

# electronics®

## LASER DESIGN USING CHARTS

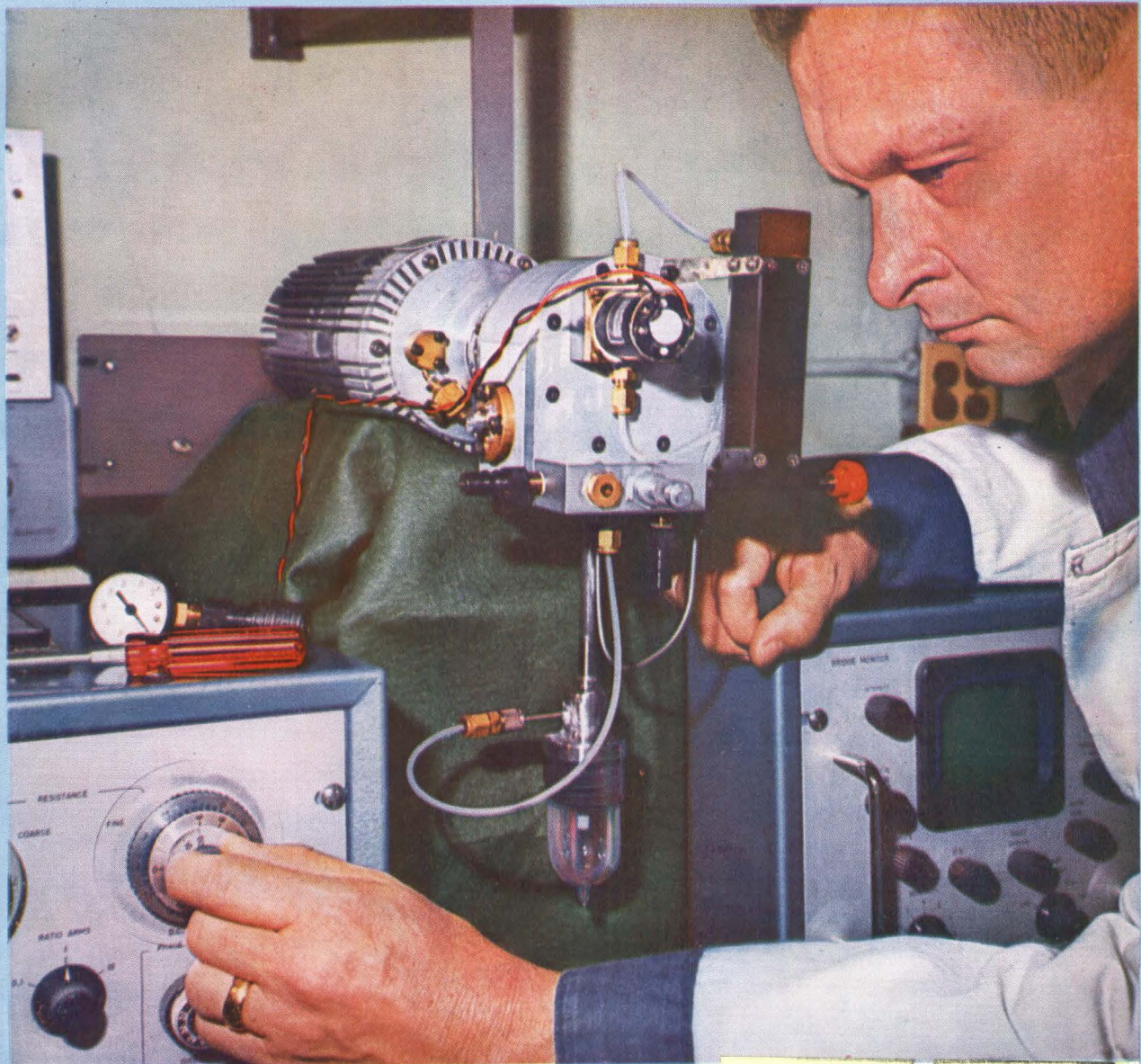
Recalls techniques  
used in microwaves

## TUNNEL DIODES FOR Q-BAND

Millimeter oscillator  
employs X-band diode

## ANY-LENGTH COUNTERS

Logic design ends  
trial and error

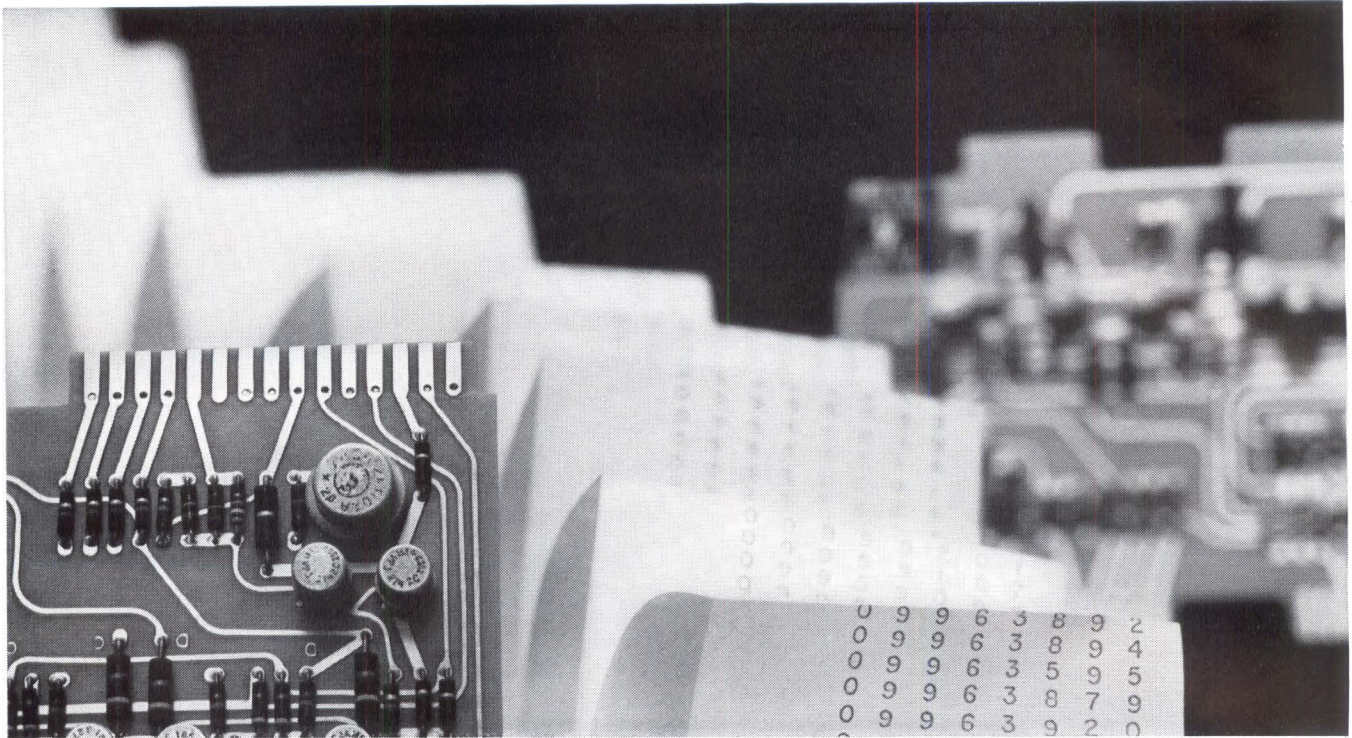


CRYOGENIC COOLER (finned unit in middle) reaches 25 deg K

In This Issue: 1963 INDEX

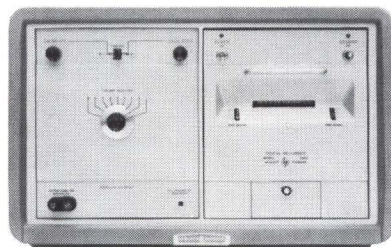
R D SKINNER  
 1020 COVINGTON RD  
 LOS ALTOS CALIF  
 C 3-





# FLEXIBLE PERFORMANCE

Prints up to 5 lines/second  
 Accepts data in just 2 msec  
 Plug-in programming for each column  
 Optional selection of several BCD codes  
 Dual input, 10-line code available



## SPECIFICATIONS

- Printing rate:** 5 lines/sec maximum
- Column capacity:** 11 columns (12 on special order)
- Print wheels:** 0 through 9, a minus and a blank; other symbols available
- Data input:** Parallel entry; BCD (1-2-2-4, 1-2-4-8, 1-2-4-2) or 10-line; difference between "1" and "0" states may be between 4 to 75 volts
- Reference voltages:** BCD codes require both "0" and "1" state references; 10-line codes require reference voltage for "0" state; reference voltages may be up to  $\pm 150$  v to chassis; input impedance is approximately 270 K ohms
- Print command:** + or - pulse, 6 to 20 volts amplitude, 1 v/ $\mu$ s minimum rise time, 20  $\mu$ s or greater in width, ac coupled
- Transfer time:** 2 ms for BCD codes
- Paper required:** hp folded paper tape, or standard 3-inch roll tape
- Line spacing:** Zero, single or double
  - Size:** Cabinet, 20 $\frac{3}{4}$ " x 12 $\frac{1}{2}$ " x 18 $\frac{1}{2}$ "; rack mount, 19" x 10 $\frac{1}{2}$ " x 16 $\frac{3}{8}$ " deep behind panel
  - Price:** Depends upon options; typically \$1300 to \$2000

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

The performance-proved hp 562A Digital Recorder is unique for its combination of speed, input capability, programming versatility and dependable operation in thousands of applications.

It prints digital data as fast as 5 lines per second, with as many as 12 digits per line. A storage feature for each column permits data transfer in 2 msec, after which the source is free to collect new data.

In addition to four-line BCD codes, ten-line code (without the data storage feature) also is available with plug-in cards. The recorder also accepts dual input (optional) to print data simultaneously from two unsynchronized sources—even if coded differently.

Analog output is available as an option for 562's which have 1-2-2-4 or 1-2-4-8 BCD column boards installed. The option, which includes controls for recorder calibration and zero adjustment, provides accurate analog output for any three columns, even when not printing.

Call or write today for complete information on the basic hp 562A and a detailed description of the many options available, together with a convenient order form that makes it easy to get the solid state recorder just right for your specific application.

with the  
**hp 562A**  
**Solid State**  
**Digital**  
**Recorder**



8870

## HEWLETT-PACKARD COMPANY

1501 Page Mill Road, Palo Alto, Calif. 94304, (415) 326-7000.  
 Sales and service in all principal areas. Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Que.



**W. W. MacDONALD, Editor**  
Dial Direct: (971-2645)  
Area Code 212

**J. M. CARROLL, Managing Editor (2293)**

**SENIOR EDITORS**

Samuel Weber (2371)  
George W. Sideris (3444)

**SENIOR ASSOCIATE EDITORS**

Michael F. Wolff (2600)  
John F. Mason (2666)

**ASSOCIATE EDITORS**

Michael F. Tomaino (2071)  
William P. O'Brien (2297)  
George J. Flynn (2188)  
George V. Novotny (3151)  
Leon H. Dulberger (3446)  
Alexander A. McKenzie (2685)

**ASSISTANT EDITORS**

Stephen B. Gray (2245)  
Barry A. Briskman (2306)  
Dan Smith (2467)  
Joel A. Strasser (2127)  
Vincent S. Acunto (2592)  
C. R. Whetstone (3495)  
Eric Valentine (2710)  
Louis S. Gomolak (2472)  
G. G. Tirellis (2187)

**REGIONAL EDITORS**

Harold C. Hood,  
1125 W. 6th St., Los Angeles 90017, Calif.  
(213-482-5450)

Laurence D. Shergalis,  
John Hancock Bldg., 255 California St.,  
San Francisco 94111, Calif. (415-362-4600)

Thomas Maguire  
McGraw-Hill Bldg., 607 Boylston St.,  
Boston 02116, Mass. (617-262-1160)

Cletus M. Wiley,  
Blair Bldg., 645 N. Michigan Ave.,  
Chicago 60611, Ill. (312-664-5800)

**ART DIRECTOR**

Howard R. Berry (2430)

**ASSISTANT ART DIRECTOR**

John C. Wright, Jr. (3430)

**EDITORIAL ASSISTANTS**

Lorraine Rossi, Virginia T. Bastian,  
Lynn Emery, Ann Mella, Lorraine Werner,  
Alice M. O'Brien, Sharon Parks,  
Claire Benell, Kay Fontana,  
Sandra A. Le Mond, Mary Jo Jadin

**FOREIGN NEWS BUREAU**

DIRECTOR, John Wilhelm, (2532);  
Lawrence Mihlon (2997), Alyne Elias  
(2998)

LONDON—John Shinn, Derek Barlow,  
Nicholas Landon, 34 Dover St., London  
W.1, England

BONN—Bruce Bendow, Richard Mikton,  
Silke McQueen, Mittelstrasse 39, Bad  
Godesberg, Germany

BRUSSELS—27 Rue Ducarle, Brussels,  
Belgium

PARIS—Robert Farrell, Arthur Erikson,  
17 Ave. Matignon, 3rd Fl., Paris 8,  
France

MILAN—Marc A. Messina, Via Manzoni  
No. 12, Milan, Italy

MEXICO CITY—Wesley Perry, Jr.,  
Lafregua 4-314, Mexico 1 D.F. Mexico

RIO DE JANEIRO—Leslie Warren, Rua  
Mexico 3-S/1507 1509, Rio de Janeiro,  
Brazil

MOSCOW—Stewart Ramsey,  
Kutuzovsky Prospekt 19, Apt. 28-29,  
Moscow, USSR

TOKYO—Richard Halloran, Charles Cohen,  
John Yamaguchi, Toranomom Sangyo  
Bldg., 1 Kotohiracho Shiba, Minato-Ku,  
Tokyo, Japan

**CIRCULATION MANAGER**

Hugh J. Quinn (2310)

**C. C. RANDOLPH, Publisher (2016)**

# electronics

A McGRAW-HILL WEEKLY 75 CENTS

**INFRARED COOLER.** Cryogenic temperature down to 25 deg K needed by infrared devices, parametric amplifiers, special semiconductor devices and densely packed microcircuits is achieved by a device no larger than a football. Unit developed by Malaker Labs works on modified Stirling cycle. *This closed-cycle system requires no valves or external gas supply.* See p 46

COVER

**TELCAN RECORDER.** America got its first look last week at the home video tape recorder developed in Britain to sell for \$160. Pictures aren't studio quality, but they'll do for the entertainment market. *With the recorder goes a \$160 tv camera, so the customer can make his own tv programs, just like home movies*

10

**DESIGNING LASERS.** Pump-power chart relates pump power, wavelength and propagation direction for optically pumped laser oscillators, to provide an easier way of evaluating laser performance. Computation techniques permit evaluating power density, spectral brightness, beamwidth and bandwidth. *The charts are reminiscent of those used in microwave design. There's also a handy table of definitions for laser-parameter symbols.*

By R. A. Kaplan, Wheeler Labs 23

**NEAR-FIELD PLOTTER.** This new design tool for microwave antennas makes use of a small near field as the resulting wave in the antenna feed line is measured as a function of probe location. The use of field recordings as a design tool is a modification of the spinning dipole method. The new technique is superior to direct field measurement at millimeter wavelengths. *The procedure is used to refine initial design based on ray optics or first-order calculations.*

By P. Wolfert, Sylvania 29

**TUNNEL DIODES AT Q-BAND.** An impedance transformation technique allows a tunnel-diode intended for X-band operation to function at up to four times its rated frequency—at 33 to 50 Gc. One advantage of operating the diode above its theoretical frequency limit is that diode cost is lowered. *This millimeter-wave oscillator makes use of principles previously employed to make S-band diodes function at X-band.*

By S. V. Jaskolski and K. Ishii, Marquette Univ. 32

**ARBITRARY-LENGTH BINARY COUNTERS.** This article presents a simple set of rules that will save time in counter design. These rules can be used to produce a logic design that will permit a counter to count to some arbitrary length sequence with a minimum number of packages, and in which the required fan-in and fan-out of the gates used is minimized. *It can supplant trial-and-error design procedures now widely used.*

By B. W. Meyer, Signetics Corp. 34

Contents continued



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

Title ® registered U.S. Patent Office; © copyright 1963 by McGraw-Hill Publishing Co., Inc. All rights reserved, including the right to reproduce the contents of this publication, in whole or in part.

Executive, editorial, circulation and advertising offices: McGraw-Hill Building, 330 West 42nd Street, New York, N. Y., 10036. Telephone Area Code 212 971-3333. Teletype TWX N. Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

OFFICERS OF THE PUBLICATIONS DIVISION: Shelton Fisher, President; Vice Presidents: Joseph H. Allen, Operations; John R. Callahan, Editorial; Ervin E. DeGraff, Circulation; Donald C. McGraw, Jr., Advertising Sales; Angelo F. Venezian, Marketing.

OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Hugh J. Kelly, Harry L. Waddell, L. Keith Goodrich, Executive Vice Presidents; John L. McGraw, Treasurer; John J. Cooke, Vice President and Secretary.

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 and Canada, \$6.00 one year, \$9.00 two years, \$12.00 three years. All other countries \$20.00 one year. Single copies, United States and Possessions and Canada 75¢. Single copies all other countries \$1.50.

THE PUBLISHER, UPON WRITTEN REQUEST TO OUR NEW YORK OFFICE FROM ANY SUBSCRIBER, AGREES TO REFUND THAT PART OF THE SUBSCRIPTION PRICE APPLYING TO COPIES NOT YET MAILED.

Subscribers: Please send change of address notices, subscription orders or complaints to Fulfillment Manager, Electronics, at the address below. Change of address notices should provide old as well as new address, including postal zone number if any. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send Form 3579 to Fulfillment Manager, Electronics, P. O. Box 430, Hightstown, New Jersey, 08520.

**Contents continued**

**"ELECTRONIC" HOSPITAL.** An Alabama group has built a 22-bed hospital whose core is a patient-monitoring console. Equipment includes EKG telemetry, closed-circuit tv, a computer and data transmitters. *The second of these experimental hospitals is scheduled for use at the New York World's Fair* 41

**WEATHER READOUT.** System developed for NASA automatically determines azimuth, elevation and slant range of weather balloon, processes the data transmitted by the radiosonde and prints out results. *Data output can be punched on cards for computer analysis, or in a variety of other forms* 42

**DEPARTMENTS**

**Crosstalk.** We approve, With Reservations 5

**Comment.** Cascade Follower 6

**Electronics Newsletter.** Eye Operation With Laser Successful 17

**Meetings Ahead.** Symposium on Mechanized Documentation 18

**Washington This Week.** Pentagon Trying to Reduce Contract Paperwork 20

**Research and Development.** Lensless Optical System Uses Laser 44

**Components and Materials.** Miniature Closed-Cycle Cooler Produces 25 K Reliably 46

**Production Techniques.** Programmed Machine Cuts Cost of Plastic Parts 48

**New Products.** Digital Q Meter 50

**Literature of the Week** 53

**People and Plants.** GT&E Elevates Two Executives 54

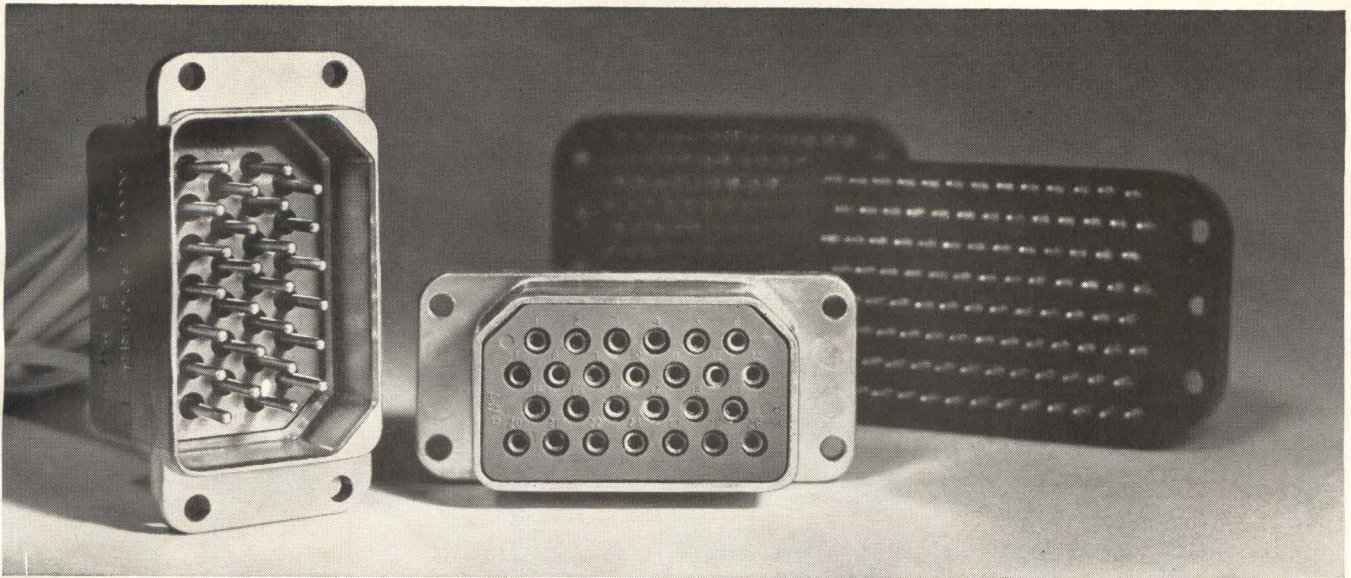
**Index to Advertisers** 56

**Editorial Index, 1963** 59

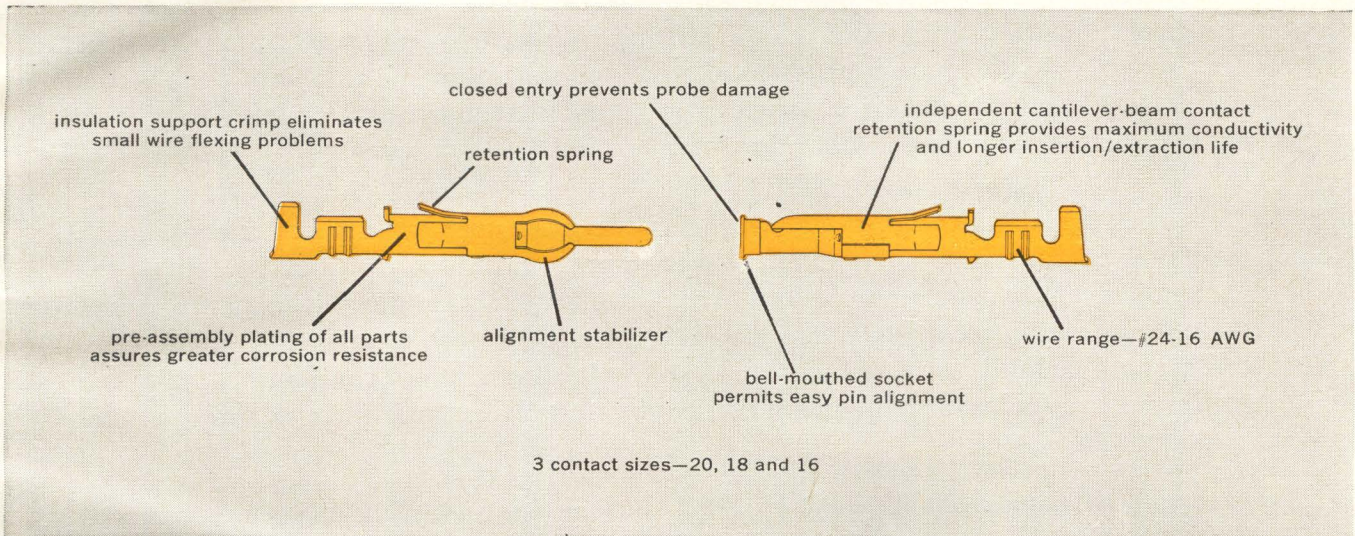


Audited Paid Circulation





## What's unique about these connectors?



## This stamped and formed contact!

This is the AMPin-cert\* TYPE III pin and socket contact—an exclusive development of AMP Incorporated. With it, you can now get reliable connector performance at a much lower initial cost . . . at the lowest applied costs in the industry. Consider these facts:

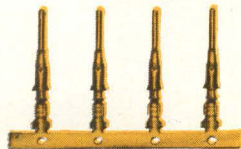
- performance characteristics conform to all dimensional and mechanical requirements of MIL-C-8384A.
- contacts are crimp, snap-in type

for assured uniformity and quick, easy connector assembly.

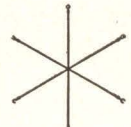
- strip-mounted, reel-fed termination with our automatic crimping machine provides rates of 1,600 uniformly crimped contacts per hour.
- contacts are available for a wide range of housing block types and configurations—including AMPin-cert "M" (MIL-C-8384), "D" and "D-D" and "W" Series Connectors.
- Standard AMP Contact Plating:

.00003" non-porous gold over .00003" nickel, special platings available on request.

Put an end to solder-pot uncertainties, hit-or-miss connections, production slow-ups due to time-consuming inspection steps. Get consistently reliable connectors and at the lowest applied costs in the industry. Specify AMPin-cert TYPE III contacts. There is no equivalent! Write today for more information.



**AMP**  
INCORPORATED  
Harrisburg, Pennsylvania



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

\*Trademark of AMP INCORPORATED



·:~] A MESSAGE FROM DU PONT ON... ]~·

# CLEANING

## AS A WAY OF CUTTING REJECTS

Modern manufactured products, both consumer and industrial, are characterized by the ever-tightening specifications under which they must be made. This places a major burden on the quality-control function in manufacturing. While stringent specifications must be reliably maintained, increasing production costs will not allow many rejects. As a result, *production cleaning* of manufactured articles and components has become vitally important in many industries as a way to hold down rejects and thus control costs.

We are interested in the subject of cutting rejects through cleaning because we make FREON fluorocarbons, already familiar as refrigerants and aerosol propellents. From the same chemical family comes a group of FREON solvents with interesting cleaning properties. Because these FREON cleaning agents do such a thorough job, they have in many cases caused acceptable limits of rejects to be reset downward. Numerous companies have found that they were rejecting large quantities of product simply because their cleaning systems were inadequate.

As the basis of a reliable cleaning system, FREON solvents have these unique properties for cutting reject rates of manufactured products:

**They're Thorough**—FREON solvents effectively remove dust, lint, dirt, scale, grease, oil, chips and other contaminants. And they penetrate the tiniest openings and spaces because their surface tension is lower than that of other solvents. So they'll make your product consistently pass the tightest cleanliness specifications.

**They're Selective**—Despite their thorough cleaning action, FREON solvents have no deleterious effect on metallic and non-metallic materials of construction, such as elastomers, plastics, paints and finishes. So delicate tolerances are never harmed.

**They're Pure**—FREON solvents are among the purest chemical compounds in commercial pro-

duction today. As such, they leave no residue on or in parts being cleaned, when they vaporize. And FREON can be easily repurified in a simple still or filter unit.

FREON solvents have already been successfully used in cutting reject rates in the electronic, electrical and aerospace industries. We think they might be able to do the same in your own manufacturing operation. They're priced at \$7.50/gallon, but if their properties are applicable to your situation, they could easily save you hundreds of times your original investment. Also, FREON solvents are very stable, so you can use them over and over for maximum economy.

Write us for full details. If you wish, we'll send a specialist to analyze your current cleaning setup. Du Pont Company, FREON Products Div., N-2420E-12, Wilmington 98, Del.

**FREON<sup>®</sup>**  
cleaning solvents



BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY



## We Approve, With Reservations

**THERE IS** a move afoot in Washington to broaden government support of research. Behind the move are reasons that can be called both positive and negative. We salute the positive reasons and thumb-down the negative ones.

The positive approach holds that there are numerous social and scientific problems that have not been solved. Greater funding of programs in, for example, pollution control, medical research, meteorology and oceanography, and studies of such problems as the impact of automation, are being urged.

Acceleration of research in such fields would be socially, scientifically and economically rewarding. The electronics industry, in particular, could anticipate greater opportunities to diversify into nonmilitary product areas—diversification that would aid its growth and long-range stability.

It is, therefore, an attractive proposal.

But our enthusiasm is tempered by some of the negative reasoning behind the proposal.

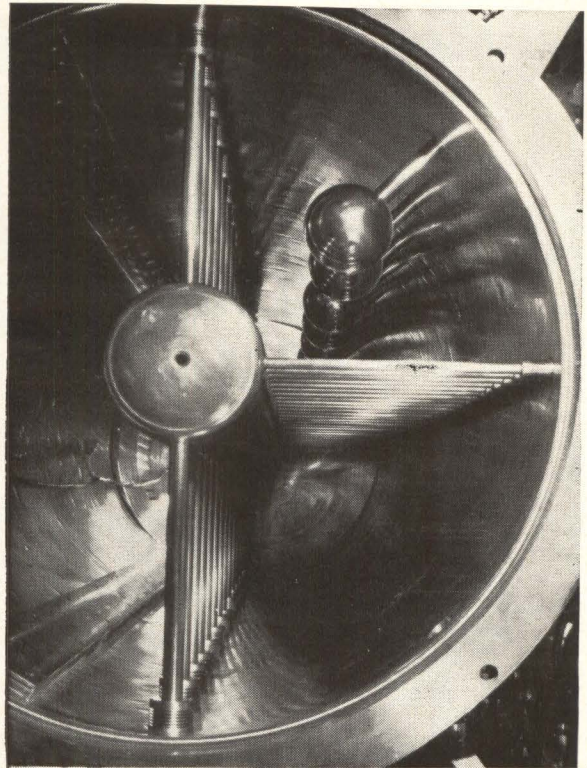
The strongest backing seems to come from those concerned about slowdowns in military research. They want a program to maintain the impetus that military research has given the economy and technology—as a substitute for military research.

If the proposal is accepted on this basis there is danger that the program will never get off the ground. Worse, promoting nonmilitary research as a substitute for military research can build up pressures to decrease military research solely for the purpose of increasing nonmilitary research. It could easily go too far.

This sort of reasoning is highly undesirable because it could stigmatize government-funded nonmilitary research as a sort of scientific WPA that would have to compete with pork-barrel projects for appropriations. It would be very difficult at present to build an effective case for programs to forestall a depression in the "business" of R&D. One recent survey (*ELECTRONICS*, p 18, Dec. 6) predicted that R&D expenditures in the U.S. next year would total \$20 billion, reflecting a \$1.1-billion increase in government funding and \$500-million increase in industry spending.

If the object of the proposal is to pump money and technology into the economy, rather than to get a job of work done, then there is no necessity for shifting from military to nonmilitary research.

It seems clear, therefore, that government support of nonmilitary research should be supported on the



ZERO GRADIENT SYNCHROTRON at Argonne National Laboratory is one of the latest additions to national research facilities. This is the ZGS's 110-foot linear accelerator

merits of projects proposed. To cite just one example, air pollution: It has been estimated that air pollution costs the nation over \$11 billion a year in money and perhaps 19,000 deaths a year. Problems such as this are well worth solving for their own sake.

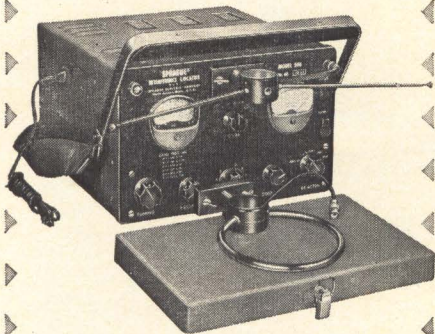
## Coming In Our January 3 Issue

**THE NEW YEAR.** Our next issue contains our annual electronics markets special report. It probes the electronics industry and highlights areas of profit, plateau or penury—in detail. We've developed the outlook for 1964, and beyond, through interviews with government, military, industrial, scientific and marketing specialists. The men we spoke to not only know fairly accurately what is going to happen, in many cases they make it happen. They are in the top echelon of our industry, and their comments reflect the best information obtainable on where the dollars will be spent. In text and figures, we've brought informed order to much of the disparate information we gathered. Join us next week for an inside view of the year ahead.



# SPRAGUE®

## MODEL 500 INTERFERENCE LOCATOR



This versatile instrument is a highly sensitive interference locator—with the widest frequency range of any standard available unit! Model 500 tunes across the entire standard and FM broadcast, shortwave, and UHF-TV spectrums from 550 kc. to 220 mc. in 6 bands.

It's a compact, portable, rugged, versatile instrument—engineered and designed for most efficient operation in practical field use. It features a transistorized power supply, meter indications proportional to carrier strength as well as sensitivity of 5 microvolts minimum for 5% meter deflection over entire tuning range.

Send for brochure IL-106.

**SPRAGUE ELECTRIC COMPANY**  
35 Marshall Street, North Adams, Mass.



564-R2

6 CIRCLE 6 ON READER SERVICE CARD

## COMMENT

### CASCODE FOLLOWER

I noted with interest the excellent article by R. W. Johnson entitled, The Cascode Follower, which appeared in your Dec. 6 edition (p 69).

The application note at the bottom of the page suggested that a transistor version of this circuit should be possible. You may be interested in the fact that a transistor version of this circuit was published in the Second Edition of the General Electric Transistor Manual as a "hi-fi" amplifier of low output impedance for directly driving loudspeakers. The work that I did on this transistor circuit was, in turn, suggested by Dr. R. A. Stasior who had become acquainted with a similar tube circuit in his student days in Canada. In looking up the tube circuit, we found that it was published, strangely enough, in *ELECTRONICS* magazine in November of 1946 (p 206).

Perhaps the only conclusion that can be drawn from this is that there should be some technique for making useful circuits available so that it is not necessary for an engineer to "re-invent the wheel." The only suggestion I have is for some publisher like McGraw-Hill to classify circuits somewhat in the form of a dictionary so a person could, for example, find the "cascode follower" circuit with a minimum of difficulty.

H. R. LOWRY

Semiconductor Products Department  
General Electric Company  
Syracuse, New York

- The United States Patent Office is working on a system for classifying patented transistor circuits with digital codes, to simplify the processing of incoming patent applications.

### FIELD EFFECT DEVICE

I read with interest the *Research and Development* article, New Field Effect Device May Aid Integrated Circuit Design, in the Nov. 29 issue (p 44). I would be interested in obtaining one of these devices for experimental purposes. I would appreciate any information or help that you could give me in this matter.

WALTER MAUDERLI

Department of Radiology  
College of Medicine  
University of Florida-Gainesville  
Gainesville, Florida

- For further information, write to H. C. Nathanson (one of the inventors) at Westinghouse Research Laboratories, Pittsburgh 35, Pennsylvania.

### REVERSED DIODE

At the risk of being called a "nit picker," I should like to point out what I feel is a discrepancy appearing in your *Electronics Color Code* chart (p 37, Nov. 15).

At the head of the column describing diode coding, a schematic symbol of the diode appears. However, since the sample color coding of the diodes shown below it show the cathode as being on the left (and it is labelled as such on the chart), it infers that the triangle end of the diode symbol is also the cathode, and the bar end the anode. I am lost—shouldn't it be the other way?

Being heavily involved in solid-state logic circuitry for the last few years and having used the bar end of the diode symbol as the cathode with remarkable success, I feel the symbol should be turned around to agree with the color coding shown. Don't you agree?

Seriously though, the chart is a beautiful one, which I will keep for reference until the standards change and a new one will be issued (hopefully).

M. ARNAUTOFF

Redondo Beach, California

- We agree. That diode symbol should be turned around.



## WORKHORSE



**Downtime's nemesis, rugged and reliable** as a purebred workhorse — that's Mincom. Common denominator of dependability in all four basic Mincom Recorder/Reproducers is the exclusive Mincom DC Top Plate. Here's a tape transport built with beautiful simplicity: Only 12 moving parts with four easy adjustments, full dynamic braking, instant six-speed pushbutton control, seven or fourteen tracks — plus tape speed accuracy within  $\pm 0.005\%$  using Mincom's Cyclelock®. Whether your specifications call for wideband predetection at 1.5 mc, or a comfortable 120 kc at 60 ips, there's a reliable Mincom workhorse to meet your facility's needs. Write today for details.

**Mincom Division** **3M**  
COMPANY

2049 South Barrington Avenue, Los Angeles 25  
425 13th Street N.W., Washington 4, D.C.



## GENERAL FEATURES

- Fan-Out:** Guaranteed fan-out is 4 from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Buffer element increases fan-out to 30.
- Speed:** Guaranteed worst-case propagation delay of 40 nanoseconds per node.
- Power:** Average dissipation per function varies from 4 milliwatts to 10 milliwatts. Typical, 2 milliwatts per node.
- Application:** Simple design rules permit rapid application and insure compatibility between functions.

### Functional Complexity:

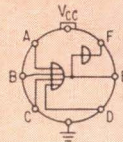
Shifting and counting can be done with a single element. Other elements are also of high complexity.

The average element consists of 4 NOR functions, thus permitting the use of two-sided printed circuit board for element inter-connection and resulting in exceptionally high packaging density.

Cost is not linearly proportional to functional complexity, but is related primarily to die size. Additional elements of like complexity can be produced on a custom basis at a comparable price. For example, in quantities of 49-200:

Elements	R	D <sub>2</sub>
Transistors	15	4
Resistors	21	6
Die area	2500 mil <sup>2</sup>	1600 mil <sup>2</sup>
Price	\$33.15 ea.	\$16.25 ea.

### GATE ELEMENT, G



$$E = \overline{A+B+C+D} \quad (\text{Positive logic})$$

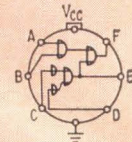
$$F = A+B+C+D$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D	1 Load
Fan-Out — Pin E	3 Loads
— Pin F	4 Loads
Signal Propagation Delay — Output E (Note 3)	40 nsec
— Output F	70 nsec
Power Consumption*	5.0 mW

### ADDER ELEMENT, A



$$E = CD \quad (\text{Positive logic})$$

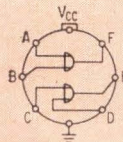
$$F = (A+B)(C+D)$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D	1 Load
Fan-Out — Pin E	3 Loads
— Pin F	4 Loads
Signal Propagation Delay — Output E	70 nsec
— Output F	100 nsec
Power Consumption*	12.5 mW

### DUAL 2-INPUT GATE ELEMENT, D<sub>2</sub>



$$E = \overline{C+D} \quad (\text{Positive logic})$$

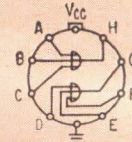
$$F = \overline{A+B}$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D	1 Load
Fan-Out — Pins E, F	4 Loads
Signal Propagation Delay — Pins E, F	40 nsec
Power Consumption*	5.0 mW

### DUAL 3-INPUT GATE ELEMENT, D<sub>3</sub>



$$H = \overline{A+B+C} \quad (\text{Positive logic})$$

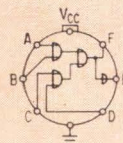
$$G = \overline{D+E+F}$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D, E, F	1 Load
Fan-Out — Pins G, H	4 Loads
Signal Propagation Delay — Pins G, H	40 nsec
Power Consumption*	5.0 mW

### EXCLUSIVE OR ELEMENT, HALF ADDER, H



$$E = \overline{(A+B)(C+D)} \quad (\text{Positive logic})$$

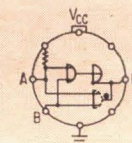
$$F = \overline{(A+B)(C+D)}$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D	1 Load
Fan-Out — Pin E	4 Loads
— Pin F	3 Loads
Signal Propagation Delay — Output E	100 nsec
— Output F	70 nsec
Power Consumption*	10 mW

### BUFFER ELEMENT, B



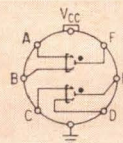
$$E = \overline{A+B} = \overline{AB} \quad (\text{Positive logic})$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B	2 Loads
Fan-Out — Pin E	30 Loads
Signal Propagation Delay — Output E (Full Load)	60 nsec
Power Consumption — 50 percent duty and full load*	12.5 mW

### EXPANDER GATE, E



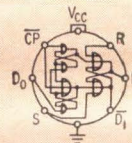
The E element is used to increase the fan-in capabilities of the family. The E is similar to the D element except that the output node resistors are omitted. The E can extend the fan-in of any other element, except the Buffer, up to a maximum of 4 additional inputs without exceeding the guaranteed electrical performance of the other elements.

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins A, B, C, D	1 Load
Fan-Out — Pins E, F (Note 2)	N.A.
Signal Propagation Delay — Pins E, F	40 nsec
Power Consumption (Note 2)	N.A.

### REGISTER ELEMENT, R



The R element is a synchronous set and reset flip-flop with asynchronous set and reset. This element can be used both as a full shift register stage or as a complementing binary flip flop. The complementing function is achieved by coupling back  $\overline{D_0}$  to  $D_1$ . Data at  $D_0$  are entered during a one-to-zero transition of CP. The data bit  $D_1$  must be present a minimum of 70 nsec before, and 20 nsec after the 50-percent point of a one-to-zero transition of CP.

$$D_0 = S + CPD_0$$

$$\overline{D_1} = R + CPD_1$$

#### ELECTRICAL PERFORMANCE

(Worst case)  $V_{CC} = 3\text{V}$ ;  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

Input Loading — Pins D <sub>0</sub> , S, R	1 Load
— Pin CP	2 Loads
— Pins D <sub>0</sub> , $\overline{D_1}$	3 Loads
Signal Propagation Delay — Synchronous Entry	Note 1A
— Asynchronous Entry	Note 1B
Power Consumption*	15 mW

### NOTES:

- 1A. Synchronous entry of data: When data are being entered through the  $D_0$  input, the 50-percent points of the  $D_0$  and  $\overline{D_1}$  waveforms shall occur within 120 nsec of the one-to-zero transition of CP.
- 1B. Asynchronous set and reset: When the R element is set or reset through the R and S inputs, the 50-percent points of the  $D_0$  and  $\overline{D_1}$  waveforms shall occur within 70 nsec of the 50-percent point of the R or S pulse.

2. The fan-out and power consumption for the E element are not applicable. The ratings for the element being expanded apply.
3. The maximum signal propagation delay is defined for the entire temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  and any combination of the rated loading. Measurement is made between 50-percent points input-output with a G element as a driver.

\* Maximum fan-out.



# IMMEDIATE AVAILABILITY



## LOW POWER INTEGRAL LOGIC CIRCUITS

### *General Micro-electronics Inc.*

offers its first *Multi-Log* set, a family of low-power logic functions designed for critical military applications at milliwatt power levels. The devices are manufactured by modern planar epitaxial processes and the latest masking technology which, coupled with simplicity of circuit design, provides the customer with the following advantages:

- High Performance
- High Reliability
- Prompt Delivery
- Low Cost

### PACKAGING

The elements are immediately available in standard TO-5 type header with low-silhouette cap, 8 and 10 leads. Hermetically-sealed flat pack will soon be available.

### QUALITY ASSURANCE

The best assurance that a product is reliable is through careful evaluation of extensive data. Hence, in addition to the standard MIL-S-19500 Lot Acceptance Life Data, General Micro-electronics will provide up-to-date product distribution, operating life, storage life, stress-to-failure and MTBF calculations on a continuous basis for every product.

For detailed Electrical Specifications and Design Rules Handbook, contact Mr. Earl Gregory, Manager, Semiconductor Device Marketing.



***General Micro - electronics Inc.***

2920 SAN YSIDRO WAY, SANTA CLARA, CALIFORNIA 95051 TWX 737-9961 (408) PHONE 739-2897 (408)



# Home Tv Tape Recorder—It Really

By **ALEXANDER A. MCKENZIE**  
Associate Editor

**DAN SMITH**  
Assistant Editor

British device gives  
picture adequate for  
entertainment purposes

**NEW YORK**—At an offhand demonstration last week, the American press got its first glimpse of the much-publicized Telcan home video tape recorder (p 19, Sept. 13; p 7, Aug. 23; p 7, Aug. 16; p 8, July 5).

Allowing for conditions, which were terrible, two observers from **ELECTRONICS** agreed that the British device probably does live up to its advance billing. It should provide adequate recordings of television programs and vidicon-camera signals, and at its price—\$160 for the model to be sold in the United Kingdom beginning in March—may find a wide market among ordinary tv viewers.

The demonstration, held in a basement room of a local Cinerama theater, was bad on two counts. Tv reception was poor at the location, so that the signals fed to the recorder were weak and fuzzy, and interference, probably from stray tv signals, played hob with the recordings.

Michael Turner, a director of Nottingham Electronic Valve Co., Ltd., of England, developer of the device, said the interference problem in Manhattan had been overlooked in planning the presentation. The trouble, he said, could be easily corrected with proper shielding of the recorder. To illustrate his point, he moved his hand back and forth near the recorder head, producing a visible change in the interference displayed on the tv screen.

**Picture Quality**—Deterioration is another matter, Turner said. Some is always present between the signal picked up by the tv receiver and that reproduced by the recorder. The deterioration was evident in the demonstration, but, because of the interference and the poor quality of the tv signals, it was impossible to judge exactly how good a picture Telcan can deliver.

However, this much could be told. The pictures that actually were re-

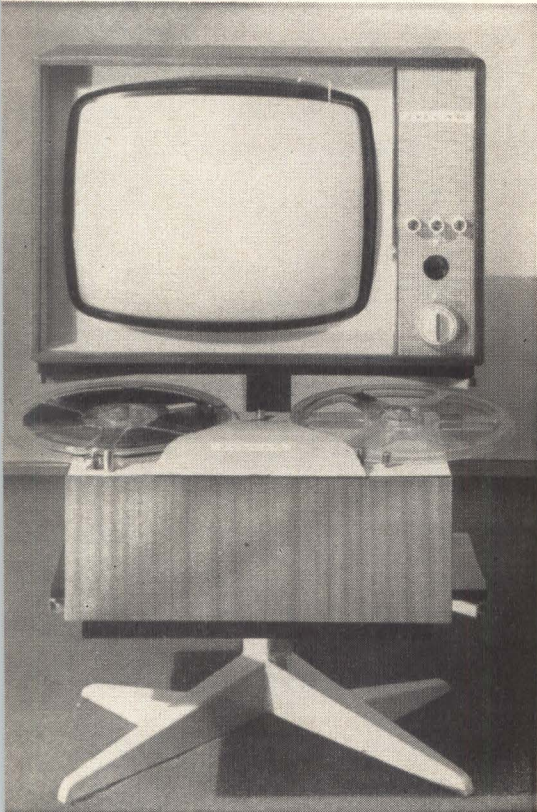
produced probably would have been found adequate—if barely so—by most viewers, but the degree of deterioration makes it unlikely Telcan can be used for any purpose other than entertainment. Pictures taken with an inexpensive vidicon camera, which the company also plans to sell for about \$160, were reproduced more clearly by the tape recorder.

**Price Is Right**—The announced price of the tape recorder, which has been greeted with some skepticism in the press, will be no trouble to meet, according to Turner. But a more sophisticated version than the one planned for the British market might be selected for the U. S., he said, with a consequent increase in price. Nottingham Electronic will make the recorder for the United Kingdom market. A new company, jointly owned by Cinerama and Nottingham, will manufacture the devices for sale in the western hemisphere. These won't reach the U. S. in any quantity until next fall, Turner said.

Major innovations in the tape recorder, Turner said, have to do with actual recording methods—the setting of the tape, for instance. Nottingham Electronic is reluctant to discuss these because it presently holds only a British provisional patent on the device. However, Turner did supply many technical details.

**Overall System**—The recorder is connected to the detector circuit of the home tv set and records whatever signal is tuned in on the set. Alternatively, it records signals from a home camera. In this case, the NEV camera feeds r-f output into the antenna input of the tv receiver. On playback, the recorder works into the detector-output point of the tv set and the signal, amplified by the video stages, is normally displayed.

**Recorder**—The recorder has one motor to operate the tape-drive capstan, and, through a pulley and belt arrangement, the tape supply and tape take-up reels. Tape speed



FIRST MODEL to reach the market will have the Telcan tv tape recorder mounted on a slide under the tv receiver (top), which Nottingham Electronic will also sell. Second version will combine the recorder and tv set



# Works

is 120 inches per second. Tape used is ¼-inch, ½-mil Mylar. Machine can handle up to 1½-inch diameter reels. Transport is capable of handling thinner tapes that would give up to 30 minutes on a side but such tape is not presently available.

With present reels and tapes, 22 minutes of recording are possible on each side of tape, or a total of nearly 45 minutes. With automatic tape turning, a continuous performance of 45 minutes might be possible. The tape-turning mechanism is not yet available.

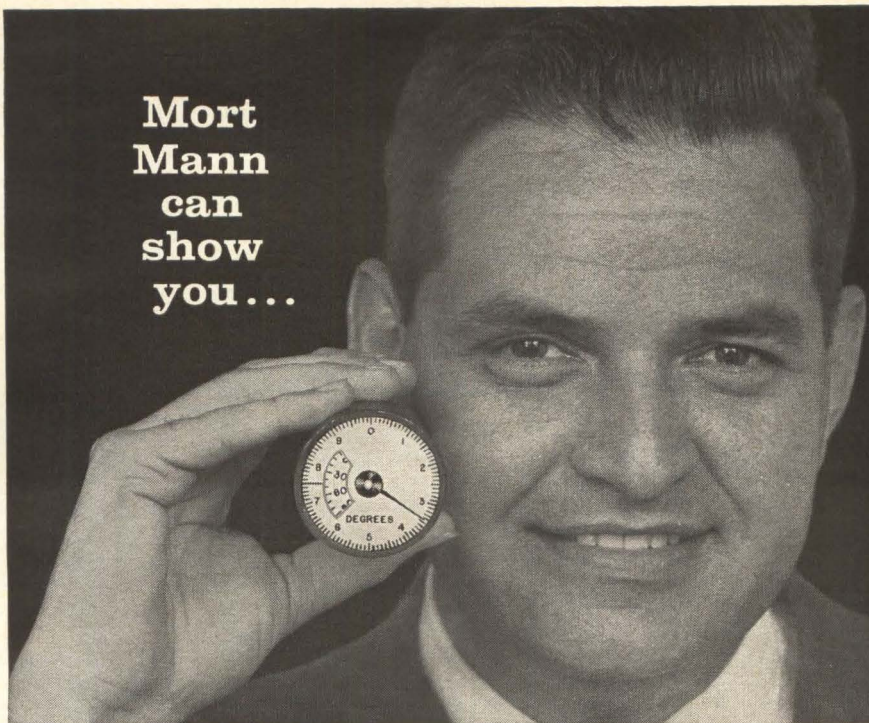
As received by the recorder—which handles the picture processing—the composite video signal is split into synchronizing and video information, amplified and fed into the one video recording head. On replay, a preamplifier separates sync and video signals and feeds them into the appropriate receiver circuits. Bandwidth is better than 2 Mc but the equipment has a 3-Mc rise time and its resolution depends upon noise. Resolution in the highlights is better than in the blacks. Resolution is enhanced between mid-gray and peak white.

The high-resolution heads are not expensive nor are they long-lasting. They are expected to be serviceable for about 100 hours after which they can be replaced for about \$2, like a record stylus.

Recorder circuits are transistor and the driving transistor delivers about 1 watt to the recording head. The signal off the tape is about 1 to 1.5 volts and a divider across the output maintains that level. The volume control on the tv set, therefore, is operated normally. In the future, color can be accommodated (at half the playing time per tape—driving the tape in one direction only) by using one of the 18-mil signal tracks for color difference signals.

**Camera**—The vidicon camera's circuits are all-transistor. It delivers about 30 millivolts to the antenna terminals of the receiver. Tv camera techniques (no shutter needed) allow putting most of the money into good optics. An f 1.9 lens is used.

**Mort  
Mann  
can  
show  
you...**


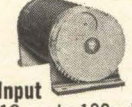





*Sales Engineer, North Atlantic Industries*

## how North Atlantic's instrument servos fill the five major systems jobs... exactly.

Measurement, remote display, data conversion, control, computation... Name the task and it's probable that the North Atlantic man can show you how to meet it precisely from NAI's comprehensive line of 3" and 2" vacuum tube and all solid state instrument servos.

Production models are available for high- and low-level ac, dc, synchro, strain gage, thermocouple, resistance bulb and other inputs. Most can be supplied with choice of pointer, counter, torque shaft or digitizer outputs. All utilize flexible design that permits any combination of input-output features to be supplied rapidly to user requirements, for both ground and airborne applications. Some are described below.

SBI-7000	SBI-7090	SBI-8010	SBI-8020	SBI-8050
Single Pointer DC Ratiometer	A-to D Converter	Shaft Position Repeater	Three-Digit Counter Readout	Dual Scale Readout
				
Input Denom. 5-50v Num. 10 mv-100v Accuracy ±.2 to ±.5% fs Resolution .1 to .2% Response .25 sec. fs	Input 10 mv to 100v dc Accuracy ±.1% fs Resolution from 0.05%* Response from 2 sec fs* *depending on encoder used	Input ac, dc or synchro Accuracy ±.1 to ±.5% fs Resolution .05 to .25% Response 7 sec. @ 15 oz-in	Input ac, dc, or synchro Accuracy ±.5 to .1% fs Resolution .02 to .05% Response 15 sec. fs	Input ac, dc, or synchro Accuracy .05 to .1% fs Resolution .02 to .05% Response 6 sec. fs

If there's a critical job for an instrument servo in your system design, it will be worth your while to talk to your North Atlantic engineering representative. For his name, call or write today. Or request Catalog SFC-1 for complete data.

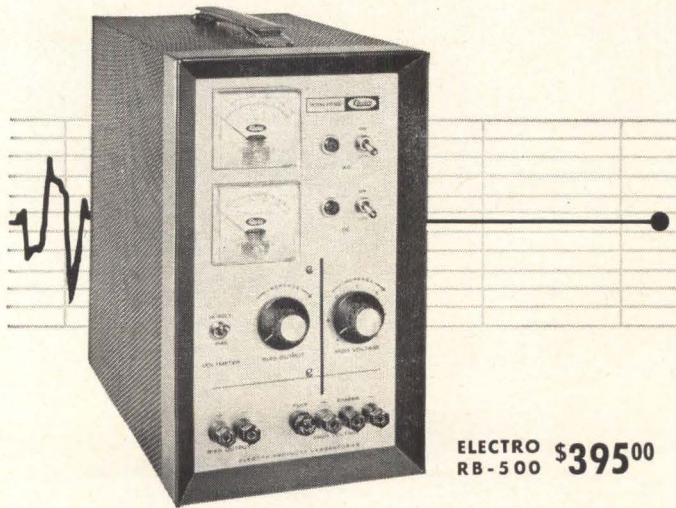


**NORTH ATLANTIC industries, inc.**  
TERMINAL DRIVE, PLAINVIEW, L. I., NEW YORK • OVerbrook 1-8600



PRODUCT  
NEWS from EPL

# NEW... hi-voltage regulated DC Power Supply under \$400.



ELECTRO  
RB-500 \$395.00

### Compare Value

Brand	Volts	Current	Regulation (Combined line & load)	Price
K	0-325	0-200 MA	0.02%	\$495.00
S	0-500	0-200 MA	2.0%	400.00
Electro RB-500	0-500	0-250 MA	0.03%	395.00

### Compare Features

**High Voltage Output:** 0-500 VDC. 0-250 MA  
**Precise Regulation:** 0.03% or .015V, whichever is greater, for combined line (105-125V) and load (no-load to full-load) variations.  
**Ripple:** 5MV, RMS maximum.  
**Bias Output:** 0-150 VDC.  
**Filament Outputs:** Two separate 6.3V at 5A outputs for 6.3V at 10A or 12.6V at 5A.  
**Primary and Secondary Protection.**  
**2% D'Arsonval Meters:** Dual scale . . . 0-500V/0-150V. 0-250 MA  
**Separate AC, DC Switches.**  
**Continuous Output Voltage Adjustment:** Regulation maintained well below 3V output setting.  
 Wherever precisely regulated DC power is a must, the EPL RB-500 fills the bill economically. Engineered and built for heavy-duty production testing; electronic circuitry development and design in industry, laboratories and schools.

