, write today in strict confidence to Mr. W. J. Kelly, Div. 69-WP

COMMUNICATION PRODUCTS DEPARTMENT

GENERAL ELECTRIC

Mountain View Road, Lynchburg, Va.
An Equal Opportunity Employer

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 98)

NATIONAL CASH REGISTER CO. Electronics Division Hawthorne, California	91*	13
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	125*	14
SCOPE PROFESSIONAL PLACEMENT CENTER Waltham, Massachusetts	99	15
SNELLING & SNELLING Boston, Massachusetts	99	16
SVERDRUP & PARCEL AND ASSOCIATES INC. St. Louis, Missouri	99	17
SYLVANIA MOUNTAIN VIEW OPERATIONS Mountain View, California	124*	18

* These advertisements appeared in the 4/13/62 issue.

SEARCHLIGHT SECTION
(Classified Advertising)
BUSINESS OPPORTUNITIES
EQUIPMENT - USED or RESALE

INDEX TO ADVERTISERS

Audited Paid Circulation

■

MANUFACTURERS' REPRESENTATIVES

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EQUIPMENT
(Used or Surplus New)

INDEX TO CLASSIFIED ADVERTISERS

■

• See odvertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

Notice to subscribers . . .

RECENT INQUIRY DELAYS DUE TO CHANGE OVER TO SPEEDY, SAME-DAY SERVICE

Processing of **electronics** reader inquiry cards has been transferred recently to high-speed computers at a new location.

During the transfer, some delays occurred, and your cards did not reach the advertisers with our usual promptness.

Should you experience a delayed response to recent inquiries, it was occasioned by the change over process, and is in no manner the fault of the advertiser.

We are back on schedule, servicing all cards on a current daily basis.

electronics

A McGraw-Hill Publication, 330 West 42nd St., N. Y. 36

electronics

Audit Bureau of Circulations — Associated Business Publications

Audited Paid Circulation

SPERRY microwave memo

Now . . . SPERRY packs 10 W output, 60 db gain into a 10 cu. in. TWT

ACTUAL SIZE

Because of the space age demand for smaller, more rugged components with outstanding performance characteristics, the new STX-186 is now available on 60-day delivery from Sperry Electronic Tube Division.

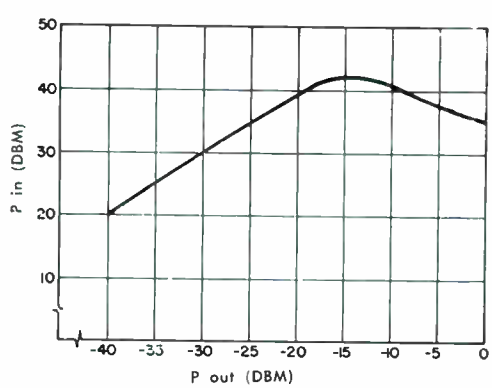
This new X band traveling wave tube is ideally suited to the rigors of aerospace application. It delivers a minimum 10 watts of CW output across X band, at gain levels up to 60 db. Yet it is only 10½ inches long, weighs only 12 ounces, and occupies only 10 cubic inches of payload space. Rugged metal-ceramic construction enables the PPM focused STX-186 to withstand the shock, vibration, and altitude extremes of the most demanding aerospace environments.

Designers can realize maximum benefit from the tube's small size by adapting mounting and cooling arrangements to meet specific environmental demands. Cooling may be air, heat sink, or liquid.

BROAD APPLICATION POSSIBILITIES

In addition to its small size and physical ruggedness, the STX-186 boasts performance characteristics that open a broad range of application possibilities.

Across the entire band of 7 to 11 Gc, this new TWT delivers a minimum 10 watts CW at up to 60 db gain. The dynamic range of broadband signal amplification extends 25 db below saturation. These characteristics make the STX-186 eminently suitable for rocket, drone, and aircraft application in radar augmenter, ECM, or comunications systems.