Write for Literature & Name of Your Electro Distributor!



## ELECTRO PRODUCTS LABORATORIES

6125-F Howard, Chicago 48 (Niles), Ill.  
Phone: 647-6125

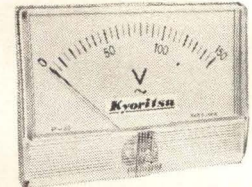
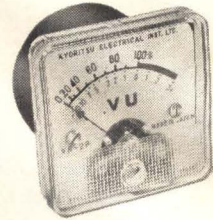
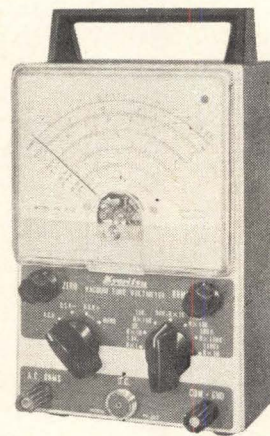
Canada: Atlas Radio Corp., Toronto

Since 1936—Pioneers in DC Power Supplies

3200

Around the world . . .

## KYORITSU Measuring Instruments



# Kyoritsu

ELECTRICAL INSTRUMENTS WORKS, LTD.

120, Nakane-cho, Meguro-ku, Tokyo, Japan

Cable address: KYORITSUKEIKI TOKYO

Telephone: 717-0131/5

Telex: TK 2849

CIRCLE 200 ON READER SERVICE CARD

### TO ORDER REPRINTS

Fill in, cut out coupon below  
insert in envelope and mail to:

electronics

Reprint Dept.

330 W. 42nd Street, New York, N. Y. 10036

### REPRINT ORDER FORM

(To help expedite mailing of your reprints please send cash, check or money order with your order.)

For Listing of Reprints Available see the Reader Service Card.

For Reprints of the latest Special Report:

What's New in Semiconductors

Send me . . . . . Reprints of Key No. R-45 1-10, copies 75¢ ea. 10-24, 60¢ ea. 25 or more 50¢ ea.

For Reprints of previous Special Reports or Feature Articles fill in below:

Send me . . . . . Reprints of Key No.(s) . . . . . @ . . . . .¢ each.  
(For prices, see Reader Service Card.)

\*For orders of Bulk Reprints of other editorial articles in this issue or past issues:

Send me . . . . . Reprints of page No.(s) . . . . . of issue date . . . . .

of article entitled . . . . .

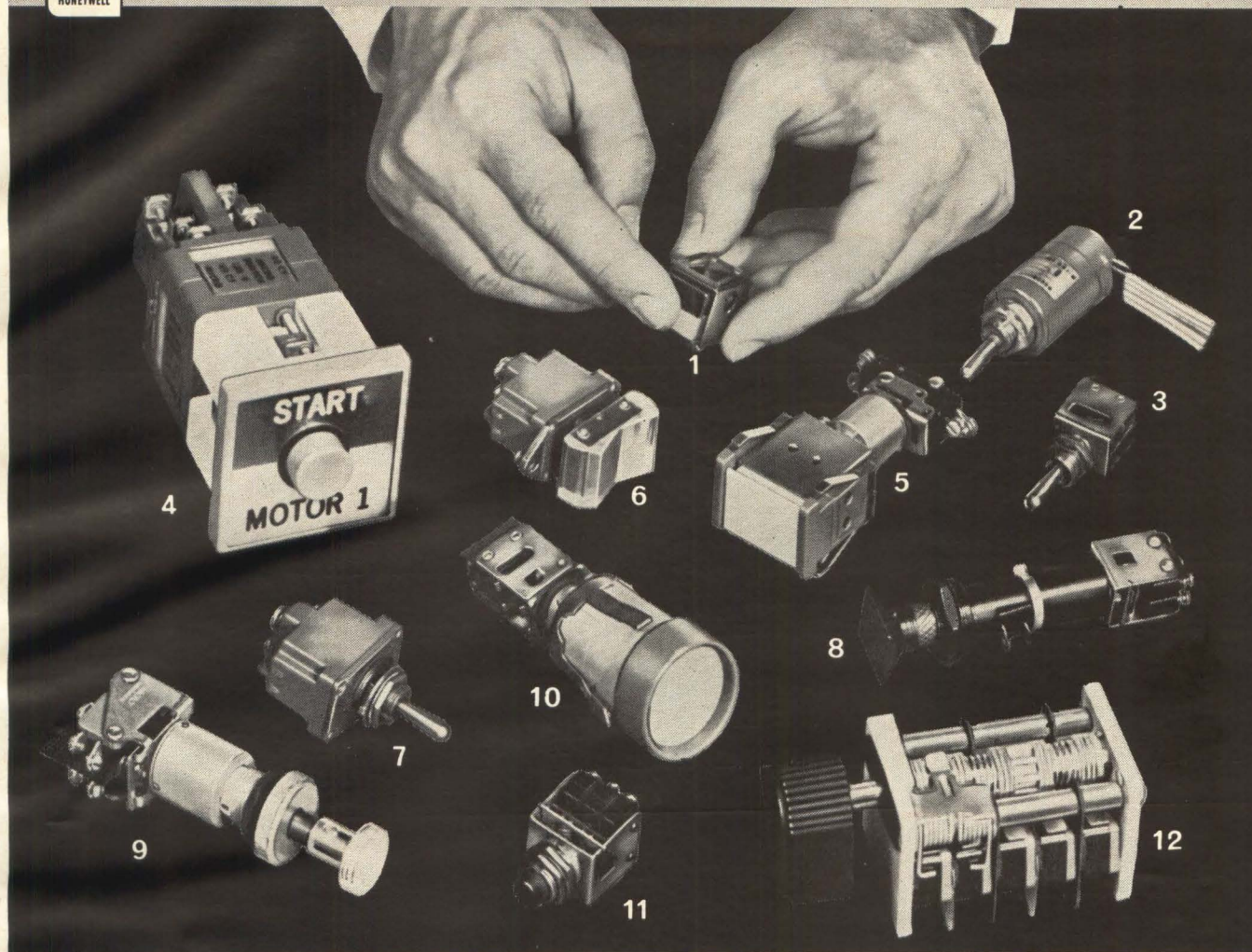
\*Minimum bulk order 100 copies. You will be advised of costs by return mail.

Name . . . . .

Number of Street . . . . .

City, Zone No., State . . . . .





# HUNDREDS AVAILABLE to give you the right one...quickly !

Answers to literally thousands of control problems are ready for you in the broad selection of panel switches by MICRO SWITCH. Because of this wide choice, you are protected from compromise on design, quality and cost.

The MICRO SWITCH selection is the result of years of experience in developing switches for every known requirement throughout industry—commercial, aerospace, electronics, etc. And, a staff of experienced engineers is ready to give you seasoned design and application assistance.

For information, call your MICRO SWITCH Branch Office (see Yellow Pages), or write for catalogs.

- 1. Miniature lighted pushbutton switch. Indication and control in less than one cubic inch.
- 2. Magnetic hold-in toggle switch. Completely sealed.
- 3. Multi-circuit toggle switch. Gold or silver contacts.

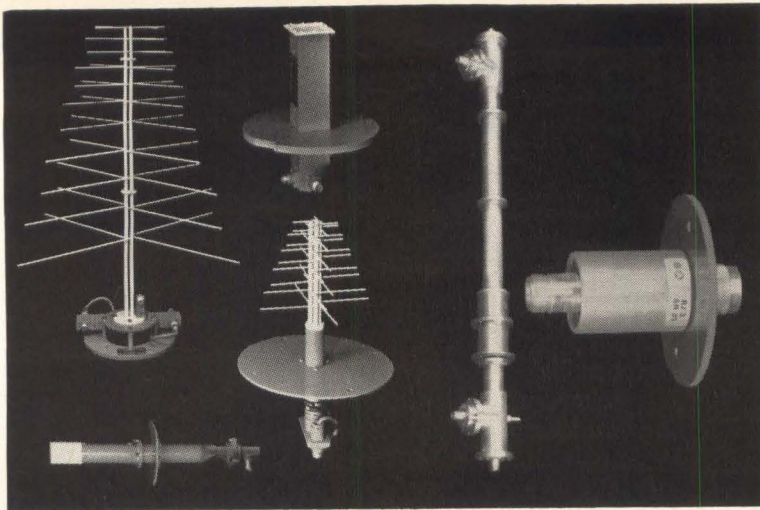
- 4. Coordinated Manual Control. Pushbutton and/or rotary operation, lighted display.
- 5. Modular lighted pushbutton switch. 20 switch modules.
- 6. Rocker-actuator switch. Toggle versatility, pushbutton control.
- 7. Sealed 3-position toggle switch. Complete circuitry selection.
- 8. Lighted pushbutton switch. Small size, easy mounting.
- 9. Heavy-duty pushbutton switch. Rugged. Oiltight panel seal.
- 10. Modular lighted pushbutton switch. Round companion to No. 5.
- 11. Multi-circuit miniature pushbutton switch. Features good switching action feel.
- 12. Rotary-selector switch assembly. Up to 8 poles available.



**MICRO SWITCH**  
FREEPORT, ILLINOIS  
A DIVISION OF HONEYWELL  
IN CANADA: HONEYWELL CONTROLS LIMITED, TORONTO 17, ONTARIO

HONEYWELL INTERNATIONAL—SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD. MANUFACTURING IN UNITED STATES, UNITED KINGDOM, CANADA, NETHERLANDS, GERMANY, FRANCE, JAPAN.





### Broadband Antennas & Feeds

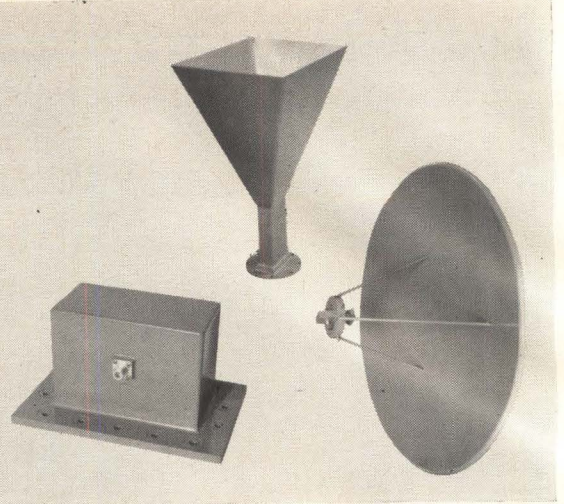
Log and Crossed  
Log Periodics  
Four-Ridge Waveguide  
Circular Waveguide

### Rotary Joints & Slip Rings

Single Channel  
Dual Channel  
Slip Ring  
Assemblies

### Antenna Test Range Components

Transmitting Antennas  
Gain Standards  
Mixers & Adapters



Write today to: ■ Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta, Georgia 30324 Phone: 404-938-2930 TWX: 404-938-1322

# Scientific-Atlanta, Inc. SA

CIRCLE 201 ON READER SERVICE CARD

## COMINCO

HIGH PURITY METALS  
AVAILABLE FORMS

*clip and save*

Product	ALUMINUM	ANTIMONY	ARSENIC	BISMUTH	CADMIUM	GOLD	INDIUM	LEAD	SILVER	TIN	ZINC
BARS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SHEETS	✓				✓	✓	✓	✓	✓	✓	✓
WIRE	✓				✓		✓	✓		✓	✓
POWDER		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SHOT		✓		✓	✓	✓	✓	✓	✓	✓	✓
ROD	✓			✓	✓		✓	✓	✓	✓	✓
RIBBON							✓	✓			
PRE-FORMS	✓				✓	✓	✓	✓	✓	✓	✓
SALTS					✓		✓				

## COMINCO PRODUCTS, INC.

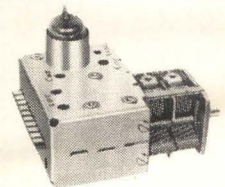
electronic materials division

933 West Third Avenue, Spokane 4, Washington  
Phone Area Code 509 RI 7-7103 • TWX 509 328-1207

3502

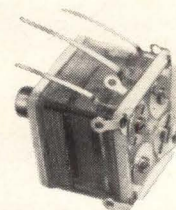
14 CIRCLE 14 ON READER SERVICE CARD

### AM-FM Tuner Unit



AM SEC. CAPACITY: MAX. 377PF  
MIN. 12PF  
TUBE: 6AQ8, 12DT8, 17EW8

### PLASTIC VARIABLE CONDENSER



Square Size:  
15mm., 17mm.,  
20mm., 21mm.,  
Single band:  
2 band, 3 band  
and for FM only.



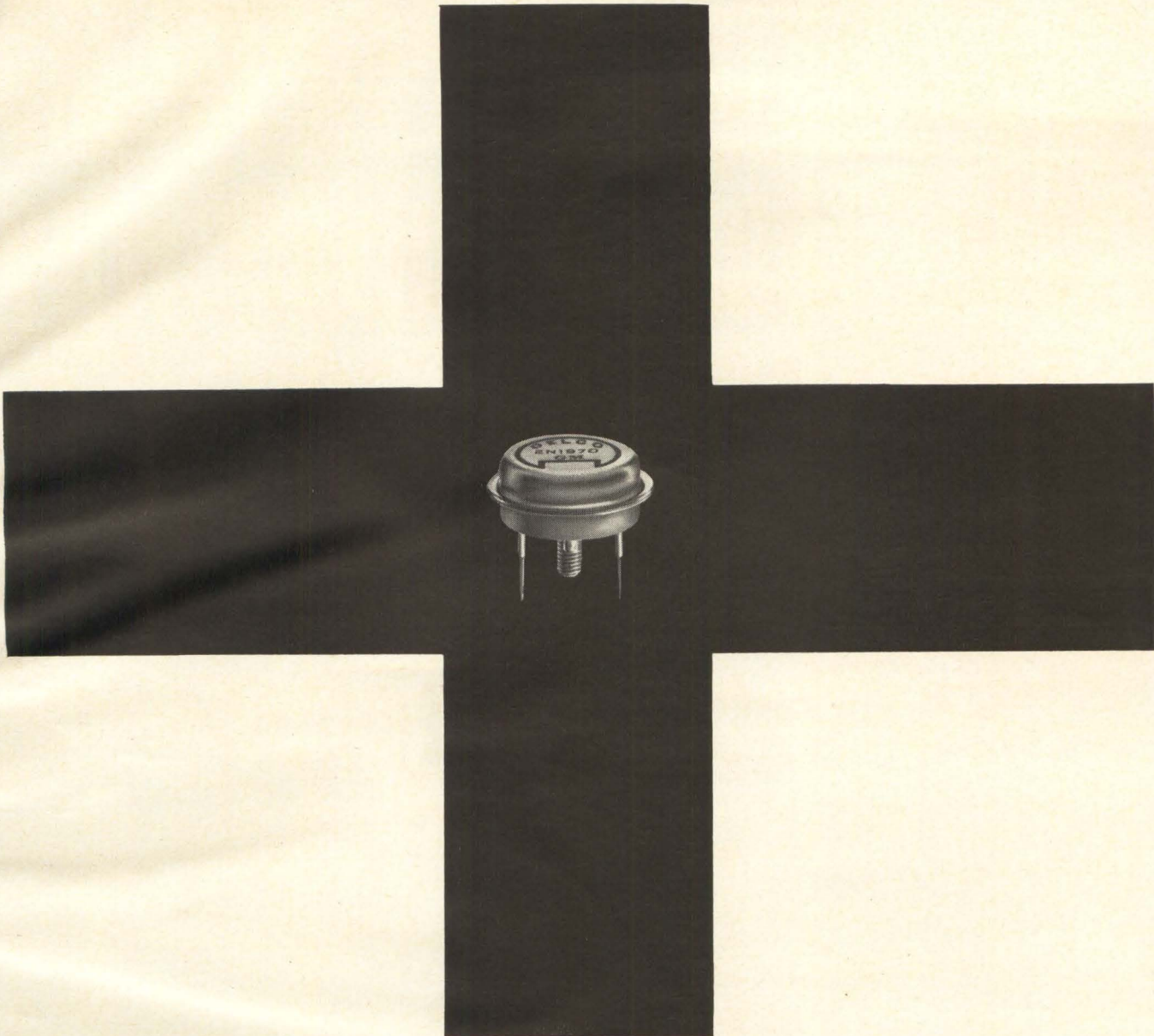
**SAN ESU  
ELECTRONICS  
CO., LTD.**

Cable address: SANESVARICON TOKYO:  
1425, 4-chome, Higashinakanobu,  
Shinagawa-ku, Tokyo, Japan.

CIRCLE 202 ON READER SERVICE CARD

December 27, 1963 electronics





## Any resemblance to 21 other power transistors is purely intentional

Delco Radio's 2N1970 is a high current, high voltage, low cost power transistor that you can substitute for any of 21 other TO-36 power transistors.

The 2N1970 can directly replace the 2N174, 2N1100, 2N2076, 2N2077 and 2N2490 in nearly every application—at a cost savings. With minor circuit modifications, the 2N1970 can also replace the 2N173, 2N277, 2N278, 2N1099, 2N1358, 2N1412, 2N2075, 2N2079, 2N2080, 2N2081, 2N2082, 2N2210, 2N2379, 2N2491, 2N2492 and 2N2493—at a cost savings. It's as close as you can get to a universal power transistor. Reduce production cost without sacrificing product quality. Place your order for Delco's 2N1970 at one of our sales offices listed below, or phone your nearest Delco Radio Semiconductor Distributor.

By the way, there are engineering laboratories in Santa Monica, Chicago, and Union, N. J. as well as in Kokomo to assist you in circuit design or modification.

Ic (MAX.)	Vcbo (MAX.)	Vebo (MAX.)	Vceo (MAX.)	Sat. Voltage @ Ic (MAX.)	Gain Min./Max. @ Ic	Thermal Resistance (MAX.)
15A	100V	40V	50V	1.0V @ 12A	17/40 @ 5A	.5° C/watt

\*Union, New Jersey  
324 Chestnut Street  
MURdock 7-3770  
AREA CODE 201

Detroit, Michigan  
57 Harper Avenue  
TRinity 3-6560  
AREA CODE 313

Palo Alto, California  
201 Town & Country Village  
DAvenport 6-0365  
AREA CODE 415

\*Santa Monica, California  
726 Santa Monica Blvd.  
UPTon 0-8807  
AREA CODE 213

Syracuse, New York  
1054 James Street  
GRAnite 2-2668  
AREA CODE 315

\*Chicago, Illinois  
5151 N. Harlem Ave.  
775-5411  
AREA CODE 312

\*Office includes field lab and resident engineer for applications assistance.

General Sales Office: 700 E. Firmin, Kokomo, Ind., Gladstone 2-8211—Ext. 500 • Area Code 317

**DELCO**  
DEPENDABILITY  
**RADIO**  
RELIABILITY



# The new Clifton Servo Motors fight Temperature 2 ways

## 1 Reduce Heat Rise

The same or greater torque is achieved in these motors by considerably less wattage input. Result—a cooler running motor. In addition, heat rise is reduced by special designs and materials with high thermal conductivity for improved heat dissipation.

## 2 Materials Withstand 200°C

Special and improved high temperature resistant magnet wire, lubricant, slot insulation, impregnation and other materials in these new servo motors withstand, if necessary, 200°C.

Temperature problem? Call 215 MADison 2-1000, TWX 623 6068 or our Representatives.

CLIFTON PRECISION PRODUCTS CO., INC.

**cppc**

Clifton Heights, Pa.  
Colorado Springs, Colo.

CIRCLE 16 ON READER SERVICE CARD



# ComSat Proposals Due Feb. 10

WASHINGTON — Industry proposals for the first commercial communications satellite system (p 20, Dec. 20) are due Feb. 10. Design specifications for the system were detailed this week by the Communications Satellite Corp.

The corporation wants designs for both intermediate-altitude and high-altitude synchronous satellites and may choose either or both for six-month follow-on studies. Intermediate satellites would be ready for launch in 1966, with initial global coverage in 1967; synchronous system launch would begin in 1967, for global coverage in 1968.

The satellite system is to permit one-way monochrome television to be transmitted on an alternate basis with two-way 4-kc channels. There is to be a capability of 270 two-way channels in 1966 to 1968; 400 two-way 4-kc channels in 1969; 600 in 1970, 800 in 1971 and 1,200 in 1972.

The corporation wants 18 satellites for a random intermediate-alti-

tude system; 12 satellites for a phased intermediate-altitude system, or 6 satellites for a synchronous-altitude system. Frequencies specified include 5,925 to 6,425 Mc for the up-link and 3,700 to 4,200 Mc for the down-link.

ComSat Corp. also plans to launch an earlier, experimental synchronous satellite, independent of these design requests, in 1965 to link the U.S. and Europe. Bandwidth and power capability would provide for either tv facsimile or telegraph message traffic, or up to 240 two-way telephone channels. Purchase of these satellites will be negotiated directly with Hughes, developer of the Syncom satellites.

## Experts Lay Groundwork For World-Wide Dialing

GENEVA — Telecommunication experts have quietly given the go-ahead for world-wide direct dialing.

International Telecommunications Union's Committee for the General Plan for Development of Telecommunication Networks, meeting in Rome, agreed on future routing and a numbering plan using a series of 11 or 12 digits.

Recommendations were also made about planning, operations, standards and maintenance. The enormous distances, the noise problem, the propagation time and the need for echo-suppressors were cited as examples of the difficulties to be overcome. It was agreed that the line and information signals should be kept separate. Line signaling would be link by link using a compelled sequence code of signals, and the inter-register signalling system would use a multifrequency code. Automatic exchanges would contain memories to store dialing data.

## Omega Approved For Use in Fleet

NAVY Bureau of Ships says the Omega long-range navigational system has been proved feasible and eventually should be installed throughout the fleet, possibly by 1969 (p 17, Dec. 20). About \$9.5 million will be spent on the system during the 1963 fiscal year.

"An improved aircraft receiver will be ready to test fly very shortly," a spokesman said. "Development of data necessary for preparation of world-wide charts is proceeding on schedule. The British government is cooperating and in October, Omega test transmissions were started at Criggion, Wales."

## Dielectric Speeds Up Integrated Circuits

SUNNYVALE, CALIF. — Low-capacitance dielectric, with breakdown voltage near 1,000 v, should in-

## Patient Says Laser Healed Eye

MENLO PARK, CALIF.—First human patient operated on by laser for a detached retina says the treatment was a success (p 17, Sept. 13 and p 30, April 19). His physicians are more cautious. The patient is Donald Scheuch, director of the Electronics and Radio Sciences Division of Stanford Research Institute. He suffered the injury while playing ball and received his first laser treatment about Sept. 1 from Dr. H. Christian Zweng and Dr. Milton Flock. Two subsequent treatments were given.

Scheuch reports he is leading a normal, active life and the retina has remained attached. Dr. Zweng and Dr. Flock say the longer it remains attached, the greater the chances for full recovery, but they will not make a long-range forecast.

Dr. Scheuch says the treatment is simple and requires no anaesthetic as does the Zeiss machine used on comedian Bob Hope here last week. This machine requires about one to one and one-half second pulse, while laser pulse is less than one-half millisecond. Dr. Scheuch says you see only short, bright light. No discomfort is experienced



crease attainable speeds of semiconductor integrated circuits by at least one order of magnitude—possibly to more than 100 Mc—says its developer, Signetics. The development eliminates the use of reverse biased *p-n* junctions that presently provide d-c isolation between components. A new approach to the fabrication of components in a monolithic block is substituted, the firm says. Result is a radical change in the circuit's physical structure that is expected to produce wider junction configuration variety and improve yields significantly, according to Signetics.

## FAA Asks for Comments On Cockpit Recorders

FAA HAS PUT its stamp of approval on cockpit recorders and asked interested parties for their comments (p 53, Nov. 15). Little opposition

is expected because the concept has already received the endorsement of plane manufacturers, airlines and pilots. Under the FAA proposal, commercial jetliners would be required to have the devices by July 1, 1965; four-engine prop airliners by Jan. 1, 1966, and two-engine planes by July 1, 1966. The recorder would retain 30 minutes of crew conversation to aid investigators in the event of a crash.

## NASA Awards \$60 Million Lunar Orbiter Pact

WASHINGTON — Boeing Co. has been awarded a \$60-million incentive contract to build five lunar orbiter spacecraft, designed to take high-resolution photographs of the lunar surface. The photos will help find landing sites for LEM vehicles and for unmanned landings of Ranger and Surveyor spacecraft.

The first Lunar Orbiter, slated for launch in 1966, will also carry radiation measuring and micrometeoroid density sensors. Later orbiters will carry a larger variety of sensors. The craft will have an Eastman-Kodak camera system and RCA communications subsystem.

## Punch-Card Shopping Bows at Swedish Market

FOOD SHOPPING by data cards is being tried in Sweden. Shelves in one Stockholm market hold samples of each commodity, with batches of punched cards beneath. The shopper takes one and gives it to the cashier for invoicing by a Bull data machine. The bill is sent to a basement stock room where clerks collect items by hand and bag them; the customer then picks up her goods at the door. The store, which opened in August, says personnel costs and shoplifting are reduced, sales areas kept smaller, stock control aided, and shopping made easier. Possible disadvantages? Fresh foods are virtually eliminated, the firm says, and the customer may feel rigidly mechanized or deprived of the "charm" of shopping. She must also line up twice—once to pay, again to collect purchases.

## MEETINGS AHEAD

RELIABILITY-QUALITY CONTROL NATIONAL SYMPOSIUM, IEEE, ASQC, ASME, EIA; Statler Hilton Hotel, Washington, D. C., Jan. 7-9.

ENGINEERING INSTITUTE: LASERS, University of Wisconsin; University, Madison, Wisconsin, Jan. 9-10.

INTEGRATED CIRCUITS SEMINAR, IEEE New York Chapter; Stevens Institute of Technology, Hoboken, New Jersey, Jan. 15.

CHARGE TRANSFER COMPLEX SYMPOSIUM, USAF Scientific Research Labs; Denver, Colo., Jan. 19-24.

ANTENNA RESEARCH APPLICATIONS FORUM, Midwest Electronics Research Center; University of Illinois, Urbana, Ill., Jan. 27-30.

MANAGEMENT CONFERENCE, ERA; New Orleans, La., Jan. 28-31.

ANNUAL MEETING-SEMINAR, Precision Potentiometer Manufacturers' Association, Hollywood Beach Hotel, Hollywood, Fla., Jan. 29-31.

INSTRUMENTATION SYMPOSIUM, ISA North Central Area; New Sheraton-Ritz Hotel, Minneapolis, Minn., Jan. 30-31.

MILITARY ELECTRONICS WINTER CONVENTION, IEEE-PTGMIL; Ambassador Hotel, Los Angeles, Calif., Feb. 5-7.

ELECTRONIC COMPONENTS INTERNATIONAL EXHIBITION, FNIE, SDSA; Paris Exhibition Park, Paris, France, Feb. 7-12.

PHYSICAL METALLURGY OF SUPERCONDUCTORS MEETING, AIMPE Metallurgical Society; Hotel Astor, New York, N. Y., Feb. 18.

INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE, IEEE, University of Pennsylvania; Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa., Feb. 19-21.

NUMERICAL CONTROL PRESIDENTS' CONFERENCE, Numerical Control Society; Hotel Plaza, New York, N. Y., Feb. 20-21.

SCINTILLATION-SEMICONDUCTOR COUNTER SYMPOSIUM, IEEE, AEC, NBS; Hotel Shoreham, Washington, D. C., Feb. 26-28.

### ADVANCE REPORT

SYMPOSIUM ON STATISTICAL ASSOCIATION METHODS FOR MECHANIZED DOCUMENTATION, RICASIP, NBS, American Documentation Institute; National Bureau of Standards, Washington, D. C., March 17-19; Jan. 15 is deadline for submitting titles and 200-word abstracts to Mary Elizabeth Stevens, National Bureau of Standards, Washington, D. C. 20234. Topics include information retrieval and search renegotiation, statistical association methods and citation indexing, automatic classification and categorization, automatic assignment indexing, pioneering applications of statistical association techniques in documentation.

## Gamma-Ray Exposure Retards Lasing Action

SPOKANE, WASH.—Gamma rays hinder lasing in uranium and neodymium-doped crystals, says GE. Twice as much energy was needed to induce laser action after the crystals were exposed to 1.5-million roentgens of gamma radiation—making the firm doubtful that gamma energy can be converted to laser output energy. The studies, conducted at GE's Hanford Labs, were stimulated by speculation that useful energy could be converted from nuclear reactors and fission products; now GE thinks this improbable due to the increase in energy required after gamma exposure. The phenomenon could bear also on the use of lasers in space probes, GE says, or in other space applications.



## Computers Due for Another Good Year

WASHINGTON—The electronic computing and accounting machine industry continues to move ahead, with 1964 factory shipments, estimated at \$1.99 billion, expected to show a 9.5-percent increase over 1963 shipments of \$1.82 billion, the U. S. Department of Commerce, estimates.

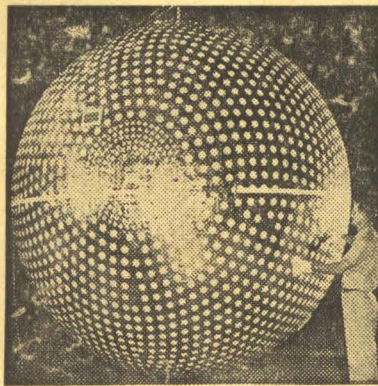
Shipments of electronic computing and accounting machines rose 10.8 percent in 1963 over 1962; 1964 shipments are estimated to rise about 9.5 percent. Electronic data processing machines and associated equipment showed a greater percentage rise than the whole industry in 1963, 16 percent, and are expected to show a 13.6 percent increase in 1964. Conventional computing and related machines, including cash registers, rose 6.8 percent in 1963 and are estimated to continue at this rate in 1964.

Dollar volume of 1963 exports rose to \$295 million, an increase of 9 percent over 1962 exports of \$271 million. The estimate of 1964 exports is \$340 million, a 15-percent increase over 1963.

Federal government use of computers has soared from one computer in 1949 to an estimated 1,248

computers in 1963. An additional 317 are planned for installation during fiscal year 1964. The government spent \$188 million for computer leasing in 1963; the 1964 estimate is \$243 million.

### New Explorer



AIR DENSITY Explorer launched last week is expected to tell NASA whether there are enough gas molecules to cause resistance or drag to spacecraft moving through them. White painted dots control temperature for tracking beacon, solar cells and batteries mounted on skin

### Teaching-Machine Market Getting Big, New Entrant?

IBM'S ANNOUNCEMENT last week that it plans to buy Science Research Associates, Inc., Chicago, a publisher of educational materials, stirred speculation that the giant manufacturer of computers might be getting ready to enter the teaching-machine market. An IBM spokesman said he had no comment on this but that his company had been conducting research on teaching machines for some time. Science Research Associates prints mostly programmed teaching material, similar to material used in teaching machines, a representative of that firm told ELECTRONICS.

## IN BRIEF

**TIROS 8** weather satellite, successfully launched last Saturday, will evaluate the first experimental Automatic Picture Transmission (APT) camera system (p 20, July 26).

**POST OFFICE** has given Farrington Manufacturing Co. a \$1,176,277 contract to produce an automatic mail address reader. The machine, which will go into operation a year from now in Detroit, will sort 27,000 letters an hour for 50 states and 50 large cities.

**FIRST** industry-built Saturn initial stage, scheduled for launching from Cape Kennedy late next year, was turned over to NASA's Michoud Operation by Chrysler Corp. this week.

**LOCKHEED** says instrumentation aboard polar orbiting satellites indicates the auroral curtain is several hundred miles thick.

**MODEL** of Airborne Instruments Laboratories' microwave instrument landing system (p 24, Aug. 2) will be part of the science exhibit at the New York World's Fair. It will include a complete ground control pattern of an airport with an airplane that periodically lands and taxis up to unload.

**SYLVANIA** has tested an electronic device that protects bombers from air-to-air and ground-to-air, radar-guided weapons.

**ORDERS** for the Honeywell 200 (p 10, Dec. 13) total \$50 million in sales value, firm says.

**EITEL-McCULLOUGH** has licensed two British companies to manufacture its family of uhf, tv klystron tubes in England. The two firms are English Electric Valve Co. and Standard Telephones & Cables, Ltd., ITT's British subsidiary.

**DOUGLAS** has received an additional \$48,064,658 contract for its part in the Saturn program.

**UNIVERSITY** of Michigan will study radar detection of moving ground vehicles from the air for the Air Force.

**DEEP-SEA** seismometers are being used in the Pacific to develop methods for detecting underground nuclear detonations. Tests, part of the Vela uniform program, will also help development of underwater devices.

**SWEDISH** newspapers report that three Swedish companies, Saab Asea and L. M. Eriksson — have combined forces to make a \$50,000, six-month preliminary study for Europe's first satellite.

### Closed-Cycle Plasma

#### Power Source Developed

NEW YORK—The Martin Company said last week it has produced electrical power with a closed-cycle magnetoplasmadynamic system. Mostafa E. Talaat, manager of Martin's Energy Conversion Laboratories, said the experiment proved the principle that with magnetically-induced, non-equilibrium ionization, electron temperatures twice the temperature of the host gas could be obtained (p 29, Sept. 1, 1961). Gas conductivity at 2,600 F was equivalent to that at 5,200 F in combustion gases.

Martin estimates that the new equipment would occupy about one-tenth the space of a comparative steam turbogenerator. Talaat thinks mpd plants will have efficiencies on the order of 50 percent, compared to 30 to 35 percent for conventional systems. With fewer moving parts, maintenance is also expected to be less costly.



## Red Tape Will Be Next Target of Pentagon Scissor

**A pilot study aimed at reducing** Defense Department monitoring of contracts will begin soon. The objective is to cut back on the volume of reporting, auditing and other controls without losing the effectiveness of the monitoring. Northrop Corporation's production of the T-38 jet trainer and F-5 fighter has been picked for the first test. An electronics firm will be selected early next year for a similar study.

The Pentagon believes that reducing the burden of paperwork on its contractors will let them lower costs, and in turn offer the government lower prices. This thinking stems from the new emphasis on fixed-price contracting. In the loosest type of contract—cost plus fixed fee—need for monitoring is highest. But it declines steadily with the tighter forms of contracting the government now favors.

## By Watching the Millions, Says Air Force, It Saved a Billion

**Air Force is now detailing** the results of its cost-cutting efforts in the past year. It claims savings of \$1.2 billion against a programmed goal of \$982 million. The goal for the current fiscal year is \$1.5 billion. Here are some examples of methods being used to reduce costs:

- A contractor buying a high-reliability vacuum tube for the Minuteman from a single source was directed by Air Force's contract management branch at Philadelphia to a lower-price commercial tube. Total saving: \$1 million.

- Flying suits for high-altitude use were being bought from a single company. Air Force divided the suit into its components. As a result, three firms divided the order, eliminating subcontracting. Davis Clark Co. supplied coveralls, gloves, boots and helmets; Pioneer Central got the controllers portion, and Firewel Co. the regulators portion. Saving: \$3 million.

- A magnetic-tape rehabilitation facility—believed to be the first of its kind—was put into operation, with equipment supplied by General Kinetics, Inc. Some 18 million feet of used tape was cleaned up in a few months, at a saving of one-quarter of the \$40 cost of a new reel. Total saving: \$50,000.

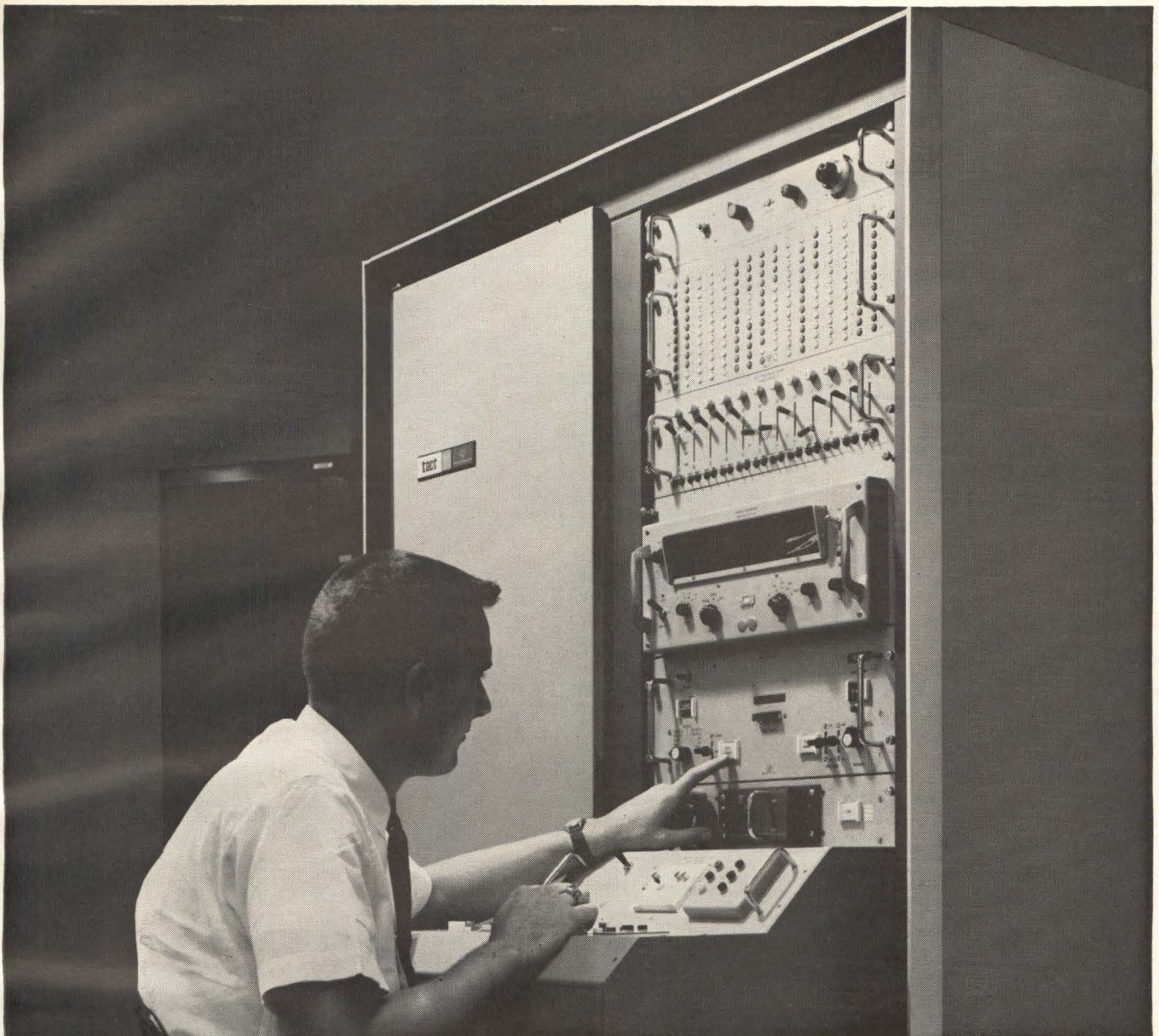
## NASA Wants Spanish Station

**A giant tracking station** will be built in Spain by the National Aeronautics and Space Administration, providing agreement can be reached with the Spanish government. The station is needed for tracking the three-man Apollo spacecraft. The Spanish government wants complete assurance that the purpose is peaceful.

## President May Ground Nuclear Rocket Program

**President Johnson is now deciding** the fate of Project Rover. His 1965 federal budget spending plans will include a basic decision on whether to hold back or go full steam ahead on the big-payload-capacity spacetruck (ELECTRONICS, p 20, Nov. 22, 1963; p 24, Dec. 28, 1962). Rover was one of Johnson's pet projects when he headed the National Space Council, but his science adviser, Jerome B. Wiesner, is suggesting that a cutback in the nuclear rocket effort offers a chance for big savings. Atomic Energy Commission and NASA, however, say their request for next year for \$280 million has already been cut to \$200 million for Rover by Wiesner and the Budget Bureau. This is about as deeply as the program can safely be cut, they argue. But Wiesner counters that by stressing reactor development work only, and slowing down space vehicle development, the total AEC-NASA expenditure could be held to \$50 million.





## Save Device Handling Time add switching time measurements to your **tact\*** system

The Switching Time Measuring Unit, added to your TACT system, can cut your device handling at least 50% because all tests are made in a single socket . . . you do not have to change units from one socket to another. You do not need additional scopes or pulse generators. Switching time measurements on semi-conductors can be intermixed in any order with other parameters. And with TACT, automatic data

recording will increase your savings. Digital card programming eliminates set-up and operating errors, assures repeatability. Standard switching time parameters,  $t_d$ ,  $t_r$ ,  $t_{on}$ ,  $t_s$ ,  $t_f$ ,  $t_{off}$  may be measured within the range of 1 nano-second to 10 microseconds. Performance circuits are precisely matched to your requirements . . . the desired circuit selectable by the program card. The switching time measuring unit is

another planned advancement of the ever-expanding TACT system. Since its introduction in 1960 with d-c capability, the Transistor And Component Tester has continuously expanded with pulse, h-parameter,  $h_{FE}$ , low-current measurements, and environmental tests. Now switching time can be added to every TACT system, new or old. Let a TI engineer show you how to save by using the TACT system.

\*Trademark of Texas Instruments Incorporated

INDUSTRIAL  
PRODUCTS  
GROUP

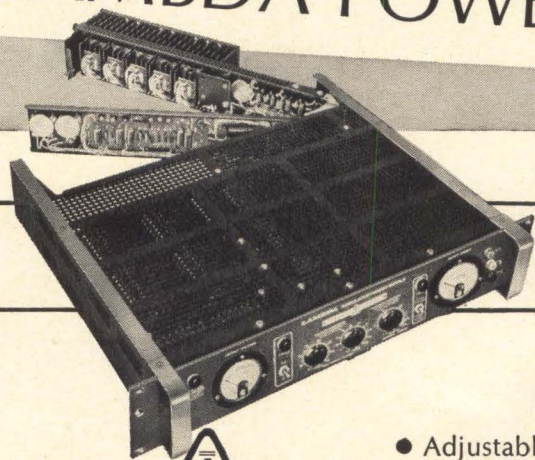


**TEXAS INSTRUMENTS**  
INCORPORATED  
P. O. BOX 66027 HOUSTON 6, TEXAS

608



# WHY MILITARY SYSTEMS DESIGNERS CHOOSE LAMBDA POWER SUPPLIES



## MIL SPEC DESIGNS

VIBRATION: MIL-T-4807A  
 HUMIDITY RESISTANCE  
 FUNGUS RESISTANCE  
 SALT SPRAY  
 TEMPERATURE SHOCK  
 MIL-E-5272C • (ASG) Procedure 1  
 SHOCK: MIL-E-4970A • Procedure 1 & 2  
 ALTITUDE: MIL-E-4970A • (ASG) Procedure 1  
 QUALITY: MIL-Q-9858  
 MARKING: MIL-STD-130  
 (Certified Test Data available upon request)



## ADVANCED ENGINEERING FEATURES

- All solid state
- Completely protected
- Adjustable automatic current limiting
- Continuously variable
- Constant voltage/constant current
- Wide input frequency and voltage range
  - Convection cooled
- Series/Parallel operation
- Remotely programmable
  - resistance and voltage

## MASS PRODUCTION PRICES

### LE SERIES CONDENSED DATA

DC OUTPUT (VOLTAGE REGULATED FOR LINE AND LOAD)<sup>(1)</sup>

Model	Voltage Range	Current Range	Price <sup>(2)</sup>
LE101	0-36 VDC	0- 5 Amp	\$420
LE102	0-36 VDC	0-10 Amp	525
LE103	0-36 VDC	0-15 Amp	595
LE104	0-36 VDC	0-25 Amp	775
LE105	0-18 VDC	0- 8 Amp	425
LE106	0-18 VDC	0-15 Amp	590
LE107	0-18 VDC	0-22 Amp	695
LE109	0- 9 VDC	0-10 Amp	430
LE110	0- 9 VDC	0-20 Amp	675

<sup>(1)</sup> Current rating applies over entire voltage range.  
<sup>(2)</sup> Prices are for nonmetered models. For models with ruggedized MIL meters add suffix "M" to model number and add \$40 to the non-metered price. For metered models and front panel control add suffix "FM" and add \$50 to the nonmetered price.

### REGULATED VOLTAGE:

Regulation  
 (line and load) . . . . . Less than .05 per cent or 8 millivolts  
 (whichever is greater). For input  
 variations from 105-135 VAC and for  
 load variations from 0 to full load.

Remote Programming . . . . . 50 ohms/volt constant over entire  
 voltage range.

Ripple and Noise . . . . . Less than 0.5 millivolt rms.

Temperature Coefficient . . . . . Less than 0.015%/°C.

AC INPUT: . . . . . 105-135 VAC; 45-66 CPS and 320-480  
 CPS in two bands selected by switch.

### PHYSICAL DATA:

Mounting . . . . . Standard 19" rack mounting.

Size . . . . . LE 101, LE 105, LE 109 3½" H x 19" W x 16" D  
 LE 102, LE 106, LE 110 5¼" H x 19" W x 16" D  
 LE 103, LE 107 . . . . . 7" H x 19" W x 16½" D  
 LE 104 . . . . . 10½" H x 19" W x 16½" D

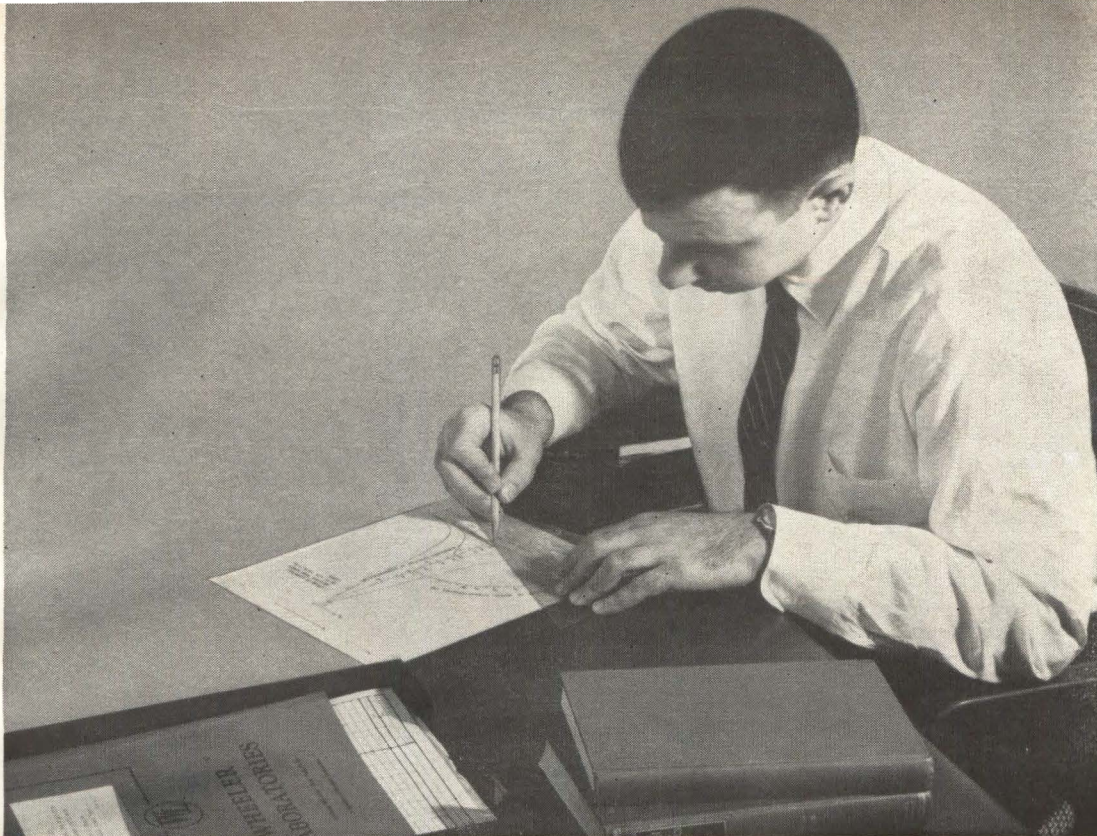
SEND FOR COMPLETE LAMBDA CATALOG.



**LAMBDA ELECTRONICS CORP.**  
 515 BROAD HOLLOW ROAD • MELVILLE, L. I., NEW YORK • 516 MYRTLE 4-4200

CIRCLE 22 ON READER SERVICE CARD





AUTHOR evaluates a laser design with the help of his pump-power chart

## DESIGNING

# LASERS WITH PUMP-POWER CHARTS

Chart relates the three most easily measured, and most often specified laser parameters—pump power, wavelength and propagation direction—in easy-to-use graphical form, for rapid performance evaluation of lasers

By **ROBERT A. KAPLAN**  
Wheeler Laboratories  
Great Neck, New York

**THE DEVELOPMENT** of the laser provides a source of highly coherent radiation at optical wavelengths. Numerous applications of this device have been proposed; however, the evaluation of a laser requires an understanding of the characteristics of the emitted radiation.

As is well known, a laser oscillator comprises two essential parts: an active material and a resonant circuit. The active material is capable of storing the pump energy and using this energy to amplify an elec-

tromagnetic wave. Energy is stored by pumping the active system into excited energy levels. Amplification is accomplished by stimulated emission of a photon and a corresponding quantum transition of the system between the laser energy levels.

The resonant circuit of the laser is usually a modified Fabry-Perot interferometer formed of high-reflectivity end walls and low-reflectivity side walls. Because of the large dimensions of the typical resonator, compared to the wavelength of the emitted radiation, the cavity can support a large number of modes, where each mode is described by a particular stable field configuration.<sup>1-4</sup> The usual method

of designating a particular mode is by three integers, which are related to the field variations along particular coordinates in the resonator. An alternate method is to specify the resonant wavelength and direction of propagation, relative to the resonator axis, of the nearly plane waves which comprise that mode. This latter description permits a simplified approach to the evaluation of laser performance.

The possible modes that can be supported by the resonant cavity of a laser depend on the resonator geometry and the wavelength. The modes that actually oscillate, however, depend not only on the geometry of the resonator, but also on the



properties of the active material and the pump power. These factors contribute to the loss and gain, which in turn determine the threshold condition. (The threshold condition is specified by the requirement that the gain exceed the loss.) The geometry and the wall reflectivity are the major factors determining the loss in each mode; this loss depends chiefly on the off-axial direction of propagation of the nearly plane waves comprising the mode. The characteristics of the material determine the gain in each mode as a function of pump power; this gain depends chiefly on the departure of the resonant wavelength from the central wavelength of the quantum transition. By specifying the modes of a laser in terms of a direction of propagation and resonant wavelength, the conditions for oscillation may be readily found by means of the pump-power chart.

As a first step, the modes of the resonator are plotted on a mode chart in terms of the direction of propagation and resonant wavelength of the plane waves comprising those modes. The relation be-

tween threshold pump power and these factors appears as contours on the chart, forming the pump-power chart.<sup>5</sup> This chart permits the determination of the modes of oscillation of a laser at a given pump level in terms of wavelength and direction of propagation, and thereby permits the determination of the frequency and angular spectra of the emitted radiation. In particular, the total bandwidth and beamwidth of the laser output may be obtained directly. Although the chart does not provide exact values for the wavelength and direction of propagation of each mode of oscillation, the information provided is useful in practical situations.

**Resonator Modes**—The modes of most interest in a laser are those with directions of propagation near the resonator axis. If the resonator dimensions are large compared to the wavelength, an approximate relation between resonant wavelength and direction of propagation can be used to describe these modes.<sup>5</sup> This relation, given in Eq. 1, forms the basis of a mode chart,

similar to those used at microwave frequencies.<sup>6</sup> The use of normalized variables,  $\Theta$  and  $\Lambda$ , simplifies the extension of this chart to lasers of arbitrary configuration and material. The transverse character of a mode is described by  $\Theta$ , where  $\Theta$  can only assume discrete values corresponding to each transverse mode. The axial character of a mode is described by  $\Delta p$ ; modes with the same value of  $\Delta p$  are said to lie along a "modal characteristic."

$$\frac{2L}{\lambda_0} \frac{\delta \lambda}{\lambda_0} \Lambda = -\Delta p - \frac{D^2}{L(\lambda_0)} \Theta^2 \quad (1)$$

A typical example of a chart is presented by the solid curves in Fig. 1A. Note that the  $\Theta$  scale is quadratic, so that the modal characteristics are linear. In addition, since only certain discrete values of  $\Theta$  are allowed, as determined by transverse considerations, the actual modes of oscillation are represented by discrete points on the chart. These points are determined by the intersections of the modal characteristics and horizontal lines representing the possible values of  $\Theta$ . The permissible values of  $\Theta$  are represented by the dotted lines in Fig. 1A. The spacing between these lines ( $\Delta \Theta$ ) is given in Eq. 2. This  $\Delta \Theta$  is usually small so that  $\Theta$  may often be considered almost as a continuous parameter; for clarity the spacing between horizontal lines has been exaggerated in Fig. 1A.

$$\Delta \Theta = \frac{1}{2} \left( \frac{\lambda_0 L}{D^2} \right) \quad (2)$$

Although the modal characteristics have been drawn for a specific laser configuration and material, the mode chart with a quadratic  $\Theta$ -scale may be obtained by the following simple procedure for any other laser. Since the modal characteristics of Fig. 1A are linear, all that need be known is their slope and intercept. The slope ( $m$ ), as determined from Eq. 1, is given in Eq. 3. The absolute value of the intercept of the central modal characteristic is arbitrary within the approximation made in Eq. 1; however, the spacing between intercepts for successive modal characteristics ( $\Delta \Lambda$ ) can be determined and is given in Eq. 4.

$$m = 2 \frac{\delta \lambda}{\lambda_0} \left( \frac{L}{D} \right)^2 \quad (3)$$

$$\Delta \Lambda = \frac{1}{2} \frac{\lambda_0^2}{L \delta \lambda} \quad (4)$$

### Definitions and Symbols—TABLE I

$L$	= resonator length (cm)
$D$	= resonator width or diameter of laser filament (cm)
$R$	= $\sqrt{R_1 R_2}$ = effective combined reflectivity of end plates (power ratio)
$R_s$	= effective specular reflectivity of side walls (power ratio)
$g$	= gain by stimulated emission (power ratio)
$g_0$	= gain at central wavelength of quantum transition (power ratio)
$N$	= population density of active particles ( $\text{cm}^{-3}$ )
$\Delta N$	= inversion population density = excess of systems in excited state over number in terminal state ( $\text{cm}^{-3}$ )
$\alpha$	= $\frac{\Delta N}{N}$ = fraction of inversion
$t$	= photon lifetime in resonator = average time a photon in a given mode will remain in the resonator before removal by transmission, absorption or scattering (sec)
$t_0$	= photon lifetime of axial modes (sec)
$P$	= pump power (watts)
$P_0$	= threshold pump power (watts)
$v$	= velocity of electromagnetic waves in resonator material (cm/sec)
$c$	= velocity of electromagnetic waves in free space (cm/sec)
$\lambda$	= wavelength in resonator medium (cm)
$\lambda_0$	= central wavelength (in medium) of quantum transition (cm)
$\delta \lambda$	= natural half-power linewidth of quantum transition (cm)
$\Delta \lambda$	= $\lambda - \lambda_0$ (cm)
$\Lambda$	= $\Delta \lambda / \delta \lambda$ = normalized wavelength
$p$	= axial mode number = number of half wavelengths in axial dimension (integer)
$p_0$	= axial mode number of central-wavelength mode (integer)
$\Delta p$	= $p - p_0$ (integer)
$m$	= $2(\delta \lambda / \lambda_0) (L/D)^2$ = slope of modal lines
$\Delta \Lambda$	= $\frac{1}{2}(\lambda_0^2 / L \delta \lambda)$ = spacing of $\Lambda$ -intercepts
$n$	= $c/v$ = index of refraction of resonator medium
$\theta$	= angle from axis to direction of propagation in resonator (radians)
$\Theta$	= $(L/D)\theta$ = normalized direction of propagation (radians)
$\Delta \Theta$	= $\frac{1}{2}(\lambda_0 L / D^2)$ = spacing of modes on $\Theta$ -axis (radians)
$\phi$	= angle from axis to direction of radiation (radians)
$\Delta \phi$	= total beamwidth of laser oscillator (radians)
$\Delta f$	= total bandwidth of laser oscillator (cycles/sec)



**Resonator Loss**—The loss experienced by a wave in a laser resonator is one of the two important factors determining the threshold condition. This loss depends on the geometry and wall reflectivity of the resonator and on the particular mode under consideration. The lack of perfect reflectivity of the resonator end plates is often the major factor determining the loss in the axial modes, since this loss is by design usually made equal to or greater than the total losses due to dissipation, diffraction and scattering to maximize the laser output. Loss can be specified in terms of a photon lifetime, which is the average time a photon in a given mode will remain in the resonator. This photon lifetime is directly proportional to the Q of the mode. In particular, the photon lifetime of the axial modes is given by<sup>7</sup>.

$$t_0 = \frac{L}{v(1-R)} \quad (5)$$

For off-axial modes the lifetime is limited by both the end-plate reflectivity and the finite number of reflections before a photon in a particular mode leaves the cavity at the side walls. The approximate lifetime may be derived directly from geometrical considerations by considering the average number of reflections a photon will experience.

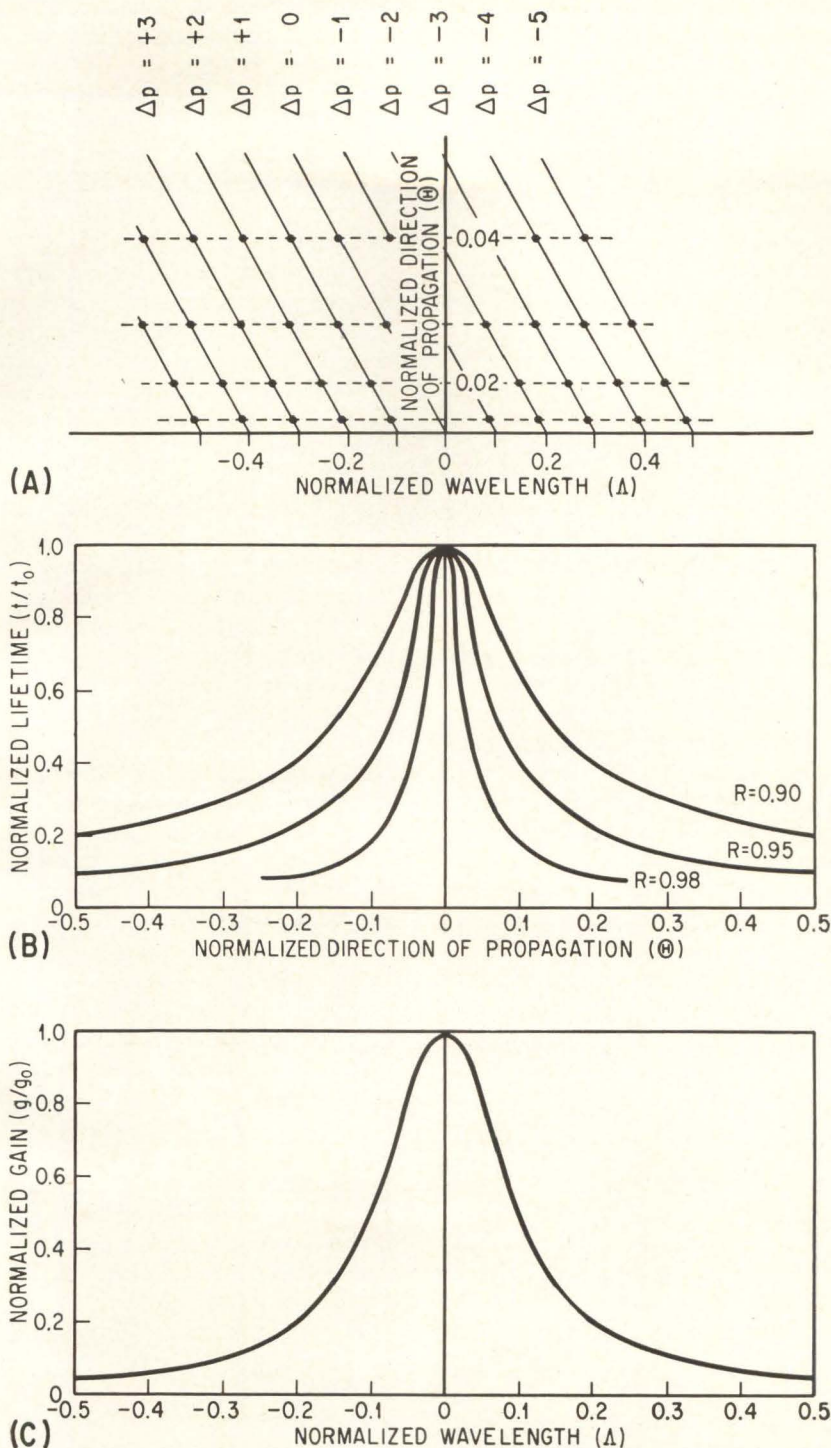
$$t = \frac{L}{v \cos \theta} \frac{1 - R^{1/\theta}}{(1-R)} \quad (6)$$

The lifetime of off-axial modes with nonreflecting side walls and highly reflecting end walls, normalized to that of the axial modes, is therefore

$$\frac{t}{t_0} = \frac{1 - R^{1/\theta}}{\cos \theta} \approx \frac{(1-R)}{\theta} \quad (7)$$

The normalized lifetime of a photon in a resonator is shown as a function of the normalized direction of propagation in Fig. 1B for three different values of end-wall reflectivity. This curve, therefore, graphically presents the relation between the loss and the off-axial direction of propagation, in terms of the photon lifetime.

**Gain**—The other important factor, which determines the threshold condition, is the gain in the laser material. An electromagnetic wave propagating through a laser material may experience gain due to stimulated emission if enough systems (active



MODE CHART for laser resonator (A); dependence of photon lifetime on direction of propagation (B); dependence of laser gain on wavelength (C)—Fig. 1

atoms or ions of the material) are in an excited state. The conditions required for gain were originally presented in Ref. 7.

The gain of the laser is a function of the wavelength because of the finite linewidth of the laser material. For most materials the spectral distribution assumes a Lorentzian shape, maximum gain occurring at the central wavelength of the quantum transition. The gain as a func-

tion of wavelength, normalized to that at the central wavelength of the quantum transition, is

$$\frac{g}{g_0} = \frac{(\delta\lambda)^2}{(\lambda - \lambda_0)^2 + (\delta\lambda)^2} = \frac{1}{\Lambda^2 + 1} \quad (8)$$

This function is shown graphically in Fig. 1C. It presents the relative gain of a laser material as a function of wavelength.

The gain ( $g$ ) of the laser is directly proportional to the popula-



tion inversion ( $\Delta N$ ).<sup>8</sup> Since this population inversion is a function of pump power, the gain is also a function of the pump power. For a four-level system, the population inversion and gain are directly proportional to pump power. This assumes that the population of the metastable state equals the population inversion. For a three-level system the population inversion and gain are less sensitive functions of the pump power; they are proportional to the pump power plus a large constant. This is because a large fraction of the power is required to maintain the population of the metastable level equal to that of the terminal level without providing the population inversion necessary for gain.

**Pump-power Chart**—The dependence of gain on pump power and wavelength, developed above, can be combined with the dependence of the losses on the direction of propagation to determine the conditions for oscillation of the individual modes of the laser. The relation between these three parameters (pump power, wavelength and direction) is not simple, however, and the relation may best be presented graphically. This graph has been termed the pump-power chart.<sup>5</sup> The significance of this chart is that it relates the three most easily measured and most often specified parameters of a laser, and thereby permits the rapid evaluation of performance.

The pump-power chart is based on the threshold condition of a laser oscillator. The power required for stimulated emission, for any particular values of wavelength and direction of propagation, depends on the photon lifetime (Fig. 1B) and relative gain (Fig. 1C) of the material. The pump power must be sufficient to provide a gain equal to or greater than the losses represented by the shortness of the photon lifetime. The particular value of power required for stimulated emission in the central wavelength, axial mode (highest-Q mode) is termed the threshold power ( $P_o$ ). For a four-level laser material, this power is inversely proportional to the product of the photon lifetime and the relative gain of the quantum system.<sup>8</sup> Therefore, the pump power, required for stimulated emission in

any other mode relative to the threshold pump power, is given by

$$\frac{P}{P_o} = \frac{1}{(t/t_o)} \frac{1}{(g/g_o)} \quad (9)$$

(This assumes that the modes of the resonator are weakly coupled, which is a good assumption for many lasers.)

For a three-level laser material, the required pump power is a different function of the gain, as mentioned. The pump power required for stimulated emission in any mode, relative to the threshold pump power, is

$$\frac{P}{P_o} = \frac{(t/t_o)(g/g_o) + \alpha}{(t/t_o)(g/g_o)} \quad (10)$$

However, it should be noted that at wavelengths far from the center of the quantum transition, the power is again inversely proportional to the gain.

The curves of Fig. 1B and 1C combined with Eq. 9 or 10 may be used to plot contours of constant  $P_o/P$  on the mode chart shown in Fig. 1A. For each value of normalized direction of propagation ( $\Theta$ ) and wavelength ( $\Lambda$ ), the normalized values of lifetime and gain may be determined from Fig. 1B and 1C respectively. These values may then be substituted in either Eq. 9 or 10 to determine a value of  $P_o/P$  for those particular values of  $\Lambda$  and  $\Theta$ . Contours of constant  $P_o/P$ , plotted in the  $\Lambda$ - $\Theta$  plane, are shown in Fig. 2. Since this plane is also the plane of the mode chart, shown in Fig. 1B, the individual modes are represented by points and Fig. 2 can be used to determine the relative pump power required for oscillation in each mode. For this reason, this figure is termed the pump-power chart.

A typical pump-power chart for a four-level laser is shown in Fig. 3. The end-plate reflectivity has been chosen as 0.95; the side walls are assumed completely non-reflecting. The modal characteristics have not been plotted directly on the chart but are obtained by using the circular reference scale. For a specified resonator geometry and material, the proper line is obtained by computing the slope ( $m$ ) of the modal characteristic. A family of parallel lines is then obtained with a separation along the  $\Lambda$ -axis given by  $\Delta \Lambda$ . (The exact location of this family of lines is indefinite by an amount

$\Delta \Lambda$ , since a cavity resonance has arbitrarily been assumed to occur at  $\lambda_o$ .) The points on the lines, representing the off-axial modes, are separated by  $\frac{1}{2} (\lambda_o L/D^2)$  along the  $\Theta$ -axis. These rules may be used to graphically determine the point representing any particular mode.

To illustrate the use of the chart, it is noted that at any relative value of pump power, oscillation can occur only in those modes within the proper power contour as shown in Fig. 4A. The total bandwidth of all the modes of the laser output is proportional to the maximum spread of normalized wavelength determined by the intersection of the modal characteristic curves and the power contour; the actual bandwidth is

$$\Delta f = \frac{v \delta \lambda}{\lambda_o^2} (\max \Lambda - \min \Lambda) \quad (11)$$

The wavelength spectrum of the output, as derived from the pump-power chart, is shown in Fig. 4B. Each point on the pump-power chart, representing a single mode, gives rise to a single frequency in the laser output, as shown by the vertical lines in Fig. 4B. Each group of modes on the same modal characteristic, having the same value of  $\Delta p$ , gives rise to a broad spectrum represented by the envelope of the vertical lines, also shown in Fig. 4B. The amplitude of each mode is not shown exactly since this level is a complicated function of pumping conditions. Part of the information required to determine this level is available from the pump-power chart; however a consideration of the competition between modes for the available excited systems is also required. For short pulses, competition between modes may be neglected and, since the gain in each mode is proportional to the intensity of that mode,<sup>8</sup> the relative output of the modes is expected to be a function of  $\exp(P/P_o - 1)$ . Also, since the wavelength separation of off-axial modes is very small, the spacing of these modes is only shown symbolically.

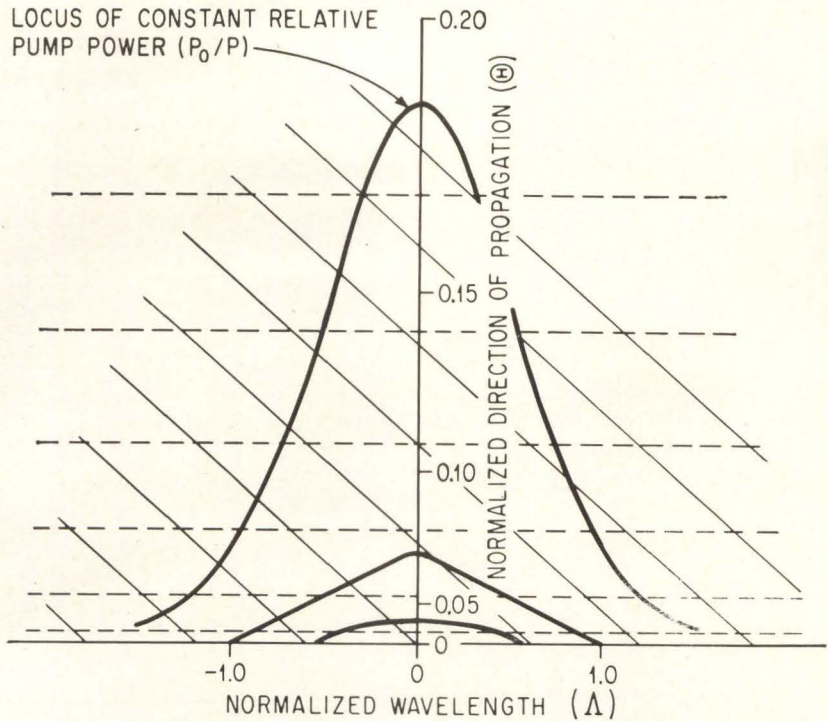
The radiation beamwidth of the laser output is proportional to the maximum direction of propagation of the modes of the resonator, which is again determined by the intersection of the modal characteristic curves and the power contour; the beamwidth is



$$\Delta \phi = 2n \frac{D}{L} \max \Theta \quad (12)$$

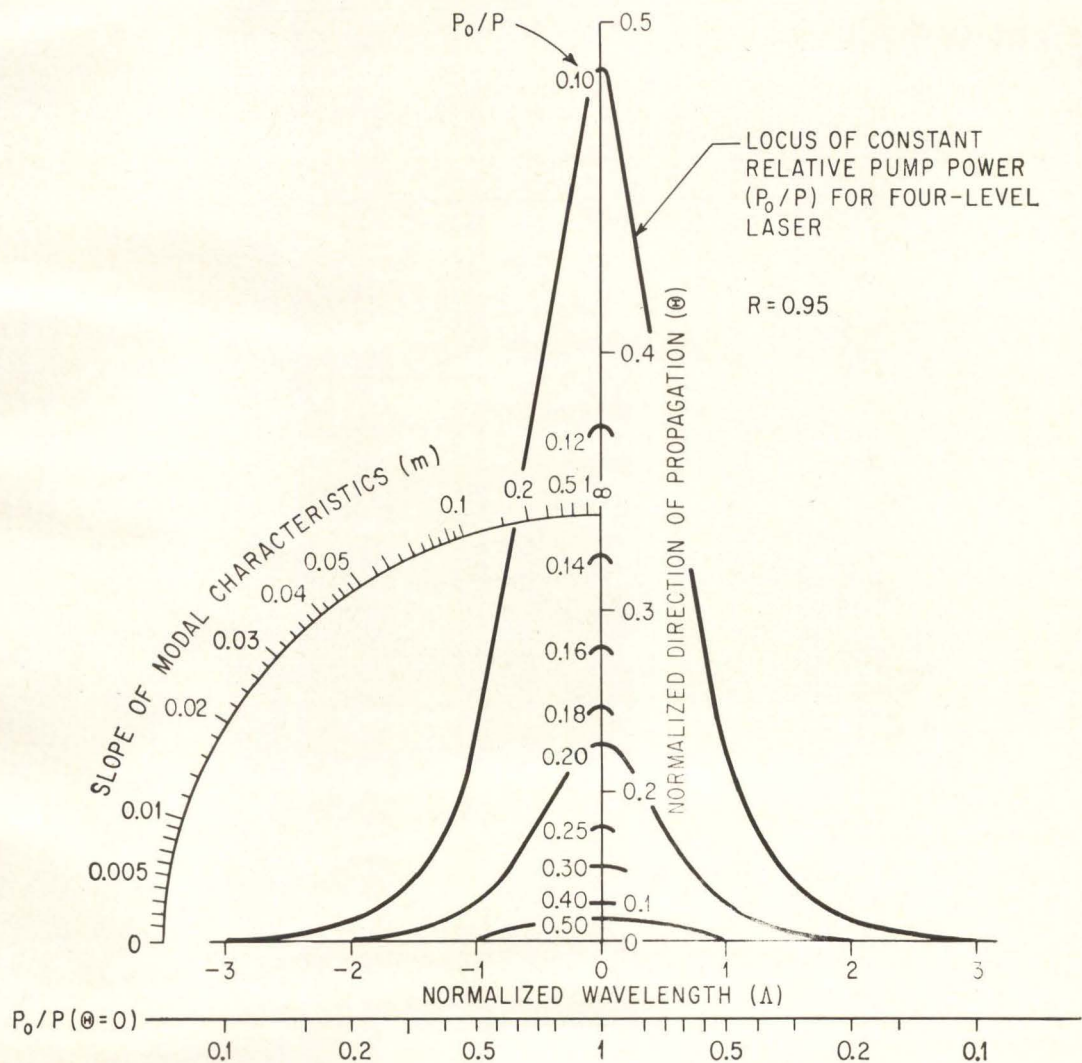
This relation describes the beamwidth as determined by geometric optics. It is not valid in the special case when only one mode is excited since the beamwidth will then be determined by diffraction. An angular spectrum, similar to the wavelength spectrum shown in Fig. 4B, could also be obtained directly from the pump-power chart.

The above discussion has indicated the use of the chart for a given set of input conditions and laser parameters. The variation of the laser oscillator bandwidth and beamwidth as a function of the input conditions (pump power) and laser parameters (dimensions, linewidth, end-plate reflectivity, etc.) may also be determined directly from the pump-power chart. The effects of pump power are indicated by the power contours; the effects of laser parameters are determined by drawing new modal characteristics. Be-



CONTOURS of constant pump power on laser mode chart —Fig. 2

PUMP-POWER chart—Fig. 3





cause of the particular choice of normalization used, the relative power contours do not depend on the parameters of the laser.

**Application Example**—The application of the pump-power chart will be investigated by computation of the performance of a specific four-level solid state laser oscillator. The pertinent data for this oscillator are listed in Table II.

First, the slope of the modal characteristic ( $m$ ) is computed to be 0.003 (Eq. 3); this line ( $O-A$ ) is drawn on the power chart, using the circular reference scale as shown in Fig. 4A. The family of modal characteristics are spaced along the  $\Delta$ -axis by a computed value of 0.3 (Eq. 4) and are drawn parallel to  $O-A$ . As discussed previously, the

actual  $\Delta$ -intercepts of these lines may not be known exactly, since the central wavelength of the quantum transition may not exactly correspond to resonance in an axial mode of the cavity. Since, in general, there are a large number of modes, the character of the output is essentially independent of the exact location of the modal characteristics on the pump-power chart. The modes in which oscillation may occur are represented by points within the power contour as shown.

It is noted that the minimum normalized wavelength of oscillation is  $-0.97$  as indicated on the chart. The maximum normalized wavelength is 0.90. The oscillation bandwidth, as computed by Eq. 11 from the parameters obtained from the chart is 26 Gc. The entire spectrum

is shown in Fig. 4B. As can be seen, there are a large number of overlapping modes so that the resultant spectrum will appear essentially continuous. The results are in qualitative agreement with reported measurements of the bandwidth of laser oscillators.<sup>9</sup>

The maximum normalized angle of propagation is 0.73 as indicated on the chart. The radiation beamwidth, as computed from Eq. 12, is therefore 48 milliradians.

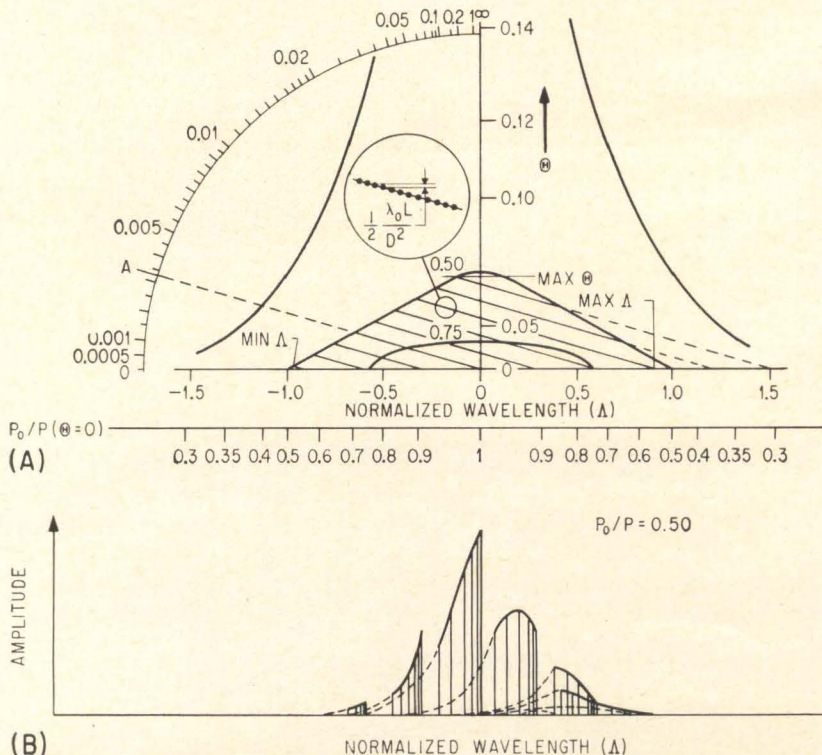
This illustrates a typical operation on the pump-power chart. The chart is being used at Wheeler Laboratories to evaluate more complex laser parameters such as power density, spectral brightness and beamwidth and bandwidth as a function of power input. In all these cases, approximate results are easily obtained by this graphical technique.

In addition, the variation of the bandwidth and beamwidth with the parameters of the laser, (length, diameter, wavelength and linewidth) are obtained by considering the changes in the modal characteristics with the respective parameter. Therefore, the pump-power chart may be used as a tool to picture the effects of variations in the parameters of a laser oscillator on the character of the output signal.

The study described in this article was performed for Hazeltine Electronics Division, Little Neck, New York. The author wishes to acknowledge the assistance of H. W. Redlien and E. R. Schineller and the advice of H. A. Wheeler.

**Parameters of Typical Laser Oscillator—TABLE II**

Quantity	Units	Value
Diameter (D)	centimeters	0.32
Length (L)	centimeters	1.86
Wavelength ( $\lambda_0$ )	centimeters	$5.5 \times 10^{-5}$
Linewidth ( $\delta\lambda$ )	centimeters	$2.7 \times 10^{-9}$
Pump power (P)	watts	$2 P_0$
Refractive index		1.92

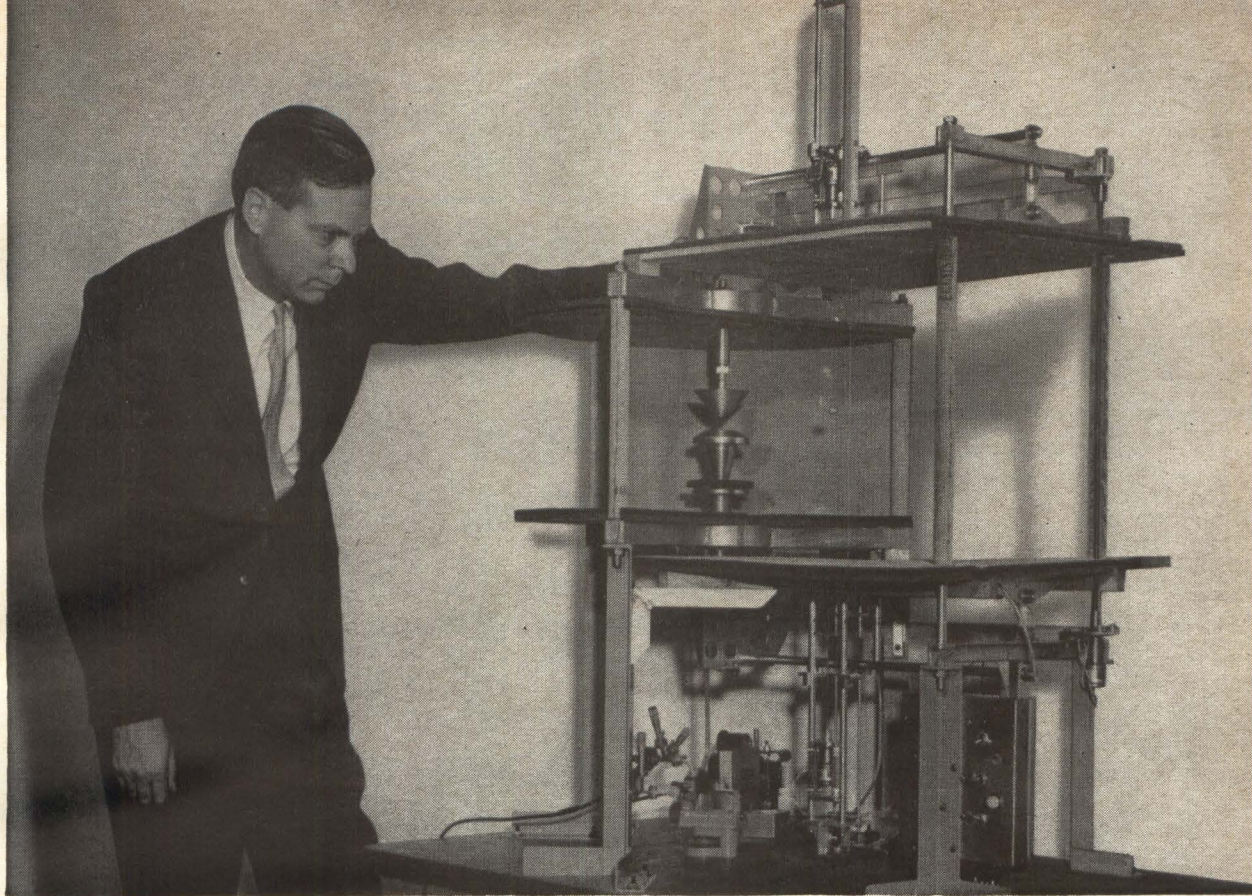


**OBTAINING** modal characteristics on the pump-power chart (A); wavelength spectrum of laser output (B)—Fig. 4

**REFERENCES**

- (1) A. G. Fox and T. Li, Resonant Modes in an Optical Maser, *Proc IRE*, **48**, p 1904, Nov. 1960. Also, *BSTJ*, **40**, p 453, Mar. 1961.
- (2) A. G. Fox and T. Li, Resonant Modes in a Maser Interferometer, "Advances in Quantum Mechanics" (J. R. Singer, Ed.) p 308, 1961.
- (3) G. D. Boyd, Confocal Resonator for Millimeter through Optical Wavelength Masers, "Advance in Quantum Mechanics" (J. R. Singer, Ed.) p 318, 1961. Also, *BSTJ*, **40**, p 489, Mar. 1961.
- (4) G. D. Boyd and H. Kogelnik, Generalized Confocal Resonator Theory, *BSTJ*, **41**, p 1347 July 1962.
- (5) R. A. Kaplan, The Pump-Power Chart for Evaluation of Modes in a Laser Oscillator, *Proc. of the Symposium on Optical Masers*, Polytechnic Institute of Brooklyn, April 16-18, 1963.
- (6) N. A. Spencer, Cavity-Resonator Design Charts, *ELECTRONICS*, **27**, p 186, May 1954. Also Wheeler Laboratories Report 594, Oct. 6, 1953.
- (7) A. L. Schawlow and C. H. Townes, Infrared and Optical Masers, *Phys Rev*, **112**, p 1940, Dec. 15, 1958.
- (8) A. Yariv and J. P. Gordon, The Laser, *Proc. IRE*, **51**, p 4, Jan. 1963.
- (9) M. Ciftan, A. Krutchkoff and S. Koozekanani, Resonant Frequency Modes of Ruby Optical Masers, *Proc IRE*, **50**, p 84, Jan 1962.





PROBE scan apparatus showing the rotary joint, feed and conical reflector at left

## NEAR-FIELD PLOTTER:

# Design Tool for Millimeter-Wave Antennas

Initial design based on ray optics or first-order calculations  
is refined in consecutive steps using field recordings

By **PAUL WOLFERT\***  
Sylvania Electronic Systems  
Sylvania Electric Products Inc.  
Williamsville, N. Y.

**FIELD RECORDING** used as a design tool is a modification of the spinning dipole technique described by Cullen and Parr.<sup>1</sup> A small scattering probe is introduced into the antenna near field and the associated reflected wave in the antenna feed line measured as a function of

probe location. The field perturbation method at millimeter wave lengths is actually superior to direct measurement of the local field. The probe is suspended by a nylon cord and rotated to modulate the reflected signal. It is thus readily distinguished from spurious reflections from stationary objects. The probe must be small to prevent disturbance but large enough so the reflected signal is above the receiver noise level.

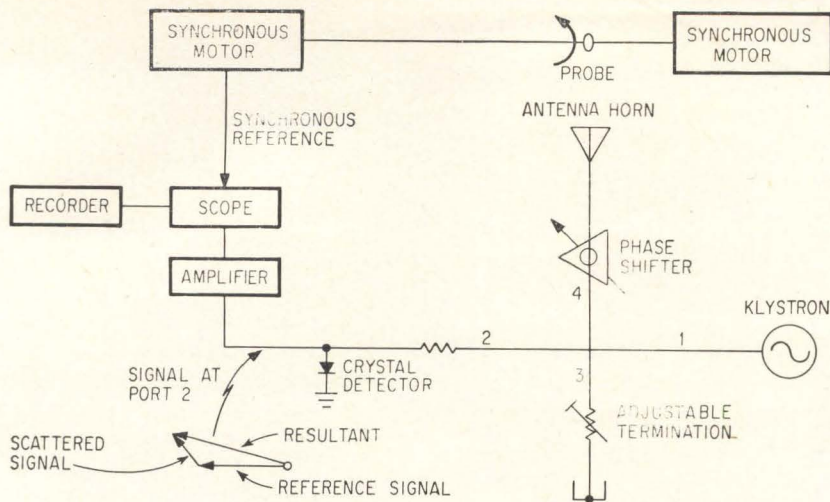
**Oval Mirror**—A flat, elliptically shaped metallic reflector is best.

The probe is rotated about its minor axis, with the rotation axis oriented approximately parallel to the H vector of the antenna field. The reflected signal comprises a series of pulses, of a period twice the probe rotation frequency. A pulse occurs each time the probe faces are parallel to the local wavefront of the field.

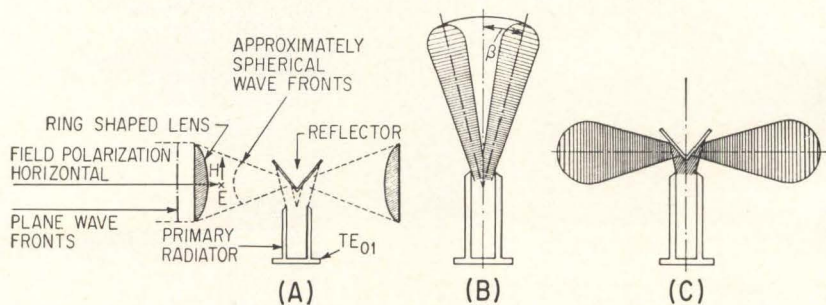
The test setup is shown in Fig. 1. A c-w microwave signal is applied through a hybrid junction and a phase shifter to the antenna. A servo system scans the probe through the antenna field. The wave

\* Now with Bell Aerosystems, a Division of Textron, Inc., Buffalo, N. Y.

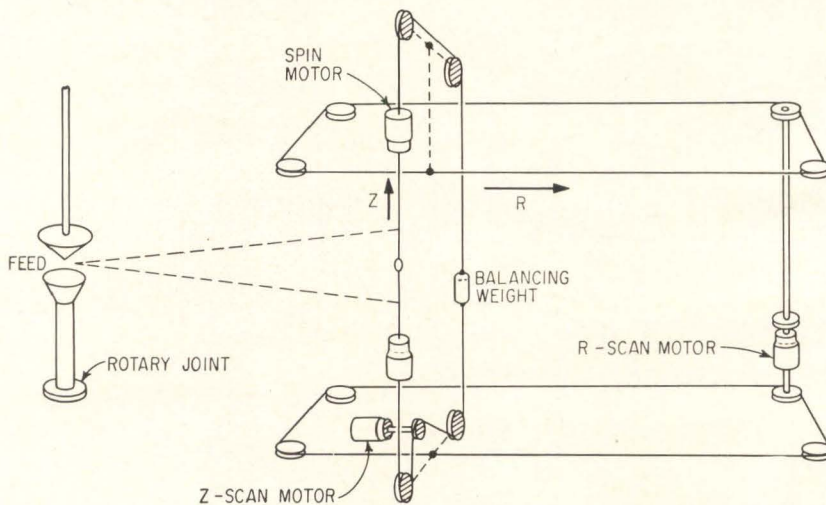




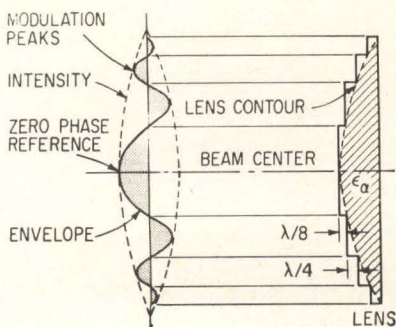
SPINNING probe technique in which reflected energy is returned to the antenna from probe. Vector diagram shows relationships—Fig. 1



FEED and lens system (A) radiation intensity from the cylindrical horn (B) and beam deflected horizontally (C)—Fig. 2



SERVO system used to position the probe scan apparatus relative to the antenna—Fig. 3



LENS design is possible using a single-scan record—Fig. 4

reflected by the probe passes through the phase shifter and the hybrid to be detected at port 2. Port 3 is terminated in a load with a tunable mismatch, which causes a part of the microwave signal to bypass the antenna and go directly to port 2. The crystal detector at port 2 receives two signals, the small reflected signal and a fixed phase reference from the termination at port 3. A time vector presentation of the resultant signal is shown for a particular phase between the reference and reflected signals. The signal is detected and the a-c components are amplified and displayed on an oscilloscope or recorded with a galvanometer.

**Wavefronts**—To measure the wavefronts of the field, it is practical to scan the probe at a constant velocity and to record the changing modulation as a function of the scanning coordinate. Modulation records are made with a compressed time scale so only the envelope of the modulation pulses is shown. A change of the envelope amplitude from a maximum to a null corresponds to a rotation of the reflected signal vector through 90 degrees from in-phase to out-of-phase with the reference signal vector. The 90-degree rotation is related to a phase difference of 45 degrees, or  $\pi/4$ , between the E-fields at the two probe locations at which the envelope maximum and null are recorded as shown in the photograph.

**Probe Scan**—The design of the apparatus must be adapted to the field configuration of the antenna system under measurement. In particular, the scanning coordinates must be chosen such that the probe rotation axis is maintained approximately parallel to the H field throughout probe scan. However, this condition is not critical during tests of the crude antenna design. As the desired field configuration is approached through design refinements, errors caused by incorrect orientation of the probe's rotation axis decrease.

The layout of the millimeter wave antenna system to which the experimental design technique was applied is shown in Fig. 2A. The system has rotational symmetry about the vertical system axis and consists of a conical horn, a reflector



and a ring-shaped lens. The mode in the feed waveguide is the circular  $TE_{01}$ , which propagates into the conical horn (Fig. 2B) and is deflected at the reflector to form a flat pancake-like radiation pattern shown at Fig. 2C. The intensity maximum is directed horizontally and the wavefronts radiated by the horn-reflector combination are approximately spherical. Considering the  $TE_{01}$ -mode pattern (Fig. 2A), it is evident that the E-field lines form circles about the system axis. The H-field lines are orthogonal to the E field and parallel to the wavefronts.

**Phase Front**—The field configuration of concern, which determines the far-field characteristics of the antenna system, is the amplitude and phase pattern at the aperture of the ring-shaped lens. A cylindrical phase front (flat, as seen in an elevation plane) is required, with an appropriate illumination taper to obtain optimum gain and sidelobe level ratios.

The probe scanning apparatus was designed to provide vertical probe scanning parallel to the wavefront of the desired field, with the probe's rotation axis parallel to the H field. For vertical scanning, the probe can be set at different radial distances from the system axis. A photograph shows the apparatus and a horn-reflector combination under test. Rigid mounting makes possible exact alignment of the antenna system elements.

Scattering from structural elements in the region of high field intensity is reduced by using Eccosorb covers. The three-pole mounting unit supporting the antenna elements during near-field tests (at the left in the photograph) can be detached and used as a mount for far-field testing. The rotary joint in the feed line and the bearings needed to rotate the antenna system during tests for cylindrical symmetry are an integral part of the mounting unit.

The servo system used to rotate and scan the probe through the antenna near-field is illustrated in Fig. 3. Accurate probe setting and a constant scan velocity with no noticeable backlash were achieved using precision-ground drillrod rails to guide the motor assemblies during the scanning operations. At 70 Gc, a tolerance of 0.010 inch nor-

## PRAGMATIC APPROACH

This rapid and reliable technique of measuring the near-field pattern makes possible the design of millimeter-wave antenna systems regardless of the number of parameters. Systems too complex for calculations can be optimized experimentally in iterative steps

mal to the wavefront corresponds to a phase error of approximately 21 degrees. The horizontal and vertical scan velocity is 0.84 cm per sec. Probe rotation is 943 rpm.

**Antenna Design**—The design of the antenna system was begun with the layout of the horn-reflector combination. The horn flare angle and the desired illumination function at the lens aperture were assumed and the reflector profile was constructed using ray tracing. The lens was designed last, using the measured wavefront of the finalized horn-reflector field.

For the field tests, the horn and the reflector were set in the mounting unit in precise axial alignment. Circular symmetry of the near-field was tested first. Noncircular modes in the circular feed waveguide were eliminated by mode filtering. The experimental design of the reflector was then carried out. The design procedure consists of axially positioning and contour shaping the reflector under observation of the

field wavefront and illumination at the lens aperture.

A typical vertical scan record taken at the approximate lens distance is shown in the photograph first referred to. Distances between two consecutive nulls of a scan record correspond to phase differences of  $\pi/2$ . The wavefronts of the field were obtained from a set of such records taken in an elevation plane approximately  $\lambda/4$  apart. A scaled mapping of the envelope nulls of all the records of the set was made. Identification of equal phase points was easily made and the wavefronts were drawn  $\lambda/4$  apart. The illumination (field intensity), was then plotted by evaluating the magnitudes of envelope maxima, which are proportional to  $E^2$ .

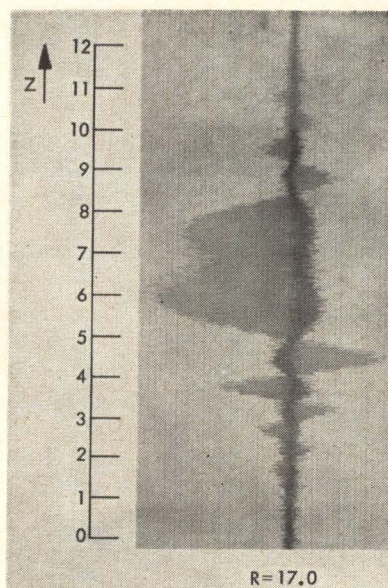
**Final Result**—In conducting the experimental reflector design, it was found that necessary incremental changes of the position and the shape of the reflector needed to approach the desired field were easily derived. Increasing or decreasing the separation between the horn and the reflector shifts the direction of the intensity maximum up or down without appreciably influencing the shape of the wavefronts. By increasing reflector convexity, the illumination is broadened.

A lens was designed and built to collimate the wavefronts of the final horn-reflector combination. A cross section of a lens designed from a single probe scan record is shown in Fig. 4.

The aperture field of the complete antenna system was tested for phase errors. Deviations in the order of 10 degrees were measured by vertically scanning the probe close to the lens face and observing the modulation waveforms on the oscilloscope. Lens corrections were made accordingly.

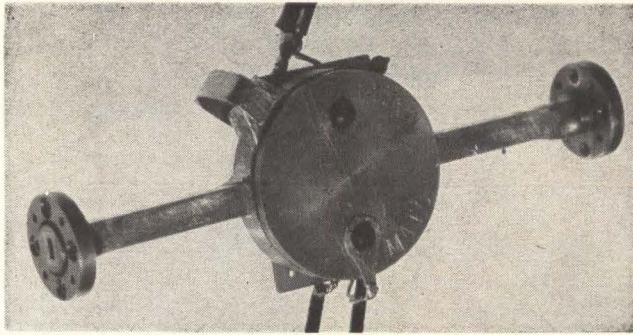
## REFERENCE

- (1) A. Cullen and T. Parr, A new perturbation method for measuring microwave fields in free space, Proc. IRE, Paper 1921R, Sept. 1955.

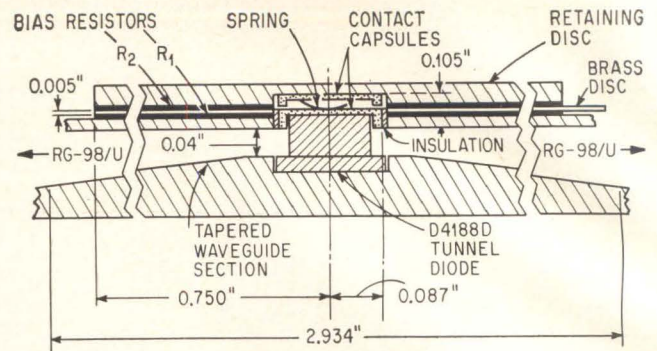


VERTICAL scan record for a fixed distance from the antenna shows main lobe at approximate center scale





X-BAND TUNNEL diode in Rg-98/U waveguide produces Q-band frequencies at much less expense than a Q-band diode—Fig. 1



THE TAPERED waveguide section serves as an impedance transformation device in waveguide mount. Special requirements are placed on the film resistors—Fig. 2

# Operating X-Band Tunnel Diodes

Impedance transformation technique allows a tunnel diode to operate at up to four times rated frequency. And an X-band diode may cost only 1/12th as much as a Q-band diode (Q band = 33 to 50 Gc)

**TUNNEL DIODE** oscillation above theoretical limits has recently been achieved.<sup>1,2,3</sup> Using a specially designed tunnel diode waveguide transformer and mount, a 1N3219A S-band tunnel diode has produced fundamental X-band oscillations. To obtain this X-band oscillation, the microwave circuit was "designed so that the microwave impedance of the circuit matches the negative impedance of the tunnel diode at a desired operating frequency."<sup>1</sup> This was accomplished by impedance transformation, with the lumped junction and package capacitance of the packaged tunnel diode transformed into the distributed parameter capacitance of the waveguide. This technique does not eliminate these parameters, but it does reduce their effect on the maximum frequency of oscillation. Also, the technique<sup>4</sup> allows a redefinition of the terminals in the tunnel-diode equivalent circuit.

Employing the same principle of impedance trans-

formation, a millimeter wave circuit has now generated Q-band (33 to 50 Gc) fundamental oscillations with an X-band (8.2 to 12.4 Gc) tunnel diode. The tunnel diode employed is a D4168D, Serial Number 1381-63, A89-3, X-band diode. Pertinent parameters for this particular diode are:  $I_p = 2.00$  ma,  $C_J = 0.6$  pf,  $R_s = 2.1$  ohms,  $R_n = 69$  ohms,  $f_{osc} = 11.3$  Gc, and  $f_{ro} = 21.74$  Gc.

Tunnel diodes for Q-band are commercially available but most of them are permanently mounted in a waveguide and are not interchangeable. Also, such a tunnel diode-waveguide system is 12 times more expensive than the X-band tunnel diode utilized in this investigation. The size, weight and power consumption advantages of the tunnel diode as compared to the klystron at millimeter frequencies are self-evident.

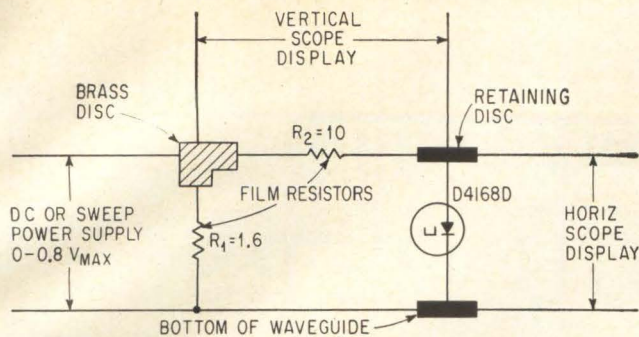
**Diode Mount**—The tunnel diode waveguide mount is shown in Fig. 1 and a cross-section is shown in Fig. 2. The mount uses the impedance transformation technique of a tapered waveguide section and was designed specifically for a packaged, commercially available tunnel diode. The diode is mounted in the center of the waveguide with a spring-loaded pressure contact. Retaining disk and the waveguide are fastened together with nonconducting bolts. When necessary, these sections are also insulated from one another with an acrylic insulating material.

Resistive films are specially designed to bias the tunnel diode, to display volt-ampere characteristics, and most important, to suppress low-frequency parasitic oscillation. As shown in Fig. 3, the resistive films are separated by a brass disk. The d-c power

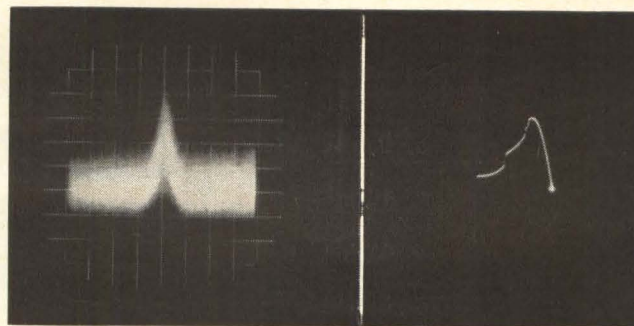
## OUTSMARTING TUNNEL DIODES

In the June 1, 1962 issue of **Electronics**, Professor Ishii and C. C. Hoffins presented results of their work on extending the frequency of oscillation of an S-band tunnel diode up to X-band. Now the same basic principles with some new refinements are used to push an X-band diode up to Q-band frequencies. Much cheaper diode cost is the reason for using the lower frequency unit to get the higher frequency output





OSCILLATION FREQUENCY is primarily determined by the magnitude of the bias voltage. A tuning range of 250 Mc was obtained with this circuit—Fig. 3



KINK IN TUNNEL diode characteristic (right) indicates the diode is oscillating. Output signal (left) is 42.355 Gc at 70 dbm—Fig. 4

## at Q-Band

By STANLEY V. JASKOLSKI and KORYU ISHII, Department of Electrical Engineering, Marquette University, Milwaukee, Wisconsin

supply, whose output is placed across  $R_1$ , has an output impedance of one ohm. Consequently,  $R_1$  must be approximately one ohm to insure that disturbances within the power supply are not propagated to the tunnel diode circuit. This tends to isolate the power supply from the tunnel diode circuit. The volt-ampere characteristic is monitored on an oscilloscope, placing the voltage across the diode on the horizontal, and the voltage across  $R_2$ , which is proportional to the current through the diode, on the vertical. Total resistance of  $R_1$  in series with  $R_2$  is 11.6 ohms.

**Film Resistors**—The film bias resistors must be so constructed that current paths are through the films rather than around them. Current flow must be straight through conduction current as opposed to radial current. Also, the conductivity per unit area per film resistor must be extremely uniform to eliminate current bunching within the film. Satisfactory resistors tend to maintain uniform field distribution within the waveguide circuit.

Film resistor  $R_1$  consists of an extremely porous paper base coated with a homogeneous mixture of number ten motor graphite and silver conducting paint. Resistor  $R_2$  is painted directly on the waveguide retaining disk, thereby reducing contact resistance at this point, and consists of a homogeneous mixture of Q-dope polystyrene and number ten motor graphite. Both resistors were baked at 125 C for 45 minutes, then placed in the waveguide circuit; the waveguide retaining disk was then bolted to the waveguide. The resistors were cured this way for two weeks. At the end of this aging period, the films appear uniform and constant in conductivity.

Oscillation of the D4168D tunnel diode in the circuit was detected by a large kink, Fig. 4, in the negative resistance region. Shape and magnitude of this kink is a function of how tightly the retaining disk and the waveguide are bolted together. Correspondingly, since the amount of pressure applied varied the value of the bias resistors, the magnitude of the film

bias resistors affects circuit operation. As the pressure is varied oscillation can be completely suppressed.

**Frequency**—With the pressure set to obtain the large kink, oscillation was detected with a RWT receiver having a range from 2 to 75 Gc. Fundamental oscillation was detected and verified with both the receiver and a calibrated shorting plunger at 42.29 Gc for a bias of 155 mv. Oscillation frequency is essentially a linear function of bias voltage, ranging from 42.39 Gc at 130 mv to 42.14 Gc at 200 mv, giving a 250 Mc tuning range with bias voltage. The oscillation is easily reproducible and is stable with time and variations in load. Output power is a function of load, bias voltage and the magnitude of the film bias resistors. Maximum power output was -70 dbm at 42.34 Gc and bias of 160 mv. Oscilloscope display of the RWT receiver output due to the tunnel diode oscillating at 42.29 Gc is shown in Fig. 4.

Exhaustive experiments were conducted to verify that the observed oscillation was a fundamental and not a harmonic.

Unpackaged, laboratory made tunnel diodes, mounted in waveguide structures, have been operated at 100 Gc.<sup>5</sup> Such diodes are not commercially available but packaged tunnel diodes, designed for operation up to 30 Gc, are commercially available upon special request.

The authors thank J. E. Billo, J. A. Stefancin, S. Krupnik, Jr. and C. C. Hoffins for their assistance in this investigation. This research is supported in part by a University Committee on Research grant.

### REFERENCES

- (1) K. Ishii, C. C. Hoffins, Extending Tunnel Diode Operating Frequency, *ELECTRONICS*, 35, June 1, 1962.
- (2) K. Ishii, C. C. Hoffins, X-Band Operation of S-Band Esaki Diodes, *Proc IRE* (Correspondence), 50, July, 1962.
- (3) C. C. Hoffins, K. Ishii, Microwave Tunnel Diode Operation Beyond Cutoff Frequency, *Proc IEEE* (Correspondence), 51, Feb., 1963.
- (4) M. K. McPhun, Operation of the Tunnel Diode Above the Resistive Cutoff Frequency, *Proc IEEE* (Correspondence), 51, p 1265, Sept., 1963.
- (5) C. A. Burrus, Millimeter Wave Esaki Diode Oscillators, *Proc IRE* (Correspondence), 48, p 2024, Dec., 1960.



# HOW TO DESIGN Arbitrary-Length BINARY COUNTERS

Simple set of design rules for building binary counters for any length sequence saves time and eliminates trial-and-error procedures

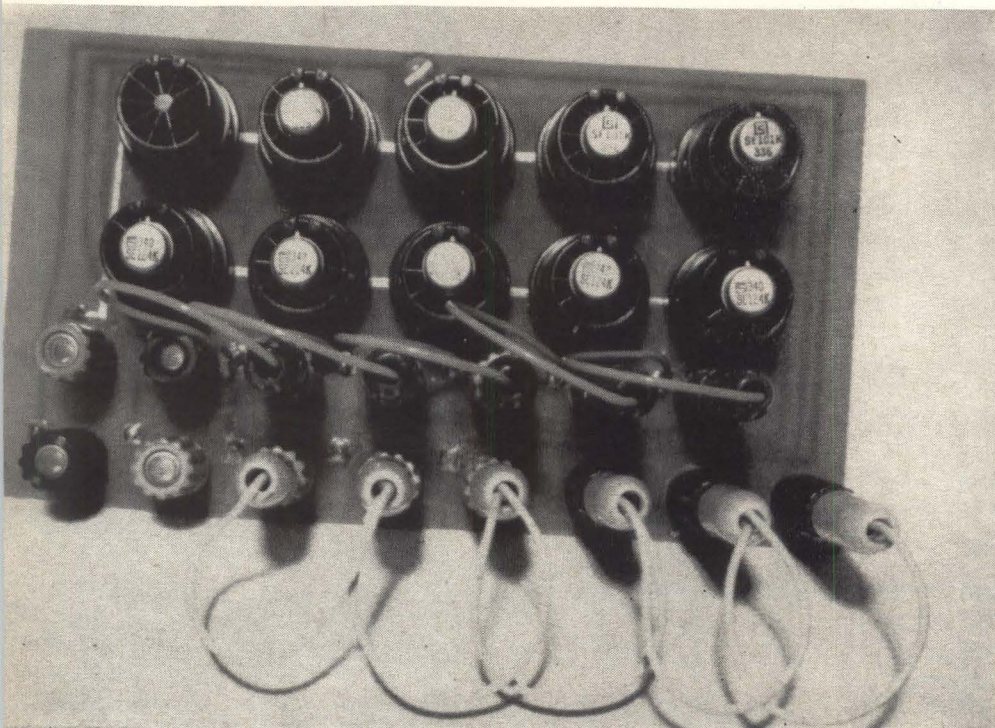
By **B. W. MEYER**, Signetics Corp., Sunnyvale, Calif.

---

## INSIDE THE COUNTER

The variable-modulus counter, shown in the photo, is made up of integrated circuits, fabricated within monolithic silicon substrates by planar techniques. The circuits are designed for applications in high-speed low-power computer systems

---



VARIABLE MODULUS counter, designed for and using integrated circuit modules, shown packaged in modified TO-5 cans

**IN NEARLY EVERY** system designed, the need arises over and over again for counters to count to some arbitrary length sequence. By trial and error, one can eventually find a logic design that will do the job, but trial and error seldom produces a minimum package count. Here is a set of rules that will consistently produce a design for a counter of any length sequence with a minimum number of packages, and in which the required fan-in and fan-out of the gates used are minimized. Also, in applications where the

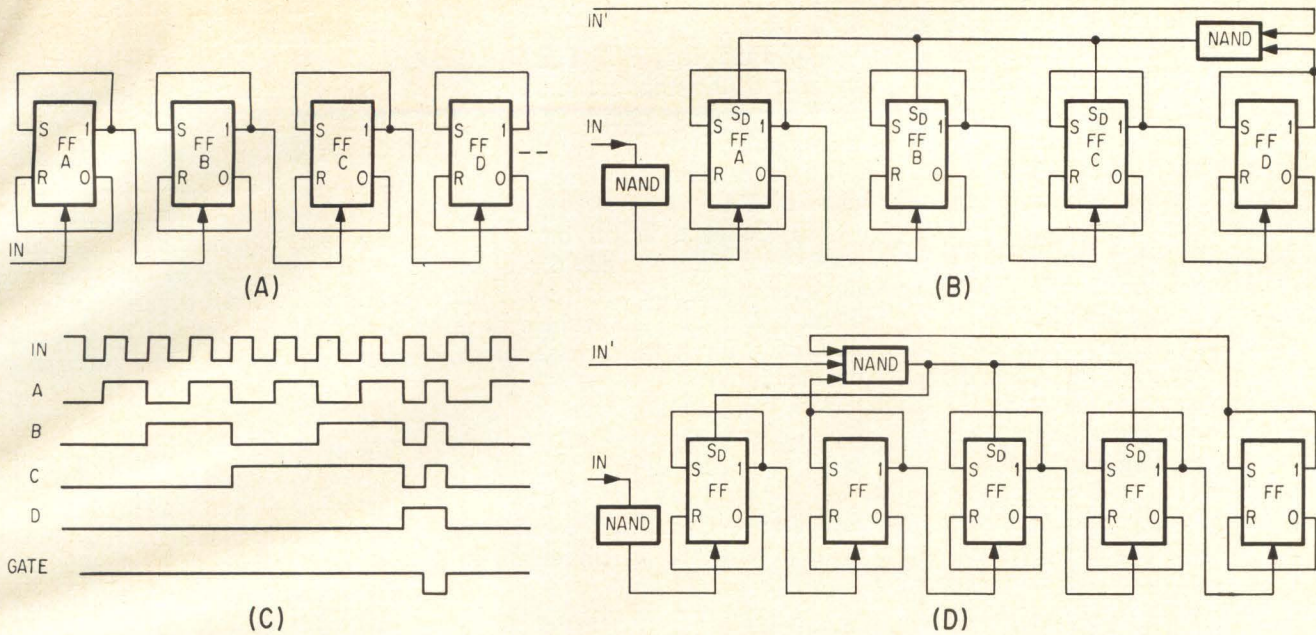
---

## BINARY COUNT SEQUENCE

D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

---





SIMPLE binary ripple counter (A); nine counter (B) and timing chart (C); 19 counter (D). Direct set input is  $S_D$ —Fig. 1

counter designed according to these rules must merely count repetitively rather than start at a predetermined state, no "clear" signal is necessary. After a short count through some of the out-of-sequence states, the counter will automatically go into the desired sequence.