Typical drive curve STX-186 at 9 Gc

IMMEDIATE AVAILABILITY

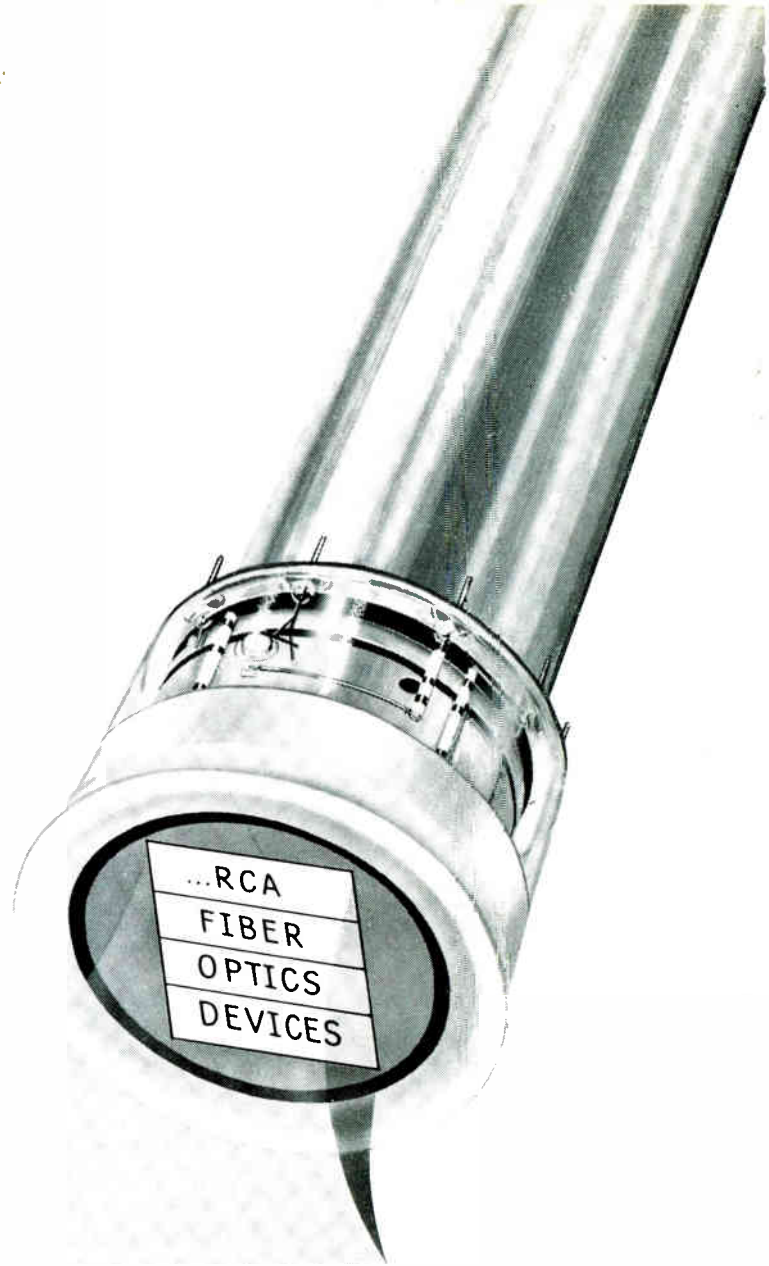
Sperry is now producing the STX-186 in quantity, and limited numbers are available within 60 days of receipt of order.

A NEW TECHNICAL BROCHURE, WHICH DESCRIBES THE CHARACTERISTICS OF THE STX-186 IN DETAIL, IS NOW AVAILABLE. FOR YOUR FREE COPY, WRITE TO SPERRY ELECTRONIC TUBE DIVISION, SEC. 120, GAINESVILLE, FLORIDA.

To avail yourself of the outstanding performance of this new tube, place your order now. Your Cain & Co. salesman, who represents Sperry Electronic Tube Division, will be happy to provide application assistance and quotation. Or you may communicate directly with us at Great Neck, N. Y.

SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION



RCA is now incorporating the unique properties of fiber optics into customized Vidicons, Image Orthicons, and Oscillograph Tubes.

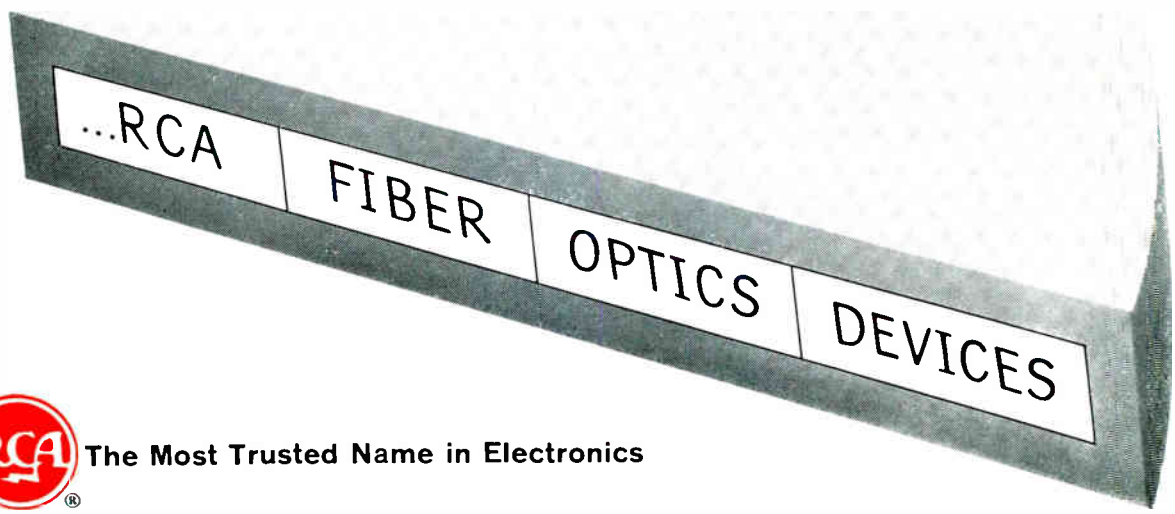
Light images from special fiber-optics systems can be "piped" into fiber-optics camera tubes thus opening many new applications to the inherent advantages of television.

The pickup of remote or otherwise inaccessible information, and direct contact read-out and printing are new possibilities.

Already in use in such areas as medicine, high-speed printing, encoding and decoding, and facsimile, fiber optics may solve your specific sensing and display requirements. Consult RCA about them.

For further information, write: Marketing Manager, RCA Electron Tube Division, Lancaster, Pa.

NOW-SOPHISTICATION IN IMAGE CONVERSION



RCA® **The Most Trusted Name in Electronics**