**Operation**—Consider first a simple binary ripple counter as shown in Fig. 1A.

The flip-flops trigger on the negative-going edge of the clock input signal if one logic input is down. If the first flip-flop of the counting chain above is in the ZERO state, the ONE output is low, and therefore, the set input is low. When the input line goes down, the flip-flop goes to the ONE state, with its ONE output high, and ZERO output (and, therefore, reset input) low. On the falling edge of the next clock pulse the flip-flop returns to the ONE state; thus, the first flip-flop changes state on the falling edge of every input pulse. In similar fashion the second flip-flop changes state every time the ONE output of the first flip-flop falls, and similarly for succeeding stages. Thus it can be seen that the network counts the input pulses in binary. If a continuous train of pulses is applied to the input, the counter will cycle through all of its possible states, return to its initial state and cycle through the same states repetitively. Since the number of pos-

sible states is a power of two, the length of the counting sequence is also a power of two. Specifically, if the number of flip-flops is  $n$ , the length of the sequence is  $2^n$ , which, for the counter shown, is 16. Now consider how to get sequences of other lengths.

**Modifications**—To understand the design procedure, consider the count sequence in the table for a simple four-stage binary counter. There are a total of 16 possible states in the table, and therefore, the counter will count a sequence of length 16. If means are provided to prevent the counter from reaching some of the possible states, then the length of the sequence can be limited to any desired number ( $L$ ) less than 16.

A commonly accepted practice is to force the counter to go from the state representing  $L-1$  back to the beginning of its normal sequence (all zeros) on the  $L$ th clock pulse. This is usually accomplished with a configuration of gates that causes the counter to reset automatically on the  $L$ th pulse. This technique, however, may frequently require an uneconomical number of gates. In the following example, it will be shown that with a minimum number of gates, one can force a counter from  $L-1$  through its normal final count (all ones) and back to all zeros, in the duration of the  $L$ th clock period.

Assume the 16-counter shown above is to count a sequence of length 9. Note from the table that on the eighth count ( $L-1$ ) flip-flops  $A$ ,  $B$  and  $C$  are zeros, and  $D$  is ONE. The objective is to return the counter to all zeros by the end of the ninth clock pulse. If one connects, as inputs to a NAND gate, the clock pulse and the ONE side of flip-flop  $D$ , the output of this gate will go down only when both of these inputs are high. Connect the output of this gate to the set inputs of flip-flops  $A$ ,  $B$  and  $C$  as shown in Fig. 1B. Now consider the timing diagram for this counter, Fig. 1C. On the falling edge of the eighth clock pulse, the counter goes to 1000 with flip-flop  $D$  up. On the rising edge of the ninth clock pulse, the gate output goes down, since both its inputs are up, and thus causes flip-flops  $A$ ,  $B$  and  $C$  to change to ones. Flip-flop  $D$  remains at ONE, being unaffected by a rising voltage at its clock input. In half a clock time, then, the counter has gone from state 8, or 1000, to state 15, or 1111. On the falling edge of the ninth clock pulse, the gate output rises, and the counter goes to all zeros. Thus, the cycle from state 8 through 15 and back to zero is completed during one clock time, and the counter has made nine counts.

It should be noted that, in the practical implementation of this



technique, the propagation delay through the feedback gate should be compensated for to assure reliable operation. This is readily done by inserting an identical gate in the clock line. Since the gate will invert its input signal, the input to this gate and to the feedback gate must be complementary. Relative timing of  $In$  and  $In'$  is not critical, the only requirement being that  $In'$  go down no later than  $In$  goes up.

Note also, in the example given, that it is not necessary to use the entire configuration for state 8 as a feedback or reset signal, as is commonly the case. Fan-in and fan-out requirements for the feedback gate are minimized, because only those flip-flops that are ones for the  $L-1$  state are connected to gate inputs, and the gate fans out only to those flip-flops that are zeros for state  $L-1$ .

**Design Rules**—The example and observations above can be generalized into the following set of design rules:

- (1) Determine desired length of sequence. Call this  $L$ .
- (2) If  $L$  is a power of 2—as 4, 8, 16, etc.—merely construct a binary ripple counter according to instruction 4, with  $L = N$ .
- (3) If  $L$  is not a power of 2,

find the next higher power of 2. Call this  $N$ .

(4) Find  $\log_2 N$ . This is the number of flip-flops required in the ripple counting chain. Construct this counter.

(5) Determine the binary equivalent of  $L-1$ .

(6) Connect, as an input to a NAND gate, the ONE side of all flip-flops that will be ones when the counter reaches  $L-1$ . Include as an additional input the inverse of the counter input.

(7) Connect the gate output to the d-c SET input of all flip-flops which are zeros at  $L-1$ .

**Example**—Construct counter to count a sequence of length 19.

- (1)  $L = 19$ .
- (2)  $L \neq$  a power of 2.
- (3) Next larger power of 2,  $N = 32$ .
- (4)  $\log_2 N = \log_2 32 = 5, \therefore 5$  flip-flops required.
- (5)  $(L - 1)_2 = (18)_2 = 10010$ .

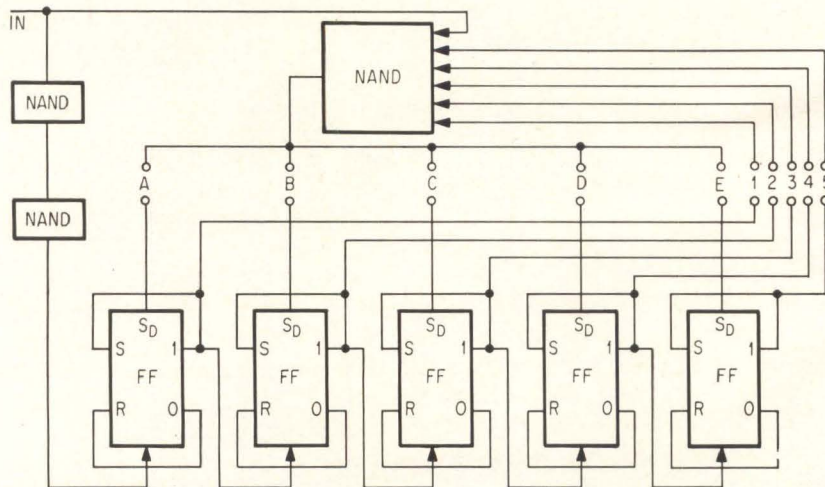
Construct the counter as shown in Fig. 1D. The added gate, previously discussed, compensates for the delay of the feedback gate. Actually, for those counter configurations that do not require feedback to the first stage, the delay problem does

not exist, and this added gate may be eliminated.

**Limitations**—As with counters of other designs, consideration must always be given to limitations on counting rate. The maximum rate at which the counters described here can count is a function of the length of the sequence. In the worst case, a signal must propagate through the length of the counter, back through the feedback gate and through the first flip-flop again before the next input pulse arrives. In cases where this propagation time must be decreased, consideration should be given to breaking the counter into a number of smaller counters running in parallel with their outputs gated together. The sequence length is then the product of the sequence lengths of the individual counters, and the maximum propagation time is that of the largest individual sequence length plus the delay associated with the required gating at the output. In designing such counters, care should be taken to avoid the occurrence of common factors in the sequence lengths of any of the individual counters used. Where common factors occur, the sequence length will be the product of the individual sequence lengths divided by the common factor. Thus, an 18 and a 6 counter operated in parallel and gated together will count 18 and not 108.

It should be apparent from the discussion that counters designed in accordance with the rules specified will automatically come into the desired sequence no matter what their state when power is first applied. If it is necessary to have the counter start at all zeros when power is applied, an initial clear signal should be applied to all the d-c reset inputs. Provided that this signal is longer than the maximum possible carry propagation, the counter will be forced to the clear state.

The rules and observations presented here were checked empirically on an experimental variable-modulus counter in which the sequence length can be changed conveniently on a patch panel (Fig. 2). This counter can be made to count up to any number from 2 to 32, by connecting the feedback gate inputs and outputs in accordance with the table in Fig. 2, which conforms to the rules previously discussed.



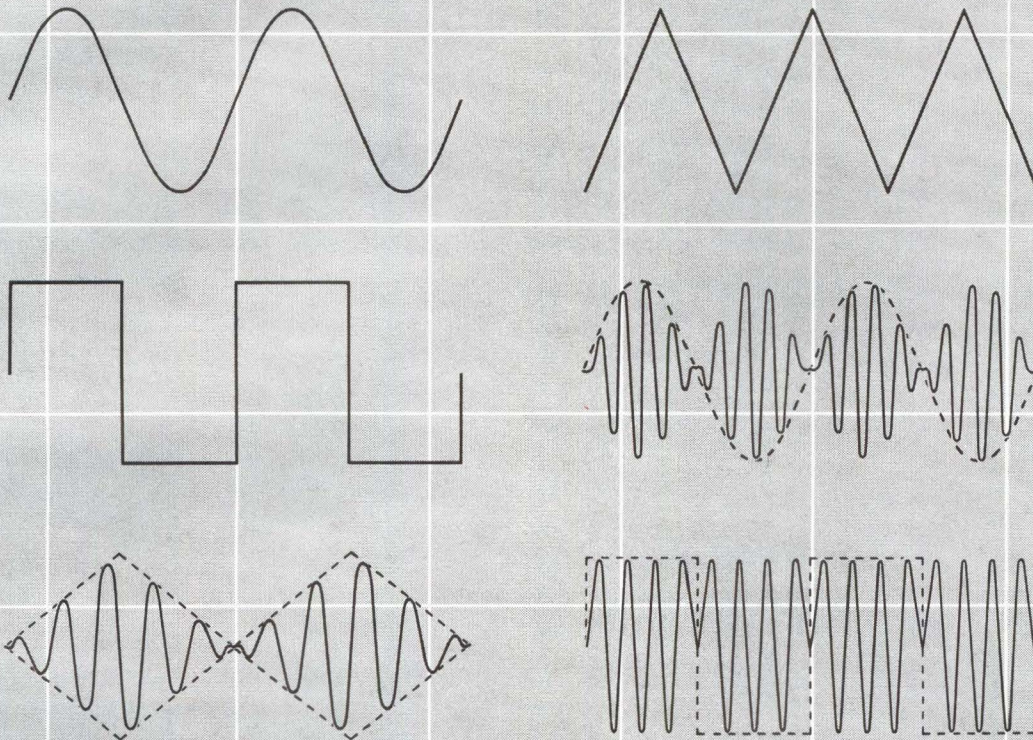
		SEQUENCE LENGTH																															
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
FEEDBACK CONNECTIONS	GATE INPUTS	NONE	2	NONE	3	1 3	2 3	NONE	4	1 4	2 4	1 3 4	2 3 4	NONE	5	1 5	2 5	1 3 5	2 3 5	1 2 3 5	2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	GATE OUTPUTS	NONE	A	NONE	A B	B	A	NONE	A B C	B C	A C	C	A B	B	A	NONE	A B C D	B C C D	C C D	D	A B D	B D	D	D	A B C	B C	A C	C	A C	A B	B A	A	NONE

VARIABLE MODULUS counter and chart of connections for constructing a counter of any length from 2 to 32—Fig. 2



# NEW → 'The Mercury' SERVOMATIC® ANALYZER

WAVESHAPES AVAILABLE: Sine, Triangle, Square, Modulated Sine, Modulated Triangle, Modulated Square (see selected specifications below)



### Model 1990

Also available: Model 1990X with CRT indicator and Model 1990R for rack mounting; other models available for specific applications with dc-only servo systems.\*

\*Lower prices on models in this series.

Servo's new SERVOMATIC® Analyzers are the standards for comprehensive servo system test and analysis. Write for complete specifications and arrange a demonstration from your local representative.

### SELECTED SPECIFICATIONS FOR MODEL 1990

Frequency range . . . . . 0.005-1,000 cps, cont. var. in 5 ranges for all waveshapes

Eleven available signal outputs:

- 0° and 90° sine wave and mod. sine wave . . . . . 0-40 v, p-p min.
- Square wave and mod. square . . . . . 0-40 v, p-p min.
- 0° and 90° triangular wave and mod. triangular . . . . . 0-35 v, p-p min.
- Synchronized sweep . . . . . 7 v min.
- Synchronized pulse . . . . . 3 v pos; 9 v neg
- Carrier acceptance . . . . . 50-10,000 cps (ext); 1 watt, 26 v/115 v terminals provided
- Phase measurement . . . . . 0°-360° dial; 0° and 90° reference points
- PRICE (U.S.A.) . . . . . \$3,450.00



## SERVO CORPORATION OF AMERICA

111 New South Road, Hicksville, L.I., N.Y., Wells 8-9700 • Sales and service offices coast to coast.



# Who says all females are alike?

All females are supposed to be unpredictable, unreliable, and hard to handle.

Here's one that isn't. It's the "better half" of Amphenol's new Ultra-Mate\* connector.

## GO/NO-GO RELIABILITY

The Ultra-Mate connector is more than predictable. You can bet your life on it—which is exactly what astronauts do each time they soar away from the launch pad. Ultra-Mate will mate *only* if every pin fits snugly into every socket. No mis-connection intermittencies.

## EASY TO HANDLE, TOO

Ultra-Mate gets its go/no-go reliability from the female half's hard faced, closed entry receptacle. Ultra-Mate is the only truly environmental, space age connector that combines a hard dielectric with *front* servicing. Any stubby-fingered technician can assemble or disassemble an Ultra-Mate connector in mere seconds.

How did we do it?

Take a close look at the female Ultra-Mate. You'll see 55 funnel-shaped openings, one for each contact. These hard-dielectric entryways guide contact-pins smoothly into their sockets. Like Figure 1 at the right. If pins are bent out of line, the connector halves just won't mate.

Now, look a little closer. See those tiny slots fanning out of each entryway? These are the secret of Ultra-Mate's front release system.

Only the standard removal tool will fit into these slots. No wrong-size contacts. No oversize test prods. Ultra-Mate is idiot-proof. And it's fast. Contact positions are clearly marked in front of the dielectric.

## MIL-C-26500 PERFORMANCE

For the first time, an environmental connector combines tamper-proof safety and service features with MIL-C-26500 performance. Ultra-Mate also meets the requirements of MIL-C-38300, a recently issued Air Force specification that retains the rigid environmental and temperature standards of MIL-C-26500, but specifies either a hard closed-entry or soft dielectric. It also employs, as does MIL-C-26500, front removal of contacts and incorporates new reliability requirements never included in connector specifications to date.

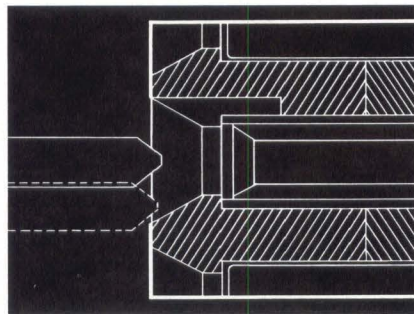
Here's what you get with a fully pressurized Ultra-Mate connector:

1. Operates continuously, with current load, at 200°C ambient.

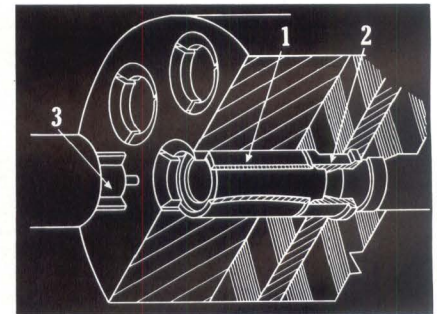
2. Undamaged by 50 g's shock.
3. Withstands thermal shock, 5 cycles between -55°C and +260°C.
4. Carries 1,500 volts RMS submerged in salt water while pressure is alternated between sea level and 75,000-ft. altitude equivalents.
5. Handles 1,000 volts RMS at altitudes up to 110,000 feet.
6. Insulation resistance exceeds 5,000 megohms.
7. Unaffected by exposure to hydraulic fluid, lubricating oil, ozone, and moisture.

## ULTRA-MATE AVAILABILITY

You can specify Ultra-Mate connectors now in all basic sizes referenced in MIL-C-26500. Bayonet or threaded couplings. Any Amphenol Sales Engineer can give you the complete specs and engineering data. Or, write to: Dick Hall, Vice-President, Marketing, Amphenol, 1830 S. 54th Avenue, Chicago 50, Illinois.



**Figure 1.** Slight misalignment is self-corrected by the beveled entry of the Ultra-Mate connector. Badly bent pins will prevent mating until they are replaced.



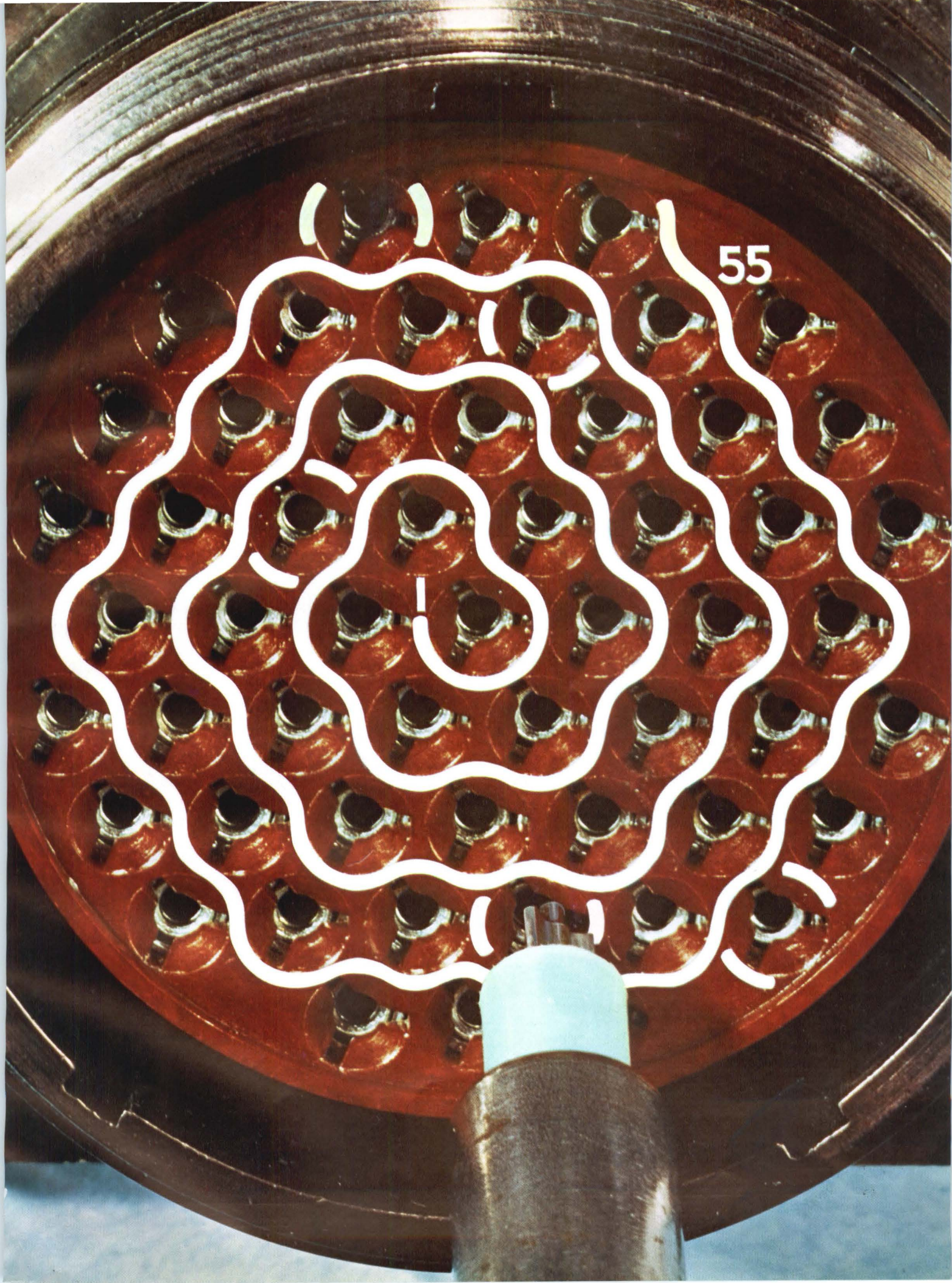
**Figure 2.** Standard removal tool depresses activation sleeve (1) which spreads tangs of retention clip (2) apart. Tool (3) never directly touches clip.

\*Ultra-Mate is a Trademark of Amphenol-Borg Electronics Corporation



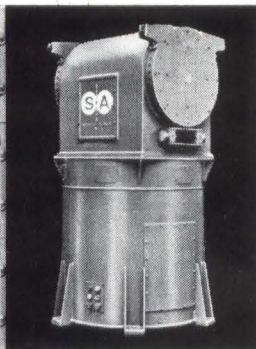
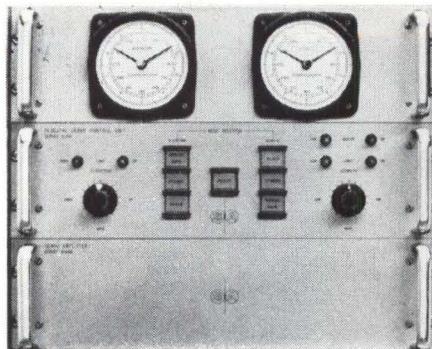
A DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION





55





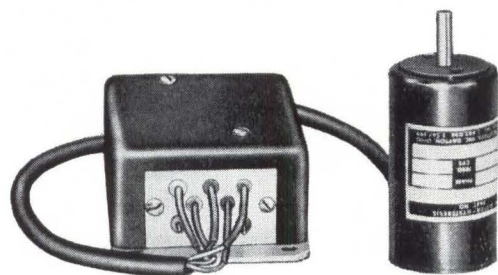
## Front line duty!

### Scientific-Atlanta's Servo-Controlled Tracking Pedestal Systems

In Europe . . . in Australia . . . in many locations at home and over the world, Scientific-Atlanta's tracking systems are hard at work under operating conditions that are demanding and difficult. Proved and proved again, these systems offer advantages not found anywhere else in the industry . . . production-line assembly from standardized modules offer substantial off-the-shelf economy and adaptability . . . designed to meet MIL SPEC environmental and RFI conditions . . . solid state servos for maximum dependability . . . fail-safe brakes with electrical and mechanical stops assure safety and reliability . . . takes antennas up to 30 feet diameter with output torques from 250 to 15,000 lbs./ft., velocities to 30°/sec., accelerations to 30°/sec.<sup>2</sup>, and accuracies to 0.05°/rpm dynamic. Multiple mode operation, automatic, slave, manual, or preprogrammed tracking, and a full range of options and accessories make a system package able to meet any requirement. Write today for full data. ■ Scientific-Atlanta, Inc., P.O. Box 13654, Atlanta 24, Georgia Phone: 404-938-2930. TWX: 404-938-1322. Zip: 30324

# Scientific-Atlanta, Inc. SA

CIRCLE 203 ON READER SERVICE CARD



## HOLD MOTOR SPEED TO 1% IN ALL ENVIRONMENTS

Maintain motor speed accurately to  $\pm 1\%$  at temperatures fluctuating from  $-55^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ , at any speed from 3,600 to 24,000 rpm, and with voltage fluctuating from 22 to 32 v.d.c. Globe's new frequency controlled d.c. to a.c. device combines all advantages of brushless d.c. operation with unusually precise 1% speed control over wide environment variations, and within 0.5% in a constant environment! Speed control weighs 10 ounces, measures  $1\frac{1}{16}$ " high x  $2\frac{1}{4}$ " wide x  $3\frac{3}{4}$ " long.

Life can exceed 10,000 hours. Device has no moving parts or electrical contacts, and is designed to meet MIL-E-5272 for environmental protection. Fits many sizes of motors. Reverse polarity protection and transient voltage protection are available. Request Bulletin OPC. Globe Industries, Inc., 1784 Stanley Avenue, Dayton, Ohio 45404.

**GLOBE**

40 CIRCLE 40 ON READER SERVICE CARD



Induction Heating's Most  
Trusted and Creative  
Craftsmen Since 1926

## High Frequency INDUCTION HEATING UNITS

for

- BRAZING
- MELTING
- SOLDERING
- ZONE REFINING
- HEAT TREATING
- CRYSTAL GROWING
- BOMBARDING
- PLASMA TORCH

### ELECTRONIC TUBE GENERATORS

Kilocycle Frequency Units

Megacycle Frequency Units

Dual Frequency Units

- SPARK GAP CONVERTERS
- ACCESSORY EQUIPMENT

FREE APPLICATION ENGINEERING SERVICE—Our engineers will process your work samples and submit recommendations.

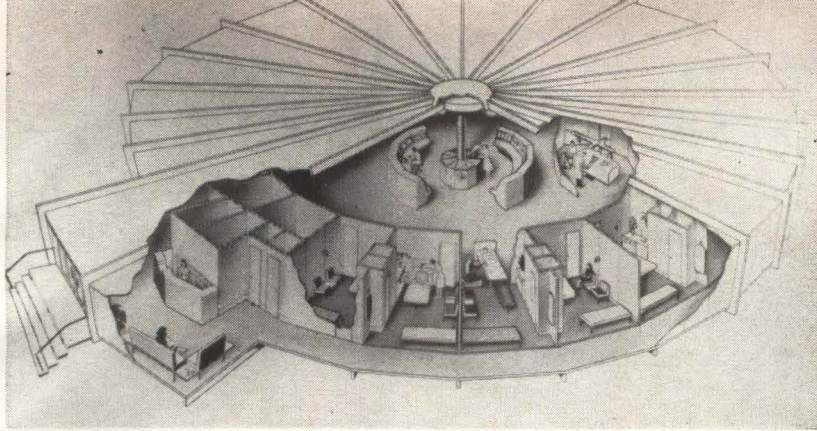
**Lepel** WRITE FOR NEW LEPEL CATALOG  
HIGH FREQUENCY LABORATORIES, INC.

55th St. & 37th Ave., Woodside 77, N.Y.C.

Chicago Office for Sales & Service: 6246 W. NORTH AVE.

CIRCLE 204 ON READER SERVICE CARD





CUTAWAY VIEW shows arrangement of rooms around monitoring consoles

## “Electronic” Hospital Opens

Experimental hospital's twin will be used at New York World's Fair

**MONTGOMERY, ALA.**—Business and medical men here are backing a new concept in hospital design, one aimed at lowering the cost of medical care. Hospital bedrooms are built around a core containing electronic patient-monitoring and data-handling consoles.

The first Atomedic Research Center was opened here last month with an assist from electronics firms who loaned or donated much of the equipment.

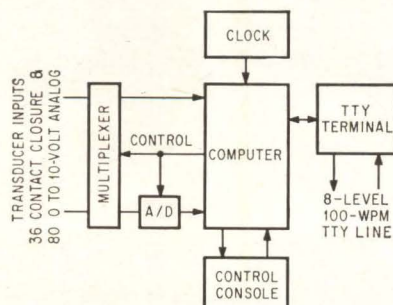
Atomedic's director, Dr. Hugh C. MacGuire, hopes the experimental hospital will step up world-wide use of modern medical technology. A twin of the 22-bed hospital in the round is scheduled to serve the New York World's Fair in March.

**Monitoring**—For electrocardiogram monitoring, miniature transducers and an 87-Mc f-m transmitter are taped to the patient. Signals are picked up by a monopole antenna in the bedroom ceiling and go by coaxial cable to one of 22 receivers at the central console. The ekg waveform is displayed on a Tektronix 565 oscilloscope. An abnormal heartbeat triggers an alarm lamp and buzzer. Aero Geo Astro, which designed the equipment, says the system can be expanded to handle other physiological parameters, such as temperature and respiration, by adding modules and multiplexing the transducer signals.

**Computer**—A Control Data 160 computer scans data inputs and activates the alarms when readings exceed preset limits or change from past readings. It can scan 80 analog and 36 closure inputs at rates of 100 and 1,000 points a second. Data is converted to digital form and displayed or recorded on demand. This system, when expanded, will also record ambient hospital conditions and handle clerical data and information retrieval.

**Closed-Circuit Tv**—This system lets nurses watch four beds at once from the central console. Low-light-level, automatic cameras made by Packard Bell are installed in each room. Miratel supplied the monitors.

Southern Bell's communications system provides for outside phone calls and also acts as an intercom system. Data-Phone transmission units can be plugged in to transmit medical data to a larger parent facility in the future.



COMPUTER processes and presents data from patient-monitoring transducers

# VITREOSIL®

PURE FUSED  
QUARTZ  
TAKES  
MORE  
SHOCK,  
HEAT  
AND  
ACID

THAN GLASS  
OR PORCELAIN —

RESISTS  
TEMPERATURES TO  
1050°C —

HANDLES  
MOST HOT ACIDS  
WITHOUT ETCHING —

WITHSTANDS  
CONSTANT THERMAL  
SHOCK —

EXCELLENT  
ELECTRICAL AND  
OPTICAL  
PROPERTIES —

LABORATORY AND  
INDUSTRIAL WARE —

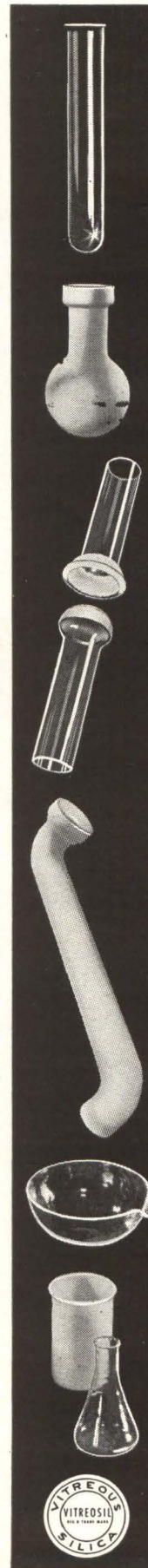
SPECIAL  
FABRICATION —

SPECTROSIL®  
FOR PURITY

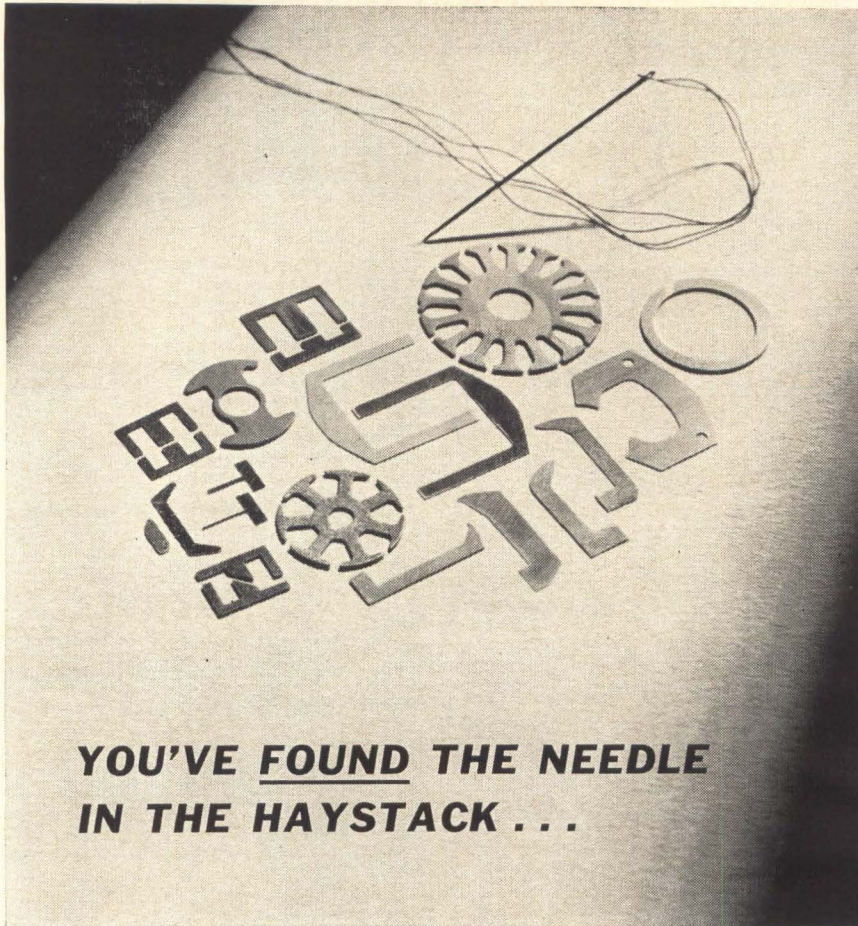
ASK FOR  
32 PAGE FREE  
CATALOG —

THERMAL  
AMERICAN  
FUSED QUARTZ CO.

RT. 202 AND  
CHANGE BRIDGE RD.  
MONTVILLE, N. J.







**YOU'VE FOUND THE NEEDLE  
IN THE HAYSTACK . . .**

## TOP QUALITY THIN-GAUGE NICKEL IRON LAMINATIONS FOR YOUR MINIATURIZATIONS

Special die-making processes and press equipment are available at Arnold's Pacific Division in Fullerton, California, to produce the tiniest of parts in production quantities for your designs. Material thicknesses of .001", .002", .003" and .004", etc. are available in 4-79 Permalloy, Mumetal, 4750 and other high permeability nickel-iron alloys—as well as a range of silicon steels—from which these parts may be produced to meet your magnetic requirements.

Special hydrogen-annealing furnaces are also available for optimum heat treatment after anneal.

The complete Arnold processing techniques used are capable of producing thin-gauge laminations to exacting dimensional tolerances. Their perfection of size and surface finish can be strong factors in protecting the uniformity and quality of your equipment.

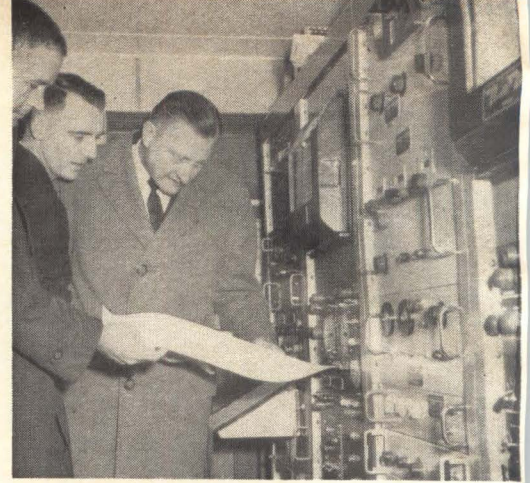
Specify Arnold thin-gauge miniature parts for your requirements in magnetic recording and pickup heads, etc.; and for tiny motor and transformer laminations. We invite your inquiries for the tooling and production of special shapes. *Technical data on request.*

4673RIA

ADDRESS DEPT. E-12

**PACIFIC DIVISION**  
  
**ARNOLD**  
 SPECIALISTS in MAGNETIC MATERIALS

THE ARNOLD ENGINEERING COMPANY, Main Office: MARENGO, ILL.  
 PACIFIC DIVISION: 1551 E. Orangethorpe Ave., Fullerton, Calif. • TRojan 1-1560



MARSHALL Space Flight Center officials check automatic readout

Radiosonde data is gathered and printed out by ground station

## Weather Readout

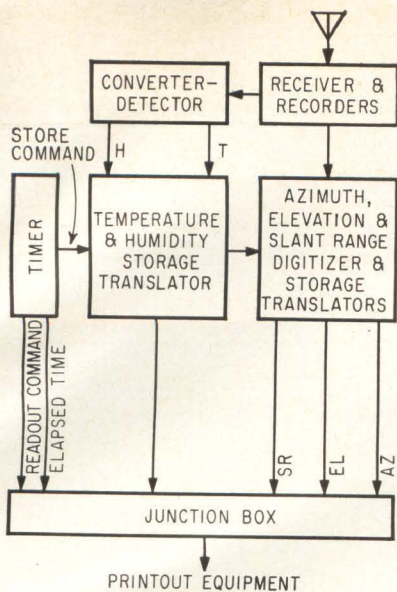
**WEATHER STATION** that automatically translates and prints out radiosonde data as it is received has been demonstrated by NASA's Marshall Space Flight Center at Huntsville, Ala.

The radiosonde automatic data-processing system was designed by Friez division of Bendix to work with the Rawin set AN/GMD-2 (or upgraded AN/GMD-1) and modified radiosonde AN/AMQ-9 or AN/DMQ-9. Every five seconds, it will print out a card giving temperature, humidity, slant range, azimuth and elevation angles of the weather balloon, and the time the card is prepared.

**Data Handling**—Angle and range data are converted from the synchro signal outputs of the GMD-2 to bcd (binary coded decimal) form with servo-driven shaft-to-digital encoders. Data are then put into 10-line decimal form and stored by transistor-controlled relay matrixes for simultaneous, automatic readout on commands from the timer.

The AMQ-9 transmits meteorological signals at 1,680 Mc to the GMD-2 receiver. The GMD-2's a-f signals go to the converter-detector chassis and are converted to d-c voltages for level detection and fur-





DATA is read out of system on IBM cards at rates of 6 or 12 cards a minute. A 1620 computer then processes data

## Is Automated

ther conversion to bcd form.

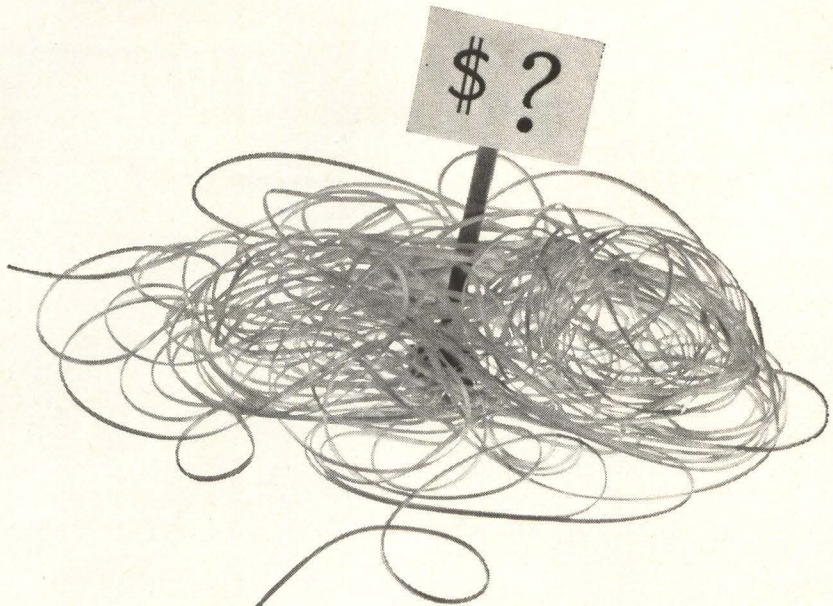
Temperature and humidity frequency ratios are stored in separate bcd to 10-line decimal matrices in synchronism with the radiosonde commutator. Although the Huntsville installation feeds an IBM 526 card punch, output can be in field data, teletypewriter, bcd or 10-line decimal codes if needed.

**Equipment Modifications**—In the Huntsville system, a control recorder and an AN/TMQ-5 radiosonde recorder normally provide manual backup. The control recorder also provides antenna slewing, receiver tuning and power distribution by remote control.

Two AN/GMD-1b Rawin sets were modified to slant-range measuring capability in meters. AN/AMQ-9 radiosondes with new commutators provided short duration reference identifiers preceding humidity and temperature segments to facilitate decommutation. The equipment cost \$72,000 to build using commercially available parts.

Bendix Friez recently developed a distance indicator to correct for ambiguous slant-range measurements resulting from signal loss. The company expects to put this feature in future versions of the system.

# HOW MUCH MORE WILL THE COST BE IF YOU SPECIFY GUDEBROD LACING TAPE?



### GUDEBROD FLAT BRAIDED LACING TAPES FOR EVERY NEED

Strict manufacturing control guarantees the quality of Gudebrod Tapes. There are many different types meeting wide range of needs, including:

**GUDELACE®-non-slip**—Nylon with microcrystalline wax finish—complies with MIL-T-713A.

**GUDELACE-H®**—Nylon with special coating of fungistatic synthetic rubber.

**STUR-D-LACE-FLH®**—Dacron\* fibers impregnated with fungistatic, burn proof finish. Tem. -100°F. to 350°F.

**TEMP-LACE PRE-SHRUNK®** Teflon\*—virtually unaffected by temperatures from -100°F to 425°F.

**GUDE-Q®**—Extreme Temperature—excellent tying qualities. Essentially stable in excess of 1500°F.

The Gudebrod Cable-Lacer speeds and eases the Harness tying operation. Inquire about it.

\*Du Pont registered trademarks

Lacing tape might represent as little as 1/100,000th part of the total cost for producing a standard electronic unit. The labor cost for tying the harness with this tape could be as much as 500 times greater than the material cost. Where then, can the economy of saving a few cents on wire lacing be profitable? Of much more worth is the confident knowledge that in specifying Gudebrod Flat Braided Lacing Tapes you are providing the very best for your wire harness lacing work.

Specifically made for wire harness lacing, Gudebrod Lacing Tapes meet many particular requirements for fungus resistance, temperature fluctuations, chemical content, as well as meeting or exceeding MIL-T-713A specifications.

In addition Gudebrod Lacing Tapes are soft and flat. Stress is distributed over the full width without cut-through or harshness to injure insulation or fingers. Knots stay tied. The good handle of Gudebrod Tapes pleases harness room workers—assures production improvement.

For samples, for further information, for the Technical Data Book, get in touch with your local Gudebrod representative, or write to the Electronics Division.

**GUDEBROD BROS. SILK CO., INC.**  
FOUNDED IN 1870



*Electronics Division*

12 SOUTH 12TH STREET, PHILADELPHIA, PENNSYLVANIA 19107



# Lensless Optical System Uses Laser

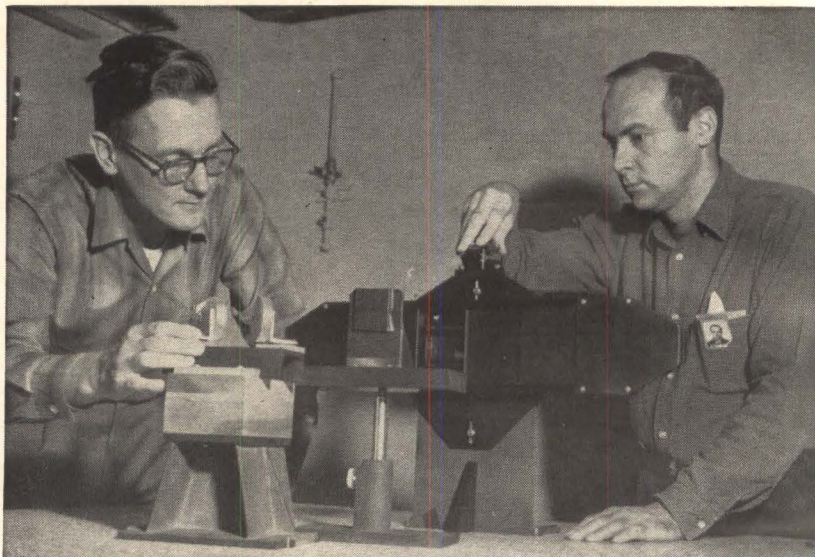
Opaque 3-D objects may be imaged without lenses using reflected light

By **LEON H. DULBERGER**  
Associate Editor  
**CHARLES WIXOM**  
McGraw-Hill World News

**CLEAR PHOTOGRAPHS** are being produced without use of lenses in a new optical technique developed at the University of Michigan. The new system may have extensive effects on photographic technology. Though it has not been demonstrated at x-ray wavelengths, the lensless technique may afford sharp images, rather than the shadow-graph images now available for x-ray systems.

The work was carried out at the University's Institute of Science and Technology, by Emmett N. Leith and Juris Upatnieks. The research engineers use a two-step process, requiring spatially coherent and monochromatic light. The experiments are readily carried out with a helium-neon gas laser. A mercury arc lamp and an interferometer may also be used, with longer exposure.

Using a transparency as the object to be reproduced, light from the laser is passed through the transparency onto a film contained in a camera-like device (see photo). At the same time, a portion of the laser light is passed through a prism, set at an angle to direct it onto the film, superimposing it on the Fresnel diffraction pattern produced by the light passing through the transparency. The second beam, termed a reference beam, provides phase information by producing a fringe pattern superimposed on the diffraction pattern. Thus a hologram recording is produced with phase information for later reconstruction. The fringe pattern is both amplitude and phase modulated by the Fresnel



**LENSLESS CAMERA** at University of Michigan. Film is held in fixture at right; object to be photographed in device at center; reference beam of laser light is reflected past object and onto film by mirrors at left. Second step in process yields recognizable photograph

diffraction pattern; the film acts as a square-law modulating device.

In the second step of the process, collimated monochromatic light from the laser is directed through the hologram, using a projector-like device. The hologram acts as a diffraction grating, which produces a real image at a displaced position, a distance from the hologram. A photograph of this reconstructed image produces a high-quality picture of the original transparency, without the use of lenses. The reconstructed image has the same contrast as the original, and is positive if the transparency is positive.

**Laser Application**—Gas lasers rated at 1 to 5 mw were used. Operating wavelength is 6328 Å. Pulsed lasers should also work, and might have advantages when short exposure times are desired. The type of spatial coherence required of the light source is such that the phase at one point in space be time-invariant with respect to the phase at another point in space. However, the point-by-point variation of this phase can be a completely random function.

Thus the laser light may be passed through a frosted glass to diffuse the light, and the two-step process can still be carried out. Monochromaticity must be provided.

According to Emmett Leith, commercial uses may be hastened as the process is extended to shorter wavelengths—regions of the spectrum where good lenses are not available, as u-v, ir and x-ray.

Leith points out that it is possible to record opaque three-dimensional objects using reflected light, and that this has been done. The image reconstructed from the hologram can be photographed, completing the second step. In addition it is possible to view the reconstructed image directly by placing the eye so as to intercept the light emerging from the hologram. A three-dimensional projection is formed, having the effect of stereo projection, though only one hologram is used.

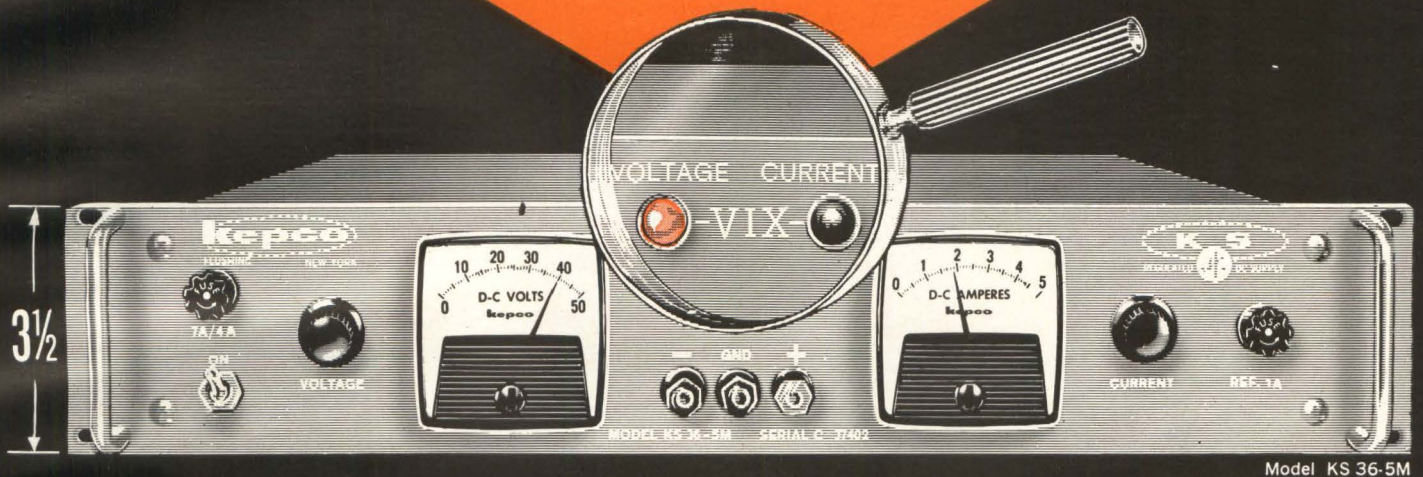
An important beginning to this work was made by D. Gabor, who published a paper on a two-step imaging process in 1949. It did not, however, permit reproduction of continuous-tone transparencies.



# KEPCO

## ADDS EXTRA VALUE

## VIX REGULATED POWER SUPPLIES



Model KS 36-5M

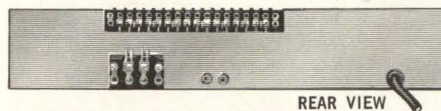
# NEW **VIX**\* INDICATORS AT NO EXTRA COST!

T.M.

Kepeco voltage/current regulated power supplies in the KS series now come equipped with voltage/current mode indicators called "VIX". Time saving and added utility are provided by these indicators which show at a glance whether the power supply is in its voltage regulating mode or its current regulating mode. This indication is especially useful in the Kepeco KS Models since they have extremely sharp cross-over characteristics.

\*VOLTAGE/CURRENT CROSSOVER SIGNAL

Send for complete data on  
Kepeco KS Models  
featuring NEW "VIX" Indicators



**KEPCO 3 1/2" K S MODELS**  
REGULATED DC SUPPLY

**0.01% REGULATION and STABILITY**

DC OUTPUT RANGE		MODEL	PRICE
VOLTS	AMPS		
0-8	0-15	KS 8-15M	\$595.00
0-18	0-10	KS 18-10M	550.00
0-36	0-5	KS 36-5M	495.00
0-60	0-2	KS 60-2M	495.00

**kepeco**  
Inc. ®

131-38 SANFORD AVE. • FLUSHING, N.Y. 11352  
Phone (212) IN 1-7000 • TWX # 212-539-6623  
Cable Address: KEPCOPOWER NEWYORK

### Other features include:

- High Power in Compact Design  
3 1/2" H x 19" W x 14" D
- SCR Preregulation
- 10-turn-pot Resolution
- Flexible Programming
- Dual Kepeco "Bridge Circuitry" with Automatic Cross-over
- Remote VIX Signal
- Key Circuitry brought to rear Terminal Board
- Six Operating Modes with External Connections
- Series/Parallel Versatility

† Patents issued and pending.

See our complete  
Catalog in



CIRCLE 45 ON READER SERVICE CARD



## OPPORTUNITIES IN MELPAR'S RAPIDLY EXPANDING ELECTRONICS DIVISION

Melpar's Electronics Division has an immediate need for Engineers to fill these important positions:

### MICROWAVE RECEIVER DESIGN

Specific problems include parametric amplifiers, varactor techniques, microwave filters, ultra-stable programmable oscillators, and dual and triple channel balanced receivers for monopulse and guard antenna gating.

### DATA PROCESSING SYSTEMS DESIGN

Perform the logic design of digital equipment to process real time flight data. Problems include specifying necessary digital/analog interface equipment and the design of computer systems for a variety of applications.

### COMPUTER PROGRAMMING

Generate programs for fixed point real time computers to be used with special purpose digital and analog equipment.

### COMMUNICATIONS

Perform design studies of terminal equipments for time frequency dodging, matched filters, adaptive highly reliable communications throughout the electromagnetic spectrum. Techniques of interest include spread spectrum circuitry, error detection and correction coding, and privacy and security circuitry.

For Further Details,  
write in confidence to:

**John A. Haverfield**

Manager—Professional Placement

**MELPAR INC.**

(A Subsidiary of Westinghouse  
Air Brake Co.)

3436 ARLINGTON BLVD.  
FALLS CHURCH, VA.

(A Suburb of Washington, D.C.)

*an equal opportunity employer*

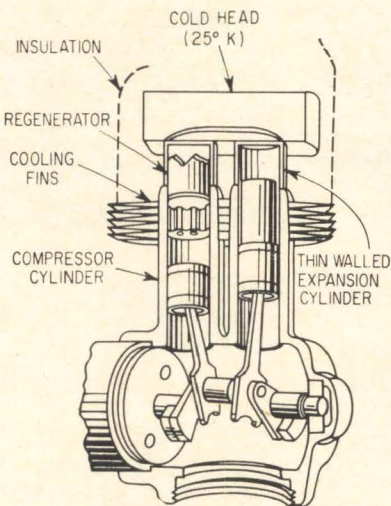
## COMPONENTS AND MATERIALS

# Miniature Closed-Cycle Cooler Produces 25°K Reliably

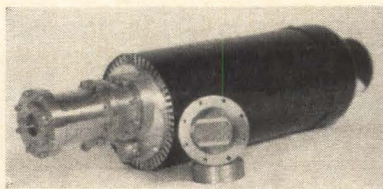
Valveless unit cascaded  
for lower temperatures  
for space systems

By **C. R. WHETSTONE**  
Assistant Editor

**HIGH BRIDGE, N. J.**—Cryogenic temperatures on the order of 25° K are produced by a miniature in-line cooler no larger than a football. Working on a modified Stirling cycle, the closed-cycle system has a cooling capacity of 12 watts at 77° K—the temperature of liquid nitrogen—with a rotary input of 100-watts.



ARTISTS CONCEPTION of Cryomite cryogenic cooler



COOLER measures 14 inches in length and 5-inches in diameter yet cold head reaches temperatures on the order of 25°K

Some of the applications for the Cryomite—developed by Malaker Laboratories—include continuous cooling of infrared devices, temperature-sensitive semiconductor devices antennas and parametric amplifiers; reliquefaction and refrigeration of gases; cooling of densely packed electronic units for space applications; and spot cryogenic cooling of airborne or satellite components.

The Cryomite can mount infrared sensors or other devices directly on the cold head. It has also been designed into systems that previously used liquid nitrogen from a supply dewar.

**Cooling Methods**—There are five basic methods for cryogenic cooling: 1) cascaded evaporation systems; 2) systems based on Joule-Thompson cooling; 3) isentropic expansion systems, such as the Claude system, using reciprocating expansion engines or turbo expanders; 4) the Taconis system, using displacement expanders; and 5) modified Stirling cycle systems.

Careful evaluation of the various methods disclosed problems that would be encountered in miniaturization. For example, lack of reliable, miniature, block-free expansion valves make it difficult to utilize cascaded evaporation, Joule-Thompson, or Claude systems. The major drawback of the Taconis system is that a source of pressurized gas or an external compressor is required for operation.

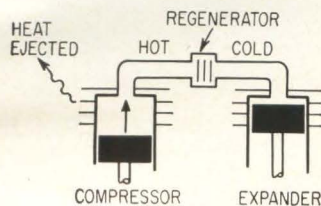
**Stirling Cycle**—The modified Stirling-cycle engine picked by Malaker Laboratories, has a simple construction, partly because no valves are used. Since it is a closed-cycle system, there is no problem of contamination. The system is self-contained, and requires no external gas



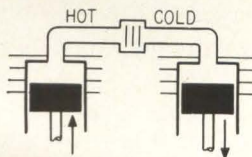
supply. No constrictive passages for gas flow exist, so blockage problems are avoided. The refrigeration temperature can be adjusted to the desired value by control of the motor speed. The engine can readily be made in a variety of sizes, based on a single design.

The fundamental requirements for a Stirling-cycle refrigerating engine are: to have a compression volume,  $V_c$ , at the higher temperature,  $T_c$ ; an expansion volume  $V_E$ , at the lower temperature,  $T_E$ ; and to allow a fixed quantity of gas to pass alternately from one volume to the other via a regenerator—thus no valves are used (see fig.). In order to maintain a refrigerating effect, the movements of the pistons in the two volumes must be out of phase, such that the expansion volume leads with respect to the compression volume. The necessary steps in the functioning of a refrigerating engine operating on an idealized Stirling cycle are shown in the figure.

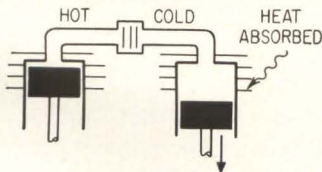
(A) ISOTHERMAL COMPRESSION



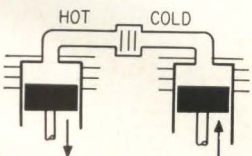
(B) CONSTANT VOLUME GAS TRANSFER



(C) ISOTHERMAL EXPANSION



(D) CONSTANT VOLUME GAS TRANSFER



MODIFIED STIRLING cycle—basic system used in unit to obtain cryogenic temperatures efficiently

Attend

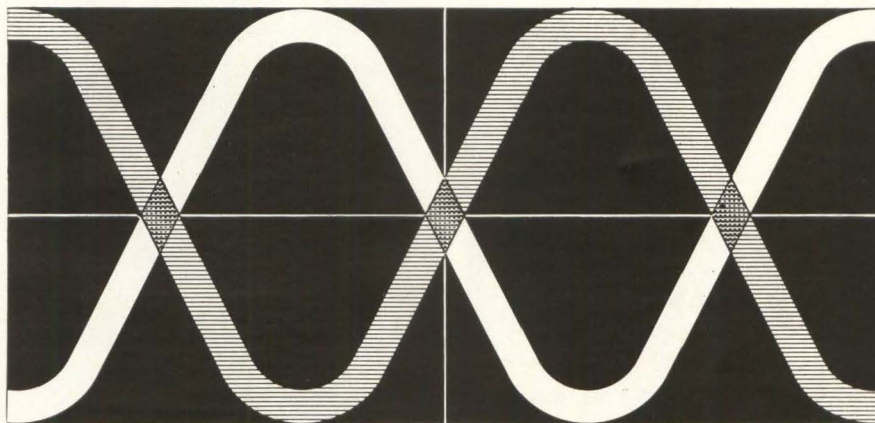
the greatest annual meeting in the electronics industry

from February 7 to 12, 1964

Paris, Porte de Versailles

INTERNATIONAL EXHIBITION OF

# ELECTRONICS



# COMPONENTS

All components, tubes and semiconductors, measuring and control and electro-acoustic devices . . .



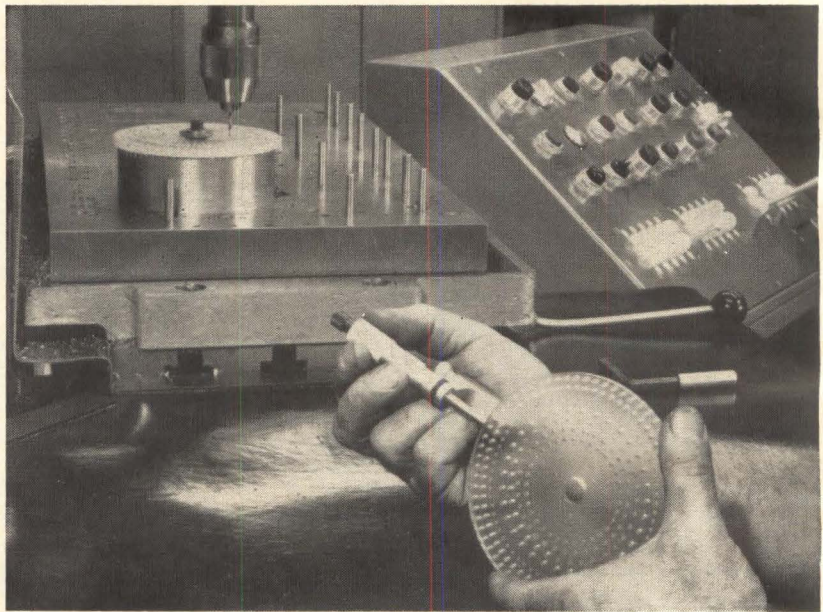
For all information and forms:

S.D.S.A. 23 RUE DE LUBECK  
PARIS 16: (TEL.) PASSY 01-16



## PRODUCTION TECHNIQUES

# Programmed Machine Cuts Cost of Plastic Parts



WORKPIECE is drilled by machine controlled with punched paper tape. Self-contained tape puncher is programmed by the operator



Let us  
help you  
cut costs!

CARBON FILM RESISTOR

# Rohm

TOYO  
ELECTRONICS  
INDUSTRY  
CORPORATION

P, O, BOX 103 CENTRAL  
KYOTO JAPAN

Cost is less in short  
runs than molding  
or conventional drilling

By **BEN E. SHERESHAU**  
Chief Engineer  
Dun-Rite Manufacturing, Inc.  
East Rutherford, N. J.

**INCREASED** use of plastics in electronic equipment in small quantities is posing a tough production problem for the electronics industry: how to hold down production costs and lead time on short-run, high-precision plastic parts. A practical answer is a low-cost numerically controlled milling machine.

**Example**—A small order from ITT Federal Laboratories, Nutley, N. J. is an example of the savings in both

lead time and money with low-cost numerically controlled systems.

This order called for 30 Rexalite 1422 discs (Rexalite 1422 is a translucent, thermosetting, styrene-based copolymer with a low dielectric constant). These discs, were to have a diameter of 4.76 in. and be 0.291 in. thick, and have 267 holes drilled at intervals of 5.45 deg in concentric circles positioned to an accuracy of 1 mil.

**Alternate Methods**—Injection molding, the most common production technique for high-volume, low-precision plastic parts, was quickly rejected because shrinkage of the material inside the mold during cooling moves the closely spaced holes out of tolerance. The mold costs \$2,500 with six to eight weeks required for fabrication.

Rotary indexing devices essential for conventional drilling introduce large margins and many drilling er-



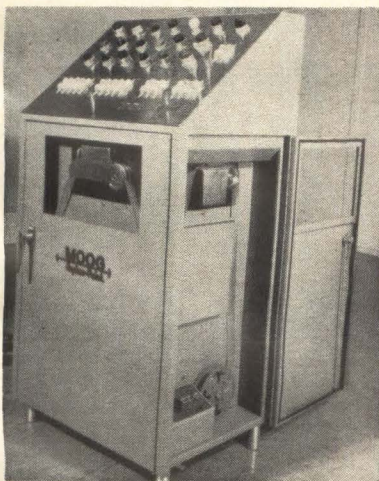
rors. An automatic indexing device would help but costs \$2,500.

The most practical solution to precision short runs such as this is obviously numerical control. With this technique a Bridgeport milling machine is driven by a numerical control console made by Hydra-Point division of Moog Servo Controls, Inc., Depew, N. Y. It is equipped with a self-contained Hydra-Point automatic tape punch. Coordinate locations for the holes are punched into the tape that moves the drilling spindle of the milling machine. To maintain a high degree of accuracy, drill chucks are changed manually on signal from the programmed tape. To avoid error, an indicator points out the specific chuck required. Once the first work piece is checked out against the program sheet there is no longer any possibility of error.

Six hours was devoted to programming followed by tape punching at the numerically controlled machine. The first part, made during the punching of the tape, was checked: four errors were found. It took a total of two hours to find and correct the errors (all four were human errors made during programming).

The 30 pieces were run off one at a time under tape control taking 130 minutes each. No further inspection was needed.

The complete job, from receipt of the customer's order, including procurement of materials, took 30 days and was accomplished during regular working hours.



CONTROL CONSOLE has key board for operator to set in drilling coordinates. Tapes are reused for each work piece

## ELECTRONICS ENGINEERS . . . EVALUATE THIS COIL . . . DELEVAN'S MOLDING TECHNIQUES OPEN NEW HORIZONS FOR **VARIABLE COILS**

Discover new reliability in molded variable coils. Eliminate the "weak link" in your system. Most variable coils (and transformers) are designed and built today exactly as they were 10 years ago. With the Delevan Molded "Variable," the state-of-the-art for variables is advanced to equality with all other reliable components. Available with either powdered iron or ferrite cores, each coil is designed for minimum capacity and optimum Q. Delevan is proud of this achievement in high-reliability programming.

### SPECIFICATIONS: **SERIES 4000 MOLDED VARIABLE COILS**

- Size: 0.40" Diameter; 0.93" Molded Length
- Mounting: Chassis or Printed Circuit
- Inductance: .18 uh to 70,000 uh
- Environment: Grade 1, Class B, MIL-C-15305



### **Delevan Electronics Corporation**

A SUBSIDIARY OF AMERICAN PRECISION INDUSTRIES INC.  
270 QUAKER ROAD EAST AURORA NEW YORK 14052



HERE ARE 2 NEW COIL ENGINEERING KITS THAT EQUIP YOU WITH THE RIGHT COIL FOR ANY DESIGN APPLICATION.



KIT No. 1 supplies 15 Series 4000 KIT No. 2 provides components to  
molded variable coils. design your own variable coils.

Write for further information on these engineering kits today.

CIRCLE 49 ON READER SERVICE CARD

**HELP YOUR POST OFFICE  
TO SERVE YOU BETTER  
BY  
MAILING EARLY IN THE DAY  
NATIONWIDE IMPROVED MAIL SERVICE  
PROGRAM**

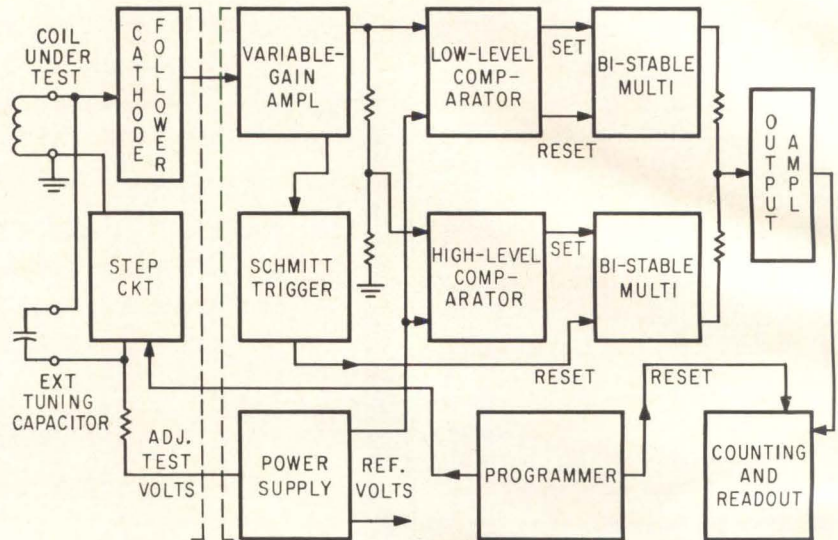
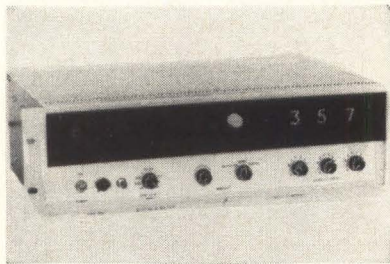


# Instrument Displays Q Digitally

Device eliminates constant oscillator retuning

**TYPE 71A** digital Q meter displays measurement information in digital form in the Q range between 0 and 999. Complete measurements can be performed in a fraction of a second, even by unskilled personnel. The instrument's inherent digital design eliminates the necessity for retuning the Q meter for each inductor being tested.

Unit can also be used for go/no-go testing. Preset switches permit Q-limit selection throughout the full range of the instrument. Panel lamps



indicate the over- or under-limit status of each measurement.

Type 71A is intended for testing the characteristics of components such as toroids, filters and i-f transformers. It is readily adapted to automated production setups and digital or analog recording of measurements.

Frequency range of the device is 10 kc to 1 Mc. Test voltages are selectable in ten steps from 10 mv to 10 v. Inductance range is 10  $\mu$ h to 1 h. Accuracy is 2% or 1 digit of Q, depending upon which is greater. Type 71A is priced at \$2,190. J-Omega Co., 2278 Mora Way, Mountain View, Calif.

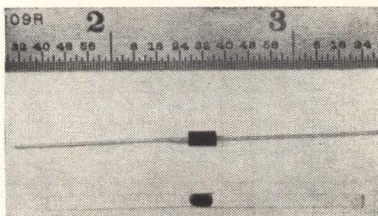
CIRCLE 301, READER SERVICE CARD

# Tiny Zener Diodes Have Low Impedance

**Micro Zener** diodes are 750 mw units featuring sharp zener breakdowns, low impedance and leakage and low zener noise voltage. Voltage ranges from 6.8 v to 47 v. Units will meet specifications for MIL-S-19500 and can be supplied with specific burn-in, environmental and device specification reliability

test data for individual units or lots.

Size is 0.150 inch  $\times$  0.060 inch with 0.5-inch minimum gold-plated silver leads that are 0.046-inch  $\times$  0.006-inch thick. Price ranges between \$4.32 and \$5.63 per unit in quantities of 100. MicroSemiconductor Corp., 11250 Playa Court, Culver City, Calif. (302)



## F-M Transmitter for Telemetry Band

A NEW f-m telemetry transmitter for operation in the 216 to 260-Mc telemetry band and featuring all

solid-state construction has been developed. Model 3116 also features completely separate power supply ground, case ground and modulation input return. Missile instrumentation system using the 3116 will not have the ground loop prob-



lems of other off-the-shelf transmitters not having separate grounds. Designed with built-in protection against transients and short circuits, the transmitter's circuitry provides a 4-w minimum power output at high efficiency for a wide input voltage range and extremes of temperature. Unit accommodates any signal having components between 30 cps and 200 kc, and differential input allows complete freedom in system input circuitry design and shielding arrangement. Radiation Inc., Melbourne, Fla. (303)

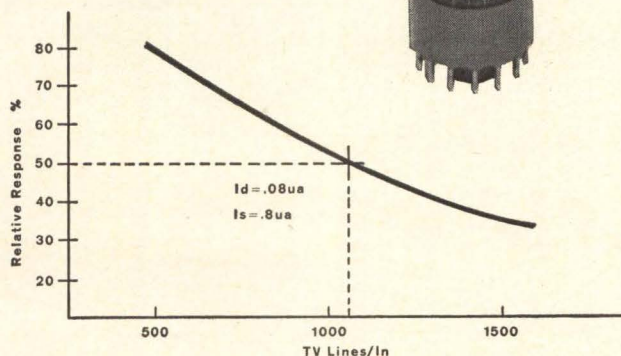
### Shrinkable Tube Is Flame Resistant

SHRINKABLE tubing of modified Teflon FEP that shrinks instantly at 300 F and lower to permit inserted objects to have a surface of Teflon with a continuous service temperature of 400 F is now available. The shrinking process does not affect the electrical, mechanical and chemical properties of the modified Teflon FEP: good dielectric strength (500 to 1,000 v/mil); low dielectric constant (2.0) and dissipation factor (0.002); no change of electrical properties with temperature ( $-25$  C to  $+250$  C) or frequency (60 cps to 100 Mc); zero moisture absorption; unaffected by any commercial chemical. Penntube II-SMT is available in natural color and lightweight wall thickness. Pennsylvania Fluorocarbon Co., Inc., Clifton Heights, Pa. (304)

### Push-Pull Tetrode Heats Instantly

INSTANT-HEATING, push-pull tetrode—the 8118—is intended for use as an r-f amplifier, driver or frequency multiplier at frequencies up to 500 Mc. In typical Class C operation as an r-f amplifier, it can deliver over 21 w of useful power to the load at 470 Mc with as little as 3 w drive power. Plate dissipation rating is  $2 \times 10$  w under CCS conditions. Input capacitance is 4.5 pf, while output capacitance is 1.8 pf. Tube

## 2" Vidicon



### Only one vidicon has resolution exceeding 2000 TV lines

The new ML-2058G 2-inch diameter TV pickup vidicon is the only vidicon that provides this high detail resolution. Features of the ML-2058G include: 1.4" diagonal working area; a limiting resolution exceeding 2000 TV lines; 50% amplitude modulation at 1100 TV lines. It is designed for operation with conventional image orthicon deflection coils. Length is 12". Available with x-ray sensitive photoconductor. For complete details write The Machlett Laboratories, Inc., Springdale, Conn. An affiliate of Raytheon Co.







## GLOW DISCHARGE INDICATOR TUBE FOR SMALL SIGNALS (TYPE TG121A)

"Brand: Digitube"

The DIGITUBE TG121A is a display indicator specifically designed for transistorized equipment, with important advantages over neon indicators and miniature incandescent lamps. It can be switched on and off by an input signal of a few volts, and thus operated directly by transistor output voltage without amplification. Since it is a cold cathode device there is no heating problem, even when many are used. This, coupled with small size (length 18mm, diameter 8mm), makes it ideal for miniaturized equipment. Characteristics are stable and life is practically limitless. Studies have shown that it does not in any way affect the transient characteristics of a logic circuit and no circuit compensation is required. (See IRE Transactions, PGED, Vol. ED-9 No. 3, May 1962.) For details contact our nearest representative.

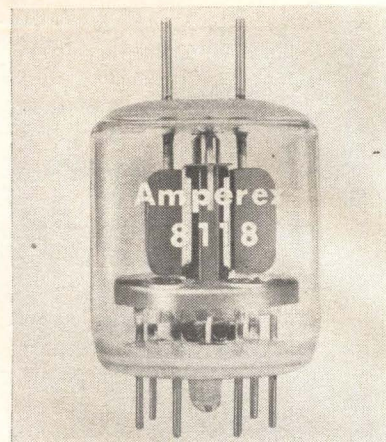
 **FUJITSU LIMITED**  
Communications and Electronics  
Tokyo, Japan

Represented by: U.S.A.: THE NISSHO AMERICAN CORP. 80 Pine St., New York 5, N.Y., Phone: WH 3-7840 THE NISSHO PACIFIC CORP. 120 Montgomery St., San Francisco 4, California, Phone: YU 2-7901/7906 CANADA: NISSHO (CANADA) LTD. 100 University Avenue, Toronto, Phone: EM 2-4794 UNITED KINGDOM: WALMORE ELECTRONICS LIMITED 11-15 Betterton Street, Drury Lane, London W.C. 2, Phone: TEM 0201-5 GERMANY: NEUMULLER & CO. GMBH 8 München 13, Schraudolphstr. 2a Phone: 29 97 24 SCANDINAVIA: SCAPRO AB Kungsbrolan 2, Stockholm K, Sweden, Phone: 53 04 36, 53 04 51

CIRCLE 52 ON READER SERVICE CARD

**WANT TO  
DO BUSINESS  
WITH THE  
GOVERNMENT ????????**

Then check the Military and Government Procurement Guide in the orange section of your **ELECTRONICS BUYERS' GUIDE**.



has a directly heated Harp Cathode which operates on a heater voltage of 1.6 v and warms up to deliver 70 percent of full power output within 500 millise. Amperex Electronic Corp., Hicksville, L.I., N.Y., 11802.

CIRCLE 305, READER SERVICE CARD



### Data Logging System Features Flexibility

MODEL 6511 includes solid state circuits; voltage, resistance and time measurements; 120 channel scanner capacity with provisions for true random scanning; plug-in crossbar scanner switch and 1 to 2 readings per sec average speed. The individual modules are standard catalog items, making a variety of basic system combinations possible. Model 6511 readily adapts to measurements of temperature, pressure, acceleration, shock, velocity and electrical quantities for either military or industrial use. Electro Instrument, Inc., 8611 Balboa Ave., San Diego 12, Calif. (306)



## LITERATURE OF THE WEEK

**COMPUTER SYSTEMS** Radio Corp. of America, Camden 2, N.J., offers a brochure containing 11 technical papers on computer systems. (360)

**DYNAMIC ANALYZER TUNER** Spectral Dynamics Corp. of San Diego, P. O. Box 671, San Diego, Calif., 92112. Description and specifications of a new dynamic analyzer tuner are presented in a four-page bulletin. (361)

**PRECISION POTENTIOMETERS** Markite Corp., 155 Waverly Place, New York 10014. Six standard sizes of thinner, lower-cost Slimline infinite resolution conductive plastic precision pots are described in bulletin SL. (362)

**INDUSTRIAL INSTRUMENTS** Texas Instruments Inc., P. O. Box 66027, Houston, Texas 77006. Short form catalog covers a line of recording, testing, digitizing and sensing instruments. (363)

**MAGNET MATERIAL** Indiana General Corp., Valparaiso, Ind. Data bulletin 350A discusses a new improved Alnico V-7 magnet material. (364)

**CONDUCTIVE EPOXY ADHESIVES** Chomerics, Inc., 380 South St., Plainville, Mass. Booklet describes the nature of electrically conductive epoxy adhesives, cements and solders—and factors of primary importance in their selection and application. (365)

**ADJUSTABLE POWER SUPPLIES** Sola Electric Co., Elk Grove Village, Ill. Bulletin DC-105 describes Solavolt a-c and d-c adjustable power supplies. (366)

**CONNECTORS** The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill. Bulletin 674 is a 12-page reference guide to a line of environmental-resistant plugs and receptacles used primarily in electronic and aerospace industries. (367)

**TOGGLE SWITCH** Micro Switch, a division of Honeywell, Freeport, Ill. Data sheet 211 describes the 7ETL-T, a 3-position magnetic hold-in toggle switch. (368)

**VIBRATION MEASURING INSTRUMENTS** MB Electronics, P. O. Box 1825, New Haven, Conn. 06508. An 8-page booklet describes a full line of vibration measuring instruments. (369)

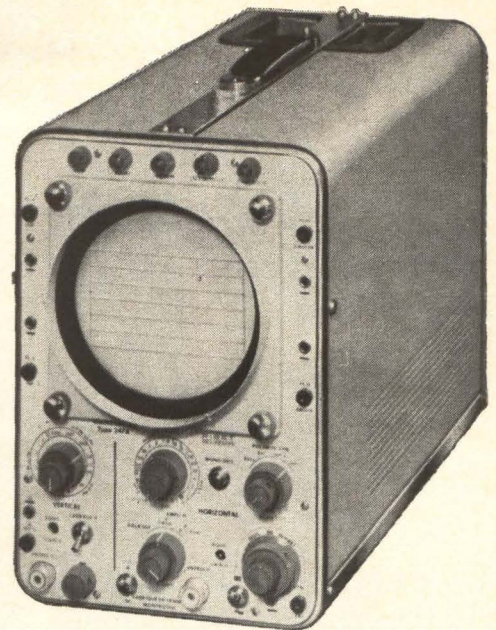
**POWER SOURCES AND INSTRUMENTS** Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. An 8-page catalog supplement describes a line of full range power sources and solid state instruments. (370)

**METALLIZED PAPER CAPACITORS** Aerovox Corp., New Bedford, Mass. Bulletin NPJ-128 gives data on microminiaturized dipped type P95ZN metallized paper capacitors. (371)

**B-W OSCILLATOR** Stewart Engineering Co., 467 Bean Creek Road, Santa Cruz, Calif. Technical bulletin describes the SE-303 miniature X-band backward-wave oscillator. (372)

## NEW ! HIGH SENSITIVITY

## GENERAL PURPOSE 247A



The type 247-A oscilloscope fully qualifies as a universal instrument because its performances and the size (13 cm (5") dia.) of its C.R. Tube authorize accurate measurements and tests in all fields of low-frequency instrumentation. Also, because of its simplicity of operation, the 247-A is ideally suited for practical laboratory work of an educational nature.

### TECHNICAL SPECIFICATIONS

#### Vertical amplifier

1 channel; Frequency range: DC to 1 Mc/s (-3 dB)  
Sensitivity: 50 mV/cm

AC: 10 c/s sine wave or 50 c/s square-wave to 100 Kc/s (-3 dB)  
Sensitivity: 5 mV/cm

Calibrated attenuator: step-adjustable from 5 mV to 20 V/cm in 12 positions  
Sequence: 1 - 2 - 5 - 10 etc...

Attenuator vernier ratio 1/3  
Constant input impedance: 1 M  $\Omega$  47 pF

#### Sweep

Free-running - triggered - single sweep  
Duration: 1 s/cm to 0.5  $\mu$ s/cm in 20 calibrated positions  
Vernier: 1:3 ratio -  
x 5 magnification expanding  
sweep durations from 3 s/cm to 0.1  $\mu$ s/cm

#### Sync

5 positions: single-sweep, HF, LF, TV-line, TV-frame  
Polarity: + or - internal or external  
selection of triggering level

#### Horizontal Amplifier

Frequency range: 0 to 500 Kc/s (-3 dB)

Sensitivity: 1 V/cm or 10 V/cm (switch-selected)

Vernier: 0 to 1

Constant input impedance: 1 M  $\Omega$  and 47 pF

#### Cathode-ray Tube

5 ADP 2 or equivalent type  
Screen: 13 cm (5") dia.

deflection factors:  
X: 30 V/cm (approx.)  
Y: 20 V/cm (approx.)

Direct drive of H and V plates  
Acceleration voltage: 3 Kv

### MECHANICAL FEATURES

Light-alloy chassis, readily-detachable panel for easy access to circuits.

#### 1) Tube complement

9/ECF80 - 2 6N2L or equivalent types

#### 2) Power supply

105 - 115 - 127 - 220 - 240 V - 50 or 60 c/s

#### 3) Dimensions

Width: 20,5 cm - (8")  
Depth: 38,5 cm - (15")  
Height: 31 cm - (12")  
Weight: 14 kg - (30 lbs)

## OTHER INSTRUMENTS

### Oscilloscopes

204 A - High speed and fast rise oscilloscope  
241 A - 242 A - 243 A, Multi-function osc. with plug-in preamplifiers.  
255 B - Portable oscilloscope  
245 A - High performance portable oscilloscope  
246 A - High sensitivity low-frequency oscilloscope  
248 A - Maintenance oscilloscope.

### Sweep frequency Generators

411 A - Laboratory sweep frequency generator  
410 B - TV - FM sweep frequency generator  
476 A - Radio sweep frequency generator

### Signal Generators

405 A - Low frequency RC signal gen. (30 c/s-300 Kc/s)

428 A - HF constant amplitude signal generator (100 Kc/s-30 Mc/s)  
458 - Pulse generator (5 c/s - 50 Kc/s).

### TV pattern generators

465 C - Portable electronic pattern generator  
464 A - Test - pattern generator

### Regulated power supplies

117 A - Transistorised regulated power supply  
114 A - Regulated power supply

### Cameras

1000 A - oscilloscope camera with Polaroid  
1001 B - oscilloscope recorder

# RIBET-DESJARDINS

MEASURE & CONTROL DEPARTMENT, 13-17, rue Périer MONTROUGE/PARIS TEL: ALESIA 24-40  
CANADIAN BRANCH: RIBET-DESJARDINS (CANADA) Room 114, 5757 Decelles Avenue - MONTREAL.

INTER-PLANS





H. F. Lello



D. H. Deaver

## GT&E Elevates Two Executives

**HERBERT F. LELLO** has been named executive vice president-manufacturing of General Telephone & Electronics Corp., New York City, effective January 2. He is now president of GT&E's subsidiary, Automatic Electric Co., Northlake, Ill., where he has been active in telecommunications equipment manufacturing since 1923.

Darwin H. Deaver, executive vice president of Automatic Electric, succeeds Lello as president. He joined the firm in 1945 and was elected executive vice president last year.

Automatic Electric produces communications equipment for the independent telephone industry and also manufactures automatic control systems and devices. In addition to Automatic Electric, the domestic manufacturing subsidiaries of GT&E include Sylvania Electric Products Inc., and Lenkurt Electric Co., Inc.

## Keonjian Accepts Grumman Post

**EDWARD KEONJIAN** has been appointed a full-time staff consultant by the Grumman Aircraft Engineering Corporation, Bethpage, N. Y. He will lead the efforts to apply microelectronics concepts to advanced systems, integrate Grumman-funded microelectronic advanced development programs and prescribe areas for incorporation of microelectronics into current weapon system programs.

Formerly, Keonjian was a staff scientist at Arma's Garden City, N. Y., Division. He continues in his posts as chairman of the EIA Advisory Committee on Microsystem Electronics and as a member of the Avionics Panel of the NATO Advisory Group for Aeronautical Research and Development

## Antenna Systems Elects Williams

**ANTENNA SYSTEMS, INC.**, Manchester, N.H., announces that A. G. Williams has been elected to the position of vice president by the board of directors. He will continue to act as manager of ASI's Electronic Systems division in Maitland, Fla.

## PEOPLE IN BRIEF

**Basil Staros** leaves Sperry Rand Corp. to join General Applied Science Laboratories, Inc., as director of systems technology. **Charles E. Kuivinen**, formerly with Hughes Aircraft Co., appointed product mgr., microwave tube products, at Electra Megadyne Inc. **J. N. Marshall** promoted to mgr., common components and standards engineering, RCA Electronic Data Processing. **George M. Underberger**, previously with Microwave Products, named project mgr. on the technical

staff of E&M Laboratories. **William E. Bushor** joins Bryant Computer Products from LaRue and Cleveland, Inc., as director of information services. **Paul D. Rodgers** advances to associate director of the Tracking and Instrumentation lab of the Astrionics Center, ITT Federal Laboratories. **Lyman R. Fink**, former GE v-p, elected a v-p of Otis Elevator Co. in charge of engineering. **James Bailey** and **Leo Galin** move up to director of R&D and chief engineer, respectively, at Switchcraft, Inc. **Gilbert B. Sokolow** elevated to v-p, mfg., by Reon

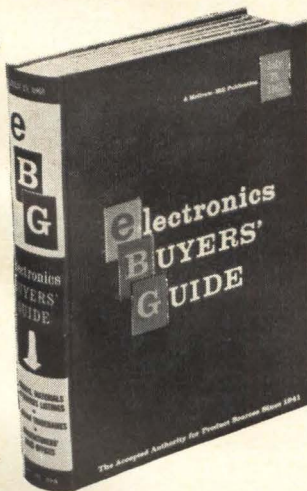
Resistor Corp. **Joseph Sternberg** raised to R&D mgr. for Martin Co.'s Baltimore div. **Bartow Bechtel**, formerly with Astro Technology Corp., appointed senior design engineer at Frequency Engineering Laboratories. **Byron Mable**, from Advanced Vacuum Products to Ceramics International Corp. as chief development engineer. **William Johnston** promoted to mgr., established reliability products, at Electra Mfg. Co. **Robert W. Graham**, ex-International Electric Corp., named mgr. of data communications for ACF Electronics.



# HOW TO USE YOUR ELECTRONICS BUYERS' GUIDE

## Advertising Product Sections

Advertisements in the ELECTRONICS BUYERS' GUIDE are grouped together according to the kind of product advertised. All Power Supply advertisements, for example, will be found in the same section of the book. Thus it is made convenient for you to "shop" through the specifications presented to you by advertisers, without having to flip pages back and forth constantly. Keep your ELECTRONICS BUYERS' GUIDE close to your work area at all times.



## EMPLOYMENT OPPORTUNITIES

POSITION VACANT

**Electronic Engineers, Mechanical Engineers, Consultants, Managers**—Work for leading firm of licensed professional Engineers. Write to United Engineers, 150 Causeway Street, Boston 14, Mass.

### SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES  
EQUIPMENT - USED or RESALE

#### DISPLAYED RATE

The advertising rate is \$27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured 3/8 inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

#### UNDISPLAYED RATE

\$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, \$2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

## Antique

TELEPHONES

As is complete, decorative purpose \$17.50. Working order, inter-comm. \$19.50 Ext. on dial \$24.50, talking circuit only. Write for complete list. All shipments FOB, Simpson, Pa.

TELEPHONE ENGINEERING CO.  
Dept. 1264, Simpson, Pa.



CIRCLE 951 ON READER SERVICE CARD

THIS 2K25 Klystron Mount. PRD type w/  
WEEK var att. & full-shielding. \$45.00 ea.

RADAR AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS  
3 & 10 CM. SCR 584 AUTOTRACK RADARS. M-33 RADAR  
TPS-1D SEARCH. APS-45TPS-100 HT. FINDERS. WK RADARS.  
FPN-32CCA. APS-10 APS-15B APS-27 (AMT) SEARCH. ■ ■ ■  
APN-102 DOPPLER. DOZENS MORE. CARCINOTRONS. PPN'S.  
.25-5-1-2-3-6 MEGAWATT PULSE MODULATORS. CAVITIES.  
PULSE TRANSFORMERS. RF STRIPS. WAVEGUIDE. BENDS  
200 MC. 1 KMC. 3 KMC. 6 KMC. 9 KMC. 24 KMC. RF PKGS.

RADIO RESEARCH INSTRUMENT CO.  
550 5TH AVE., NEW YORK 36, N.Y. JU 6-4691

CIRCLE 952 ON READER SERVICE CARD

OVER 2,000,000

## RELAYS

IN STOCK!

Send for Catalog 55

Universal RELAY CORP.

42 WHITE ST., N.Y. 13, N.Y. • WAlker 3-6900

CIRCLE 954 ON READER SERVICE CARD

Your Inquiries to  
Advertisers Will  
Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and — more advertisers mean more information on more products or better service — more value—to YOU.

# NCR

## ELECTRONIC ENGINEERS CIRCUIT/SYSTEMS/LOGIC INTEGRATED CIRCUITS

### Character Recognition:

Participate in system design of integrated automatic document handling and character recognition system.

### BS-MSEE

3-5 years experience in one of the following:

Circuit Design (High speed digital) (Wide bank analog circuits)

Information Processing System Design

Electromechanical Design

Working knowledge of optics, photoelectronics, principles of information theory and system design theory.

Salary open.

### Processor and Display Devices:

For high speed analog signal processors and cathode ray display devices.

Timing circuits, oscillators and digital logic circuits as part of high speed analog and digital signal processing equipment.

To select digital modules for economical instrumentation of logic. Assist in design of wide band-width signal processing circuits.

### BS-MSEE

3 or more years experience in circuitry design. Logical design and use of digital modules in complex mixed analog-digital system.

### EDP Systems:

A senior level position currently exists at the R & D facilities of NCR in Dayton, Ohio.

The individual with whom we are interested in discussing the present opportunity will have a BSEE or MSEE and 3 to 5 years' experience in digital techniques with EDP hardware systems orientation.

You are invited to investigate the many advantages of being associated with a major computer manufacturer whose stability is enhanced by previously established compatible products.

Please address inquiries to: Mr. T. F. Wade, Technical Placement, The National Cash Register Company, Main & K Streets, Dayton 9, Ohio

An equal opportunity employer



# INDEX TO ADVERTISERS

• AMP Incorporated . . . . .	3	• Kepco, Inc. . . . .	45	Texas Instruments Incorporated	
• Amphenol		• Kyoritsu Electrical Instruments		Industrial Products Group . . . . .	21
A Div. of Amphenol-Borg		Works, Ltd. . . . .	12	Thermal American Fused Quartz	
Electronics Corp. . . . .	38, 39			Co., Inc. . . . .	41
Arnold Engineering Co., The . . . . .	42			• Toyo Electronics Industry	
				Corp. . . . .	48
		• Lambda Electronics Corp. . . . .	22		
• Clifton Precision Products Co.,		Lepel High Frequency			
Inc. . . . .	16	Laboratories, Inc. . . . .	40		
• Cominco Products, Inc. . . . .	14				
Delco Radio . . . . .	15	Machlett Laboratories, The . . . . .	51		
Delevan Electronics Corp. . . . .	49	Melpar Inc. . . . .	46		
duPont de Nemours & Co., Inc.,		• Microswitch			
E. I. . . . .	4	Division of Honeywell . . . . .	13		
		Minnesota Mining & Mfg. Co.			
		Mincom Division . . . . .	7		
Electro Products Laboratories. . . . .	12				
• Federation Nationale des		• North Atlantic Industries, Inc. . . . .	11		
Industries Electroniques . . . . .	47				
• Fujitsu Ltd. . . . .	52	Radio Corporation of America			
		4th cover			
		• Ribet-Desjardins . . . . .	53		
General Micro-electronics					
Inc. . . . .	8, 9	San Esu Electronics Co., Ltd. . . . .	14		
Globe Industries Inc. . . . .	40	Scientific-Atlanta, Inc. . . . .	14, 40		
Gudebrod Bros. Silk Co., Inc. . . . .	43	Servo Corporation of America . . . . .	37		
		Sperry Electronic Tube			
		Div. Sperry Rand Corp. . . . .	3rd cover		
• Hewlett-Packard Company . . . . .	2nd cover	Sprague Electric Co. . . . .	6		

## CLASSIFIED ADVERTISING F. J. Eberle, Business Mgr. (2557)

## EMPLOYMENT OPPORTUNITIES . . . . . 55

## EQUIPMENT (Used or Surplus New) For Sale . . . . . 55

## CLASSIFIED ADVERTISERS INDEX

National Cash Register Co. . . . .	55
• Radio Research Instrument Co. . . . .	55
Telephone Engineering Co. . . . .	55
• Universal Relay Corp. . . . .	55

• See advertisement in the July 25, 1963 issue of electronics Buyers' Guide for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but **electronics** assumes no responsibilities for errors or omissions.

## electronics



Audit Bureau  
of Circulation



Associated Business  
Publications

### AUDITED PAID CIRCULATION

**JAMES T. HAUPTLI (2210)**  
Advertising Sales Manager

**HENRY M. SHAW (3485)**  
Market Research Manager

**DAVID M. TEMPEST (3139)**  
Promotion Manager

### electronics Buyers' Guide

**R. S. QUINT (2335)**  
General Manager

**RICHARD J. TOMLINSON (3191)**  
Business Manager

**THEODORE R. GEIPEL (2044)**  
Production Manager

**NEW YORK TELEPHONE:** Dial Direct:  
971 plus number in parenthesis,  
Area Code 212

## ADVERTISING REPRESENTATIVES

**ATLANTA, GA. 30309**  
Michael H. Miller, Robert C. Johnson  
1375 Peachtree St. N.E.,  
Trinity 5-0523 (area code 404)

**BOSTON, MASS. 02116**  
William S. Hodgkinson  
McGraw-Hill Building, Copley Square,  
Congress 2-1160 (area code 617)

**CHICAGO, ILL. 60611**  
Harvey W. Wernecke,  
Robert M. Denmead  
645 North Michigan Avenue,  
Mohawk 4-5800 (area code 312)

**CLEVELAND, OHIO 44113**  
Paul T. Fegley  
55 Public Square, Superior 1-7000  
(area code 216)

**DALLAS, TEXAS 75201**  
Frank Le Beau  
The Vaughn Bldg.,  
1712 Commerce St.  
Riverside 7-9721 (area code 214)

**DENVER, COLO. 80202**  
John W. Patten  
Tower Bldg., 1700 Broadway,  
Alpine 5-2981 (area code 303)

**HOUSTON, TEXAS 77025**  
Kenneth George  
Prudential Bldg., Halcombe Blvd.,  
Riverside 8-1280 (area code 713)

**LOS ANGELES, CALIF. 90017**  
Ashley P. Hartman, John G. Zisch,  
1125 W. 6th St., Huntley 2-5450  
(area code 213)

**NEW YORK, N. Y. 10036**  
Donald H. Miller (212) 971 3615  
George F. Werner (212) 971 3617  
Donald R. Furth (212) 971 3616  
500 Fifth Avenue

**PHILADELPHIA, PA. 19103**  
Warren H. Gardner, William J. Boyle  
6 Penn Center Plaza,  
LOcust 8-4330 (area code 215)

**SAN FRANCISCO, CALIF. 94111**  
Richard C. Alcorn  
255 California Street,  
Douglas 2-4600 (area code 415)

**LONDON W1:**  
Edwin S. Murphy Jr.  
34 Dover St.

**FRANKFURT/Main:**  
Matthee Herfurth  
85 Westendstrasse

**GENEVA:**  
Michael R. Zeynel  
2 Place du Port

**TOKYO:**  
George Olcott,  
1, Kotohiracho, Shiba, Minato-ku



Additional copies available at 25¢ each

A

ACOUSTICS See Audio

AIR NAVIGATION AND TRAFFIC CONTROL

(See also Space Electronics)

Airlines look to computers to end delays . . . . . p 66 Oct 25

Army seeks gear for air traffic and navigation . . . p 10 Nov 22

British develop new VLF navaid . . . . . p 36 Aug 16

Crosstalk: Europe's zero-zero landings . . . . . p 3 Aug 23

Easy way to test accelerometers . . . . . p 82 Jul 19

FAA cutting localizer cost . . . . . p 10 Sep 27

F-m feedback stabilizes airborne solid-state VHF transponders . . . . . p 66 Dec 6

For 'copters, microwave ILS? . . . . . p 40 Oct 4

Fork drives ILS antenna . . . . . p 24 Aug 2

Ground position system uses magnetic logic . . . p 8 Aug 9

Improved air traffic communication and weather nets planned. . . . . p 92 Jan 4

Microelectronic Loran-C will fly next year . . . p 22 Jun 28

Multicomputers to rule English sky . . . . . p 14 Oct 11

New air-traffic system predicts flight paths . . . p 27 Feb 1

New light on air traffic: bright plan display with alphanumerics . . . . . p 42 Jul 26

New rdf is loopless . . . . . p 38 Nov 29

USAF to test triple navigator . . . . . p 45 Sep 13

Why U.S. lags Europe in automatic landing. . . . p 21 Aug 23

AIRCRAFT

Army wants surveillance, armament gear for air arm. . . . . p 10 Nov 29

Automatic system probes B-70 stresses . . . . . p 44 Jul 5

Electronics for the SST - what's ahead? . . . . p 24 Nov 15

F-104G: boon to Europe . . . . . p 16 Jun 21

Hot mikes will record air crew's conversation . . p 53 Nov 15

Limited-war needs spur VTOL development . . . p 30 Feb 15

Navy readies airborne data system. . . . . p 43 Sep 20

New approach to weather data: every plane a station . . . . . p 38 Jul 12

Robot copters join Navy's anti-sub arsenal . . . p 18 Apr 19

Stage is set again for RS-70 debate . . . . . p 19 Feb 1

Comment . . . . . p 4 Mar 1

Unique computer system monitors aircraft engines . . . . . p 38 Jan 11

ALARM SYSTEMS

Consumer electronics Pt III: Appliances and housewares. . . . . p 46 May 17

Infrared system detects intruders. . . . . p 26 Aug 16

Sequence pulse generator saves transistors . . . p 44 Aug 2

AMPLIFIERS

(See also D-C Amplifiers; Lasers; Magnetic Amplifiers; Parametric Amplifiers)

C-W amplifiers for space telemetry . . . . . p 78 Apr 26

Circuit with a twist: the cascode follower. . . . p 69 Dec 6

Consumer electronics Pt III: Appliances and housewares. . . . . p 46 May 17

Comment . . . . . p 4 Jul 19

Designing input circuits with lowest possible noise. . . . . p 46 Aug 2

Designing servo amplifiers for high efficiency. . . p 62 Feb 8

Comment . . . . . p 4 Apr 12

Direct coupling shrinks amplifier size and cost. . p 66 Mar 22

Comment . . . . . p 4 May 10

Dynamic null - new method for measuring equipment performance . . . . . p 78 Mar 15

Comment . . . . . p 4 May 3

Fast age amplifier locks monopulse radar on target . . . . . p 34 Sep 27

Highlights of small-signal circuit design . . . . p 46 Dec 6

Inductors no problem: new thin-film amplifier . . p 46 Jun 7

Latest approach to integrated amplifier design. . p 24 May 31

Light isolates amplifier stages . . . . . p 43 Nov 1

Low-noise preamplifier uses field-effect transistors . . . . . p 67 Apr 12

Comment . . . . . p 4 Jun 21

Muscle voltage moves artificial hand . . . . . p 34 Oct 11

NEREM: Research in New England . . . . . p 23 Nov 1

Neodymium-glass amplifier for lasers . . . . . p 42 Dec 13

New millimeter wave device - beam-plasma amplifier . . . . . p 40 Nov 8

Nomograph speeds amplifier design . . . . . p 38 Jul 5

Novel field-effect device provides broadband gain . . . . . p 30 Nov 1

Optical coupling: new approach to micro-circuit interconnections . . . . . p 23 Nov 22

Selecting tubes for wide bandwidth. . . . . p 53 Oct 25

Solving the AGC dilemma - servo system uses attenuator . . . . . p 60 Jul 19

Tv dissolve wiper. . . . . p 40 Sep 6

Tunnel diodes Pt II: Amplifiers working beyond transistor capabilities . . . . . p 68 Jun 21

Unity-gain buffer acquires precision by feedback . . . . . p 36 Dec 20

Versatile servo amplifier for 50, 60 or 400-cycle operation . . . . . p 44 Jan 18

ANALOG-DIGITAL CONVERTERS

Continuous readout of magnetic cores . . . . . p 38 Sep 6

Improving a-d converter accuracy . . . . . p 38 Sep 13

New digital conversion method provides nanosecond resolution . . . . . p 55 May 3

Tunnel diodes Pt IV: Logic and switching circuits. . . . . p 26 Jul 5

Using the latest semiconductor circuits in a UHF digital converter. . . . . p 37 Aug 30

ANALYZERS See Test Equipment

ANTENNAS

Arecibo-opens new era in radio astronomy . . . p 29 Dec 20

The arrowhead: compact new telemetry antenna . . . . . p 66 Apr 26

Can 1-f communications beat nuclear black-out? . . . . . p 11 Nov 1

Conical scan array uses variable phase shifters . . p 30 Nov 29

Encapsulating precision antennas in plastic . . . p 68 Mar 8

Fast age amplifier locks monopulse radar on target . . . . . p 34 Sep 27

German satellite station . . . . . p 74 Dec 6

Glass-fiber array produces many beams . . . . . p 28 Nov 1

How computers align phased-array radars . . . . p 29 Nov 15

How to measure field patterns with photo-sensitive probes . . . . . p 39 Jan 25

Hula-hoop antennas: a coming trend? . . . . . p 44 Jan 11

Inflating antennas in outer space . . . . . p 74 Feb 22

Latest field-mapping improvement - lead-less transceiver probe works underwater. . . . p 56 Jul 19

Measuring missile antenna impedance in flight. . . p 36 Jul 12

Microwave components . . . . . p 28 Dec 6

Multicoupler puts five transmitters on one antenna . . . . . p 35 Dec 13

Near-field plotter: design tool for millimeter-wave antennas . . . . . p 29 Dec 27

New antenna idea: scanning without phase shifters . . . . . p 27 Mar 29

New rdf is loopless . . . . . p 38 Nov 29

New telemetry antenna adds flexibility . . . . . p 48 Feb 1

Comment . . . . . p 4 Feb 15

Recent tests show tropo scatter better than believed . . . . . p 42 Mar 1

Unique bridge measures antenna operating impedance . . . . . p 51 Feb 22

Versatile R-F monitor shows power and VSWR. . . p 44 Mar 29

ARTIFICIAL INTELLIGENCE

Components that learn and how to use them . . . p 49 Mar 22

IEEE: ultra-intelligent machines by year 2000. . . p 46 Mar 1

ASTRONOMY

Aiming a 3-ton telescope hanging from a balloon . . . . . p 47 Feb 8

Eclipse to bare ionosphere's secrets. . . . . p 26 Jul 19

Racing the solar eclipse . . . . . p 37 Jul 26

USAF to test triple navigator . . . . . p 45 Sep 13

ATMOSPHERIC STUDIES

Eclipse to bare ionosphere's secrets . . . . . p 26 Jul 19

Is ionospheric pollution good? or is it bad? . . . p 40 Apr 26

Nuclear blast effects on communications . . . . p 74 Feb 8

Racing the solar eclipse . . . . . p 37 Jul 26

Radiosonde measures after-effects of solar events . . . . . p 47 Apr 19

ATOMIC CLOCKS

Frequency control lags ssb: Symposium . . . . . p 16 Jun 7

ATOMIC RESONANCE

Three-dimensional display uses atomic resonance . . . . . p 52 Jan 11

ATTENUATORS

Logarithmic attenuator spans three decades . . . p 47 Nov 15

AUDIO

Digital correlator detects voice fundamental . . . p 28 Nov 22

Highlights of small-signal circuit design. . . . . p 46 Dec 6

How hi is fi? . . . . . p 33 Jun 14

Comment . . . . . p 4 Aug 2

Novel feedback loop stabilizes audio oscillator. . p 42 Feb 1

Now a talking computer answers inventory inquiries. . . . . p 30 Aug 16

Pulses promise simpler audio. . . . . p 16 Aug 16

Sound: a better way to control pests . . . . . p 24 Jan 11

Speech operates safety switch . . . . . p 78 Jun 21

Subaudio parametric amplifier for ocean-bottom seismometer . . . . . p 28 Mar 1

Two-phase oscillator covers 0.1 to 1,000-cps . . . p 27 Oct 4

Two-state modulation simplifies audio circuits. . . p 36 Aug 23

Vocal analog synthesizes speech. . . . . p 46 Oct 11

AUTOMOTIVE

Autos boost solid-state devices . . . . . p 39 Oct 4

Consumer electronics Pt II: Home and auto controls. . . . . p 52 May 10

Hula-hoop antennas: a coming trend? . . . . . p 44 Jan 11

Multitone oscillators - new source of simultaneous frequencies . . . . . p 86 Jan 4

Reducing winter skids with a transistor warning circuit . . . . . p 56 Jan 25

AVALANCHE EFFECT

Avalanche transistors test 10-nsec logic . . . . . p 46 Jul 12

Comment . . . . . p 4 Aug 30

Avalanching transistor generates microwaves . . . p 35 Oct 25

More reliability with controlled avalanche rectifiers . . . . . p 38 Mar 29

B

BEAM-SWITCHING TUBES

Contest produces novel circuit designs . . . . . p 96 Mar 15

New antenna idea: scanning without phase shifters . . . . . p 27 Mar 29

BIONICS

Bionics Symposium: frog's eye goes to Air Force . . . . . p 18 Mar 8

ESP: is biological radio communication possible? . . . . . p 14 Mar 29

Comment . . . . . p 4 May 10

Experimental neuristor gives nerve-like pulse propagation . . . . . p 25 Mar 1

IEEE: ultra-intelligent machines by year 2000 . . p 46 Mar 1

BRIDGE CIRCUITS

High precision d-c level shifter reduces output impedance . . . . . p 65 May 3

Subaudio parametric amplifier for ocean-bottom seismometer. . . . . p 28 Mar 1

Unique bridge measures antenna operating impedance . . . . . p 51 Feb 22

Versatile R-F monitor shows power and VSWR. . . p 44 Mar 29

BUSINESS

Army of the air creates new market . . . . . p 32 Apr 12

Atomic test ban - what does it mean to our industry? . . . . . p 18 Aug 2

Autos boost solid-state devices . . . . . p 39 Oct 4

Color Tv mobilizes for '63 . . . . . p 21 Mar 1

Consumer electronics

Pt I: Entertainment . . . . . p 49 May 3

Pt II: Home and auto controls . . . . . p 52 May 10

Pt III: Appliances and housewares . . . . . p 46 May 17

Crosstalk: Believe it or not. . . . . p 3 Mar 29

Disarmament - what chance? what impact? . . . . p 56 Sep 6

Electronics industry nudges fourth place nationally. . . . . p 18 Jul 5

Electronics markets 1963. . . . . p 43 Jan 4

"Far-out" space contracts . . . . . p 18 Feb 22



Home appliances: market for solid state .....	p 14 Sep 13
How to succeed in business on someone else's research .....	p 22 Jul 12
The impact of microelectronics .....	p 51 Jun 28
Industrial electronics showing gain in sales .....	p 18 Nov 1
Industrial spy - aristocrat of thieves .....	p 32 Jul 19
Investment abroad rising .....	p 17 Sep 6
Japanese exports keep climbing .....	p 45 May 3
Military electronics will level off in fiscal 1964 .....	p 18 Jan 25
Small-screen Tv sales growing .....	p 11 Dec 6
Spacecom: \$100-million-a-year market .....	p 22 Apr 19
Stand by for those Navy RDT&E contracts: \$ 1 1/2 billion .....	p 10 Sep 13
Trade Expansion Act: help or hazard? .....	p 28 Mar 8
VE now the rule .....	p 46 Sep 13
Western sales show more zing .....	p 24 Aug 9
When will integrated circuits go civilian? Good guess: 1965 .....	p 22 May 10
Will British TWT's make further inroads? .....	p 50 Jul 12

## C

### CAPACITORS

By-pass capacitor built into Uhf tuner shaft .....	p 88 Dec 6
Capacitor provides outer coupling for modern coaxial-line circuits .....	p 62 Jan 18
Comment .....	p 4 May 31
Capacitors contain no electrolyte .....	p 52 Mar 29
Cordwood package gets new tubular ceramic capacitors .....	p 43 Aug 16
Electronics color codes .....	p 37 Nov 15
Machine coats films automatically .....	p 86 Apr 26
New glass wets tantalum oxide .....	p 76 Feb 22
Parasitics in integrated circuits: more trouble than meets the eye .....	p 32 Jul 5
Pilot plant mass produces thin films .....	p 64 Jun 7

### CARRIER SYSTEMS

Simple transistor modulators improve sideband communications .....	p 54 Mar 8
Wideband communications is Army plan .....	p 18 Apr 5

### CATHODE-RAY TUBES

CRT recording has wide bandwidth .....	p 60 Nov 15
Data display system works in microseconds .....	p 26 Nov 29
New deflection circuit uses SCR, saves power .....	p 56 Aug 9
TVIST: new look in photoelectric storage tubes .....	p 74 Jun 21

### CATHODES

Are hot cathodes on the way out? .....	p 39 Jun 7
--	------------

### CAVITY RESONATORS

New technique protects receivers from high power .....	p 32 Mar 1
Resonant-cavity tuning now made easy .....	p 46 Jan 18
Tunnel diodes Pt I: Using them as sinusoidal generators .....	p 36 Jun 14

### CERAMICS

Ceramic substrate improves microcircuit reliability .....	p 51 Nov 22
High-temperature ceramic transmits light .....	p 62 Mar 8
How ceramic benders control light rays .....	p 80 Jul 19
Comment .....	p 6 Sep 20
How good are beryllia ceramics? .....	p 75 Oct 18
Materials for space-age electronics .....	p 37 Oct 25
Window materials for high-power microwave tubes .....	p 40 May 31

### CHARACTER GENERATORS

Data display system works in microseconds .....	p 26 Nov 29
---	-------------

### CHARACTER READERS

French find 7 lucky number .....	p 28 Aug 2
ZIP goes the mail! .....	p 26 Jul 12

### CIRCULATORS

S-band param approaches noise-figure minimum .....	p 57 Jun 28
Tunnel diodes Pt II: Amplifiers working beyond transistor capabilities .....	p 68 Jun 21

### CLEAN-ROOM TECHNIQUES

Hospital technique used in work station .....	p 94 Jun 21
---	-------------

### COAXIAL CABLES

Capacitor provides outer coupling for modern coaxial-line circuits .....	p 62 Jan 18
Comment .....	p 4 May 31
Coaxial filters - a practical design technique .....	p 35 Aug 30
Five-layer diode guards cables .....	p 84 Jun 21
Getting subnanosecond precision in coax cable delay measurements .....	p 39 Feb 1

### CODES

French find 7 lucky number .....	p 28 Aug 2
New code standard in U. S. - international adoption next? .....	p 22 Jul 26

### COILS

Advances in microminiaturization .....	p 45 Feb 15
Inductors no problem: new thin-film amplifier .....	p 46 Jun 7
Versatile wind reduces costs .....	p 80 Nov 8
Voltage monitor needs only two saturable cores .....	p 50 Jun 7
What you must know to use ferrites at low frequencies .....	p 38 Mar 1

### COLOR CODES

Electronics color codes .....	p 37 Nov 15
-------------------------------	-------------

### COLOR TELEVISION

Brighter color Tv in offing? .....	p 116 Jan 4
Color Tv mobilizes for '63 .....	p 21 Mar 1
Consumer electronics Pt I: Entertainment .....	p 49 May 3
Europe's color-Tv competition .....	p 22 Aug 2
Here's that new color-Tv tube .....	p 26 Jun 28
Presenting radar targets in color .....	p 54 Oct 18
Tv test uses two colors .....	p 42 May 3
Tri-optic system projects color Tv .....	p 42 Oct 4
Two-tube color camera .....	p 28 Jun 7

### COMMUNICATION

AFCCD: Military communication systems get simpler, smaller, faster .....	p 14 Jun 14
After Echo II: what and why? .....	p 24 Sep 6
Air Force plans net to survive nuclear attack .....	p 28 Mar 22
Better superhets for sideband reception .....	p 39 May 10
Comment .....	p 4 Jul 12
Bugs and antibugs: new designs for hidden ears .....	p 10 Oct 25
Can 1-f communications beat nuclear blackout? .....	p 11 Nov 1
Communicating with future deep-space probes .....	p 28 May 31
Communications range nomograph .....	p 41 Dec 20
ComSat tackles problems - technical and fiscal .....	p 18 Aug 9
Crosstalk: Needles no more .....	p 3 Jul 5
Data communications boom gathers steam .....	p 26 May 10
DOD satellite net set for awards .....	p 26 Jun 7
Down Under - suddenly Mecca for radio men .....	p 20 Jan 4
ESP: is biological radio communication possible? .....	p 14 Mar 29
Comment .....	p 4 May 10
Fail-safe squelch circuit adapts to changing noise levels .....	p 88 Jan 4
Faster digital communications with duobinary techniques .....	p 61 Mar 22
First color facsimile transmitted by satellite .....	p 51 May 24
GaAs laser transmits wideband data .....	p 24 Oct 18
German satellite station .....	p 74 Dec 6
Getting the most out of aerospace telemetry .....	p 23 Sep 27
Hot line: for cool nuclear decisions .....	p 18 Jun 28
Hula-hoop antennas: a coming trend? .....	p 44 Jan 11
Improved air traffic communication and weather nets planned .....	p 92 Jan 4
Injection laser systems for communications tracking .....	p 35 Dec 13
Is this the ultimate in data coding? .....	p 18 Jun 21
Military radio swinging to sb .....	p 29 Apr 5
Modulated infrared diode spans 30 miles .....	p 38 Apr 5
NASA studies earth-space-earth laser links .....	p 22 May 10
New chore for orbiting dipoles .....	p 14 May 31
New code standard in U. S. - international adoption next? .....	p 22 Jul 26
New look in this year's comsats .....	p 18 Jul 19
New modulation technique simplifies circuits .....	p 52 Jan 25
New transducers for communicating by seismic waves .....	p 51 Apr 12
Comment .....	p 4 May 24
Nuclear blast effects on communications .....	p 74 Feb 8
The optical heterodyne - key to advanced space signaling .....	p 29 Jul 12
Orbital-scatter concept proves out .....	p 26 Nov 8
RFI - causes, effects, cures .....	p 37 Jun 21
Comment .....	p 4 Aug 30
Recent tests show tropo scatter better than believed .....	p 42 Mar 1
Simple transistor modulators improve sideband communications .....	p 54 Mar 8
Skip radio replaces Alaskan cable .....	p 30 Jul 26
Spacecom: \$100-million-a-year market .....	p 22 Apr 19
Speeding digital data over phone lines .....	p 30 Sep 27
Sb system goal is 2-year life .....	p 75 Oct 25
Syncom's time delay: no great problem .....	p 11 Nov 8
Telepathy maybe .....	p 42 Oct 11
Tunnel diodes Pt III: Mixer and converter circuits .....	p 60 Jun 28
Comment .....	p 4 Aug 2
Unique synchronizing technique increases digital transmission rates .....	p 75 Mar 15
West Ford dipole belt girdles earth .....	p 12 Jul 5
Wideband communications is Army plan .....	p 18 Apr 5
COMPONENTS	
Accurate gyro balancing .....	p 81 Oct 25
Active components: more breakthroughs on the way .....	p 24 May 17
British Show: Microcircuits are busting out in Britain .....	p 60 Jun 7
Components that learn and how to use them .....	p 49 Mar 22
Electrochemical Society Symposium: Bright future seen for organics .....	p 51 Oct 11
Electronics market 1963 .....	p 43 Jan 4

Microwave components .....	p 28 Dec 6
Miniature components aimed for mass markets .....	p 64 Apr 19
The negative resistance element (NRE): a new circuit component .....	p 21 May 31
Comments p 4 Jul 5, p 4 Jul 12, .....	p 4 Jul 19

### COMPUTERS

(See also Digital Techniques; Logic Circuits; Memories)	
Analog ratio computer uses Hall multiplier .....	p 46 Nov 8
Automatic computer identifies color .....	p 44 Sep 27
Computer analyzes x-rays .....	p 38 Nov 1
The computer: design assistant extraordinary .....	p 16 May 17
Computer diagnoses heart disease .....	p 80 Dec 6
Computer runs missile tracker .....	p 12 Jun 14
Computer translates Chinese into English .....	p 56 Jun 7
Computers in the front lines: micromodules make it possible .....	p 77 Jan 4
Contest produces novel circuit designs .....	p 96 Mar 15
Data communications boom gathers steam .....	p 26 May 10
Designing data registers with simple diode circuits .....	p 48 Feb 22
Designing digital equipment with semiconductor networks .....	p 35 Jan 18
FJCC: What's new in computer memories .....	p 35 Nov 8
For command & control: paper prototypes next .....	p 28 Jun 28
For life sciences: a do-it-yourself computer .....	p 28 Jul 26
How computers align phased-array radars .....	p 29 Nov 15
How to quiz a whole memory at once .....	p 43 Nov 15
ISA: Safer power plants: why not? .....	p 38 May 24
Laser may accelerate computer .....	p 39 Oct 4
Mesurca: French control systems sophisticated, as usual .....	p 14 Nov 29
Microcomputer comes off the line .....	p 14 Nov 1
Multicomputers to rule English sky .....	p 14 Oct 11
NASA unveils Apollo computer .....	p 17 Sep 27
Navy readies airborne data system .....	p 43 Sep 20
New air-traffic system predicts flight paths .....	p 27 Feb 1
Now a talking computer answers inventory inquiries .....	p 30 Aug 16
Optical computers approach reality .....	p 72 May 3
Polaris-proven electronics to guide Apollo .....	p 14 Oct 4
600,000 WPM printer races computer .....	p 26 May 24
Solid-State Conference: Computer speeds go higher .....	p 19 Mar 8
Special computer integrates rainfall .....	p 70 May 24
Three new computer systems announced .....	p 10 Dec 13
Unique computer system monitors aircraft engines .....	p 38 Jan 11
CONFERENCES	
AES: Foil stabilizes electret mike .....	p 68 Oct 25
AFCCD: Military communication systems get simpler, smaller, faster .....	p 14 Jun 14
AIP: Nuclear blast effects on communication .....	p 74 Feb 8
Aerospace Conference: Air Force outlines latest R & D plans .....	p 16 May 24
Air Traffic Association 8th Annual Meeting: Airlines look to computers to end delays .....	p 66 Oct 25
Bionics Symposium: Frog's eye goes to Air Force .....	p 18 Mar 8
Boston Laser Conference: The medical laser: new tool for cancer research .....	p 15 Aug 16
Britain Physics Show: Tunable detectors, faster microwave switching .....	p 22 Feb 1
British Show: Microcircuits are busting out in Britain .....	p 60 Jun 7
ECCANE: Active thin-film device problems fade .....	p 41 Oct 11
Electrochemical Society: Chelate lasers are coming on strong .....	p 32 Apr 26
Electrochemical Society Symposium: Bright future seen for organics .....	p 51 Oct 11
Electron Beam Symposium: Microwelding - laser or electron beam? .....	p 23 Jul 5
Electronic Components Conference: Active components: more breakthroughs on the way .....	p 24 May 17
Electronic Packaging Conference: Hot-air machine speeds soldering .....	p 44 May 31
FJCC: What's new in computer memories .....	p 35 Nov 8
IEEE: Conductive memory points to new displays .....	p 10 Nov 8
IEEE: Device powers go higher .....	p 57 Nov 15
IEEE: Instruments extend operating ranges, are easier to work .....	p 33 Mar 15
IEEE: Microcircuits graduate into hardware products .....	p 38 Mar 15
IEEE: Preview of first convention .....	p 63 Mar 15
IEEE: Space round trips push techniques .....	p 40 Sep 27
IEEE: Ultra-intelligent machines by year 2000 .....	p 46 Mar 1
IEEE Solid State Conference: Look at what optical semiconductors do now .....	p 32 Jun 28
IEEE Solid State Conference: New laser structure drives output past 1 w .....	p 24 Jun 21
INEL: Transistors control trains .....	p 10 Sep 27
INTERMA: Packing a half-million bits in a cubic inch .....	p 58 Apr 19
IRE: Large displays: military market now, civilian next .....	p 24 Jan 25
IRE Millimeter Conference: Try developing MM components .....	p 24 Jan 18



ISA: Safer power plants: why not? .....	p 38	May 24
ISA: Telemetry on muscle power .....	p 14	Sep 20
The impact of microelectronics .....	p 51	Jun 28
International Symposium on Nuclear Electronics: Nuclear instruments near picosecond working speed .....	p 43	Dec 13
Laser meetings double up .....	p 22	Apr 12
MHD Conference: Plasma accelerator work shows promise .....	p 38	Apr 26
Mesucora: French control systems sophisticated, as usual .....	p 14	Nov 29
Metallurgical Society of AIME: Future keyed to materials properties .....	p 66	Sep 6
NEC: Electronics in the Midwest .....	p 31	Oct 25
NEREM: Research in New England .....	p 23	Nov 1
Quantum Electronics' Symposium: What's new in lasers? .....	p 14	Mar 1
RFI: In microcircuits it's different .....	p 28	Jun 14
Radio Fall Meeting: New tubes and circuits for consumer electronics .....	p 47	Jan 11
Society for Information Display: Air Force display selects data from 1,890 channels .....	p 10	Oct 18
Society of Photographic Instrumentation Engineers symposium: From flash guns to lasers .....	p 16	Aug 16
Solid-State Conference: Computer speeds go higher .....	p 19	Mar 8
Solid-State Conference: Solid progress in solid-state seen at Philadelphia .....	p 12	Mar 1
Symposium: Field modulates laser .....	p 26	Apr 26
Comment .....	p 4	Jun 28
Symposium: Frequency controls lags sb. ....	p 16	Jun 7
Symposium: What happens to dielectrics in space? .....	p 68	Jul 19
Third National Conference on Peaceful Uses of Space - R & D goes back to earth .....	p 30	May 17
Vacuum Symposium: Modulated beams build microcircuits .....	p 26	Oct 25
WESCON: High power at millimeters - plasma harmonics the key .....	p 16	Aug 30
WESCON: Invited sessions dig into future techniques .....	p 26	Aug 9
WESCON: Micro-packaging for micro- electronics .....	p 88	Aug 9
WESCON: The technical highlights .....	p 49	Aug 9
WESCON: Watchful eye on company seminars ..	p 29	Aug 9
<b>CONNECTIONS</b>		
Ceramic substrate improves microcircuit reliability .....	p 51	Nov 22
Checking connector production .....	p 96	Feb 8
Flip chips easier to connect .....	p 82	Oct 18
Interconnections pose design problems .....	p 54	Feb 1
Laser welds copper leads .....	p 88	Oct 25
Machine simplifies bonding process .....	p 60	Feb 1
New circuit board planned for Apollo accommodates integrated circuit blocks .....	p 84	Jun 21
Preformed circuits reduce joining operations ..	p 45	Aug 23
Programming speeds wire wraps and routing ..	p 62	Sep 13
Serrations solve wire-termination problem ..	p 86	Jan 25
Tool speeds solderless terminations .....	p 68	Aug 2
WESCON: Micro-packaging for micro- electronics .....	p 88	Aug 9
What makes a solder joint good? .....	p 50	Nov 29
Which permanent electrical connection should you use? .....	p 50	Jan 25
<b>CONSTANTS</b>		
Designing zero-drift d-c differential amplifiers ..	p 66	Nov 8
<b>CONTROL CIRCUITS</b>		
Magnetic strip keeps tape running true .....	p 42	Jan 11
Mesucora: French control systems sophisticated, as usual .....	p 14	Nov 29
Speech operates safety switch .....	p 78	Jun 21
Taking human error out of nuclear experiments .....	p 46	Jun 14
Using varactors to extend frequency-control ..	p 48	Nov 8
<b>CONVERTERS</b>		
(See also Analog-Digital Converters)		
Inside the orbiting geophysical observatory ..	p 61	Feb 15
Latest multivibrator improvement - linear voltage-to-frequency converter .....	p 64	Apr 26
Multi-quantum conversion shown .....	p 50	Sep 20
New digital conversion method provides nanosecond resolution .....	p 55	May 3
Tunnel diodes Pt III: Mixer and converter circuits .....	p 60	Jun 28
Comment .....	p 4	Aug 2
Unijunction transistor simplifies voltage- frequency converter .....	p 56	Oct 25
<b>CORES</b>		
(See also Ferrite Devices; Memories)		
Continuous readout of magnetic cores .....	p 38	Sep 6
Plated holes simplify memory design .....	p 34	Nov 1
Thick-film memory has high output .....	p 40	Nov 1
Voltage monitor needs only two saturable cores .....	p 50	Jun 7

<b>COUNTERMEASURES</b>		
Bugs and antbugs: new designs for hidden ears ..	p 10	Oct 25
Countermeasures equipment eyes Cuba .....	p 22	Feb 8
Designing radar receivers to overcome jamming ..	p 50	May 17
Radio-interference control .....	p 56	Apr 26
Comment .....	p 4	Jan 7
Shrike will be "big buy" .....	p 26	Jun 14
Will lasers protect our cities against ICBM's? ..	p 20	May 3
<b>COUNTERS</b>		
Bi-quinary indicator uses 7 transistors .....	p 58	Jul 12
Bi-quinary scaling: accuracy and simplicity at 500 Mc .....	p 34	Nov 15
Designing data registers with simple diode circuits .....	p 48	Feb 22
Developing true solid-state static alternators ..	p 58	May 24
Getting subnanosecond precision in coax cable delay measurements .....	p 39	Feb 1
How to design arbitrary-length binary counter ..	p 34	Dec 27
Novel coincidence technique for transistor decade counter .....	p 71	Feb 15
Radiosonde measures after-effects of solar events .....	p 47	Apr 19
Simple counter tester uses cascaded one-shots ..	p 40	Apr 5
Tunnel diodes Pt IV: Logic and switching circuits .....	p 26	Jul 5
Unique synchronizing technique increases digital transmission rates .....	p 75	Mar 15
Using microcircuits in high-resolution range counters .....	p 31	Nov 22
VHF counter measures time intervals precisely .....	p 27	Aug 23
Why a ring counter - why not a binary? .....	p 44	Jan 25
<b>CRYOGENICS</b>		
Cryogenics for the electronics engineer .....	p 29	Aug 30
Homogeneous semiconductors - a new generation of devices .....	p 65	Jun 21
Novel test techniques measure Q in cryogenic resonant circuits .....	p 43	Feb 22
<b>CRYSTALS</b>		
Crystal-controlled multivibrator has better stability .....	p 60	Apr 12
Comment .....	p 4	May 17
Gatling-gun laser - novel approach to optical radar .....	p 25	Sep 20
Materials for space-age electronics .....	p 37	Oct 25
New 40-mm silicon crystals permit larger- capacity devices .....	p 84	Feb 8
Solid crystal modulates light beams .....	p 58	Dec 20
Thin films: automatic deposition control .....	p 33	Mar 29
Ultrasonics state-of-the-art report .....	p 33	Oct 18
Wires cut crystals accurately .....	p 46	Nov 1
<b>D</b>		
<b>DATA PROCESSING</b>		
Circuit converts one-trace scopes to raster display .....	p 33	Nov 29
Data communications boom gathers steam .....	p 26	May 10
Faster digital communications with duobinary techniques .....	p 61	Mar 22
Is this the ultimate in data coding? .....	p 18	Jun 21
Navy readies airborne data system .....	p 43	Sep 20
<b>D-C AMPLIFIERS</b>		
Designing zero-drift d-c differential amplifiers ..	p 66	Nov 8
Developing radiation-proof space equipment ..	p 70	Aug 9
Pulse-width modulator offers precision performance .....	p 29	Oct 11
<b>DELAY LINES</b>		
Ultrasonics state-of-the-art report .....	p 33	Oct 18
<b>DEMODULATORS</b>		
New phase-tracking demodulator will not lock on sidebands .....	p 52	Feb 8
<b>DETECTION</b>		
Air Force research aim: detection capabilities .....	p 72	Apr 26
Black box blast detection - hope or hoax? .....	p 26	Jan 4
Bugs and antbugs: new designs for hidden ears ..	p 10	Oct 25
Consumer electronics Pt II: Home and auto controls .....	p 52	May 10
Infrared mine detector a reality .....	p 54	Aug 2
Infrared system detects intruders .....	p 26	Aug 16
Long-range spectrometer seeks missile defense clues .....	p 16	May 10
Microwave device detects plastic, metal mines ..	p 7	Aug 9
Predetection recording: Solution to the telemetry dilemma? .....	p 30	Sep 13
Test-ban monitors set for launch .....	p 57	Oct 18
<b>DIGITAL TECHNIQUES</b>		
(See also Pulse Techniques)		
Bi-quinary scaling: accuracy and simplicity at 500 Mc .....	p 34	Nov 15
Circuit converts one-trace scopes to raster display .....	p 33	Nov 29

Contest produces novel circuit designs .....	p 96	Mar 15
Delta modulator codes television waveguide link .....	p 50	Aug 2
Digital correlator detects voice fundamental .....	p 28	Nov 22
Faster digital communications with duobinary techniques .....	p 61	Mar 22
Inside the orbiting geophysical observatory .....	p 61	Feb 15
Low-cost circuit measures frequency translation ..	p 51	Nov 8
Microelectronic Loran-C will fly next year .....	p 22	Jun 28
New chore for orbiting dipoles .....	p 14	May 31
New code standard in U. S. - international adoption next? .....	p 22	Jul 26
New digital conversion method provides nanosecond resolution .....	p 55	May 3
New modulation technique simplifies circuits ..	p 52	Jan 25
Realistic sonar trainer simulates ship's wakes .....	p 84	Mar 15
Sequence pulse generator saves transistors .....	p 44	Aug 2
Simple counter tester uses cascaded one-shots ..	p 40	Apr 5
Simulating tactical radar and sonar .....	p 25	Dec 13
Slow sampling saves time .....	p 40	Nov 29
Speeding digital data over phone lines .....	p 30	Sep 27
Unique synchronizing technique increases digital transmission rates .....	p 75	Mar 15
Using microcircuits in high-resolution range counters .....	p 31	Nov 22
Well neon photoconductors replace relays in low-speed logic? .....	p 46	May 10
<b>DIODES</b>		
(See also Tunnel Diodes)		
Backward-diode clamp reduces tunnel- diode delays .....	p 56	Feb 8
Basic rules for designing reliability into semiconductor circuits .....	p 62	Apr 12
Built-in diodes protect nickel cadmium cells .....	p 50	Dec 13
Designing data registers with simple diode circuits .....	p 48	Feb 22
Diode lamp makes tape readers faster .....	p 44	May 17
Comment .....	p 4	Jul 26
Diode receives optical signals .....	p 17	Sep 13
Diodes tolerate high radiation .....	p 48	Nov 29
Electronics color codes .....	p 37	Nov 15
Epoxy pellets improve diode production .....	p 64	Jul 26
Family tree of semiconductors .....	p 45	Apr 26
Five-layer diode guards cables .....	p 84	Jun 21
High speed integrated circuits with load- compensated diode-transistor logic .....	p 68	Mar 15
Highlights of small-signal circuit design .....	p 46	Dec 6
Hot carrier diodes switch in picoseconds .....	p 53	Jul 19
How diodes keep current to constant value .....	p 74	Jan 25
IEEE Solid State Conference: Look at what optical semiconductors do now .....	p 32	Jun 28
Improving pulse rise time with snap-off diodes ..	p 68	Feb 15
Comment .....	p 4	Apr 5
A key to nanosecond switching combining tunnel and charge-storage diodes .....	p 42	Oct 18
Logarithmic attenuator spans three decades .....	p 47	Nov 15
Modulated infrared diode spans 30 miles .....	p 38	Apr 5
More reliability with controlled avalanche rectifiers .....	p 38	Mar 29
New look at negative-resistance devices .....	p 35	Mar 8
Comment .....	p 4	Apr 26
New technique protects receivers from high power .....	p 32	Mar 1
The PIN diode: versatile microwave component .....	p 40	Mar 8
Rapid method measures diode characteristics .....	p 50	Jun 14
Solid-state components shrink photoflash control .....	p 70	Apr 12
Three new approaches to pulse modulation .....	p 62	May 3
The versatile point-contact diode - how it detects and amplifies laser light .....	p 82	Jan 4
Comment .....	p 4	Mar 8
WESCON: technical highlights .....	p 49	Aug 9
<b>DIP SOLDERING See Soldering; Printed Wiring</b>		
<b>DIPOLLES</b>		
Crosstalk: Needles no more .....	p 3	Jul 5
West Ford dipole belt girdles earth .....	p 12	Jul 5
West Ford dipoles diffusing as planned .....	p 7	Jul 26
<b>DISPLAYS</b>		
Air Force display selects data from 1,890 channels .....	p 10	Oct 18
Air-sea-sub display plots naval targets .....	p 20	Jun 7
Bi-quinary indicator uses 7 transistors .....	p 58	Jul 12
Circuit converts one-trace scopes to raster display .....	p 33	Nov 29
Data display system works in microseconds .....	p 26	Nov 29
Large displays: military market now, civilian next .....	p 24	Jan 25
Latest antisubmarine aid: magnetic contour display system .....	p 58	Aug 9
New air-traffic system predicts flight paths .....	p 27	Feb 1
New light on air traffic: bright plan display with alphanumerics .....	p 42	Jul 26
Presenting radar targets in color .....	p 54	Oct 18
Subnanosecond radar shows high resolution .....	p 36	May 31



Sweep measurements - making the tough ones easy .....	p 52 Apr 19
Three-dimensional display uses atomic resonance .....	p 52 Jan 11
<b>DOPPLER EFFECT</b>	
Low-noise c-w klystron oscillators meet doppler radar requirements .....	p 85 Dec 6
Phase-locked klystrons simulate doppler radar .....	p 44 Apr 19

## E

<b>EDUCATION</b>	
Crosstalk: Continuing education .....	p 3 May 17
FCC may move airborne Tv to microwave .....	p 20 Nov 8
Lab courses .....	p 4 Aug 23

<b>ELECTROLUMINESCENCE</b>	
Air Force display selects data from 1,890 channels .....	p 10 Oct 18
Breakthrough in light amplifiers - el-pc image intensifier uses control-grid .....	p 30 Sep 20
Consumer electronics Pt II: Home and auto controls .....	p 52 May 10
Large displays: military market now, civilian next .....	p 24 Jan 25
Solid panel amplifies images .....	p 20 May 24
Thin-film photocells get brighter faster .....	p 99 Sep 6

<b>ELECTRON BEAMS</b>	
Construction of electron-beam space welder begins .....	p 30 Jul 19
Electron Beam Symposium: Microwelding - laser or electron beam? .....	p 23 Jul 5
Electron beam welding solves relay sealing problems .....	p 90 Jun 28
Electrons work tiny ferrites .....	p 72 Nov 15
Generator for one-millimeter waves - Tornadotron .....	p 21 Aug 16
Infrared Tv tube uses new principle .....	p 48 Sep 13
New millimeter wave device - beam-plasma amplifier .....	p 40 Nov 8
Novel bwo doesn't use magnet .....	p 47 Sep 27
Screen mesh factors affect electron beams .....	p 67 Nov 15
Simulating tactical radar and sonar .....	p 25 Dec 13

<b>ELECTRONIC MUSIC</b>	
Consumer electronics Pt I: Entertainment .....	p 49 May 3

<b>ENCAPSULATION</b>	
Encapsulating precision antennas in plastic .....	p 68 Mar 8
Epoxy pellets improve diode production .....	p 64 Jul 26

<b>EPITAXIAL TECHNIQUES</b>	
High speed integrated circuits with load-compensated diode-transistor logic .....	p 68 Mar 15

<b>EPOXIES</b>	
Epoxy pellets improve diode production .....	p 64 Jul 26

## F

<b>FACSIMILE</b>	
First color facsimile transmitted by satellite .....	p 51 May 24

<b>FERRITE DEVICES</b>	
Electrons work tiny ferrites .....	p 72 Nov 15
Tunnel diodes Pt II: Amplifiers working beyond transistor capabilities .....	p 68 Jun 21
Waffle iron shape boath memory .....	p 50 Mar 1
What you must know to use ferrites at low frequencies .....	p 38 Mar 1

<b>FIBER OPTICS</b>	
Fiber optics, servo built into tape handler .....	p 66 Feb 22
Glass-fiber array produces many beams .....	p 28 Nov 1
Light beam controls potentiometers .....	p 76 Jun 28
Optical computers approach reality .....	p 72 May 3

<b>FIELD EFFECT TRANSISTORS</b>	
Highlights of small-signal circuit design .....	p 46 Dec 6
New field effect device may aid integrated circuit design .....	p 44 Nov 29
Novel field-effect device provides broadband gain .....	p 30 Nov 1
Simple circuits measure FET parameters .....	p 34 Aug 23
Sb system goal is 20-year life .....	p 75 Oct 25

<b>FILTERS</b>	
Coaxial filters - a practical design technique .....	p 35 Aug 30
Couplers kill reflected RFI .....	p 75 Nov 8
Digital correlator detects voice fundamental .....	p 28 Nov 22
Now you can use nonreciprocal devices at low frequencies .....	p 56 Feb 22
Ultrasonics state-of-the-art report .....	p 33 Oct 18

<b>FOREIGN ELECTRONICS</b>	
Crosstalk: Microelectronics abroad .....	p 3 Aug 2

Down Under - suddenly Mecca for radio men .....	p 20 Jan 4
Electronics markets 1963 .....	p 43 Jan 4
Europe's color-Tv competition .....	p 22 Aug 2
F-104G: boon to Europe .....	p 16 Jun 21
French reveal new field-effect structure .....	p 56 Jun 14
French Tv spurred by new stations .....	p 47 Sep 20
Hot line: for cool nuclear decisions .....	p 18 Jun 28
Investment abroad rising .....	p 17 Sep 6
Japan debunks reports on color-Tv production .....	p 18 Nov 1
Japan's two-tube color camera .....	p 28 Jun 7
Japanese exports keep climbing .....	p 45 May 3
Microelectronics around the world .....	p 37 Aug 2
Russian metrology - it looks as good as ours .....	p 27 Jul 26
Soviets planning transmission from Mars .....	p 18 Jan 11
Trade Expansion Act: help or hazard? .....	p 28 Mar 8
West still leads East in electronics .....	p 22 Apr 5
Will British TWT's make further inroads? .....	p 50 Jul 12

<b>FREQUENCY ALLOCATIONS</b>	
ITU agrees on space allocations .....	p 17 Nov 15
ITU allocations: final list .....	p 14 Nov 22
Vital band freed for radio astronomy .....	p 18 Nov 8

<b>FREQUENCY MEASUREMENT</b>	
Binary frequency sensing measures a single pulse .....	p 42 Apr 5
F-m discriminator without tuned circuits .....	p 36 Nov 29
Low-cost circuit measures frequency translation .....	p 51 Nov 8
Sweep measurements - making the tough ones easy .....	p 52 Apr 19
Symposium: Frequency control lags sb .....	p 16 Jun 7
Thin films: automatic deposition control .....	p 33 Mar 29
Two-phase oscillator covers 0.1 to 1,000-cps .....	p 27 Oct 4
Unique frequency comparator has sense of direction .....	p 36 Mar 1

<b>FREQUENCY MODULATION</b>	
Consumer electronics Pt I: Entertainment .....	p 49 May 3
Fitting a wide-band signal into a narrow-band receiver .....	p 47 Mar 8
F-m discriminator without tuned circuits .....	p 36 Nov 29
F-m feedback stabilizes airborne solid-state VHF transponder .....	p 66 Dec 6
Gated pulses yield selected frequency output .....	p 38 Dec 20
Latest field-mapping improvement - leadless transceiver probe works underwater .....	p 56 Jul 19
New aerospace transmitter packs 3-watts in fist-sized can .....	p 52 Jan 18
Operating X-band tunnel diodes at Q-band .....	p 32 Dec 27
Servo tracks pill in human body .....	p 58 Mar 22
Wireless milkes get F-M band .....	p 26 Jun 28

<b>FREQUENCY MULTIPLIERS</b>	
Frequency septupler provides stable 420-cps voltage .....	p 58 May 3
Highlights of small-signal circuit design .....	p 46 Dec 6
How to design solid-state microwave generators .....	p 23 Oct 11

## G

<b>GENERATORS</b>	
Developing true solid-state static alternators .....	p 58 May 24
Sequence pulse generator saves transistors .....	p 44 Aug 2

<b>GUIDED MISSILES</b>	
Army protects missiles against stray r-f .....	p 16 Apr 5
Computer runs missile tracker .....	p 12 Jun 14
Conical scan array uses variable phase shifters .....	p 30 Nov 39
Long-range spectrometer seeks missile defense clues .....	p 16 May 10
Measuring missile antenna impedance in flight .....	p 36 Jul 12
Microcomputer comes off the line .....	p 14 Nov 1
New infrared system tracks missiles against bright Florida sky .....	p 39 Apr 19
New techniques pay off for Polaris fire-control system .....	p 61 Oct 25
Predetection recording: Solution to the telemetry dilemma? .....	p 30 Sep 13
Shrike will be "big buy" .....	p 26 Jun 14
Tv camera tracker - can it detect missile decoys? .....	p 51 Apr 26
Zeus may never defend cities .....	p 24 Mar 8

## H

<b>HALL EFFECT</b>	
Analog ratio computer uses Hall multiplier .....	p 46 Nov 8
Electronics color codes .....	p 37 Nov 15
Hall-effect devices may find wide use .....	p 51 Nov 22
Now you can use nonreciprocal devices at low frequencies .....	p 56 Feb 22
Standards urged for Hall effect devices .....	p 47 Jul 5

**HIGH FIDELITY** See Audio

**IMAGE INTENSIFIERS** See Light Amplifiers

<b>INDUSTRIAL ELECTRONICS</b>	
Electronics market 1963 .....	p 43 Jan 4

ISA: Safer power plants: why not? .....	p 38 May 24
Mesurca: French control systems sophisticated, as usual .....	p 14 Nov 29
Transistors control trains .....	p 10 Sep 27

## INFORMATION RETRIEVAL

Crosstalk: Information: the whole picture .....	p 3 May 31
How to quiz a whole memory at once .....	p 43 Nov 15
TVIST: new look in photoelectric storage tubes .....	p 74 Jun 21

## INFRARED

Diode lamp makes tape readers faster .....	p 44 May 17
Comment .....	p 4 Jul 26
Infrared inspection promises to assure production reliability .....	p 62 Jun 14
Infrared mine detector a reality .....	p 54 Aug 2
Infrared system detects intruders .....	p 26 Aug 16
Infrared Tv tube uses new principle .....	p 48 Sep 13
Modulated infrared diode spans 30 miles .....	p 38 Apr 5
NEC: Electronics in the Midwest .....	p 31 Oct 25
New infrared system tracks missiles against bright Florida sky .....	p 39 Apr 19
No-chop IR detector cuts size .....	p 28 May 24

## INSTRUMENTS

Hybrid voltmeter avoids aging errors .....	p 41 Sep 20
IEEE: Instruments extend operating ranges, are easier to work .....	p 33 Mar 15
ISA: Telemetry on muscle power .....	p 14 Sep 20
Nuclear instruments near picosecond working speed .....	p 43 Dec 13
RFI - causes, effects, cures .....	p 37 Jun 21
Comment .....	p 4 Aug 30
Two-phase oscillator covers 0.1 to 1,000-cps .....	p 27 Oct 4

## INTEGRATED CIRCUITS

British Show: Microcircuits are busting out in Britain .....	p 60 Jun 7
Choosing logic for microelectronics .....	p 23 Oct 4
Compatible techniques for integrated circuits .....	p 82 May 3
Family tree of semiconductors .....	p 45 Apr 26
Flip chips easier to connect .....	p 82 Oct 18
High speed integrated circuits with load-compensated diode-transistor logic .....	p 68 Mar 15
IEEE: Microcircuits graduate into hardware products .....	p 38 Mar 15
IEEE Solid State Conference: New laser structure drives output past 1 w .....	p 24 Jun 21
Integrated-circuit oscillator requires few components .....	p 40 Dec 13
Integrated circuits go operational .....	p 26 Feb 15
Latest approach to integrated amplifier design .....	p 24 May 31
Microelectronic Loran-C will fly next year .....	p 22 Jun 28
Microelectronics around the world .....	p 37 Aug 2
Modules incorporate integrated circuits .....	p 78 May 24
New circuit board planned for Apollo .....	p 84 Jun 21
New device simplifies power supply design .....	p 39 May 17
New field effect device may aid integrated circuit design .....	p 44 Nov 29
Optical soldering promotes automated packaging .....	p 90 Mar 22
Parasitic in integrated circuits: more trouble than meets the eye .....	p 32 Jul 5
Trends in logic circuit design .....	p 38 Dec 6
WESCON: technical highlights .....	p 49 Aug 9
When will integrated circuits go civilian? Good guess: 1965 .....	p 22 May 10

## INTERFERENCE

Can RFI control prevent weapons failures? .....	p 43 Nov 8
Couplers kill reflected RFI .....	p 75 Nov 8
Crosstalk: What price RFI control? .....	p 3 Jun 14
Designing radar receivers to overcome jamming .....	p 50 May 17
The high fences at White Sands .....	p 64 Oct 18
RFI - causes, effects, cures .....	p 37 Jun 21
Comment .....	p 4 Aug 30
RFI: In microcircuits it's different .....	p 28 Jun 14
Radio-interference control .....	p 56 Apr 26
Comment .....	p 4 Jun 7
Radio receiver detects faulty parts or joints .....	p 86 Oct 18

## INVERTERS

Power and control circuits .....	p 51 Dec 6
----------------------------------	------------

## J

**JAMMING** See Countermeasures

## K

## KLYSTRONS

Low-noise c-w klystron oscillators meet doppler radar requirements .....	p 85 Dec 6
Phase-locked klystrons simulate doppler radar .....	p 44 Apr 19



Secondary emission makes klystron tubes self quenching .....	p 40 Oct 18
UHF transmitter operates by remote control .....	p 61 Aug 2

## L

<b>LAMPS</b>	
Diode lamp makes tape readers faster .....	p 44 May 17
Comment .....	p 4 Jul 26
Will neon photoconductors replace relays in low-speed logic .....	p 46 May 10

<b>LASERS</b>	
Aerospace Conference: Air Force outlines latest R & D plans .....	p 16 May 24
Chelate lasers are coming on strong .....	p 32 Apr 26
Danger - reflected laser beams .....	p 7 Aug 9
Designing lasers with pump-power charts .....	p 23 Dec 27
Diode lasers at 5.2 microns .....	p 19 Nov 1
Electrochemical Society Symposium: Bright future seen for organics .....	p 51 Oct 11
Electron Beam Symposium: Microwelding - lasers or electron beam? .....	p 23 Jul 5
First color photos show active region in visible-light diode laser .....	p 35 Mar 1
Future keyed to materials properties .....	p 66 Sep 6
GaAs laser transmits wideband data .....	p 24 Oct 18
Gas laser applied to inspecting large optics .....	p 38 Aug 16
Gas laser for optical radar .....	p 59 Sep 20
Gatling-gun laser - novel approach to optical radar .....	p 25 Sep 20
Giant ruby laser produces harmonics .....	p 60 May 10
Helium-neon laser averages 1-w output .....	p 19 Sep 20
How rare earth chelate lasers work .....	p 67 Nov 15
IEEE Solid State Conference: New laser structure drives output past 1 w .....	p 24 Jun 21
Injection laser systems for communications tracking .....	p 35 Dec 13
Injection lasers .....	p 61 Dec 6
Kerr-effect readout uses gas laser .....	p 48 Apr 5
Laser beam carries TV video and audio .....	p 28 Feb 22
Laser may accelerate computer .....	p 39 Oct 4
Laser may find new role in navigation .....	p 7 Feb 8
Comment .....	p 4 Apr 19
Laser meetings double up .....	p 22 Apr 12
Laser pulses track targets .....	p 64 Oct 18
Laser used to confirm physical standards .....	p 74 Mar 22
Laser welds copper leads .....	p 88 Oct 25
Lasers fill medical needs .....	p 30 Apr 19
Lasers last week: more colors, more power .....	p 7 Aug 23
MIT laser detects meteoric fragments .....	p 78 Oct 25
Measuring laser output with rat's nest calorimeter .....	p 36 Feb 1
The medical laser: new tool for cancer research .....	p 15 Aug 16
NASA studies earth-space-earth laser links .....	p 22 May 10
NEC: Electronics in the Midwest .....	p 31 Oct 25
NEREM: Research in New England .....	p 23 Nov 1
Neodymium-glass amplifier for lasers .....	p 42 Dec 13
Nonlinear effects convert laser beam, amplify light .....	p 30 May 3
Now lasers are industrial tools .....	p 16 Mar 29
One GaAs laser is quenched by another .....	p 57 Jul 26
The optical heterodyne - key to advanced space signaling .....	p 29 Jul 12
Pulse power supply design for laser pumping .....	p 33 Dec 20
Quantum Electronics' Symposium: what's new in lasers? .....	p 14 Mar 1
Raman scattering explains liquid lasers .....	p 74 Feb 15
Russia tries gamma-ray laser .....	p 11 Oct 4
Comment .....	p 6 Nov 22
Servo controls helium-neon gas laser output .....	p 58 Mar 8
Silicon-carbide laser emits blue light .....	p 17 Sep 6
Society of Photographic Instrumentation Engineers symposium: From flash guns to lasers .....	p 16 Aug 16
Solid-State Conference: solid progress in solid-state seen at Philadelphia .....	p 12 Mar 1
Symposium: field modulates laser .....	p 26 Apr 26
Comment .....	p 4 Jun 28
Thermoplastic video tape ready soon .....	p 54 Jul 26
Try for triode lasers .....	p 32 May 24
Undersea coherent light .....	p 30 Feb 22
The versatile point-contact diode - how it detects and amplifies laser light .....	p 82 Jan 4
Comment .....	p 4 Mar 8
WESCON: technical highlights .....	p 49 Aug 9
Will lasers protect our cities against ICBM's? .....	p 20 May 3
Will lasers weld circuit components? .....	p 54 Jul 12

<b>LIGHT AMPLIFIERS</b>	
Breakthrough in light amplifiers - el-pc image intensifier uses control-grid .....	p 30 Sep 20
Solid panel amplifies images .....	p 20 May 24

<b>LOGIC CIRCUITS</b>	
Advances in microminiaturization .....	p 45 Feb 15
Choosing logic for microelectronics .....	p 23 Oct 4
Circuit trends in nanosecond switching .....	p 35 Sep 20

Components that learn and how to use them .....	p 49 Mar 22
Computers in the front lines: micromodules make it possible .....	p 77 Jan 4
Designing data registers with simple diode circuits .....	p 48 Feb 22
Designing digital equipment with semiconductor networks .....	p 35 Jan 18
High speed integrated circuits with load-compensated diode-transistor logic .....	p 68 Mar 15
High-speed production checking of logic wiring .....	p 56 Mar 29
How to achieve majority and threshold logic with semiconductor networks .....	p 23 Nov 29
A key to nanosecond switching combining tunnel and charge-storage diodes .....	p 42 Oct 18
Latest antisubmarine aid: magnetic contour display system .....	p 58 Aug 9
Logic principles for multi-emitter transistors .....	p 25 Sep 13
One-stage scaler needs no complex feedback .....	p 32 Sep 27
Put more snap in logic circuits with field-effect transistors .....	p 43 Jun 14
Saving microcircuit power with tunnel-diode coupling .....	p 30 Aug 23
Sb system goal is 20-year life .....	p 75 Oct 25
Thin magnetic films create logic circuits .....	p 62 Feb 22
Transistor-transistor logic circuits .....	p 54 Mar 22
Trends in logic circuit design .....	p 38 Dec 6
Tunnel diodes Pt IV: Logic and switching circuits .....	p 26 Jul 5
Tunnel diodes boot TRL speed .....	p 50 May 10
Tunnel resistor - new device to speed up tunnel diodes .....	p 42 Jul 12
Using the latest semiconductor circuits in a UHF digital converter .....	p 37 Aug 30
Will neon photoconductors replace relays in low-speed logic? .....	p 46 May 10

<b>LOUDSPEAKERS</b>	
Consumer electronics Pt I: Entertainment .....	p 49 May 3
Comment .....	p 4 Jul 5
Electronics color codes .....	p 37 Nov 15

## M

<b>MACHINE TRANSLATION</b>	
Computer translates Chinese into English .....	p 56 Jun 7

<b>MAGNETIC RECORDING</b>	
Developing radiation-proof space equipment .....	p 70 Aug 9
Fiber optics, servo built into tape handler .....	p 66 Feb 22
Magnetic strip keeps tape running true .....	p 42 Jan 11
Now a talking computer answers inventory inquiries .....	p 30 Aug 16
Telcan - 2 U.S. firms compete for rights .....	p 7 Aug 16

<b>MAGNETICS</b>	
(See also Ferrite Devices; Superconductivity)	
Components that learn and how to use them .....	p 49 Mar 22
Continuous readout of magnetic cores .....	p 38 Sep 6
Foils get thinner, more versatile .....	p 60 Jul 26
French find 7 lucky number .....	p 28 Aug 2
Generator for one-millimeter waves - Tornatron .....	p 21 Aug 16
INTERMAG: Packing a half-million bits in a cubic inch .....	p 58 Apr 19
Latest antisubmarine aid: magnetic contour display system .....	p 58 Aug 9
Magnetic field rotates ultrasonic waves .....	p 64 Jan 25
Multi-quantum conversion shown .....	p 50 Sep 20
National Magnet Lab pushes for 250 kgauss .....	p 56 May 17
Neglected precision circuits: magnetically coupled multivibrators .....	p 42 Mar 29
Nonlinear effects convert laser beam, amplify light .....	p 30 May 3
Semipermanent memory: latest use for twistors .....	p 80 Mar 15
Sparks shape Alnico magnets .....	p 60 Sep 13
Superconducting magnets head for 100,000 gauss .....	p 18 Mar 1
Thick-film memory has high output .....	p 40 Nov 1
Thin magnetic films create logic circuits .....	p 62 Feb 22
TWT uses new focusing concept .....	p 80 Jun 28
Watch magnets find new uses .....	p 82 Oct 25
What you must know to use ferrites at low frequencies .....	p 38 Mar 1

<b>MAGNETOHYDRODYNAMICS</b>	
MHD Conference: plasma accelerator work shows promise .....	p 38 Apr 26

<b>MAGNETOSTRICTION</b>	
Components that learn and how to use them .....	p 49 Mar 22
What you must know to use ferrites at low frequencies .....	p 38 Mar 1

<b>MAGNETRONS</b>	
Sparks shape Alnico magnets .....	p 60 Sep 13

## MAINTENANCE See Servicing

<b>MARINE ELECTRONICS</b>	
How Navy flies ASW boats .....	p 14 Jul 5
Latest antisubmarine aid: magnetic contour display system .....	p 58 Aug 9
Navy's new ship program calls for more electronics .....	p 10 Oct 4
Sea drone snares capsules .....	p 18 Aug 16

## MARKETING See Business

<b>MASERS</b>	
Field-operational S-band maser .....	p 48 Mar 29
High-frequency optical phonon masing reported .....	p 102 Jan 4
Ultrasonics state-of-the-art report .....	p 33 Oct 18

<b>MATCHING</b>	
Circuit with a twist: the cascode follower .....	p 69 Dec 6
How to get maximum input impedance with field-effect transistors .....	p 44 Mar 8
Multicoupler puts five transmitters on one antenna .....	p 33 Dec 13
Operating X-band tunnel diodes at Q-band .....	p 32 Dec 27
Versatile R-F monitor shows power and VSWR .....	p 44 Mar 29

<b>MATERIALS</b>	
How rare earth chelate lasers work .....	p 67 Nov 15
Materials for space-age electronics .....	p 37 Oct 25

<b>MEASUREMENTS</b>	
Automatic computer identifies color .....	p 44 Sep 27
Automatic system probes B-70 stresses .....	p 44 Jul 5
Binary frequency sensing measures a single pulse .....	p 42 Apr 5
Designing lasers with pump-power charts .....	p 23 Dec 27
Digital correlator detects voice fundamental .....	p 28 Nov 22
Dynamic null - new method for measuring equipment performance .....	p 78 Mar 15
Comment .....	p 4 May 3
Easy-to-use chart for VSWR .....	p 38 Nov 22
Easy ways to make microwave phase measurements .....	p 50 Mar 8
Electromechanical timer for lab application .....	p 78 Feb 15
Fresh approach to measuring transistor beta .....	p 47 Jul 26
Getting subnanosecond precision in coax cable delay measurements .....	p 39 Feb 1
How to measure field patterns with photosensitive probes .....	p 39 Jan 25
Hybrid voltmeter avoids aging errors .....	p 41 Sep 20
IEEE: Instruments extend operating ranges, are easier to work .....	p 33 Mar 15
Inductive telemetry improves spin-system measurements .....	p 41 Nov 15
Laser used to confirm physical standards .....	p 74 Mar 22
Latest field-mapping improvement - lead-less transceiver probe works underwater .....	p 56 Jul 19
Low-cost circuit measures frequency translation .....	p 51 Nov 8
Measuring laser output with rat's nest calorimeter .....	p 36 Feb 1
Measuring missile antenna impedance in flight .....	p 36 Jul 12
Microwave radiation probes shock plasma .....	p 56 Jan 18
New microwave power meter .....	p 48 Mar 29
Novel test techniques measure Q in cryogenic resonant circuits .....	p 43 Feb 22
Phosphors trace heat flow patterns .....	p 40 Aug 23
Practical way to measure transistor thermal resistance .....	p 66 Feb 15
Comment .....	p 4 Jun 14
Quick way to find beta (h- $\beta$ ), alpha (h- $\beta$ ), and (h- $\beta$ ) .....	p 64 Aug 9
RFI - causes, effects, cures .....	p 37 Jun 21
Comment .....	p 4 Aug 30
Racing the solar eclipse .....	p 37 Jul 26
Rapid method measures diode characteristics .....	p 50 Jun 14
Reactor monitor .....	p 30 Dec 6
Reducing winter skids with a transistor warning circuit .....	p 56 Jan 25
Russian metrology - it looks as good as ours .....	p 27 Jul 26
Simple circuits measure FET parameters .....	p 34 Aug 23
Slow sampling saves time .....	p 40 Nov 29
Standardizing noise-figure measurement .....	p 124 Jan 4
Sweep measurements - making the tough ones easy .....	p 52 Apr 19
Symposium: What happens to dielectrics in space? .....	p 68 Jul 19
Thin films: automatic deposition control .....	p 33 Mar 29
Tunnel diode detects currents down to 100 femtoamperes .....	p 33 Apr 5
Comment .....	p 4 Apr 26
Unique bridge measures antenna operating impedance .....	p 51 Feb 22
Unique frequency comparator has sense of direction .....	p 36 Mar 1
Unusual waveform analyzer aids automatic testing .....	p 56 Apr 12
VHF counter measures time intervals precisely .....	p 27 Aug 23
Versatile R-F monitor shows power and VSWR .....	p 44 Mar 29



Voltage monitor needs only two saturable cores ..... p 50 Jun 7

**MEDICAL ELECTRONICS**

Biotelemetry: prime space need ..... p 20 Feb 22  
Can synthetic sleep save time? ..... p 20 May 24  
Computer analyzes x-rays ..... p 38 Nov 1  
Computer diagnoses heart disease ..... p 80 Dec 6  
Computers pace progress in medical humanetics ..... p 10 Oct 11  
Designing a simple telemeter for medical research ..... p 47 Jan 25  
Implanted radio aids paraplegics ..... p 17 Nov 1  
Lasers fill medical needs ..... p 30 Apr 19  
The medical laser: new tool for cancer research ..... p 15 Aug 16  
Muscle voltage moves artificial hand ..... p 34 Oct 11  
New transducers at biomedical meeting ..... p 60 May 10  
Portable electronic muscle exerciser nears production ..... p 16 Jul 12  
Servo tracks pill in human body ..... p 58 Mar 22

**MEMORIES**

Components that learn and how to use them ..... p 49 Mar 22  
FJCC: What's new in computer memories ..... p 35 Nov 8  
How to quiz a whole memory at once ..... p 43 Nov 15  
IEEE: Conductive memory points to new displays ..... p 10 Nov 8  
INTERMAG: Packing a half-million bits in a cubic inch ..... p 38 Apr 19  
Kerr-effect readout uses gas laser ..... p 48 Apr 5  
Metal sheets memory operates independent of temperature ..... p 16 Jul 12  
New device lowers memory element cost ..... p 25 Jul 12  
New digital conversion method provides nanosecond resolution ..... p 55 May 3  
Plated holes simplify memory design ..... p 34 Nov 1  
Semipermanent memory: latest use for twisters ..... p 80 Mar 15  
Thick-film memory has high output ..... p 40 Nov 1  
Thin-film memory might cost 0.3 cent per bit ..... p 44 Nov 22  
Thin magnetic films create logic circuits ..... p 62 Feb 22  
Tunnel diodes Pt IV: Logic and switching circuits ..... p 26 Jul 5  
TVIST: new look in photoelectric storage tubes ..... p 74 Jun 21  
Waffle iron shape boosts memory ..... p 50 Mar 1  
Will solid state nip relay markets? ..... p 66 May 10

**METEOROLOGY**

More target data with sideband coherent radar ..... p 40 Jan 18  
Comment ..... p 4 Mar 29  
Need weather data? Buy a satellite ground station ..... p 20 Jul 26  
New approach to weather data: every plane a station ..... p 38 Jul 12  
Special computer integrates rainfall ..... p 70 May 24  
WESCON: Technical highlights ..... p 49 Aug 9

**MICROELECTRONICS**

(See also Integrated Circuits)  
Advances in microminiaturization ..... p 45 Feb 15  
British Show: Microcircuits are busting out in Britain ..... p 60 Jun 7  
Ceramic substrate improves microcircuit reliability ..... p 51 Nov 22  
Choosing logic for microelectronics ..... p 23 Oct 4  
Circuit trends in nanosecond switching ..... p 35 Sep 20  
Computers in the front lines: micromodules make it possible ..... p 77 Jan 4  
Crosstalk: Microelectronics abroad ..... p 3 Aug 2  
Designing digital equipment with semiconductor networks ..... p 35 Jan 18  
Folios get thinner, more versatile ..... p 60 Jul 26  
IEEE: Microcircuits graduate into hardware products ..... p 38 Mar 15  
IEEE topics ..... p 132 Mar 15  
The impact of microelectronics ..... p 51 Jun 28  
Inductors no problem: new thin-film amplifier ..... p 46 Jun 7  
Microcomputer comes off the line ..... p 14 Nov 1  
Microelectronics around the world ..... p 37 Aug 2  
Micropower circuits - new frontier in solid state ..... p 47 Jul 19  
Module production quality assured by thermal cycling and life testing ..... p 92 Jul 19  
Modules incorporate integrated circuits ..... p 78 May 24  
NEC: Electronics in the Midwest ..... p 31 Oct 25  
Navy pushes microcircuits Reason: technician shortage ..... p 34 Jun 28  
Navy report defines microcircuit functions ..... p 63 Aug 2  
Optical coupling: new approach to microcircuit interconnections ..... p 23 Nov 22  
Optical soldering promotes automated packaging ..... p 90 Mar 22  
RFI: In microcircuits it's different ..... p 28 Jun 14  
Self-setting parallel-gap welder for microcircuits ..... p 91 Dec 6  
Solid-state ion implants forge tailor-made junctions ..... p 26 Apr 19  
System packaging uses book configuration ..... p 56 Apr 5  
Transfer process avoids P-C open circuits ..... p 68 Jan 18  
Using microcircuits in high-resolution range counters ..... p 31 Nov 22

Using microcircuits in micromodules ..... p 86 Jul 19  
Vacuum Symposium: Modulated beams build microcircuits ..... p 26 Oct 25  
WESCON: Micro-packaging for microelectronics ..... p 88 Aug 9

**MICROMODULES See Microelectronics**

**MICROPHONES**

AES: Foil stabilizes electret mike ..... p 68 Oct 25  
Bugs and antibugs: new designs for hidden ears ..... p 10 Oct 25  
Electronics color codes ..... p 37 Nov 15  
Wireless mikes get F-M band ..... p 26 Jun 28

**MICROPOWER TECHNIQUES**

Micropower circuits - new frontier in solid state ..... p 47 Jul 19  
Micropower devices are going to nanopower level ..... p 38 Jun 28  
Micropower goes international ..... p 46 Jul 5

**MICROWAVES**

(See also Millimeter Waves)  
Avalanching transistor generates microwaves ..... p 35 Oct 25  
ESP: is biological radio communication possible? ..... p 14 Mar 29  
Comment ..... p 4 May 10  
How to design solid-state microwave generators ..... p 23 Oct 11  
Microwave tubes get cheaper, less noisy ..... p 52 Dec 13  
New microwave power meter ..... p 48 Mar 29  
Waveguide telemeters space-chamber data ..... p 74 Jun 28  
Window materials for high-power microwave tubes ..... p 40 May 31

**MILITARY ELECTRONICS**

Air Force plans net to survive nuclear attack ..... p 28 Mar 22  
Air Force research aim: detection capabilities ..... p 72 Apr 26  
Air/ground teams seek new systems ..... p 15 Aug 23  
Army demands new electronics techniques ..... p 20 Jul 12  
Army of the air creates new market ..... p 32 Apr 12  
Army wants surveillance, armament gear for air arm ..... p 10 Nov 29  
Atomic test ban - what does it mean to our industry? ..... p 18 Aug 2  
Crosstalk: Believe it or not ..... p 3 Mar 29  
Disarmament - what chance? what impact? ..... p 56 Sep 6  
Electronics industry nudges fourth place nationally ..... p 18 Jul 5  
Electronics market 1963 ..... p 43 Jan 4  
Military electronics will level off in fiscal 1964 ..... p 18 Jan 25  
Military radio swinging to sb ..... p 29 Apr 5  
National Military Command system moves forward ..... p 20 Apr 26  
Side-looking radar makes maps in flight ..... p 22 Mar 22  
Spacecom: \$100-million-a-year market ..... p 22 Apr 19  
Stand by for those Navy RDT&E contracts: \$1 1/2 billion ..... p 10 Sep 13  
VE now the rule ..... p 46 Sep 13

**MILLIMETER WAVES**

Generator for one-millimeter waves - Tornadotron ..... p 21 Aug 16  
High power at millimeters - plasma harmonics the key ..... p 16 Aug 30  
IRE Millimeter Conference: try developing MM components ..... p 24 Jan 18  
Microwave radiation probes shock plasma ..... p 56 Jan 18  
Microwave tubes get cheaper, less noisy ..... p 52 Dec 13  
Multi-quantum conversion shown ..... p 50 Sep 20  
Near-field plotter: design tool for millimeter-wave antennas ..... p 29 Dec 27  
New millimeter components and techniques ..... p 33 Jan 11  
New millimeter wave device - beam-plasma amplifier ..... p 40 Nov 8

**MINIATURIZATION**

(See also Microelectronics)  
Miniature components aimed for mass markets ..... p 64 Apr 19

**MISSILES See Guided Missiles**

**MIXERS See Converters**

**MODULATORS**

Delta modulator codes television waveguide link ..... p 50 Aug 2  
NEREM: Research in New England ..... p 23 Nov 1  
New modulation technique simplifies circuits ..... p 52 Jan 25  
The PIN diode: versatile microwave component ..... p 40 Mar 8  
Pulse-width modulator offers precision performance ..... p 29 Oct 11  
Pulses promise simpler audio ..... p 16 Aug 16  
Simple transistor modulators improve sideband communications ..... p 54 Mar 8  
Solid crystal modulates light beams ..... p 58 Dec 20  
Symposium: field modulates laser ..... p 26 Apr 26  
Comment ..... p 4 Jun 28  
Three new approaches to pulse modulation ..... p 62 May 3  
Two-state modulation simplifies audio circuits ..... p 36 Aug 23

Unijunction transistor simplifies voltage-frequency converter ..... p 56 Oct 25

**MOTOR CONTROL**

Electronics color codes ..... p 37 Nov 15  
Transistors control trains ..... p 10 Sep 27  
Will r-f control artificial hearts? ..... p 86 Jun 21

**MULTIVIBRATORS**

Basic rules for designing reliability into semiconductor circuits ..... p 62 Apr 12  
Crystal-controlled multivibrator has better stability ..... p 60 Apr 12  
Comment ..... p 4 May 17  
Designing NRE monostable multivibrators ..... p 34 Sep 13  
Developing radiation-proof space equipment ..... p 70 Aug 9  
Latest multivibrator improvement - linear voltage-to-frequency converter ..... p 64 Apr 26  
Neglected precision circuits: magnetically coupled multivibrators ..... p 42 Mar 29  
Simple counter tester uses cascaded one-shots ..... p 40 Apr 5  
Using a new component: the NRE as a free-running multivibrator ..... p 50 Jul 26  
Vacuum deposited circuits use field effect ..... p 80 Apr 12

**N**

**NAVIGATION SYSTEMS**

Doppler sonar plots ship's course ..... p 14 Nov 22  
Navy's new ship program calls for more electronics ..... p 10 Oct 4

**NEGATIVE RESISTANCE**

Designing NRE monostable multivibrators ..... p 34 Sep 13  
How to make tunnel diodes even more useful ..... p 52 Jun 7  
The negative resistance element (NRE): a new circuit component ..... p 21 May 31  
Design of D-C switches with negative resistance elements ..... p 32 Jul 12  
Using a new component: the NRE as a free-running multivibrator ..... p 50 Jul 26  
Comments p 4 Jul 5, p 4 Jul 12, ..... p 4 Jul 19  
Raising tank-circuit Q with the NRE ..... p 30 Oct 4  
Secondary emission makes klystron tubes self quenching ..... p 40 Oct 18

**NEON DEVICES**

Consumer electronics Pt II: Home and auto controls ..... p 52 May 10  
Will neon photoconductors replace relays in low-speed logic ..... p 46 May 10

**NETWORKS**

Experimental neuristor gives nerve-like pulse propagation ..... p 25 Mar 1  
F-m discriminator without tuned circuits ..... p 36 Nov 29  
IEEE: ultra-intelligent machines by year 2000 ..... p 46 Mar 1  
Multicoupler puts five transmitters on one antenna ..... p 33 Dec 13  
Now you can use nonreciprocal devices at low frequencies ..... p 56 Feb 22

**NEURISTORS**

Aerospace Conference: Air Force outlines latest R & D plans ..... p 16 May 24  
Experimental neuristor gives nerve-like pulse propagation ..... p 25 Mar 1  
Optical computers approach reality ..... p 72 May 3

**NOISE**

Cut-out slide rule simplifies noise calculations ..... p 64 Feb 8  
Designing input circuits with lowest possible noise ..... p 46 Aug 2  
Fail-safe squelch circuit adapts to changing noise levels ..... p 88 Jan 4  
How to choose transistors for low noise ..... p 50 Jan 11  
Low-noise preamplifier uses field-effect transistors ..... p 67 Apr 12  
Comment ..... p 4 Jun 21  
RFI - causes, effects, cures ..... p 37 Jun 21  
Comment ..... p 4 Aug 30  
Rapid evaluation of complex receiving systems ..... p 44 Feb 1  
Standardizing noise-figure measurement ..... p 124 Jan 4

**NOMOGRAPHS**

Cut-out slide rule simplifies noise calculations ..... p 64 Feb 8  
Communications range nomograph ..... p 41 Dec 20  
Nomograph speeds amplifier design ..... p 38 Jul 5  
Quick way to find beta (h-FE), alpha (h-FB), and (h-FC) ..... p 64 Aug 9  
Rapid evaluation of complex receiving systems ..... p 44 Feb 1  
Recent tests show tropo scatter better than believed ..... p 42 Mar 1



**NUCLEONICS**

Atomic test ban - what does it mean to our industry? .....	p 18 Aug 2
Black box blast detection - hope or hoax? .....	p 26 Jan 4
Blast signatures - key to test ban treaty .....	p 24 Feb 22
How radio can plot high-altitude nuclear blasts .....	p 28 Jan 11
New underwater gamma spectrometer .....	p 56 Mar 8
Nuclear blast effects on communications .....	p 74 Feb 8
Nuclear instruments near picosecond working speed .....	p 43 Dec 13
Probes can take nuclear blasts .....	p 78 Aug 9
Radioactive source generates probabilities .....	p 54 Sep 13
Reactor monitor .....	p 30 Dec 6
Taking human error out of nuclear experiments .....	p 46 Jun 14
Test-ban monitors set for launch .....	p 57 Oct 18

**O**

Editorial Staff:

**OCEANOGRAPHY** See Underwater Electronics**OPTICS**

Diode lamp makes tape readers faster .....	p 44 May 17
Comment .....	p 4 Jul 26
Fiber optics, servo built into tape handler .....	p 66 Feb 22
Gas laser for optical radar .....	p 59 Sep 20
Gatling-gun laser - novel approach to optical radar .....	p 25 Sep 20
High-frequency optical phonon masing reported .....	p 102 Jan 4
How ceramic benders control light rays .....	p 80 Jul 19
Comment .....	p 6 Sep 20
IEEE Solid State Conference: Look at what optical semiconductors do now .....	p 32 Jun 28
Laser pulses track targets .....	p 64 Oct 18
Light beam controls potentiometers .....	p 76 Jun 28
Light isolates amplifier stages .....	p 43 Nov 1
Modulated infrared diode spans 30 miles .....	p 38 Apr 5
New infrared system tracks missiles against bright Florida sky .....	p 39 Apr 19
New material improves polarization of light .....	p 17 Sep 20
Optical computers approach reality .....	p 72 May 3
Optical coupling: key to design freedom .....	p 82 Mar 22
Optical coupling: new approach to micro-circuit interconnections .....	p 23 Nov 22
The optical heterodyne - key to advanced space signaling .....	p 29 Jul 12
Optical radar for space rendezvous .....	p 44 Oct 4
Optical soldering promotes automated packaging .....	p 90 Mar 22
Raman scattering explains liquid lasers .....	p 74 Feb 15
WESCON: technical highlights .....	p 49 Aug 9

**ORGANIZATIONS**

IEEE: The lone nominee - his views .....	p 38 Aug 9
--	------------

**OSCILLATORS**

(See also Lasers; Signal Generators)	
Advanced Clapp oscillator features 3-to-1 dynamic range .....	p 60 Feb 22
Avalanching transistor generates microwaves .....	p 35 Oct 25
Blocking oscillator has variable width output .....	p 156 Mar 15
Chemicals affect oscillator output .....	p 46 Dec 13
Designing a simple telemeter for medical research .....	p 47 Jan 25
Frequency control lags ssb: Symposium .....	p 16 Jun 7
Generator for one-millimeter waves - Tornatron .....	p 21 Aug 16
How to design solid-state microwave generators .....	p 23 Oct 11
Integrated-circuit oscillator requires few components .....	p 40 Dec 13
Low-noise c-w klystron oscillators meet doppler radar requirements .....	p 85 Dec 6
More target data with sideband coherent radar .....	p 40 Jan 18
Comment .....	p 4 Mar 29
Multitone oscillators - new source of simultaneous frequencies .....	p 86 Jan 4
Neglected precision circuits: magnetically coupled multivibrators .....	p 42 Mar 29
New millimeter components and techniques .....	p 33 Jan 11
New phase-tracking demodulator will not lock on sidebands .....	p 52 Feb 8
Novel bwo doesn't use magnet .....	p 47 Sep 27
Novel feedback loop stabilizes audio oscillator .....	p 42 Feb 1
Operating X-band tunnel diodes at Q-band .....	p 32 Dec 27
R-F oscillator has improved stability .....	p 62 Aug 9
Raising tank-circuit Q with the NRE .....	p 30 Oct 4
Resonant-cavity tuning now made easy .....	p 46 Jan 18
Secondary emission makes klystron tubes self quenching .....	p 40 Oct 18
Thin films: automatic deposition control .....	p 33 Mar 29
Tunnel diodes Pt I: Using them as sinusoidal generators .....	p 36 Jun 14
Tunnel diodes Pt III: Mixer and converter circuits .....	p 60 Jun 28
Comment .....	p 4 Aug 2

Two-phase oscillator covers 0.1 to 1,000-cps ...	p 27 Oct 4
Using varactors to extend frequency-control range .....	p 48 Nov 8

**OSCILLOSCOPES**

Circuit converts one-trace scopes to raster display .....	p 33 Nov 29
Dynamic null - new method for measuring equipment performance .....	p 78 Mar 15
Comment .....	p 4 May 3

**P****PACKAGING**

Flip chips easier to connect .....	p 82 Oct 18
Kitting cuts assembly errors .....	p 46 Aug 30
New package for microtransistor .....	p 75 Nov 8

**PARAMETRIC AMPLIFIERS**

NEREM: Research in New England .....	p 23 Nov 1
5-band param approaches noise-figure minimum .....	p 57 Jun 28
Subaudio parametric amplifier for ocean-bottom seismometer .....	p 28 Mar 1
The versatile point-contact diode - how it detects and amplifies laser light .....	p 82 Jan 4
Comment .....	p 4 Mar 8

**PARASITICS**

Parasitics in integrated circuits: more trouble than meets the eye .....	p 32 Jul 5
--	------------

**PARTICLES**

Brookhaven Laboratory finds new anti-particle ..	p 39 Aug 23
Multi-quantum conversion shown .....	p 50 Sep 20

**PATENTS**

Big printed-circuit fight: Technograph loses round 1 .....	p 24 Jun 7
--	------------

**PHASE MEASUREMENT**

Conical scan array uses variable phase shifters ..	p 30 Nov 29
Easy ways to make microwave phase measurements .....	p 50 Mar 8

**PHOTOELECTRIC DEVICES**

Aiming a 3-ton telescope hanging from a balloon .....	p 47 Feb 8
Are hot cathodes on the way out? .....	p 39 Jun 7
Breakthrough in light amplifiers - el-pc image intensifier uses control-grid .....	p 30 Sep 20
Diode lamp makes tape readers faster .....	p 44 May 17
Comment .....	p 4 Jul 26
Diode receives optical signals .....	p 17 Sep 13
Family tree of semiconductors .....	p 45 Apr 26
GaAs laser transmits wideband data .....	p 24 Oct 18
High-speed servo positioner bonds mesa transistors .....	p 58 Feb 8
How to measure field patterns with photosensitive probes .....	p 39 Jan 25
Light beam controls potentiometers .....	p 76 Jun 28
Light isolates amplifier stages .....	p 43 Nov 1
New approach to weather data: every plane a station .....	p 38 Jul 12
New underwater gamma spectrometer .....	p 56 Mar 8
Radioisotope measures after-effects of solar events .....	p 47 Apr 19
Thin-film photocells get brighter faster .....	p 99 Sep 6
TVIST: new look in photoelectric storage tubes ..	p 74 Jun 21
The versatile point-contact diode - how it detects and amplifies laser light .....	p 82 Jan 4
Comment .....	p 4 Mar 8
Will new photoconductors replace relays in low-speed logic? .....	p 46 May 10

**PHOTOGRAPHY**

Breakthrough in light amplifiers - el-pc image intensifier uses control-grid .....	p 30 Sep 20
CRT recording has wide bandwidth .....	p 60 Nov 15
Consumer electronics Pt III: Appliances and housewares .....	p 46 May 17
Data on polaroid prints .....	p 47 Aug 30
Phosphors trace heat flow patterns .....	p 40 Aug 23
Society of Photographic Instrumentation Engineers symposium: From flash guns to lasers .....	p 16 Aug 16
Solid-state components shrink photoflash control .....	p 70 Apr 12

**PLASMA TECHNIQUES**

Are hot cathodes on the way out? .....	p 39 Jun 7
Electron Beam Symposium: Microwelding - laser or electron beam? .....	p 23 Jul 5
High power at millimeters - plasma harmonics the key .....	p 16 Aug 30
Homogeneous semiconductors - a new generation of devices .....	p 65 Jun 21
MHD Conference: Plasma accelerator work shows promise .....	p 38 Apr 26

Microwave radiation probes shock plasma .....	p 56 Jan 18
New millimeter wave device - beam-plasma amplifier .....	p 40 Nov 8
Plasma metal junction generates 29th harmonic .....	p 8 Jun 28
Sparking thin films drive plasma engine .....	p 40 Jun 28

**POTENTIOMETERS**

Experts evaluate nonwirewound pots .....	p 44 Aug 30
Light beam controls potentiometers .....	p 76 Jun 28

**POWER SUPPLIES**

Accurate gyro balancing .....	p 81 Oct 25
Arc-protection circuits .....	p 54 Feb 22
Battery for space finds consumer uses .....	p 49 Oct 4
Capacitance chargers for space employ controlled rectifiers .....	p 32 Oct 11
Comment .....	p 6 Nov 1
Computers in the front lines: micromodules make it possible .....	p 77 Jan 4
Frequency septupler provides stable 420-cps voltage .....	p 58 May 3
Inside the orbiting geophysical observatory .....	p 61 Feb 15
New device simplifies power supply design .....	p 39 May 17
New way to saturable reactors: stabilizing high-power rectifiers .....	p 62 May 24
Overload protection without high power dissipation .....	p 36 Mar 29
Power and control circuits .....	p 51 Dec 6
Pulse power supply design for laser pumping .....	p 33 Dec 20
Silicon rectifier controls power in either direction .....	p 63 Dec 20
Supplying low-impedance power for tunnel diodes .....	p 60 Jan 18
Thermoplastic video tape ready soon .....	p 54 Jul 26

**PRINTED WIRING**

Better techniques toughen connections on P-C boards .....	p 70 May 10
Big printed-circuit fight: Technograph loses round 1 .....	p 24 Jun 7
Deplating process makes circuit boards .....	p 92 Jun 21
Dips and waves improve soldering .....	p 48 Jul 5
Electronic Packaging Conference: Hot-air machine speeds soldering .....	p 44 May 31
Etched molds form p-c boards .....	p 108 Sep 6
Fabrication aids cut submodule rejection rate .....	p 68 May 17
Iron or machine can solder printed cables .....	p 74 Nov 15
Optical soldering promotes automated packaging .....	p 90 Mar 22
Plated holes simplify memory design .....	p 34 Nov 1
Preformed circuits reduce joining operations ..	p 45 Aug 23
Sintering toughens printed circuits .....	p 60 Jan 11
Transfer process avoids P-C open circuits .....	p 68 Jan 18
Ultrasonic waves clean circuit boards .....	p 86 May 24
Xerography simplifies p-c production .....	p 50 Sep 27

**PRINTERS**

600,000 WPM printer races computer .....	p 26 May 24
--	-------------

**PRODUCTION TECHNIQUES**

Electron beam welding solves relay sealing problems .....	p 90 Jun 28
Electrons work tiny ferrites .....	p 72 Nov 15
Epoxy pellets improve diode production .....	p 64 Jul 26
Fabrication aids cut submodule rejection rate .....	p 68 May 17
High-speed servo positioner bonds mesa transistors .....	p 58 Feb 8
High-speed production checking of logic wiring .....	p 56 May 29
Honeycomb enhances cordwood packaging .....	p 94 Feb 15
IEEE topics .....	p 132 Mar 15
Immersion gold solution used in electroplating .....	p 100 Feb 15
Inside-diameter saws slice semiconductors .....	p 65 Sep 20
Kitting cuts assembly errors .....	p 46 Aug 30
Layout machine scribes on glass .....	p 52 Oct 4
Machine coats films automatically .....	p 86 Apr 26
Machine simplifies bonding process .....	p 60 Feb 1
Multiblade saws cut wafering heat .....	p 58 Oct 11
Multi-frequency transducers improve ultrasonic cleaning .....	p 54 Nov 22
New 40-mm silicon crystals permit larger-capacity devices .....	p 84 Feb 8
Notation language speeds production changes ..	p 92 May 3
Optical soldering promotes automated packaging .....	p 90 Mar 22
PERT aids small runs, too .....	p 66 Dec 20
Prototype parts produced efficiently .....	p 82 Feb 22
Radial-lead film resistor automatically produced .....	p 54 Mar 1
Sparks shape Alnico magnets .....	p 60 Sep 13
Spot-testing aids manufacture of high-reliability relays .....	p 106 Apr 12
Thin-film production performed continuously ..	p 70 Apr 19
Thin films: automatic deposition control .....	p 33 Mar 29
Versatile winder reduces costs .....	p 80 Nov 8
Wetting agent solves photoetching problems ..	p 54 Dec 13
Wires cut crystals accurately .....	p 46 Nov 1



Xerography simplifies p-c production ..... p 50 Sep 27

**PROTECTIVE CIRCUITS**

Five-layer diode guards cables ..... p 84 Jun 21  
New technique protects receivers from high power ..... p 32 Mar 1  
Overload protection without high power dissipation ..... p 36 Mar 29  
Versatile R-F monitor shows power and VSWR ... p 44 Mar 29

**PULSE TECHNIQUES**

(See also Digital Techniques)  
Arc-protection circuits ..... p 54 Feb 22  
Binary frequency sensing measures a single pulse ..... p 42 Apr 5  
Chart gives RLC values for critical damping ... p 34 May 31  
Contest produces novel circuit designs ..... p 96 Mar 15  
Designing a simple telemeter for medical research ..... p 47 Jan 25  
Gated pulses yield selected frequency outputs... p 38 Dec 20  
Gatling-gun laser - novel approach to optical radar ..... p 25 Sep 20  
Getting subnanosecond precision in coax cable delay measurements ..... p 39 Feb 1  
How coded-pulse techniques extend radar range . p 34 Nov 22  
Improving pulse rise time with snap-off diodes ..... p 68 Feb 15  
Comment ..... p 4 Apr 5  
Logarithmic attenuator spans three decades ... p 47 Nov 15  
New underwater gamma spectrometer ..... p 56 Mar 8  
One-stage scaler needs no complex feedback... p 32 Sep 27  
Pulse power supply design for laser pumping ... p 33 Dec 20  
Pulse-width modulator offers precision performance ..... p 29 Oct 11  
Pulses promise simpler audio ..... p 16 Aug 16  
Selecting tubes for wide bandwidth ..... p 53 Oct 25  
Semipermanent memory: latest use for twisters . p 80 Mar 15  
Sequence pulse generator saves transistors ... p 44 Aug 2  
TV dissolve wiper ..... p 40 Sep 6  
Three new approaches to pulse modulation ..... p 62 May 3  
Tunnel resistor - new device to speed up tunnel diodes ..... p 42 Jul 12  
Two-state modulation simplifies audio circuits... p 36 Aug 23  
Unique synchronizing technique increases digital transmission rates ..... p 75 Mar 15

**R**

**RADAR**

Air-sea-sub display plots naval targets ..... p 20 Jun 7  
Army wants surveillance, armament gear for air arm ..... p 10 Nov 29  
Bugs and antbugs: new designs for hidden ears .. p 10 Oct 25  
Consumer electronics Pt II: Home and auto controls ..... p 52 May 10  
Designing radar receivers to overcome jamming ..... p 50 May 17  
Fast agc amplifier locks monopulse radar on target ..... p 34 Sep 27  
Gas laser for optical radar ..... p 59 Sep 20  
Gatling-gun laser - novel approach to optical radar ..... p 25 Sep 20  
The high fences at White Sands ..... p 64 Oct 18  
How coded-pulse techniques extend radar range . p 34 Nov 22  
How computers align phased-array radars ..... p 29 Nov 15  
Long-range spectrometer seeks missile defense clues ..... p 16 May 10  
Low-noise c-w klystron oscillators meet doppler radar requirements ..... p 85 Dec 6  
Marines to get 3-D radar ..... p 24 May 3  
Microwave components ..... p 28 Dec 6  
More target data with sideband coherent radar ..... p 40 Jan 18  
Comment ..... p 4 Mar 29  
Multicomputers to rule English sky ..... p 14 Oct 11  
NASA's newest trackers go to Australia ..... p 54 Nov 8  
Navy readies airborne data system ..... p 43 Sep 20  
New air-traffic system predicts flight paths  
New infrared system tracks missiles against bright Florida sky ..... p 39 Apr 19  
Optical radar for space rendezvous ..... p 44 Oct 4  
Phase-locked klystrons simulate doppler radar ..... p 44 Apr 19  
Presenting radar targets in color ..... p 54 Oct 18  
Pulse radar to guide Gemini ..... p 16 Aug 23  
Radar designs acquiring new versatility ..... p 10 Sep 20  
Shrike will be "big buy" ..... p 26 Jun 14  
Side-looking radar makes maps in flight ..... p 22 Mar 22  
Simulating tactical radar and sonar ..... p 25 Dec 13  
Special computer integrates rainfall ..... p 70 May 24  
Stage is set again for RS-70 debate ..... p 19 Feb 1  
Comment ..... p 4 Mar 1  
Subnanosecond radar shows high resolution ... p 36 May 31

**RADIATION**

Bad medicine for semiconductors ..... p 10 Nov 1

Can RFI control prevent weapons failures? .... p 43 Nov 8  
Developing radiation-proof space equipment .... p 70 Aug 9  
Diodes tolerate high radiation ..... p 48 Nov 29  
Radioactive source generates probabilities ..... p 54 Sep 13  
Radioisotope measures after-effects of solar events ..... p 47 Apr 19  
Surface effects of ionizing radiation ..... p 34 Oct 4  
Symposium: What happens to dielectrics in space? ..... p 68 Jul 19

**RADIO ASTRONOMY**

Arecibo-new era in radio astronomy ..... p 29 Dec 20  
ARECIBO: world's biggest ear ..... p 18 May 17  
Radio astronomy gains frequencies ..... p 17 Sep 27  
Vital band freed for radio astronomy ..... p 18 Nov 8

**RADIOISONDE**

Radioisotope measures after-effects of solar events ..... p 47 Apr 19

**RAILROADS**

RR's seek traffic aids ..... p 26 Oct 18  
Transistors control trains ..... p 10 Sep 27

**RECEIVERS**

Better superhets for sideband reception ..... p 39 May 10  
Comment ..... p 4 Jul 12  
Binary frequency sensing measures a single pulse ..... p 42 Apr 5  
Consumer electronics Pt I: Entertainment ..... p 49 May 3  
Cut-out slide rule simplifies noise calculations ..... p 64 Feb 8  
Designing radar receivers to overcome jamming ..... p 50 May 17  
Fail-safe squelch circuit adapts to changing noise levels ..... p 88 Jan 4  
Fitting a wide-band signal into a narrow-band receiver ..... p 47 Mar 8  
First details on Mercury spacecraft command receiver ..... p 32 Feb 1  
Miniature components aimed for mass markets ..... p 64 Apr 19  
New phase-tracking demodulator will not lock on sidebands ..... p 52 Feb 8  
New technique protects receivers from high power ..... p 32 Mar 1  
Radio-interference control ..... p 56 Apr 26  
Comment ..... p 4 Jun 7  
Radio receiver detects faulty parts or joints ..... p 86 Oct 18  
Rapid evaluation of complex receiving systems . p 44 Feb 1  
Tunnel diodes Pt III: Mixer and converter circuits ..... p 60 Jun 28  
Comment ..... p 4 Aug 2

**RECORDERS**

CRT recording has wide bandwidth ..... p 60 Nov 15  
Developing radiation-proof space equipment ... p 70 Aug 9  
Electronic pen uses ink instead of electron beam ..... p 51 Sep 13  
Fiber optics, servo built into tape handler ... p 66 Feb 22  
Hot mikes will record air crew's conversation ... p 53 Nov 15  
Magnetic strip keeps tape running true ..... p 42 Jan 11  
Predetection recording: Solution to the telemetry dilemma? ..... p 30 Sep 13  
Thermoplastic video tape ready soon ..... p 54 Jul 26

**RECTIFIERS**

Consumer electronics Pt II: Home and auto controls ..... p 52 May 10  
Developing true solid-state static alternators . p 58 May 24  
Electronics color codes ..... p 37 Nov 15  
Epoxy pellets improve diode production ..... p 64 Jul 26  
Family tree of semiconductors ..... p 45 Apr 26  
Immersion gold solution used in electroplating ..... p 100 Feb 15  
More reliability with controlled avalanche rectifiers ..... p 38 Mar 29  
New 40-mm silicon crystals permit larger-capacity devices ..... p 84 Feb 8  
New way to saturable reactors: stabilizing high-power rectifiers ..... p 62 May 24  
Solid-state components shrink photoflash control ..... p 70 Apr 12

**REGULATORS**

How diodes keep current to constant value ..... p 74 Jan 25  
Overload protection without high power dissipation ..... p 36 Mar 29

**RELAYS**

Electron beam welding solves relay sealing problems ..... p 90 Jun 28  
Spot-testing aids manufacture of high-reliability relays ..... p 106 Apr 12  
Will solid state nip relay markets? ..... p 66 May 10

**RELIABILITY**

Basic rules for designing reliability into semiconductor circuits ..... p 62 Apr 12

Can RFI control prevent weapons failures? .... p 43 Nov 8  
Checking connector production ..... p 96 Feb 8  
If a satellite fails - go up and fix it ..... p 12 May 31  
Infrared inspection promises to assure production reliability ..... p 62 Jun 14  
Comment ..... p 4 Jun 28  
Module production quality assured by thermal cycling and life testing ..... p 92 Jul 19  
More reliability with controlled avalanche rectifiers ..... p 38 Mar 29  
New approaches to electronic self-repair ..... p 96 Jan 4  
New techniques pay off for Polaris fire-control system ..... p 61 Oct 25  
Phosphors trace heat flow patterns ..... p 40 Aug 23  
Power-transistor circuits - getting both reliability and economy ..... p 54 May 24  
Reliability slide rule ..... p 44 Sep 6  
Spot-testing aids manufacture of high-reliability relays ..... p 106 Apr 12  
Sub system goal is 20-year life ..... p 75 Oct 25  
Surface effects of ionizing radiation ..... p 34 Oct 4  
Underwater testing aids solid-state reliability . p 93 Oct 25  
Which permanent electrical connection should you use? ..... p 50 Jan 25

**REPAIRS See Servicing**

**RESEARCH & DEVELOPMENT**

Aerospace Conference: Air Force outlines latest R & D plans ..... p 16 May 24  
Air Force upgrades space research microwave center ..... p 28 Jan 25  
Chemicals affect oscillator output ..... p 46 Dec 13  
How to succeed in business on someone else's research ..... p 22 Jul 12  
Industrial spy - aristocrat of thieves ..... p 32 Jul 19

**RESISTORS**

Electronics color codes ..... p 37 Nov 15  
How to apply pellet resistors ..... p 91 Feb 15  
The negative resistance element (NRE): a new circuit component ..... p 21 May 31  
Comments p 4 Jul 5, p 4 Jul 12 ..... p 4 Jul 19  
New charts speed thin-film resistor design ..... p 72 Apr 12  
Parasitics in integrated circuits: more trouble than meets the eye ..... p 32 Jul 5  
Pilot plant mass produces thin films ..... p 64 Jun 7  
Radial-lead film resistor automatically produced ..... p 54 Mar 1  
Tunnel resistor - new device to speed up tunnel diodes ..... p 42 Jul 12

**S**

**SALES See Business**

**SATELLITES**

(See also Space Electronics)  
After Echo II: what and why? ..... p 24 Sep 6  
ComSat tackles problems - technical and fiscal.. p 18 Aug 9  
DOD satellite net set for awards ..... p 26 Jun 7  
First color facsimile transmitted by satellite... p 51 May 24  
German satellite station ..... p 74 Dec 6  
If a satellite fails - go up and fix it ..... p 12 May 31  
Latest satellite stabilizers let gravity do the work ..... p 16 Aug 23  
Need weather data? Buy a satellite ground station ..... p 20 Jul 26  
New look in this year's comsats ..... p 18 Jul 19  
Radar designs acquiring new versatility ..... p 10 Sep 20  
Slow sampling saves time ..... p 40 Nov 29  
Space area code sorts commands for satellites ..... p 18 Jun 28  
Syncom's time delay: no great problem ..... p 11 Nov 8  
Test-ban monitors set for launch ..... p 57 Oct 18  
Trick revives Telstar ..... p 30 Jan 11

**SATURABLE REACTORS**

New way to saturable reactors: stabilizing high-power rectifiers ..... p 62 May 24

**SCANNERS**

Computer analyzes x-rays ..... p 38 Nov 1  
Conical scan array uses variable phase shifters . p 30 Nov 29  
High-speed servo positioner bonds mesa transistors ..... p 58 Feb 8  
New antenna idea: scanning without phase shifters ..... p 27 Mar 29  
TV camera tracker - can it detect missile decoys? ..... p 51 Apr 26

**SCATTER SYSTEMS**

Orbital-scatter concept proves out ..... p 26 Nov 8  
Skip radio replaces Alaskan cable ..... p 30 Jul 26



## SCHMITT CIRCUITS

- Fail-safe squelch circuit adapts to changing noise levels ..... p 88 Jan 4  
Improved Schmitt trigger uses SCR ..... p 68 Apr 26  
Schmitt trigger drives low impedance loads ..... p 28 Aug 16

## SEISMOGRAPHY

- New transducers for communicating by seismic waves ..... p 51 Apr 12  
Comment ..... p 4 May 24  
Subaudio parametric amplifier for ocean-bottom seismometer ..... p 28 Mar 1

## SEMICONDUCTORS

- (See also Diodes; Transistors)  
Advances in microminiaturization ..... p 45 Feb 15  
Auto boost solid-state devices ..... p 39 Oct 4  
Bad medicine for semiconductors ..... p 10 Nov 1  
Basic rules for designing reliability into semiconductor circuits ..... p 62 Apr 12  
Can RFI control prevent weapons failures? ..... p 43 Nov 8  
Chelate lasers are coming on strong ..... p 32 Apr 26  
Chemicals affect oscillator output ..... p 46 Dec 13  
Designing digital equipment with semiconductor networks ..... p 35 Jan 18  
Developing true solid-state static alternators ..... p 58 May 24  
Experimental neuristor gives nerve-like pulse propagation ..... p 25 Mar 1  
Family tree of semiconductors ..... p 45 Apr 26  
French reveal new field-effect structure ..... p 56 Jun 14  
Future keyed to materials properties ..... p 66 Sep 6  
Gate turn-off - unique solid state switch ..... p 60 Apr 26  
Home appliances: market for solid state ..... p 14 Sep 13  
Homogeneous semiconductors - a new generation of devices ..... p 65 Jun 21  
Hot carrier diodes switch in picoseconds ..... p 53 Jul 19  
How to achieve majority and threshold logic with semiconductors ..... p 23 Nov 29  
IEEE Solid State Conference: Look at what optical semiconductors do now ..... p 32 Jun 28  
Inside-diameter saws slice semiconductors ..... p 65 Sep 20  
Materials for space-age electronics ..... p 37 Oct 25  
Microelectronics around the world ..... p 37 Aug 2  
Micropower circuits - new frontier in solid state ..... p 47 Jul 19  
More reliability with controlled avalanche rectifiers ..... p 38 Mar 29  
New 40-mm silicon crystals permit larger-capacity devices ..... p 84 Feb 8  
New look at negative-resistance devices ..... p 35 Mar 8  
Comment ..... p 4 Apr 26  
New Tecnetrons switch 15 amp ..... p 75 Sep 6  
Optical coupling: new approach to micro-circuit interconnections ..... p 23 Nov 22  
Solid-State Conference: solid progress in solid-state seen at Philadelphia ..... p 12 Mar 1  
Solid-state ion implants forge tailor-made junctions ..... p 26 Apr 19  
Surface effects of ionizing radiation ..... p 34 Oct 4  
Tecnetron family expands ..... p 18 May 17  
Today's semiconductors ..... p 37 Dec 6  
Trends in logic circuit design ..... p 38 Dec 6  
Highlights of small-signal circuit ..... p 46 Dec 6  
Power and control circuits ..... p 51 Dec 6  
WESCON: technical highlights ..... p 49 Aug 9

## SERVICING

- If a satellite fails - go up and fix it ..... p 12 May 31

## SERVOMECHANISMS

- Aiming a 3-ton telescope hanging from balloon ..... p 47 Feb 8  
Designing servo amplifiers for high efficiency ..... p 62 Feb 8  
Comment ..... p 4 Apr 12  
Fiber optics, servo built into tape handler ..... p 66 Feb 22  
High-speed servo positioner bonds mesa transistors ..... p 58 Feb 8  
Servo tracks pill in human body ..... p 58 Mar 22  
Solving the AGC dilemma - servo system uses attenuator ..... p 60 Jul 19  
Tv camera tracker - can it detect missile decoys? ..... p 51 Apr 26  
Versatile servo amplifier for 50, 60, or 400-cycle operation ..... p 44 Jan 18

## SIGNAL GENERATORS

- Contest produces novel circuit designs ..... p 96 Mar 15  
Crystal-controlled multivibrator has better stability ..... p 60 Apr 12  
Comment ..... p 4 May 17  
Sweep measurements - making the tough ones easy ..... p 52 Apr 19

## SILICON CONTROLLED RECTIFIERS

- Capacitance chargers for space employ controlled rectifiers ..... p 32 Oct 11  
Comment ..... p 6 Nov 1  
Consumer electronics Pt II: Home and auto controls ..... p 52 May 10  
Developing true solid-state static alternators ..... p 58 May 24  
Home appliances: market for solid state ..... p 14 Sep 13  
New deflection circuit uses SCR, saves power ..... p 56 Aug 9

- Power and control circuits ..... p 51 Dec 6  
Silicon rectifier controls power in either direction ..... p 63 Dec 20  
Soaking multiplies SCR peaks ..... p 17 Sep 20

## SIMULATORS

- Phase-locked klystrons simulate doppler radar ..... p 44 Apr 19  
Radioactive source generates probabilities ..... p 54 Sep 13  
Realistic sonar trainer simulates ship's wakes ..... p 84 Mar 15  
Simulating tactical radar and sonar ..... p 25 Dec 13  
Task force trains ashore ..... p 40 Nov 22

## SINGLE-SIDEBAND RADIO

- Better superhets for sideband reception ..... p 39 May 10  
Comment ..... p 4 Jul 12  
Low-cost circuit measures frequency translation ..... p 51 Nov 8  
Military radio swinging to ssb ..... p 29 Apr 5  
Simple transistor modulators improve sideband communications ..... p 54 Mar 8

## SOLAR CELLS

- Solid-state ion implants forge tailor-made junctions ..... p 26 Apr 19

## SOLDERING

- Dips and waves improve soldering ..... p 48 Jul 5  
Electronic Packaging Conference: Hot-air machine speeds soldering ..... p 44 May 31  
Iron or machine can solder printed cables ..... p 74 Nov 15  
Module production quality assured by thermal cycling and life testing ..... p 92 Jul 19  
Pulses control soldering quality ..... p 57 Oct 11  
Selecting the right soldering-iron and tip ..... p 48 Aug 16  
WESCON: Micro-packaging for micro-electronics ..... p 88 Aug 9  
What makes a solder joint good? ..... p 50 Nov 29

## SOLID STATE See Semiconductors; Micro-electronics; Lasers

## SONAR

- Doppler sonar plots ship's course ..... p 14 Nov 22  
Gains in ASW surveillance threaten subs' invulnerability ..... p 10 Sep 6  
Realistic sonar trainer simulates ship's wakes ..... p 84 Mar 15  
Simulating tactical radar and sonar ..... p 25 Dec 13  
Sonar navigates at 1 Mc ..... p 18 Aug 23  
Stand by for those Navy RDT&E contracts: \$1 1/2 billion ..... p 10 Sep 13

## SPACE ELECTRONICS

- Air Force successfully tests new space booster ..... p 26 Jul 26  
C-W amplifiers for space telemetry ..... p 78 Apr 26  
Communicating with future deep-space probes ..... p 28 May 31  
Crosstalk: Needles no more ..... p 3 Jul 5  
Developing radiation-proof space equipment ..... p 70 Aug 9  
"Far-out" space contracts ..... p 18 Feb 22  
First details on Mercury spacecraft command receiver ..... p 32 Feb 1  
For space, an electronics lab ..... p 42 Sep 13  
Getting the most out of aerospace telemetry ..... p 23 Sep 27  
Holmes: it wasn't frustration (interview with D. B. Holmes) ..... p 22 Jun 21  
IEEE: Space round trips push techniques ..... p 40 Sep 27  
ITU agrees on space allocations ..... p 17 Nov 15  
ITU allocations: final list ..... p 14 Nov 22  
If a satellite fails - go up and fix it ..... p 12 May 31  
Inside the orbiting geophysical observatory ..... p 61 Feb 15  
Is USSR ahead in space instruments? ..... p 16 Jul 5  
LEM electronics faces new challenges ..... p 22 Jul 19

## Long-range spectrometer seeks missile

- defense clues ..... p 16 May 10  
Mariner C shaping up for '64 ..... p 16 Aug 30  
Mariner hunts cosmic rays ..... p 50 Sep 13  
Materials for space-age electronics ..... p 37 Oct 25  
Mercury to carry new experiments and slow-scan Tv ..... p 18 Mar 22  
NASA unveils Apollo computer ..... p 17 Sep 27  
New chore for orbiting dipoles ..... p 14 May 31  
New twist in space tracking: the vehicle tracks the ground ..... p 10 Nov 15  
The optical heterodyne - key to advanced space signaling ..... p 29 Jul 12  
Optical radar for space rendezvous ..... p 44 Oct 4  
Orbiting observatory nears flight ..... p 28 Apr 12  
Polaris-proven electronics to guide Apollo ..... p 14 Oct 4  
Probes can take nuclear blasts ..... p 78 Aug 9  
Project Apollo's mission: get two Americans to the moon ..... p 18 Feb 8  
Saturn I booster launch will trigger biggest tracking test yet ..... p 10 Dec 6  
Sea drone snares capsules ..... p 18 Aug 16  
Slow sampling saves time ..... p 40 Nov 29  
Soviets planning transmission from Mars ..... p 18 Jan 11  
Space area code sorts commands for satellites ..... p 18 Jun 28  
Surface effects of ionizing radiation ..... p 34 Oct 4  
Symposium: What happens to dielectrics in space? ..... p 68 Jul 19  
Target date for moon base 1972? ..... p 14 Sep 27  
Telepathy maybe ..... p 42 Oct 11

- Test-ban monitors set for launch ..... p 57 Oct 18  
Using the latest semiconductor circuits in a UHF digital converter ..... p 37 Aug 30  
Waveguide telemeters space-chamber data ..... p 74 Jun 28  
West Ford dipole belt girdles earth ..... p 12 Jul 5  
Will lasers protect our cities against ICBM's? ..... p 20 May 3

## SPECTRUM ANALYZERS

- Contest produces novel circuit designs ..... p 96 Mar 15  
Long-range spectrometer seeks missile defense clues ..... p 16 May 10  
RFI - causes, effects, cures ..... p 37 Jun 21  
Comment ..... p 4 Aug 30

## SQUELCH CIRCUITS

- Fail-safe squelch circuit adapts to changing noise levels ..... p 88 Jan 4

## STEREO

- Consumer electronics Pt I: Entertainment ..... p 49 May 3

## STORAGE See Memories

## SUPERCONDUCTIVITY

- Novel test techniques measure Q in cryogenic resonant circuits ..... p 43 Feb 22

## SWITCHING CIRCUITS

- Chart gives RLC values for critical damping ..... p 34 May 31  
Circuit trends in nanosecond switching ..... p 35 Sep 20  
Contact arrangement simplifies design ..... p 86 Feb 8  
Comment ..... p 4 Apr 19  
Design of D-C switches with negative resistance elements ..... p 32 Jul 12  
Comments p 4 Jul 5, p 4 Jul 12, ..... p 4 Jul 19  
Developing true solid-state static alternators ..... p 58 May 24  
Gate turn-off - unique solid state switch ..... p 60 Apr 26  
High speed integrated circuits with load-compensated diode-transistor logic ..... p 68 Mar 15  
Hot carrier diodes switch in picoseconds ..... p 53 Jul 19  
A key to nanosecond switching combining tunnel and charge-storage diodes ..... p 42 Oct 18  
Mechanizing transistor switch design ..... p 47 Oct 18  
NEREM: Research in New England ..... p 23 Nov 1  
New antenna idea: scanning without phase shifters ..... p 27 Mar 29  
New Tecnetrons switch 15 amp ..... p 75 Sep 6  
The PIN diode: versatile microwave component ..... p 40 Mar 8  
Power and control circuits ..... p 51 Dec 6  
Sequence pulse generator saves transistors ..... p 44 Aug 2  
Silicon rectifier controls power in either direction ..... p 63 Dec 20  
Speech operates safety switch ..... p 78 Jun 21  
Taking human error out of nuclear experiments ..... p 46 Jun 14  
Tunnel diodes Pt IV: Logic and switching circuits ..... p 26 Jul 5  
WESCON: technical highlights ..... p 49 Aug 9

## T

## TELEMETRY

- Aiming a 3-ton telescope hanging from a balloon ..... p 47 Feb 8  
The arrowhead: compact new telemetry antenna ..... p 66 Apr 26  
C-W amplifiers for space telemetry ..... p 78 Apr 26  
Communicating with future deep-space probes ..... p 28 May 31  
Designing a simple telemeter for medical research ..... p 47 Jan 25  
Down Under - suddenly Mecca for radio men ..... p 20 Jan 4  
First details on Mercury spacecraft command receiver ..... p 32 Feb 1  
Getting the most out of aerospace telemetry ..... p 23 Sep 27  
IEEE: Space round trips push techniques ..... p 40 Sep 27  
ISA: Telemetry on muscle power ..... p 14 Sep 20  
Inductive telemetry improves spin-system measurements ..... p 41 Nov 15  
Inside the orbiting geophysical observatory ..... p 61 Feb 15  
Multitone oscillators - new source of simultaneous frequencies ..... p 86 Jan 4  
NASA's newest trackers go to Australia ..... p 54 Nov 8  
New aerospace transmitter packs 3-watts in fist-sized can ..... p 52 Jan 18  
New phase-tracking demodulator will not lock on sidebands ..... p 52 Feb 8  
New telemetry antenna adds flexibility ..... p 48 Feb 1  
Comment ..... p 4 Feb 15  
New twist in space tracking: the vehicle tracks the ground ..... p 10 Nov 15  
Predetection recording: Solution to the telemetry dilemma? ..... p 30 Sep 13



Servo tracks pill in human body	p 58 Mar 22
System packaging uses book configuration	p 56 Apr 5
Telemetry today	p 31 Sep 6
Waveguide telemeters space-chamber data	p 74 Jun 28
<b>TELEVISION</b>	
(See also Color Television)	
CRT recording has wide bandwidth	p 60 Nov 15
Consumer electronics Pt I: Entertainment	p 49 May 3
Delta modulator codes television wageguide	
link	p 50 Aug 2
For TV - a flying relay	p 32 Aug 2
French TV spurred by new stations	p 47 Sep 20
Here's that new color-TV tube	p 26 Jun 28
Infrared TV tube uses new principle	p 48 Sep 13
New tubes and circuits for consumer	
electronics	p 47 Jan 11
Platters play pictures on TV set	p 7 Aug 30
Small-screen TV	p 11 Dec 6
TV camera tracker - can it detect missile	
decoys?	p 51 Apr 26
TV dissolve wiper	p 40 Sep 6
Thermoplastic video tape ready soon	p 54 Jul 26
Tunnel diodes Pt III: Mixer and converter	
circuits	p 60 Jun 28
Comment	p 4 Aug 2
TVIST: new look in photoelectric storage	
tubes	p 74 Jun 21
UHF transmitter operates by remote control	p 61 Aug 2
<b>TEST EQUIPMENT</b>	
(See also Instruments; Oscilloscopes; Signal generators)	
Arc-protection circuits	p 54 Feb 22
Building a simple transistor tester	p 56 Apr 19
Comment	p 4 Jun 28
Checking connector production	p 96 Feb 8
Dynamic null - new method for measuring	
equipment performance	p 78 Mar 15
Comment	p 4 May 3
Easy way to test accelerometers	p 82 Jul 19
Easy ways to make microwave phase	
measurements	p 50 Mar 8
Four-in-one system tests plastic structures	p 38 Aug 9
High-speed production checking of logic	
wiring	p 56 Mar 29
Infrared inspection promises to assure	
production reliability	p 62 Jun 14
Comment	p 4 Jun 28
Module production quality assured	
by thermal cycling and life testing	p 92 Jul 19
Phosphors trace heat flow patterns	p 40 Aug 23
Radio receiver detects faulty parts or joints	p 86 Oct 18
Simple counter tester uses cascaded one-shots	p 40 Apr 5
Tester checks out thermocouple circuits	p 102 Mar 15
Comment	p 4 May 3
Two-phase oscillator covers 0.1 to 1,000-cps	p 27 Oct 4
Unique frequency comparator has sense of	
direction	p 36 Mar 1
Universal test set urged	p 11 Sep 27
Universal waveform analyzer aids automatic	
testing	p 56 Apr 12
<b>THERMISTORS</b>	
ISA: Telemetry on muscle power	p 14 Sep 20
<b>THERMOCOUPLES</b>	
Tester checks out thermocouple circuits	p 102 Mar 15
Comment	p 4 May 3
<b>THERMOELECTRICS</b>	
Consumer electronics Pt III: Appliances	
and housewares	p 46 May 17
Comment	p 4 Aug 16
New cooler uses thermomagnetic effect	p 84 Sep 6
No-chop IR detector cuts size	p 28 May 24
<b>THIN FILMS</b>	
Advances in microminiaturization	p 45 Feb 15
British Show: Microcircuits are busting out	
in Britain	p 60 Jun 7
ECCANE: Active thin-film device problems	
fade	p 41 Oct 11
FJCC: What's new in computer memories	p 35 Nov 8
Family tree of semiconductors	p 45 Apr 26
Flip chips easier to connect	p 82 Oct 18
Foils get thinner, more versatile	p 60 Jul 26
Graphite masks cut thin-film expense	p 61 Nov 8
IEEE Solid State Conference: New laser	
structure drives output past 1 w	p 24 Jun 21
Inductors no problem: new thin-film amplifier	p 46 Jun 7
Microelectronics around the world	p 37 Aug 2
Micropower circuits - new frontier in	
solid state	p 47 Jul 19
Modules incorporate integrated circuits	p 78 May 24
New charts speed thin-film resistor design	p 72 Apr 12
Parasitics in integrated circuits: more	
trouble than meets the eye	p 32 Jul 5
Pilot plant mass produces thin films	p 64 Jun 7
Solution process sprays thin films on	
substrates	p 24 Jul 26

Thin-film memory might cost 0.3 cent per bit	p 44 Nov 22
Thin-film photoacells get brighter faster	p 99 Sep 6
Thin-film production performed continuously	p 70 Apr 19
Thin films: automatic deposition control	p 33 Mar 29
Thin magnetic films create logic circuits	p 62 Feb 22
Transfer process avoids P-C open circuits	p 68 Jan 18
Vacuum deposited circuits use field effect	p 80 Apr 12
Vacuum Symposium: Modulated beams build	
microcircuits	p 26 Oct 25
<b>THYRATRONS</b>	
New thyatron peaks at 200 Mw	p 94 Apr 12
<b>TIMERS</b>	
Electromechanical timer for lab applications	p 78 Feb 15
Simple counter tester uses cascaded one-shots	p 40 Apr 5
Taking human error out of nuclear	
experiments	p 46 Jun 14
Unique synchronizing technique increases	
digital transmission rates	p 75 Mar 15
VHF counter measures time intervals precisely	p 27 Aug 23
<b>TRACKING</b>	
Air-sea-sub display plots naval targets	p 20 Jun 7
Computer runs missile tracker	p 12 Jun 14
Conical scan array uses variable phase shifters	p 30 Nov 29
Injection laser systems for communications	
tracking	p 35 Dec 13
Laser pulses track targets	p 64 Oct 18
Long-range spectrometer seeks missile	
defense clues	p 16 May 10
NASA's newest trackers go to Australia	p 54 Nov 8
New infrared system tracks missiles against	
bright Florida sky	p 39 Apr 19
New twist in space tracking: the vehicle tracks	
the ground	p 10 Nov 15
TV camera tracker - can it detect missile	
decoys?	p 51 Apr 26
<b>TRANSCEIVERS</b>	
Latest field-mapping improvement - lead-	
less transceiver probe works underwater	p 56 Jul 19
<b>TRANSDUCERS</b>	
Easy way to test accelerometers	p 82 Jul 19
ISA: Telemetry on muscle power	p 14 Sep 20
Inductive telemetry improves spin-system	
measurements	p 41 Nov 15
Magnetic strip keeps tape running true	p 42 Jan 11
Multi-frequency transducers improve ultrasonic	
cleaning	p 54 Nov 22
New transducers at biomedical meeting	p 60 May 10
New transducers for communicating by	
seismic waves	p 51 Apr 12
Comment	p 4 May 24
No-chop IR detector cuts size	p 28 May 24
Now you can use nonreciprocal devices at	
low frequencies	p 56 Feb 2
Probes can take nuclear blasts	p 78 Aug 9
Ultrasonics state-of-the-art report	p 33 Oct 18
<b>TRANSDUCTORS See Saturable Reactors</b>	
<b>TRANSFORMERS</b>	
Are tunable transmitters on the way out?	p 30 Jun 21
Electronics color codes	p 37 Nov 15
Frequency septupler provides staple 420-cps	
voltage	p 58 May 3
<b>TRANSISTOR CIRCUITS</b>	
(See also Amplifiers; Bridge Circuits; Computers; Control Circuits; Converters; Counters; D-C Amplifiers; Digital Techniques; Logic Circuits; Modulators; Oscillators; Protective Circuits; Pulse Techniques; Receivers; Schmitt Circuits; Switching Circuits; Transmitters)	
Aiming a 3-ton telescope hanging from a	
balloon	p 47 Feb 8
Basic rules for designing reliability into	
semiconductor circuits	p 62 Apr 12
Designing input circuits with lowest	
possible noise	p 46 Aug 2
Designing servo amplifiers for high	
efficiency	p 62 Feb 8
Comment	p 4 Apr 12
Gate turn-off - unique solid state switch	p 60 Apr 26
New deflection circuit uses SCR, saves power	p 56 Aug 9
New look at negative-resistance devices	p 35 Mar 8
Comment	p 4 Apr 26
Novel coincidence technique for transistor	
decade counter	p 71 Feb 15
Reducing winter skids with a transistor	
warning circuit	p 56 Jan 25
Solving the AGC dilemma - servo system	
uses attenuator	p 60 Jul 19
Tunnel diode detects currents down to 100	
femtoamperes	p 33 Apr 5
Comment	p 4 Apr 26
Unity-gain buffer acquires precision by feed-	
back	p 36 Dec 20
Using the latest semiconductor circuits in a	
UHF digital converter	p 37 Aug 30

<b>TRANSISTORS</b>	
(See also Field Effect Transistors)	
Advances in microminiaturization	p 45 Feb 15
Avalanche transistors test 10-nsec logic	p 46 Jul 12
Comment	p 4 Aug 30
Avalanching transistor generates microwaves	p 35 Oct 25
Building a simple transistor tester	p 56 Apr 19
Comment	p 4 Jun 28
Crosstalk: Defeat in Venice	p 3 Jul 12
Family tree of semiconductors	p 45 Apr 26
Fresh approach to measuring transistor beta	p 47 Jul 26
Here's that new color-TV tube	p 26 Jun 28
High-speed servo positioner bonds mesa	
transistors	p 58 Feb 8
How to choose transistors for low noise	p 50 Jan 11
How to get maximum input impedance with	
field-effect transistors	p 44 Mar 8
IEEE: Device powers go higher	p 57 Nov 15
IEEE Solid State Conference: Look at what	
optical semiconductors do now	p 32 Jun 28
Logic principles for multi-emitter transistors	p 25 Sep 13
Low-noise preamplifier uses field-effect	
transistors	p 67 Apr 12
Comment	p 4 Jun 21
Mechanizing transistor switch design	p 47 Oct 18
New device simplifies power supply design	p 39 May 17
New look at negative-resistance devices	p 35 Mar 8
Comment	p 4 Apr 26
New package for microtransistor	p 75 Nov 8
Optical coupling: key to design freedom	p 82 Mar 22
Parasitics in integrated circuits: more	
trouble than meets the eye	p 32 Jul 5
Power-transistor circuits - getting both	
reliability and economy	p 54 May 24
Practical way to measure transistor thermal	
resistance	p 66 Feb 15
Comment	p 4 Jun 14
Put more snap in logic circuits with field-	
effect transistors	p 43 Jun 14
Quick way to find beta (h-FE), alpha (h-FB),	
and (h-FC)	p 64 Aug 9
Surface effects of ionizing radiation	p 34 Oct 4
Teu-neutron family expands	p 18 May 17
Today's semiconductors	
Highlights of small-signal circuit design	p 46 Dec 6
Power and control circuits	p 51 Dec 6
Two collectors better than one	p 30 May 17
Unijunction transistor simplifies voltage-	
frequency converter	p 56 Oct 25
<b>TRANSMISSION LINES</b>	
Speeding digital data over phone lines	p 30 Sep 27
<b>TRANSMITTERS</b>	
Are tunable transmitters on the way out?	p 30 Jun 21
Army may buy radios for every front-line soldier	p 10 Nov 1
Bugs and antibiotics: new designs for hidden ears	p 10 Oct 25
C-W amplifiers for space telemetry	p 78 Apr 26
Easy-to-use chart for VSWR	p 38 Nov 22
Multicoupler puts five transmitters on one	
antenna	p 33 Dec 13
New aerospace transmitter packs 3-watts in	
fist-sized can	p 52 Jan 18
RFI - causes, effects, cures	p 37 Jun 21
Comment	p 4 Aug 30
Servo tracks pill in human body	p 58 Mar 22
Ssb system goal is 20-year life	p 75 Oct 25
UHF transmitter operates by remote control	p 61 Aug 2
Versatile R-F monitor shows power and VSWR	p 44 Mar 29
Wireless mikes get F-M band	p 26 Jun 28
<b>TRANSPONDERS</b>	
Communicating with future deep-space probes	p 28 May 31
F-m feedback stabilizes airborne solid-state	
VHF transponders	p 66 Dec 6
Undersea transmitters to locate missile	
impacts	p 18 Feb 15
<b>TRAVELING-WAVE TUBES</b>	
Subnanosecond radar shows high resolution	p 36 May 31
TWT uses new focusing concept	p 80 Jun 28
Ultrasonics state-of-the-art report	p 33 Oct 18
The versatile point-contact diode - how it	
detects and amplifies laser light	p 82 Jan 4
Comment	p 4 Mar 8
Will British TWT's make further inroads?	p 50 Jul 12
<b>TROPOSPHERIC SCATTER</b>	
Recent tests show tropo scatter better than	
believed	p 42 Mar 1
<b>TUBE CIRCUITS</b>	
Arc-protection circuits	p 54 Feb 22
Circuit with a twist: the cascade follower	p 69 Dec 6
Hybrid voltmeter avoids aging errors	p 41 Sep 20
New tubes and circuits for consumer	
electronics	p 47 Jan 11
R-F oscillator has improved stability	p 62 Aug 9
<b>TUBES</b>	
Are hot cathodes on the way out?	p 39 Jun 7
Better superhets for sideband reception	p 39 May 10
Comment	p 4 Jul 12



C-W amplifiers for space telemetry .....	p 78 Apr 26
Electronics color codes .....	p 37 Nov 15
Generator for one-millimeter waves - Tornadatron .....	p 21 Aug 16
IEEE: Device powers go higher .....	p 57 Nov 15
Infrared Tv tube uses new principle .....	p 48 Sep 13
Microwave tubes get cheaper, less noisy .....	p 52 Dec 13
New tubes and circuits for consumer electronics .....	p 47 Jan 11
Novel bwo doesn't use magnet .....	p 47 Sep 27
Selecting tubes for wide bandwidth .....	p 53 Oct 25
Welding improves grid construction .....	p 62 Sep 20
Will tunnel cathode bring new tubes? .....	p 86 Feb 15
Window materials for high-power microwave tubes .....	p 40 May 31
<b>TUNERS</b>	
Are tunable transmitters on the way out? .....	p 30 Jun 21
New technique protects receivers from high power .....	p 32 Mar 1
Resonant-cavity tuning now made easy .....	p 46 Jan 18
Tunnel diodes Pt I: Using them as sinusoidal generators .....	p 36 Jun 14
<b>TUNNEL DIODES</b>	
Backward-diode clamp reduces tunnel-diode delays .....	p 56 Feb 8
Circuit trends in nanosecond switching .....	p 35 Sep 20
Continuous readout of magnetic cores .....	p 38 Sep 6
Delta modulator codes television waveguide link .....	p 50 Aug 2
How to make tunnel diodes even more useful .....	p 52 Jun 7
A key to nanosecond switching combining tunnel and charge-storage diodes .....	p 42 Oct 18
Latest field-mapping improvement - lead- less transceiver probe works underwater .....	p 56 Jul 19
New look at negative-resistance devices .....	p 35 Mar 8
Comment .....	p 4 Apr 26
One-stage scaler needs no complex feedback .....	p 32 Sep 27
Operating X-band tunnel diodes at Q-band .....	p 32 Dec 27
Saving microcircuit power with tunnel-diode coupling .....	p 30 Aug 23
Supplying low-impedance power for tunnel diodes .....	p 60 Jan 18
Trends in logic circuit design .....	p 38 Dec 6
Tunnel diode detects currents down to 100 femtoamperes .....	p 33 Apr 5
Comment .....	p 4 Apr 26
<b>Tunnel diodes</b>	
Pt I: Using them as sinusoidal generators .....	p 36 Jun 14
Pt II: Amplifiers working beyond transistor capabilities .....	p 68 Jun 21
Pt III: Mixer and converter circuits .....	p 60 Jun 28
Comment .....	p 4 Aug 2
Pt IV: Logic and switching circuits .....	p 26 Jul 5
Tunnel diodes boost TRL speed .....	p 50 May 10
Tunnel resistor - new device to speed up tunnel diodes .....	p 42 Jul 12
Using the latest semiconductor circuits in a UHF digital converter .....	p 37 Aug 30

<b>TWISTERS</b>	
INTERMAG: Packing a half-million bits in a cubic inch .....	p 58 Apr 19
Semipermanent memory: latest use for twistors .....	p 80 Mar 15
<b>U</b>	
<b>ULTRASONICS</b>	
Consumer electronics Pt III: Appliances and housewares .....	p 46 May 17
Future keyed to materials properties .....	p 66 Sep 6
Magnetic field rotates ultrasonic waves .....	p 64 Jan 25
Multi-frequency transducers improve ultrasonic cleaning .....	p 54 Nov 22
Ultrasonic rotary drive may open up many new applications for micro devices .....	p 56 Jan 11
Ultrasonic waves clean circuit boards .....	p 86 May 24
Ultrasonics state-of-the-art report .....	p 33 Oct 18

<b>UNDERWATER ELECTRONICS</b>	
(See also Sonar)	
Air-sea-sub display plots naval targets .....	p 20 Jun 7
Floating drill gets on-the-spot help .....	p 17 Sep 27
Gains in ASW surveillance threaten subs' invulnerability .....	p 10 Sep 6
How Navy flies ASW boats .....	p 14 Jul 5
Hydrophones will track subs .....	p 19 Feb 15
Latest antisubmarine aid: magnetic contour display system .....	p 58 Aug 9
Navy's new ship program calls for more electronics .....	p 10 Oct 4
New techniques pay off for Polaris fire-control system .....	p 61 Oct 25
New underwater gamma spectrometer .....	p 56 Mar 8
Next frontier the oceans? .....	p 56 Nov 8
Optical device to contract dolphins .....	p 46 Nov 22
Realistic sonar-trainer simulates ship's wakes .....	p 84 Mar 15
Robot copters join Navy's anti-sub arsenal .....	p 18 Apr 19
Subaudio parametric amplifier for ocean- bottom seismometer .....	p 28 Mar 1
Task force trains ashore .....	p 40 Nov 22
Undersea transmitters to locate missile impacts ..	p 18 Feb 15

<b>V</b>	
<b>VACUUM DEPOSITION</b>	
Inductors no problem: new thin-film amplifier ...	p 46 Jun 7
Pilot plant mass produces thin films .....	p 64 Jun 7
Thin-film production performed continuously .....	p 70 Apr 19
Vacuum deposited circuits use field effect .....	p 80 Apr 12
Vacuum Symposium: Modulated beams build microcircuits .....	p 26 Oct 25

<b>VARACTORS</b>	
F-m feedback stabilizes airborne solid-state VHF transponder .....	p 66 Dec 6
Highlights of small-signal circuit design .....	p 46 Dec 6
How to design solid-state microwave generators .....	p 23 Oct 11
New aerospace transmitter packs 3-watts in fist-sized can .....	p 52 Jan 18
S-band param approaches noise-figure minimum .....	p 57 Jun 28
Using varactors to extend frequency-control .....	p 48 Nov 8
Varactor cutoff 800 Gc .....	p 31 Jun 7

<b>W</b>	
<b>WAVEGUIDES</b>	
Delta modulator codes television waveguide link .....	p 50 Aug 2
New millimeter components and techniques .....	p 33 Jan 11
Waveguide telemeters space-chamber data .....	p 74 Jun 28

<b>WEATHER FORECASTING See Meteorology</b>	
<b>WELDING</b>	
Construction of electron-beam space welder begins .....	p 30 Jul 19
Electron Beam Symposium: Microwelding - laser or electron beam? .....	p 23 Jul 5
Electron beam welding solves relay sealing problems .....	p 90 Jun 28
Electronic Packaging Conference: Hot-air machine speeds soldering .....	p 44 May 31
High power at millimeters - plasma harmonics the key .....	p 16 Aug 30
Laser welds copper leads .....	p 88 Oct 25
Self-setting parallel-gap welder for micro- circuits .....	p 91 Dec 6
Welding improves grid construction .....	p 62 Sep 20
Welding joins aluminum to other metals easily ...	p 56 Nov 22
WESCON: Micro-packaging for micro- electronics .....	p 88 Aug 9
Will lasers weld circuit components? .....	p 54 Jul 12

<b>WIRE</b>	
Electronics color codes .....	p 37 Nov 15
Machine simplifies bonding process .....	p 60 Feb 1
Serrations solve wire-termination problem .....	p 86 Jan 25
Which permanent electrical connection should you use? .....	p 50 Jan 25

<b>Z</b>	
<b>ZENER DIODES</b>	
High precision d-c level shifter reduces output impedance .....	p 65 May 3
New device simplifies power supply design .....	p 39 May 17

## AUTHORS' INDEX

<b>A</b>	
Addeo, E., Air Force successfully tests new space booster .....	p 26 Jul 26
Lasers fill medical needs .....	p 30 Apr 19
Addeo, E & others, High power at millimeters - plasma harmonics the key .....	p 16 Aug 30
Algar, L. E. & others, New thyratron peaks at 200 Mw .....	p 94 Apr 12
Allen, G. F., Reliability slide rule .....	p 44 Sep 6
Anderson, W. W., latest antisubmarine aid: magnetic contour display system .....	p 58 Aug 9
Anello, B. & L. H. Dulberger, Electronics markets 1963 .....	p 43 Jan 4
Arnold, J. A., High-speed production checking of logic wiring .....	p 56 Mar 29
Auer, J., Cordwood package gets new tubular ceramic capacitors .....	p 43 Aug 16
<b>B</b>	
Babits, V.A., Infrared Tv tube uses new principle .....	p 48 Sep 13

Baker, R. M., Measuring laser output with rat's nest calorimeter .....	p 36 Feb 1
Balamuth, L., Ultrasonic rotary drive may open up many new applications for micro devices .....	p 56 Jan 11
Balder, J. C. & C. Kramer, Delta modulator codes television waveguide link .....	p 50 Aug 2
Barditch, I. F. & C. Z. Leinkram, Wetting agent solves photoetching problems .....	p 54 Dec 13
Barlow, D., British develop new VLF navaid .....	p 36 Aug 16
Microcircuits are busting out in Britain .....	p 60 Jun 7
Multicomputers to rule English sky .....	p 14 Oct 11
New from Britain: tunable detectors, faster microwave switching .....	p 22 Feb 1
Will British TWT's make further inroads? .....	p 50 Jul 12
Barlow, D. & others, Microelectronics around the world .....	p 37 Aug 2
Barry, G. H. & J. D. Hawkins, Multicoupler puts five transmitters on one antenna .....	p 33 Dec 13
Baumann, H., Inductive telemetry improves spin-system measurements .....	p 41 Nov 15
Practical way to measure transistor thermal resistance .....	p 66 Feb 15
Comment .....	p 4 Jun 14
Benjaminson, A., Phase-locked klystrons simulate doppler radar .....	p 44 Apr 19
Bergman, R. H. & M Cooperman, Tunnel resistor - new device to speed up tunnel diodes .....	p 42 Jul 12

Biddlecomb, R. W., Latest multivibrator improvement - linear voltage-to-frequency converter .....	p 64 Apr 26
Bidwell, A. C., Layout machine scribes on glass .....	p 52 Oct 4
Bignell, T. R., How to get maximum input impedance with field-effect transistors .....	p 44 Mar 8
Blair, W. L. & J. C. Wright, F-m feedback stabilizes airborne solid-state VHF trans- ponder .....	p 66 Dec 6
Bockemuehl, R.R., Simple circuits measure FET parameters .....	p 34 Aug 23
Bodnar, M., Versatile servo amplifier for 50, 60 or 400-cycle operation .....	p 44 Jan 18
Bohley, P. & others, Measuring missile antenna impedance in flight .....	p 36 Jul 12
Bok, J., Homogeneous semiconductors - a new generation of devices .....	p 65 Jun 21
Bondley, R. J., Window materials for high- power microwave tubes .....	p 40 May 31
Bonwitt, W. F. & T. Shahnazarian, Checking connector production .....	p 96 Feb 8
Boyer, J. M., Hula-hoop antennas: a coming trend? .....	p 44 Jan 11
Briskman, B. A., Are tunable transmitters on the way out? .....	p 30 Jun 21
Military communication systems get simpler, smaller, faster .....	p 14 Jun 14
Military radio swinging to ssb .....	p 29 Apr 6
Telemetry today .....	p 31 Sep 6



Broom, R. F. & C. Hilsum, Diode lamp makes tape readers faster .....	p 44	May 17
Brown, H. J. & other, Racing the solar eclipse .....	p 37	Jul 26
Brown, M. N. & C. F. Vieter, Serrations solve wire-termination problem .....	p 86	Jan 25
Brown, W. G. & others, C-W amplifiers for space telemetry .....	p 78	Apr 26
Bruene, W. & others, Better superhets for sideband reception .....	p 39	May 10
Comment .....	p 4	Jul 12
Brunetto, F., Gate turn-off - unique solid state switch .....	p 60	Apr 26
Bud, P. J., Ultrasonic waves clean circuit boards .....	p 86	May 24
Budde, C. A., One-stage scaler needs no complex feedback .....	p 32	Sep 27
Burfeindt, K. L., Overload protection without high power dissipation .....	p 36	Mar 29
Burns, G. & M. I. Nathan, Injection lasers .....	p 61	Dec 6

## C

Cafarella, T. & others, Cut-out slide rule simplifies noise calculations .....	p 64	Feb 8
Caldecott, R. & others, Measuring missile antenna impedance in flight .....	p 35	Jul 12
Campaigne, R. N. & D. A. Estabrooks, Machine coats films automatically .....	p 86	Apr 26
Cannan, W. W. & W. G. Carlson, The high fences at White Sands .....	p 64	Oct 18
Carlson, W. G. & W. W. Cannan, The high fences at White Sands .....	p 64	Oct 18
Carr, E. Q., Flip chips easier to connect .....	p 82	Oct 18
Carroll, J. M., Computer analyzes x-rays .....	p 38	Nov 1
Task force trains ashore .....	p 40	Nov 22
Today's semiconductors .....	p 37	Dec 6
Carruth, R. & V. Sussman, Epoxy pellets improve diode production .....	p 64	Jul 26
Carter, E. A., Trade Expansion Act: help or hazard? .....	p 28	Mar 8
Casson, W. H. & C. C. Hall, New phase-tracking demodulator will not lock on sidebands .....	p 52	Feb 8
Charbonnier, R., Avalanche transistors test 10-nsec logic .....	p 46	Jul 12
Comment .....	p 4	Aug 30
Chow, P. & J. Cubert, A key to nanosecond switching combining tunnel and charge-storage diodes .....	p 42	Oct 18
Cichocki, C. & J. Dillon, Etched molds form p-c boards .....	p108	Sep 6
Ciehoski, R. R. & J. F. Lally, Coaxial filters - a practical design technique .....	p 35	Aug 30
Clampitt, L. L. & others, C-W amplifiers for space telemetry .....	p 78	Apr 26
Clark, L. E. & others, Highlights of small-signal circuit design .....	p 46	Dec 6
Coffey, C. S., VHF counter measures time intervals precisely .....	p 27	Aug 23
Cohen, C., For Tv - a flying relay .....	p 32	Aug 2
Japanese exports keep climbing .....	p 45	May 3
Presenting radar targets in color .....	p 54	Oct 18
Cohen, C. & others, Microelectronics around the world .....	p 37	Aug 2
Colbert, D. C. & M. C. Herzig, Voltage monitor needs only two saturable cores .....	p 50	Jun 7
Callis, R. T. H., Special computer integrates rainfall .....	p 70	May 24
Colman, R., Light beam controls potentiometers .....	p 76	Jun 28
Compagno, E. & A. Overstrom, Welding improves grid construction .....	p 62	Sep 20
Cook, A. D. & R. E. Daniels, Advanced Clapp oscillator features 3-to-1 dynamic range .....	p 60	Feb 22
Cook, H. L., New charts speed thin-film resistor design .....	p 72	Apr 12
Cooper, T. & G. McFarland, Designing digital equipment with semiconductor networks .....	p 35	Jan 18
Cooperman, M. & R. H. Bergman, Tunnel resistor - new device to speed up tunnel diodes .....	p 42	Jul 12
Crafts, H. S., Components that learn and how to use them .....	p 49	Mar 22
Crawford, H. D. & A. B. Hale, F-m discriminator without tuned circuits .....	p 36	Nov 29
Csaniky, G. & R. M. Warner Jr., Put more snap in logic circuits with field-effect transistors .....	p 43	Jun 14
Cubert, J. & P. Chow, A key to nanosecond switching combining tunnel and charge-storage diodes .....	p 42	Oct 18
Cuccia, C. L., S-band paramp approaches noise-figure minimum .....	p 57	Jun 28

## D

Dahl, W. E., Communicating with future deep space probes .....	p 28	May 31
Daniels, R. E. & A. D. Cook, Advanced Clapp oscillator features 3-to-1 dynamic range .....	p 60	Feb 22
Davis, P. D. Jr. & G. D. Ezell, Subaudio parametric amplifier for ocean-bottom seismometer .....	p 28	Mar 1
Dean, C. E. & others, Cut-out slide rule simplifies noise calculations .....	p 64	Feb 8
Dees, J. W. & A. P. Sheppard, New millimeter components and techniques .....	p 33	Jan 11
Dersch, W. C., Speech operates safety switch .....	p 78	Jun 21
Dicken, H. K., Parasitics in integrated circuits: more trouble than meets the eye .....	p 32	Jul 5
Dillon, J. & C. Cichocki, Etched molds form p-c boards .....	p108	Sep 6
Dipaola, S. J., Unique computer system monitors aircraft engines .....	p 38	Jan 11
Dixon, T. P., New infrared system tracks missiles against bright Florida sky .....	p 39	Apr 19
Dressel, H. & G. E. Weibel, Generator for one-millimeter waves .....	p 21	Aug 16
Drew, L. C., Using microcircuits in high-resolution range counters .....	p 31	Nov 22
Dulberger, L. H., Army demands new electronics techniques .....	p 20	Jul 12
Can synthetic sleep save time? .....	p 20	May 24
Gains in ASW surveillance threaten subs' invulnerability .....	p 10	Sep 6
How Navy flies ASW boats .....	p 14	Jul 5
Limited-war needs spur VTOL development .....	p 30	Feb 15
Side-looking radar makes maps in flight .....	p 22	Mar 22
Will lasers protect our cities against ICBM's? .....	p 20	May 3
Dulberger, L. H. & B. Anello, Electronics markets 1963 .....	p 43	Jan 4
Dunlap, K. W. & D. L. Williams, Will lasers weld circuit components? .....	p 54	Jul 12
Durio, J., Why a ring counter - why not a binary? .....	p 44	Jan 25
Dyson, L. M., Selecting tubes for wide bandwidth .....	p 53	Oct 25

## E

Earle, W. E., Designing zero-drift d-c differential amplifiers .....	p 66	Nov 8
Elders, D. S. & R. A. Gerhold, Modules incorporate integrated circuits .....	p 78	May 24
Ellern, F., Capacitance chargers for space employ controlled rectifiers .....	p 32	Oct 11
Comment .....	p 6	Nov 1
Elliott, R., First details on Mercury spacecraft command receiver .....	p 32	Feb 1
Engelmann, R., Bi-quinary scaling: accuracy and simplicity at 500 Mc .....	p 34	Nov 15
Erikson, A., French control systems sophisticated, as usual .....	p 14	Nov 29
French find 7 lucky number .....	p 28	Aug 2
New Tectetrons switch 15 amp .....	p 75	Sep 6
Tectetron family expands .....	p 18	May 17
What's new in lasers? .....	p 14	Mar 1
Erikson, A. & others, Microelectronics around the world .....	p 37	Aug 2
Estabrooks, D. A. & R. N. Campaigne, Machine coats films automatically .....	p 86	Apr 26
Evans, T. & R. Pecina, Taking human error out of nuclear experiments .....	p 46	Jun 14
Ezell, G. D. & P. D. Davis Jr., Subaudio parametric amplifier for ocean-bottom seismometer .....	p 28	Mar 1

## F

Fairley, D. O., How to design solid-state microwave generators .....	p 23	Oct 11
Faran, J. J. Jr., Hybrid voltmeter avoids aging errors .....	p 41	Sep 20
Farrah, H. R. & P. E. Sherr, New approach to weather data: every plane a station .....	p 38	Jul 12
Feist, W. M. & G. Wade, Are hot cathodes on the way out? .....	p 39	Jun 7
Feldman, C. & others, Vacuum deposited circuits use field effect .....	p 80	Apr 12
Firestone, J. H., Gated pulses yield selected frequency outputs .....	p 38	Dec 20

Fleenor, E. G., Low-noise preamplifier uses field-effect transistors .....	p 67	Apr 12
Comment .....	p 4	Jun 21
Fleischer, A. A. & E. Johnson, New digital conversion method provides nanosecond resolution .....	p 55	May 3
Flynn, G. J., Black box blast detection - hope or hoax? .....	p 26	Jan 4
Data communications boom gathers steam .....	p 26	May 10
Frankland, H. G. & M. Freitag, Fabrication aids cut submodule rejection rate .....	p 68	May 17
Freitag, M. & H. G. Frankland, Fabrication aids cut submodule rejection rate .....	p 68	May 17
Frings, H. and M., Sound: a better way to control pests .....	p 24	Jan 11
Fujita, H. & others, New modulation technique simplifies circuits .....	p 52	Jan 25

## G

Gaertner, W. W. & M. Schuller, Micropower circuits - new frontier in solid state .....	p 47	Jul 19
Galenian, J. C., Designing radar receivers to overcome jamming .....	p 50	May 17
Gaon, J., Simple counter tester uses cascaded one-shots .....	p 40	Apr 5
Gausman, T. E., Standardizing noise-figure measurement .....	p124	Jan 4
Gerhold, R. A. & D. S. Elders, Modules incorporate integrated circuits .....	p 78	May 24
Geyger, W. A., Frequency septupler provides stable 420-cps voltage .....	p 58	May 3
Gilleo, M. A. & J. T. Laci, Optical coupling: new approach to microcircuit interconnections .....	p 23	Nov 22
Giorgis, J. & E. Gottlieb, Tunnel diodes Pt I: Using them as sinusoidal generators .....	p 36	Jun 14
Pt II: Amplifiers working beyond transistor capabilities .....	p 68	Jun 21
Pt III: Mixer and converter circuits .....	p 60	Jun 28
Comment .....	p 4	Aug 2
Pt IV: Logic and switching circuits .....	p 26	Jul 5
Glaser, P. F. & E. R. Spangler, Inside the orbiting geophysical observatory .....	p 61	Feb 15
Goldmark, P. C., How hi is fi? (interview) .....	p 33	Jun 14
Comment .....	p 4	Aug 2
Gooch, B. R., Magnetic strip keeps tape running true .....	p 42	Jan 11
Goodykoontz, J. R., System packaging uses book configuration .....	p 56	Apr 5
Gore, T. V. & W. V. Lane, Module production quality assured by thermal cycling and life testing .....	p 92	Jul 19
Gottlieb, E. & J. Giorgis, Tunnel diodes Pt I: Using them as sinusoidal generators .....	p 36	Jun 14
Pt II: Amplifiers working beyond transistor capabilities .....	p 68	Jun 21
Pt III: Mixer and converter circuits .....	p 60	Jun 28
Comment .....	p 4	Aug 2
Pt IV: Logic and switching circuits .....	p 26	Jul 5
Grabowski, S. J., Pulse power supply design for laser pumping .....	p 33	Dec 20
Grant, C. R. & others, Modulated infrared diode spans 30 miles .....	p 38	Apr 5
Gray, S. B., Consumer electronics Pt I: Entertainment .....	p 49	May 3
Comment .....	p 4	Jul 19
Pt II: Home and auto controls .....	p 52	May 10
Pt III: Appliances and housewares .....	p 46	May 17
Comment .....	p 4	Jul 19
Three new computer systems announced .....	p 10	Dec 13
Greenburg, R., Getting both reliability and economy in power-transistor circuits .....	p 54	May 24
Grindle, B. & H. Schmid, Pulse-width modulator offers precision performance .....	p 29	Oct 11
Gruenberg, J., Safer power plants: why not? .....	p 38	May 24
Gutierrez, W. A. & others, Vacuum deposited circuits use field effect .....	p 80	Apr 12
Gutzwiller, F. W., More reliability with controlled avalanche rectifiers .....	p 38	Mar 29

## H

Hagn, G. & B. Sifford, Easy-to-use chart for VSWR .....	p 38	Nov 22
Hall, H. K. & L. Jasper, Improving a-d converter accuracy .....	p 38	Sep 13
Hale, A. B. & H. D. Crawford, F-m discriminator without tuned circuits .....	p 36	Nov 29
Hall, C. C. & W. H. Casson, New phase-tracking demodulator will not lock on sidebands .....	p 52	Feb 8
Hall, K. L., Basic rules for designing reliability into semiconductor circuits .....	p 62	Apr 12







Marshall, L., Down under— suddenly Mecca for radio men	p 20 Jan 4
Martin, A. V. J., French reveal new field-effect structure	p 56 Jun 14
Mason, J.F., Air/ground teams seek new systems	p 15 Aug 23
Army of the air creates new market	p 32 Apr 12
Army seeks gear for air traffic and navigation	p 10 Nov 22
Army wants surveillance, armament gear for air arm	p 10 Nov 29
DOD satellite net set for awards	p 26 Jun 7
"Far-out" space contracts	p 18 Feb 22
Improved air traffic communication and weather nets planned	p 92 Jan 4
National Military Command system system moves forward	p 20 Apr 26
Navy's new ship program calls for more electronics	p 10 Oct 4
New techniques pay off for Polaris fire-control system	p 61 Oct 25
Radar designs acquiring new versatility	p 10 Sep 20
Spacecom: \$100-million-a-year market	p 22 Apr 19
Stage is set again for RS-70 debate	p 19 Feb 1
Comment	p 4 Mar 1
Stand by for those Navy RDT&E contracts: \$1 1/2 billion	p 10 Sep 13
Mason, W.P., Ultrasonics state-of-the-art report	p 33 Oct 18
Maupin, J. T. & H. C. Josephs, Saving micro-circuit power with tunnel-diode coupling	p 30 Aug 23
Mawhinney, D. D., Arc-protection circuits	p 54 Feb 22
McFarland, G. & T. Cooper, Designing digital equipment with semiconductor networks	p 35 Jan 18
McGown, R. & others, Measuring missile antenna impedance in flight	p 36 Jul 12
McKenzie, A. A., Fail stabilizes electret mike	p 68 Oct 25
Hot mikes will record air crew's conversation	p 53 Nov 15
New code standard in U. S. — International adoption next?	p 22 Jul 26
Space round trips push techniques	p 40 Sep 27
McKenzie, A. A. & W. Kornberg, Hot line: for cool nuclear decisions	p 18 Jun 28
McMechan, J. D. & A. G. Potter, Designing a simple telemeter for medical research	p 47 Jan 25
McMillen, A. R., Dips and waves improve soldering	p 48 Jul 5
Meieran, S., Tester checks out thermocouple circuits	p 102 Mar 15
Comment	p 4 May 3
Messina, M. & others, Microelectronics around the world	p 37 Aug 2
Metlay, M., How rare earth chelate lasers work	p 67 Nov 15
Meyer, B. W., How to design arbitrary-length binary counter	p 34 Dec 27
Meyer, J. W. & A. M. Rich, Cryogenics for the electronics engineer	p 29 Aug 30
Meyer, J. W. & others, Modulated infrared diode spans 30 miles	p 38 Apr 5
Meyers, P., Circuit trends in nanosecond switching	p 35 Sep 20
Michael, H. G., Fail-safe squelch circuit adapts to changing noise levels	p 88 Jan 4
Mikton, R., Europe's color-TV competition	p 22 Aug 2
F-104G: boon to Europe	p 16 Jun 21
West still leads East in electronics	p 22 Apr 5
Mikton, R. & others, Microelectronics around the world	p 37 Aug 2
Miyaji, K. & T. Kohashi, Breakthrough in light amplifiers — el-pc image intensifier uses control-grid	p 30 Sep 20
Miyakawa, H. & others, How coded-pulse techniques extend radar range	p 34 Nov 22
Monser, G. J., The arrowhead: compact new telemetry antenna	p 66 Apr 26
Montague, H. R., Five-layer diode guards cables	p 84 Jun 21
Montgomery, G. F., Building a simple transistor tester	p 56 Apr 19
Comment	p 4 Jun 28
Moore, R. L., High-speed servo positioner bonds mesa transistors	p 58 Feb 8
Morrison, R. F. Jr. & M. N. Sarachan, Binary frequency sensing measures a single pulse	p 42 Apr 5
Mosser, R. & W. R. Turner, Supplying low-impedance power for tunnel diodes	p 60 Jan 18
Moulton, A. B., Chart gives RLC values for critical damping	p 34 May 31
Moxley, S. D. & J. A. Inderhees, New air-traffic system predicts flight paths	p 27 Feb 1
Mullarkey, E. J., Accurate gyro balancing	p 81 Oct 25
Mulvany, R. B. & L. H. Lee, Now a talking computer answers inventory inquiries	p 30 Aug 16
Murakami, J. & others, New modulation technique simplifies circuits	p 52 Jan 25
Murphy, B. T., High speed integrated circuits with load-compensated diode-transistor logic	p 68 Mar 15
Murphy, E. B. & C. A. Pappas, Encapsulating precision antennas in plastic	p 68 Mar 8

Murphy, R. H., Developing true solid-state static alternators	p 58 May 24
---	-------------

## N

Nail, C. D., Logarithmic attenuator spans three decades	p 47 Nov 15
Nathan, M. I. & G. Burns, Injection lasers	p 61 Dec 6
Navon, D., Diodes tolerate high radiation	p 48 Nov 29
Newhoff, H. R., Crystal-controlled multivibrator has better stability	p 60 Apr 12
Comment	p 4 May 17
Newton, A. & others, Fitting a wide-band signal into a narrow-band receiver	p 47 Mar 8
Novotny, G.V., Air Force display selects data from 1,890 channels	p 10 Oct 18
Army protects missiles against stray r-f.	p 16 Apr 5
Thermoplastic video tape ready soon	p 54 Jul 26

## O

Oberg, P. E. & S. J. Lins, Thin films: automatic deposition control	p 33 Mar 29
Ohtomo, R.G., Novel two doesn't use magnet.	p 47 Sep 27
Orvedahl, W. & J. H. Shepherd, Designing data registers with simple diode circuits	p 48 Feb 22
Osborne, T.E., Mechanizing transistor switch design	p 47 Oct 18
Osborne, W. E., Infrared mine detector a reality	p 54 Aug 2
Infrared system detects intruders	p 26 Aug 16
Ottenstein, A. S. & R. L. Paul, Sequence pulse generator saves transistors	p 44 Aug 2
Overstrom, A. & E. Compagna, Welding improves grid construction	p 62 Sep 20

## P

Pappas, C. A. & E. B. Murphy, Encapsulating precision antennas in plastic	p 68 Mar 8
Pappenfus, E. & others, Better superhets for sideband reception	p 39 May 10
Comment	p 4 Jul 12
Parshad, R. & P. K. Malhotra, Novel coincidence technique for transistor decade counter	p 71 Feb 15
Patterson, J. L., Will neon photoconductors replace relays in low-speed logic?	p 46 May 10
Patton, B. W., New aerospace transmitter packs 3-watts in fist-sized can	p 52 Jan 18
Paul, R.L. & A. S. Ottenstein, Sequence pulse generator saves transistors	p 44 Aug 2
Payne, S., ComSat tackles problems — technical and fiscal	p 18 Aug 9
Long-range spectrometer seeks missile defense clues	p 16 May 10
Pecina, R. & T. Evans, Taking human error out of nuclear experiments	p 46 Jun 14
Peck, D.S. & E.R. Schmid, Surface effects of ionizing radiation	p 34 Oct 4
Perry, J. T. Jr. & others, Semipermanent memory: latest use for twisters	p 80 Mar 15
Perry, W., Jr., Tv test uses two colors	p 42 May 3
Petrack, P., Immersion gold solution used in electroplating	p 100 Feb 15
Phillips, D. K., Unity-gain buffer acquires precision by feedback	p 36 Dec 20
Pieper, C., Sparks shape Alnico magnets — can it detect missile decoys?	p 51 Apr 26
Potter, A. G. & J. D. McMechan, Designing a simple telemeter for medical research	p 47 Jan 25
Preis, R. P. & L. C. Varuzzo, Notation language speeds production changes	p 92 May 3
Prouty, T. P., Using varactors to extend frequency-control range	p 48 Nov 8
Puthoff, H. E. & J. T. Tippett, Optical computers approach reality	p 72 May 3

## Q

Quist, T. M. & others, Modulated infrared diode spans 30 miles	p 38 Apr 5
--	------------

## R

Rabinovici, B. & others, Fitting a wide-band signal into a narrow-band receiver	p 47 Mar 8
---	------------

Rado, J. J., Designing input circuits with lowest possible noise	p 46 Aug 2
Ramsey, S., Is USSR ahead in space instruments?	p 16 Jul 5
Ratner, V.A., Predetection recording: Solution to the telemetry dilemma?	p 30 Sep 13
Rediker, R. H. & others, Modulated infrared diode spans 30 miles	p 38 Apr 5
Reed, H. H., Rapid evaluation of complex receiving systems	p 44 Feb 1
Reid, M., Air-sea-sub display plots naval targets	p 20 Jun 7
Airlines look to computers to end delays	p 66 Oct 25
LEM electronics faces new challenges	p 22 Jul 19
Project Apollo's mission: get two Americans to the moon	p 18 Feb 8
Reimer, W. A. & others, Semipermanent memory: latest use for twisters	p 80 Mar 15
Reninger, W. G. & A. S. Jensen, TVIST: new look in photoelectric storage tubes	p 74 Jun 21
Rettig, A. S., Computers in the front lines: micromodules make it possible	p 77 Jan 4
Revzin, M., Radio-interference control	p 56 Apr 26
Comment	p 4 Jun 7
Rhoades, W. T., Backward-diode clamp reduces tunnel-diode delays	p 56 Feb 8
Rich, A.M. & J.W. Meyer, Cryogenics for the electronics engineer	p 29 Aug 30
Riel, G. K., New underwater gamma spectrometer	p 56 Mar 8
Ring, D., Machine simplifies bonding process	p 60 Feb 1
Rabberson, E., R-F oscillator has improved stability	p 62 Aug 9
Robinson, A. S., Simple transistor modulators improve sideband communications	p 54 Mar 8
Robinson, T. L., Transfer process avoids P-C open circuits	p 68 Jan 18
Rodrigues de Miranda, J., Miniature components aimed for mass markets	p 64 Apr 19
Roedel, K. & R. Stoner, Unique synchronizing technique increases digital transmission rates	p 75 Mar 15
Rollett, J. M., Capacitor provides outer coupling for modern coaxial-line circuits	p 62 Jan 18
Comment	p 4 May 31
Rosengreen, A., Experimental neuristor gives nerve-like pulse propagation	p 25 Mar 1
Ross, R.R. & H.H. Manko, Selecting the right soldering-iron and tip	p 48 Aug 16
Ruegg, H. W., Transistor-transistor logic circuits	p 54 Mar 22
Rumsey, W. & others, S-band param approaches noise-figure minimum	p 57 Jun 28
Russell, C. R. & others, New thyatron peaks at 200 Mw	p 94 Apr 12
Ryder, J. D., Lab courses	p 4 Aug 23

## S

Saito, S. & others, The versatile point-contact diode — how it detects and amplifies laser light	p 82 Jan 4
Comment	p 4 Mar 8
Sakamoto, T. & others, How coded-pulse techniques extend radar range	p 34 Nov 22
Sallo, J. S., Plated holes simplify memory design	p 34 Nov 1
Sanford, R. J., Can RFI control prevent weapons failures?	p 43 Nov 8
Sarachan, M. N. & R. F. Morrison Jr., Binary frequency sensing measures a single pulse	p 42 Apr 5
Sasaki, I. & others, Integrated-circuit oscillator requires few components	p 40 Dec 13
Sauer, W. A., How to achieve majority and threshold logic with semiconductors	p 23 Nov 29
Schindler, H.R., Using the latest semiconductor circuits in a UHF digital converter	p 37 Aug 30
Schlesinger, E. R., Aiming a 3-ton telescope hanging from a balloon	p 47 Feb 8
Schmid, E.R. & D.S. Peck, Surface effects of ionizing radiation	p 34 Oct 4
Schmid, H. & B. Grindle, Pulse-width modulator offers precision performance	p 29 Oct 11
Schmid, P.E., Secondary emission makes klystron tubes self quenching	p 40 Oct 18
Schmidt, M., Improved Schmitt trigger uses SCR	p 68 Apr 26
Schneider, W. & K. Ikraht, Glass-fiber array produces many beams	p 28 Nov 1
New transducers for communicating by seismic waves	p 51 Apr 12
Comment	p 4 May 24
Schoenike, E. & others, Better superhets for sideband reception	p 39 May 10
Comment	p 4 Jul 12
Schuller, M. & W. W. Gaertner,	



Micropower circuits - new frontier in solid state ..... p 47 Jul 19

Schwartz, J., Unijunction transistor simplifies voltage-frequency converter ..... p 56 Oct 25

Setliff, J. E. & J. A. Walston, Designing servo amplifiers for high efficiency ..... p 62 Feb 8  
Comment ..... p 4 Apr 12

Shahnazarian, T. & W. F. Bonwitt, Checking connector production ..... p 96 Feb 8

Shang, D. C. T., Chemicals affect oscillator output ..... p 46 Dec 13

Share, I., Easy ways to make microwave phase measurements ..... p 50 Mar 8

Shepherd, J. H. & W. Orvedahl, Designing data registers with simple diode circuits ..... p 48 Feb 22

Sheppard, A. P. & J. W. Dees, New millimeter components and techniques ..... p 33 Jan 11

Shergalis, L. D., Blast signatures - key to test ban treaty ..... p 24 Feb 22

Electronics for the SST - what's ahead? ..... p 24 Nov 15

Light isolates amplifier stages ..... p 43 Nov 1

Looking for something to do? Try developing MM components ..... p 24 Jan 18

600,000 WPM printer races computer ..... p 26 May 24

Shergalis, L. D. & others, High power at millimeters - plasma harmonics the key ..... p 16 Aug 30

Sherr, P. E. & H. R. Farrah, New approach to weather data: every plane a station ..... p 38 Jul 12

Shores, M. W., Communications range nomograph ..... p 41 Dec 20

Shudo, K. & others, Tv dissolve wiper ..... p 40 Sep 6

Sifford, B. & G. Hagn, Easy-to-use chart for VSWR ..... p 38 Nov 22

Silverman, J. H., Now you can use nonreciprocal devices at low frequencies ..... p 56 Feb 22

Simons, K., Sweep measurements - making the tough ones easy ..... p 52 Apr 19

Skole, R. & others, Microelectronics around the world ..... p 37 Aug 2

Skoures, A. E., Choosing logic for microelectronics ..... p 23 Oct 4

Slocum, A. & A. G. Kramer, How computers align phased-array radars ..... p 29 Nov 15

Smith, D., Big printed-circuit fight: Technograph loses round 1 ..... p 24 Jun 7

How to succeed in business on someone else's research ..... p 22 Jul 12

Industrial spy - aristocrat of thieves ..... p 32 Jul 19

The lone nominee - his views ..... p 38 Aug 9

Smith, R., Atomic test ban - what does it mean to our industry? ..... p 18 Aug 2

Smith, W. W., Fast agc amplifier locks monopulse radar on target ..... p 34 Sep 27

Solomon, L., Brighter color Tv in offing? ..... p 116 Jan 4

New tubes and circuits for consumer electronics ..... p 47 Jan 11

Sommer, R. C. & A. Hauptschein, Getting the most out of aerospace telescope ..... p 23 Sep 27

Soshae, S. W. & S. M. Krakauer, Hot carrier diodes switch in picoseconds ..... p 53 Jul 19

Spangler, E. R. & P. F. Glaser, Inside the orbiting geophysical observatory ..... p 61 Feb 15

Stapelheld, R., Multitone oscillators - new source of simultaneous frequencies ..... p 86 Jan 4

Stearns, L. B., Preformed circuits reduce joining operations ..... p 45 Aug 23

Stein, L. F., Versatile R-F monitor shows power and VSWR ..... p 44 Mar 29

Stephenson, J. G., Resonant-cavity tuning now made easy ..... p 46 Jan 18

Stevens, R. T., Nomograph speeds amplifier design ..... p 38 Jul 5

Stone, R. B. & G. M. White, Digital correlator detects voice fundamental ..... p 28 Nov 22

Stoner, R. & K. Roedel, Unique synchronizing technique increases digital transmission rates ..... p 75 Mar 15

Strasser, J., After Echo II: what and why? ..... p 24 Sep 6

First color facsimile transmitted by satellite ..... p 51 May 24

For space, an electronics lab ..... p 42 Sep 13

GaAs laser transmits wideband data ..... p 24 Oct 18

Holmes: it wasn't frustration (interview with D. B. Holmes) ..... p 22 Jun 21

If a satellite fails - go up and fix it ..... p 12 May 31

Latest satellite stabilizers let gravity do the work ..... p 16 Aug 23

Mariner C shaping up for '64 ..... p 16 Aug 30

Need weather data? Buy a satellite ground station ..... p 20 Jul 26

New look in this year's comsats ..... p 18 Jul 19

New twist in space tracking: the vehicle tracks the ground ..... p 10 Nov 15

Syncom's time delay: no great problem ..... p 11 Nov 8

Target date for moon base 1972? ..... p 14 Sep 27

ZIP goes the mail ..... p 26 Jul 12

Strasser, J. & others, Racing the solar eclipse ..... p 37 Jul 26

Sugano, T. & others, Integrated-circuit oscillator requires few components ..... p 40 Dec 13

Susi, F., Solving the AGC dilemma - servo system uses attenuator ..... p 60 Jul 19

Sussman, V. & R. Carruth, Epoxy pellets improve diode production ..... p 64 Jul 26

Sutton, G. W., Plasma accelerator work shows promise ..... p 38 Apr 26

Suzuki, T. & others, How coded-pulse techniques extend radar range ..... p 34 Nov 22

Swartz, G. A., New millimeter wave device - beam-plasma amplifier ..... p 40 Nov 8

Sylvan, T. P., New device simplifies power supply design ..... p 39 May 17

T

Takeya, T. & others, How coded-pulse techniques extend radar range ..... p 34 Nov 22

Taki, Y. & others, How coded-pulse techniques extend radar range ..... p 34 Nov 22

Tarui, T., New deflection circuit uses SCR, saves power ..... p 56 Aug 9

Taylor, R. C., & others, Measuring missile antenna impedance in flight ..... p 36 Jul 12

Teich, W. W. & others, C-W amplifiers for space telemetry ..... p 78 Apr 26

Terrio, F. G. & others, New antenna idea: scanning without phase shifters ..... p 27 Mar 29

Theiler, W. C., Electron beam welding solves relay sealing problems ..... p 90 Jun 28

Theiss, J. B., More target data with side-band coherent radar ..... p 40 Jan 18

Comment ..... p 4 Mar 29

Thompson, P. N., Logic principles for multi-emitter transistors ..... p 25 Sep 13

Tippett, J. T. & H. E. Puthoff, Optical computers approach reality ..... p 72 May 3

Todd, C. D., Designing NRE monostable multivibrators ..... p 34 Sep 13

The negative resistance element (NRE) a new circuit component ..... p 21 May 31

Design of D-C switches with negative resistance elements ..... p 32 Jul 12

Using a new component: the NRE as a free-running multivibrator ..... p 50 Jul 26

Comments p 4 Jul 5, p 4 Jul 12, ..... p 4 Jul 19

Raising tank-circuit Q with the NRE ..... p 30 Oct 4

Tunnel diode detects currents down to 100 femtoamperes ..... p 33 Apr 5

Comment ..... p 4 Apr 26

Tamaino, M. F., Active components: more breakthroughs on the way ..... p 24 May 17

Bright future seen for organics ..... p 51 Oct 11

Chelate lasers are coming on strong ..... p 32 Apr 26

Materials for space-age electronics ..... p 37 Oct 25

Townsend, T. & R. Leslie, Inductors no problem: new thin-film amplifier ..... p 46 Jun 7

Trabold, W. G., Continuous readout of magnetic cores ..... p 38 Sep 6

Turner, W. R. & R. Mosser, Supplying low-impedance power for tunnel diodes ..... p 60 Jan 18

Tuttle, G. T., How to quiz a whole memory at once ..... p 43 Nov 15

U

Uno, Y. & others, The versatile point-contact diode - how it detects and amplifies laser light ..... p 82 Jan 4

Comment ..... p 4 Mar 8

Uzunoglu, V., A new look at negative resistance devices ..... p 35 Mar 8

Comment ..... p 4 Apr 26

V

Vagt, T., New light on air traffic: bright plan display with alphanumerics ..... p 42 Jul 26

Varuzzo, L. C. & R. P. Preiss, Notation language speeds production changes ..... p 92 May 3

Veth, G. J., Optical soldering promotes automated packaging ..... p 90 Mar 22

Vieser, C. F. & M. N. Brown, Serrations solve-wire termination problem ..... p 86 Jan 25

Villeneuve, A. T. & others, New antenna idea: scanning without phase shifters ..... p 27 Mar 29

Vilmur, R. J. & K. Ishii, Avalanche transistor generates microwaves ..... p 35 Oct 25

Vogel, S., High-frequency optical phonon maser reported ..... p 102 Jan 4

RFI - causes, effects, cures ..... p 37 Jun 21

Comment ..... p 4 Aug 30

Van Zastrow, E. E., Power and control circuits ..... p 51 Dec 6

Voorrips, H. C. & others, Silicon rectifier controls power in either direction ..... p 63 Dec 20

Wade, G. & W. M. Feist, Are hot cathodes on the way out? ..... p 39 Jun 7

Waibel, E., Radiosonde measures after-effects of solar events ..... p 47 Apr 19

Waldhauer, F. D., Latest approach to integrated amplifier design ..... p 24 May 31

Walston, J. A. & J. E. Setliff, Designing servo amplifiers for high efficiency ..... p 62 Feb 8  
Comment ..... p 4 Apr 12

Wanlass, F. M., Novel field-effect device provides broadband gain ..... p 30 Nov 1

Warner, R. M. Jr. & G. Csanky, Put more snap in logic circuits with field-effect transistors ..... p 43 Jun 14

Wasik, J. W., Computer runs missile tracker ..... p 12 Jun 14

Mercury to carry new experiments and slow-scan Tv ..... p 18 Mar 22

Test-ban monitors set for launch ..... p 57 Oct 18

Comment ..... p 4 Aug 30

Undersea transmitters to locate missile impacts ..... p 18 Feb 15

Watford, S. E., Low-cost circuit measures frequency translation ..... p 51 Nov 8

Webb, J. A., Unique frequency comparator has sense of direction ..... p 36 Mar 1

Weber, S., Laser beam carries Tv video and audio ..... p 28 Feb 22

Sab system goal is 20-year life ..... p 75 Oct 25

Weber, S. & M. F. Wolff, Solid progress in solid-state seen at Philadelphia ..... p 12 Mar 1

Weibel, G. E. & H. Dressel, Generator for one-millimeter waves ..... p 21 Aug 16

Welsh, N., How diodes keep current to constant value ..... p 74 Jan 25

White, B. S., Circuit converts one-trace scopes to raster display ..... p 33 Nov 29

White, G. M. & R. B. Stone, Digital correlator detects voice fundamental ..... p 28 Nov 22

White, P. R. & R. F. Jack, Sintering toughens printed circuits ..... p 60 Jan 11

Whitley, J. H., Which permanent electrical connection should you use? ..... p 50 Jan 25

Wieder, H. H., Analog ratio computer uses Hall multiplier ..... p 46 Nov 8

Wiley, C. M., Here's that new color-Tv tube ..... p 26 Jan 28

Home appliances: market for solid state ..... p 14 Sep 13

NEC: Electronics in the midwest ..... p 31 Oct 25

Next frontier the oceans? ..... p 56 Nov 8

R & D goes back to earth ..... p 30 May 17

Telemetry on muscle power ..... p 14 Sep 20

Will solid state nip relay markets? ..... p 66 May 10

Wilkerson, J. L., How to choose transistors for low noise ..... p 50 Jan 11

Williams, D. L. & K. W. Dunlap, Will lasers weld circuit components? ..... p 54 Jul 12

Williams, L. E. & others, Conical scan array uses variable phase shifters ..... p 30 Nov 29

Williams, L. L. & D. J. Hamilton, How to make tunnel diodes even more useful ..... p 52 Jun 7

Williams, M., Thin magnetic films create logic circuits ..... p 62 Feb 22

Willing, H. A., New technique protects receivers from high power ..... p 32 Mar 1

Willis, J., High precision d-c level shifter reduces output impedance ..... p 65 May 3

Wilson, H. L. & others, Vacuum deposited circuits use field effect ..... p 80 Apr 12

Wolfert, P., Near-field plotter: design tool for millimeter-wave antennas ..... p 29 Dec 27

Wolff, M. F., Advances in microminiaturization ..... p 45 Feb 15

Air Force outlines latest R & D plans ..... p 16 May 24

Conductive memory points to new displays ..... p 10 Nov 8

Device powers go higher ..... p 57 Nov 15

Field modulates laser ..... p 26 Apr 26

Comment ..... p 4 Jun 28

Frequency control lags sb ..... p 16 Jun 17

Future keyed to materials properties ..... p 66 Sep 6

Gatling-gun laser - novel approach to optical radar ..... p 25 Sep 20

How hi is fi? (interview with P. G. Goldmark) ..... p 33 Jun 14

Comment ..... p 4 Aug 2

Look at what optical semiconductors do now ..... p 32 Jun 28

New field effect device may aid integrated circuit design ..... p 44 Nov 29

New laser structure drives output past 1 w ..... p 24 Jun 21

When will integrated circuits go civilian? Good guess: 1965 ..... p 22 May 10

What's new in computer memories ..... p 35 Nov 8

Wolff, M. F. & S. Weber, Solid progress in solid-state seen at Philadelphia ..... p 12 Mar 1

Wolff, M. F. & others, Microelectronics around the world ..... p 37 Aug 2

Wright, C. S., Unique bridge measures antenna operating impedance ..... p 51 Feb 22



Wright, J. C. & W. L. Blair, F-m feedback stabilizes airborne solid-state VHF transmitter ..... p 66 Dec 6

Y

Yamamura, K. & T. Kurimura, New way to saturable reactors: stabilizing high power rectifiers ..... p 62 May 24

Yanai, H. & others, Integrated-circuit oscillator requires few components ..... p 40 Dec 13  
Yasuda, Y. & others, New modulation technique simplifies circuits ..... p 52 Jan 25  
Yoshida, M. & others, Integrated-circuit oscillator requires few components ..... p 40 Dec 13  
Yoshida, T. & others, How coded-pulse techniques extend radar range ..... p 34 Nov 22  
Young, L. R. & others, Conical scan array uses variable phase shifters ..... p 30 Nov 29  
Young, R. E., Why U.S. lags Europe in automatic landing ..... p 21 Aug 23

Yu, Y. P., Two-phase oscillator cover 0.1 to 1,000-cps ..... p 27 Oct 4

Z

Zega, B. & others, Silicon rectifier controls power in either direction ..... p 63 Dec 20  
Zito, R. Jr., Three-dimensional display uses atomic resonance ..... p 52 Jan 11



# A few examples of the best U band oscillator capability in the industry

These families of Sperry tubes are representative of the most complete selection of U band klystron oscillators available anywhere.

Four tuning arrangements—fixed-tuned, gap-tuned, trim-tuned, and dielectric-tuned—enable the designer to select the U band klystron with the exact combination of operating characteristics

required by his system.

Since Sperry's line of U band klystrons is already in the hardware stage, you get fast delivery and low prices. For complete information, contact your Cain & Co. Sales Engineer, or write Sperry, Gainesville, Florida. In Europe, contact Sperry Europe Continental, Paris.

For High Power Output	For Extreme Mechanical Stability	For Low Voltage Operation	For Wide Tuning Range
 <p>Fixed-tuned (Two-cavity) Klystrons (SOU-4040 Series)</p>	 <p>Fixed-tuned (Two-cavity) Klystrons (SOU-4040 Series)</p>	 <p>Gap-tuned Reflex Klystrons (SRU-419 Series)</p>	 <p>Gap-tuned Reflex Klystrons (SRU-419 Series)</p>
 <p>Gap-tuned Reflex Klystrons (SRU-419 Series)</p>	 <p>Trim-tuned Reflex Klystrons (SRU-4470 Series)</p>	 <p>Trim-tuned Reflex Klystrons (SRU-4470 Series)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4430 Series)</p>
 <p>Trim-tuned Reflex Klystrons (SRU-4470 Series)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4430 Series)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4430 Series)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4480 Series, in development)</p>
 <p>Dielectric-tuned Reflex Klystrons (SRU-4480 Series, in development)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4480 Series, in development)</p>	 <p>Dielectric-tuned Reflex Klystrons (SRU-4480 Series, in development)</p>	 <p><b>SPERRY</b> ELECTRONIC TUBE DIVISION</p> <p>SPERRY RAND CORPORATION GAINESVILLE FLORIDA</p>

CIRCLE 901 ON READER SERVICE CARD





## RCA-A15288 PENCIL TRIODE



### MORE TUBE POWER FOR MINIATURIZED MICROWAVE DESIGNS

Increased power per unit weight—that's the challenge successfully met by the RCA-A15288. An excellent example of recent advances in Microwave tube design, this tiny pencil triode can provide 1 Kw of useful peak power output at 5 Gc as a plate-pulsed oscillator.

For use in telemetry, altimeters, and UHF transceivers, the ceramic-metal RCA-A15288 is designed to operate at altitudes up to 25,000 feet at 3.5 Kv without pressurization. Furthermore, the coaxial arrangement of electrodes around the RCA-A15288 heater practically eliminates tube characteristic

changes caused by heater-voltage variations.

If your design involves miniaturized Microwave equipment for application in the 5 Gc region, consider the RCA-A15288. It offers exceptional reliability in vibration and shock environments. Heater power requirement is a low 1.6 watts; warm-up time is 4 seconds.

For information on how the RCA-A15288 can be used in your design circuits, see your RCA Industrial Field Representative, or write: Manager, Microwave Marketing, RCA Electronic Components and Devices, Harrison, New Jersey.

RCA-A15288

Plate-Pulsed Oscillator at 5 Gc	Typical Operation
Peak Positive Plate Supply Voltage	2,500 volts
DC Plate Current	0.0022 amp
DC Grid Current	0.0015 amp
Grid Resistor	2,000 ohms
Useful Power Output at Peak of Pulse	1,000 watts
Pulse Duration	1.0 $\mu$ sec
Pulse Repetition Rate	1,000 pps
Plate Efficiency	20%

**RCA FIELD OFFICES:**

OEM SALES: Newark 2, N. J., 32-36 Green St., (201) 485-3900 • Chicago 54, Ill., Suite 1154, Merchandise Mart Plaza, (312) 527-2900 • Los Angeles 22, Calif., 6801 E. Washington Blvd., (213) RA 3-8361 • GOVERNMENT SALES: Harrison, N. J., 415 South Fifth St., (201) 485-3900 • Dayton 2, Ohio, 224 N. Wilkinson St., (513) 461-5420 • Washington 6, D. C., 1725 "K" St., N.W., (202) FE 7-8500 • INTERNATIONAL SALES: RCA International Division, Clark, New Jersey, (201) 382-1000



**THE MOST TRUSTED NAME IN ELECTRONICS**